Draft

Standard Specifications for Road and Bridge Works

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Prepared by the Division of Roads and Transport Technology, CSIR
Environmental Statement

Roads and transport routes, by their nature, are potentially intrusive to the environment. Numerous unnecessary scars have been left on landscapes, many still visible after a number of years. Public complaints stemming from road development and the unsustainable practices associated with it as well as the resultant increases in traffic are escalating. It is therefore important that Employers, Engineers and Contractors ensure that roads and related structures are constructed in a responsible and sustainable manner in order that negative impacts on the environment are minimised as far as possible, while positive impacts associated with the provision of the infrastructure are enhanced. The implementation of an integrated environmental management procedure during the project cycle will identify environmental issues, either perceived or real, which can be addressed during the early stages of the development. In new road projects, this will allow uninterrupted construction and could prevent costly time delays, resulting from disputes and actions involving affected parties. Incorporation of the procedure into the maintenance and operation of existing transport routes can enhance rehabilitation and management programmes.

“We have not inherited this earth from our parents, but are borrowing it from our children”
## STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE WORKS

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A layer of material constructed on top of the subbase, or in the absence thereof, the selected layer. A base may extend to outside the travelled way.

An area within designated boundaries, approved for the purpose of obtaining borrow material. A borrow pit is the excavated pit in a borrow area.

Any gravel, sand, soil, rock or ash obtained from borrow areas, dumps or sources other than cut within the road prism and which is used in the construction of the Works. It shall not include crushed stone or sand obtained from commercial sources.

A structure erected over a depression, river, watercourse, railway line, road or other obstacle for carrying motor, railway, pedestrian or other traffic or services and having a length of 6 m or more, measured between the abutment faces along the centre line of the road at girder-bed level, except that road-over-rail or rail-over-road structures are always classed as bridges.

The surface normally traversed by vehicles and which consists of one or a number of contiguous traffic lanes, including auxiliary lanes and shoulders.

A longitudinal drain or bank outside the road prism for diverting water that would otherwise flow into the road prism.

A structure other than a bridge, which provides an opening under the carriageway or median for drainage or other purposes.

Cut shall mean all excavations from the road prism, including side drains, excavations for cross-roads, interchanges, and, where classified as cut, excavations for open drains.

A mixture to predetermined proportions of aggregate, filler and bituminous binder material prepared off the road and usually placed by means of a paving machine.

The layer or layers of asphalt constructed on top of the base, and, in some cases, the shoulders.
1111 EXCESS OVERBURDEN

Overburden within a borrow area which is not required or is unsuitable for use in construction.

1112 FILL

That portion of the road prism consisting of approved imported material which lies above the roadbed and is bounded by the side slopes, shown on the typical cross-sections on the Drawings running downwards and outwards from the outer shoulder breakpoint and on which the selected layer, subbase, base, shoulders and, in the case of dual carriageways, the median, are to be constructed. Material imported to replace unsuitable material in the roadbed shall also be classified as fill.

1113 GENERAL CONDITIONS OF CONTRACT

The appropriate edition of the General Conditions of Contract issued by the Road Authority for which the Contract is being executed, together with any Special Conditions of Contract forming part of the Contract.

1114 GRADE LINE

The grade line is a reference line in the Drawings of the longitudinal sections of the road indicating at regular intervals the elevations according to which the road is to be constructed. The grade line may refer to the level of the completed road, base or any other layer and may indicate the elevations either along the carriageway centre line or along any designated position on the road cross-section.

1115 GRADING MODULUS (GM)

The cumulative percentages by mass of material in a representative sample of aggregate, gravel or soil retained on the 2.00 mm, 0.425 mm and 0.075 mm sieves, divided by 100.

1116 INLET AND OUTLET DRAINS

Channels leading into or discharging from culverts, stormwater conduits and minor bridges.

1117 LANE

Part of a travelled way intended for a single stream of traffic in one direction, which has normally been demarcated as such by road markings.

1118 LOT

A sizable portion of work or quantity of material which is assessed as a unit for the purpose of quality control and selected to represent material or work produced by essentially the same process and materials.

1119 MEDIAN

The area between the two travelled ways of a dual carriageway, excluding the inner shoulders.

1120 MEDIAN DRAIN

A longitudinal drain situated between the inner shoulders of a dual carriageway.

1121 MITRE DRAIN AND BANK

A drain constructed at an angle to the centre line of the road to divert water from a side drain. Mitre drains include mitre banks placed across the side drains.

1122 PAVEMENT LAYERS

The upper layers of the road comprising the selected layers, subbase, base or gravel wearing course, and the shoulder layers.

1123 PIONEER LAYER

An initial layer constructed over a weak roadbed where selected material is used to provide a stable platform for the construction of subsequent layers.

1124 PROJECT SPECIFICATIONS

The specifications relating to a specific project, which form part of the Contract documents for such project, and which contain supplementary and/or amending specifications to the Standard Specifications.

1125 ROADBED

The natural in situ material on which the fill, or in the absence of fill, any pavement layers, are to be constructed.

1126 ROAD PRISM

That portion of the road construction included between the original ground level and the outer boundaries of the slopes of cuttings, fills and side drains. It shall not include the selected layer, subbase, base, surfacing, shoulders or roadbed.
1127 ROAD RESERVE

The entire area included by the boundaries of a road as proclaimed.

1128 ROLLER PASSES

Unless otherwise specified in the Specifications or the Project Specifications, an area will be taken to have received one roller pass when a roller has passed over such area once. Additional passes made only as a result of nominal overlapping so as to ensure full coverage shall not be taken into account.

1129 SEAL

The application of one or more layers of bituminous binder with or without layers of crushed stone or sand in successive layers on the carriageway, shoulders or on any other compacted layer on which movement of traffic takes place.

1130 SELECTED LAYER

The lower layer or layers of the pavement which is constructed direct onto the fill, or in some cases the roadbed. It may include roadbed material compacted in situ.

1131 SERVICES

Cables, pipes or other structures to provide, inter alia, conduits for electricity, telephone and telegraph connections, water, sewage, etc.

1132 SIDE DRAIN

An open longitudinal drain situated adjacent to and at the bottom of cut or fill slopes.

1133 SHOULDER

(a) When referring to this as a surface: The area between the outside edge of the travelled way and the shoulder breakpoint.

(b) When referring to this as a pavement layer: The upper pavement layer lying between the outside edge of the base and the shoulder breakpoint.

1134 SHOULDER BREAKPOINT

The line along which the extended flat planes of the surface of the shoulder and the outside slope of the fill and pavement intersect. This edge is normally rounded to a predetermined radius.

1135 STABILISATION

The treatment of the materials used in the construction of the roadbed, fill or pavement layers by the addition of a cementitious binder such as lime or Portland cement or the mechanical modification of the material through the addition of a soil binder or a bituminous binder. Asphalt and concrete shall not be considered as materials that have been stabilised.

1136 SLOPE

Unless otherwise stated, slope is given in terms of the ratio of the vertical difference in elevation between any two points and the horizontal distance between them. This ratio may also be expressed as a percentage.

1137 SPOIL (MATERIAL)

Material originating from construction operations and which is not utilised for construction purposes.

1138 SUBBASE

The layer of material on top of the selected layers or fill and below the base and shoulders.

1139 SUBSOIL DRAINAGE SYSTEM

A system of subsoil drainage pipes (including any permeable material) constructed to intercept and remove subsoil water.

1140 TRAVELLED WAY

That portion of the carriageway which includes the various traffic lanes and auxiliary lanes but excludes the shoulders.

1141 VERGE

The area between the outer edge of the road prism and the boundary of the road reserve.
FIGURE 1

THE ROAD PRISM IN FIGURE 1: THE VOLUME EXCAVATED BETWEEN ABCDEFGHIA AND ANY FILL CONSTRUCTED ON BC & GH

FIGURE 2

THE ROAD PRISM IN FIGURE 2: THE VOLUME EXCAVATED BETWEEN BCDEFB AND THE FILL ABGA

FIGURE 1100: CROSS-SECTIONAL ELEMENTS OF A ROAD

THESE TWO DIAGRAMS ARE INTENDED TO ILLUSTRATE THE DEFINITIONS OF SECTION 1100 ONLY, AND, WHERE TO THE CONTRARY, THE DEFINITIONS SHALL PREVAIL
This Contract may include certain work relating to the moving and reinstating of existing services that may be affected by the construction of the Works.

The Employer will, in the Contract documents, provide information regarding the location of existing utility services, but the Employer does not accept responsibility for the accuracy of this information.

The Contractor shall check and determine on the site the positions of any services shown on the Drawings. This shall be done by visual inspections, using detecting apparatus, and by making excavations to expose the position of the service at critical points. This shall also be done where no services are shown on the Drawings but where such services are nevertheless believed to be present. The positions of all services so detected shall be marked carefully and then drawn in on the Drawings. These services will then be defined as known services. The Contractor shall take all reasonable precautions not to damage the services during the search, when the onus shall rest with him to prove that, in the event of damage being done to such services during the search, it was not his fault that they had been damaged.

The Contractor will be held responsible for any damage caused by him to known services, unless he can prove that he has taken all the above precautions and that the damage has nevertheless been caused because the position of the known service had deviated by more than one metre from the position as may reasonably have been deduced from the investigation made by him.

The Contractor shall take all reasonable precautions to protect existing services during construction and during the relocation of such services. Where protective measures involve the construction of permanent work, the Contractor shall execute the work in accordance with the Engineer's instructions, and payment shall be made as provided for in the Project Specifications.

All pipes, cables, conduits or other known services of any nature whatsoever damaged as a result of the Contractor's operations shall be repaired and reinstated forthwith by the Contractor or by the Authority concerned, all at the expense of the Contractor and to the satisfaction of the Engineer.

Where work is to be carried out in the vicinity of overhead powerlines, the Contractor shall ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes, or other large masses of steel, are in the vicinity of powerlines. The Contractor shall be required to provide the Engineer with the positions of all powerlines and to the satisfaction of the Engineer. The Contractor shall be required to work outside the clearances stated in BS162 which gives safe clearance for the various voltages.

It shall be clearly understood that, in certain instances, existing services can be relocated only after the Contractor has advanced sufficiently on or has completed certain sections of earthworks or certain structures.

Whenever services are encountered which interfere with the execution of the Works and which require to be moved and relocated, the Contractor shall advise the Engineer, who will determine the extent of the work, if any, to be undertaken by the Contractor in moving, relocating and reinstating or protecting such services.

Any work required to be undertaken by the Contractor in protecting, moving and relocating the services for which no provision has been made in the Contract documents, or for which there are no appropriate tender rates, will be classed as extra work, as provided for in the General Conditions of Contract.

The Contractor shall work in close co-operation with private Owners or public authorities controlling services which have
to be protected, moved or relocated. Details regarding the state of negotiations concluded between the Employer and the Owner at the time of tendering in respect of the time when either the Owner is prepared to start moving such services or when the Contractor is required to or will be allowed to start moving the services, and the duration of such operations, will either be stated in the tender documents or be made available to tenderers. Should the Owners of services refuse to co-operate with the Contractor in a reasonable manner in connection with the protection or moving of services belonging to them, the Contractor shall refer the matter to the Engineer.

When the Contractor details his programme of work as referred to in the relevant clause of the General Conditions of Contract, he shall, in consultation with the Engineer, clearly indicate as to when he proposes to start with and conclude the moving of each service or when he will require the Owner to start with and conclude the moving of each service. Should it thereafter, through delays on the part of the Employer or the Owner of the service to be moved, be impossible to adhere to the programme of work, such programme shall be suitably amended by the Contractor in consultation with the Engineer so as to limit, in so far as is possible, the extent of any damages or delays. Should it be impossible to limit entirely the damages or delays resulting from the amendments necessary to the programme of work, the Contractor shall be reimbursed for any additional costs incurred or damages suffered by him.

1203 ROAD INTERSECTIONS AND JUNCTIONS

Except where otherwise specified, no additional payment over and above payment for the various items of work included in this Contract will be made for the construction, in a confined space, of curves, tapers, bellmouths, traffic islands, farm accesses and other appurtenant Works in connection with the construction and maintenance of road intersections and junctions.

The Contractor shall be required to provide the safe and unrestricted flow of public traffic at all times during the construction and maintenance of such intersections and junctions.

1204 PROGRAMME OF WORK

Should the Contractor fall behind with the programme submitted by him in terms of the relevant clause of the General Conditions of Contract, which programme has been approved by the Engineer, the Employer may, without prejudice to his rights in terms of the relevant clause of the General Conditions of Contract, require the Contractor to submit, within seven days of the date on which he has received a notice to this effect, a revised programme in terms of this Clause, which indicates the manner in which the Contractor undertakes to complete the Works within the required time. Any proposal in the revised programme to accelerate the rate of progress shall be accompanied by positive steps to increase production by more and/or better labour and equipment being utilised more effectively.

The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer would be satisfied if the work is carried out in accordance with such programme and that the Contractor undertakes to carry out the work in accordance with the programme.

Neither shall it limit the right of the Engineer to instruct the Contractor to vary the programme should circumstances so require. The above shall not be taken to limit the right of the Contractor to claim for damages or extension of time to which he may be fairly entitled in terms of the General Conditions of Contract for delay or disruption of his activities.

Should the Employer request and the Contractor undertake to finish the whole or part of the Works ahead of the time originally required by the Contract, payment for accelerating the work shall be made only if agreed on beforehand, in writing, and in terms of such agreement.

1205 WORKMANSHIP AND QUALITY CONTROL

The onus rests with the Contractor to produce work which conforms in quality and accuracy of detail to all the requirements of the Specifications and Drawings, and the Contractor shall, at his own expense, institute a quality-control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

The Contractor shall conduct tests or have them conducted continually on a regular basis, to check the properties of natural materials and processed natural materials and of products manufactured on the site, such as concrete and asphalt. Although not a requirement for the Contractor to conduct regular tests on any commercially produced products such as cement, bitumen, steel and pipes, the Contractor shall remain fully responsible for any defective material or equipment provided by him. Similarly, the quality of all elements of the Works shall be checked on a regular basis so as to ensure compliance with the specified requirements.

The intensity of control and of tests to be conducted by the Contractor in terms of these obligations is not specified but shall be adequate to ensure that proper control is being exercised.

Where any natural materials or products made from natural materials are supplied, and upon completion of each element of the construction work, the Contractor shall test and check such materials, products and/or elements for compliance with the specified requirements and shall submit his results to the Engineer for approval. Such submission shall include all his measurements and test results and shall furnish adequate proof of compliance with the specified requirements.

No specific pay items are provided as compensation for the above obligations, including the provision of all samples delivered to the Engineer, the repair of places from which samples were taken, and the provision of the necessary personnel and testing apparatus and facilities, for which compensation shall be included in the tendered rates of the Contractor for the various items of work to which these obligations apply.

The Contractor’s attention is also drawn to the provisions of Clause 7208 in regard to instituting specific process-control systems.
1206 THE SETTING-OUT OF WORK AND PROTECTION OF BEACONS

The Contractor’s attention is drawn to the requirements of the relevant clause of the General Conditions of Contract, and he shall also comply with all legal provisions in regard to surveying and setting out work.

The Contractor shall check the condition of all reference and level beacons and shall satisfy himself that they have not been displaced and are true in regard to position and level. If beacons have been destroyed, displaced or damaged before the site is handed over to the Contractor, the Engineer will arrange to have new beacons installed. A beacon which has been displaced shall not be used unless its true position and level have been re-established and the new values verified by the Engineer.

Where a beacon is likely to be displaced during construction operations, the Contractor shall establish suitable reference beacons at locations where they will not be displaced during construction. No beacon shall be covered over, displaced or destroyed before accurate reference beacons have been established and details of the positions and levels of such beacons have been submitted to and approved by the Engineer. The Contractor’s reference beacons shall be of at least the same quality and durability as the existing beacons.

The Contractor shall submit to the Engineer the method of setting-out he proposes to employ. To ensure beyond all doubt that the complex elements of the road, such as traffic interchanges, structures and other important features are located truly and correctly, the Contractor shall check all setting-out by a second method. The Engineer may at any time request the Contractor to submit proof that his setting-out has been satisfactorily checked.

In cases where the displacement of or damage to property beacons or trigonometrical-survey beacons is unavoidable, the Contractor shall notify the Engineer in good time so that he may arrange to have such beacons suitably referenced and later on reinstated. The cost of such work, if paid for by the Contractor, shall be reimbursable as extra work, as provided for in the General Conditions of Contract.

For the purposes of this Clause and of the relevant clause of the General Conditions of Contract, any beacon made from a metal peg cast in concrete and any boundary beacon, whether or not cast in concrete, shall be regarded as a beacon. Centre-line pegs shall not be classified as beacons.

To protect beacons, the boundary fences of the road reserve shall be splayed at corners so as to avoid the use of corner posts in the same position as property or trigonometrical-survey beacons, all as shown on the Drawings.

Accurate control of line and level shall be provided by the Contractor at all stages of construction. In respect of the road itself, control shall be at 20 m intervals or such closer intervals as may be directed for horizontal and vertical curves. Wherever necessary, but particularly on completion of the fill and the base, the Contractor shall re-establish stake-line pegs at sufficiently close intervals to determine accurately the position of the edges of the base, surfaced and especially kerbing, guardrails and other road elements permanently visible.

The setting-out of work will not be measured and paid for directly, and compensation for the work involved in setting-out will be deemed to be covered by the rates tendered and paid for in the various items of work included in this Contract.

1207 NOTICES, SIGNS AND ADVERTISEMENTS

The Contractor and Subcontractors shall not erect any signs, notices or advertisements on or along the Works or the site of the Works without the written approval of the Engineer.

At each end of the Works the Contractor shall provide and erect, as part of his obligations under Section 1300, and on approved locations, at the starting and ending points of the Works, signboards of sound, weatherproof construction, painted by an approved firm of signwriters in accordance with the details shown on the Drawings.

These signs are to be erected not later than one month after the Contractor has been given access to the site.

The Engineer shall have the right to have any sign, notice or advertisement moved to a better position or to have it removed from the site of the Works if it should in any way prove unsatisfactory, inconvenient or dangerous to the general public.

All advertisements, notices and signs shall be removed by the Contractor upon issuance of the final certificate of completion.

1208 MEASUREMENTS

(a) Units of measurements

All work shall be measured in accordance with the SI System of metric units.

(b) Schedule of quantities

The quantities set out in the Schedule of Quantities are estimated quantities and are used for the comparison of tenders and for awarding the Contract. It must be clearly understood that only the actual quantities of work done or materials supplied will be measured for payment, and that the scheduled quantities may be increased or decreased as provided for in the General Conditions of Contract.

(c) Measurement of completed work

All distances along the centre line of the road as shown on the Drawings are horizontal distances, which will be used in calculating the quantities of fill and pavement layers for purposes of payment. All cross-sections shall be taken in a vertical plane.

All materials which are specified to be measured in the vehicle shall be hauled in vehicles of such type and size that the actual volume may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle shall bear a plainly legible identification mark indicating its specific approved capacity.

The quantity of bituminous and similar materials to be paid by volume shall be measured at the temperature of application.
Structures shall be measured to the neat lines shown on the Drawings and shall include any changes ordered in writing by the Engineer and, for purposes of payment, the calculated volume of concrete structures shall include the volume of reinforcing steel, and minor ducts up to 150 mm in diameter.

1209 PAYMENT

(a) Contract rates

In computing the final Contract amount, payment shall be based on the actual quantity of authorised work done in accordance with the Specifications and Drawings. The tendered rates shall apply, subject to the provisions of the General Conditions of Contract, irrespective of whether the actual quantities are more or less than the scheduled quantities.

Where no rate or price has been entered against a pay item in the Schedule of Quantities by a tenderer, it shall be understood that he does not require any compensation for such work. Where, however, a pay item described in these Specifications or in the Project Specifications does not appear in the Schedule of Quantities, the Contractor will receive reasonable compensation for such work if required, unless anything to the contrary has been determined elsewhere.

(b) Rates to be inclusive

The Contractor shall accept the payment provided for in the Contract and represented by the rates tendered by him in the Schedule of Quantities, as payment in full for executing and completing the work as specified, for procuring, furnishing, placing and installing all materials, for procuring and providing labour, supervision, constructional plant, tools and equipment, for wastage, transport, loading and off-loading, handling, maintenance, temporary work, testing, quality control including process control, overheads, profit, risk and other obligations and for all other incidentals necessary for the completion of the work and maintenance during the period of maintenance.

The Contractor shall note that the cost of all Works and materials for minor construction details at bridges, for example small quantities of caulking compound and joint filler (other than expansion joints), anchor-bar covers, etc, not shown in the Schedule of Quantities, shall be included in the tendered rates for concrete.

This Clause shall apply in full to all pay items except where these requirements may be specifically amended in each case.

(c) The meanings of certain phrases in payment clauses

(i) Procuring and furnishing ... (material)

Where any of the words "supply", "procure", "provide", "provision of" or "furnish (material)" are used in the description of a pay item, it shall mean the supply and delivery to the point of use of all materials of any kind required for the work covered by the particular pay item, including all tax, purchase costs, claims, damages, royalties and transport costs involved, but excluding overhaul. In the case of borrow materials, stone and sand, it shall also include all negotiations with the Owners concerned, excavating, producing, preparing, processing, testing, hauling and delivering the material to the point of use; the construction, repair, maintenance and making good after completion of all access roads, and all work required in opening, using and finishing off borrow pits unless covered by other pay items in the Schedule of Quantities.

(ii) Placing material

The phrase "placing material" shall mean the off-loading, spreading, blending, processing, watering, mixing, shaping and compacting (where specified) of the material in the pavement layers, fills and embankments, as well as the procuring, furnishing, applying and admixing of water; the breaking-down of oversize material, the removing of oversize material which cannot be broken down, correcting irregular or uneven surfaces or layers, the thickness of which is not to specification, finishing-off to within the specified tolerances, the refilling of test holes and maintaining the completed work. In the case of asphalt courses and bituminous seals, it shall also mean the heating and spraying of binder, the spreading of aggregate or asphalt mixtures, rolling, compacting, finishing-off to within the specified tolerances, and maintaining the completed work.

The phrase "procuring, furnishing and placing" shall mean procuring and furnishing in addition to placing, all as defined herein.

(d) Pay items

The descriptions under the pay items in the various sections of the Specifications, indicating the work for which allowance shall be made in the tendered rates for such pay items, are for the guidance of the Contractor and do not necessarily repeat all the details of work and materials required by and described in the Specifications.

These descriptions shall be read in conjunction with the relevant Specifications and Drawings, and the Contractor shall, when tendering, bear in mind that his rates shall be inclusive as specified in Subclause (b) above.

(e) Materials on the site

Payment in terms of the relevant clause of the General Conditions of Contract for materials on the site, which have not yet been incorporated in the Works, will be calculated at 80% of their purchase price, or, in the case of crushed stone which has not been purchased but has been produced on the site, at 80% of a fair valuation of such material.

The Engineer may at his sole discretion allow payment under "materials on the site" in respect of articles such as precast beams manufactured and stored off site, subject to their having been completed, to proof of their ownership as being that of the Contractor, and to the articles being clearly marked with the Contractor's name, the Contract number and other particulars in accordance with the Engineer's instructions.

(f) Rate-only items

Against an item in the Schedule of Quantities where no quantity is given but a rate only is required, the Contractor shall fill in a rate or amount which will constitute payment for work which may be done in terms of this item. Such rate-only item is used where it is estimated that little or no work will be required under the item, or where the item is to be considered as an alternative for another item where a
quantity is given, or for variations in rates of application or mix proportions in terms of Clause 1213.

Work under rate-only items will be paid for only if it has been executed in terms of a written instruction by the Engineer.

1210 CERTIFICATE OF COMPLETION OF THE WORKS

A certificate of completion of the Works in terms of the relevant clause of the General Conditions of Contract will be issued only if the following sections of the Works as may be applicable have, inter alia, been duly completed:

(a) The gravel wearing course, seals, asphalt or concrete pavement;
(b) all above-ground and subsoil drainage structures;
(c) all fencing;
(d) the finishing-off of medians and slopes of cuts and fills;
(e) all the necessary road signs and road-surface markings;
(f) all guardrails;
(g) all structures.

1211 TRAFFIC OVER COMPLETED PAVEMENT LAYERS

Traffic over structures or pavement layers of an uncompleted road shall, in addition to other restrictions specified elsewhere, be restricted to equipment required for its construction, with the proviso that traffic for hauling material over pavement layers, in so far as is possible, shall be limited to a minimum by the use of construction roads and diversions.

Traffic over structures or the completed road will be restricted to the maximum axle load permitted in terms of statutory provisions. Any damage to structures or completed layers caused by the Contractor’s traffic shall be repaired at his own cost.

1212 ALTERNATIVE DESIGNS AND OFFERS

Unless anything to the contrary has been determined elsewhere in the Contract documents, a tenderer may, together with his tender for the original designs contained in the Contract documents, submit alternative designs and offers for consideration. Such alternative designs and offers shall be subject to the following conditions and requirements.

(a) Tenders

An alternative offer or design will be considered only if the tender for the original items has been fully priced and completed.

Unless the alternative offer stipulates to the contrary, it shall be assumed that the period for completion of the Works shall be the same as for the original design.

An alternative offer or design shall be submitted together with the tender for the original items or design, otherwise it will not be considered when tenders are adjudicated.

Calculations, drawings and a modified Schedule of Quantities (as determined hereafter) in respect of each alternative offer or design shall accompany the alternative tender offer.

(b) Design codes

Alternative designs shall be executed strictly in accordance with the appropriate design codes and prescriptions of the Employer. Copies of such codes and prescriptions will be available for perusal at the office of the Engineer, but the onus rests with the Contractor to ensure that he complies with the design requirements of the Employer.

(c) Preliminary calculations

Preliminary calculations for an alternative design shall be submitted with the tender. Such calculations shall give adequate details so as to enable an assessment to be made of the general efficacy of the design and of its principal elements, also of the degree to which the design prescriptions and codes of the Employer are being complied with. The calculations shall be clear and in a logical sequence and shall clearly reflect all the design assumptions.

(d) Preliminary drawings

Preliminary drawings of the alternative designs shall also be submitted with the tender. These drawings shall comprise adequate layout plans, elevations and sections and shall clearly illustrate the general efficacy of the design and its principal elements. Foundation depths and other elements depending on foundation conditions shall, in so far as may be applicable, be in accordance with foundation particulars appearing in the Contract document.

Drawings for alternative designs shall be prepared in accordance with the provisions of Clause 1221.

(e) Quantities

Each alternative offer shall be accompanied by a modified priced Schedule of Quantities compiled in accordance with the Standard Specifications, in so far as it is applicable, which clearly shows the manner in which the price for the original Schedule of Quantities which fall away or are being changed. In addition to the Schedule of Quantities, a set of calculations shall be supplied to show how the quantities have been determined. All assumptions in regard to foundation conditions or other factors which will determine quantities shall be clearly and conspicuously marked by underlining or colouring, and shall indicate whether or not the assumptions have been based on information furnished in the Contract documents (with the necessary references).

(f) Further details

Should the Engineer find that the calculations and drawings submitted for alternative designs are not complete enough for proper adjudication of the alternative designs, it may mean that no further consideration will be given to such alternative designs. The Employer, however, reserves the right to call on the tenderer to submit such further calculations and drawings as may be required. If such further details are not submitted within ten days of having been requested, the alternative designs may possibly not be given further consideration.
(g) Preliminary adjudication of alternative designs

The Engineer will undertake a preliminary scrutiny of any alternative designs for compliance with the specified requirements of the Employer. Should he find any mistakes or unsatisfactory aspects, he may afford the Contractor the opportunity to rectify them within a period to be determined by the Engineer. However, it is emphasised that the preliminary scrutiny of the design and tender by the Engineer, by its very nature, cannot be comprehensive, and no guarantee can be given in this regard that all the mistakes made by the Contractor will in fact be detected. Any correction of such mistakes shall be made with the tender price of the Contractor being retained, and, wherever necessary, the priced Schedule of Quantities for the alternative design shall be adjusted accordingly.

(h) Acceptance of alternative design

The Contractor shall note that the acceptance of a tender which includes alternative designs shall mean that the alternative designs have been approved in principle only. If the final calculations, drawings and details do not comply with the specified requirements, such alternative designs may be rejected, unless they are suitably amended by the Contractor so as to be acceptable to the Engineer.

(i) Final drawings and calculations and the priced Schedule of Quantities

Where a tender with an alternative design has been accepted, the Contractor shall, not less than three months before he intends starting with the construction of such design, submit to the Engineer a complete set of working drawings, detailed calculations and a complete Schedule of Quantities, for approval. The Schedule of Quantities shall be based on the preliminary Schedule of Quantities, but with the necessary adjustments in quantities and prices and with the tendered price for the alternative design being retained.

Within six weeks of having received the above, the Engineer will indicate which drawings, calculations, quantities, prices and other particulars are acceptable to him and which not, with reasons furnished. The Contractor shall then submit to the Engineer in good time any modified drawings and other particulars for approval, for which he will require two weeks. Any delay arising from the fact that the amended particulars do not meet the requirements shall be the responsibility of the Contractor.

No work which will be affected by an alternative design may be commenced, unless the Drawings, Schedule of Quantities and prices for such alternative design have been approved. Should the Contractor fail to modify any drawings, calculations, quantities, prices or any other particulars to the satisfaction of the Engineer, the alternative design will be rejected and the original design shall be constructed for the same amount as has been tendered for the alternative design.

(j) Responsibility for alternative design

The approval of a design by the Engineer shall in no way relieve the Contractor of his responsibility to produce a design which conforms in all respects to all the specified requirements and which will be suitable for the purpose envisaged.

Should it appear later during construction or during the maintenance period that the design does not conform to the specified requirements, the Contractor only shall be liable for any damage arising therefrom and he shall, at his own expense, do all the necessary work to ensure that the structure conforms to all the specified requirements.

(k) Payments for alternative designs

Payments for alternative designs will be based on the finally approved Schedule of Quantities and rates for such designs. The lump sum for an alternative design will remain fixed and will be the final amount payable to the Contractor in regard to such design, except only for deviations arising from:

(i) foundation conditions which differ from foundation conditions shown in the Contract documents, or in regard to assumptions regarding foundation conditions stated in his tender by the Contractor and accepted by the Engineer;

(ii) changes not arising from any failure or fault of the Contractor, but from modifications requested by the Engineer.

(l) Cost of checking alternative designs

The Contractor shall, in his tender for each alternative design, include an item to cover the cost for checking his design. This item shall be 5% of the tendered amount of the design without any price adjustment in terms of the relevant clause of the General Conditions of Contract being considered, and the amount will be payable to the Engineer only upon an authorisation issued by the Employer.

(m) Alternative offers

Alternative offers in this context shall mean offers not relating to a structure, such as a bridge, which requires a comprehensive structural analysis. It involves, in the main, offers for the use of other materials, construction programmes, alternative routes, etc. In this case the provisions of Clause 1212 will still apply, except in the case where the Contractor, in consultation with the Employer, may agree to amend or delete certain of the provisions, depending on the nature of the offer, but subject to a written agreement beforehand with the Employer.

1213 VARIATION FROM SPECIFIED NOMINAL RATES OF APPLICATION OR NOMINAL MIX PROPORTIONS

The various sections of these Specifications specify nominal rates of application or nominal mix proportions for materials such as bituminous materials, aggregates, fillers, stabilising agents, paint and the like. Tenderers shall base their tenders on these nominal rates of application and mix proportions.

Where such nominal rates of application or mix proportions are specified, provision is made for deviations in the quantities of material in consequence of the rates of application or mix proportions prescribed by the Engineer in each particular case in consideration of the available materials and the conditions on the site.

Where the actual rates of application or mix proportions used in the Works vary from the specified nominal rates and mix proportions, adjustment of compensation will be made:
(a) as a payment to the Contractor in respect of any authorised increase in quantities which exceed those specified, where such increase has been ordered, in writing, by the Engineer;

or

(b) as a refund to the Employer in respect of the decrease in quantities which are less than those specified, irrespective of whether such decrease results from an authorised decrease in the rates of application or mix proportions, or from unauthorised reductions on the part of the Contractor.

Payment for a prescribed rate of application or mix proportion shall be based on the actual rate of application or mix proportion used, provided that this does not exceed the prescribed rate of application or mix proportion, plus any tolerance in the rate of application or mix proportion allowed. If the actual rate of application or mix proportion exceeds the prescribed rate or proportion, payment shall be based on the prescribed rate of application or mix proportion plus any tolerance allowed. If the actual rate of application or mix proportion is below the prescribed rate of application or mix proportion ordered, payment shall be based on the actual rate of application or mix proportion ordered, but any increase or decrease in rates of application or mix proportions shall be based on the actual rate of application or mix proportion used, plus any tolerance in the rate of application or mix proportion allowed.

The Employer shall be refunded for any decrease in the specified rates of application or mix proportions at the same rate per unit of measurement as that tendered by the Contractor for additional materials required by an increase in the rates of application or mix proportions.

1214 CONTRACTOR'S ACTIVITIES IN RESPECT OF PROPERTY OUTSIDE THE ROAD RESERVE AND OF SERVICES MOVED, DAMAGED OR ALTERED

(a) The Contractor shall exercise any rights that may be ceded to him by an Authority in terms of any statutory provisions for purposes of executing the Contract, on condition that:

(i) the Contractor complies strictly with the requirements of such statutory provisions, particularly in regard to the matters relating to serving notice on the Owner or consultation with him;

(ii) in each case a written agreement is made with the Engineer regarding the details of the Contractor's proposed actions before the rights of the Contractor in terms of the statutory provisions are exercised.

(b) The Contractor shall put in writing all his agreements with Owners of property outside the road reserve or of services inside or outside the road reserve in respect of the following matters:

(i) The location, extent and use of borrow pits, haul roads, construction roads and bypasses outside the road reserve.

(ii) Compensation, if applicable, for land or materials taken or for land temporarily used or occupied.

(iii) The reinstatement of property occupied, used, damaged or destroyed, or compensation therefor in lieu of reinstatement.

(iv) The procedure for the moving of services and details as to how and when this is to be done.

(v) Any similar matter directly related to the Contractor's activities on or in respect of private property or services.

These agreements shall be signed by all the parties concerned and delivered to the Engineer.

Where the Contractor cannot obtain the Owner's agreement in writing, he shall refer the matter to the Engineer and shall furnish him with details, in writing, of any verbal agreement made.

(c) Where, in addition to any agreement with the Owner of any property to be entered upon or temporarily occupied or any service to be moved, it is understood or required that the Contractor shall serve notice on the Owner immediately before actually entering upon or occupying the private property or moving a service, and shall give proper notice thereof in writing, and the Engineer shall be supplied with a copy of such notice, together with acknowledgement of receipt.

(d) On completion of his operations, the Contractor shall obtain, from the Owner concerned, a written statement to the effect:

(i) that the Contractor has fulfilled his obligations under any written agreement, or, in the absence of a written agreement,

(ii) that the Owner has received all the compensation he is entitled to and is also satisfied that all property occupied, including borrow pits, haul roads and construction roads, has been properly restored and is in a satisfactory condition.

In respect of services moved, altered, damaged or affected in any way, the Contractor shall similarly obtain a written statement from the Owner that the services have been taken over in a satisfactory condition.

All such statements shall be signed, dated and delivered to the Engineer.

(e) Should the Contractor wish to use land outside the area provided by the Employer for storing or keeping material or equipment required for the construction of the permanent Works, it will be subject to the following:

(i) That the Engineer approve any area selected for this purpose.

(ii) That such land be physically separated from any production plant or activities and suitably fenced in.

(iii) That the area used for the aforesaid purpose be surveyed, and, where the land does not belong to the Contractor, he shall enter into a contract of lease with the Owner of such land in respect of the full period for which such land shall be used for such purpose, which contract shall stipulate that the Owner shall not have any right whatsoever to any material stockpiled on such land during the currency of the contract of lease.

(iv) That suitable, permanent reference beacons, approved by the Engineer, be placed next to the area, at the cost of the Contractor, for use by the Engineer with a view to, if applicable, taking cross-sections for determining quantities.

(v) That only material used for this contract shall be stored on such land.
1215 EXTENSION OF TIME RESULTING FROM ABNORMAL RAINFALL

Extension of time in terms of the relevant clause of the General Conditions of Contract in respect of abnormal rainfall shall be determined in terms of Method 1 below, unless the Project Specifications determine that Method 2 shall be used.

The maximum extension of time which will be considered in respect of a given period, will be the number of working days in the period concerned on which work may be executed in accordance with the provisions of the relevant clause of the General Conditions of Contract.

(a) Method 1 (Rainfall formula)

Extension of time in accordance with this method shall be calculated separately for each calendar month or part thereof according to the formula below. It shall be calculated for the full period of completion of the Contract, including any extension thereof which may have been granted:

\[ V = \frac{(N_w - N_n) + (R_w - R_n)}{X} \]

If any value of \( V \) is negative and its absolute value exceeds \( N_n \), then \( V \) shall be taken as equal to minus \( N_n \).

The symbols shall have the following meanings:

\( V \) = Extension of time in calendar days in respect of the calendar month under consideration.

\( N_w \) = Actual number of days during the calendar month on which a rainfall of \( Y \) mm or more has been recorded.

\( R_w \) = Actual rainfall in mm for the calendar month under consideration.

\( N_n \) = Average number of days in the relevant calendar month, as derived from existing rainfall records provided in the Project Specifications, on which a rainfall of \( Y \) mm or more has been recorded.

\( R_n \) = Average rainfall in mm for the calendar month, as derived from the rainfall records supplied in the Project Specifications.

\( X \) = 20, unless otherwise provided in the Project Specifications.

\( Y \) = 10, unless otherwise provided in the Project Specifications.

The total extension of time shall be the algebraic sum of the monthly totals for the period under consideration. But if the grand total is negative, the time for completion shall not be reduced on account of abnormal rainfall. Extension of time for parts of a month shall be calculated by pro rata values of \( N_n \) and \( R_n \) being used.

The factor \( (N_w - N_n) \) shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds \( Y \) mm. The factor \( (R_w - R_n) + X \) shall be considered to represent a fair allowance for variations from the average for the number of days during which rainfall does not exceed \( Y \) mm but when wet conditions prevented or disrupted work. This formula does not take into account any flood damage, which could cause further or concurrent delays and should be treated separately in so far as extension of time is concerned.

Accurate rain gaugings shall be taken at a suitable point on the site, and the Contractor shall, at his own expense, take all necessary precautions to ensure that the rain gauges cannot be interfered with by unauthorised persons.

Information regarding existing rainfall records, if available from a suitable rainfall station near the site, will be supplied in the Project Specifications, together with calculations of extensions of time for previous years in accordance with the above formula.

If no suitable rainfall records are available, the above formula will not apply.

(b) Method 2 (Critical-path method)

Where the critical-path method is specified in the Project Specifications for determining extension of time resulting from abnormal rainfall, it shall be applied as follows:

(i) A delay caused by inclement weather conditions will be regarded as a delay only if, in the opinion of the Engineer, all progress on an item or items of work on the critical path of the working programme of the Contractor has been brought to a halt. Delays on working days only (based on a five-day working week) will be taken into account for the extension of time, but the Contractor shall make provision in his programme of work for an expected delay of "n" working days caused by normal rainy weather, for which he will not receive any extension of time. The value of "n" shall be given in the Project Specifications.

(ii) Extension of time during working days will be granted to the degree to which actual delays, as defined above, exceed the number of "n" workings days as mentioned in the Project Specifications.

1216 INFORMATION FURNISHED BY THE EMPLOYER

Certain information contained in these Contract documents or provided separately is being offered in good faith but, in the circumstances pertaining to the type of information furnished, no guarantee can be given that all the information is necessarily correct or representative of the in situ conditions.

This applies more specifically to all soil tests, soil mapping, drilling results, geophysical surveys, geological reports, borrow-pit information, material surveys and reports, and similar information, the accuracy of which is necessarily subject to the limitations of testing, sampling, the natural variation of material or formations being investigated and the measure of certainty with which conclusions can be drawn from any investigations made. It also applies to any materials-utilisation diagram provided, as the diagram may be subject to major alterations during the progress of the work, depending on site conditions.

The Employer will not accept any liability for the correctness or otherwise of the information furnished or for any resulting damage, whether direct or consequential, should it appear, during the course of the Contract, that the information supplied is either incorrect or not representative.

Any reliance placed by the Contractor on this information shall be at his own risk.
Notwithstanding the above, the Employer will accept responsibility for the correctness of the following:

(a) Any rock cores purported to be recovered from designated test-drill holes.

(b) Visual information apparent from the inspection of open trial pits.

(c) The results only of any centre-line, borrow-area or other soil tests given in the Drawings or schedules forming part of the Contract documents.

1217 PROTECTION OF THE WORKS AND REQUIREMENTS TO BE MET BEFORE CONSTRUCTION OF NEW WORK ON TOP OF COMPLETED WORK IS COMMENCED

The general obligations of the Contractor in terms of the relevant clause of the General Conditions of Contract, shall, inter alia, include the following:

(a) The provision of temporary drainage works such as drains, open channels, banks, etc, and providing and operating temporary pumps and such other equipment as may be necessary for adequately protecting, draining and dewatering the Works and temporary Works. This will be in addition to any permanent drainage works specified and installed, and in addition to any temporary drainage works specifically paid for separately in the case of diversions.

(b) Material in borrow pits shall not be allowed to become excessively wet, all completed layers shall be properly drained, dumps of material on completed layer work shall not inhibit surface drainage or form wet spots under and around dumps, and all parts of the Works shall be protected against erosion by floods and rain.

Material shall not be spread on a layer that is so wet as to result in the danger of any damage being caused to the layer during compaction of a subsequent layer, or when opened to traffic.

When material is spread out on the road, the Contractor shall ensure that, during wet periods, it will have a good cross-fall and a light compaction on the surface in order to facilitate run-off during rainy weather.

(c) Fill and cut slopes shall be repaired immediately whenever damaged by surface water. Where erosion occurs on high fills, the slopes shall be repaired by cutting back to form benches and by compacting the backfill mechanically to the specified controlled densities, using suitable light equipment.

(d) Excavations for pipe drains, culverts, service ducts and similar structures shall be adequately protected against the possible ingress of water during rain-storms.

(e) All completed layer work shall be protected and maintained until the following layer is constructed. Maintenance shall include immediate repairs to any damage or defects which may occur and shall be repeated as often as may be necessary to keep the layer continuously intact and in a good condition.

(f) Before any completed layer is primed or a succeeding layer is constructed thereon, any damage to the existing layer shall be repaired, so that, after repair or reconstruction if necessary, it will conform in all respects to the requirements specified for that layer. All repair work other than minor surface damage repairs shall be submitted to the Engineer for inspection before it is covered up.

The previously constructed layer shall be thoroughly cleaned by the removal of all foreign material before construction of a succeeding layer or application of a prime coat, surfacing or surface treatment. In the case of all bituminous work in particular, the existing layer shall be thoroughly broomed and all dung, clay, mud and other deleterious material completely removed. Where necessary, the surface shall be sprayed with water before, during and after brooming to remove all foreign material.

Work performed as part of the above obligations shall not be measured and paid for separately, and the cost thereof shall be included in the rates tendered for the various items of work requiring protection and the items for the Contractor's establishment on the site, as specified in Section 1300.

1218 REMEDIAL WORK

When any part of the Works or any equipment or material is found, upon examination by the Engineer, not to conform to the requirements or at any stage before final acceptance is damaged so that it no longer conforms to the requirements of the Specifications, the Engineer may order its complete removal and replacement, at the Contractor's expense, with satisfactory work, equipment or material, or he may permit the Contractor to apply remedial measures in order to make good any such defects or damage. The actual remedial measures taken shall at all times be entirely at the Contractor's own initiative, risk and cost, but subject to the Engineer's approval regarding the details thereof.

In particular, remedial measures shall ensure full compliance with the requirements of the Specifications of the final product, shall not endanger or damage any other part of the Works, and shall be carefully controlled and submitted to the Engineer for examination when completed or at any intermediate stage as may be required.

For the guidance of the Contractor, an indication is given below of what would normally be required in the more common cases of defects or damage, but the Engineer will in no way be bound to accept or approve the measures given below, as the actual remedial measures will be dictated by the circumstances of each particular case.

(a) Earthworks

(i) Where a cut slope has been over-excavated or undercut, backfilling will not normally be allowed and the entire slope may have to be retrimmed to obtain a uniform slope.

(ii) Where the floor of a cutting has been taken too deep, it will normally require backfilling and recompaction with selected gravel in the case of soil or gravel excavation, and with crushed stone or suitably sized rock in the case of hard excavations. All necessary measures shall be taken to drain away groundwater that may accumulate in backfilled sections.

(iii) Excess width of fills will have to be trimmed down.

(iv) Where erosion has damaged the surface of cuts or fills, the damage shall be made good by backfilling with suitable material and retrimming. In more serious cases, the slopes may have to be cut back by benching, backfilled and
Specifications shall comply with the various dimensional and
The work specified in the various sections of these
Specifications shall comply with the various dimensional and
other tolerances specified in each case. Where no
tolerances are specified, the standard of workmanship shall
be in accordance with normal good practice. No
representation is made that the full specified tolerances will
be available independently of each other, and the Contractor
is cautioned that the liberal or full use of any one or more
tolerances may deprive him of the full or any use of
tolerances relating to other aspects of the work. The latter
would apply particularly in respect of level tolerances on
layer work and the related requirements regarding layer
thicknesses.

In the description of certain pay items, where it is stated that
quantities will be determined from the authorised
dimensions, this shall be taken to mean the dimensions as
specified or shown on the Drawings or, if changed, as finally
instructed by the Engineer, without any allowance for
tolerances being specified. If the work is therefore
constructed in compliance with the authorised dimensions,
plus or minus any tolerances allowed, quantities will be
based on the authorised dimensions regardless of the actual
dimensions to which the work is constructed.

Where the work is not constructed in accordance with the
authorised dimensions, plus or minus any tolerances allowed, the Engineer may nevertheless, in his sole
discretion, accept the work for payment. In such cases no
payment will be made in respect of quantities of work or
material in excess of those calculated from the authorised
dimensions and where the actual dimensions are less than
the authorised dimensions, minus any tolerance allowed,
quantities for payment shall be based on the actual
dimensions as constructed.

1221 DRAWINGS PROVIDED BY THE CONTRACTOR

Where the Contractor is required to prepare any drawings
for the purpose of this Contract, they shall be prepared as
specified below and in accordance with any further
requirements specified by the Engineer.

The Contractor shall be provided with one transparent
polyester standard drawing sheet and one steel schedule
sheet, which shall be used as masters for all drawings
prepared by him and submitted to the Engineer for
consideration.

The Contractor shall submit to the Engineer for his
adjudication one transparent polyester print, 0.05 mm thick,
of each drawing prepared by him. The standard of detailing
and quality of print shall be the same as those of the
Drawings supplied to the Contractor under the Contract.

The Drawings shall be compiled in the official language of
the Contract and shall comply in all respects with the
requirements of the Employer.

Accepted Drawings shall form an integral part of the
Contract documents, and any drawing not accepted and
signed with an approval will not be permitted on the site of the Works for
construction purposes and/or used for the manufacture of
any item. Notwithstanding the approval and/or acceptance
and signing of the Drawings, the Contractor shall take full
responsibility for all details, discrepancies, omissions,
errors, etc. in respect of the said Drawings as well as for the
consequences thereof.

The Contractor shall submit only fully completed Drawings
in accordance with this specification and shall not be entitled
to claim for delays resulting from the submission of
incomplete drawings. The Engineer will require a period of
four to eight weeks, depending on circumstances, for reviewing the complete drawings.

No direct payment for design, preparation and submission of Drawings will be made and all costs shall be included in the rates tendered for the relevant pay items as provided in the Schedule of Quantities. The cost of reviewing the design/drawings shall be for the Contractor’s account.

1222 USE OF EXPLOSIVES

Generally the Contractor will be permitted to use explosives for breaking up rock and hard material during excavation, for demolishing existing structures, and for such other purposes for which it may normally be required, subject to the following conditions:

(a) The Engineer will have the right to prohibit the use of explosives in cases where, in his opinion, the risk of injury to persons or damage to property or adjoining structures is too high. Such action by the Engineer shall not entitle the Contractor to any additional payment for having to resort to other less economical methods of demolition unless otherwise provided in the Project Specifications or the Schedule of Quantities.

(b) The provisions of Section 3300 shall be complied with.

(c) Legal provisions in regard to the use of explosives and the requirements of the Inspector of Explosives or equivalent shall be strictly complied with.

(d) The Contractor shall, at his own cost, make arrangements for supplying, transporting, storing and using explosives.

(e) Before any blasting is undertaken, the Contractor, together with the Engineer, shall examine and measure up any buildings, houses or structures in the vicinity of the proposed blasting and establish and record, together with the Owner thereof, the extent of any cracks or damage that may exist before blasting operations are commenced. It shall be the responsibility of the Contractor to make good, at his own expense, any further damage to such houses, buildings or structures which results from the blasting operations.

(f) Where there is considerable danger of damage to power or telephone lines or underground or other services or any other property, the Contractor shall suitably adapt his method of blasting and the size of the charges, and shall take adequate protective measures, such as cover blasting, in order to limit the risk of damage as far as possible.

(g) The Engineer shall, twenty-four hours before each blasting operation is carried out, be advised thereof, in writing, unless otherwise agreed on with the Engineer.

1223 WORK ON, OVER, UNDER OR ADJACENT TO RAILWAY LINES

All work carried out on, over, under or adjacent to railway lines shall be carried out strictly in accordance with the latest edition of the Specifications of the relevant Rail Authority, a copy of which will normally be included in the Project Specifications. Where no such copy is included in the Project Specifications or where the copy included in the Project Specifications is amended or superseded by another, the Contractor shall obtain the latest edition, which shall be kept on the site before any work of this nature is commenced.

Attention is drawn particularly to the requirements contained in the Specifications regarding the approval that must be obtained from the Rail Authority for a work permit or occupation of its property and the approval of falsework and formwork plans.

1224 THE HANDING-OVER OF THE ROAD RESERVE

The road reserve will be handed over to the Contractor for construction, subject to such conditions as may be specified in the Project Specifications regarding matters such as the sequence in which sections will be handed over and must be completed, the maximum total length of bypasses that will be allowed to be in operation at any time, and any other matters relating to the Contractor’s use and occupation of the road reserve.

1225 HAUL ROADS

The Contractor shall submit to the Engineer for approval full details of any haul and construction roads he proposes to build. Such details shall be submitted well in advance in order to afford the Engineer sufficient time to investigate their implications. Haul roads may not be built without the Engineer's prior approval, and shall be kept to a minimum, particularly in areas where their impact on the environment may be serious.

1226 MEASUREMENT OF DEPTH OF TRENCHES AND FOUNDATION EXCAVATIONS

Where trenches or foundation excavations are required below the level of mass excavations for the road prism, the depth of excavation of the trenches or foundations shall be measured from ground level after completion of the mass excavation, unless the Engineer is satisfied that the excavation of the trenches or foundations from the original ground level or any lower level was unavoidable. Where trenches are excavated in accordance with the fill method in the completed or partly completed road prism, the depth of excavation shall be measured from the levels at which the Engineer instructed the Contractor to commence trench excavations. The Contractor shall ensure that he obtains such instructions in good time and, where required, shall submit proposals to the Engineer for approval.

1227 MONTHLY SITE MEETINGS

The Contractor or his authorised representative shall attend monthly meetings on the site with representatives of the Employer and the Engineer, at dates and times to be determined by the Employer. Such meetings will be held for evaluating the progress of the Contract and for discussing matters pertaining to the Contract which any of the parties represented may wish to raise. Such meetings are not intended for discussing matters concerning the normal day-to-day running of the Contract.
Colour photographs showing the progress of the Works shall be taken every month by the Contractor from positions to be selected by the Engineer.

The number of photographs required is given in the Special Specifications. Prints 200x150 mm of each photograph together with the negatives shall be handed to the Engineer. Each photograph shall be numbered and a statement shall be submitted giving the locations, date when taken and a brief description or title.

1228 LEGAL PROVISIONS

The Contractor shall keep himself fully conversant with the latest enactments, provisions and regulations of all legislative and statutory bodies, and, in all respects and at all times, shall comply with such enactments, provisions and regulations in regard to executing the Contract.

1229 FINAL CLEARANCE

Upon completion of each section of the Works, the Contractor shall cleanup the site, remove all temporary buildings, plant and debris. He shall level off and fine grade all excavated material which is surplus to requirements. The whole of the site shall be left in a clean and workmanlike condition to the satisfaction of the Engineer.

No separate payment shall be made for any work included in this clause and the costs shall be deemed to be included in the rates of the relevant items entered in the Schedule of Quantities.
SERIES 1000 : GENERAL

SECTION 1300 : CONTRACTOR'S ESTABLISHMENT ON SITE AND GENERAL OBLIGATIONS

CONTENTS
1301 SCOPE
1302 GENERAL REQUIREMENTS
1303 PAYMENT

1301 SCOPE

This Section covers the establishment of the Contractor's organisation, camp and constructional plant on the site and their removal on completion of the contract. It also covers payment for certain general obligations, risks and liabilities and general items of cost not covered elsewhere.

1302 GENERAL REQUIREMENTS

(a) Camps, constructional plant and testing facilities

The Contractor shall establish his construction camps, offices, stores, workshops and testing facilities on the site. The exact location of these facilities shall be approved beforehand by the Engineer. Accommodation, ablution and other facilities for site staff shall also be provided as required and the standard of accommodation and the location of all facilities shall comply with the requirements of the authorities concerned and those of the Engineer.

Prior to starting with construction, the Contractor shall also move all constructional plant and personnel to the site. On completion of the work and after receiving approval in writing from the Engineer, all constructional plant, buildings, fencing and other temporary structures shall be removed and the camp site shall be restored to its original condition and left neat and tidy.

(b) Maintenance during construction

During construction the Contractor's camps, staff living quarters and other facilities shall be maintained in a neat and tidy condition.

(c) Legal and contractual requirements and responsibility to the public

The Contractor shall take all the necessary steps to comply with the General Conditions of Contract, particularly in respect of the insurances and sureties required and his general obligations to the public and the Employer. He shall comply with all the regulations of statutory bodies.

1303 PAYMENT

Item Unit

13.01 The Contractor's general obligations:

(a) Fixed obligations . . . . . . . . . . . . lump sum
In the event of the Contractor not being able to satisfy the Engineer as to the ownership of the camps and constructional plant, the Engineer shall have the right to withhold parts of any payments to be made under this subitem, until the Works have been completed.

The lump sum tendered under Subitem 13.01(b) shall represent full compensation for that part of the Contractor's general obligations, which are a function of only the value of the work, but not of the period of completion. Should the final value of the work (excluding any payments in terms of the General Conditions of Contract) increase or decrease by 20% or less in relation to the tendered amount (less any allowances, if any, in the tender for price adjustments in terms of the General Conditions of Contract), the lump sum tendered for Subitem 13.01(b) will be increased or decreased pro rata in full settlement of any difference in value-related general obligations resulting from an increased or decreased value of the work.

However, should the said increase or decrease in the final value of the work exceed 20% of the tendered amount, the above-mentioned pro rata increase or decrease in the lump sum tendered under Subitem 13.01(b) shall apply up to the limit of 20%, and the provisions of the General Conditions of Contract shall apply to that portion of the said increase or decrease which is in excess of the said limit of 20% of the tendered amount.

The lump sum tendered in Subitem 13.01(b) will be payable monthly in instalments in relation to the value of work done (excluding the value of any price adjustments in terms of the General Conditions of Contract).

The tendered rate per month for Subitem 13.01(c) represents full compensation for that part of the Contractor's general obligations which are mainly a function of construction time. The tendered sum will be paid monthly, pro rata for parts of a month, from the date on which the Contractor has received a written instruction, in terms of the General Conditions of Contract, to start the work until the end of the period for completion of the Works, plus any extension thereof as provided for in the General Conditions of Contract, provided that:

(a) should the Works be certified as having been completed before the contractual date for completion of the Works, the Contractor will then be entitled to payments in regard to the unexpired period for completion;

(b) should the progress of the Contractor in terms of the value of work done be in arrears in regard to his approved original programme, payments in respect of this item may be limited to payments for that period, which, in his original programme (after suitable adjustments in respect of the extension of time granted) agrees with the actual value of work done.

Any payment made under Item 13.01 will not be taken into account when determining whether the value of a certificate complies with the "minimum amount of interim certificate", as laid down in the appendix to tender. The adjustments specified in Subitems (a), (b) and (c) will be made only if the value of the work or the period for completion were to change and it is agreed that such adjustments will be in full settlement of the changed compensation for amended general obligations.
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SERIES 1000 : GENERAL

SECTION 1400 : HOUSING, OFFICES AND LABORATORIES FOR THE ENGINEER'S SITE PERSONNEL

CONTENTS
1401 SCOPE
1402 OFFICES AND LABORATORIES
1403 HOUSING
1404 SERVICES
1405 PROVISION OF VEHICLES
1406 GENERAL
1407 MEASUREMENT AND PAYMENT

1401 SCOPE

This Section covers the provision of accommodation for the Engineer's supervisory staff. This accommodation shall include the necessary office and laboratory accommodation, houses and quarters for employees, and the provision of all the necessary services.

1402 OFFICES AND LABORATORIES

(a) General

Buildings for offices and laboratories shall be constructed from timber, fibre-cement, or other approved materials. The buildings shall have double walls filled with insulating material and lined on the inside with timber or other approved material. Ceilings shall be provided for both office and laboratory buildings. Office buildings shall have timber floors or concrete floors with vinyl floor tiles and laboratory buildings shall have concrete floors. Window areas of these buildings shall be at least equal to 25% of the floor area. Each building shall be provided with a verandah on one side, running for the full length of the building. The verandah shall be 1.5 m wide and shall have a 100 mm thick concrete floor.

Stores shall have galvanised corrugated steel roofs and 100 mm thick concrete floors. The sides of the stores shall be fenced off from floor level to the roof with 50 mm diamond-mesh wire. Each store shall have one lockable door.

Office and laboratory buildings shall be painted with an approved paint after erection. The paintwork shall be maintained during the contract period.

Each door shall be provided with a lock and two keys.

The various units of accommodation and the fittings shall be constructed in accordance with the details as shown on the Drawings or provided by the Engineer.

The sitting and orientation of all offices, laboratories, housing or other accommodation shall be to the Engineer's satisfaction and shall be decided on in consultation with him and confirmed in writing before erection. All accommodation shall include the provision of 220/250 volt electricity, and where required, fresh clean potable water and sewerage, including septic tanks, if necessary, which will be considered as part and parcel of the accommodation provided and will not be paid for separately, except in so far as the cost thereof shall be covered under Item 14.06.

The clear height of all offices between floor and ceiling shall be 2.4 m minimum. All windows shall be of the type that can open over the full window area.

All accommodation shall meet with the approval of the Engineer.

(b) Offices

The various types of offices required shall be as shown on the Drawings and schedules. Unless otherwise specified or detailed, the fittings, furniture and equipment provided in accordance with the Schedule of Quantities shall conform to the following requirements:

(i) Each office desk shall have a surface area of at least 1.5 m² and shall be provided with at least three drawers, one of which can be locked.

(ii) General-purpose steel cabinets shall have at least 1.5 m² shelf area and a volume of 0.70 m³ each. Each cabinet shall have a lock with two keys.

(iii) Steel filing cabinets shall each be fitted with four drawers on runners. Each cabinet shall be fitted with a lock and shall be approximately 1 300 mm high, 460 mm wide and 600 mm from front to back.

(iv) Shelves shall be suitable for storing all the contract drawings or shall else be as detailed on the Drawings.

(v) Each wash-hand basin shall be fitted with taps and a drain.

(vi) Air-conditioning units and heaters shall be as specified in Subclause 1402(f).

(vii) Lights shall be of the fluorescent type, either double 80 watt, single 80 watt or double 55 watt, or of the incandescent type according to that which is required or specified.

(viii) Each draughtsman's stool shall be fitted with a padded seat with an adjustable seat height.

(ix) Electric power plug points shall be provided. Each office shall have at least two 15 amperc plug points.

(x) Each drawing table shall have either an inclined or a horizontal drawing surface as may be required and a smooth top built to the dimensions shown on the Drawings.

(xi) Chairs shall be robust and comfortable.

(xii) A complete telephone service, together with an exchange line and the number of extensions specified shall be provided. The prime cost sum shall also include the cost of all telephone calls in connection with contract administration.

(xiii) Each conference table shall be large enough to seat twelve persons, and shall have an area of at least 4 m².

(xiv) Blinds shall be one of two types, as may be required:

(1) Adjustable venetian blinds to permit light to enter the room, but which will exclude direct light;

(2) Opaque roller blinds.
(c) **Laboratories**

All or any of four types of laboratories may be required:
- soils laboratories
- bituminous-materials laboratories
- chemical laboratories
- concrete-testing laboratories

The sizes, layout and other details of the laboratories shall be as shown on the Drawings and schedules of fittings, equipment and furniture.

The laboratories, fittings, furniture and equipment shall be as follows:

(i) Ordinary chairs, telephone extensions, 15 ampere 220/250 volt electricity plug points, air-conditioners, heaters and lights shall meet the same requirements as specified for offices.

(ii) Shelf space provided against walls shall be of robust construction and shelving shall be of suitable timber or fibre-cement material, depending on requirements. Shelving below work-tables shall be 390 mm above floor level, and above working areas, 1 980 mm above floor level.

(iii) Work-bench areas shall be of two types as may be required:

1. Of wooden construction: The tops shall be hard and smooth and free from warping or other defects.

2. With concrete tops: The tops shall be at least 75 mm thick concrete slabs with a smooth, hard steel-trowelled finish.

All work-benches shall be robust and their upper surfaces shall be 920 mm above floor level.

(iv) Gas installations shall consist of the necessary gas cylinders, regulators, tubing and taps.

(v) High stools for use at work-benches shall be robust and, if of fixed height, shall be 800 mm high.

(vi) Where required, a 380 volt 3-phase electric power supply shall be provided. Power points for ovens shall be suitable for the purpose. Power points in oven rooms shall be 1.2 m above floor level.

(vii) Concrete working floors shall be at least 125 mm thick and provided with a hard smooth finish. The working areas shall be either entirely open or under a shelter as may be required.

(viii) Wash basins shall be as prescribed either of stainless steel or precast concrete with an area of at least 0.3 m² and a minimum depth of 0.3 m. They shall be provided with swan-neck type laboratory taps and drain pipes.

(ix) A supply of fresh clean potable water at a constant head of not less than 3 m at the taps shall be provided. Storage capacity in respect of the laboratory water supply shall be not less than 700 litres.

(x) Fire extinguishers shall be of the BCF (bromochlorodifluoromethane) type manufactured to BS 1721 and suitable for Types A, B, C and E fires. The extinguishers shall contain not less than 2.5 kg of extinguishing fluid and shall be fitted to the wall at suitable positions by means of quick-release brackets. They shall be freshly charged and the seals shall be unbroken.

(xi) Extractor fans, where required, shall be so mounted as to operate noiselessly. They shall have a capacity of at least 0.15 kW each.

(xii) Fume cupboards shall be constructed in accordance with the details shown on the Drawings.

(xiii) Where required, concrete footings and pedestals shall be constructed to the dimensions indicated by the Engineer for installing certain testing equipment.

(xiv) When required, baths for curing concrete test cubes, beams and cylinders shall be provided. The baths shall be rectangular in shape and regarding the inside dimensions the width shall not exceed 1.0 m and the depth shall not exceed 0.6 m.

(xv) When required, a 0.3 m³ capacity refrigerator shall be supplied.

(d) **Car ports**

Car ports shall be so constructed as to protect vehicles parked in them at all times against the direct rays of the sun and from hail. The car ports shall be at least 20 m² in area and the floors shall consist of a layer of broken stone to alleviate dusty and muddy conditions.

(e) **Areas around offices**

The access and other roads around the offices shall be treated to make them dust free either by crushed stone, suitable dust-laying chemicals, or bituminous surfacing being used or other approved means being adopted. They shall be well drained and kept trafficable and free from mud at all times. Footpaths shall be similarly treated to provide convenient access to all buildings.

(f) **Air-conditioning units and heaters**

Where required by the Engineer, the Contractor shall provide and install air-conditioning units and heaters.

The air-conditioning units shall be of the electrically operated compressor type with closed circuit and of the evaporation type. The capacity of the air-conditioning units shall be at least 2.2 kW each.

Heaters shall preferably be of a space-heating type without exposed elements and shall have a capacity of not less than 1.5 kW each.

The Contractor may also be required to install air-conditioning units in any housing accommodation provided.

(g) **Ablution units**

Ablution units shall be well-ventilated units constructed in accordance with the details shown on the Drawings. They may be constructed from fibre-cement sheeting with steel frames or from other suitable approved materials, and the floors shall be of concrete with vinyl floor tiles. Latrines shall be provided with vitreous enamel WC pans with PVC seats and covers and flush cisterns. Wash basins shall be of vitreous enamel, complete with taps and drains.

 Provision shall be made for suitable sewerage as specified in Clause 1404.
Where required, a separate shower and change room shall be provided, complete with shower, hot and cold running water and drains.

Each latrine or shower shall be provided with a door fitted with a latch. Each ablution unit shall be provided with an outside door with a lock. At least two keys shall be provided for each lock.

1403 HOUSING

(a) Prefabricated houses

Prefabricated houses shall be constructed of wood, fibre-cement or other approved material and shall have double walls filled with insulating material. Each house shall have a clear height from floor to ceiling of at least 2.74 m.

Glass-fibre insulating material shall also be provided on top of the ceilings. Floors shall be of timber or alternatively of concrete covered with suitable carpeting or vinyl tiles.

Each house shall have a floor area of at least 120 m², with three bedrooms, a living-room, dining-room, bathroom and kitchen. In addition, the house shall have an enclosed veranda of approximately 20 m² in area.

The main frame of each house shall be of steel or light alloy. All timber used shall be of a good quality, properly oven dried and treated against pests. All fittings shall be accurately installed.

Each house shall, after erection, be properly painted inside and outside with an approved paint, and the paintwork shall be maintained during the contract period.

Each house shall be provided with the following:

(i) A bath and shower with drain and inside flush toilet.

(ii) A wash basin with drain pipe.

(iii) A metal kitchen-sink unit with stainless steel basin and draining boards and a cupboard with shelves.

(iv) A kitchen dresser, linen cupboard, and built-in wardrobes in the bedrooms.

(v) A suitable geyser, a kitchen stove and refrigerator. The geyser shall have a capacity of approximately 140 litres with a water supply from an outside tank or from a water main. The stove shall be a four-plate stove complete with grill, oven and splash plate. The refrigerator shall have a volume of at least 0.3 m³.

(vi) Cold-water pipes from a suitable source to the bath, shower, wash basin, toilet and sink units, complete with taps where required.

(vii) Hot-water pipes from the geyser to the bath, shower, wash basin and sink unit, complete with taps.

(viii) Electric lights in all rooms and passages, with plug points in the kitchen, living-room and all bedrooms. The house shall be fully wired and connected to a 220/250 volt AC power source.

(ix) Good-quality locks on all doors.

(x) Where the water supply of the house is not connected to a water main, an external elevated cold-water storage tank with a capacity of at least 3 000 litres shall be provided in order to obtain a minimum head equal to 3 m of water at the taps, together with the pipes leading to the supply tank.

(b) Outbuildings

A car port as described in Subclause 1402(d) for one or two cars shall be provided with each house.

A servant's room with a minimum area of 12 m², constructed as specified for offices and laboratories, shall be provided with each house. A latrine with flush toilet and separate shower shall also be provided.

(c) Rented accommodation

(i) Instead of the houses described above, the Contractor may provide suitable rented or purchased houses, approved by the Engineer, which will provide at least the same standard of comfort as that of the prefabricated houses described above, in the nearest town or elsewhere.

The terms of any lease for such accommodation shall be subject to the Engineer's approval and shall contain provision, where the Owner agrees, for an extension of the lease on pre-agreed terms during any extended time for completion of the Contract, as well as provision for the lease to be taken over by the Engineer or another Contractor in the event of default by or insolvency of the Contractor. Notwithstanding the Engineer's approval of the conditions of the lease, the Contractor shall be solely responsible for providing the accommodation for the full period required and for suitable substitute accommodation should the alternative accommodation be no longer available.

The Contractor shall also be responsible for the cost of additional travelling expenses, if any, arising from the use of alternative or substitute permanent housing. Such costs may be subtracted from any moneys owing to the Contractor for providing housing.

(ii) The Engineer may also order the Contractor to pay for any hotel or other accommodation or leased houses required and available. This accommodation may be in addition to or instead of the accommodation specified. The Contractor shall enter into the necessary contracts for the lease of such accommodation as may be required and shall not unreasonably object to the terms and conditions of such leases to be negotiated by the Engineer.

The cost of drawing up and entering into such leases shall be refundable if paid by the Contractor. Where such accommodation is contemplated in advance, allowance shall be made for the cost thereof by inclusion of a suitable provisional sum. The provision of such accommodation shall be classed as "extra work" and payment therefor shall be made as specified in the relevant clause of the General Conditions of Contract.

(iii) The Contractor's attention is drawn to the distinction made between alternative accommodation offered by him in terms of Subclause (i) above and accommodation he is ordered to provide in terms of Subclause (ii) above, in so far as the method of payment, his obligation and risks and the period for which the accommodation is to be provided and paid for are concerned.
(d) Accommodation for labourers

Accommodation for labourers employed by the Engineer shall be provided either on the site or, if this is not possible, in the Contractor's own compound or in the nearest town. In the latter case, the Contractor shall make provision for daily transport of the labourers arriving on the site at 07:00 and departing from the site at 17:30. The accommodation shall be constructed as specified for offices and laboratories in housing units in accordance with the details shown on the Drawings. Each unit shall be provided with opaque windows, all of which can be opened at least halfway, and a steel door with lock or padlock. Provision shall be made for 6 m² of floor area for each labourer, in addition to a sturdy bedstead, a new mattress of acceptable quality, a 0.5 m² in area and 300 m deep suitable for washing clothes, or smoke-free coal-fired stove, a large wash basin at least 1.0 m² in size with hanging and shelf space, and which can be locked, and a sturdy steel chair. A wooden table at least 1.0 m² in size shall be provided for every three labourers. If shown on the Drawings, the units shall be provided with approved heaters.

An ablation unit shall consist of one well-ventilated section containing a flush-type latrine complete with WC pan and PVC seat and cover, and another section containing a shower and a wash basin, all complete with the necessary running hot and cold water, taps, drains and sewerage. The hut shall be of robust construction with a concrete floor and may be steel or timber-framed and clad with galvanised-iron or fibre-cement sheeting. It shall have a roof and only one door provided with a lock and two keys.

A cooking unit shall consist of a hut as detailed on the Drawings. The hut shall be of the same construction as specified for the ablation unit. It shall be provided with a gas or smoke-free coal-fired stove, a large wash basin at least 0.5 m² in area and 300 m deep suitable for washing clothes, a single kitchen sink, and at least 1.0 m² of concrete working surface, and may be steel or timber-framed and clad with galvanised-iron or fibre-cement sheeting. It shall have a roof and only one door provided with a lock and two keys.

A latrine shall consist of a single well-ventilated hut of the same construction as specified for ablation huts and containing a flush-type latrine complete with WC pan and PVC seat and cover.

The Contractor may offer the use of already available accommodation of equal standard in lieu of any of the accommodation specified above.

Where electricity is available, the Contractor shall supply electric lights in all housing units. A reasonable supply of fuel shall be provided for firing stoves for cooking and hot water.

The Contractor shall be responsible for obtaining the necessary approval from any state department or any Local Authority having jurisdiction in the matter for:

(i) the siting of the accommodation;
(ii) the plans according to which the accommodation is to be constructed;
(iii) the accommodation as constructed.

The proposals by the Contractor, which in regard to (i), (ii) and (iii), are to be submitted to the Authorities concerned for approval, shall be drafted in consultation with the land Owner.

The approval for (i) and (ii) above shall be obtained prior to construction and for (iii) prior to the handing-over for occupation.

1404 SERVICES

(a) Sanitary arrangements

The Contractor shall be responsible for providing all sanitary services necessary for keeping latrines in a clean, neat and hygienic condition.

When no municipal sewage treatment is available, the Contractor shall provide the necessary septic tanks for all latrines. Waste water and septic-tank effluent shall be taken into properly designed French drains. The Contractor shall also make provision for the removal of all rubbish.

Where the construction of septic tanks or a water-borne sewerage scheme is not feasible, the Contractor shall construct conservancy tanks and make arrangements for the removal and disposal of sewage.

(b) Water, electricity and gas

The Contractor shall provide a constant supply of clean potable water suitable for human consumption as well as the necessary electric power at 220/250 volts to the offices, laboratories and housing.

The Contractor shall, at his own cost, provide and maintain a supply of electricity and the reticulation thereof to the housing, offices and laboratories.

The power source shall be suitable for domestic, office and laboratory use with an anticipated large variance in load factor. Three-phase power shall be supplied at a nominal voltage of 400/231 volts and a nominal frequency of 50 Hz. The source of power shall be either from a recognised power-supply Authority or by an on-site alternator.

The electrical load shall be determined by an appropriate diversity factor being applied to the sum of the connected load, due allowance being had for the starting load, efficiency and power factor of motors, or shall be estimated on the basis of 10 kVA single phase per house, 1.2 kVA/m² of laboratory floor area (three phase) and 0.35 kVA/m² of office area. Allowance shall be made for a spare capacity of 15% with a minimum of 15 kVA. A detailed load estimate shall be submitted to the Engineer for approval prior to any final arrangements being made for a source of power.

In the event of electricity being generated by the Contractor, the motor-alternator shall be suitable to maintain the voltage so that it will not deviate by more than ±5% from the nominal voltage, and to maintain the frequency so that it will not deviate from the nominal frequency by more than ±2 Hz over the entire load range from 0% to 100% of full load, also in the event of switching on and off all normal loads connected to the supply. Power shall be available to the housing, offices and the laboratory for 24 hours per day and between 06:00 and 22:00 for other accommodation.

Power shall be distributed by means of enclosed distribution boards with adequate weather and tamper protection, suitably rated circuit breakers, earth-leakage units or fuses, and by means of adequately sized underground cables and earth conductors. Sizing of cables and rating of protective and control devices shall take into account the load and fault currents that can occur on the system.

The reticulation network and the wiring installation of all buildings and structures shall be installed and maintained to ensure absolute safety and a high standard of reliability, with particular reference to the earthing installation and safety and protective devices. The installations shall comply with
the requirements of SABS 0142 and SABS 1500, or equivalent.

The Contractor shall at all times maintain the power supply, the distribution network and the wiring installation of all buildings and structures at the highest standard of safety and usability.

The Contractor shall also supply liquid petroleum gas for the burners used in the laboratories.

(c) Maintenance

The Contractor shall provide all labour, equipment and material which may be necessary for keeping all the buildings in a neat and clean condition, and any repairs shall be made immediately at the request of the Engineer.

(d) Cooking facilities

The Contractor shall make available suitable cooking facilities for the Engineer's labourers near the Engineer's laboratories and shall supply fuel for cooking purposes.

1405 PROVISION OF VEHICLES

The Contractor shall, if so ordered, supply new vehicles and maintain them for the use of the Resident Engineer and his staff.

A description of the number and types of vehicles to be provided is given in the Special Specification.

Unless otherwise specified, the vehicles shall be owned by the Contractor and be licensed and comprehensively insured by the Contractor for use on the public highway within the country by any licenced driver authorised by the Engineer together with authorised passengers and the carriage of goods and samples. The Contractor shall provide fuel, oil, maintenance including replacing defective parts, tyres and the like, whenever required, in conformity with the vehicle manufacturer’s recommendations or as may be necessary. The vehicles shall be fuelled, oiled and maintained as aforementioned until release by the Engineer. The vehicles on being released shall revert to the Contractor. Each vehicle shall be fitted with a fire extinguisher, first aid kit, tow hook and rope, tool kit, spare wheel, wheel wrench, jack and handle and seat belts.

The Contractor shall provide a replacement for any vehicle by a similar new vehicle after it has completed 100 000 km if, in the opinion of the Engineer, such vehicle cannot be maintained in a satisfactory condition.

The Contractor shall provide competent and licensed drivers approved by the Engineer for the vehicles indicated above. Sufficient drivers shall be available at night and at weekends whenever work is being carried out on site.

1406 GENERAL

(a) At the time when the Contract is awarded, the Engineer shall furnish the Contractor with full details, in writing, regarding the number, type and layout of all housing units required, including details of the fittings, furniture and equipment required. The Contractor shall not order any housing, materials, equipment or fittings on the basis of what is specified or scheduled without written confirmation by the Engineer. No buildings shall be erected without the Engineer's written instructions as to the exact position and orientation of the buildings.

(b) Unless otherwise agreed on, the offices and laboratories shall be erected in close proximity to the Contractor's offices and laboratories. Should the Contractor decide to move his own offices and/or laboratories to a new site, the offices, laboratories and other buildings erected for the use of the Engineer shall be moved to the new site and re-erected if required, at no additional charge.

(c) Housing supplied by the Contractor shall be ready for use within six weeks of the date of such instruction, but the Contractor may not proceed with the permanent Works before the required offices and laboratories have been erected by him. If the houses for the Engineer's site personnel are not ready for occupation when the permanent Works are commenced, the Contractor shall provide suitable temporary board and lodging at his own cost.

If any further accommodation is required during the currency of the Contract, the Engineer shall inform the Contractor at least three months before such additional accommodation is to be ready for use.

(d) The ownership of all offices, laboratories, housing, sanitary facilities, laboratory equipment and other items provided by the Contractor shall, when they are no longer required by the Engineer, revert to the Contractor upon written advice by the Engineer and shall be dismantled and removed from the site.

(e) The Contractor shall take all reasonable precautions to prevent unauthorised entry to the offices and laboratories and to ensure the general security of the offices and laboratories.

(f) The Contractor shall ensure that all accommodation complies with the appropriate statutory provisions operative in the area concerned.

(g) The Contractor shall provide adequate security by day and by night for the Engineer's offices, laboratory, vehicles and houses, and for the Engineer's staff. This shall include the provision of suitable gates and fencing and the full-time attendance of permanent watchmen, all to the satisfaction of the Engineer.

1407 MEASUREMENT AND PAYMENT

14.01 Office and laboratory accommodation:

The provision of accommodation as specified, including roof, external and internal walls, windows complete with glazing, doors with locks and fittings, painting, floors, the provision of a 220/250 volt electrical installation with wiring, switchboards, etc, water and sewerage installation, complete, in accordance with the Drawings and Specifications, except for items scheduled elsewhere:
The unit of measurement and payment shall be the square metre or linear metre in the case of fencing or number of units in the case of gates, of each item provided, measured in accordance with the authorised inner dimensions.

### Item 14.02 Office and laboratory furniture:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Chairs</td>
</tr>
<tr>
<td>(b)</td>
<td>Draughtsman's stools</td>
</tr>
<tr>
<td>(c)</td>
<td>High chairs for laboratory</td>
</tr>
<tr>
<td>(d)</td>
<td>Desks, complete with drawers and locks</td>
</tr>
<tr>
<td>(e)</td>
<td>Drawing tables</td>
</tr>
<tr>
<td>(f)</td>
<td>Conference tables</td>
</tr>
</tbody>
</table>

The unit of measurements shall be the number of units supplied in accordance with the Specifications, Drawings and the Engineer's instructions.

### Item 14.03 Office and laboratory fittings, installations and equipment:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Items measured by number:</td>
</tr>
<tr>
<td>(i)</td>
<td>220/250 volt power points</td>
</tr>
<tr>
<td>(ii)</td>
<td>400/231 volt 3-phase power points</td>
</tr>
<tr>
<td>(iii)</td>
<td>Double 80 watt fluorescent-light fittings complete with ballast and tubes</td>
</tr>
<tr>
<td>(iv)</td>
<td>Single 80 watt fluorescent-light fittings complete with ballast and tubes</td>
</tr>
<tr>
<td>(v)</td>
<td>Double 55 watt fluorescent-light fittings complete with ballast and tubes</td>
</tr>
<tr>
<td>(vi)</td>
<td>Single incandescent-light fittings complete with 100 watt globes</td>
</tr>
<tr>
<td>(vii)</td>
<td>Wash-hand basins complete with taps and drains</td>
</tr>
<tr>
<td>(viii)</td>
<td>Laboratory basins complete with swan-neck taps and drains</td>
</tr>
<tr>
<td>(ix)</td>
<td>Extractor fans installed complete with own power connection</td>
</tr>
<tr>
<td>(x)</td>
<td>Fume cupboards complete according to the Drawings</td>
</tr>
<tr>
<td>(xi)</td>
<td>Fire extinguishers, 2.5 kg, BCF type, complete, mounted on wall with brackets</td>
</tr>
<tr>
<td>(xii)</td>
<td>Air-conditioning units with 2.2 kW minimum capacity, mounted and with own power connection</td>
</tr>
<tr>
<td>(xiii)</td>
<td>Heater, space-heating type, minimum capacity 1.5 kW</td>
</tr>
<tr>
<td>(xiv)</td>
<td>Curing chamber for UCS specimens, complete with water connection, including the provision of brick partitions, plaster, paint and shelving, all complete according to the Drawings</td>
</tr>
<tr>
<td>(xv)</td>
<td>General-purpose steel cupboards with shelves</td>
</tr>
<tr>
<td>(xvi)</td>
<td>Steel filing cabinets with drawers</td>
</tr>
<tr>
<td>(xvii)</td>
<td>Refrigerators</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the authorised number of units supplied and installed, complete and in accordance with the Specifications and Drawings, together with all minor fittings, brackets, connections, leads, mountings, etc.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Prime-cost items and items paid for in a lump sum:</td>
</tr>
<tr>
<td>(i)</td>
<td>The provision of telephone service, including the cost of calls in connection with contract administration and telephone rental</td>
</tr>
<tr>
<td>(ii)</td>
<td>Handling costs and profit in respect of Subitem 14.03(b)(i) above</td>
</tr>
<tr>
<td>(iii)</td>
<td>The provision of 400/231 volt 3-phase electrical power installation, including all wiring, switchboards, mains connections, etc</td>
</tr>
</tbody>
</table>
The provision of low-pressure gas installations, including gas-storage cylinders, tubing, regulators, gas burners and shut-off cocks. The prime-cost items shall be paid for in accordance with the provisions of the General Conditions of Contract. The tendered percentage is a percentage of the amount actually spent under Subitem 14.03(b)(i), which shall include full compensation for the handling costs of the Contractor, and the profit in connection with providing the telephone service.

The tendered lump sums shall be full compensation for providing the complete service or installation and the use thereof, including any fixed and usage charges payable to local or other Authorities.

(c) Items measured by area:

(i) Shelving as specified, complete with brackets. The unit of measurement shall be the square metre of the item supplied and installed. The area shall be determined from the authorised outside dimensions in plan, except the constant-temperature baths, which shall be measured per square metre of water surface area irrespective of their depth, and the blinds, which shall be measured by the width multiplied by the height.

Item | Unit
--- | ---
14.05 Housing for labourers:

(a) Housing as specified, including beds, mattresses, chairs, tables and lockers. The unit of measurement in urban areas shall be a man month.)

(b) Ablution unit, as specified, including latrines, wash basins, showers and taps. The unit of measurement shall be the number of complete units supplied and erected according to the Specifications and Drawings. The unit of measure for fencing shall be the linear metre of fencing and number of gates erected according to the Specifications and Drawings.

Item | Unit
--- | ---
14.06 Prefabricated houses:

Prefabricated houses with outbuildings as specified in Subclauses 1403(a) and 1403(b). The unit of measurement shall be the number of prefabricated houses complete as specified which are provided on the Engineer's instructions.

Item | Unit
--- | ---
14.07 Rented, hotel and other accommodation:

(a) Provisional sum for providing rented housing, hotel or other accommodation as described in Subclause 1403(c)(ii). Expenditure under this item shall be made in accordance with the General Conditions of Contract. The tendered percentage is a percentage of the amount actually spent under Subitem 14.07(a), which shall include full compensation for the handling costs of the Contractor, and the profit in connection with providing the rented accommodation.

Item | Unit
--- | ---
### 14.08 Services:

The provision of water, electricity, low-pressure gas, sewerage, septic tanks, sewage and rubbish removal, cleaning services, maintenance and repairs, all as specified in Clause 1404, including the construction and maintenance of the access roads, footpaths, etc:

(a) Services at offices and laboratories:

(i) Fixed costs ...................... lump sum

(ii) Running costs ...................... month

(b) Services for prefabricated houses:

(i) Fixed costs ...................... lump sum

(ii) Running costs ...................... month

(c) Services for rented houses ...................... month

(d) Services for labourers’ accommodation on the site:

(i) Fixed costs ...................... lump sum

(ii) Running costs ...................... month

The lump sum and the rate per month tendered for each subitem shall collectively include full compensation for providing the specified services to the total number of units which fall in the corresponding category of accommodation.

### 14.09 Combined office and laboratory accommodation:

(Alternative to the use of Items 14.01 up to and including 14.05 when so required in the Project Specifications)

Office and laboratory accommodation, including fittings, furniture and equipment, car ports and housing for labourers in accordance with the details given in the project Specifications and on the Drawings ...................... lump sum

The tendered lump sum shall be in full compensation for supplying and erecting the accommodation, fittings and furniture as specified in the Project Specifications and shown on the Drawings, and for the proper maintenance and the subsequent removal thereof from the site on completion of the Works.

### 14.10 Provision of photostat facilities

The tendered rate per month shall include full provision for providing and maintaining an approved photocopier (capable of making A3-sized copies) and its use, including all accessories such as paper, etc, for making a maximum number of 1 000 A4 or equivalent number of A3 copies per month.

### 14.11 Supply and maintenance of Engineer’s vehicles

Vehicles as specified in special specification ...................... km

This tendered rate/km shall include full provision for providing the vehicle as specified, maintaining the vehicle in good condition as well as the fuel and oil required.

### General: Method of payment

Payment under Items 14.01 up to and including 14.06 and for Item 14.09 will be made as follows:

80% of the amount will be paid when the item is provided and erected, fitted or installed to the Engineer’s satisfaction. A further 10% will be paid when the value of all permanent work done, excluding escalation, exceeds one-half of the tendered amount, and the remaining 10% will be payable in the certificate which follows the removal of the items from the site.

Payment for expenditure under Item 14.07 will be made in full as and when the money is expended subject to written proof by the Contractor of payment of the amounts. The tendered lump sums shall include full compensation for all fixed expenditures required in connection with these services, and will be payable upon completion of the work in respect of each subitem. The tendered rates per month shall be payable monthly for so long as the services are required, but not in respect of any period after the tendered date of completion or any extension thereof which may have been granted.

The tendered rates for the various items scheduled in this Section shall include full compensation for providing, procuring, erecting, installing and/or fitting the item or service, as may be required or specified, for the use of the item or service, including replacements when defective, and finally the dismantling and removal of each item, including all transport, handling and other costs.

Payment for alternative accommodation provided in terms of Subclause 1403(c) shall be adjusted pro rata in accordance with the time it is required during the period of construction or any extension thereof for which an extension of time shall have been granted.
1501 SCOPE

This Section covers the construction and maintenance of the necessary diversions and detours, barricades and signs, and everything necessary for the safe and easy passage of all public traffic during the construction and maintenance periods, and also the obliteration of diversions as they become redundant.

1502 GENERAL REQUIREMENTS

(a) Handing over the site

The site will be handed over to the Contractor in the lengths and sequence specified in the Project Specifications.

(b) Providing diversions

Except where the existing road is to remain in use for through traffic, the Contractor shall provide, construct or put in order such diversions as may be required for deviating traffic from such sections of the road as are handed over to him.

The Contractor shall be responsible for the safe and easy passage of public traffic past and/or over sections of roads of which he has occupation. The Contractor shall at all times in all his operations and in using his constructional plant take the necessary care to protect the public and to facilitate the flow of traffic.
required by such officials in the execution of their duties. It shall be incumbent upon the Contractor to see to it that the above-mentioned traffic-control facilities are present at all times and are functioning properly, but, prior to any section of the road which requires the above facilities being opened to traffic, the Contractor shall submit his proposals in this connection to the Engineer for his information and comment.

The Contractor shall inspect all traffic-control facilities at least once daily, and report to the Engineer and immediately make good any shortcomings. The Contractor shall indemnify the Employer against all proceedings, claims, actions, damages and costs which may arise from or be related to the absence or improper functioning or placement of road-traffic signs, barricades, traffic-control facilities, channelisation devices, warning devices and road-traffic markings. Road signs, channelisation devices and barricades no longer required may be moved for re-use, and, if no longer suitable for use, replaced without any additional compensation if they are required for re-use.

The type of construction, spacing and placement of traffic-control facilities shall be in accordance with the prescriptions and recommendation of the latest edition of the relevant Road Traffic Signs Manual, and in accordance with the instructions and drawings of the Engineer. The various traffic-control facilities which may be required are the following:

(a) Traffic-control devices

Traffic-control devices involve the use of flagmen, portable STOP and GO signs, and traffic-control signs, whichever may be the most suitable method under prevailing circumstances. Traffic-control signs shall be erected only if so specified in the Project Specifications or upon an instruction in writing, by the Engineer.

(b) Road signs and barricades

Road signs shall include all road signs in the R, W and G series, which shall also include danger plates and movable barricades (ROAD CLOSED signs and the chevron type). Road signs shall be made of steel sheets, 1.40 mm thick, but may also be made from Chromadek; all background letters and symbols shall be of engineering-grade retro-reflective material. Road signs shall comply with the requirements of Section 5400.

(c) Channelisation devices and barricades

Channelisation devices shall include cones, delineators and drums. Barricades include barrier lattices or other types as shown on the Drawings, and movable barricades.

Steel drums shall be cut, painted white and provided with retro-reflective tape strips as shown on the Drawings. Drums shall be kept in position with ballast of sand or soil. Stones shall not be used for this purpose. Drums shall be maintained in a clean and serviceable condition.

(d) Barriers

Barriers for preventing vehicles from leaving the permitted lanes may consist of guardrails on both sides of steel drums for separating two opposite traffic streams, movable concrete barriers (New Jersey type), or ordinary guardrails which comply with the provisions of Section 5200.

(e) Warning devices

Warning devices shall consist of amber flicker lights.

(f) Road markings

Road markings, as specified in Section 5500, may be required on sealed surfaces and will include road-marking studs wherever necessary. The road markings shall be made in accordance with the provisions of Section 5500. Any painted road markings which no longer apply shall be removed or overpainted with black road paint. Road-marking studs shall be removed completely.

1504 WIDTH OF DIVERSIONS

The roadway width of gravel diversions accommodating two-way traffic shall be not less than 10 m. Where diversions consist of two separate one-way lanes, the minimum usable width of each lane shall be not less than 5 m.

The roadway width of a two-way diversion with a bituminous surface shall be at least 7.4 m and shall be provided with bituminous shoulders of at least 1.0 m on each side.

If wider diversions are required, such widths shall be specified in the Project Specifications and/or on the Drawings.

1505 TEMPORARY DRAINAGE WORKS

The Contractor shall construct the necessary temporary drainage works such as side drains, catchwater drains, mire drains, culverts, etc., to deal adequately with any surface run-off.

Temporary culverts of the type and size required by the Engineer shall be installed on existing drainage channels wherever required by the Engineer. Any suitable prefabricated culverts salvaged from an existing road or an abandoned diversion may be re-used if in a good condition and approved by the Engineer.

Any damage caused to diversions on account of temporary culverts installed and maintained in accordance with the Engineer’s instructions being unable to cope with floods effectively shall be repaired. The Contractor will be paid for the cost of such work at applicable rates or, where no such rates exist, in accordance with the provisions of the relevant clause of the General Conditions of Contract.

Payment for the construction of temporary culverts will be made under the appropriate items provided in this Section and payment for the construction of the other drainage works for diversions and for the maintenance of all drainage works shall be included in the rates tendered for Item 15.01, Accommodating traffic and maintaining diversions.

1506 EARTHWORKS FOR DIVERSIONS

The Contractor shall shape and grade the diversions and shall make full use of all material that can be obtained from alongside the diversions, from side cuts or from the immediate vicinity. If an adequate quantity of material cannot be obtained in this manner, he shall import material from other sources. Where necessary, cuttings shall be
made to obtain a satisfactory vertical alignment. The Contractor shall also perform the necessary clearing and grubbing, including the removal of all trees and stumps. Where the subgrade is not sufficiently dense in its natural state, it shall be given three roller passes compaction as specified in Section 3400 prior to the construction of the earthworks.

All material shall be watered, mixed and compacted with suitable compaction equipment to give sufficient density to the material so that it will be capable of carrying traffic without undue wear or distress. In case of disagreement between the Engineer and the Contractor as to the adequacy of this compaction, a dry density of 90% of modified AASHTO density shall be taken as the required minimum density.

Any fills which may be necessary for any reason, eg for the construction of fords, shall be constructed and compacted by the Contractor as described above. Wherever possible, fords shall be constructed from rockfill or coarse material so as to limit, in so far as is possible, damage caused by flood waters. Pollution and siltation of water courses shall be controlled. The Contractor shall construct cuttings where required.

**1507 GRAVELLING OF DIVERSIONS OR OF EXISTING ROADS USED AS DIVERSIONS**

When the earthworks for diversions as described in Clause 1506 have been completed, those sections of the diversions and of existing gravel roads used as diversions, as indicated by the Engineer, shall be provided with a wearing course of suitable gravel approved by the Engineer.

The Contractor shall provide, spread, water, mix and compact such material to a density where it can carry traffic without undue wear and tear. In case of disagreement between the Engineer and the Contractor as to the adequacy of the compaction, a dry density equal to 93% of modified AASHTO density shall be taken as the required minimum density.

**1508 SELECTED-GRAVEL LAYERS, CRUSHED-STONE OR ASPHALT BASE, STABILISATION, AND ROAD MARKING REQUIRED FOR BITUMEN-SURFACED DIVERSIONS**

Where specified in the Project Specifications or required by the Engineer, gravel layers of selected subgrade or subbase quality, crushed-stone base, asphalt base or stabilised gravel layers shall be constructed and sealed and roadmarking shall be done by the Contractor, all in accordance with the requirements of the relevant sections of these Specifications and the Engineer's instructions.

**1509 TEMPORARY BITUMEN-SURFACE DIVERSIONS**

Where required in the Project Specifications or by the Engineer, temporary diversions shall be provided with bituminous surfacing in accordance with the requirements of the Project Specifications or of Series 4000, or as may be prescribed by the Engineer.

**1510 EXISTING ROADS USED AS DIVERSIONS**

Where existing roads are to be used as diversions, the Contractor shall, after consultation with the Owner or Authority having control of such road, carry out any repairs, alterations or additions to such roads as may be required to bring them to a condition suitable for traffic. This work will be paid for as stipulated in Clause 1517.

**1511 MAINTENANCE OF GRAVEL DIVERSIONS AND EXISTING GRAVEL ROADS USED AS DIVERSIONS**

All gravel diversions and existing gravel roads used as diversions shall be maintained by the Contractor in a safe trafficable condition. Whenever required by the Engineer, the roads and diversions shall be bladed by means of self-propelled road graders to provide a smooth riding surface free from corrugations. All potholes shall be repaired immediately.

The Engineer may also instruct the Contractor to water the diversions to keep down dust or to facilitate the proper blading of the surface. An approved chemical dust suppressant may be used instead of water if considered by the Engineer to be more effective. All drainage works shall be maintained in a good working order.

The blading of surfaces of diversions and the application of gravel and water or chemical dust suppressant shall be measured and paid for separately, but all other maintenance shall be deemed to be included in the rate tendered for Item 15.01, Accommodating traffic and maintaining diversions.

**1512 MAINTENANCE OF TEMPORARY DIVERSIONS WITH BITUMINOUS SURFACING AND EXISTING ROADS WITH BITUMINOUS SURFACING USED AS DIVERSIONS**

All roads with bituminous surfacing used by public traffic bypassing construction shall be maintained in a good and safe trafficable condition for the entire period during which such roads are used. Maintenance shall include the patching and repair of the bituminous surfacing, the clearing of shoulders, the clearing of all drains, including culvert inlet and outlet drains, and other incidentals and, unless otherwise specified in the Project Specifications, also the care and maintenance of all road markings, road signs, guide blocks and guardrails.

The cost of all maintenance to diversions with bituminous surfacing shall be included in the rates tendered under Item 15.01, except for the cost of repairs to the bituminous surfacing and pavement, which shall be paid for separately under Item 15.09.

**1513 ACCOMMODATION OF TRAFFIC WHERE THE ROAD IS CONSTRUCTED IN HALF WIDTHS**

Where, by reason of difficult terrain or for any other reason, the construction of diversions is not feasible, the Contractor shall, upon the written instruction of the Engineer, construct the road in half widths to allow traffic to use that half of the road not under construction. The length of the half-width construction shall be kept to a minimum, with provision for
traffic travelling in opposite directions to pass at frequent intervals.

The Contractor shall arrange his work so as to allow traffic to have free one-way access to at least half the width of the roadway at all times during the construction period. He shall maintain that half of the road, which is being used for traffic for the time being, free from corrugations, to the satisfaction of the Engineer.

Wherever possible, the Contractor shall ensure that the entire road width shall be open at night and shall be left, at the end of each day’s work, in a good and safe trafficable condition to the satisfaction of the Engineer.

Should the road be not in a safe trafficable condition for two-way traffic over the entire width at the end of each day’s work, the Contractor shall provide adequate flagmen, signs, barricades, lights and the necessary staff at his own cost to ensure a reasonably free flow of traffic alternately in each direction throughout the entire period when the roadway is open to one-way traffic only.

1514 TEMPORARY FENCING, GATES AND GRID GATES

Where ordered by the Engineer or specified on the Drawings or in the Project Specifications, the Contractor shall make his own arrangements for providing either new fencing and gates or moving and subsequently reinstating existing fencing and gates in accordance with the provisions of Section 5300.

1515 THE USE OF DIVERSIONS BY THE CONTRACTOR

Where the Contractor constructs diversions, haul and/or construction roads for accommodating construction traffic, he shall construct and maintain them at his own cost and in accordance with details previously agreed on with the Engineer, in writing. Such roads shall be obliterated and their surfaces properly reinstated when no longer required, all at the Contractor's own cost.

The Contractor shall have the right to use public roads, including diversions open to public traffic, but where his own traffic causes excessive damage or wear to such roads or constitutes a condition hazardous to public traffic, the Engineer shall have the right to regulate his traffic over such diversions and require the Contractor to provide, at his own cost, such maintenance, including wearing-course gravel and watering, as in the Engineer’s opinion will be necessary in addition to that which would be required to maintain the diversions properly when not used by the Contractor’s construction traffic. Where regulation of the Contractor’s traffic does not alleviate the traffic hazard satisfactorily or the maintenance of the diversions cannot be or is not properly executed, the Contractor shall, where conditions permit, divert his traffic over construction roads provided and maintained at his own cost.

1516 OBLITERATION OF DIVERSIONS

When traffic is routed permanently onto the new road following the completion of construction, the diversions which are no longer required and, unless otherwise instructed by the Engineer, such sections of obsolete roads and road markings as instructed by the Engineer, shall be obliterated in accordance with Section 5800.

1517 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.01</td>
<td>Accommodating traffic and maintaining diversions</td>
<td>kilometre (km)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the kilometre, measured along the centre lines of temporary diversions, existing roads used as diversions, and roads constructed in half-widths. It shall not include sections along which the traffic is diverted onto existing roads where the Contractor is not responsible for the maintenance of such existing roads.

The tendered rate shall include full compensation for accommodating traffic and maintaining diversions, including roads constructed in half-widths and existing roads used as diversions during construction and maintenance periods, but excluding maintenance and repair work for which payment is specifically made under the other pay items provided in Section 1500. The tendered rate shall also include full compensation for the provision of communications equipment required for regulating the traffic, arranging for the moving of services, solving traffic problems, complying with the legal requirements of all Authorities concerned, for providing temporary access to private property, and for the provision and maintenance of temporary drainage, but excluding the work specifically paid for under Item 15.12. The tendered rate shall also include full compensation for the specified general requirements and all incidental items of cost which are required under the provisions of Section 1500 and which are not specifically paid for under the other pay items provided in Section 1500.

Payment will be made in two equal instalments in respect of each section. The first instalment will be made when suitable diversions have been approved for use or when traffic is taken over half-width construction. The second instalment will become due when the traffic can be accommodated on the new road, all diversions have been obliterated and all general obligations of the Contractor have been complied with, all to the satisfaction of the Engineer.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.02</td>
<td>Earthworks for diversions:</td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Shaping of diversions</td>
<td>kilometre (km)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the kilometre of diversions shaped, compacted and constructed in accordance with the provisions of Clause 1506. Where the Contractor has to provide access roads to private property, the length of such access roads outside the road reserve shall be included in the quantity measured for payment.

The tendered rate shall include full compensation for clearing and grubbing where necessary, the removal of small trees and stumps, the shaping and grading, watering, mixing and compacting of the material and all cuts and fills constructed from material obtained from alongside the diversions or side cut, but including only such portions of the fills which are less than 0.5 m in height.
(b) Cut and borrow to fill .......................... cubic metre (m³)

The unit of measurement shall be the cubic metre of fill measured in situ from levelled cross-sections taken before and after construction where such material is either imported from a locality more than 100 m from the point of use or is utilised in a portion of a fill which is in excess of 0.5 m above the original ground level.

Where measurement by cross-sections is impractical, the volume can be assumed to be equal to 70% of the loose volume measured in trucks in the case of soil and gravel material, and equal to 60% of the loose volume in trucks in the case of hard material consisting predominantly of particles of which the maximum dimension exceeds 100 mm.

The tendered rate shall include full compensation for procuring, furnishing and the placing all the classes of material, including transporting over a free-haul distance of 0.5 km.

(c) Cut to spoil .......................... cubic metre (m³)

The unit of measurement shall be the cubic metre of authorised excavation taken from cut in diversions or removed from fill in redundant diversions and carted to spoil on the instructions of the Engineer, all measured in situ before excavation by means of levelled cross-sections.

The tendered rate shall include full compensation for excavating in all classes of material, loading, transporting, off-loading, including the shaping and levelling of spoil material and transporting over a free-haul distance of 0.5 km.

**Item** | **Unit**
---|---
**15.03 Temporary traffic-control facilities:**
(a) Flagmen .......................... lump sum
(b) Portable STOP and GO signs ...... number (No)
(c) Temporary traffic-control signs as specified or as shown on the Drawings .......................... number (No)
(d) Amber flicker lights ................. number (No)
(e) Road signs, R-series, 1 200 mm in diameter .......................... number (No)
(f) Road signs, W-series, 1 524 mm sides .......................... number (No)
(g) Road signs, G-series (excluding G49) .......................... square metre (m²)
(h) Danger plates and delineators .......................... number (No)
(i) Movable barricades (chevron and ROAD CLOSED types) .......................... number (No)
(j) Traffic cones .......................... lump sum
(k) Drums .......................... number (No)
(l) Double guardrails attached to drums .......................... metre (m)
(m) Single guardrails attached to posts .......................... metre (m)
(n) Barrier rails .......................... metre (m)
(o) Movable concrete barriers .......................... metre (m)

Road markings will be paid for as specified at the end of this Clause.

(a) The lump sum tendered for flagmen shall include full compensation for all flagmen who may be required to control traffic by way of flags or portable STOP and GO signs and shall include the provision of flags.

(b), (c), (d), (e), (f) and (h) The unit of measurement shall be the number of each sign provided, and, as may be applicable, completely erected.

The tendered rates shall include full compensation for providing, and where applicable, erecting each sign complete. In the case of Subitem (h) it shall also include moving the sign as may be necessary.

(g) The unit of measurement shall be the square metre of sign face, measured on the face of each item provided.

The tendered rate shall include full compensation for providing and erecting each sign, complete with posts.

(i) The unit of measurement shall be the number of movable barricades, complete with road signs provided.

The tendered rate shall also include full compensation for moving the barricades to fresh positions as and when necessary.

(j) The lump sum for traffic cones shall include full compensation for providing as many cones as may be necessary, irrespective of their number, and for all labour and costs required for their placement, removal or moving as may be necessary.

(k) The unit of measurement shall be the number of drums, complete with red reflectorised triangles, painted white, and provided with ballast.

(l) The unit of measurement shall be the metre of straight or curved barricade provided and erected, complete with two guardrails, reflective plates, end pieces and drums to which they are attached.

(m) The unit of measurement shall be the metre of straight or curved temporary guardrails erected, complete with end units, posts, reflective plates, etc.

(n) The unit of measurement shall be the metre of barrier rails erected, complete with white and red bands or string and stakes to which it is attached.

(o) The unit of measurement shall be the metre of movable concrete barriers provided and erected.

**General:**

The tendered rates for the respective traffic-control facilities shall also include full compensation for their maintenance and the replacement of items which have become unserviceable, and their removal when no longer necessary. 75% of the tariff will be payable when the items have been provided and erected, and 25% when finally removed from the site.
## Item Unit

### 15.04 Re-use or removal of traffic-control facilities:

(a) Temporary traffic-control signs as specified or as shown on the Drawings ........................................ number (No)
(b) Amber flicker lights ...................................... number (No)
(c) Road signs, R and W-series .............................. number (No)
(d) Road signs, G-series (excluding G49) ............... number (No)
(e) Danger plates and delineators .......................... number (No)
(f) Drums ...................................................... number (No)
(g) Double guardrails attached to drums ................ metre (m)
(h) Single guardrails attached to posts ................... metre (m)
(i) Barrier rails ............................................. metre (m)
(j) Movable concrete barriers ......................... metre (m)

The unit of measurement shall be the number or metre length of each unit removed once and re-erected. In the case of drums, it shall include their removal to an entirely new locality, and no payment will be made for their removal to a fresh position virtually at the same location.

The tendered rates shall include full compensation for the dismantling, storing if necessary, transporting and re-erecting in a fresh position of the various items specified above.

### 15.05 Gravelling and repair of diversions cubic metre (m³)

The unit of measurement shall be the cubic metre of gravel provided as wearing course for the surfacing of diversions, computed from the dimensions of the layer as actually constructed in place, in accordance with the Engineer's instructions.

Where measurement by the above method is considered to be impracticable by the Engineer, the volume may be computed by taking 70% of the loose volume of the gravel as measured in the hauling vehicles.

The tendered rate shall include full compensation for procuring, furnishing, placing and compacting the gravel wearing course, including a free-haul distance of 1.0 km, and the repair of local sections of the diversions.

### 15.06 Watering of diversions

(a) Watering of diversions ................................. kilolitre (kl)
(b) Diluted chemical dust suppressant .................... litre (l)

The unit of measurement shall be the kilolitre of water or litre of diluted chemical dust suppressant applied to the diversions on the written instruction of the Engineer. Water required for the construction of diversions will not be measured for payment.

The tendered rate shall include full compensation for the supply, transport and application of the water or dust suppressant. Overhaul shall not apply to transporting the water used for the watering of diversions.

### 15.07 Blading of diversions and existing roads used as diversions by road grader kilometre-pass (km-pass)

The unit of measurement for using a road grader to blade the surfaces of diversions and existing roads used as diversions shall be the kilometre-pass, that is, each kilometre of the full width of diversion the entire surface of which has been bladed by one pass of the road grader. In the case of diversions constructed as two separate one-way roads, they shall be considered as one full width of the diversion for purposes of measurement.

Only the number of kilometre-passes actually authorised by the Engineer, in writing, will be measured.

Where the blading of diversions has not been carried out satisfactorily and the surface has not been improved as much as can reasonably be expected from such an operation, the Contractor shall carry out further grading work at his own expense until a satisfactory result is obtained.

The tendered rate shall include full compensation for providing the road graders and operators, flagmen, guards, barricades, signs and all other costs incidental thereto and for blading the roads to a smooth surface free from corrugations.
The provisional sum provided to cover the cost of work ordered by the Engineer in terms of Clause 1512 for repairing and maintaining the bituminous surfacing and pavement of existing and temporary roads with bituminous surfacing used as diversions, shall be expended in accordance with the provisions of the relevant clause of the General Conditions of Contract.

### Item 15.10 Accommodation of traffic

**Unit**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.10 Accommodation of traffic where the road is constructed in half-widths</td>
<td>kilometre (km)</td>
</tr>
</tbody>
</table>

The unit of measurement for accommodating traffic where the road is constructed in half-widths shall be the kilometre measured along the centre line of the road which is constructed in half-widths on the written instructions of the Engineer.

The tendered rate shall include full compensation for providing all plant, equipment, tools, transport, labour, supervision, flagmen, guards, signs, lights, barricades and all other incidentals necessary for the proper and safe handling of traffic as specified and shall include full compensation for all additional costs and work resulting from constructing the road in half widths.

### Item 15.11 Traffic lights

**Unit**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.11 Traffic lights</td>
<td>provisional sum</td>
</tr>
</tbody>
</table>

The provisional sum provided to cover the cost of providing traffic lights shall be expended in accordance with the provisions of the relevant clause of the General Conditions of Contract.

### Item 15.12 Temporary culverts:

**Unit**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.12 Temporary culverts:</td>
<td></td>
</tr>
<tr>
<td>(a) Provision and laying of temporary prefabricated culverts complete (state size, type and bedding)</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Re-use of prefabricated culverts complete (state type, size and type of bedding)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of culvert provided and installed by the Contractor.

The tendered rate shall include full compensation for procuring and furnishing new culverts, all excavations, bedding, laying and backfilling and the eventual removal of the culverts, including excavation, loading and transporting off the site, and the reinstating of surfaces.

The unit of measurement shall be the metre of culvert installed.

The tendered rate shall include full compensation for taking up the culverts in the positions originally installed and installing the culverts in fresh positions, including all excavation, backfilling and bedding, the loading and transporting, off-loading of the culverts and their eventual removal, including excavation, loading, transporting, off-loading and stacking at a suitable site, and the reinstatement of surfaces.

**Notes:** The following pay items described in other sections will be listed under this Section in the Schedule of Quantities where they relate to work executed under this Section.

1. Overhaul as specified in Section 1600.
2. The clearing and grubbing of large trees as specified in Section 1700.
3. The removal of overburden as specified in Section 3100.
4. The construction of mass earthworks and pavement layers as specified in Series 3000.
5. Bituminous seals as specified in Series 4000 or in the Project Specifications.
6. Temporary fencing and gates as specified in Section 5300.
7. Road markings as specified in Section 5500.

1500-7
SERIES 1000 : GENERAL

SECTION 1600 : OVERHAUL

CONTENTS
1601 SCOPE
1602 DEFINITIONS
1603 MEASUREMENT AND PAYMENT

1601 SCOPE

This Section covers the hauling of overhaul material as defined herein from the place of excavation or stockpile to the position of placement, where such haul distance is in excess of the free-haul distance as defined herein.

1602 DEFINITIONS

(a) Overhaul material

Overhaul material shall be transported material to which overhaul shall apply when hauled in excess of the free-haul distance and shall include only the following materials:

(i) Gravel, soil or rock materials used in the construction of fills, pavement layers, banks and dykes.
(ii) Topsoil or gravel prescribed by the Engineer as wearing course for diversions, and selected gravel material used for backfilling drain and culvert excavations, but excluding permeable material used in filter drains supplied from commercial sources.
(iii) Spoil material resulting from the authorised excavations of the road prism, drains, culverts and other structures and from fills in redundant diversions.
(iv) Crushed stone used in the construction of subbase and base, but only when overhaul applies in the circumstances specified in Clause 3608 Item 36.01 and 36.02.

(b) Overhaul

Two types of overhaul shall apply to this Contract, and, depending on circumstances, any one or both may apply in respect of the same hauling operation.

Restricted overhaul shall apply to fill material from cut and borrow and to spoil material from excavations when hauled in excess of the free-haul distance of 0.5 km in respect of haul up to and including 1.0 km, and shall be measured and paid for by the cubic metre of material hauled between or over these distances.

Ordinary overhaul shall apply to all overhaul material in respect of haul in excess of 1.0 km, and shall be measured by the product of the volume of material hauled, measured as specified hereafter, and the overhaul distance as defined in Clause 1602(e) hereof.

Both restricted and ordinary overhaul shall be paid in respect of material having a free-haul distance of 0.5 km when hauled in excess of 1.0 km.

(c) Haul distance

The haul distance for cut to fill shall be the distance between the centre of volume of the overhaul material in the cut before excavation and the centre of volume of the portion of the fill constructed with the overhaul material.

The distance between the centres of volume shall be measured along the centre line of the road, and any additional distance of haul ascribed to the following of a different haul route will not be considered. Cut and fill volumes for ramps, road approaches and connections on either side of the road shall be considered as concentrated at the centre line of the main roadway under construction for computing overhaul quantities for payment, unless otherwise specified in the Project Specifications.

The haul distance for borrow material and cut to spoil material shall be measured along the shortest route determined by the Engineer as being feasible and satisfactory. Should the Contractor choose to haul material over some other longer route, computations for payment shall nevertheless be based on the haul distance measured along the shortest route designated by the Engineer. The haul distance for borrow materials and cut to spoil shall be measured to the nearest 0.1 km.

(d) Free-haul distance

The free-haul distance shall be the distance up to which overhaul material may be hauled before overhaul becomes payable. This distance shall be 1.0 km in the case of all overhaul materials, except cut and borrow to fill and cut to spoil material where the free-haul distance is 0.5 km.

(e) Overhaul distance

The overhaul distance applying to Item 16.02 shall be the haul distance as defined above, less 1.0 km, measured to the nearest 0.1 km.

1603 MEASUREMENT AND PAYMENT

Quantity of material

The quantity of material overhauled shall in all cases be measured in the same manner as the item to which the overhaul applies.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.01 Overhaul on material hauled in excess of a free-haul distance of 0.5 km, for haul up to or through 1.0 km (restricted overhaul)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of overhaul material hauled over the distance given above.
Item | Unit
---|---
16.02 Overhaul on material hauled in excess of 1.0 km (ordinary overhaul) | cubic metre-kilometre (m³-km)

The unit of measurement shall be the cubic metre of overhaul material hauled in excess of 1.0 km, multiplied by the overhaul distance.

**Note:** Both restricted and ordinary overhaul shall be payable on material having 0.5 km free haul when this material is hauled in excess of 1.0 km.

Overhaul of material in excess of that required or for a further distance as may be necessary for the completion of the Works or otherwise not authorised by the Engineer will not be measured for payment purposes.

The tendered rates for overhaul shall include full compensation for hauling material in excess of the free-haul distance.

**Notes:** In the special cases detailed below, overhaul shall be measured as follows:

(a) **Gravel crushed and/or screened (Section 3200)**

The haul distance on crushed and/or screened gravel shall be taken from the point of excavation or borrow to the crushing/screening plant and thence to the point of final use in the road or, in the case of material sieved out and discarded, to the point where finally placed.

Overhaul will be the total haul, minus the 1.0 km free-haul.

(b) **Crushed-stone base or subbase material (Section 3600)**

The following applies to crushed-stone base or subbase material as specified in Section 3600 to which overhaul applies, ie material not obtained from commercial sources.

The haul distance shall be measured from the approved borrow pit to the crusher site and thence to the point where used on the road. The quantity shall be the actual quantity only of subbase or base material measured for payment and does not include material excavated but discarded or lost at the crusher.

(c) **Oversize material removed from the road (Clause 3210)**

The haul on all oversize material removed from the road and taken to spoil shall be considered as two haul operations, and overhaul shall be calculated separately as follows:

(i) Haul from the point of procurement of the oversize material to the point where it is deposited on the road

Haul and overhaul shall be calculated in the normal manner, but no overhaul will be payable on the first portion of the oversize material which does not qualify for payment under any item for the "removal of oversize material".

(ii) Haul from the point where it is bladed off the road to the point of disposal

The haul distance shall be from the point alongside the road where the oversize material is bladed off to the point where it is finally deposited. Overhaul shall apply to all oversize material removed, including material not paid for under any item for the "removal of oversize material". Overhaul shall be the haul distance minus the 1.0 km free-haul.
This Section covers the clearing of the site and the grubbing necessary for construction of the Works covered by the Contract, in accordance with these Specifications.

(a) Clearing

Clearing shall consist of the removal of all trees, brush, other vegetation, rubbish, fences and all other objectionable material, including the disposal of all material resulting from the clearing and grubbing.

It shall also include the removal and disposal of structures that overture, encroach upon or otherwise obstruct the work and which can be cleared by means of a bulldozer with a mass of approximately 20 tonnes and an engine developing approximately 145 kW at the flywheel. Structures which cannot be cleared in this manner shall be broken down in accordance with the requirements of the Project Specifications for the removal and disposal of structures.

No payment will be made for the moving of soil or gravel material which may be inherent in or unavoidable during the process of clearing. Clearing shall also include the removal of all rocks and boulders of up to 0.15 m³ in size which are exposed or lying on the surface.

Payment for fences which have to be taken down and the material sorted, coiled and stacked shall be made under Section 5300.

(b) Grubbing

In the roadway all stumps and roots exceeding 75 mm in diameter shall be removed to a depth of no less than 600 mm below the finished road level and a minimum of 75 mm below the original ground level. Where the roadbed has to be compacted, all stumps and roots, including matted roots, shall be removed to a depth of at least 200 mm below the cleared surface.

Except at borrow areas, the cavities resulting from the grubbing shall be backfilled with approved material and compacted to a density of at least the density of the surrounding ground.

(c) Conservation of topsoil

Where suitable topsoil occurs within the limits of the area to be cleared and grubbed, the Contractor shall, if so ordered by the Engineer, remove the topsoil together with any grass and other suitable vegetation. If not used immediately, the topsoil shall be transported and deposited in stockpiles for later use. The Contractor will not be required to remove topsoil to an average depth of less than 150 mm from any particular area.

This work shall be measured and paid for under Section 5700. Where topsoil can be removed without the necessity of first doing clearing and grubbing, no payment will be made for clearing and grubbing under this Section.

(d) Conservation of vegetation

Where provided for in the Project Specifications, certain designated plants encountered in the road reserve and borrow areas shall be carefully protected by the Contractor. He shall include, in his tendered rates for clearing and grubbing full compensation for the careful removal and planting of the plants in a protected and fenced-off area, and, on completion of the road, the replanting of the plants in suitable positions in the road reserve in accordance with the Engineer's instructions.

(a) Areas to be cleared and grubbed

Normally the portions of the road reserve falling within the limits of the road prism and certain borrow areas shall be cleared and grubbed. The Engineer shall designate the areas to be cleared, which shall not necessarily be limited to those mentioned above.

The areas occupied by an existing road prism will normally be excluded.

No clearing and grubbing shall be done other than on the written instructions of the Engineer, who shall designate in detail the exact areas to be cleared and grubbed and the time when it shall be done. The Contractor shall note that, in order to avoid reclearing, the clearing and grubbing may have to be done at the last practicable stage of construction.

Individual trees designated in writing by the Engineer shall be left standing and uninjured. A penalty of US$100.00 or the equivalent in local currency shall be imposed for every such tree which is unnecessarily removed or damaged.

(b) Cutting of trees

The Contractor shall take the necessary precautions to prevent damage to structures and other private or public property. If necessary, the trees shall be cut in sections from the top downwards. The branches of trees to be left standing shall be trimmed so as to leave a 7 m clearance above the carriageway.

Where clearing and grubbing on government property would involve the cutting down of indigenous forest containing a significant number of trees with a trunk diameter exceeding 200 mm, the Engineer shall inform the officials of the responsible Government Department at tender stage before commencing with clearing and grubbing of such areas so as to enable that Government Department to salvage any usable timber and to identify the trees before they are removed.
(c) Disposal of material

Material obtained from clearing and grubbing shall be disposed of, as indicated by the Engineer, in borrow pits or other suitable places and covered up with soil or gravel. The burning of material will not normally be permitted and may be done only with the prior written approval of the Engineer. All statutory provisions in regard to air pollution shall be carefully observed.

All tree trunks and branches in excess of 150 mm in diameter shall be cleaned of secondary branches, sawn into suitable lengths and stacked at sites indicated by the Engineer. Such timber shall not be used by the Contractor and shall remain the property of the Employer unless otherwise agreed on with the Engineer.

Fencing wire shall be neatly wound into reels and all such wire, together with all fence posts and other usable material from structures, etc, shall be stacked at sites indicated by the Engineer.

(d) Reclearing of vegetation

When portions of the road reserve, borrow or other areas have been cleared in accordance with the Specifications, but vegetation grows again in the course of time during construction, the Engineer may, if he considers it necessary, order that the area be reclered.

Such reclerding of areas previously cleared includes the removal and disposal of grass, shrubs and other vegetation in the same manner as for the first clearing operation.

1704 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.01 Clearing and grubbing</td>
<td>hectare (ha)</td>
</tr>
</tbody>
</table>

The unit of measurement for clearing and grubbing shall be the hectare (to the nearest 0.1 ha) designated by the Engineer and cleared and grubbed in accordance with these Specifications.

The tendered rate shall include full compensation for all work necessary for the clearing of the surface, the removal and grubbing of trees and tree stumps (except large trees and stumps as defined below), cutting of branches, backfilling of cavities, demolishing and disposal of structures except where otherwise provided in the Project Specifications, and the removal, transporting and disposal of material, all as specified in this Section.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.02 Removal and grubbing of large trees and tree stumps:</td>
<td></td>
</tr>
<tr>
<td>(a) Girth exceeding 1.0 m up to and including 2 m</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Girth exceeding 2 m up to and including 3 m</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) Etc, in steps of 1.0 m girth</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The girth of trees or stumps shall be measured at the narrowest point of the tree or stump in the first metre of its height above ground level. Trees and stumps with a girth exceeding 1.0 m shall be measured individually and classified according to size in increments of 1.0 m as indicated above.

The tendered rates shall include full compensation for all work necessary for the clearing and grubbing of trees and stumps of all sizes, the backfilling of holes and the removal and disposal of material, all as described in this Section.

Where construction is carried out through plantations or where the number of trees with a girth exceeding 1.0 m renders individual measurement impracticable, the Project Specifications shall provide that the clearing and grubbing of trees in such areas be measured in hectares. If this method of measurement is used, the areas where it applies will be shown on the Drawings, stated in the Project Specifications, or indicated to tenderers during site inspection.

Where the Project Specifications provide payment for the clearing and grubbing of large trees per hectare in certain specific cases, the tendered price shall include full compensation for all work as described in connection with individual trees above.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.03 Reclearing of surfaces (on the written instructions of the Engineer only)</td>
<td>hectare (ha)</td>
</tr>
</tbody>
</table>

The unit of measurement for reclearing areas which have previously been cleared shall be the hectare. The quantity shall be measured to the nearest 0.1 ha.

The tendered rate shall include full compensation for all work necessary for the clearing of the surface, grubbing if necessary, backfilling of holes and the removal and disposal of material, all as described in this Section.
SERIES 2000

DRAINAGE

2100 Drains
2200 Prefabricated culverts
2300 Concrete kerbing, concrete channeling, chutes and downpipes, and concrete linings for open drains
2400 Asphalt and concrete berms
2500 Pitching, stonework and protection against erosion
2600 Gabions
2101 SCOPE

This Section covers all work in connection with the excavation and construction of open drains, subsoil drainage and banks and dykes at the locations and to the sizes, shapes, grades and dimensions as shown on the Drawings or as directed by the Engineer, and the test flushing of subsoil drains.

It also covers the cleaning of open drains and the repairing of subsoil drainage. In special circumstances this work may be executed outside the road reserve.

It also covers the clearing of existing culverts, including amongst others the removal of all undesirable materials that have accumulated in and around inlet and outlet structures and in the barrels of the culverts.

2102 OPEN DRAINS

Open-drain excavation shall involve the excavating of open drains and channels, including channels to direct the course of streams, all as shown on the Drawings or as directed by the Engineer.

Open-drain excavation shall include all excavation required for constructing a channel with a bottom width of less than 4 m or a V-shaped channel with side slopes steeper than 1:4, and total width at the top of less than 5 m. Any excavation required for constructing a channel with a bottom width of 4 m or more, or a V-shaped channel with side slopes equal to or flatter than 1:4, or where the width at the top exceeds 5 m, shall be classed as "cut" and shall be measured and paid for under Section 3300.

Open drains within the road prism, such as median drains, side drains and open drains on excavation-slope benches, shall be classed as "cut" and shall be measured and paid for under Section 3300, except where, on account of the shape of such open drains, excavation by bulk excavating equipment would not be feasible and either hand excavation or special excavating equipment, such as backactors, draglines or similar equipment, would be required, in which case such excavation shall be paid for as open-drain excavation.

Open drains shall be constructed true to line, grade and cross-section and shall be so maintained for the duration of the Contract.

Care shall be taken to avoid excavation below the required grades for the open drains and any excavation carried beyond the required grade shall be backfilled with suitable material and compacted to at least 90% of modified AASHTO density by the Contractor at his own expense.

Material resulting from the excavations for open drains shall be used in the construction of fills, banks and dykes, or for other purposes, or shall be disposed of to spoil, all as directed by the Engineer.

In respect of material resulting from open-drain excavation and not taken to spoil but used elsewhere in the construction of the Works, payment will be made for open-drain excavation as well as for any item of permanent construction built from such material. Material from open-drain excavation which is taken to spoil will be paid for as open-drain excavation only.

If ordered by the Engineer, all existing open drains, but excluding open drains constructed by the Contractor himself, shall be cleared and, where necessary, shaped by removing the sediment and trimming the floors and sides. The specified requirements for constructing open drains shall apply mutatis mutandis to cleaning and shaping the open drains.

Measurement and payment in respect of the cleaning and shaping of existing open drains not classified as cut in accordance with the classification instructions in Subclause 2102(b), shall be made under Item 21.02, and those in respect of existing open drains classified as cut under the appropriate items in Section 3300.

Any pitching of open drains ordered by the Engineer shall be done in accordance with the requirements of Section 2500. The concrete lining of open drains shall be done as specified in Section 2300.

All culverts indicated by the Engineer shall be cleared. The Contractor shall remove all undesirable materials, such as amongst others all silt, sediment, driftwood, debris and rubble that have accumulated in and around the culvert inlet and outlet structures and in the culvert barrels. All materials resulting from the clearing operations shall be disposed of at locations approved by the Engineer. The clearing shall preferably be done by means of hand tools in order to prevent damage to existing drainage and other structures. The Contractor shall repair all structures damaged by him at his own cost, and to the satisfaction of the Engineer.

2103 BANKS AND DYKES

Mitre banks, catchwater drains and dykes shall be constructed of approved soil or gravel obtained from open-drain excavation or, if no suitable material can be obtained from that source, from suitable alternative sources, and be placed in such a way that the water will flow on the natural ground and against the bank.

The banks and dykes shall be properly compacted to 90% of modified AASHTO density in layers not exceeding 150 mm in thickness, unless thicker layers have been approved by the Engineer.

If so preferred by the Contractor and approved by the Engineer, mitre banks may also be constructed of hand-packed stone, provided that the interstices are filled with an approved cohesive soil.
2104 SUBSOIL DRAINAGE

(a) Materials

(i) Pipes

Pipes for subsoil drainage shall have the specified internal diameter, which shall be not less than 100 mm, and shall be one of the following types:

1. Perforated pitch-fibre pipes complying with SABS 921 or equivalent;
2. Perforated or slotted unplasticised PVC pipes complying with SABS 791 or equivalent;
3. Perforated high-density polyethylene pressure pipes complying with the requirements of SABS 533, Part II or equivalent.

The size of perforations in perforated pipes shall be in all cases be 8 mm in diameter ± 1.5 mm and the number of perforations per metre shall be not less than 26 for 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced in two rows for 100 mm pipes and as shown on the Drawings for 150 mm pipes.

Slotted pipes shall have a slot width of 8 mm ± 1.5 mm. The arrangement of slots shall be subject to the Engineer's approval, but the total slot area shall be not less than that specified for perforations.

Pipes without slots or perforations required for conveying ground water from the subsoil drainage proper to the point of discharge, shall be unperforated pitch fibre, PVC or polyethylene pipes of the types specified above, or concrete pipes complying with the requirements of SABS 677 or equivalent.

(ii) Natural permeable material

Natural permeable filter materials for subsoil drainage shall consist of sand and/or crushed stone of suitable gradings. Natural permeable materials shall conform to the following requirements:

1. Sand

Sand shall be clean, hard sand obtained from approved borrow pits. The sand shall comply with the requirements of SABS 1083 or equivalent and shall be either coarse, medium or fine as specified. The nominal particle size for the various grades shall be as shown in Table 2104/1.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Nominal max particle size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>4.75</td>
</tr>
<tr>
<td>Medium</td>
<td>2.00</td>
</tr>
<tr>
<td>Fine</td>
<td>0.20</td>
</tr>
</tbody>
</table>

2. Crushed stone

Crushed stone shall comply with the requirements of SABS 1083 or equivalent and shall be either course (19.0 mm nominal size) or fine (13.2 mm nominal size) as specified.

The aggregate shall be evenly graded between these limits. The stone shall have a 10% FACT of not less than 110 kN when tested in accordance with TMH1 Method B2 or equivalent.

(3) General

When no suitable sand and/or crushed stone is available from borrow pits, the Engineer may require that it be procured from commercial sources outside the site.

The Engineer shall indicate the grades of sand and crushed stone to be used in each case to comply with the requirements.

In the case of any sand and/or crushed stone, not more than 5% of the material shall pass through the 0.075 mm sieve.

(iii) Synthetic-fibre filter fabric

Should the use of synthetic-fibre filter fabric in subsoil drainage, or as filter blankets, or for any other purposes, be specified, it shall comply with the requirements as specified hereinafter.

(iv) Composite in-plane draining fabric

The make and class of fabric shown on the Drawings or approved by the Engineer shall be used.

(b) Construction of subsoil drainage systems

(i) With natural permeable material

Trenches for subsoil drainage systems shall be excavated to the dimensions and gradients shown on the Drawings or as directed by the Engineer.

A layer of natural permeable material of the grade and thickness as shown on the Drawings shall be placed on the bottom of the trench and be lightly tamped and finished to the required gradient.

Pipes of the type and size required shall then be firmly bedded on the natural material, true to level and grade, and be coupled in accordance with the requirements. Thereafter the trench shall be backfilled with natural permeable material to such height above the pipes as shown on the Drawings or as directed by the Engineer. The natural permeable material shall be lightly compacted and trimmed to the required level. Further layers of finer natural permeable material shall then be placed, lightly compacted and finished to an even surface, as directed by the Engineer. The remainder of the trench, if any, shall be backfilled with approved impermeable material and as required by the Engineer, in layers not exceeding 100 mm, and compacted to at least the same density as the surrounding material. The trench shall be specially protected against the ingress of water until the impermeable layer has been completed. The width of the backfill that will be measured for payment shall not exceed the specified width of the trench.

Natural permeable material shall be placed in layers not exceeding 300 mm in thickness at a time and be lightly compacted. The total thickness of each type of natural permeable material shall be carefully controlled, and when the thinner layers are placed, suitable spacers shall be used. When successive layers are placed, the lower layer shall not be walked on and, as far as possible, shall not be disturbed. Care shall be taken to prevent the contamination of natural permeable material during construction of the
subsoil drainage system and all natural permeable material contaminated by soil or silt shall be removed and replaced by the Contractor at his own expense.

Perforated and slotted pipes shall be jointed by means of couplings. Perforated pipes shall be laid with perforations at the top or bottom as may be prescribed.

The higher end of each subsoil drainage pipe shall be sealed off with a loose concrete cap of Class 20/19 concrete, as shown on the Drawings, and at the lower end the pipe shall be built into a concrete head wall providing a positive outlet or it shall be connected to stormwater pipes or culverts. The complete system, together with head walls, shall be constructed in one process starting at the lower head wall.

Any section of a subsoil drainage system constructed of pipes without perforations or slots shall be backfilled with impermeable backfill material as described herein. Where suitable, the excavated material may be used for backfilling.

(ii) With polyethylene lining to trenches for subsoil drainage systems

Where shown on the Drawings or directed by the Engineer, trenches for subsoil drainage systems shall be lined with approved polyethylene sheeting 0.15 mm thick. The polyethylene sheet shall cover the bottom of the trench and shall extend upwards on both sides for as far as may be directed by the Engineer in each particular case, in order to form a waterproof channel. At joints the polyethylene sheeting shall be heat-welded together or lapped by a minimum of 200 mm.

When backfilling the trench with natural permeable material, care shall be taken not to displace or damage the polyethylene lining in any way. The use of plastics other than polyethylene will be considered, provided that the material is of equal quality and is approved by the Engineer.

(iii) With synthetic-fibre filter fabric

Where specified that synthetic-fibre filter fabric shall be used for lining in subsoil drainage systems, it shall be procured, furnished and installed as specified and shown on the Drawings. The lining shall not be displaced or damaged in any way when the trench is being filled with natural permeable material. The filter fabric shall be lapped both longitudinally and transversely by at least 300 mm or as instructed by the manufacturers. The transverse lap shall be positioned on top of the box forming the drain and shall be stitched together with plastic/galvanised wire or strong synthetic thread at 1.0 m intervals. The longitudinal lap shall be in the direction of flow. Filter fabric shall be stored under suitable cover and shall not be exposed to direct sunlight for prolonged periods and shall be protected from mechanical damage during installation and construction.

(iv) With composite in-plane drainage fabric

Wherever specified, composite in-plane drainage systems shall be constructed in accordance with the details shown on the Drawings. The elements of the system shall be assembled above ground in manageable lengths, and all exposed surfaces shall be sealed with an approved geofibre seal. The trench sides shall be vertical, and the composite in-plane system shall be installed against the side through which the subsoil flow is expected. The trench shall then be backfilled with sand, which shall be saturated with water after placement, up to the prescribed level. The upper part of the trench shall be backfilled with impermeable material which shall be compacted to the density of the surrounding material, in layers not exceeding 100 mm in thickness.

(c) Test flushing

Final acceptance of longitudinal subsoil drains will be subject to satisfactory test flushing after completion and installation of the rodding eye inlets. Flushing tests shall be carried out in the presence of the Engineer’s representative by flushing the drain and metering the outflow to ensure the drain is clear of blockage. Should blockages be apparent the Contractor shall locate and clear the obstruction and repeat the test.

2105 CLASSIFICATION OF MATERIALS

All excavations for open drains and subsoil drainage systems shall be classified as follows for payment purposes:

(a) Hard material

Material which cannot be excavated except by drilling and blasting, or with the use of pneumatic tools or mechanical breakers, and boulders exceeding 0.10 m³ shall be classified as hard material.

Where more than 40% of any material (by volume) consists of boulders each exceeding 0.10 m³ in size, the material shall be classified as hard material.

(b) Soft material

All material not classified as hard material shall be classified as soft material.

2106 MANHOLES, OUTLET STRUCTURES AND CLEANING EYES

Manholes, outlet structures and cleaning eyes for subsoil drainage systems shall be constructed in accordance with the details shown on the Drawings or in positions as instructed by the Engineer.

2107 MEASUREMENT AND PAYMENT

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<td>(a)</td>
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(b) Extra over Subitem 21.01(a) for excavation in hard material, irrespective of depth . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of material excavated in accordance with the authorised dimensions, measured in place before excavation. Excavation for open drains only as defined in Subclause 2102(b) shall be measured.

Irrespective of the total depth of the excavation, the quantity of material in each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for the excavation of the material to the required lines, levels and grades, all temporary shoring and strutting, and the disposal of the material as directed, including a free haul of 1.0 km.

For payment purposes a distinction shall be made between soft and hard material, as defined in Clause 2105.

Item Unit
21.02 Clearing and shaping existing open drains . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of sediment removed, measured in place before removal.

The tendered rate shall include full compensation for excavating the material, protecting the existing drainage structures, trimming the floors and sides of the open drains and disposing of material as prescribed, including free-haul over a distance of 1.0 km.

The clearing of existing concrete side drains will be measured and paid for under Item 21.18.

Item Unit
21.03 Excavation for subsoil drainage systems:

(a) Excavating soft material situated within the following depth ranges below the surface level:

(i) 0 m up to 1.5 m . . . . . . . . . . . . cubic metre (m³)
(ii) Exceeding 1.5 m and up to 3.0 m . . . . . . . . . . . . cubic metre (m³)
(iii) Etc, in increments of 1.5 m . . . . . . . . . . . . cubic metre (m³)

(b) Extra over Subitem 21.03(a) for excavation in hard material irrespective of depth . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of material excavated in accordance with the authorised dimensions, measured in place before excavation. Irrespective of the total depth of excavation, the quantity of the material in each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for the excavation of the material to the required lines, levels and grades, all temporary shoring and strutting, and the disposal of the material as directed, including a free haul of 1.0 km. For payment purposes a distinction shall be made between soft and hard material, as defined in Clause 2105.

Where subsoil drainage systems are adjacent to structures such as culverts, that part of the excavation for subsoil drainage systems which can be made by widening the excavation for the structure shall be measured and paid for under excavation for such structure, and not under excavation for the subsoil drainage systems.

Item Unit
21.04 Impermeable backfilling to subsoil drainage systems . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of completed backfill, measured in place in the subsoil drainage systems and calculated in accordance with the authorised dimensions.

The tendered rate shall include full compensation for procuring, furnishing, placing and compacting the backfilling and a free haul of 1.0 km.

Item Unit
21.05 Banks and dykes . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of material, measured in place in the banks or dykes, and calculated in accordance with the authorised dimensions.

The tendered rate shall include full compensation for procuring, furnishing, placing, watering, compacting, shaping and trimming the material in the banks and dykes and a free haul of 1.0 km.

Item Unit
21.06 Natural permeable material in subsoil drainage systems (crushed stone):

(a) Crushed stone obtained from approved sources on the site (state grade) . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of approved crushed stone in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipe shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for procuring, furnishing and transporting from the borrow areas and placing the material as specified.

For payment purposes a distinction shall be made between the different grades of crushed stone.

(b) Crushed stone obtained from commercial sources (state grade) . . . . . . . . . . . . cubic metre (m³)

The unit of measurement shall be the cubic metre of crushed stone in place in the drains, calculated in
accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for procuring, furnishing and transporting approved crushed stone from commercial suppliers, including the cost of transporting the material to the site, and placing the materials as specified. For payment purposes a distinction shall be made between the different grades of crushed stone.

The unit of measurement shall be the cubic metre of approved sand in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for procuring, furnishing, transporting from the borrow areas and placing the sand as specified.

For payment purposes a distinction shall be made between the different grades of sand.

The unit of measurement shall be the cubic metre of sand in place in the drains, calculated in accordance with the authorised dimensions. The volume occupied by the pipes shall be deducted when calculating the volume of the permeable material.

The tendered rate shall include full compensation for furnishing, procuring, cutting, overlapping, jointing, placing and protecting the sheeting as specified, as well as for wastage.

The unit of measurement shall be the square metre of filter fabric supplied and installed as specified.

The tendered rate shall include full compensation for furnishing, procuring, assembling, installing and jointing the composite in-plane drainage system, including perforated or other types of pipes, complete as specified.

The unit of measurement shall be the metre of composite in-plane drainage system measured in place along the centre line of the system.

The tendered rate shall include full compensation for furnishing, procuring, assembling, installing and jointing the composite in-plane drainage system, including perforated or other types of pipes, complete as specified.

The unit of measurement shall be the number of outlet structures, manhole boxes, junction boxes and cleaning eyes for subsoil drainage systems.

The tendered rate shall include full compensation for furnishing, laying and jointing the pipes and fittings as specified.

(a) Sand obtained from approved sources on the site (state grade) .................. cubic metre (m³)

(b) Sand from commercial sources (state grade) ................... cubic metre (m³)

(c) High-density type polyethylene pressure pipes and fittings, complete with couplings (state size, type and class and whether or not perforated) ..................... metre (m)

(d) Concrete pipes (state type and diameter) ......................... metre (m)

The unit of measurement for pipes shall be the metre of pipe, measured in place along its centre line, including the length of fittings.

The tendered rate shall include full compensation for furnishing, laying and jointing the pipes and fittings as specified.
(b) Manholes boxes ................. number (No)
(c) Junction boxes ................. number (No)
(d) Cleaning eyes ................. number (No)

The unit of measurement shall be the number of outlet structures, manhole boxes, junction boxes and cleaning eyes for subsoil drainage systems constructed in accordance with the details on the Drawings and the Engineer’s instructions.

The tendered rates shall include full compensation for all excavation, backfilling, compacting to 90% of modified AASHTO density, disposing of surplus excavated material, keeping the excavations safe, dealing with any surface or subsurface water, procuring and furnishing all materials, providing, erecting and removing formwork, mixing, transporting, placing and curing the concrete, and all labour and constructional plant required for constructing the concrete outlet structures, manhole boxes, junction boxes and cleaning eyes, complete as specified.

Item Unit
21.13 Concrete caps for sub-
soil drain pipes ................. number (No)

The unit of measurement shall be the number of caps supplied, and the tendered rate shall include full compensation for supplying and installing the caps.

Item Unit
21.14 Repairing or replacing
existing drainage
systems ................. provisional sum

The provisional sum given for repairing or replacing existing drainage systems shall be expended in terms of the General Conditions of Contract.

Item Unit
21.15 Overhaul for material
hauled in excess of
1.0 km free-haul
(normal overhaul) ................. cubic metre-
kilometre (m³-km)

The measurement and payment for overhauling material referred to in Items 21.01, 21.02, 21.03, 21.04, 21.05, 21.06, 21.07 and 21.16 shall be in accordance with Section 1600, and the overhaul quantities shall be listed in Clause 2107.

Item Unit
21.16 Backfilling existing
eroded side drains ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of approved granular material placed and compacted to 93% of modified AASHTO density, measured in place after compaction, where instructed by the Engineer.

The tendered rate shall include full compensation for trimming the side drains, disposing of the resulting material and procuring, furnishing, transporting, placing and compacting the granular material and a free-haul of 1.0 km.

Item Unit
21.17 Test flushing of
pipe subsoil drains ................. number (No)

The unit of measurement shall be the number of tests satisfactorily completed on unblocked sections of drain. No payment will be made for tests which have to be repeated due to blocked pipes or faulty workmanship.

The tendered rate shall include full compensation for the provision of a water tanker, water, equipment and labour necessary to carry out the tests, complete as specified.

Item Unit
21.18 Excavation for the
clearing of existing
drainage systems:

(a) Manholes and inlet and
outlet structures ................. cubic metre (m³)
(b) Culvert barrels ................. cubic metre (m³)
(c) Concrete side drains ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of material excavated and removed, measured in place before excavation.

The tendered rate shall include full compensation for excavating the material, protecting the existing drainage structures, dealing with any surface or subsurface water, and disposing of the excavated material, including shaping and levelling-off piles of spoil material. The tendered rate shall also include full compensation for transporting the excavated material for a free-haul distance of 1.0 km.

Item Unit
21.19 Selected backfill
material under
concrete-lined side
drains compacted to
93% of modified AASHTO
density ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted material and the quantity shall be calculated from the authorised dimensions given on the Drawings.

The tendered rate shall include full compensation for procuring, as if from soft excavation or borrow pits, breaking down, placing and compacting the material in 150 mm layers, transporting for a free haul distance of 1.0 km, and for shaping the top surface in accordance with the Drawings.
SERIES 2000 : DRAINAGE

SECTION 2200 : PREFABRICATED CULVERTS

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2201 SCOPE

This Section covers work in connection with the construction from prefabricated units of culverts and other closed conduits such as stormwater ducts, tremies and service ducts, together with inlet and outlet structures, manholes and other appurtenant structures.

2202 TYPES OF CULVERTS

For the purposes of this specification, the term "prefabricated culverts" shall mean culverts constructed from:

(a) prefabricated concrete pipe culvert units
(b) portal and rectangular prefabricated concrete culvert units
(c) corrugated metal culvert units
(d) fine granular material
(e) protective coating for metal culverts

Other types of prefabricated culverts not mentioned above, if required, will be specified in the Project Specifications or Schedule of Quantities or on the Drawings.

2203 MATERIALS

The prefabricated culvert units shall be factory produced by a reputable manufacturer of these articles and shall comply with the following requirements:

(a) prefabricated concrete pipe culvert units
(b) portal and rectangular prefabricated concrete culvert units
(c) corrugated metal culvert units
(d) fine granular material
(e) protective coating for metal culverts

Wherever the use of fine granular material is specified in this Section for the bedding of culverts, it shall mean sand or other cohesionless material, all of which shall pass through a 6.7 mm sieve and not more than 10% of which shall pass through a 0.15 mm sieve.

The mastic asphalt shall bear a registered trade mark, and shall contain asbestos fibres and an approved filler and shall...
be supplied as a spray or brush-grade material as prescribed.

The surfaces to be protected shall be cleaned to remove all moisture, dirt, oil, paint, grease, alkalis, rust, mill scale or other deleterious matter.

The material shall be mixed until all asbestos fibres and filler are uniformly distributed.

Spray-grade mastic shall be applied by means of an airless gun and shall be of a suitable consistency without the addition of a harmful amount of thinners.

Brush-grade mastic shall be applied with an ordinary roofing brush, with the second coat being applied at right angles to the first coat.

The final film thickness measured on the crest of corrugations shall be a minimum of 1.3 mm or such other thickness as may be specified.

Care shall be taken not to damage the protective coating, and all damage to the coating shall be repaired before the culvert is put to use.

(f) Skewed ends

Where culverts are to be constructed at a skew angle, the culvert units at the inlet and outlet of the culvert shall be supplied with skew ends by the manufacturer, if required. The cutting of skewed ends on site shall not be allowed.

Portal and rectangular units shall be provided with square ends and any portions that would otherwise be cut off, shall project beyond the culvert head walls.

Where instructed by the Engineer, portal and rectangular culverts shall be provided with skewed ends constructed from cast in situ reinforced concrete in accordance with the details shown on the Drawings.

(g) Defects

All broken, bent, chipped, cracked, dented, corroded or otherwise damaged units shall be repaired to the Engineer’s satisfaction or, where this is not possible, they shall be removed and replaced with undamaged units.

Culvert units which are thinner than the specified thickness, or the spelter coating of which has been bruised or broken, or which may exhibit signs of faulty work, will be rejected.

The following defects will be regarded as poor work, and the presence of any of or all such defects or any other defects in any individual unit or in general shall constitute adequate reason for rejection:

Uneven joints, distorted shapes, deviations from a straight centre line, irregular or diagonally ruptured sides, loose rivets, rivets not in line or irregularly spaced, poorly finished rivet heads, illegible trade marks, or a lack of rigidity.

(h) Material at joints

Joint filter and joint sealing material shall comply with the requirements of Clause 6003.

(i) In situ concrete

All concrete work shall be carried out in accordance with the requirements of Sections 6200, 6300 and 6400.

(j) Material at joints

All concrete work shall be carried out in accordance with the requirements of Sections 6200, 6300 and 6400.

2204 CONSTRUCTION METHODS

Prefabricated culverts shall be installed by either:

(a) the "trench method", where the units are laid in a trench excavated below the existing ground level or in a trench excavated in previously constructed subgrade and, if necessary, subbase layers; or

(b) the "embankment method", where the units are laid approximately on the existing ground surface and the subgrade is then constructed on either side and over the culvert.

Culverts shall be constructed by the method shown on the Drawings or specified in the Project Specifications.

The larger sizes of metal culverts and the larger portal or rectangular culverts shall normally be constructed by the embankment method.

Surface drainage shall be controlled by the construction of temporary earth berms and drainage channels.

The Contractor shall comply strictly with all the appropriate statutory provisions in regard to trench excavations.

2205 EXCAVATION FOR CONSTRUCTION BY THE TRENCH METHOD

(a) Depth of excavation

In the case of culverts to be constructed by the trench method, the Contractor shall first construct the fill, subgrade and, if necessary, the subbase to such level as will provide a minimum cover, above the proposed level of the top of the culvert, as described hereinafter for the various types of culvert. The Contractor may then commence excavating the trench for the culvert.

The amount by which the excavation is to exceed the proposed level of the invert of the culvert shall be sufficient to allow the type and thickness of bedding material to be placed as specified or as shown on the Drawings.

The minimum cover above the top of the culvert and minimum depth of excavation below the bottom side of the culvert shall be as specified in Subclause 2205(a).

Notwithstanding the provisions of Subclause 2205(a), the base shall not be constructed before the culvert and the backfill have been completed.

(i) Concrete pipe culverts

The minimum height of embankment construction over the top of the proposed pipe culvert before excavation may be commenced, shall be the minimum cover specified on the Drawings for the type of pipe and bedding onto which it shall be laid.

The minimum amount by which the excavation is to exceed the proposed level of the bottom side of the pipe shall be 75 mm or such other amount as may be required for
accommodating the type of bedding required for the pipe in each case.

(ii) Portal and rectangular culverts

The minimum height of embankment construction over the top of the proposed culvert before excavation may be commenced, shall be 100 mm or such greater height as may be shown on the Drawings, whichever is the greater.

The minimum amount by which the excavation is to exceed the proposed level of the bottom of the culvert invert slab shall be 75 mm in the case of culverts with precast invert slabs. In the case of culverts with cast in situ invert slabs, the excavation shall exactly accommodate the invert slab.

(iii) Metal culverts

The minimum height of embankment construction over the top of the proposed metal culvert before excavation may be commenced, shall be the minimum cover specified on the Drawings for the type of metal culvert, or 0.25 times the diameter of pipes, with a minimum of 0.3 m, or 0.25 times the span of pipe arches, whichever is the greatest.

The minimum amount by which the excavation is to exceed the proposed level of the bottom of the pipe shall be 75 mm or such other amount required for accommodating the type of bedding required for the culvert in each case.

(b) Width of excavation

The widths of excavations shall be sufficient to allow the proper laying, bedding and backfilling of culverts. The widths of the excavation for each type and size of culvert shall be as shown on the Drawings or as may be prescribed by the Engineer in writing.

If the width of an excavation is increased by the side of the trench slipping or collapsing, the Contractor shall immediately inform the Engineer and shall not proceed with any further laying of culverts or backfilling until the Engineer has reviewed the circumstances and has given instructions as to the need for altering the class of culvert or type of bedding.

2206 PREPARATION FOR CONSTRUCTION BY THE EMBANKMENT METHOD

Where culverts are to be constructed by the embankment method as defined in Clause 2204 above, the Contractor shall level the existing ground by excavating, filling and compacting as necessary so as to provide exactly the required slope and a uniform density over the entire length of the culvert.

The finished level of the ground for the bedding of the culvert shall be the same depth below the proposed bottom level of the culvert as specified above in Clause 2205 for the various types of culverts.

2207 UNSUITABLE FOUNDING CONDITIONS

Where the bottom of the trench does not provide a suitably firm foundation for the culvert on account of soft, mucky or otherwise unsuitable material being encountered, the unsuitable material shall be excavated to a depth below the bottom of the culvert as may be indicated by the Engineer.

The Contractor shall excavate the unsuitable material to the depth indicated and shall replace it with gravel or other approved material properly compacted to provide a firm earth cushion.

The width of the excavation and earth cushion shall be as prescribed by the Engineer, but in the case of culverts to be constructed by the embankment method, the width shall be at least one diameter or span, as the case may be, wider than the culvert on each side.

Other special construction methods may be shown on the Drawings or specified in the Project Specifications in specific cases.

2208 CLASSIFICATION OF EXCAVATION

All excavations for prefabricated culverts shall be classified as provided in Clause 2105 for payment purposes.

2209 DISPOSAL OF EXCAVATED MATERIAL

Where excavated material does not comply with the requirements for backfilling material as specified in Clause 2109 or is surplus to backfilling requirements, such excavated material shall be removed from the site and used for rehabilitation of borrow pits or at other places as directed by the Engineer.

Material suitable for use in the Works, however, shall be used as prescribed by the Engineer.

Payment for such material will be made as for excavation under Item 22.01, and also under the appropriate item for such part of the Works as may be constructed from such material.

All excavated material shall be subject to a free-haul distance of 1.0 km.

2210 LAYING AND BEDDING OF PREFABRICATED CULVERTS

(a) Concrete pipe culverts

Concrete pipe culverts shall be laid on Class A, B, C or D bedding as shown on the Drawings or as directed by the Engineer. The pipe ends shall be laid hard up against each other so as to obtain tight joints. Ogee pipes shall be laid with their spigot ends pointing downstream. The joints shall be sealed on the outside with two layers of bitumen-impregnated burlap as specified in Subclause 2210(b).

The insides of the culverts shall be smooth and without any displaced joints. All pipes shall be laid true to line and level.

(i) Class A bedding

The pipe shall be laid with its bottom part on a 20 MPa concrete bedding cradle of specified thickness below the lower part of the pipe, which concrete shall extend upwards on both sides of the pipe to a specified portion of its height.

Before concreting, the pipes shall be supported on suitably shaped cradles at the correct level. No longitudinal construction joints on the horizontal plane will be permitted.
(ii) Class B and Class C beddings

The pipes shall be laid on a bedding cradle of compacted selected granular material as specified. The bedding shall extend upwards on both sides of the pipe to a specified portion of its height, as shown on the Drawings. Joint holes shall be formed in the bedding cradle for pipe sockets and couplings, to ensure that each pipe is fully supported throughout the length of its barrel on the bedding cradle.

(iii) Class D bedding

The pipes shall be laid on the in situ material in the excavation bottom after the bottom has been hand trimmed to support the pipe along the entire length of its barrel in accordance with the details shown on the Drawings. Wherever necessary, the in situ material shall first be stabilised in accordance with the details shown on the Drawings or as prescribed by the Engineer.

(iv) Rock foundation

Where rock, shale or other hard material is encountered on the bottom of excavations, the installation of pipes on Class B bedding shall proceed as follows:

1. The material below the pipe shall be excavated and replaced with a bed of sand or approved gravel or soil to a depth as shown on the Drawings or prescribed by the Engineer. Such material shall be classed as backfill for purposes of payment.

2. The backfill material shall be watered and compacted to provide a firm earth cushion. Class B bedding shall then be prepared as described in Subclause 2210(a).

(v) Concrete casing

Where shown on the Drawings or ordered by the Engineer, pipes shall be fully encased in concrete according to class and dimensions as shown on the Drawings or as ordered by the Engineer. Supports shall be provided close to the pipe ends to support the pipes during the placing of concrete. The concrete shall be so placed as to fill all spaces below the pipe completely. Poker vibrators shall be used to ensure the proper filling of all spaces below and around the pipes with concrete. Concrete casing shall be cast in one continuous operation until completed.

(b) Portal and rectangular culverts

(i) Cast in situ floor slabs

Cast in situ floor slabs shall be constructed to the dimensions and at the locations as shown on the Drawings or as may be prescribed by the Engineer. They shall be reinforced with steel reinforcement as detailed on the Drawings. Joints of the types detailed on the Drawings shall be formed in the floor slabs, and between the floor slabs and the inlet and outlet structures.

(ii) Prefabricated floor slabs

A layer of fine-grained material at least 75 mm thick shall be placed on the bottom of the excavation, levelled, compacted and trimmed to line and grade, to form a bed to receive the precast slabs.

The slabs shall be carefully placed on the prepared bed, true to line and grade, and so bedded that they will be uniformly supported over their whole area on the bedding.

(iii) Placing the portal portions of culverts

The portal portions of portal and rectangular culverts shall be placed accurately and symmetrically on the floor slabs, with a thin layer of mortar of one part of cement and six parts of sand between the contact surfaces to ensure a firm and uniform support.

The units shall be butted end to end with butt joints, which joints shall be covered with two layers of burlap of 340 g/m², pre-impregnated with a bituminous emulsion, or a similar approved material. The strip of burlap shall be at least 150 mm wide and placed symmetrically over the joint. The units shall first be treated with a primer of 60% bitumen emulsion over the width of the strip of burlap.

Where two or more culverts are placed side by side to form a multi-barrel culvert, the space between the culverts shall be filled with concrete up to the level of the top of the culvert. Where prescribed, filter fabric shall be applied to the vertical outer faces in accordance with the details shown on the Drawings.

(c) Metal culverts

The excavation shall be trimmed to the shape of the invert of the culvert and a bed of fine granular material not less than 75 mm thick shall be placed, watered, compacted and shaped to enable the culverts to be bedded as shown on the Drawings.

Where rock is encountered, the depth of excavation shall extend to a depth of at least 200 mm below the invert of the culvert, and shall be filled with granular material as before.

The culverts shall be installed in accordance with the manufacturer’s recommendations as approved by the Engineer. Where these Specifications are inconsistent with the manufacturer’s recommendations, these Specifications shall have preference. Anchor bolts shall be installed at the ends of metal pipe culverts in accordance with the manufacturer's instructions to bond them into inlet and outlet head walls, which head walls shall be constructed as soon as possible after installation of the culverts.

No concrete bedding or casing shall be used in the installation of metal culverts.

Where prescribed, the invert of metal culverts with diameters or spans exceeding 1 500 mm which are laid on steep grades shall be protected with a layer of concrete with dimensions and class as shown on the Drawings.

(d) Extension of existing culverts

Where an existing culvert requires extension or portal replacement, the new section shall be placed at the same grade and, where it joins the existing structure, at the same level as the existing structure.

Any sections of existing wing walls, approach slabs and head walls which may obstruct any new work shall be demolished and removed. Existing culvert ends shall not be damaged, but, should damage occur, the repair work shall be done before the placement of any fresh concrete or new culverts. Loose material shall be removed and joint faces thoroughly cleaned to the satisfaction of the Engineer.

Joining shall be done in accordance with Clause 2214.
After completion of the extension or partial replacement of a culvert, new approach slabs, head walls, wing walls, catchpits, etc., shall be constructed in accordance with the Drawings and Clause 2212.

(e) Construction of culverts in half widths in existing roads

If necessary for accommodating traffic or for any other reasons, or if so instructed by the Engineer, culverts shall be constructed in half widths.

Unless otherwise prescribed, the downstream section shall be constructed first. The end of the excavation adjoining the traffic lane shall be properly supported to prevent displacement from occurring. The necessary warning signs shall be erected in accordance with the requirements of Section 1500.

Where the culvert is constructed in an existing road and it has been so prescribed by the Engineer, the pavement layers at least shall be benched and recompacted during backfilling. The depth of benching shall equal the respective layer thicknesses, and the width shall be at least 150 mm.

(f) General

The construction of culverts shall be commenced at one end of the culvert, the position of which shall be fixed as shown on the Drawings or as prescribed by the Engineer.

Units which have been deformed or cracked, or which are not constructed to the required lines, levels and grades, or which become displaced in the process of the work or during the maintenance period, shall be removed and replaced by the Contractor at his own expense.

Prefabricated units shall be lifted and handled by means of approved lifting devices only. Lifting eyes shall be caulked with a suitable mortar after the units have been installed.

The Contractor shall exercise due care not to damage, overstress or displace any prefabricated culverts with his own traffic or compaction equipment. Where loads exceeding those prescribed in the appropriate statutory provisions are likely to pass over completed culverts, the Contractor shall provide additional cover over the culverts so as to ensure that the design stresses on the culverts will not be exceeded.

All concrete work shall be carried out in accordance with the provisions of Series 6000.

When the Contractor is required to supply and install culverts at a slope exceeding 1:4, the work shall be carried out as specified in Clause 2216.

2211 BACKFILLING OF PREFABRICATED CULVERTS

After the culverts have been firmly laid on the required bedding as described in Clause 2210, backfilling shall be carried out as follows:

(a) The material used for the backfilling of those portions of culverts subject to traffic loads shall be selected material of at least subbase quality or such other lower quality as may be permitted by the Engineer. Where the excavated material is not of adequate quality, selected material shall be imported for this purpose. The Contractor shall, in advance, ascertain from the Engineer as to which portions will require selected-quality material for backfilling.

In the case of concrete pipe culverts on Class B bedding and metal culverts, the backfilling material shall be thoroughly tampered in under the flanks of the culverts to provide a uniform bedding, all to the Engineer's satisfaction. Metal culverts shall be temporarily ballasted during backfilling to prevent them from lifting.

(b) Backfilling alongside and over all culverts shall be placed at optimum moisture content and compacted in layers not exceeding 150 mm after compaction, to a density of at least the density required for the material in adjoining layers of fill, subgrade and subbase. The density of backfilling in excavations made in natural ground shall be at least 90% of modified AASHTO density.

(c) Backfilling shall be carried out simultaneously and equally on both sides of a culvert to prevent unequal lateral forces from occurring.

(d) Where the Engineer so directs, metal culverts with large diameters or spans or multi-barrel culverts shall be constructed by the embankment method as defined in Subclause 2204(b). In such cases the backfilling shall be carried out to the same standard as described above, simultaneously and equally on both sides of the culvert and placed over the culvert until the minimum specified cover is obtained. The width of backfill on each side of the culvert, after completion, shall be at least equal to the diameter (or span) of one of the openings of the culvert.

Metal culverts shall be backfilled symmetrically to prevent distortion of the units, and the Contractor shall also ensure that the required cover as specified is in place to allow construction equipment to pass over it without causing damage.

(e) Whenever specified or as may be instructed by the Engineer, the backfilling shall consist of concrete placed between the side of the culvert and the excavation up to the top of the culvert.

(f) When specified or ordered by the Engineer, the backfilling of culverts shall be done using a wet or a stiff mixture of soil cement in lieu of a compacted gravel or lean concrete. A wet mixture of soil cement shall consist of an approved soil or gravel mixed with 5% of ordinary Portland cement and only sufficient water to give a consistency that will permit the soil cement to be placed with vibrators, so that all voids between the pipes and the sides of excavations and between culverts in the case of multi-barrel culverts will be properly filled. A stiff mixture of soil cement shall contain 3% of ordinary Portland cement and just sufficient water for it to be placed and compacted like ordinary backfill material. The height to which the soil cement backfill shall be taken shall be as prescribed by the Engineer or as shown on the Drawings, and any remaining backfill shall be carried out as described above with a granular material.

The aggregate used for soil cement shall preferably be a sandy material but may contain larger particles up to 38 mm. It shall not have a plasticity index exceeding 10%. Detrimental percentages of silt or clay shall be avoided, and the aggregate shall be obtained from an approved source.

The soil cement shall be mixed on the site with suitable concrete mixers, and the water and cement contents shall be carefully controlled. The material shall be placed and then thoroughly compacted so that all voids are filled as described above. At culvert ends stones shall be packed to

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prevent the soil cement from flowing beyond the required limits.

Soil cement shall not be used for backfilling corrugated metal culverts.

(g) A free-haul distance of 1.0 km shall apply in respect of all imported materials used for backfilling the culverts but no overhaul shall be paid on any cement, water or concrete aggregates used.

2212 INLET AND OUTLET STRUCTURES, CATCHPITS AND MANHOLES

Inlet and outlet structures for prefabricated culverts as well as catchpits and manholes shall be constructed in accordance with the details shown on the Drawings.

(a) Excavation and backfilling

The specifications given elsewhere in this Section for excavating and backfilling the culverts shall apply mutatis mutandis to inlet and outlet structures, catchpits and manholes.

No backfilling of a concrete structure may be done for a period of at least seven days after the structure has been completed, unless otherwise specified or directed by the Engineer.

(b) Concrete work

Concrete work shall be carried out in accordance with the provisions of Series 6000 and the Drawings.

(c) Brickwork

Bricks shall be engineering bricks conforming to the requirements of SABS 227 or equivalent.

The limit for water absorption in the 24 hour immersion test shall be 8%.

Brickwork shall be built in English bond in a mortar consisting of one part of cement and six parts of sand, or in stretcher bond where its thickness does not exceed 115 mm. It shall be well and regularly bonded without any false headers. All bricks shall be unbroken, except where required as closers. Bricks shall be well wetted before laying and each brick shall be pressed into its bed so as to leave a finished joint not exceeding 10 mm in thickness. All joints shall be filled solid with mortar, and joints for exposed faces shall be pointed as the work proceeds.

Where pipes enter brickwork, they shall be thoroughly caulked into the wall and rendered with mortar.

(d) Plaster

Where the plastering of brickwork is required, all joints shall be well raked out and the brick face thoroughly wetted before plaster is applied. Plaster shall not be less than 12 mm or more than 20 mm thick. Plaster finish shall be smooth and even and shall not show any trowel marks. Unless otherwise specified, all plaster shall be finished with a steel trowel. Plaster shall consist of one part of cement to four parts of approved fine sand.

Plaster shall be cured for at least 48 hours.

(e) Manhole covers, grid inlets, etc

Manhole covers and frames, grid inlets and other metal accessories shall be supplied and/or manufactured in accordance with the details shown on the Drawings. Road and pavement manhole covers and frames shall comply with the requirements of SABS 558 or equivalent and shall be of the size and type indicated.

Before fixing manhole covers and frames, they shall be dipped in an approved preservative and gratings and frames painted with two coats of bituminous paint. Manhole frames shall be set firmly in a cement mortar to leave the covers flush with the final surface.

(f) Prefabricated concrete chambers and shafts

Prefabricated chambers and shafts shall be constructed from non-pressure concrete pipes which comply with the requirements of SABS 677 or equivalent. Pipes with ogee joints shall be provided unless otherwise specified. The pipes shall be to the diameters specified. All chambers and shafts shall be installed with the spigot ends pointing upwards and shall be bedded in mortar thoroughly caulked to ensure watertight joints.

(g) Benching

All benching shall be rendered in 20 mm granolithic plaster and finished smooth and true with a steel trowel. Corners shall be rounded to dimensions shown on the Drawings.

(h) Prefabricated inlet and outlet structures

Where specified for use, prefabricated inlet and outlet structures shall be manufactured in accordance with the dimensions shown on the Drawings. The units shall be laid and jointed generally as specified for prefabricated concrete pipe culverts.

(i) Prefabricated energy dissipaters in outlet structures

Where shown on the Drawings, the Contractor shall supply and install in the outlet structures, prefabricated reinforced-concrete energy dissipaters of Class 25/19 concrete with dimensions as shown on the Drawings. All concrete work shall comply with the requirements of Series 6000.

2213 REMOVAL OF EXISTING WORK

Where shown on the Drawings or directed by the Engineer, existing inlets or outlets to pipe culverts shall be demolished and debris or rubbish disposed of in an approved waste site as directed by the Engineer. Existing pipes shall be removed where necessary and saved for later use. All such work shall be carried out so as to prevent damage being done to former work which is to remain.
The Contractor's attention is directed to the provisions of Section 1700 which specifies any structures which have to be removed as part of the clearing and grubbing operations, the removal of which will therefore not be measured and paid for under this Section.

Pipes shall be carefully removed from existing culverts and thoroughly checked.

Undamaged pipes shall be re-used in the Works where indicated by the Engineer. Pipes which cannot be re-used shall remain the property of the Employer and shall be stacked within the road reserve or where directed by the Engineer.

2214 JOINING NEW WORK TO OLD

Where partial demolition is required for extension work to existing structures, the contact face shall be cut to predetermined lines and levels, any loose and fragmented material shall be removed, and projecting steel cleaned and bent as directed by the Engineer. Where partial demolition is not required but extension work only, the contact surface shall be roughened and cleaned of all dirt and loose particles.

If dowels are required, they shall be installed in holes drilled into the existing structure, in accordance with the details shown on the Drawings, and secured by means of an approved type of epoxy resin grout.

Fresh concrete shall be bonded to the old concrete in accordance with the requirements specified in Section 6400.

Reinforcement or plain concrete removed in the process of partial demolition shall be measured and paid for under Item 22.12 and the installation of dowels and those surfaces treated with an epoxy bonding compound will be paid for separately, but no separate payment will be made for any other work described above, the cost of which shall be deemed to be included in the rates tendered for the concrete supplied for the extensions to the existing structures.

2215 SERVICE DUCTS

Where required, the Contractor shall construct service ducts for the easy installation and maintenance of existing, new and future cables and other services. Service ducts shall be constructed from one or more of the following materials:

(i) Normal-duty uPVC pipes in accordance with SABS 791 or equivalent.
(ii) Pitch-fibre pipes in accordance with SABS 921 or equivalent.
(iii) Fibre-cement pressure pipes in accordance with SABS 1223 or equivalent. Class C pipes shall be used unless other types are specified.
(iv) Reinforced-concrete pipes in accordance with SABS 677 or equivalent.

Where required, the pipes shall be cut lengthwise and accurately in two halves. The actual type of pipe required shall be in accordance with the Specifications. The pipes shall be installed in the required positions, and accurate record shall be kept regarding the depth, position and number of pipes installed in each duct. Pipes shall be laid at the grades shown on the Drawings to facilitate flushing with water and shall, where required, be encased in concrete or soil cement.

The width of excavation for service-duct trenches shall be equal to the nominal inside diameter of the pipe, plus 150 mm on each side of the duct. Where ducts consist of two or more units, the minimum spacing between the units shall be 75 mm, and the 150 mm side clearance specified above shall apply to the outside units of the group.

Below the carriageway the depth of excavation shall accommodate a minimum cover of 1.0 m above the upper side of the installed service duct.

All pipes shall be joined with watertight couplings made from the same material as the pipe. Fibre-cement couplings shall be of the rubber-ring type.

Split pipes shall normally be used only for providing ducting for existing services which cannot be severed and threaded through the ducts. The pipes shall be accurately cut longitudinally in two halves and opposite halves shall be matched as sawn. Split pipes shall be placed around the service as required, firmly bound by steel straps and finally encased in concrete if required.

Excavating, laying and bedding the pipes shall be in accordance with the Specifications for prefabricated culverts with any modifications as may be necessary or specified here.

Duct ends shall be provided with suitable conical wooden stoppers to prevent dirt from entering the ducts. Two strands, 2.5 mm in diameter, of galvanised steel wire shall be threaded through each unit and shall extend 2 m beyond each end and firmly wedged into position with the wooden stoppers.

The end of each duct shall be marked with a marker block constructed to the details shown on the Drawings. Each duct marker block shall be at least 50 mm proud of the finished surface level.

2216 CULVERTS ON STEEP GRADIENTS

Where culverts are constructed on gradients exceeding 1:4, they shall be referred to as inclined culverts. Inclined culverts shall be constructed from the type of unit required, normally either circular concrete pipe units or metal culvert units as described in Clause 2203.

Particular care shall be taken to protect excavations against stormwater damage. The trenches shall be excavated down to firm ground, and backfilled with selected gravel or concrete if it is necessary to over-excavate for obtaining a firm floor.

After the outlet structure has first been completed, the culvert units shall be laid in the normal manner by starting from the lower end and placing successive units firmly against each other to prevent subsequent movement. The lower unit shall be securely cast into the outlet structure, and metal culverts shall be provided with the necessary anchor bolts at both inlet and outlet structures and also at all thrust and anchor blocks.

Thrust and anchor blocks shall be constructed from concrete as required in accordance with the Drawings and details furnished by the Engineer. Anchor bolts, straps and
other anchoring devices required at anchor and thrust blocks shall be provided.

The backfilling of trenches shall be done in horizontal layers starting at the lower end.

2217 STORMWATER DUCTS, TREMIES AND OTHER CLOSED CONDUITS

The specifications given in this Section for culverts, including the method of measurement and payment, shall apply mutatis mutandis to the construction of stormwater ducts, tremies or any other closed conduits constructed from the prefabricated units described in Clause 2203, whether intended for drainage or for any other purpose.

No distinction will be made in the Schedule of Quantities between the construction of culverts as defined in Section 1100 and that of the other closed conduits described above, all being classed as culverts.

Tremies constructed from prefabricated units shall be classed as inclined culverts where laid to a grade steeper than 1:4.

2218 MEASUREMENT AND PAYMENT

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<th>Item</th>
<th>Unit</th>
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22.01 Excavation:

(a) Excavating soft material situated within the following depth ranges below the surface level:

(i) 0 m up to 1.5 m ............... cubic metre (m³)

(ii) Exceeding 1.5 m and up to 3.0 m .................. cubic metre (m³)

(iii) Exceeding 3.0 m and up to 4.5 m .................. cubic metre (m³)

(iv) Etc in increments of 1.5 m .... cubic metre (m³)

(b) Extra over Subitem 22.01(a) for excavation in hard material, irrespective of depth .................. cubic metre (m³)

The unit of measurement shall be the cubic metre of material excavated within the specified widths over the lengths and depths authorised by the Engineer in each case. Excavation in excess of the widths specified or authorised by the Engineer shall not be measured for payment.

Irrespective of the total depth of the excavation, the quantity of material in each depth range shall be measured and paid for separately.

When measuring excavation for the removal of existing culverts, the volume occupied by the culvert shall not be subtracted from the calculated volume of excavation.

In the case of manholes, catchpits and inlet and outlet structures, the dimensions for determining the volume of excavation shall be the neat outside dimensions of the structure, plus an allowance of 0.5 m of working space around the structure.

The tendered rates shall include full compensation for all excavation, temporary timbering, shoring and strutting, for preparing the bottom of the excavation for the culvert beds, the disposal of excavated material unsuitable for backfilling, keeping excavations safe, dealing with any surface or subsurface water, and for any other operations necessary for completing the work as specified.

Payment shall distinguish between soft and hard material as defined in Clause 2208.

The tendered rates shall include full compensation for transporting the excavated material for a free-haul distance of 1.0 km.

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<th>Item</th>
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22.02 Backfilling:

(a) Using the excavated material ......................... cubic metre (m³)

(b) Using imported selected material ......................... cubic metre (m³)

(c) Extra over Subitems 22.02(a) and (b) for soil cement backfilling (percentage of cement indicated) .................. cubic metre (m³)

The unit of measurement shall be the cubic metre of material in place after compaction. The quantity shall be calculated from the leading dimensions of the backfilling as specified or as authorised by the Engineer.

If excavations were carried out in excess of the dimensions authorised by the Engineer, the quantity of backfilling will nevertheless be based on the authorised dimensions. The volume occupied by the culvert shall be subtracted when calculating the volume of backfilling.

The tendered tariffs shall include full compensation for backfilling under, alongside and over conduits, for watering, and for compacting the backfill material to the specified density. The tendered rate for Subitem 22.02(b) shall, in addition, include full compensation for supplying selected material of subbase quality from approved sources, including a free haul of 1.0 km.

The tendered rate for Subitem 22.02(c) shall be additional to the rates tendered for Subitems 22.02(a) and (b) and shall include full compensation for all incidentals required for the complete backfilling with soil cement as specified.

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<th>Item</th>
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22.03 Concrete pipe culverts:

(a) On Class A bedding (type and diameter indicated) ................. metre (m)

(b) On Class B bedding (type and diameter indicated) ................. metre (m)
22.04 Metal culverts:
(a) Size, wall thickness and type indicated ........................ metre (m)
(b) Cutting off bevelled and/or skew ends (size and type indicated) ........................ number (No)
(c) Anchor bolts ........................ number (No)

The unit of measurement shall be the metre of culvert laid, the number of cuts made and the number of anchor bolts installed as shown on the Drawings or ordered by the Engineer.

In the case of a metal pipe, the culvert length shall be measured along the pipe centre line. In the case of a metal pipe arch, the culvert length shall be measured along the bottom of the pipe arch. In both cases the length of bevelled and/or skew ends shall be included.

The tendered rates shall include full compensation for providing, testing, loading, transporting and unloading the culverts, for providing and placing the fine-grained material, where required, and for the installation, laying and jointing of the culverts, as specified.

Payment shall be made separately for the cutting of bevelled and/or skew ends, and the tendered rate shall include full compensation for all work in connection with the cutting of ends.

The tendered rate per anchor bolt shall include full compensation for procuring, providing and installing the bolts.

Item Unit
22.05 Portal and rectangular culverts:
(a) Complete with prefabricated floor slabs (size and type indicated) ........................ metre (m)
(b) Without prefabricated floor slabs (size and type indicated) ........................ metre (m)

The unit of measurement for prefabricated portal or rectangular culverts shall be the metre of culvert laid as shown on the Drawings or as directed by the Engineer.

The length shall be measured along the soffit of the culvert.

The tendered rates shall include full compensation for supplying, testing, loading, transporting and off-loading all culverts, providing and placing the fine-grained material where required for installing the culverts, and installing, laying and jointing the culverts as specified, including cutting them on the site, and waste.

Payment will be made separately for floor slabs of cast in situ concrete.

Payment shall distinguish between the different sizes and types of culverts and between culverts installed with or without prefabricated floor slabs.

Item Unit
22.06 Extra over Items 22.03, 22.04 and 22.05 for constructing inclined culverts ........................ metre (m)

The unit of measurement shall be the metre of culvert installed at a grade steeper than 1:4 as specified in Clause 2216.

The tendered rate shall include full compensation for additional or more difficult work of any nature in regard to laying, excavating and backfilling as may be required for installing the culverts at a grade steeper than 1:4.

Item Unit
22.07 Cast in situ concrete and formwork:
(a) In Class A bedding, screeds and the encasing for pipes, including formwork, (class of concrete indicated) ........................ cubic metre (m³)
(b) In floor slabs for portal or rectangular culverts, including formwork and Class U2 surface finish (class of concrete indicated) ........................ cubic metre (m³)
(c) In inlet and outlet structures, catchpits, manholes, thrust and anchor blocks, excluding formwork but including Class U2 surface finish (class of concrete indicated) ................ cubic metre (m³)

(d) Formwork of concrete under Subitem 22.07(c) above (type of finish indicated) ............ square metre (m²)

(e) In concrete linings for the inverts of metal culverts, including formwork and Class U2 surface finish (class of concrete indicated) ................ cubic metre (m³)

Measurement of formwork and cast in situ concrete shall be as specified in Sections 6200 and 6400.

Payment for formwork and cast in situ concrete shall be made as provided in Sections 6200 and 6400, except that payment for the formwork for concreting in Subitems 22.07(a), (b) and (e) shall not be made separately, and the Contractor's rates for concrete shall include full compensation therefor.

No separate payment shall be made for the construction of joints in culvert floor slabs or at inlet and outlet structures, and the tendered rates for concrete shall include full compensation for forming the joints complete in accordance with the details shown on the Drawings.

Item Unit

22.08 Concrete backfill for culverts (class indicated) ................ cubic metre (m³)

The unit of measurement shall be the cubic metre of concrete backfill. The quantity shall be calculated from the dimensions of the excavation as specified or as may be authorised by the Engineer, minus the volume taken up by the culverts, irrespective of whether the actual excavation to be backfilled exceeds the specified or authorised dimensions.

Payment shall be made as for concrete in Item 22.07(a) above.

Item Unit

22.09 Prefabricated concrete inlets and outlets to culverts (size and type indicated) ................ number (No)

Prefabricated concrete inlets and outlets for concrete pipe culverts shall be measured per inlet or outlet, complete in position.

The tendered rate shall include full compensation for procuring, providing, loading, transporting, off-loading and installing the inlets or outlets as specified.

22.10 Steel reinforcement:

(a) Mild steel bars ....................... tonne (t)
(b) High-tensile steel bars ............. tonne (t)
(c) Welded steel fabric ................. kilogram (kg)

Measurement and payment for steel reinforcement shall be made as specified in Section 6300.

Item Unit

22.11 Dowels for joining old and new concrete .............. kilogram (kg)

The unit of measurement shall be the kilogram of steel dowels installed.

The tendered rate shall include full compensation for supplying all materials, all cutting, drilling and grouting, and any other operation or item necessary for the proper execution of the work.

Item Unit

22.12 Removing existing concrete:

(a) Plain concrete ....................... cubic metre (m³)
(b) Reinforced concrete ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of existing concrete removed.

The tendered rates shall include full compensation for all demolition and for loading, transporting and disposing of the products of demolition, including a free haul of 1.0 km.

Payment shall distinguish between plain and reinforced concrete. For the purposes of this item, reinforced concrete shall be defined as concrete containing at least 0.2% of steel reinforcement measured by volume.

The tendered rates shall also include full compensation for cutting straight grooves of the specified depth at joint positions where shown on the Drawings.

Item Unit

22.13 Removing and re-laying existing pipes (size and type of bedding indicated) ........... metre (m)

The unit of measurement shall be the metre of existing pipe removed and re-laid.

The tendered rate shall include full compensation for lifting, loading, transporting for a free-haul distance of 5 km, off-loading, and laying pipes according to the Specifications.

Payment for any excavation and backfilling required for the removal and relaying of existing pipes shall be made separately under Items 22.01 and 22.02.
Where existing pipes are loaded, transported and used in diversions, they shall not be measured for payment under this item, but payment therefor shall be made in terms of Section 1500.

<table>
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<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>22.14 Removing and stacking existing prefabricated culverts (all sizes)</td>
<td>metre (m)</td>
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</tbody>
</table>

The unit of measurement shall be the metre of existing prefabricated culverts removed and stacked.

The tendered rate shall include full compensation for lifting, loading, transporting to stack, off-loading, and stacking the prefabricated culverts. Payment for any excavation and backfilling required for removing and stacking the existing prefabricated culverts shall be made separately under Items 22.01 and 22.02. The free-haul distance shall be 5 km.

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<tr>
<th>Item</th>
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<tbody>
<tr>
<td>22.15 Treating surfaces with epoxy resin for joining new to old concrete (type of epoxy resin specified)</td>
<td>litre (l)</td>
</tr>
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</table>

The unit of measurement shall be the litre of epoxy-resin compound used at the specified rate of application.

The tendered rate shall include full compensation for providing and applying the epoxy-resin compound.

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<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>22.16 Protective mastic asphalt coating for corrugated metal culvert units (state whether to be applied by brush or by spray gun)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of protective coating applied as specified and as directed by the Engineer. When both inside and outside surfaces are treated, both surfaces shall be measured.

The tendered rate shall include full compensation for procuring and furnishing the mastic asphalt, applying the material, and for all other additional work and incidentals required for providing the protective coating as specified.

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<th>Item</th>
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<tr>
<td>22.17 Manholes, catchpits, precast inlet and outlet structures complete:</td>
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<tr>
<td>(a) Manholes (type indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Catchpits (type indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) Precast inlet and outlet structures (type indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

(d) Extra over or less than Subitem 22.17(a) for variations in the depths of manholes from the standard depth designated for tendering purposes (standard depth and type of manhole indicated) ........................ metre (m)

(e) Extra over or less than Subitem 22.17(b) for variations in the depths of catchpits from the standard depth designated for tendering purposes (standard depth and type of catch-pit indicated) ........................ metre (m)

The unit of measurement, in the case of Subitems (d) and (e) above shall be the complete unit as shown on the Drawings, including all concrete, brickwork, covers, frames, grids and other accessories.

The tendered rates shall include full compensation for procuring, furnishing and installing, and laying where applicable, the complete units except for excavation and backfilling, which shall be measured separately. The tendered rate shall also include full compensation for connecting up to and building any conduits into the walls of the various structures.

Where the above items of work cannot be conveniently standardised for payment according to complete units, the various types of work and items of material provided shall be measured separately in accordance with Items 22.18 to 22.21 and such other items as may be necessary.

Concrete and formwork shall be measured and paid for under Subitems 22.07(c) and (d) respectively, excavation under Item 22.01, and backfilling under Item 22.02.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.18 Brickwork:</td>
<td></td>
</tr>
<tr>
<td>(a) 115 mm thick</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) 230 mm thick</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(c) 345 mm thick</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of brickwork built, calculated from the leading dimensions of the brickwork. Areas in walls occupied by conduits, shall not be included in the areas measured, and corners and intersections common to more than one brickwall shall be measured only once.

The tendered rates per square metre shall include full compensation for the brickwork complete as specified, including pointing and the building-in of conduits.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.19</td>
<td>Plaster</td>
</tr>
<tr>
<td></td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of plasterwork provided.

The tendered rate shall include full compensation for raking out joints in the brickwork and applying a 1:4 plaster, as specified, to all surfaces where required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.20</td>
<td>Benching</td>
</tr>
<tr>
<td></td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of benching, measured in plan, constructed in Class 20/19 concrete with granolithic rendering.

The tendered rate shall include full compensation for procuring and furnishing all materials, placing the concrete benching, and rendering with the specified granolithic rendering.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.21</td>
<td>Accessories:</td>
</tr>
<tr>
<td>(a)</td>
<td>Manhole covers including frames (description) number (No)</td>
</tr>
<tr>
<td>(b)</td>
<td>Inlet grids including frames (description) number (No)</td>
</tr>
<tr>
<td>(c)</td>
<td>Step irons (description) number (No)</td>
</tr>
<tr>
<td>(d)</td>
<td>Etc for other accessories number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of each type of accessory delivered and installed.

The tendered rates shall include full compensation for procuring, furnishing and installing the accessories.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.22</td>
<td>Anchors for pipes (description) number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of complete anchors installed, including straps, bolts, etc, but excluding any concrete work, which shall be measured under Subitem 22.07(c) and (d).

The tendered rate shall include full compensation for procuring, providing and installing the anchors.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.23</td>
<td>Service ducts:</td>
</tr>
<tr>
<td>(a)</td>
<td>Ordinary pipes (type and diameter indicated) metre (m)</td>
</tr>
<tr>
<td>(b)</td>
<td>Split pipes (type and diameter indicated) metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be a metre of service duct laid.

The tendered rates shall include full compensation for procuring, providing and laying the pipes, including end stops, draw wires and complete installation, but shall exclude excavation, backfilling, and encasing with concrete, which shall be measured for payment under the appropriate items of payment of this Section.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.24</td>
<td>Duct marker blocks (type indicated) number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of marker blocks installed, and the tendered rate shall include full compensation for manufacturing, delivering and installing the marker blocks, complete as shown on the Drawings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.25</td>
<td>Overhaul on excavated material carted to spoil, backfill material (but excluding Portland cement in the case of soil cement), existing structures demolished and removed to spoil, and removing and relaying, and removing and stacking existing prefabricated culverts, for haul in excess of the free-haul distance cubic metre-kilometre (m³-km)</td>
</tr>
</tbody>
</table>

Measurement and payment for overhaul shall be made in accordance with the provisions of Section 1600, except that the free-haul distance shall be as specified in each item.

In the case of culverts, the outer volume of each pipe shall be measured.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.26</td>
<td>Hand excavation to determine the positions of existing services cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material excavated within the lengths and widths authorised by the Engineer and the depth required to expose the service. Excavation in excess of the authorised dimensions shall not be measured for payment.

The tendered rate shall include full compensation for all excavation, backfilling, compacting to 90% of modified AASHTO density, disposing of any surplus excavated material, keeping the excavations safe, dealing with any surface or subsurface water, taking special care to ensure that services are not damaged in any way and any other operation necessary for completing the work. The tendered rate shall also include the transporting of surplus excavated material for a free-haul distance of 1.0 km. Any damage to a service caused by the Contractor shall be repaired at his own cost, to the satisfaction of the Owner of the service and the Engineer.
No distinction will be made between hard and soft material, neither will distinction be made between the various types of services to be exposed or the depths to which excavations are taken.

### Item 22.27 Reinstating trenches crossing roads:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Selected layers ............ square metre (m²)</td>
</tr>
<tr>
<td>(b)</td>
<td>Subbase ................. square metre (m²)</td>
</tr>
<tr>
<td>(c)</td>
<td>Base (including prime coat) .................... square metre (m²)</td>
</tr>
<tr>
<td>(d)</td>
<td>Bituminous surfacing (including tack coat) ............ square metre (m²)</td>
</tr>
<tr>
<td>(e)</td>
<td>Kerbing ......................... metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement for Subitems (a) to (d) shall be the square metre of the layer reinstated where instructed by the Engineer.

The unit of measurement for Subitem (e) shall be the metre of kerbing replaced due to trench excavations where instructed by the Engineer.

Any reinstatement required beyond the agreed or instructed dimensions owing to damage caused by the Contractor will not be measured for payment.

The appropriate Sections of the Specifications shall also be applicable to the reinstatement of the trenches.

The tendered rates shall include full compensation for procuring, furnishing, placing, compacting and finishing all materials, providing all labour and constructional plant, cutting and preparing the edges of the existing surfacing, and protecting and maintaining the completed reinstatement as specified.

### Item 22.28 Prefabricated reinforced-concrete skew end units for concrete culverts constructed at a skew angle (type and dimensions of unit and class of bedding indicated) ..................... number (No)

The unit of measurement shall be the number of each type and size of prefabricated reinforced-concrete skew end unit provided and installed, irrespective of the angle of skew.

The tendered rates shall include full compensation for providing, testing loading and unloading the units, constructing the prescribed class of bedding, and for installing, laying and joining the units, complete as specified and in accordance with the details shown on the Drawings.
SERIES 2000 : DRAINAGE

SECTION 2300 : CONCRETE KERBING, CONCRETE CHANNELLING, OPEN CONCRETE CHUTES AND CONCRETE LININGS FOR OPEN DRAINS

CONTENTS
2301 SCOPE
2302 MATERIALS
2303 TYPES OF STRUCTURES
2304 CONSTRUCTION
2305 INLET AND OUTLET STRUCTURES AND TRANSITION SECTIONS
2306 CONSTRUCTION TOLERANCES AND SURFACE FINISH
2307 MEASUREMENT AND PAYMENT

2301 SCOPE

This Section covers the construction of concrete kerbing and channelling, open concrete chutes and concrete linings for open drains at the locations and to the details as shown on the Drawings or as directed by the Engineer.

2302 MATERIALS

(a) Concrete
All concrete work shall be carried out in accordance with the requirements of Sections 6200, 6300 and 6400.

(b) Kerbing and channelling
Prefabricated kerbing and channelling shall comply with the requirements of SABS 927 or equivalent. Cast in situ kerbing and channelling shall be of the class of concrete indicated.

(c) Joint sealant
(i) Cold-applied joint sealant shall be a two-part polysulphide sealing compound conforming to the requirements of BS 4254.

(ii) Polyurethane-based joint sealants shall comply with the requirements of SABS 1077 or equivalent.

(iii) Silicone-based joint sealants shall comply with the requirements of the Project Specifications.

(d) Bedding material
The material on which concrete kerbs and channels are to be bedded shall consist of crushed stone, cinders, slag, sand or other approved porous material with a maximum particle size of 13.2 mm.

Concrete may also be prescribed as bedding material, in which case it shall comply with the requirements of Section 6400.

2303 TYPES OF STRUCTURES

Kerbing shall include barrier kerbs, mountable and semi-mountable types. All these elements may be prefabricated units or constructed in a continuous operation using slipforms. Channelling may be cast in situ, prefabricated units or else of slipform construction. Chutes may be either prefabricated units or cast in situ, and the concrete lining of open channels shall be cast in situ only, except that side slabs may be precast. Downpipes shall be prefabricated units.

2304 CONSTRUCTION

(a) Excavation, and preparation of bedding

(i) Kerbs and channels
Trenches for kerbs and channels shall be excavated to the required depth and all unsuitable material shall be removed and replaced with a layer of approved bedding material at least 75 mm thick. The bedding shall be compacted and accurately shaped to the required grade. No concrete or precast concrete units shall be placed on uncompacted or disturbed material.

(ii) Concrete linings
The excavation work for open drains shall be executed and paid for in accordance with the provisions of Section 2100.

The excavations shall then be neatly trimmed to the lines and levels specified so as to permit the accurate construction of the concrete linings. All loose material shall be compacted to a density of not less than 93% of modified AASHTO density.

Where the in situ material is unsuitable, the Engineer may order that it be removed to the required depth and replaced with selected material compacted to a density of 93% of modified AASHTO density.

Where excavations for open drains are in rock, overbreak shall be backfilled as ordered, either with mass concrete or with selected natural gravel or soil compacted to a modified AASHTO density of at least 93%.

(iii) Chutes
Excavations for chutes shall be neatly trimmed. All loose material shall be thoroughly compacted, and where overbreak occurs in hard material, the excavations shall be backfilled with mass concrete. If required by the Engineer, the excavations shall be taken deeper to accommodate a concrete screed cast to act as a working platform for the construction of the chutes.

(b) Prefabricated concrete kerbing and channelling
Prefabricated concrete kerbing and channelling shall be laid on the approved bedding with close joints filled with 3:1 sand:cement mortar not exceeding 10 mm in thickness and neatly pointed with a pointing trowel. The exposed faces of kerbs and edging shall be constructed true to line and elevation. Kerbing around curves shall first be laid along the full curve length before the joints are filled, unless otherwise allowed by the Engineer. Kerbs shall be temporarily propped during construction.
Unless otherwise instructed by the Engineer, prefabricated concrete kerb units shall be 1.0 m in length, except at curves at road junctions, where they shall be 0.3 m in length.

Prefabricated concrete kerbs shall be laid with a Class 1:4:8/25 cast in situ concrete support behind the kerbs in accordance with the details shown on the Drawings.

(c) **Prefabricated concrete chutes on side slopes of fills and cuts**

Prefabricated concrete chutes shall be manufactured in accordance with the dimensions shown on the Drawings, and the units shall fit neatly into each other as shown.

The bottom unit shall rest against the outlet structure or footing as shown on the Drawings.

The units shall be laid true to line and grade from the bottom up so that each unit fits neatly into the previous one.

A transition section shall be constructed at the inlet to lead the water into the chute as shown on the Drawings.

(d) **Slip-form kerbing**

Slip-form kerbs and channels shall be placed on an approved bedding by a continuous process with an approved machine. Contraction joints shall be sawn at intervals shown on the Drawings or prescribed by the Engineer in a manner so as not to cause the concrete to spall at the joint. The concrete shall be cured in accordance with the requirements of Clause 6409.

The kerbs and channels shall be constructed true to line and elevation and shall have a neat appearance. Where transverse cracks occur, the Contractor shall replace the entire section between the contraction joints at his own cost.

(e) **Cast in situ kerbs and channels**

Forms for kerbs and channels shall be accurately set to line and elevation and shall be firmly held in position during the placing of the concrete. Stops and jointing material at the ends of sections shall be accurately placed so as to ensure that joints between adjacent sections are truly perpendicular to the surface of the concrete and at right angles to the edge of the road.

After concrete has been placed in the forms, it shall be tamped and worked until mortar entirely covers any exposed faces. Exposed faces shall then be finished to smooth and even surfaces and edges shall be rounded to the radii shown on the Drawings.

Forms shall be removed from any concrete surfaces that will be exposed, within a period of 24 hours of the concrete having been placed. Minor defects shall be repaired with a 2:1 sand:cement mortar. Plastering shall not be permitted on exposed faces and all rejected portions shall be removed and replaced at the Contractor's expense. When completed, the sections shall be cured in accordance with the requirements specified in Clause 6409.

The completed kerbs and channels shall be true to line and elevation and shall have an even and neat appearance.

(f) **Cast in situ chutes on cut slopes**

Cast in situ concrete chutes on cut slopes, together with the inlet and outlet structures, shall be constructed in accordance with the Drawings. The class of concrete shall be as indicated on the Drawings.

Where required by the Engineer, a concrete screed shall first be cast on excavations that cannot be trimmed accurately. The screed shall be accurately finished to the level of the underside of the chute floor slab and allowed to set before the floor slab is cast. Where the material being excavated cannot be accurately trimmed or where the chute sides have to extend above the surface of cut slopes, the outer faces of the sides shall be cast against formwork.

(g) **Concrete-lined open drains**

The exposed surfaces of the concrete linings of open drains shall be given a Class U2 surface finish as defined in Clause 6209. Concrete shall be cured in accordance with the requirements of Clause 6409.

Sealed joints in concrete shall be in accordance with the details indicated on the Drawings and the provisions of Section 6600. Cold joints shall be painted with a coat of approved bituminous emulsion containing 60% of pure bitumen by mass, or with an approved anti-adhesive before any adjoining slabs are cast.

Expansion joints shall be made in accordance with the Drawings.

Where required, the surfaces on which concrete lining is to be cast shall, after having been trimmed, be covered with polyethylene sheeting 0.15 mm thick and all joints in the sheeting shall be overlapped by at least 150 mm.

(h) **Backfilling**

After completing the concrete work, the spaces at the backs of kerbs shall be backfilled with approved material to pavement or road shoulder level. Spaces adjoining chutes shall be backfilled level with the side slope. Such backfill shall be placed in layers not exceeding 150 mm and each layer shall be compacted to 93% of modified AASHTO at optimum moisture content before the succeeding layer is placed thereon.

Where kerbs and channels are laid after construction of the base, the spaces between the concrete and adjoining base shall be backfilled with premixed bituminous material.

(i) **Construction sequence**

(i) Where kerbs and channelling are constructed before the base.

In this case slip-form units or cast in situ units may be constructed. During working and constructing the base, precautionary measures shall be taken to prevent the concrete work from being damaged or shifted.

(ii) Where kerbs and channelling are constructed after the base

The base shall be constructed wider than the specified width, after which a neat trench shall be dug for the kerbing or channelling. Any over-excavation shall be filled with
concrete cast simultaneously with the kerbs and channelling.

(iii) Where kerbs and channelling are constructed after
the asphalt base and/or asphalt surfacing

The asphalt base and/or asphalt surfacing shall be
constructed wider than the specified width and shall then be
cut back accurately with a mechanical saw to a marked line
to give a neat joint line between the kerbs or channelling and
the asphalt layer. The base shall then be removed to the
required depth.

Any concrete split onto the asphalt surface shall be
removed. Where so required by the Engineer, the
Contractor shall, without any additional compensation, paint
emulsion over the stained surface.

(j) Protection

During transporting and laying care shall be taken to protect
all precast units against chipping or breakage.

Concrete kerbing and channelling as well as any other
structures adjacent to the road shall be protected against
staining by bitumen being sprayed or premix being placed.
Where bitumen is to be sprayed, all such work shall be
completely covered with polyethylene sheeting at least
0.25 mm thick, specially reinforced paper or other approved
material, properly secured to prevent the sheeting from
lifting during windy conditions. Any work stained by bitumen
shall be broken down and replaced, unless all such bitumen
is completely removed so as not to show any stains.
Painting over stained work is strictly prohibited.

(k) Cutting existing bituminous surfacing and
pavement layers

Where the Engineer instructs kerbing, channelling or
concrete-lined drains to be constructed against existing
bituminous surfacing, the full depth of the bituminous
surfacing, and the base and subbase if necessary, shall be
accurately cut with a mechanical saw to the required line
before the kerbing, channelling or concrete-lined drain is
constructed. The edge shall be vertical for kerbing and
channelling. The concrete shall then be placed directly
against the cut edge without formwork. All material outside
the cut edge shall be removed to the required depth before
the concrete is placed. The debris shall be disposed of at
a dumping site to be provided by the Contractor subject to
the approval of the Engineer. The bituminous surfacing
shall be protected and kept clean to the Engineer’s
satisfaction.

2305 INLET AND OUTLET STRUCTURES AND
TRANSITION SECTIONS

Transition sections on kerbing, kerbing-channelling
combinations and concrete-lined open drains shall be
constructed to the same standards and by the same
methods as described for the uniform sections, but with the
required modifications. Sections may be either precast or
cast in situ units.

Inlet and outlet structures may be either precast or partially
precast concrete units or of cast in situ concrete.

Where shown on the Drawings or instructed by the
Engineer, the Contractor shall supply and install in the outlet
structures energy dissipaters consisting of prefabricated
reinforced-concrete blocks of Class 20/19 concrete of the
dimensions shown on the Drawings or listed in the Schedule
of Quantities. All concrete work shall comply with the
requirements of Series 6000.

Components such as grids, covers and frames shall be in
accordance with the details shown on the Drawings and the
requirements of Subclause 2212(e).

2306 CONSTRUCTION TOLERANCES AND SURFACE
FINISH

(a) Concrete kerbing and channelling

Concrete kerbing and channelling shall be constructed to
within the following dimensional and alignment tolerances:

(i) Horizontal alignment

The maximum deviation of edges, centre line, or vertical
surfaces from the specified position shall be 25 mm.

The maximum deviation of edges, centre line, or vertical
surfaces from the specified alignment, shall be 1:500 when
taken over any section exceeding 10 m in length.

(ii) Vertical alignment and level

The inside edge of channelling shall nowhere be above the
finished road level nor more than 10 mm below the finished
road level. The invert level of channels and open drains and
the top of kerbing shall nowhere deviate by more than
10 mm from the required level and nowhere shall channels
or drains have any adverse grade.

(iii) Trueness of exposed surfaces

When tested with a 3 m straight-edge, no surface
irregularities shall exceed 6 mm.

(iv) Cross-sectional dimensions

All cross-sectional dimensions shall be within 6 mm of the
specified dimensions except that the underside of
channelling may extend up to 25 mm below the level at
which it would have the required thickness.

(b) Concrete-lined open drains and concrete chutes

Concrete-lined open drains and concrete chutes shall be
constructed to within the following tolerances:

(i) Horizontal alignment

The maximum deviation from the true position of the edges
or centre line shall be 25 mm.

(ii) Vertical alignment

The invert level of concrete-lined open channels shall
nowhere deviate by more than 25 mm from the required
level and nowhere shall the open drain invert have an
adverse grade.

(iii) Trueness of exposed surface

When tested with a 3 m straight-edge, no exposed surface
shall show surface irregularities exceeding 10 mm.

2300-3
(iv) Cross-sectional dimensions

All cross-sectional dimensions shall be within 10 mm of the specified dimensions, and the average thickness of a floor or side slab shall not be less than the specified thickness when considering any complete slab or a slab section with a surface area of 10 m² or more, and disregarding a thickness exceeding 10 mm of the specified thickness.

(c) Surface finish

All unformed exposed concrete surfaces shall have a Class U2 surface finish and all formed exposed concrete surfaces shall have a Class F2 surface finish as defined in Clause 6209.

2307 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.01 Concrete kerbing (class of concrete indicated for in situ concrete):</td>
<td></td>
</tr>
<tr>
<td>(a) (Description of type with reference to drawing)</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Etc for other types</td>
<td>metre (m)</td>
</tr>
<tr>
<td>23.02 Concrete kerbing-channelling combination (class of concrete indicated for cast in situ concrete):</td>
<td></td>
</tr>
<tr>
<td>(a) (Description of type with reference to drawing)</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Etc for other types</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of completed chute as constructed, including any overlap, measured along the slope as laid but excluding transition sections and inlet and outlet structures measured separately.

The tendered rate per metre shall include full compensation for procuring, furnishing and installing the completed chutes as specified and for all excavation and the preparation of bedding, backfilling, formwork and finishing required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.04 Cast in situ concrete chutes (measured by components):</td>
<td></td>
</tr>
<tr>
<td>(a) Concrete (class indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Formwork (surface finish indicated)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

Measurement and payment for formwork and concrete shall be as specified in Sections 6200 and 6400, except that payment for excavation and gravel or soil backfilling shall be deemed to be included in the rates tendered for concrete and shall not be measured and paid for separately.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.05 Inlet, outlet, transition and similar structures (typical designs):</td>
<td></td>
</tr>
<tr>
<td>(a) (Description of structure, type, etc, with reference to drawing and class of concrete)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Etc for other types</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement and payment shall be the number of completed units of each type of structure constructed, and payment shall include full compensation for all formwork, concrete, excavation, trimming and backfilling, including such accessories as grids, etc, as may be specified on the Drawings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.06 Inlet, outlet, transition and similar structures (measured by components):</td>
<td></td>
</tr>
<tr>
<td>(a) Concrete (class indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Formwork (surface finish indicated)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(c) Other components</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The measurement and payment for formwork and concrete shall be as specified in Sections 6200 and 6400, except that excavation, trimming and backfilling shall not be measured and paid for separately, the cost of which shall be deemed to be included in the rates tendered for concrete.
The unit of measurement for other components such as grids shall be the number of each type of component installed. The tendered rates shall include full compensation for procuring, furnishing and installing the components, including any painting or protective coating specified in the Project Specifications or as shown on the Drawings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.07 Trimming of excavations for concrete-lined open drains:</strong></td>
<td></td>
</tr>
<tr>
<td>(a) In soft material</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) In hard material</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of excavation trimmed to receive concrete lining.

The tendered rates shall include full compensation for all labour, plant, materials and other additional work and incidentals necessary for trimming the excavations for open drains to the standard of finish required for the construction of concrete linings. All excavation, including the removal of unsuitable ground and backfilling with suitable material, shall be measured and paid for under Section 2100. Payment shall distinguish between trimming in soft material and trimming in hard material as defined in Section 2200. No extra payment shall be made in respect of any soil or gravel backfilling, additional concrete or mass-concrete backfilling required on account of overbreak or unavoidable unevenness of the excavations in difficult ground, the cost of which shall be deemed to be included in the tendered rates for trimming in hard material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.08 Concrete lining for open drains:</strong></td>
<td></td>
</tr>
<tr>
<td>(a) Cast in situ concrete lining (class of concrete and type of open drain indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Class U2 surface finish to cast in situ concrete (type of open drain indicated)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

Measurement of and payment for concrete lining shall be as specified in Section 6400, but the tendered rate shall include full compensation for painting open joint surfaces as specified.

The unit of measurement for surface finish shall be the square metre of finished surface.

The tendered rate for surface finish shall include full compensation for all labour, plant, material and other additional work and incidentals required for trimming the concrete lining as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.09 Formwork to cast in situ concrete lining for open drains (Class F2 surface finish):</strong></td>
<td></td>
</tr>
<tr>
<td>(a) To sides with formwork on the internal face only</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) To sides with formwork on both internal and external faces (each face measured)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(c) To ends of slabs</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

Measurement of and payment for formwork shall be as specified in Section 6200. Formwork under Item 23.09(a) shall be measured and paid for only when the side slope of the slabs exceeds 1:2 and the slabs cannot be constructed without formwork even when a stiff concrete mix is used. When the Contractor elects to use precast side slabs, payment will be made for formwork as if cast in situ concrete had been used.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.10 Sealed joints in concrete linings of open drains</strong> (description of type with reference to drawing)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of completed joint of each size and type.

The tendered rate shall include full compensation for the supply of all materials and for all labour, formwork and incidentals necessary for sealing the joint as shown on the Drawings or specified in the Project Specifications.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.11 Concrete screed or backfill below chutes</strong> (class of concrete indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of concrete screed or backfill as may be instructed by the Engineer to be placed below chutes.

The tendered rate shall include full compensation for furnishing, procuring and placing the concrete in screed or backfill.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.12 Steel reinforcement:</strong></td>
<td></td>
</tr>
<tr>
<td>(a) Mild steel bars</td>
<td>tonne (t)</td>
</tr>
<tr>
<td>(b) High-tensile steel bars</td>
<td>tonne (t)</td>
</tr>
<tr>
<td>(c) Welded steel fabric</td>
<td>kilogram (kg)</td>
</tr>
</tbody>
</table>

Measurement and payment shall be in accordance with the provisions of Section 6300.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23.13 Polyethylene sheeting</strong> (0.15 mm thick) for concrete-lined open drains</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>
The unit of measurement shall be the square metre of area covered with polyethylene sheeting.

The tendered rate shall include full compensation for procuring, furnishing and installing the polyethylene sheeting, including wastage and overlap.

### Item 23.14 Cutting bituminous surfacing and pavement layers for concrete kerbing, channelling or concrete line drains

The unit of measurement shall be the metre of bituminous surfacing and pavement layers cut where instructed by the Engineer, irrespective of the depth cut. The various layers shall not be measured separately for payment.

The tendered rate shall include full compensation for all labour, constructional plant and materials required for cutting the surfacing and pavement layers to the required depth, removing and disposing of the debris, and protecting and keeping the surfacing clean, all as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.14 Cutting bituminous surfacing and pavement layers for concrete kerbing, channelling or concrete line drains</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

### Item 23.15 Precast concrete blocks in outlet structures

The unit of measurement shall be the number of precast concrete blocks provided and installed as shown on the Drawings or directed by the Engineer.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.15 Precast concrete blocks in outlet structures</td>
<td>number (No)</td>
</tr>
</tbody>
</table>
2403 COMPOUNDING, MIXING AND TRANSPORTING ASPHALT MIXES

(a) Compounding the mixture

Asphalt containing penetration-grade bitumen shall contain, by mass of the dry aggregate, 7% of net 60/70 or 80/100 penetration-grade bitumen and 1% of active filler.

Asphalt containing mix-grade bitumen emulsion shall contain, by mass of the dry aggregate, 7% of net bitumen. The asphalt mix shall be in accordance with the requirements of the project specification.

The composition of the asphalt mix shall in all cases be subject to the prior approval of the Engineer.

(b) Mixing plant

The mixing plant shall be in accordance with the requirements of Clause 2404.

(c) Mixing, transporting and placing

Asphalt with penetration-grade bitumen shall be mixed, transported and placed in accordance with the requirements of Section 4200, and asphalt with mix-grade bitumen-emulsion in accordance with the requirements of the project specification.

2404 PREPARING THE BERM FOUNDATION

If shown on the Drawings, the prime coat sprayed onto the base and shoulders shall extend over a wider area to allow space for the berms to be placed.

Where the Engineer so instructs that berms shall be constructed, the specified width of the base projecting beyond the sides of the paved shoulder shall be thoroughly cleaned. The shoulder material adjacent to the base shall be compacted and trimmed to the upper level of the base and all loose material removed.

A prime coat consisting of 30% bitumen-emulsion shall be applied at a rate of 0.4 /m² onto that part of the berm foundation falling outside the paved surface of the road. In the case of asphalt berms, a tack coat of 30% bituminous emulsion shall be applied at a rate of 0.4 /m² over the entire berm foundation. The tack coat shall be left to break before the berm is placed.

2405 PLACING

When the berms are placed, proper care shall be taken at all times to ensure that the toe of the berm does not encroach on the side of the carriageway or shoulder by more than 25 mm.

(a) Placing by hand

The mixture shall be placed and shaped in situ in a rigid portable mould to form a trapezoidal kerb of the dimensions indicated on the Drawings.
In the case of asphalt berms the mixture shall be thoroughly compacted to form a hard unyielding berm, true to level, shape and line, within the specified tolerances. The moulds may be removed as soon as the material has cooled to air temperature, or, in the case of a cold asphalt mix, as soon as it has hardened.

(b) Placing by machine

A machine of approved design may be used for placing the berm. In general, machine-placed work will not require any additional compaction. In areas where, in the opinion of the Engineer, the compaction is inadequate, the machine shall be weighted with additional mass, or other measures shall be taken to ensure that adequate compaction is obtained.

(c) Placing under guardrails

Should the berm be placed first, the holes for the guardrail posts shall be excavated with care to prevent damage being done to the berm. Where chutes are required against fills, the berm shall be discontinued for the width of the top of the chute and finished to form a proper inlet for the water into the chute, as indicated on the Drawings.

(d) General requirements

The berms shall be placed true to level, shape and line. All berms deviating more than 10 mm from the specified line when measured at the inner edge of either their crests or their bases, or of which the height or width, measured at the crest, varies by more than 5 mm from the specified height or width, will be rejected and shall be removed and replaced at the Contractor's own expense.

The surfaces of concrete berms placed by machine, and all unformed surfaces, shall be given a Class U2 finish, and formed surfaces a Class F2 finish. Joints shall be provided at 3 m intervals in all concrete berms, either by casting in alternate sections or by cutting machine-placed sections. All such joints shall be neatly formed and finished so as not to leave any irregularities or loose concrete at the joints.

2406 TRANSITION SECTIONS FOR NEW JERSEY TYPE OF RAILS

Where transition sections for New Jersey type of bridge rails are required to be constructed from asphalt, the instructions for asphalt berms shall apply in regard to the asphalt composition and the preparation of the foundation.

2407 MEASUREMENT AND PAYMENT

Item Unit

24.01 Asphalt berms:

(a) Placed where there are no guardrails (types of asphalt and binder indicated) ................ metre (m)

(b) Placed at existing guardrails (types of asphalt and binder indicated) ................ metre (m)

Item Unit

24.02 Concrete berms:

(a) Placed where there are no guardrails ........................ metre (m)

(b) Placed at existing guardrails ........................ metre (m)

The unit of measurement shall be the metre of asphalt berm placed as specified.

The prime and tack coats shall be paid for under Item 24.03.

Item Unit

24.03 Prime and tack coats:

(a) Prime coat:

(i) Under asphalt berms (primer indicated) ................ square metre (m²)

(ii) Under concrete berms (primer indicated) ................ square metre (m²)

(b) Tack coat (type indicated) ................ square metre (m²)

The unit of measurement shall be the square metre of completed prime coat or tack coat applied in accordance with the Specifications.

The tendered rates shall include full compensation for procuring and providing all material and for mixing and applying the adhesive and primer complete as specified, including cleaning, compacting and trimming the coat being primed.

Payment shall be made under this item for the prime coat if, as instructed by the Engineer, it is applied in a separate strip independently from the prime coat of the road or shoulder surface.

If applied as an integral part of the prime coat of the road or shoulder surface by the prime coat being sprayed over a wider area to provide space for the berms, payment for the prime coat will not be made under this item.
Item | Unit
--- | ---
24.04 Transition sections for New Jersey type of rails | number (No)

The unit of measurement shall be the number of completed asphalt transition sections constructed to the details shown on the Drawings.

The tendered rate shall include full compensation for procuring, providing, mixing and placing all materials, and for all labour, formwork and incidentals required for constructing complete transition sections as specified.
SERIES 2000 : DRAINAGE

SECTION 2500 : PITCHING, STONEWORK AND PROTECTION AGAINST EROSION

CONTENTS
2501 SCOPE
2502 MATERIALS
2503 STONE PITCHING
2504 RIPRAPP
2505 STONE MASONRY WALLS
2506 SEGMENTAL BLOCK PAVING
2507 CAST IN SITU CONCRETE PITCHING
2508 MEASUREMENT AND PAYMENT

2501 SCOPE

This Section covers the furnishing of materials and the construction of a protective covering in stone pitching, cast in situ concrete pitching, bricks or prefabricated concrete blocks on exposed surfaces such as earth slopes, drains and stream beds, as well as heavier protective layers in the form of riprap and the construction of stone masonry for walls, all as shown on the Drawings or ordered by the Engineer.

2502 MATERIALS

(a) Stone

(i) Pitching

Stone for pitching shall be sound, tough and durable, without any stones less than 200 mm in minimum dimension, except that smaller pieces or spalls may be used for filling spaces between the larger stones. The shapes of the rocks or stones shall be so as to form a stable protective layer of the required thickness. Rounded boulders shall not be used on slopes steeper than 2:1 unless grouted.

All stone intended for use on a particular pitching job shall be subject to the prior approval of the Engineer.

(ii) Riprap

Stone for riprap shall be hard field or quarry stone not susceptible to disintegration or excessive weathering on exposure to the atmosphere or water. It shall be free from soft material such as sand, clay, shale or organic material and shall not contain an excessive quantity of elongated stones.

The required size of the stone will depend on the "critical mass" specified. At least 50% by mass of the material comprising the riprap shall consist of stones with a mass heavier than the critical mass, and not more than 10% by mass of the material shall consist of stones with a mass of less than 10% of the critical mass or more than 5 times the critical mass.

(b) Cement

Cement shall be ordinary Portland cement which complies with the requirements of SABS 471 or equivalent.

(c) Sand

(i) Sand for concrete

Sand for concrete, cement slurry and cement mortar shall comply with the requirements of SABS 1083 or equivalent.

(ii) Sand for bedding

Sand for bedding used for paving blocks shall not contain any deleterious impurities and shall comply with the grading requirements in Table 2502/1.

Table 2502/1

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.52</td>
<td>100</td>
</tr>
<tr>
<td>4.75</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36</td>
<td>80-100</td>
</tr>
<tr>
<td>1.18</td>
<td>50-85</td>
</tr>
<tr>
<td>0.600</td>
<td>25-60</td>
</tr>
<tr>
<td>0.300</td>
<td>10-30</td>
</tr>
<tr>
<td>0.150</td>
<td>5-15</td>
</tr>
<tr>
<td>0.075</td>
<td>0-10</td>
</tr>
</tbody>
</table>

(iii) Sand for joints

Sand used for being brushed into the joints between pavement blocks shall all pass through a 1.18 mm sieve, and between 10 and 15% of it shall pass through a 0.075 mm sieve.

(d) Paving blocks

Paving blocks shall comply with the requirements of SABS 1058 or equivalent for Class 25 paving blocks where paving blocks are made from concrete, and bricks used as paving blocks shall be facebrick units which shall comply with the requirements of SABS 227 or equivalent. Engineering units may also be used instead of facebrick units.

The surface texture and colour of all units shall be uniform.

Paving blocks for sidewalks shall be square prefabricated concrete blocks, 450 mm x 450 mm x 50 mm in size and fabricated from Class 30 concrete. As to appearance, the blocks shall comply with the requirements of Clause 3.3 of SABS 927 or equivalent. The upper surface shall have an approved pattern to provide proper skid resistance.

Concrete grass blocks shall consist of concrete slabs of the dimensions shown on the Drawings, with openings through the slab totalling at least 20% of the surface area.

(e) Concrete

Concrete work shall be carried out in accordance with the provisions of Sections 6200, 6300 and 6400.

(f) Wire

Wire for pitching kept in position by wires shall consist of 4 mm diameter galvanised wire which complies with the requirements of SABS 675 or equivalent.
(g) Permeable material for filter layer

Permeable material for filter layers shall comply with the requirements specified for permeable material for subsoil drains in Subclause 2104(a)(ii).

(h) Synthetic-fibre filter fabric

Synthetic-fibre filter fabric shall be of the grade and type specified in the Schedule of Quantities or Project Specifications and shall comply with the requirements of Subclause 2104(a)(iii).

2503 STONE PITCHING

(a) Plain stone pitching

The area shall be prepared by excavating, shaping and trimming necessary for pitching, and by thoroughly compacting the area by hand-ramming to prevent subsequent settlement. A trench shall be excavated as directed by the Engineer along the toe of any slopes to be pitched or along the unprotected edge of the pitching in the beds of streams. Two pitching methods follow, and the method to be adopted shall be decided on by the Engineer.

(i) Method 1

Commencing at the bottom of the trench, the stone shall be laid and firmly bedded into the slope and against adjoining stones. The stones shall be laid with their longitudinal axes at right angles to the slope and with staggered joints. The stones shall be well rammed into the bank or surface to be protected and the spaces between the larger stones shall be filled with spalls of approved pitching stone securely rammed into place.

Placing of rock by dumping shall not be allowed.

(ii) Method 2

The technique and requirements laid down in Method 1 shall also apply to Method 2, except in the following aspects:

(1) No small stones or spalls shall be used to fill in spaces between larger stones.

(2) Simultaneously with the placing of stones, topsoil shall be introduced between individual stones, and sufficiently rammed so as to provide a firm bonded structure. The topsoil shall be provided to the full depth of the stone pitching at any point.

(3) Rooted grass or tufts of grass shall then be planted in the topsoil between stones, and watered immediately and copiously and thereafter at regular intervals until the grass has been established.

Whichever of the above two methods is adopted, the finished surface of the pitching shall present an even, tight and neat appearance with no stones varying by more than 25 mm from the specified surface grades or lines. The thickness of the pitching, measured at right angles to the surface, shall not be less than 200 mm.

(b) Grouted stone pitching

The work shall be done in accordance with all the requirements specified for plain pitching in Subclause 2503(a) above, except that the stones shall be thoroughly cleaned of adhering dirt or clay, moistened and embedded in freshly laid cement mortar composed of one part of cement to six parts of sand. Any spaces between the stones shall be filled with cement grout of the same composition as the mortar. The mortar and grout shall be placed in a continuous operation for any day’s run at any one location. The grout shall be worked into the pitching so as to ensure that all spaces or voids between the stones will be completely filled with grout to the full depth of the stone pitching. Grout spilt onto exposed surfaces of the stone shall be removed while still soft, and the joints between stones shall be neatly finished.

The grouted pitching shall be cured with wet sacking or other approved wet cover for a period of not less than four days after grouting, and shall not be subjected to loading until adequate strength has been developed. Where required, weep holes shall be formed in the pitching.

(c) Wired and grouted stone pitching

The pitching shall be held in position at the bottom and top with wire nets with 150 mm mesh. The bottom net with wire ties fastened to it at 800 mm distances and projecting upwards, shall first be placed over the surface to be pitched. The stone shall then be laid on this net in accordance with the requirements specified for plain stone pitching in Subclause 2503(a). After the stone has been laid, the top wire net shall be drawn tightly over the stone course and securely fastened to the wire ties passing from the bottom net through the pitching. After having been tied, the ends of the ties shall be turned down into the pitching. The entire area of wired pitching shall then be grouted and finished off with cement grout in accordance with all the requirements specified for grouted pitching in subclause 2503(b).

(d) Grouted stone pitching on a concrete bed

The area to be pitched shall be prepared as described in Subclause 2503(a) and a concrete bed (Class 15 concrete) with a thickness of at least 75 mm shall then be placed. The stone pitching shall be of stones with a minimum dimension of 200 mm, which shall be laid while the concrete is still fresh. Openings between stones shall be filled with cement grout as described in Subclause 2503(b), and care shall be taken not to spill the grout onto the finally exposed surfaces of the stones. Grout spilt onto the exposed surfaces of the stones shall be removed while still soft, and the joints between stones shall be neatly finished.

Curing shall be done as described for grouted stone pitching in Subclause 2503(b).

The completed pitching shall have an even compacted appearance, and nowhere may the surface deviate by more than 25 mm from the specified lines and grades.

2504 RIPRAP

(a) General

Riprap shall consist of a course or courses of large rock placed on bank slopes and toes in stream and river beds and at other localities where protection of this type may be required.

Two types of riprap are specified here, viz one type where the rocks are individually packed, which is designated as packed riprap, and the other type where the rock is dumped
and then spread by machines, which is designated as dumped riprap. The surface of areas to receive riprap shall be neatly trimmed to line and level and all loose material compacted. The perimeters of riprap areas shall be protected by the construction of either rock-filled trenches, walls or other structures as may be required. Perimeter trenches shall normally be backfilled with rock of the same size and quality as that used in the construction of the adjoining riprap, but any voids shall be filled with smaller stone and the entire backfill shall be well compacted.

(b) Filter bed
The filter bed shall consist of a layer or layers of permeable material placed on the prepared surface to the required thickness and each layer shall be finished to an even surface and thickness. Compaction of pervious material will not be required. Care shall be taken not to mix various grades of filter material nor to disturb material already placed when subsequent layers or riprap are being placed.

When the use of synthetic-fibre filter fabric is required, the material shall be placed on the prepared surface or on the filter bed, depending on the instructions. The overlap between adjacent sheets shall be 150 mm unless otherwise specified. Care shall be taken not to damage the filter fabric when subsequent layers are being placed, nor to expose the filter fabric to the sun for periods exceeding three days before it is covered.

(c) Packed riprap
Packed riprap shall be constructed from rocks placed individually to stagger the joints and so as to be firmly bedded in the prepared surface. The spaces between larger stones shall be filled with spalls or smaller stones securely rammed into place. On inclined surfaces the rock shall be laid in long horizontal strips starting from the bottom, and not in strips up the slope.

The completed riprap shall present a tight and even surface. Local surface irregularities of the riprap shall not exceed 150 mm.

(d) Dumped riprap
Dumped riprap shall be constructed by dumping the stone on the prepared surface, spreading it by bulldozer, or other suitable earth-moving equipment, and trimming it to the required lines and levels. The material shall be placed in a manner that will prevent the segregation of the smaller and larger stones and the top layer shall be tight with a minimum of voids.

2505 STONE MASONRY WALLS

(a) General
Stone masonry walls may be plain packed stone walls with dry joints or otherwise mortared stone walls with stones bedded in cement mortar as indicated on the Drawings, as specified, or as may be ordered.

The minimum mass of each stone used shall be 10 kg and its minimum dimension 75 mm.

(b) Plain packed stone walls
A foundation trench shall be excavated down to rock, or to material with an adequate bearing capacity at a minimum depth of 300 mm below ground level. Large selected stones shall be used for the foundation layer. Flat and stratified stones shall be laid with the largest dimension in the horizontal plane. Stones shall be packed individually to stagger the joints and to provide a minimum of voids, and shall be firmly bedded against adjoining stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The larger stones shall not bear on the spalls used for filling the voids. The top and ends of the wall shall be neatly finished with selected coping stones.

The appearance of the completed wall shall present an even, tight surface.

(c) Cement-mortared stone walls
The walling shall be constructed as specified in (b) above, with the exception that the stones shall be wetted and set in a 6:1 sand:cement mortar. The exposed parts of the stones on the wall faces shall be cleaned of all mortar by washing or wire-brushing. The mortar shall be flush pointed to the satisfaction of the Engineer, who may require a capping and end treatment of the same mortar.

Weep holes shall be provided as prescribed and shall be cleaned of mortar or any other clogging material that may have entered during construction.

The walling shall be protected from the elements and kept moist for a minimum period of four days after completion.

2506 SEGMENTAL BLOCK PAVING

(a) General
The underlying layers for surfaces to be pitched shall be constructed as specified or as indicated on the Drawings. Where no specified requirements have been set in respect of the underlying layers, the top layer shall be mechanically compacted to at least 93% of modified AASHTO density down to at least 150 mm from the top. During this process the top layer shall be trimmed to the required grades and levels.

Where specified or required by the Engineer the prepared surface shall be treated with approved environmentally compatible herbicide and ant poison before the layer of sand for bedding is placed.

(b) Sand for bedding
A layer of sand for bedding shall be placed on top of the prepared surface, and, when still loose, accurately floated to an uncompacted thickness of 30 mm (± 5 mm) so as to afford the correct level to the pavement after compaction. Sand for bedding shall be placed immediately before the paving blocks are laid and shall not be compacted before the blocks have been laid.

(c) Laying the paving blocks
The pattern for laying the paving blocks shall be that as shown on the Drawings or approved or prescribed by the Engineer. Unbroken blocks shall first be laid and filler...
described in Clause 2506 for block paving. The areas shall be compacted, trimmed and prepared as described in Clause 2506(d). Where indicated, the concrete pitching shall be contained by concrete edge beams being constructed as described in Clause 2506(d).

After compaction of the pavement as described above, joint sand shall be spread and brushed into the joints until the joints have been properly filled. Any surplus sand shall then be broomed off and the pavement shall then be subjected to two further passes by the plate vibrator.

(d) Edge beams

Concrete edge-beams or any such other edge supports shall be constructed onto the supporting layer in accordance with the details shown on the Drawings, and shall be constructed and left to cure before any paving blocks are laid.

(e) Paving blocks for sidewalks

Paving blocks for sidewalks shall be laid in the same way as that described above for paving blocks, also on a bed of sand, but on the proviso that, where so specified, joints shall be filled with a 6:1 sand:cement mortar instead of with sand only. In this case the width of the joints between the stones shall be strictly in accordance with the dimensions shown on the Drawings, and the pavement shall be fully compacted before the joints are filled.

(f) Concrete grass blocks

Concrete grass blocks of the size specified or shown on the Drawings shall be placed on areas prepared for grassing as specified in Section 5700. The holes in the blocks shall be filled with topsoil, and grassed with grass cuttings or hydroseeding as specified in Section 5700.

(g) Finishing requirements

(i) Segmental block paving

The completed paving shall be even and neat, flush with the kerb or edge-beam and may not lie below the side of the kerbing. The final surface may nowhere deviate by more than 15 mm from the specified levels and planes, and no irregularities exceeding 10 mm may occur during testing with a 3 m straight-edge.

(ii) Grass-block pavement

The completed grass-block pavement shall have a neat and even appearance. The final surface of the pavement may nowhere deviate by more than 15 mm from the specified levels and planes.

2507 CAST IN SITU CONCRETE PITCHING

The areas where cast in situ concrete pitching is to be constructed shall be compacted, trimmed and prepared as described in Clause 2506 for block paving. The areas shall also be treated with an environmentally compatible herbicide and ant poison if required. The concrete shall comply with the requirements of Series 6000.

Prior to placing the concrete, the surface shall be watered and kept damp until the concrete has been placed. The type of concrete used shall, unless otherwise specified, be Class 20 and the concrete shall be accurately laid in alternate panels to the lines and levels indicated, after which the remaining panels shall be similarly placed. Accurately set-up guides shall be used to achieve the required line and slope. The concrete shall be thoroughly compacted and finished to a Class U2 surface finish.

Where indicated, the concrete pitching shall be contained by concrete edge beams being constructed as described in Clause 2506(d).

The concrete pitching shall be cured for at least seven days and no traffic shall be allowed to move across the pitching before the specified 28-day strength has been reached.

The final surface may nowhere deviate by more than 25 mm from the specified levels and planes, and no irregularities exceeding 10 mm may occur during testing with a 3 m straight-edge.

2508 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.01 Stone pitching:</td>
<td></td>
</tr>
<tr>
<td>(a) Plain pitching:</td>
<td></td>
</tr>
<tr>
<td>(i) Method 1</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(ii) Method 2</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) Grouted stone pitching</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(c) Wired and grouted stone pitching (total thickness indicated)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(d) Grouted stone pitching on a concrete bed (total thickness indicated)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for pitching shall be the square metre of each type of pitching in place.

The tendered rate for each type of stone pitching shall include full compensation for furnishing all materials, making all excavations excluding trench and bulk excavations, compacting and trimming the excavated surfaces, forming and cleaning the weepholes, placing stones and grouting, or wiring and grouting where applicable, grassing and watering (applicable to Method 2) and for all other work necessary for completing the pitching as specified. The tendered rate for grouted stone pitching on a concrete bed shall also include full compensation for the concrete bed.

Excavations for foundation trenches and concrete edge beams and the construction of the concrete edge beams will be paid for separately.
Item | Unit
---|---
25.02 Riprap: |  
(a) Packed riprap (critical mass of stone indicated) | cubic metre (m³)  
(b) Dumped riprap (critical mass of stone indicated) | cubic metre (m³)  
(c) Filter backing (Subclauses 2104(a)(ii) and 2504(b)) consisting of:  
(i) Crushed stone | cubic metre (m³)  
(ii) Filter sand obtained from borrow pits | cubic metre (m³)  
(d) Synthetic-fibre filter fabric (type, class and grade stated) | square metre (m²)  

The unit of measurement for riprap and filter layer (Subitems (a), (b) and (c) above) shall be the cubic metre of riprap or filter layer in place and shall include rock used in trench backfill. The unit of measurement for Subitem (d) shall be the square metre of filter fabric laid as specified, including overlaps.

The rates tendered for Subitems (a), (b) and (c) shall include full compensation for preparing the surfaces, including excavation (but excluding excavation for trenches and bulk excavations) and for the furnishing, transporting, handling and placing of riprap or filter layers. The rate tendered for Subitem (d) shall include full compensation for procuring and furnishing the filter fabric and for laying it as specified, including wastage. Collectively the rates shall also include full compensation for all other incidentals necessary for completing the work as specified.

Item | Unit
---|---
25.03 Stone masonry walls: |  
(a) Plain packed stone walls | cubic metre (m³)  
(b) Cement-mortared stone walls | cubic metre (m³)  

The unit of measurement for stone masonry walls shall be the cubic metre of actual walling constructed and accepted.

The tendered rate for each type of stone wall shall include full compensation for furnishing all materials, trimming the areas, placing the stones and cement-mortared masonry where necessary, and all other work necessary for completing the walls in accordance with the Specifications. Excavation of foundation trenches will be paid for separately.

Item | Unit
---|---
25.04 Concrete pitching and block paving: |  
(a) Cast in situ concrete pitching (class of concrete and thickness of pitching indicated) | square metre (m²)  
(b) Segemental block paving (type and thickness indicated) | square metre (m²)  
(c) Prefabricated concrete grass blocks | square metre (m²)  
(d) Prefabricated concrete paving blocks for sidewalk pavement (thickness indicated) | square metre (m²)  

The unit of measurement shall be the square metre of each type constructed.

The tendered rates shall include full compensation for furnishing all materials, all excavation (but excluding bulk excavation and excavation for foundation trenches and edge beams), compacting and trimming all the excavated areas, providing a sand bedding (Subitems (b) and (d)), laying and compacting the paving blocks (Subitems (b) and (d)), laying concrete grass blocks (Subitem (c)), topsoiling and grassing, (Subitem (c)), constructing concrete pitching, including normal formwork and the shaping of surfaces (Subitem (a)), making and cleaning weepholes (Subitem (a)) and for all other work necessary for completing the work as specified.

Item | Unit
---|---
25.05 Concrete edge beams |  
(class of concrete indicated) | cubic metre (m³)  

The unit of measurement shall be the cubic metre of concrete in edge beams constructed as instructed.

The tendered rate shall include full compensation for furnishing all materials and labour, including formwork as necessary, placing concrete and shaping all surfaces and all excavations required (in all classes of material).

Item | Unit
---|---
25.06 Provision of herbicide and ant poison: |  
(a) Provision of materials | Prime cost sum  
(b) Contractor's charges and profit added to the prime cost sum | per cent (%)  

Payment under the prime cost sum for providing environmentally compatible ant poison and herbicide and the Contractor's costs and profit in this respect shall be made in accordance with the provisions of the General Conditions of Contract, but, in addition, the Contractor's tendered rate for costs and profit shall include full compensation for applying the chemicals as specified.

Item | Unit
---|---
25.07 Foundation trenches | cubic metre (m³)  

The unit of measurement shall be the cubic metre of material excavated for foundation trenches irrespective of the class or depth of material. The quantity shall be calculated according to the dimensions shown on the Drawings or instructed by the Engineer.
The tendered rate shall include full compensation for the excavation of the foundation trenches irrespective of the class or depth of material, complete as specified, or as shown on the Drawings or as instructed by the Engineer.
SERIES 2000 : DRAINAGE
SECTION 2600 : GABIONS

CONTENTS
2601 SCOPE
2602 MATERIALS
2603 CONSTRUCTING GABION CAGES
2604 CONSTRUCTING GABIONS
2605 MEASUREMENT AND PAYMENT

2601 SCOPE

This Section covers the construction of gabion walls and aprons for constructing retaining walls, lining channels, revetments and other anti-erosion structures.

Generally gabions shall be flexible galvanised steel-wire-mesh cages packed with rock.

2602 MATERIALS

(a) Rock

Rock used as filling for cages shall be clean, hard unweathered boulders or rock fragments. No rock fragment shall exceed the maximum size given in Table 2602/1, and at least 85% of the rocks shall be of a size equal to or above the average least dimension size given in Table 2602/1.

Table 2602/1
Rock sizes

<table>
<thead>
<tr>
<th>Depth of cage (m)</th>
<th>Rock size according to the largest dimension of rock</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average least dimension (mm)</td>
<td>Maximum (mm)</td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>125</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>125</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>125</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>125</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

(b) Wire

All wire used for making the gabions and for tying during the construction of the gabions shall comply with the requirements of SABS 675 or equivalent for mild-steel wire.

(c) PVC-coated wire

The gabions of PVC-coated mesh shall be of an acknowledged make which shall be subject to approval by the Engineer.

(d) Galvanising

All wire used in the making of gabions shall be galvanised in accordance with the provisions of SABS 675 or equivalent for Class A heavy galvanised mild-steel wire.

(e) Wire mesh

Wire mesh shall comply with the requirements of SABS 1580 or equivalent.

(f) Filter fabric below the gabions

Filter fabric shall comply with the requirements of Subclause 2104(a)(iii) for Grade 3 filter fabric.

2603 CONSTRUCTING GABION CAGES

(a) General

Gabion cages shall be made from wire mesh of the size and type and selvedge as specified below. The cages shall be subdivided into cells by wire mesh diaphragms and will be of two types:

(i) Boxes which are generally used for the construction of gabion walls. These boxes are subdivided into cells by diaphragms spaced at 1.0 m intervals. No diaphragms are required for a box of which the length does not exceed 1.5 m.

(ii) Mattresses which are generally used as single-layer aprons only in revetments, channel linings, etc, and in which the maximum width shall be 2 m, and the maximum depth 0.5 m. Mattresses shall be subdivided by diaphragms into cells with a width of 600 mm or 1.0 m as specified in the Schedule of Quantities.

The standard sizes of boxes and mattresses are as follows:

(1) Boxes

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3 and 4 m</td>
<td>1.0 m</td>
<td>0.3 m, 0.5 m and 1.0 m</td>
</tr>
</tbody>
</table>

(2) Mattresses

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 m</td>
<td>2 m</td>
<td>0.2 m, 0.3 m and 0.5 m</td>
</tr>
</tbody>
</table>

Diaphragm spacing .... 1.0 m.

Other gabions may be supplied, provided that the Engineer's prior permission has been obtained.

(b) Selvedges

The cut edges of all mesh used in the construction of gabions, except the bottom edges of diaphragms and end panels, shall be selvedged with wire with a diameter as specified in SABS 1580 or equivalent.

Where the selvedge is not woven integrally with the mesh but has to be tied to the cut ends of the mesh, it shall be attached by tying the cut ends of the mesh to the selvedge, so that a force of not less than 8.5 kN applied in the same plane as the mesh at a point on the selvedge of a mesh sample of 1.0 m in length will be required to separate it from the mesh.
(c) Diaphragms and end-panels
The diaphragms and end-panels shall be selvedged on the top and vertical sides only. The end-panels shall be attached by the cut ends of the mesh wires at the bottom of the panel being twisted around the selvedge on the base of the gabion. Similarly, the diaphragms shall be attached by the cut ends of the mesh being twisted to the twisted joints of the mesh in the base of the gabion. In each case the force required to separate the panels from the base shall be not less than 6 kN/m.

(d) Binding and connecting wire
Sufficient binding and connecting wire for all the tying to be done during construction of the gabions as specified in Clause 2604 below, shall be supplied with the gabion cages. The diameter of the wire shall be 2.2 mm.

(e) Tolerances
The tolerance on the specified diameter of all wire shall be ± 2.5%. The length of the cages shall be subject to a tolerance of ± 10% and the width of the cages shall be subject to a tolerance of ± 5% and the depth of the cages shall be subject to a tolerance of ± 5%.

2604 CONSTRUCTING GABIONS
(a) Preparing the foundation and surface
The surface on which the gabion cages are to be laid prior to their being filled with rock shall be levelled to the depth shown on the Drawings or as directed by the Engineer so as to present an even surface. If necessary, cavities between rock protrusions shall be filled with material similar to that specified in Subclause 2602(a). Where required, a foundation trench along the toe of the revetment or wall shall be excavated to the dimensions shown on the Drawings or indicated by the Engineer.

(b) Filter fabric
One layer of Grade 3 filter fabric shall be placed where indicated on the Drawings or ordered by the Engineer. The material shall be placed, in accordance with the instructions, in strips with a minimum overlap of 300 mm at the joints, and shall be properly fastened to prevent any movement or slipping while the gabions are being placed.

(c) Assembly
The methods of constructing, stretching, placing in position, wiring and filling the gabions with rock shall generally be in accordance with the manufacturer’s instructions which have been approved by the Engineer, but nevertheless sufficient connecting wires shall be tensioned between the vertical sides of all the outer visible cells to prevent the deformation of boxes as they are being filled with stone.

It is essential that the corners of gabion cages be securely wired together to provide a uniform surface and ensure that the structure does not resemble a series of blocks or panels.

The layout and the tolerances for the layout of the boxes shall be as shown on the Drawings or as instructed by the Engineer.

(d) Rock filling
(i) Boxes in retaining walls
Particular care shall be taken in packing the visible faces of gabion boxes, where only selected stone of the specified size shall be used so as to obtain an even-faced finish. The boxes shall be filled in layers to prevent deformation and bulging. Boxes shall be filled to just below the level of the wire braces, after which the braces shall be twisted to provide tension. Care must be taken to ensure that consecutive layers of cages are filled evenly to a level surface ready to receive the next course.

(ii) Mattresses used in revetments and aprons
The 0.2 m, 0.3 m and 0.5 m gabions forming aprons and revetments shall be filled by random stones being packed in the first layer and by selected stones being used for the top layer so as to resemble normal stone pitching.

2605 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.01 Foundation trench</td>
<td>excavation and backfilling:</td>
</tr>
<tr>
<td>(a) In solid rock (material which requires blasting)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) In all other classes of material</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of each class of excavation made in accordance with the authorised dimensions.

The tendered rates shall include full compensation for excavating in each class of material, including unavoidable overbreak, the trimming of trenches and compacting the trench inverts, backfilling and compacting the backfill, and the disposing of surplus excavated material, including a free-haul of 1.0 km.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.02 Surface preparation for bedding the gabions</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for levelling and preparing surfaces for receiving the gabions shall be the square metre to the nearest dimensions of revetments, aprons or wall foundations.

The tendered rate shall include full compensation for excavating, filling any cavities with rock, and levelling the ground surface so as to be ready for receiving the gabion cages for retaining walls, aprons and revetments.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.03 Gabions:</td>
<td></td>
</tr>
<tr>
<td>(a) Galvanised gabion boxes (dimensions of box and mesh size indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>
(b) PVC-coated gabion boxes
(dimensions of box and
mesh size indicated) ............ cubic metre (m³)

(c) Galvanised gabion mattresses
(dimensions of mattress,
mesh size and diaphragm
spacing indicated) ............ cubic metre (m³)

(d) PVC-coated gabion mattresses
(dimensions of mattress,
mesh size and diaphragm
spacing indicated) ............ cubic metre (m³)

The unit of measurement shall be the cubic metre of the rock-filled cages and the quantity shall be calculated from the dimensions of the gabions indicated on the Drawings or prescribed by the Engineer, irrespective of any deformation or bulging of the completed gabions.

The tendered rates shall include full compensation for supplying all the materials, including rock fill, wire-mesh cages, tying and connecting wires, loading, transporting and off-loading, the assembling and filling of the cages, and any other work necessary for constructing the gabions.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.04 Filter fabric (type and grade indicated)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of area covered with filter fabric placed in position.

The tendered rate shall include full compensation for supplying the filter fabric, cutting, waste, placing, joining, overlapping, and securing the material in position.
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3100</td>
<td>Borrow material</td>
</tr>
<tr>
<td>3200</td>
<td>Selection, stockpiling and breaking down the material from borrow pits and cuttings, and placing and compacting the gravel layers</td>
</tr>
<tr>
<td>3300</td>
<td>Mass earthworks</td>
</tr>
<tr>
<td>3400</td>
<td>Pavement layers of gravel material</td>
</tr>
<tr>
<td>3500</td>
<td>Stabilisation</td>
</tr>
<tr>
<td>3600</td>
<td>Crushed stone base</td>
</tr>
<tr>
<td>3700</td>
<td>Waterbound macadam base</td>
</tr>
<tr>
<td>3800</td>
<td>Breaking up existing pavement layers</td>
</tr>
</tbody>
</table>
3100 BORROW MATERIALS

3101 SCOPE

This Section covers the work involved in obtaining borrow materials for work under this contract, including negotiations with Owners of the land on which borrow areas are situated, clearing the site, stripping and disposing of excess overburden, excavating selected material for use in the Works, and finishing-off the borrow areas.

3102 NEGOTIATIONS WITH OWNERS AND AUTHORITIES

With regard to borrow areas that are identified and prescribed by the Employer for the execution of the Works, the Contractor is exempted from all obligations and costs in respect of negotiations with and compensation of the Owners of the land on which the borrow areas are situated, unless otherwise specified.

The attention of the Contractor is drawn to the provisions of Clause 1214 as regards his activities on private land.

The Contractor shall observe all the legal provisions and the provisions of the Project Specifications in respect of his activities at borrow pits and when finishing off the borrow areas.

3103 USE OF BORROW PITS

The Contractor shall satisfy himself that all necessary negotiations have been made with the Owner of the ground on which any borrow pit is situated, prior to the opening of such borrow area.

The Contractor shall notify landowners both verbally and in writing at least seven days before prospecting for materials from alternative sources.

The Contractor shall give the Engineer at least thirty days notice of his intention to enter a borrow area which had been available for inspection at the time of the Tender and shall not enter thereon until the approval of the Engineer has been given.

3104 OBTAINING BORROW MATERIALS

(a) General

Borrow materials shall be obtained from approved sources of supply listed and described on the borrow-pit plans, or from such other sources as may from time to time be tested and approved by the Engineer. Borrow-pit material complying with the requirements of the Specifications for the use for which the material is intended, shall be selected from these approved sources.

(b) Borrow-pit plans

Borrow-pit plans are included in the contract documents. The information shown on the borrow-pit plans reflects the results of site investigations and laboratory tests conducted by or for the Employer and is supplied in good faith as to the sufficiency in quantity and quality of the material for the due and proper completion of the Works. The provision of these borrow-pit plans shall not in any way be construed as limiting the obtaining of borrow material to the borrow areas and/or to the depth of working specified pits shown on the plans or as necessarily limiting the use of the material to that described on the plans.

If, at any time during construction, it appears that the quality or quantity of material available in a borrow pit is inadequate or insufficient, the Contractor shall make use of other borrow areas approved by the Engineer, irrespective of whether or not such other borrow areas are shown on the borrow-pit plans. The Contractor shall provide all assistance in the form of plant, trained personnel, labour and fencing material as may be required by the Engineer for prospecting for and testing further borrow pits. The cost of such assistance will be for the Employer's account.

(c) Use of borrow materials

The decision as to which source of supply the Contractor shall use at any time shall rest with the Engineer, and the Contractor shall at any stage of the work use that approved source of supply which in the opinion of the Engineer is the most suitable in regard to the quality and quantities of the various types of available materials and the ultimate cost of the work to the Employer. Unless otherwise determined elsewhere, payment will not be made for moving the Contractor's plant from one location to another at any of the individual sources shown on the plans or subsequently approved by the Engineer.

Should the Contractor elect to obtain material from sources other than those shown on the borrow-pit plans, he shall excavate the necessary trial holes, take such samples and conduct or have conducted such tests as are deemed to be necessary by the Engineer. The Contractor shall submit the results and sufficient details to the Engineer to satisfy him that the quality and quantity of the material available in the proposed borrow area are acceptable for the intended use, all at the Contractor's own expense. Compensation to Owners and arrangements for taking any material shall be in terms of the Project Specifications.

Approval of borrow pits or borrow areas shall apply only to those portions of the pit or area from which acceptable material can be obtained or produced. The Contractor shall organise his operations in any approved pit or borrow area or portions thereof with a view to using the material for the purpose envisaged.
The Contractor shall plan his exploitation of the borrow pits in such a manner that the various types of materials excavated can be selected and loaded directly for use. When this is unfeasible for reasons beyond the Contractor's control, material to be stockpiled for later use shall be loaded, transported and temporarily stockpiled as ordered by the Engineer and as determined in Clause 3203. No material reserved for a specific purpose shall be used for any other purpose without the written approval of the Engineer.

(d) Borrow materials obtainable in the road prism or within the road reserve boundaries

Where suitable sources of materials are available in existing cuttings and side drains, or anywhere else in the road prism or within the road reserve boundaries, such materials may be used for the construction of fills, pavement layers and shoulders, if approved by the Engineer.

3105 OPENING AND WORKING BORROW PITS AND HAUL ROADS

(a) Removing topsoil

Prior to opening a borrow pit, the Contractor shall ascertain from the Engineer whether the removal of topsoil is required and shall then remove and stockpile such topsoil as instructed by the Engineer.

This work shall be carried out, measured and paid for in accordance with the provisions of Section 5700.

(b) Clearing and grubbing

Clearing and grubbing of borrow areas will be measured for payment in accordance with the provisions of Section 1700 before excavation is commenced, but only in the following cases, unless otherwise directed by the Engineer:

(i) In borrow areas located in plantations.

(ii) In borrow areas where large trees with trunks exceeding 1.0 m in circumference as defined in Section 1700 are found.

(iii) In borrow areas without any excess overburden but where the removal of grass, shrubs and roots is required.

Unless the clearing and grubbing of a borrow area have been prescribed by the Engineer in writing, no payment will be made for clearing and grubbing such borrow area. This applies particularly to borrow areas opened for obtaining rock or sand used in the construction of stone-pitching, concrete work, crushed-stone base or subbase, permeable subsurface drain material or bituminous asphalt or surfacing.

(c) Excess overburden

The Contractor shall advise the Engineer in good time, before any excavation at such borrow area is commenced, of his intention of starting to use a borrow area in order that a survey of the site can be made for the purpose of computing the quantity of excess overburden, if any, to be removed.

No removal of overburden or other quarrying operations shall be proceeded with until agreement has been reached between the Engineer and the Contractor in regard to the quantity of such overburden.

Unless, under exceptional circumstances, the clearing and grubbing of the borrow area is required to be done first, the excess overburden shall be measured only after this work has been completed.

As instructed by the Engineer, excess overburden shall be moved to the outer limits of the proposed borrow area, and, if this area is enlarged later on, the excess overburden shall be moved further to the new outer limits, or, where possible at that stage, replaced into the borrow pits as described in Clause 3105.

Excess overburden will also be measured for payment where the borrow material shall be stone or sand used for stone pitching, concrete work, crushed-stone subbase and base, permeable material in subsurface drainage systems, and asphalt pavements and seals.

(d) Excavating borrow material

Borrow material shall be excavated within the limits of depth and area shown on the borrow-pit plans or as directed by the Engineer.

Where any borrow pit contains different types of materials in separate layers which require to be mixed to produce a suitable product, the materials shall be excavated over the full depth of the approved working face in one operation without the different types of materials being separated.

The Contractor shall take all reasonable precautionary measures so as to avoid contamination of the suitable borrow material by the inclusion of clayey or otherwise unsuitable material from the floor of the borrow pit, the overburden, any unsuitable layers, or areas beyond the approved limits of the borrow area. During loading, any hard oversize material which will not break down during processing on the road shall be excluded as far as is practicable.

During borrow operations, and especially when excavating material near the floor and outer boundaries of the borrow areas, the Contractor shall plan his operations so as to reduce, in so far as is possible, the amount of earth moving work that will be necessary for finishing-off the borrow pits. Indiscriminate excavation without due regard being had to the desired final shape of the borrow pit will not be permitted.

The material in borrow pits shall be blasted or ripped and excavated in a manner that will ensure the effective breaking-down of the material in the borrow pit before it is loaded. Rippable material which tends to break into large blocks shall be cross-ripped.

(e) Control at borrow pit

The Contractor shall be responsible for controlling his operations at every borrow pit where material is being excavated to ensure compliance with all the requirements of Subclause 3105(d).

He shall carry out sufficient tests on the material being excavated from the borrow pit to satisfy himself that the quality of the material will comply with the specified requirements for the particular layer for which it will be used.
If there is any doubt concerning the quality of the borrow material being excavated at any time, the Contractor shall notify the Engineer immediately, and in any case before such material is brought onto the road. The results of all the tests carried out by the Contractor shall be submitted to the Engineer on request. The Engineer will, after further testing or inspection if necessary, instruct the Contractor regarding the use of the material in the borrow area, or he may order the borrow pit to be finished off and abandoned.

(f) Protecting borrow pits

Borrow pits shall be continuously protected against the ingress of surface water, and the Contractor shall construct such temporary banks as may be required for diverting surface water, and, in so far as is possible, his operations shall be planned in such a way that the borrow pit will be self-draining. Where this is not possible, borrow pits shall be dewatered by pumping. The Contractor shall be solely responsible for keeping borrow areas dry and ensuring that borrow material is sufficiently dry when required for use.

(g) Access roads

The Contractor shall construct and surface appropriately such access roads as are required and shall provide temporary ditches and culverts of sufficient size to ensure that the existing drainage of the area is not restricted. The Contractor shall obtain the Engineer’s prior approval to the siting of junctions of access roads with existing roads and shall comply with the Engineer’s conditions of access particularly regarding clearance of obstructions to provide adequate sight lines, temporary drainage or culverts and the provision of signs and traffic control.

The provision of access roads shall not be measured for payment.

(h) Private access roads

Where materials from a borrow pit are hauled on private access roads, such roads shall be maintained properly to the satisfaction of the Engineer during borrow operations at the borrow pit. No additional payment will be made for this work, and full compensation for maintaining private access roads used as haul roads will be regarded as being included in the rates tendered and paid for in the various items of work where the materials are used.

3106 FINISHING-OFF BORROW AREAS AND HAUL ROADS

(a) Borrow areas

On completion of his operations in a borrow area, the Contractor shall reinstate the entire area so as to blend it with the surrounding area and to permit the re-establishment of vegetation. For this purpose the borrow area shall be shaped to even contours without any slopes being steeper than 1:3, except where the Engineer so permits in specified cases. All material in and around the borrow area, whether spoil from road-building operations, excess stockpiled material, oversize material left in the borrow pit, material resulting from clearing and grubbing operations or excess overburden, shall be used or disposed of as directed by the Engineer. Solid waste and rubbish may not be dumped into the borrow area. Material incapable of supporting vegetation shall be buried and used for shaping the borrow area and shall subsequently be covered with soft material. All available soft material shall be spread evenly to the prescribed thickness, and where sufficient material is not available for so covering the entire area, the remaining portions shall be scarified along the contours so as to avoid undue erosion.

The shaping and finishing-off of the borrow pit shall be done in such a manner that the borrow pit will be properly drained wherever practicable, and, where required, the Contractor shall place earth banks to divert surface water from the borrow area.

If so directed, the borrow area shall be fenced off and provided with gates as specified in Section 5300, and topsoiled and/or hydro-seeded as specified in Section 5700.

The finishing-off of the borrow areas shall be to the entire satisfaction of the Engineer and the Contractor shall submit to the Engineer a signed certificate from the landowner or relevant Government Agency stating that the finishing-off complies with all necessary legal provisions. The Contractor’s attention is drawn to the provisions of Clause 1214 in this respect.

(b) Haul roads

All haul roads shall be obliterated and their surfaces scarified, earth banks shall be constructed to prevent erosion, and all damaged fences and other structures shall be reinstated, unless otherwise specified.

Where materials from a borrow pit are hauled on private access roads, such roads shall be restored to their original condition to the satisfaction of the Engineer when borrow operations at the borrow pit are completed, unless otherwise specified. No additional payment will be made for this work, and full compensation for restoring private access roads used as haul roads will be regarded as being included in the rates tendered and paid for in the various items of work where the materials are used.

The restoration of proclaimed roads shall be done in accordance with the instructions of the Engineer and payment will be made in accordance with applicable unit rates.

3107 DISPOSAL OF BORROW MATERIAL

The Contractor shall not have the right to use material obtained from borrow pits for any purpose other than for the execution of this contract. He shall not dispose of any borrow material whether processed or not either by sale or donation to any person without the written authorisation of the Employer.

3108 CLASSIFICATION OF BORROW PITS FOR GRAVEL MATERIALS FOR PAVEMENT LAYERS

In the case of gravel materials used in the construction of the pavement layers, the Contractor is afforded an opportunity to tender rates for each borrow pit provided by the Engineer, based on his own assessment of the material in each borrow pit.

Except for crushing and screening of material, no additional payment will be made for excavating or processing material from borrow pits, regardless of the hardness of the material.
A schedule of borrow pits is provided as a supplement to the Schedule of Quantities. This schedule shows the estimated quantity of gravel material for base, subbase selected subgrade and shoulder to be used from each borrow pit. It affords the Contractor the opportunity to tender a rate for each type of material approved along the route for use in the construction of the relevant layers and to calculate the average contract rates to be entered in the Schedule of Quantities for the construction of these layers.

The Engineer shall have the right to decide which borrow pit the Contractor shall operate from at any particular stage of the work, to approve new borrow pits during the construction period, to deviate from the estimated quantities shown in the Schedule of Quantities and in the supplement, and to adjust compensation payable in accordance with the actual quantity of material used from each borrow pit and the rate tendered in the supplement to the Schedule of Quantities for material from each borrow pit or for similar material from new borrow pits. Neglect or failure on the part of the Contractor to be covered by the contract prices paid for obtaining crushed stone for pavement layers:

Apart from the existing payment items, no direct payment will be made for procuring and providing borrow material, but it will be regarded as an additional obligation on the part of the Contractor to be covered by the contract prices paid for the various items of work for which the material is used as determined in Item 31.02 below.

### 3109 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.01 Excess overburden</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of excess overburden measured in place before stripping. Such measurement shall be based on the depth of overburden as measured in trial pits excavated by the Contractor in a square pattern at intervals of 10 m over the whole area concerned.

The tendered rate shall include full compensation for digging the trial pits, stripping, removing and stockpiling the excess overburden prior to the borrow material being excavated, for replacing the excess overburden in the borrow pit after completing the excavation of borrow material, and for levelling-off the excess overburden in the borrow area.

Where the stockpiled excess overburden has to be moved to beyond the limits originally instructed by the Engineer, it shall be measured once more for payment, but only under Item 31.01.

Where overburden material is used for filling or for other purposes, payment will not be made for removing such overburden material, but will be made in accordance with the purpose for which such material will be used.

No distinction will be made for purposes of payment, in accordance with the classification set out in Clause 3303, between the various types of material, which have been removed as overburden, except only in regard to borrow pits for obtaining crushed stone for the subbase and base, as determined in Item 31.02 below.

### 31.02 Excess overburden in borrow pits for obtaining crushed stone for pavement layers:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Overburden in soft or intermediate excavation</td>
</tr>
<tr>
<td>(b)</td>
<td>Overburden in hard excavation</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of excess overburden measured in place before stripping. The quantity shall be based on the depth of the overburden as measured in test pits. Distinction shall be made between soft and intermediate material on the one hand and hard material on the other, in accordance with the classification as described in Clause 3303 for excavations.

The tendered rates shall include full compensation for stripping, removing and stockpiling excess overburden prior to the borrow material being excavated, replacing the excess overburden in the borrow pit after excavation of the borrow material has been completed, and levelling-off the excess overburden in the borrow area.

Where the stockpiled excess overburden has to be moved to beyond the limits originally indicated by the Engineer, it shall be measured once more for payment, but only under Item 31.01.

Where overburden material is used for filling or for other purposes, payment will not be made for removing such overburden material, but will be made in accordance with the purpose for which such material will be used.

### 31.03 Finishing-off borrow areas in:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Hard material</td>
</tr>
<tr>
<td>(b)</td>
<td>Intermediate material</td>
</tr>
<tr>
<td>(c)</td>
<td>Soft material</td>
</tr>
</tbody>
</table>

The unit of measurement for finishing borrow areas shall be the hectare measured in accordance with the finally excavated area of the borrow pit before it is finished off.

The tendered rates shall include full compensation for finishing-off the borrow pits as specified, including any further earth moving necessary for finishing, but excluding the establishment of grass. Borrow pits shall be classified in accordance with the classification of the material removed therefrom and, where more than one class of material is taken from a borrow area, the area shall be apportioned proportionate to the classification purposes, in accordance with the volumes of each type of material removed.

**Notes:**

(a) **Borrow material**

Apart from the existing payment items, no direct payment will be made for procuring and providing borrow material, but it will be regarded as an additional obligation on the part of the Contractor to be covered by the contract prices paid for the various items of work for which the material is used as determined in Item 31.02 below.
prescribed in these Specifications. Payment shall, however, be made separately for certain items of work where so specified.

The tendered rates for procuring and providing borrow material, shall also include full compensation for all obligations, costs, activities and work as prescribed in Section 1200, as well as for all supervision, labour, plant, tools and incidentals required therefor, including all costs as may be necessary for conducting control tests on all materials, draining and protecting all borrow areas, and concluding all negotiations with landowners (except negotiations that are entered into by the Employer himself) as specified, also for finally shaping and finishing the borrow pits.

(b) Prospecting for materials

Payment will be made for excavating trial pits according to a grid pattern as ordered by the Engineer over the entire borrow area, and for assistance rendered by the Contractor, as may be directed by the Engineer, in prospecting for additional material as "extra work" in accordance with the provisions of the General Conditions of Contract.
The Contractor should note the provisions of Subclauses 3104(c) and 3105(d) and (e) in regard to activities at borrow pits, and of Subclause 3306(d) in regard to activities in cuttings. Where the Contractor has unnecessarily polluted or wasted suitable material, he shall supply other suitable material at his own cost.

### 3203 STOCKPILING THE MATERIAL

The Contractor shall so plan his activities that materials excavated from borrow pits and cuttings, in so far as is possible, can be transported direct to and placed at the point where it is to be used. However, where utilizing materials in this manner is impracticable, and, if so instructed by the Engineer in writing, it shall be temporarily stockpiled for later loading and transportation to where it will be used. Compensation for stockpiling materials will be payable only in regard to material stockpiled in accordance with the Engineer's written instructions.

The temporary stockpiling of material within the borrow area in heaps with a view to loading, or any other stockpiling method used in connection with the loading method adopted by the Contractor in the cutting or borrow pit, will not be classified as temporary stockpiling. The costs for these processes will be deemed to be covered by the rates for the various items of work for which material so stockpiled is used.

Stockpiling areas and maximum heights of stockpiles shall be indicated or approved by the Engineer. Before any stockpiling of material may be done, the site shall be cleaned, and all loose stones or any vegetation or other material which may cause pollution shall be removed. During use, the lower 100 mm of stockpiled material shall not be utilised for construction. After the stockpiled material has been removed, the site shall be reinstated as closely as possible to its original condition, and the surface shall be lightly scarified to promote vegetation growth.

Payment will be made for stockpiling the material from existing pavements only if the material is intended for re-use and if its stockpiling has been approved or directed by the Engineer.

### 3204 BREAKING-DOWN THE MATERIAL FROM CUT AND BORROW

(a) Breaking-down the material in cuttings and borrow pits

The material from cuttings and borrow pits shall be broken down in the cuttings or borrow pits to the maximum sizes as set out below, depending on the use envisaged for the material, before it is loaded and hauled to the road.

- Rock fills ............. 750 mm maximum dimension
- Normal fills ............ 500 mm maximum dimension
- Pavement layers ........ 300 mm maximum dimension

Spoil material need be broken down only sufficiently for convenient loading and transporting, but the Engineer may require sufficient material to be broken down to a maximum size of 500 mm with a view to effectively trimming the spoil areas.

Material intended for crushing need only be broken down sufficiently to permit acceptance by the crusher.
In order that the material can be broken down to the above-mentioned sizes, the Contractor shall adjust and control his blasting, ripping, excavating and other operations so that the desired result can be achieved as effectively as possible. In so far as may be practicable, drilling and blasting patterns shall be such as to break down the material to the desired sizes, and, where this is impracticable, secondary blasting or other methods shall be used for breaking down oversize materials.

If, in the opinion of the Engineer, the working methods of the Contractor are such that unnecessarily large quantities of oversize material are produced, he may instruct the Contractor to change his methods in order to produce less oversize material, and the Contractor shall not be entitled to any additional compensation for carrying out such instructions.

Care shall be taken not to load oversize material and to bring it onto the road. However, where this is nevertheless done, the Contractor shall, at his own cost, remove such oversize material from the road or break it down further to the required size on the road.

Where surplus material is available and the Engineer so agrees, the Contractor, instead of breaking down any oversize materials, may work it out or leave it in the borrow pits, or in the case of materials from cuttings, spoil it, but, in the latter case not without the written approval of the Engineer. The Engineer may also require oversize materials to be used for other purposes, such as for rock fills instead of breaking it down.

(b) Further breaking-down of pavement material brought onto the road

Pavement material brought onto the road shall be further broken down to the sizes as specified for each layer by using equipment suited to this purpose. The Contractor shall be at liberty to employ any methods and equipment he may prefer, but, where any difference of opinion may arise in regard to the practicability of the breaking-down process or the suitability of the methods and equipment employed by the Contractor, the Engineer may require normal grid-rolling to be done as described below. The results so obtained will then serve as the norm of the degree to which the breaking-down shall be attained by any alternative methods.

For the purposes of this specification, normal grid-rolling shall mean the following:

(i) The material shall be placed or bladed to the one side of the road to provide working space for breaking-down the material.

(ii) Subject to the approval of the Engineer a portion of the material shall be spread in a thin layer on a compacted surface to promote effective breaking-down of the material, and to a width which the grid roller shall be able to cover in a single pass.

(iii) The grid roller, which shall proceed at a speed of at least 12 km/h and which shall have a minimum mass of 13.5 tonnes, shall do four complete roller passes over the material.

(iv) Any oversized material shall be removed by hand, and/or constructional plant as provided in Clause 3210.

(v) The broken-down material shall be placed in a windrow to the opposite side of the material still to be broken-down.

(vi) Repeat steps (ii) to (v), but place the second windrow next to the first.

(vii) To mix the material, the two windrows formed in steps (ii) to (vi) shall then be bladed into a single windrow to the side of the road.

(viii) If so ordered by the Engineer steps (ii) to (vii) shall be repeated until all the material that needs to be broken-down has been treated.

However, should too much oversize material remain after normal grid-rolling, the Engineer may instruct that any one of the following be done:

(i) That additional normal grid-rolling or its equivalent be done;

(ii) That, instead of attempting to break down the material on the road, it be crushed as described in Clause 3205; or

(iii) That the Contractor and Engineer agree on the use of any other methods and equipment which may be more suitable, and determine compensation for such work in terms of the General Conditions of Contract.

Any oversize material still remaining after processing in accordance with any of the processes described above shall be removed from the road as provided in Clause 3210.

(c) Further breaking-down of fill brought onto the road

After fill material in borrow pits and cuttings has been broken down to the maximum size specified in Subclause 3204(a) and then spread on the road, it shall be further broken down by means of suitable equipment such as grid rollers, subject to the approval of the Engineer.

In many cases breaking down by the normal compaction process should be adequate, and no special effort should be necessary for breaking down the material, but, in the case of hard and coarse material, the Engineer may require that the material receive at least a light grid-rolling, and the degree to which breaking-down will occur by means of the light grid-rolling process will then serve as the norm of what may be required in regard to alternative methods the Contractor is permitted to employ. For the purposes of these Specifications light grid-rolling is defined as follows:

(i) The material shall be spread in a layer, the uncompacted thickness of which shall be more or less equal to the average maximum fragment size, but with a minimum of 200 mm. It shall then be rolled by means of at least two complete passes per 200 mm of uncompacted layer thickness by a grid roller with a mass of not less than 13.5 tonnes, moving at a speed of at least 12 km/h. Should the uncompacted layer thickness be in excess of 200 mm, the number of roller passes shall be increased pro rata. The material should then be thoroughly mixed with a motor grader to disperse the broken fragments of oversize homogeneously through the layer.

(ii) Compensation for light grid-rolling and processing as part of the compaction process will be regarded as being included in the price paid for providing and compacting the material. This grid rolling will not be included in the number of roller passes which may be paid for compacting the material.
and the latest amendments thereof shall be deemed required in terms of the Local by-laws regarding For all stages of crushing plant, precautionary measures to produce the specified end product, shall be considered to be the smallest of which need not be smaller than 6.7 mm. Screening only of material involves screening the material into various fractions through a series of screens, the smallest of which need not be smaller than 6.7 mm. For all stages of crushing plant, precautionary measures required in terms of the Local by-laws regarding Occupational Health and Safety and any other relevant Acts, and the latest amendments thereof shall be deemed included in the rates tendered for the relevant products.

**3205 CRUSHING AND SCREENING**

Where the material intended for use in the pavement layers can not be suitably broken down by the methods set out in Subclause 3204(b), the Engineer may direct that the material be crushed, screened, or crushed and screened, or be modified by screening out certain fractions.

A single-stage crushing plant implies the utilisation of a primary crushing unit in which only one size reduction stage occurs, irrespective of the magnitude of the reduction ratio possible by nature of its construction. The single stage crushing plant, shall be capable of breaking down oversize material to the maximum size specified for the layer concerned.

A second crushing stage, while not always necessary to achieve the required reduction ratio, is required by utilising a secondary crushing plant in addition to the primary crushing unit, to control the grading of the product to fall within the broader specified envelope for gravel base materials and lower quality selected materials, as well as yielding specified shape characteristics as appropriate. This shall be termed a two-stage crushing plant.

A third, and where appropriate a fourth crushing stage utilising in addition to the earlier stage crushing plant, tertiary and quaternary crushing plants as appropriate to control the grading and shape of the higher quality crushed stone materials, as well as surfacing and concrete aggregates, shall be termed a multi-stage crushing plant.

For the single-stage and two-stage crushing plant, selective screening may be ordered by the Engineer.

Screening only of material involves screening the material into various fractions through a series of screens, the smallest of which need not be smaller than 6.7 mm.

For the multi-stage plant, all screening and or any other required activity and concomitant equipment required to produce the specified end product, shall be considered to be included.

For all stages of crushing plant, precautionary measures required in terms of the Local by-laws regarding Occupational Health and Safety and any other relevant Acts, and the latest amendments thereof shall be deemed included in the rates tendered for the relevant products.

**3206 CONTROLLING THE MOISTURE CONTENT OF MATERIALS**

The Contractor shall take all reasonable precautions to prevent material in borrow pits, excavations, stockpiles and on the road from becoming excessively wet as a result of rain or groundwater or stormwater. In view hereof, the excavation of borrow pits and cuttings shall, as far as possible, be so planned and executed as to prevent the damming-up of water in the borrow pits or cuttings, and the Contractor shall also provide the necessary temporary drainage for this purpose. During the rainy season, material spread over the road shall be spread with a proper cross slope, and, if not directly compacted, it shall be rolled several times with a flat-wheeled roller in order to let the water run off and not penetrate the material unduly. Care shall also be taken not to allow the water to dam up against material heaps, windrows, or any spread material.

Where material, despite proper precautionary measures, on account of its in situ moisture content, is nevertheless too wet to comply with the requirements in regard to moisture content during compaction, the Contractor shall dry out the material until it is adequately dry for compaction, but, in the first instance, he shall, if in so far as is practicable, so plan his construction programme that material with a high natural moisture content will be used in the dry season and not in the wet.

No prescriptions apply in regard to drying out the material, and the Contractor himself shall decide on the best methods. No additional payment will be made for keeping dry and drying out the material, but the cost of such work shall be included in his tender rates for the various items of work for which the material is to be used, unless provision for additional compensation of this nature has been made in the Project Specifications.

However, where the Contractor has taken all reasonable precautions to keep the material dry and to dry it out where necessary and it is nevertheless impracticable to dry out the material as required, the Engineer shall:

(i) permit the material to be compacted at a higher moisture content, subject to the required dry density being achieved; or

(ii) declare the material to be unsuitable and instruct that it be not used, and, if already on the road, be removed at the appropriate compensation and replaced with suitable material; or

(iii) further instruct the Contractor as he may deem necessary under the circumstances and compensate him for any additional expenses brought about thereby, but only to the degree to which the additional costs have not arisen through the failure of the Contractor to comply with the provisions of this Clause.

**3207 LAYER THICKNESSES AND SPREADING THE MATERIALS**

(a) Fills

The layer thickness of fills will generally be determined by the maximum size to which the material can be broken down in the borrow pits and cuttings, and thereafter when it can be processed on the road itself. The layer thickness will therefore normally be based on the pre-estimation of what the maximum size will be to which the material can be broken down, and shall be such that the maximum size of
the fragments will be more or less equal to the layer thickness after compaction. The maximum layer thickness (after compaction) required from the Contractor shall be 200 mm, but layer thicknesses as little as 100 mm will be permitted.

In order to prevent the layer thicknesses from being determined by the presence of isolated large fragments, the Engineer may require such isolated fragments to be removed from the road, as determined in Clause 3210. The Engineer may also agree to the material being compacted in layers in excess of 200 mm or the maximum fragment size, provided that he is satisfied that the material will be properly compacted. Layer thicknesses shall be agreed on in advance between the Engineer and the Contractor.

Where a new layer is constructed on an existing or already constructed fill and the new layer will be less than 100 mm in compacted thickness, the existing fill shall be scarified to such a depth as will give a layer thickness after compaction of not less than 100 mm of the new plus the scarified material together. No additional payment will be made for this.

Where coarse material is to be processed in layer thicknesses which make mixing by road grader impracticable, the material shall be so excavated, transported and dumped that it will be properly mixed after dumping and exhibit a minimum segregation of fine and coarse material. Such material shall be placed to the correct thickness by end tipping, and the surface levelled by bulldozer, after which some fine material shall be spread on top of the layer and worked into the depressions on the surface.

(b) Pavement layers

All material placed in position before compaction shall be spread evenly over the entire surface of the layer concerned, and the quantity of material spread shall be such that every layer will comply with the specified requirements for thickness when measured after compaction.

The layer thickness shall comply with the requirements as indicated on the Drawings and in the Project Specifications.

Spreading material in restricted areas may be done in any manner approved by the Engineer, on condition that the required level and grading standards can be attained. Where the compaction apparatus used is of such a nature that the material in thicker layers cannot be properly compacted, the Engineer may instruct that material be placed and compacted in layers as thin as 75 mm.

Where the thickness of any existing pavement layer requires to be supplemented and the thickness of the added material after compaction will be less than 100 mm, the existing layer shall be scarified to a depth that will give a layer thickness of at least 100 mm after compacting together the loosened existing and added material. In the case of gravel or crushed-stone bases and subbases, the Engineer may direct the existing layer to be broken down to its full depth.

The composite layer shall be watered, mixed and compacted as determined in Clause 3208.

Payment for adding the material will be made as determined for the respective pavement layers.

### 3208 PLACING AND COMPACTING THE MATERIALS IN LAYER THICKNESSES OF 200 mm AND LESS AFTER COMPACTION

When the layer thickness after compaction is 200 mm or less, any oversize material which cannot be broken down to the required size shall first be removed from the road and then disposed of or used as may be prescribed by the Engineer. The material shall then be sprayed with water, mixed, and compacted as described hereafter.

(a) Spraying and mixing

(i) General requirements

Before the material is compacted, it shall first be thoroughly mixed by grader or other suitable plant so as to obtain an even mix of the various types of materials and to spread the fine and coarse material evenly throughout the mixture. If necessary during the mixing process, water shall also be sprayed evenly over and mixed into the material to bring it to the correct uniform moisture content.

The moisture added shall be just sufficient to bring the material to the optimum moisture content for the compacting equipment being used and the compaction required, provided that, should the moisture content of the material be in excess of 2% above the optimum moisture content for modified AASHTO density, it shall be compacted only when so approved by the Engineer.

(ii) Additional requirements in respect of work in restricted areas

The Engineer may, in restricted areas, permit the Contractor to spread, water and mix the gravel or crushed stone in a windrow next to the pavement excavation. Care shall be taken not to damage existing surfacing and not to pollute the mixed material with other deleterious material. Where this method of mixing is impracticable or impossible, the Contractor shall make use of concrete mixers or any other equipment or method acceptable to the Engineer.

Irrespective of the layer concerned, the mixing shall be of such quality that a uniform mix will be obtained at all times to the satisfaction of the Engineer.

(b) Compaction

(i) General requirements

Compaction shall be carried out in a series of continuous operations covering the full width of the layer concerned, and the length of any section of a layer being compacted shall, wherever possible, be not less than 150 m nor more than can be properly compacted with the available equipment.

The Engineer reserves the right to order the Contractor to reduce the length of any layer compacted in any single operation if the proper compaction of such layer is not being achieved.

The types of compaction equipment to be used and the amount of rolling to be done shall be such as to ensure that specified densities are obtained without damage being done to lower layers or structures. During compaction the layer shall be maintained to the required shape and cross-section, and all holes, ruts and laminations shall be removed.
(ii) Additional requirements in respect of work in restricted areas

Suitable equipment and methods acceptable to the Engineer shall be used in restricted areas so that the required densities will be obtained throughout the thickness of the layer. If necessary, the layers shall be placed in thicknesses which are less than the specified layer thickness, as determined in Subclause 3207(b).

Work in restricted areas consequent upon the actions of the Contractor himself and not upon specified work, will not be regarded as work in restricted areas for purposes of payment.

(c) In place reworking of pavement layers

Where so specified in the Project Specifications and/or instructed by the Engineer, and the material in any existing layer complies with the requirements for the new layer, the Contractor shall scarify the layer to the specified depth, add extra material if necessary, and reprocess the layer in place. Reprocessing includes watering by spraying, mixing, and compacting the layer to the density specified for the layer concerned. Payment will be made as determined for the respective pavement layers.

3209 PLACING AND COMPACTING THE MATERIALS IN LAYER THICKNESSES IN EXCESS OF 200 mm AFTER COMPACTION (only applicable in the case of fills)

(a) Soft-material fills

Materials which readily break down to a maximum size of 200 mm shall be compacted in layers not in excess of 200 mm after compaction, and spraying, mixing and compacting the material shall be executed as described in Clause 3208 for pavement layers.

In the case of cohesionless sand, the layer thicknesses may, however, be increased to as much as 400 mm, and spraying and mixing the material may be omitted or limited in so far as is practicable, all, however, subject to the required density being achieved over the full depth of the layer. In this case efficient vibratory rollers shall be used for compacting the sand.

(b) Hard-material fills

Should the material used for fills be of such a nature that, during the breaking-down effort as described in Subclause 3204(b), it does not readily break down to a maximum size of 200 mm or less, the material shall be spread as described in Subclause 3207(a) and processed as follows:

The material shall be sprayed and mixed as described in Subclause 3208(a), but, should this be impracticable on account of the thickness of the layer, these processes may be omitted on condition that the material be thoroughly mixed and placed as described in Subclause 3207(a) (last paragraph).

The material shall subsequently be compacted in accordance with one of the methods described in Section 3300, depending on the method directed by the Engineer.

(c) Rock fill

Rock-fill processing and compaction shall apply to material consisting predominantly of stone and boulders, with some fine material, and which, due to the mechanical interlocking of the rock, cannot be compacted effectively by construction methods normally used for soils and gravels.

When the layer thickness after compaction is 500 mm or less as instructed by the Engineer, the processing and compaction of such material shall not be classified as rock-fill processing and compaction, and the Engineer may prescribe that the material be compacted as described in Subclause (b) above.

The maximum size of rock which may be used in rock fill is 750 mm, and the layer thickness before compaction shall not be in excess of one and a half times the average actual size of the rock. The Engineer may prescribe that 5% of the oversize material shall be bladed off the road after the material has been dumped onto the road, and it shall be disposed of as described in Clause 3210, so that the layer thickness will not be determined by the presence of isolated large rock fragments.

The compacted layer shall contain no rock fragments with a maximum dimension greater than the compacted layer thickness.

The material to be compacted shall be off-loaded by the end-tipping method. The material shall then be spread by bulldozer or other suitable plant in such a manner that the fine material is well mixed with the rock. The routes to be followed by hauling, spreading and compaction equipment shall be uniformly distributed over the entire width of the layer to be compacted.

The material shall be broken down and compacted during the spreading and compacting process by grid or other suitable rollers and finally compacted with vibratory rollers in accordance with the following formula, to achieve a good mechanical interlock of the rock and the maximum compaction of the finer material in the spaces between the rock.

The type of vibratory roller used, the operating speed, the number of passes and the layer thicknesses are determined by means of the following formula:

\[
\frac{P_e \times n}{h \times v} = 1500 \text{ (minimum)}
\]

where

\[
P_e = \text{total static and dynamic force per metre width generated by the vibratory roller at the operating frequency given by the manufacturer (kN/m)}
\]

\[
n = \text{number of passes required}
\]

\[
h = \text{thickness of the compacted layer in metres}
\]

\[
v = \text{roller speed in metres per second.}
\]

Operating frequencies shall be between 18 Hz and 30 Hz and \(P_e\) shall be at least 120 kN/m.

3210 DISPOSING OF OVERSIZE MATERIAL

All oversize materials removed from the road in terms of Subclause 3204(a) and all excess fill removed from the road...
in terms of Subclause 3207(a) shall be disposed of at the Contractor’s cost or, with the approval of the Engineer, may be used for other suitable purposes.

Oversize pavement material left over after application of the provisions of Subclause 3204(b) and removed from the road in terms of Clause 3208, shall be loaded and disposed of as determined by the Engineer and will be paid for subject to the provisions of payment Item 32.04. Where, however, such material is used direct for any construction work, the Contractor will be entitled only to compensation at the rate in respect of the construction item in question.

Notwithstanding the methods of payment described above, the tender rates for constructing all pavement layers shall include full compensation for the removal of up to 5% by volume of oversize material without any additional payment being made to the Contractor. The limit of 5% will apply to individual layers and not to all the layers together.

The Contractor shall take all reasonable precautions not to place on the road any material which cannot be broken down to the required size by processing on the road. This shall be avoided by proper selection during excavation in the cuttings or borrow pits. If such material is encountered in cuttings, it shall be spoiled directly or used as prescribed by the Engineer.

3211 DRAINAGE AND PROTECTION

The compacted layers shall be adequately drained and shaped to prevent water from standing on or along or scouring the completed work. Windrows shall be removed to facilitate the drainage of water from the surface.

No material for a subsequent layer may be placed if the underlying layer has been softened by excessive moisture.

In cases where pavement layers are replaced over a section of the road width, or where pavement layers are widened and the new layer is more or less permeable than the adjacent existing layer, for example in the case of a stabilised or bitumen-treated layer next to an untreated adjacent existing layer, it may be specified, or the Engineer may instruct that pavement subsoil drainage be installed in accordance with the details indicated on the Drawings or determined by him.

The installation of subsoil drainage will be measured and paid for under the pay items of Section 2100.

3212 MEASUREMENT AND PAYMENT

Where provided in the various Sections of these Specifications that a payment item shall include compensation for placing or for placing and compacting the materials, the terms placing or placing and compacting shall include compensation for all work described and costs given in this Section, excepting work covered by the payment items below, for which separate payment will be made, as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.01 Providing a crushing and/or screening plant:</td>
<td></td>
</tr>
<tr>
<td>(a) Single-stage crusher</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Two-stage crusher</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) Screening plant</td>
<td>number (No)</td>
</tr>
<tr>
<td>(d) Multiple-stage crusher and screening plant</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of complete plants supplied as ordered by the Engineer.

The tendered rates shall include full compensation for providing the plant, transporting it to the site, erecting, commissioning and finally dismantling it, and loading and transporting it away from the site or to the point where it is to be re-erected, regardless of the number of types of material treated.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.02 Re-erecting the crushing and/or screening plant:</td>
<td></td>
</tr>
<tr>
<td>(a) Single-stage crusher</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Two-stage crusher</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) Screening plant</td>
<td>number (No)</td>
</tr>
<tr>
<td>(d) Multiple-stage crusher and screening plant</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of times each plant is dismantled, transported and re-erected as ordered by the Engineer, regardless of the number of types of material treated.

The tendered rates shall include full compensation for dismantling the plant, loading, transporting, off-loading and re-erecting it at new positions as ordered by the Engineer, and recommissioning it.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.03 Crushing and screening:</td>
<td></td>
</tr>
<tr>
<td>(a) Single-stage crushing</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Two-stage crushing</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(c) Screening</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(d) Multiple-stage crushing and screening</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material crushed or screened or crushed and screened and finally used in construction, measured in place after compaction. No allowance will be made for waste, except in the case of Subitems (c) and (d), where the quantity measured as above for payment shall be increased by including 70% of the loose volume, measured in stockpile, of the material screened out and discarded.

The tendered rates shall include full compensation for crushing in the case of Subitems (a) and (b), or screening in the case of Subitem (c), or crushing and screening the material in the case of Subitem (d), including all labour, plant, fuel, handling, processing, stockpiling if necessary, loading for transportation to the point of final use, and for disposing of any material screened out and discarded.
**Item** 

**32.04 Removal of oversize pavement material** ........................... cubic metre (m³)

The unit of measurement shall be the cubic metre of oversize pavement material from cut and borrow, which cannot be broken down as specified, and is removed. The volume shall be determined as prescribed by the Engineer and shall be the loose volume in stockpiles or its equivalent measured in hauling vehicles. Only that volume of oversize pavement material in excess of 5% of the compacted volume of pavement layers will be measured for payment, all as specified in Clause 3210.

The tendered rate shall include full compensation for the excavation of material in all classes of excavation, loading and transporting it to the road, placing, and any breaking-down treatment given or attempted, blading all oversize pavement material off the road, loading, transporting it to the point of disposal or subsequent re-use, including a free-haul of 1.0 km, and off-loading and spreading of the material.

**Item** 

**32.05 Additional normal grid rolling** ................................. cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted material upon which an additional "normal grid-rolling operation" as described in Subclause 3204(b) is performed in accordance with the instructions of the Engineer.

The tendered rate shall include full compensation for performing one additional normal grid-rolling operation in addition to the initial normal grid-rolling operation, the cost of which has been included in the tender rates for pavement layers.

**Item** 

**32.06 Stockpiling of material** ............................... cubic metre (m³)

The unit of measurement shall be the cubic metre of material temporarily stockpiled on the instruction of the Engineer.

The tendered rate shall include full compensation for cleaning and preparing the stockpiling sites and also for levelling and reinstating the site after completion of the work, for off-loading and spreading the material if necessary, and for loading when required for use.
SERIES 3000 : EARTHWORKS AND PAVEMENT
LAYERS OF GRAVEL OR CRUSHED STONE

SECTION 3300 : MASS EARTHWORKS

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3303 CLASSIFICATION OF CUT AND BORROW EXCAVATION
3304 CLASSIFICATION OF COMPACTION
3305 TREATING THE ROADBED
3306 CUT AND BORROW
3307 FILLS
3308 FINISHING THE SLOPES
3309 PROTECTING THE ROAD PRISM AND STRUCTURES
3310 CONSTRUCTION TOLERANCES
3311 ROUTINE INSPECTION AND TESTS
3312 MEASUREMENT AND PAYMENT

3301 SCOPE

This Section covers all work in connection with the construction of cuts and fills, the removal to spoil of material unsuitable for use, the construction and compaction of fills with cut material from the road prism or borrow material from approved borrow pits, the compaction of the roadbed and finishing of cuts and fills, up to the stage where fills are ready for the placing of the pavement layers.

3302 MATERIALS

(a) Roadbed and cut

Roadbed and cut materials which occur along the route of the roadway have been tested and the results of the tests are shown on the Drawings. The test results, read in conjunction with these Specifications, give a preliminary indication as to the purpose for which the cut material may be used as well as the treatment, if any, which the roadbed shall receive. The Engineer shall give final instructions during construction regarding the use of cut material and the treatment of the roadbed.

(b) Fill

Unless otherwise specified in the Project Specifications, fill material shall conform to the requirements specified below:

(i) The material shall not contain any rock fragments with a maximum dimension exceeding 500 mm, except in the case of rock fills, when it may be 750 mm.

(ii) Where it is possible by virtue of the quality of the available material, the minimum soaked CBR at the specified compaction shall be as follows:

<table>
<thead>
<tr>
<th>Depth below final road surface</th>
<th>Minimum soaked CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 m - 1.2 m</td>
<td>3% at 90% of modified AASHTO density</td>
</tr>
<tr>
<td>1.2 m - 9 m</td>
<td>3% at 100% of modified AASHTO density</td>
</tr>
</tbody>
</table>

Should the depth below the final road surface exceed 9 m, or should the material be not in accordance with the said requirements, the material shall conform to the requirements as set out in the Project Specifications or as prescribed by the Engineer.

The Engineer may allow or order the use of material not meeting these requirements by an order in writing, provided that he has satisfied himself regarding the stability of the embankments to be constructed from such material.

(iii) Compaction requirements, minimum in situ dry density

When the material is compacted to a percentage of modified AASHTO density

<table>
<thead>
<tr>
<th>Depth below final road surface</th>
<th>Minimum soaked CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 m - 1.2 m</td>
<td>90% or 93% (as required)</td>
</tr>
<tr>
<td>1.2 m - 9 m</td>
<td>100% of proof density</td>
</tr>
</tbody>
</table>

When the material is compacted by proof rolling

<table>
<thead>
<tr>
<th>Material</th>
<th>Minimum In Situ Dry Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rockfill</td>
<td>no density specified</td>
</tr>
</tbody>
</table>

Sand which for the purposes of this requirement is specified as non-plastic sand with not less than 95% passing through the 0.075 mm sieve, but with not more than 20% passing through the 4.75 mm sieve, shall be compacted to 100% of modified AASHTO density. Should more than 20% pass through the 0.075 mm sieve, the sand shall be compacted to 95% of modified AASHTO density.

3303 CLASSIFICATION OF CUT AND BORROW EXCAVATION

(a) Classes of excavation

The excavation of material from cut or borrow for fills shall be classified as follows for purposes of measurement and payment:

(i) Soft excavation

Soft excavation shall be excavation in material which can be efficiently removed or loaded without prior ripping by any of the following plant:

- A bulldozer with a mass of approximately 22 tons, (which includes the mass of a ripper if fitted) and an engine developing approximately 145 kW at the flywheel.

- A tractor-scraper unit with a mass of approximately 28 tons and an engine developing approximately 245 kW at the flywheel, pushed during loading by a bulldozer as specified in Subclause 3303(a).

- A track-type front-end loader with a mass of approximately 22 tons and an engine developing approximately 140 kW at the flywheel.

or

A tractor-scraping unit with a mass of approximately 28 tons and an engine developing approximately 245 kW at the flywheel, pushed during loading by a bulldozer as specified in Subclause 3303(a).

or

A track-type front-end loader with a mass of approximately 22 tons and an engine developing approximately 140 kW at the flywheel.

(ii) Intermediate excavation

Intermediate excavation shall be excavation (excluding soft excavation) in material which can be efficiently ripped by a bulldozer with a mass of approximately 35 tons when fitted with a single tine ripper and an engine developing approximately 145 kW at the flywheel.
(iii) Hard excavation

Hard excavation shall be excavation (excluding boulder excavation) in material which cannot be efficiently ripped by a bulldozer equivalent to properties as those described in Subclause 3303(a).

This type of excavation generally includes excavation in material such as formations of unweathered rock, which can be removed only after blasting.

(iv) Boulder excavation Class A

Boulder excavation Class A shall be excavation in material containing in excess of 40% by volume of boulders between 0.03 m³ and 20 m³ in size, in a matrix of softer material or smaller boulders.

Excavation in dolomite formations other than solid dolomite shall also be classed as Class A excavation if the formations contain in excess of 40% by volume of lumps of hard dolomite between 0.03 m³ and 20 m³ in size, in a matrix of softer material or smaller lumps of hard dolomite.

Excavation of solid boulders or lumps of hard dolomite each in excess of 20 m³ in size shall be classed as hard excavation. Excavation of fissured or fractured rock shall not be classed as boulder excavation but as hard or intermediate excavation according to the nature of the material.

(v) Boulder excavation Class B

Where material contains 40% or less by volume of boulders or lumps of hard dolomite ranging from 0.03 m³ to 20 m³ in size, in a matrix of soft material or smaller boulders or lumps of hard dolomite, then those boulders or lumps of hard dolomite between 0.03 m³ and 20 m³ in size shall be classed as Class B boulder excavation.

The excavation of the rest of the material shall be classed as soft or intermediate excavation according to the nature of the material.

All the equipment specified in Subclauses (i) and (ii) above shall be in a good mechanical condition. The expressions "efficiently ripped", "efficiently removed" or "efficiently loaded" as used in this Subclause shall in this context mean ripped, removed or loaded (as the case may be) in a manner which can reasonably be expected from the equipment in question, with regard to the production achieved.

(b) Method of classification

The Contractor shall be at liberty to use any method he wishes to use for excavating any class of material, but the method of excavating the material shall not dictate the classification of the excavation.

The Engineer shall decide under which one of the above classes any excavation shall be classified for purposes of payment. In the first instance the classification shall be based on an inspection of the material to be excavated, which classification shall be agreed on before excavation may be started. In the event of a disagreement between the Contractor and the Engineer, the Contractor shall, if required, make available such mechanical plant as specified in Subclauses 3303(a)(i) and (ii) at his own cost, in order to determine whether or not the material can reasonably be removed. The decision of the Engineer as to the classification shall thereafter be final and binding, subject to the provisions of the General Conditions of Contract.

The Contractor shall immediately inform the Engineer if and when the nature of the material being excavated changes to the extent that a new classification for further excavation is warranted. Failure on the part of the Contractor to advise the Engineer thereof in good time shall entitle the Engineer to classify, at his discretion, such excavation as may have been executed in material of a different nature.

3304 CLASSIFICATION OF COMPACTION

For purposes of measurement and payment the method of processing and the compaction of fill material shall be classified as described below. The Engineer will decide in advance as to which classification of compaction shall be employed and the classification of material for purposes of excavation shall not in any way be taken into consideration in respect of the classification of the compaction of material.

(a) Compaction to a minimum percentage of modified AASHTO density

Wherever a density requirement in respect of a fill or pavement layer is specified in these Specifications, on the Drawings or in the Project Specifications or is prescribed by the Engineer in terms of a percentage of modified AASHTO density, the Contractor shall be at liberty to employ any type of compaction equipment he may choose so as to achieve such density over the full specified depth of the layer, provided always that he complies in all respects with the general requirements of these Specifications and that the equipment employed is adequate and suitable for the purpose and will not in any way be detrimental to any part of the already completed Works.

(b) Compaction to a minimum percentage of proof density

(i) Materials

For materials compacted to a percentage of proof density the requirements of Subclause 3304(a) shall apply, save that the required density shall be expressed as a percentage of a proof density as described below, instead of as a percentage of modified AASHTO density.

For each type of material encountered, a trial section shall be built from material that is representative of the material from which a proof density is to be determined. The materials shall be placed and compacted as described in Section 3200 and such compaction shall comprise a total of twelve passes for every 150 mm of compacted layer thickness, over every section of the layer to be compacted by various items of compaction equipment giving the most efficient combination for the material in question. The Contractor shall use a combination of all or any of the following equipment: heavy grid rollers, sheep’s-foot rollers, tamping rollers, heavy pneumatic rollers, flatwheel rollers and vibratory rollers or any other item of plant deemed by the Engineer to be suitable. The Contractor shall base his tendered rates on the inclusion of four passes by a vibratory roller per twelve pass roller combination.

On completion of the compaction of the trial section at least 10 dry-density measurements shall be made in the top 150 mm of the layer, or in the case of non-plastic sand in
the layer 100 mm to 250 mm below the surface, and the proof density shall be the average of these dry densities.

The specified dry density to which the material shall be compacted shall be 98% of the proof density, and shall be measured in the top 150 mm of the layer in the case of soils and gravels and in the layer 100 mm to 250 mm below the surface in the case of non-plastic sands.

The Engineer shall have the authority to decide when the characteristics of new materials vary sufficiently to warrant the determination of a new proof density.

Compaction to a proof density shall only be used as an alternative to compaction to a percentage of modified AASHTO density in cases where the latter has been specified and serious difficulties are encountered in obtaining specified densities.

(ii) Equipment

The plant shall be of any size and type as may be deemed to be suitable by the Engineer, except that the following items of plant shall comply with the requirements stated below:

(1) Pneumatic-tyred roller

The pneumatic tyred roller shall consist of pneumatic tyred wheels mounted on a rigid frame with loading platform or body suitable for ballast loading to produce a load of not less than 70 kN on each wheel and arranged in a manner that will allow all wheels to bear equally while operating on uneven surfaces.

The total load on any axle line shall not exceed 300 kN. Under operating conditions tyres shall be uniformly inflated to a pressure within the range of 500 to 800 kPa. The roller shall be ballasted in accordance with the requirements of the Engineer.

(2) Vibratory roller

The vibratory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/m width for every metre of loose-layer thickness at an operating frequency not exceeding 25 Hz and shall move at a speed not exceeding 4 km/h.

(3) Grid roller

The grid roller shall have a mass of not less than 13.5 tons when ballasted, shall be loaded to this mass, and shall move at a speed of not less than 12 km/h.

(4) Tamping roller

The tamping roller shall consist of a cylindrical drum fitted with specially designed tamping feet, and shall have a total mass of not less than 13.5 tons, and shall move at a speed of not less than 12 km/h. The feet shall be rectangular in shape and shall have two or three consecutive rolling faces, and shall be designed so as not to loosen any material during the process of rolling.

(5) Oscillatory roller

The oscillatory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/metre width for every metre of loose-layer thickness at an operating frequency not exceeding 50 Hz and shall move at a speed not exceeding 4 km/h.

(c) Rock fill

When so directed by the Engineer, the rock fill shall be constructed as determined in Subclause 3209(c).

(d) Twelve-roller -passes compaction

Where the degree of compaction cannot be satisfactorily controlled by way of testing the in situ density on account of the nature of the material, the Engineer may instruct that the material be placed and compacted as described in Subclause 3304(b) by twelve passes or coverages (for every 150 mm of compacted layer thickness) by a combination of various items of compaction equipment. The Engineer may also instruct that the required number of passes be increased or decreased and that the payment be adapted accordingly.

The provisions of Subclause 3304(b) shall apply mutatis mutandis to this method of compaction with the proviso that compaction to a specified density will not be required but that the full number of roller passes ordered and paid for shall be applied.

3305 TREATING THE ROADBED

(a) Removing unsuitable material

Any roadbed material which is considered by the Engineer to be of a quality that would be detrimental to the performance of the completed road shall be removed to such widths and depths as may be instructed by the Engineer and shall be disposed of as prescribed. The excavated spaces shall then be backfilled with approved imported material compacted to the required density.

The Engineer may also order that material which is too wet to provide a stable platform for the construction of the fill be removed and replaced with suitable dry material. The Contractor shall be paid for this work, provided that the Engineer is satisfied that, despite adequate temporary drainage installed by the Contractor and permanent drainage installed by the Engineer's instructions, the wet condition is unlikely to be remedied within a reasonable time and could not have been reasonably foreseen and avoided by proper advance planning for construction being done during a dry period.

The removal of unsuitable material shall be paid for under Item 33.07. For payment, a distinction shall first be made in respect of the depth of the material removed and secondly in respect of the stability of the material and the construction plant to be used. For removing any stable material, payment will be made only under this item should the instruction to remove be given after completion of the excavations in accordance with the original instructions or should the thickness of the layer to be removed be less than 200 mm. If not, payment will be made therefore under Item 33.04 as for ordinary excavated material which is taken to spoil.

For the purposes of this Clause and of payment Item 33.07, stable material shall be defined as material which can be removed effectively by means of normal road-construction equipment such as bulldozers or road graders or scrapers, whereas unstable material shall be material which can be removed effectively only by means of mechanical shovels, dragline scrapers, or similar equipment.
(b) Three-roller-passes compaction

Any portion of the roadbed which, by reason of its inadequate in situ density is shown on the Drawings or is specified or is prescribed by the Engineer to be given three-roller pass compaction, shall be prepared by shaping if necessary and then compacting with a heavy pneumatic-tyred roller or a vibratory roller which complies with the requirements specified in Subclause 3304(b), or with an impact roller.

The impact roller shall be a single multi-faced roller with a maximum of five flat or nearly flat faces and a roller mass of between 8 and 10 tonnes. The roller and towing mechanism, which shall be of the free-fall type, shall be so designed that all the energy applied in lifting the roller, when the roller is supported on the ridge between adjacent faces, will be available for application on impact when the roller drops down again. The roller shall be towed at a speed between 8 km/h and 24 km/h.

Except where otherwise authorised by the Engineer, compaction shall comprise not less than three complete coverages by the wheels of the roller, specified or ordered, over every portion of the area being compacted. Although it is not the intention that water be applied to the roadbed by the Contractor under this class of compaction and no rigid control of the moisture content will be exercised during compaction, the Contractor shall nevertheless satisfy the Engineer that every possible endeavour is being made to take advantage of favourable soil-moisture conditions and to carry out such compaction in so far as is possible during periods when the roadbed is neither excessively dry nor excessively wet.

The Engineer shall be fully authorised to decide as to when conditions are favourable for compaction and where such compaction shall be done at any particular time and he is authorised to instruct the Contractor to water the roadbed at the Contractor's expense where, in the opinion of the Engineer, the Contractor has failed to comply with these requirements. Where required, three-pass roller compaction shall be followed up by the process described in (c) below.

(c) Preparing and compacting the roadbed

Any part of the roadbed which is classified as being suitable for use in situ, save that it fails to meet density requirements, shall be scarified, watered and compacted to a percentage of modified AASHTO density. The type of compaction and the depth of compaction shall be as directed by the Engineer. If necessary, roadbed material may have to be temporarily bladed off to windrow in order to achieve the necessary depth of compaction.

Where any additional material has to be imported to obtain the required level and layer thickness, and where the thickness of the layer of imported material would be less than the specified layer thickness after compaction, then the roadbed material shall be scarified, the necessary imported material placed, and this combined material mixed and compacted to the full specified depth of the layer. The imported material shall be measured and paid for under Item 33.01, Cut and borrow to fill, and the roadbed material shall be measured and paid for under Item 33.10, Roadbed preparation and compaction of material.

(d) In situ treatment of roadbed

Wherever shown on the Drawings or as may be directed by the Engineer, the roadbed shall be treated in situ by undesirable formations of hard or rocky materials being broken up in order to achieve a uniform standard of compaction or to improve drainage.

Treatment in situ shall consist of ripping or blasting the roadbed to depths which, on normally cambered sections, shall increase from the centre of the roadbed to the edges. Unless otherwise indicated on the Drawings or directed by the Engineer, the depth of ripping in the centre of the roadbed shall be not less than 300 mm and at the edges of the roadbed not less than 500 mm. Similarly the depth of drilling and blasting shall be not less than 700 mm at the centre of the roadbed, and shall slope outwards to not less than 1 000 mm at the edges of the roadbed. On superelevated sections the treatment shall, if so directed by the Engineer or shown on the Drawings, have a uniform cross fall and a minimum depth of 400 mm in the case of ripping and 850 mm in the case of blasting.

After ripping or blasting the material shall be processed as follows:

(i) Where the Engineer instructs the Contractor to rip the in situ material, all the material shall be sized by rolling or knapping until the maximum dimensions of any clod or spall do not exceed two-thirds of the thickness of the layer after compaction.

(ii) The material shall then be compacted as described in Section 3200 and in Subclause 3304(b) by means of twelve passes of an approved combination of various rollers.

Where instructed by the Engineer, the Contractor shall blast the in situ material, and all the material shall be processed and compacted as described in Subclause 3209(c).

In both cases surplus material resulting from bulking after treatment in situ shall be removed and disposed of or utilised elsewhere as directed by the Engineer.

(e) Draining of roadbed

Any drainable waterlogged roadbed, such as saturated material overlying less pervious strata, shall first be drained by the installation of all permanent surface or subsoil drainage shown on the Drawings or as directed by the Engineer, before any other construction may be started on these sections.

Such drains shall be constructed, measured and paid for in accordance with the requirements of Section 2100.

(f) Method specification for collapsible soils

The Engineer may order field trials to establish the type of equipment to be used for compaction of the road bed and the number of roller passes to be applied to areas of collapsible materials.

The Engineer may instruct that preparation of the road bed be undertaken by applying a specified number of roller passes using one or more of the roller types detailed in Subclause 3304(b) or 3305(b).

The field trials will be paid for as dayworks in accordance with the General Conditions of Contract. Each square metre roller pass shall be paid for under Item 33.06 for the relevant roller used in the trials.
3306 CUT AND BORROW

(a) Dimensions of cuts

The dimensions of cuts shall be generally in accordance with the details of the typical cross-sections, and of the interchange and intersection as shown on the Drawings and shall further be defined or amended during the course of construction by instructions from the Engineer. The Contractor shall obtain instructions beforehand from the Engineer regarding the slope of the sides of cuttings and the depth to which cuttings are to be taken, including the dimensions of any in situ treatment of cuts that may be required below the level of the top of subgrade. In rock cuts the rock shall be removed to the level that will permit the construction of the subbase layer, unless otherwise instructed.

All cuts carried below the specified levels shall be backfilled with suitable material and compacted to the satisfaction of the Engineer at the Contractor’s own expense. In the case of cuttings made in hard or boulder material, where a certain amount of overbreak would be inevitable, the Contractor is, however, afforded the opportunity of pricing an item to cover his costs in respect of unavoidable overbreak on the floor and backfilling in such sections.

The Engineer may, when he considers it necessary, instruct the Contractor to widen existing, completed or partly completed cuttings either uniformly or by altering the slope of the sides of the cutting, or by cutting benches, or in any other way. Those parts of cut slopes exceeding 2.5 m in depth and widened by less than 4 m measured horizontally shall be measured and paid for as specified in Clause 3312, Item 33.08. Those parts of widened cut slopes which are less than 2.5 m in depth, and parts widened by more than 4 m measured horizontally, shall be measured and paid for as cut to fill or cut to spoil as the case may be.

(b) The use of cut material

All suitable and approved materials excavated from the road prism shall, in so far as is practicable, be used for the construction of fill, side fill, shoulders, pavement layers and cuts to fill or cut to spoil as the case may be.

The Engineer shall have full control of the use of all material obtained from cut excavations, but the Contractor shall plan his operations and particularly his cut-to-fill operations in such a manner that all cut material may be used to the best advantage of the Employer. This would mean that no material shall be unnecessarily spoiled, borrowed or hauled. The Contractor shall neither borrow nor spoil any material without the Engineer's approval and without satisfying the Engineer that this is necessary and the most economical method of constructing the Works.

Where sufficient quantities of suitable cut material are not available, additional material shall be excavated from borrow areas shown on the Drawings or as directed by the Engineer. In lieu of borrow, cuts may be widened or their slopes flattened, provided that the Engineer determines the need for such action before the Contractor starts work on any particular cut. If the Engineer requires existing cuts or partly completed cuts to be widened, such widening shall be measured and paid for separately as provided in Subclause 3306(a).

Additional material required for the construction of the work shall, wherever possible, be obtained by the shortest haul distance from approved borrow areas being used.

The Engineer shall have the right to decide which sources of supply of approved material shall be used by the Contractor at any particular time.

Where satisfactory material is obtainable at shorter haul distances and the Contractor elects to use material which will require longer hauls, the Contractor will be paid at the rate for the shorter haul.

(d) Selection

The Engineer may order that particular materials in borrow pits or in cuts be selected for a specific purpose. Where selection is ordered, the method of excavation and the programme of work shall be so arranged as to avoid, in so far as is possible, double handling and to meet the requirements of the Engineer. If selected materials designated by the Engineer are contaminated, used incorrectly or become unavailable through injudicious planning of borrow pit or excavating operations, the Contractor will be required to replace the shortfall with material of at least equal quality, excavated and transported from borrow pits at his own expense.

In general the excavated materials shall be placed direct in their final positions in the fill.

When the stability of a fill may be materially improved by the controlled placing of earth and rock-fill in successive layers, a concurrent supply of both types of material shall be arranged.

When ordered by the Engineer, the better class fill material shall be selected for use in the top layer of the fills and in the lower layers of high fills.

(e) Temporary stockpiling of materials

Where the earthworks pattern is such that selected materials cannot be placed directly in their appropriate positions, the Engineer may authorise their removal to temporary stockpiles as described in Clause 3203. Temporary stockpile sites selected by the Engineer shall be prepared by clearing and light grading.

The selected material shall be stockpiled in successive layers over the full stockpile area to the approximate dimensions required by the Engineer and shall subsequently be reloaded and placed.

(f) The disposal of surplus material

Any surplus material resulting from excavations, including any waste or oversize material bladed off the road, shall be disposed of as directed by the Engineer. However, no
material shall be disposed of without the written instructions of the Engineer. Spoil material shall not require compaction but shall, if required, be spread, shaped and given a smooth surface as may normally be obtained by careful bulldozer operations.

(g) General

The Contractor shall take proper care when excavating cuts not to loosen, where it can be avoided, any material outside the specified cut line, whether by ripping, blasting or by other means, which would endanger the stability of the slopes or which would subsequently cause undue erosion or disintegration of the batters. This would normally entail modifying the methods of excavating when work is done in the vicinity of the final cut surface.

Care shall also be taken not to undercut any slopes, and proper control shall at all times be exercised by regular survey checking and by using batter poles at close intervals. Where the batters are nevertheless undercut, backfilling and compacting with imported material will not normally be considered to be a suitable remedy, and the Engineer may order such remedial measures as he may consider to be necessary to be implemented at the Contractor’s expense, which, in serious cases, may include cutting back the entire or large sections of the batter to a uniform slope.

3307 FILLS

(a) General

The dimensions of fills shall be in accordance with the typical cross-sections and the interchange or intersection details shown on the Drawings, as further defined or amended by the Engineer during the course of construction. Before starting construction, the Contractor shall obtain instructions regarding the required slope of each fill, any roadbed preparation or subsoil drainage required, details of earthwork at interchanges and intersections, the selection of materials, the method and classification of compaction, and any other matter that may affect the construction of the fill or sequence of operations.

Where, for one of the following reasons, material is oversize or otherwise unsuitable for use:

(i) because it was not properly broken down, during the excavation process, to the maximum size as described in Clause 3204;

(ii) because it was not properly selected or was contaminated as described in Subclause 3202;

(iii) because it was excavated in a manner detrimental to its intended use as described in Subclause 3104(d);

such material shall be removed from the road and disposed of, and its removal and disposal shall not be paid for.

Where a local surplus of cut material or material which, for the above reasons, is unsuitable or oversize, occurs, payment will nevertheless be made for the removed material as for the disposing of cut material to the extent in which such material or an equal volume of other material would in any case have to be spoiled.

All material used for the construction of fills shall, during excavating, placing and compacting, be broken down, placed and compacted as described in Section 3200. The density of fill shall comply with the requirements of Subclause 3302(b) unless otherwise authorised by the Engineer, as in the case of the bottom layer of a fill on marshy ground or in rock fill.

The layer thickness used for the construction of the fills will depend on the type and maximum size of material used. The Engineer shall first determine the layer thicknesses with reference to the provisions of Clauses 3207, 3208 and 3209, and shall also determine the type of compaction to be employed.

Wherever practicable, fill shall be placed in successive layers parallel to the final road surface, and the construction of wedge-shaped layers shall be restricted to the bottom layers of fill where this may be unavoidable on account of cross fall, the tapering out of fills, or the superelevation of the final road surface.

(b) Placing of rock

Rock material containing particles in excess of 300 mm in size shall not be used at a depth of less than 150 mm below the top of the fill unless otherwise authorised by the Engineer.

The Contractor shall, by the judicious planning of layer thicknesses and by selecting the smaller sized material for placing in the thinner fill layers, avoid unnecessary spoiling of the larger sized rock material and shall ensure its fullest practicable utilisation in fills.

(c) Constructing on unstable ground (pioneer layer)

Where fill is to be constructed across water-logged or soft clayey ground exhibiting excessive movement under normal compaction equipment and haulage trucks, and such conditions preclude the effective compaction of the bottom fill layers, the Engineer may direct that a pioneer layer be constructed on the unstable ground. This layer shall be constructed by successive loads of suitable coarse material being dumped and spread in a uniform layer with a thickness just sufficient to provide a stable working platform for constructing the further fill layers which are to be compacted to a controlled density. Light hauling equipment shall be used, and, where necessary, end tipping for placing the material. The layer shall be compacted by light compaction equipment which will give the most effective compaction without the roadbed being overstressed. Pioneer layers will not require compaction to a controlled density. The distinction between the construction of a pioneer layer and a rock fill as described in Clause 3209 will be determined by the purpose for which it is constructed.

The compacted volume of material used may be determined by 70% of the loose volume in trucks being taken as an alternative to taking cross-sections before and after construction.

(d) Benching

Where the natural cross fall of the roadbed exceeds 1:6, the fills shall be bonded to the roadbed by means of benches excavated in the roadbed.

The height of the benches shall be determined by the Engineer. Benches in hard material may normally be smaller than those in soft material. Where benches are cut into rock, the toe of the fill shall preferably also be constructed from rock material, and the benches shall be at least as high as the largest boulders in the fill material. The
floor of the first bench in rock material shall also be serrated in order to resist horizontal forces effectively. Benches in rock material shall also be excavated to slope slightly inwards so as to obtain a better bond.

The benches may be constructed in either one of the following two ways:

(i) Method A

This method requires the cut of the first bench in the existing roadbed to be of adequate width for accommodating normal-width self-propelled construction equipment. The widths of successive benches shall be determined by the width of the fill at the relevant height.

The width of benches shall decrease gradually up to the stage where the fills in any case are wide enough for accommodating normal-width self-propelled construction equipment.

(ii) Method B

This method does not require the benching in the toe of the fill to be cut back adequately for accommodating normal construction equipment, but requires the fills to be so much wider as may be necessary for accommodating such equipment up to the height where the fills are sufficiently wide in any case. In this case the Engineer shall determine the width of the lowest bench to be cut in the fill.

The position of the first bench at the toe of the fill shall be properly measured and clearly set out. All suitable material obtained from the excavations for benching shall, in so far as is possible, be re-used for constructing the fills. Measurement of and payment for constructing the benches shall be treated as “cut to fill” or “cut to spoil” as the case may be, unless otherwise determined in the Project Specifications. In the case of Method B construction, the Engineer may require excess width at the toe of the fill to be removed later on, in which case it shall be classified as soft excavation material.

(e) Construction of high fills

The construction of high fills may require special techniques to prevent the development of excessive pore pressure and to ensure the stability of such fills during and after construction. These may include, inter alia, the selection of better class material for use in the bottom layers of the fill, the construction of sand filter blankets and the strict control of moisture content during compaction. Where these measures are required, such fills shall be designated as high fills, which shall be constructed in accordance with the Project Specifications.

(f) Sand filter blankets

At the bottom of fills, and sometimes at intermediate levels, the construction of sand filter blankets may be required to facilitate the drainage of fills. Sand filter blankets shall be constructed in accordance with the details on the Drawings and shall normally consist of a layer of selected sand with a suitable grading to provide effective drainage and to prevent the infiltration of fill or roadbed material into the sand filter blanket. The surface on which the sand filter blanket is to be constructed, shall be smooth and even and the sand shall be spread evenly to the required thickness and be given a light compaction with suitable rollers. The final surface of the sand filter blanket shall be finished off true to line and level.

The Engineer may require the layers immediately below and above the filter blanket to be constructed from selected soil or gravel. Sand filter blankets will be measured and paid for separately.

(g) Construction of fills near structures

At all fills adjoining uncompleted structures such as bridges and large culverts, where the construction of the fill and the backfilling behind the structure cannot be done simultaneously, the fills shall be so constructed that the longitudinal slope of the surface of the fill at all stages will form a continuous plane sloping towards ground level at the structure at a gradient not exceeding 10%. When the structure is completed, the remaining portion of the fill shall be similarly completed simultaneously with the backfilling behind the structure, while the backfill behind the structure is being maintained at the same elevation as the adjoining fill. No additional payment will be made for constructing fills in this manner outside the restricted areas as defined in Clause 6106.

(h) Constructing rock protection at the toes of fills

Where required, the toes of fills shall be protected against erosion by special rock protection, which shall be installed as shown on the Drawings and as further explained by the Engineer, by the outer part of the toes of fills being constructed from assorted boulders and/or blasted rock, as described below.

The rock protection shall be constructed simultaneously with the rest of the fill and shall consist of selected durable rock material varying in size between 150 mm and 750 mm. If required, a layer of synthetic-fibre filter material shall be installed at the interface between the normal fills and the rock protection. Care shall be taken not to damage or tear such material.

The rock protection shall be constructed and compacted as described in Clause 3209 for rock fill, but the following additional requirements shall be taken into consideration:

The outer part of the rock protection shall consist of larger boulders properly bedded by means of smaller fragments so as to form a stable interlocking rip-rap surface.

If placing with mechanical construction equipment does not achieve the required result, the equipment shall be supplemented by manual labour to select, bar and place keystones in between the larger boulders until the correct placing is achieved and the rocks are firmly interlocked.

(i) Widening fills

Where existing fills are required to be widened or where already constructed fills are required to be widened or flattened, it shall be done by way of bench construction as described in Subclause 3307(d) for forming a firm bond between the existing and new construction.

Where the existing filling is loose on the outside and shows inadequate compaction, benches shall, if necessary, be cut back further than may be necessary to accommodate construction equipment until adequately compacted material is found. As the work proceeds, the Contractor shall liaise constantly with the Engineer in view of receiving continuous instructions regarding the extent to which existing fills have to be cut back and the material so excavated has to be re-used in the fills.
3308 FINISHING THE SLOPES

(a) Cut slopes

The slopes of cuttings shall be trimmed to neat lines and to a standard that is generally attainable with proper care and workmanship in the type of material concerned. All loose rocks, stones and nests of loose material shall be removed, especially in solid-rock cuts, which must be completely free from such material. The final surface of batters must not be absolutely smooth but shall have a slightly rough finish which will be suitable for subsequent grassing or for the establishment of natural vegetation.

(b) Fill slopes

Fill slopes shall be finished to neat lines with all loose rocks and uncompacted material removed. The degree of finish required shall depend on the nature of the material used for the fill slope but shall be as smooth as is consistent with the material involved and good workmanship.

No individual boulders occurring in otherwise smaller sized material shall be allowed to project beyond the surface. All excess fill shall be removed immediately.

In the case of rock fill, soft material shall be dumped over the sides of fills and worked into the interstices between the rock on the surface of the slope. Any soft material ordered by the Engineer to be dumped over the sides of rock fills without further shaping or trimming shall be classified as "cut to spoil", but if shaping and finishing have been ordered, the material shall be classified as "cut to fill", and all such material shall be measured for payment additional to fill, which is measured in accordance with the net specified dimensions of the road prism. The volume of such material shall be taken to be equal to 70% of the loose volume measured in the trucks.

(c) Median slopes and interchange areas

Median slopes shall be finished to the same level tolerances as specified in Subclause 3310(a) for the top layers of fills. This tolerance shall apply to both the top layer of the fill and the final surface of the topsoil.

The area between interchange ramps shall be finished to the same tolerance as that specified for median slopes. For the sides of fills steeper than 1:4, the provisions of Subclauses 3308(b) and (d) will apply.

(d) General

Except in solid rock, the tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded as indicated on the Drawings or as ordered by the Engineer. Slopes at the junctions of cuts and fills shall be adjusted and warped to flow into one another or into the natural ground surfaces without any noticeable break. When so directed by the Engineer, adjustment to the slopes shall be made in order to avoid damage being done to standing trees and to harmonise with existing landscape features. The transition to such adjusted slopes shall be gradual.

Cut and fill slopes shall be finished to a uniform appearance without any noticeable break which can be readily discerned from the road. The degree of finish required for all fill slopes and for cut slopes flatter than 1:4 shall be that normally obtainable by motor grader or hand-shovel operations.

The slopes of cuts and fills which are designated for grassing shall, after finishing, be prepared for grass planting and/or for topsoil for grass planting as specified in Section 5700.

All trimming of cut slopes shall be completed before any work on the subbase is commenced inside such cuttings.

3309 PROTECTING THE ROAD PRISM AND STRUCTURES

During construction, the road prism shall be kept well-drained and protected at all times as specified in Clause 1217. All windows shall be cut away after construction to prevent the concentrated flow of water on completed fill layers, but, where necessary, flat berms shall be constructed to prevent the undue erosion of fill slopes. All permanent drains shall be constructed as soon as possible, together with sufficient additional temporary drains as may be necessary to protect the road prism, and shall be maintained in a good working order. Ruts and potholes developing in the subgrade after completion shall be repaired, and damaged portions of the subgrade shall be reshaped and recompacted at the Contractor’s own cost.

All cut and fill slopes shall be maintained by the Contractor until the road has been certified as being finally completed. All erosion and flood damage to slopes shall be promptly repaired as specified in Clauses 1217 and 1218.

Side drains discharging water from cuts and all other drains shall be so constructed in such a way that damage to the fills by erosion is avoided.

Proper precautions and temporary measures shall be taken in all cases to ensure that the method or procedure by which the fills are constructed will not impose loads on structures, especially on uncompleted structures, which may damage or overstress such structures.

3310 CONSTRUCTION TOLERANCES

The work described in this Section shall be constructed to the dimensional tolerances given below.

(a) Level

The level tolerances referred to in Clause 7205 shall be as follows for fill, but shall apply only to the top layer of the fill:

- $H_{90}$ ........................................... ± 25 mm
- $H_{\text{max}}$ ........................................... ± 33 mm.

(b) Width

(i) Common fill

The horizontal measurement taken from the centre line of the road to the side of the fill, shall nowhere be more than
125 mm less or 250 mm more than the specified dimension when measured at any level.

(ii) Rock fill

The horizontal measurement taken from the centre line of the road to the side of the fill, shall nowhere be more than 250 mm less or 500 mm more than the specified dimension when measured at any level.

(iii) Cut slopes

No specific tolerances are given, but the cut slopes shall be finished to a standard generally attainable with proper care and workmanship, where the nature of the excavated material is borne in mind. Care shall also be taken not to undercut any slopes which would cause sections to have a steeper slope than specified. All loose material shall be removed.

3311 ROUTINE INSPECTION AND TESTS

Routine inspection and tests will be made by the Engineer to determine whether the quality of materials and the workmanship comply with the requirements of this Section. Fills comply with the requirements of Clause 3302 in cases where the results of at least 75% of in situ density tests on any lot are equal to or exceed the specified values and no single density is more than 5 percentage points below the specified value.

3312 MEASUREMENT AND PAYMENT

Note: Determining the quantities

Upon completion of all work in connection with clearing and grubbing and working the roadbed, and where the classification of the excavations change, the Contractor, at his own cost, shall take cross-sections at 20 m intervals so as to determine quantities, and shall submit the results so obtained to the Engineer for approval. The Engineer will take control measurements to determine the accuracy and adequacy of the cross-sections, and may instruct the Contractor to correct any faulty work and to take such additional measurements and cross-sections as may be deemed necessary by him. Such cross-sections shall be taken before any cut or fill work is done. Where the Contractor proceeds with such work before final approval of the cross-sections and before the Contractor and the Engineer have agreed on the cross-sections, the Engineer’s decision regarding the cross-sections to be used shall be final and binding on the Contractor.

Where there are valid reasons for believing that the roadbed is subsiding as fills are being constructed, and after the roadbed work has been completed and cross-sections have been agreed on, the Contractor may request that the fill quantities shall be adjusted accordingly. Such request shall be lodged without delay, and the Contractor shall submit the required supporting evidence to the Engineer. Where the Engineer is satisfied that significant subsidence is occurring, he, together with the Contractor, shall decide as to how the extent of the subsidence is to be determined, and, where no agreement can be reached, the decision of the Engineer shall be final. Any adjustments of this nature shall be made only where the average subsidence exceeds 50 mm.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>33.01 Cut and borrow to fill, including free-haul up to 0.5 km:</td>
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</tr>
<tr>
<td>(a) Gravel material in compacted layer thicknesses of 200 mm and less:</td>
<td></td>
</tr>
<tr>
<td>(i) Compacted to 90% of modified AASHTO density</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) Compacted to 93% of modified AASHTO density</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(iii) Twelve roller passes compaction</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Gravel material in compacted layer thicknesses from 200 mm to 500 mm:</td>
<td></td>
</tr>
<tr>
<td>(i) Compacted to 90% of modified AASHTO density</td>
<td>cubic metre (m³)</td>
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<tr>
<td>(c) Rock fill (as specified in Subclause 3209(c))</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(d) Rock protection at the toes of fills</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(e) Pioneer layer</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(f) Sand filter blanket</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material measured in the compacted fill. The quantity measured shall be computed by the method of average end areas from levelled cross-sections prepared from the ground line after clearing and grubbing and the removal of topsoil and the completion of any preparatory roadbed treatment which may have been ordered by the Engineer, but prior to the construction of the fill, and the final specified or authorised fill cross-section superimposed thereon at 20 m intervals along the centre line of the road. All measurement shall be neat, and that part of the fill placed in excess of the authorised cross-section shown on the Drawings or directed by the Engineer, will not be paid for irrespective of the tolerances in workmanship allowed under the Contract. Where the roadbed has subsided under the fills, the quantities shall be adjusted to make allowance for such subsidence, as set out in the note at the commencement of this Clause. Measurement of fill shall distinguish between the alternative methods of processing and compacting.

Material excavated for the construction of open drains, subsoil drains, culverts, bridge foundations and other structures, shall, if suitable and if so directed by the Engineer, be used for the construction of fills, and payment shall be made under Item 33.01 irrespective of any payment made previously for the excavation of such material. All such material shall be classified as soft excavation.

The tendered rates shall include full compensation for procuring, furnishing and placing the material, including excavating as if in soft excavation, for transporting the material for a free-haul distance of 0.5 km; for preparing,
processing, shaping, watering, mixing, and compacting the materials to the densities or in the manner specified herein and for removing and disposing of up to 5% oversize material from the road after processing, including transport for a free-haul distance of 1.0 km.

Payment shall distinguish between the various methods of processing and compacting specified, as itemised above.

### Item 33.02 Sand fills (as described in Clause 3302, including free-haul up to 0.5 km):

(a) Non-plastic sand with up to 20% passing through the 0.075 mm sieve, compacted to 100% of modified AASHTO density .......................... cubic metre (m³)

(b) Non-plastic sand with more than 20% passing through the 0.075 mm sieve, compacted to 95% of modified AASHTO density .......................... cubic metre (m³)

The unit of measurement shall be the cubic metre of sand measured in fills as determined in Item 33.01, but with the difference that no distinction will be made between different layer thicknesses in which the material is placed and compacted.

The tendered rates shall include full compensation for procuring, placing and compacting the sand fills, as well as 0.5 km free-haul.

### Item 33.03 Extra over Item 33.01 for excavating and breaking down material in:

(a) Intermediate excavation ........ cubic metre (m³)

(b) Hard excavation ................. cubic metre (m³)

(c) Boulder excavation
   - Class A ............................. cubic metre (m³)
   - Class B ............................. cubic metre (m³)

The unit of measurement shall be the cubic metre of material removed as specified.

Measurement of Items (a), (b) and (c) shall be in the original position in the cut or borrow pit, and the quantity shall be computed by the method of average end areas from levelled cross-sections at intervals not exceeding 20 m measured along the centre line of the road in the case of cuts and at intervals not exceeding 10 m parallel to one another in the case of borrow pits, before and after the removal of the material. Measurement of boulder excavation Class B shall be by the volume of individual boulders being measured after removal, or, where this is considered to be impracticable, by taking the in situ volume of boulder excavation to be equivalent to 50% of the loose volume in the hauling vehicles.

Except as provided under Item 33.05, no material excavated in excess of the authorised cross-section shall be paid for, notwithstanding any tolerances in workmanship allowed.

The tendered rates shall be paid as extra over the rates applying to soft excavation in Item 33.01 and shall include full compensation for the additional costs to excavate and break down the various classes of material, including the cost of all the necessary additional effort, plant, tools, materials, labour and supervision.

The extra over payment shall distinguish between intermediate, hard, boulder Class A and boulder Class B excavation.

### Item 33.04 Cut to spoil, including free-haul up to 0.5 km.

#### Material obtained from:

(a) Soft excavation ................. cubic metre (m³)

(b) Intermediate excavation ........ cubic metre (m³)

(c) Hard excavation ................. cubic metre (m³)

(d) Boulder excavation
   - Class A ............................. cubic metre (m³)
   - Class B ............................. cubic metre (m³)

The unit of measurement shall be the cubic metre of material measured in its original position in cut and computed by the method of average end areas from levelled cross-sections taken along the ground line after clearing and grubbing and the removal of topsoil, if any, but prior to excavating the cut, with the final specified or authorised cross-section of the cut super-imposed thereon at intervals not exceeding 20 m along the centre line of the road.

Measurement of boulder excavation class B shall be by the volume of individual boulders being measured after removal, or, where this is considered to be impracticable, by taking the in situ volume of boulder excavation to be equivalent to 50% of the loose volume in the hauling vehicles.

Where measurement by cross-sections is considered by the Engineer to be impracticable, cut to spoil may be measured in the hauling vehicles, by taking the in situ volume of the material in the case of soils and gravel to be the equivalent of 70% of the loose volume in the haul vehicles, and, in the case of boulder material, as equal to 50% of the loose volume in the haul vehicles.

Except as provided under Item 33.05, no excavation in excess of the authorised cross-section shall be paid for, notwithstanding any tolerances in workmanship allowed.

The tendered rates for cut to spoil shall include full compensation for excavating from the road prism and roadbed in the various classes of excavation, for loading, transporting the material for a free-haul distance of 0.5 km, off-loading and disposing of the material as specified, including shaping and levelling-off any piles of spoil material.

This payment item will also apply to the removal of unsuitable roadbed material, provided that it is stable
material, and that instruction in respect of its removal be
given before the excavations reach the level of the roadbed
material to be removed, all as described in Subclause
3305(a).

Item  Unit

33.05 Overbreak in hard
and boulder Class A
excavation ............... square metre (m²)

The unit of measurement shall be the square metre of
exposed roadbed in completed hard and boulder Class A
cuts.

The tendered rate for overbreak in hard and boulder Class
A cuts shall include full compensation for unavoidable
overbreak which may occur during excavation and for the
cost of backfilling with suitable rock material and compacting
it to the lines and levels specified for the excavation. This
item shall not apply when Item 33.12 is applied in respect of
the same area.

Item  Unit

33.06 Variations in the number
of roller passes (applicable
to Subitems 33.01(a)(iii) and
33.01(b)(iii) and Item 33.11):

(a) Pneumatic tyred
rollers .............. square-metre-pass (m²-pass)
(b) Vibratory rollers .. square-metre-pass (m²-pass)
(c) Heavy grid rollers .. square-metre-pass (m²-pass)
(d) Tamping rollers .. square-metre-pass (m²-pass)
(e) Oscillatory rollers .. square-metre-pass (m²-pass)
(f) Impact rollers .. square-metre-pass (m²-pass)

The unit of measurement for the increased or decreased
number of roller passes used for roadbed compaction shall
be the square-metre coverage, and shall be computed by
multiplying the number of square metres to which the
changed pass efforts apply by the increased or decreased
number of roller passes. In the case of Item 33.01, it will be
computed on the basis of a 200 mm layer thickness.

Where a change in the compaction effort is requested, the
Contractor will be compensated at the tendered rates for the
above items in respect of the increased number of square-
metre roller passes of each type of roller required over and
above that specified in the relevant standard effort. His
compensation will be decreased simultaneously, at the
applicable rates, by the number of square-metre roller
passes of each type of roller which is either decreased or
completely left out.

The tendered rate for each additional square metre-pass
ordered by the Engineer over and above the specified
number of passes, shall include full compensation for all
supervision, labour, plant, equipment, fuel, materials, work
and incidentals necessary for completing and control testing
the work. The same rates shall be accepted by the
Contractor during computation of a decrease in his
compensation where the number of roller passes for each
specific type of roller is decreased.

Item  Unit

33.07 Removal of unsuitable
material (including free-haul
of 0.5 km):

(a) In layer thicknesses of
200 mm and less:
(i) Stable material ............ cubic metre (m³)
(ii) Unstable material ........... cubic metre (m³)
(b) In layer thicknesses
exceeding 200 mm:
(i) Stable material ............ cubic metre (m³)
(ii) Unstable material ........... cubic metre (m³)

The unit of measurement shall be the cubic metre of
unsuitable material removed by the Contractor in
accordance with the Engineer’s instructions, and it shall be
the in situ volume of the material calculated in accordance
with its authorised dimensions.

Subitems 33.07(a)(i) and (b)(i) shall apply only in
circumstances as specified in Subclause 3305(a) and Item
33.04.

For the purposes of this Clause the definitions of stable and
unsuitable material shall be as set out in Subclause 3305(a).

The tendered rates shall include full compensation for the
removal of all classes of unsuitable material and shall
distinguish only between stable and unsuitable material and
layer thicknesses of less than and exceeding 200 mm. It
will also include compensation for free-haul of 0.5 km.

Item  Unit

33.08 Widening of cuts (extra
over Items 33.01, 33.02 and 33.04):

(a) In hard material ............ cubic metre (m³)
(b) In boulder material
Class A or Class B ............ cubic metre (m³)
(c) In all other materials ........ cubic metre (m³)

The unit of measurement shall be the cubic metre of
material excavated during the widening of cuts where they
are more than 2.5 m deep, measured vertically from the top
of the cut to the shoulder breakpoint and where the side
slope is widened by 4 m or less.

Measurement of the material shall be in the original position
in the cut, and the quantity shall be computed by the method
of average end areas from levelled cross-sections at
intervals not exceeding 20 m measured along the centre line
of the road before and after removal of the material.

The tendered rates for widening the cuts shall be paid extra
over the rates tendered for Items 33.01, 33.02 and 33.04
and shall include full compensation for the additional costs
involved (over and above those for excavating new cuttings)
for excavating material by widening the cuts where they
exceed 2.5 m in depth and are widened by less than 4 m.
33.09 **Material bladed to windrow** ...... cubic metre (m³)

The unit of measurement in respect of material temporarily bladed to windrow as specified in Subclause 3305(c) shall be the cubic metre of material to be bladed off, measured in the original position before blading off, in accordance with the method of average end areas.

The tendered rate shall include full compensation for the temporary removal of such material and its later replacement, and for all clearing work which may be necessary after replacement of the material.

Only material bladed to windrow on the instructions of the Engineer for exposing the underlying roadbed material for treatment will be measured and paid for as described above.

33.10 **Roadbed preparation and the compaction of material:**

(a) Compaction to 90% of modified AASHTO density .......... cubic metre (m³)

(b) Compaction to 93% of modified AASHTO density .......... cubic metre (m³)

(c) Compaction to 98% of proof density ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of roadbed material prepared and compacted as specified in Subclause 3305(c). The quantity shall be computed in accordance with the authorised dimensions of the completed layers.

The tendered rates shall include full compensation for shaping, scarifying, mixing of in situ and imported material if required, and preparing and compacting the material as specified. For payment purposes a distinction will be made between compaction to a percentage of modified AASHTO density and that to 98% proof density.

33.11 **Three roller passes compaction:**

(a) Heavy pneumatic-tyred roller ................................ square metre (m²)

(b) Vibratory roller ................................. square metre (m²)

(c) Impact roller ................................. square metre (m²)

(d) Grid roller ................................. square metre (m²)

(e) Tamping roller ................................. square metre (m²)

(f) Oscillatory roller ................................. square metre (m²)

The unit of measurement shall be the square metre of roadbed compacted in accordance with the provisions of Subclause 3305(b). The quantity will be computed in accordance with the authorised dimensions of the area to be treated.

The tendered rates shall include full compensation for shaping, providing the rollers, keeping the rollers ready for use when soil-moisture conditions are favourable as specified, and compacting the roadbed by three roller passes.

33.12 **In situ treatment of roadbed:**

(a) In situ treatment by ripping .......................... cubic metre (m³)

(b) In situ treatment by blasting .......................... cubic metre (m³)

The unit of measurement shall be the cubic metre of in situ material treated in situ as specified in Subclause 3305(d). The quantity shall be calculated from the authorised dimensions of the in situ treatment.

The tendered rates shall include full compensation for ripping or blasting, shaping, scarifying, sizing, knapping, rolling, mixing of in situ and imported material if required, and preparing and compacting the material as specified. Payment shall distinguish between in situ treatment by ripping and in situ treatment by blasting. Surplus material shall be measured and paid for as in Item 33.01 if placed in fill and Item 33.04(a) if taken to spoil, and no payment shall apply under Item 33.03.

33.13 **Finishing-off cut and fill slopes, medians and interchange areas:**

(a) Cut slopes ................................. square metre (m²)

(b) Fill slopes ................................. square metre (m²)

(c) Medians and interchange areas ........................ square metre (m²)

The unit of measurement shall be the square metre of cut or fill slopes or medians and interchange areas finished off as specified. The areas shall be measured from levelled cross-sections taken at 20 m intervals measured along the centre line of the road and shall be the sloping area between the shoulder breakpoint and the toe of the fill in the case of fill slopes, and the sloping area between the top of the cut slope and the toe in the case of cut slopes. The medians shall include the full width of the median between the inner edges of the shoulders. The area occupied by side drains or any other drains shall not be included. The area of median areas which are to be finished off shall be determined in accordance with the Drawings.

The tendered rates for finishing cut or fill slopes, medians and interchange areas shall include full compensation for all labour, plant, materials and other incidentals and work required for finishing as specified, including the loading, transporting and disposal of any material brought down during the finishing operations.
Note: The following payment items, where they relate to work under this Section, will be listed in the Schedule of Quantities.

Item 16.01  Overhaul (extra over Items 33.01, 33.02, & 16.02 33.04 and 33.07)
Item 31.01  Excess overburden at borrow pits
Item 32.04  Removal of oversize material
Item 32.06  The temporary stockpiling of material.
Item 35.01  Chemical stabilisation
Item 35.02  Chemical stabilising agent
Item 35.03  Mechanical modification
Item 35.04  Curing by covering with the subsequent layer
Item 35.05  Curing with a bituminous membrane
This Section covers the construction of selected layers, subbases, bases and shoulders, and also gravel wearing courses from approved natural gravel or partially crushed gravels.

(a) General

Gravel material shall be obtained from approved sources in borrow areas or cuts. Tests will have been made on potential borrow pits, cuts and on the roadbed along the centre line of the route envisaged, and the results will be reflected on the Drawings, which also show the use for which the material could possibly be suitable.

The requirements to be complied with by the material are set out either on the Drawings or in the Project Specifications for each of the pavement layers and, despite the indications on the Drawings regarding the possible use of the sources of natural material tested, it shall be incumbent on the Contractor to use only material which complies with the prescribed requirements for use in the relevant pavement layers.

Where natural gravel does not fully comply with the requirements in respect of maximum size after having been broken down as determined in Clause 3204 or after light crushing, oversize material shall be removed as specified in Clause 3210.

(i) Grading modulus

The minimum grading modulus shall be 1.5 unless authorised by the Engineer, in which case a minimum of 1.2 may be permitted. The grading modulus may be relaxed to below 1.2 at the discretion of the Engineer when no alternative subbase material exists provided that the specified CBR strength is obtained.

(ii) Plasticity index

The maximum plasticity index of the natural material shall be 10% and that for material to be stabilised shall not exceed 6% after treatment with the selected stabilising agent.

(iii) California Bearing Ratio

The minimum soaked CBR of the natural material shall be 30% at the specified in situ density (not less than 95% Modified AASHTO).

(b) Selected layers

In situ material falling within the selected subgrade horizon shall, when not conforming with the requirements for selected subgrade material, shall be excavated and replaced or stabilised as ordered by the Engineer. Selected subgrade shall contain no material greater than two-thirds of the layer thickness in the case of both unstabilised and stabilised materials. The material will conform with the following requirements when unstabilised unless otherwise specified in the Project Specifications:

Minimum soaked CBR at specified density:
- Upper selected layer .................... 15 %
- Lower selected layer .................... 10 %

Maximum plasticity index .... 3 x grading modulus + 10

The maximum plasticity index of material to be chemically stabilised shall be as directed by the Engineer for each source and type of material used.

(c) Subbase

Subbase materials shall be obtained from approved sources in borrow or cut or such other sources as may be specified or approved from time to time.

The completed subbase shall contain no material having a maximum dimension larger than 63 mm or larger than two-thirds of the compacted layer thickness when approved by the Engineer.

Subbase material shall, unless otherwise authorised, conform with the following requirements when finally placed:

(i) Grading modulus

The minimum grading modulus shall be 1.5 unless authorised by the Engineer, in which case a minimum of 1.2 may be permitted. The grading modulus may be relaxed to below 1.2 at the discretion of the Engineer when no alternative subbase material exists provided that the specified CBR strength is obtained.

(ii) Plasticity index

The maximum plasticity index of the natural material shall be 10% and that for material to be stabilised shall not exceed 6% after treatment with the selected stabilising agent.

(iii) California Bearing Ratio

The minimum soaked CBR of the natural material shall be 30% at the specified in situ density (not less than 95% Modified AASHTO).

(d) Base

Gravel base material shall be obtained only from approved borrow areas or such other sources of supply as may be specified or approved for use from time to time.

The completed base shall contain no material having a maximum dimension exceeding 53 mm.

Gravel base material shall, unless otherwise authorised, conform with the requirements in Table 3402/1 and below when finally placed.

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Natural base</th>
<th>Chemically stabilised base</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>80 - 100</td>
<td>80 - 100</td>
</tr>
<tr>
<td>19.0</td>
<td>60 - 90</td>
<td>60 - 100</td>
</tr>
<tr>
<td>4.75</td>
<td>30 - 65</td>
<td>30 - 80</td>
</tr>
<tr>
<td>2.00</td>
<td>20 - 50</td>
<td>20 - 63</td>
</tr>
<tr>
<td>0.425</td>
<td>10 - 30</td>
<td>10 - 41</td>
</tr>
<tr>
<td>0.075</td>
<td>5 - 15</td>
<td>5 - 20</td>
</tr>
</tbody>
</table>
(i) Grading modulus
The minimum grading modulus shall be 2.0 if unstabilised or 1.7 if the material is to be chemically stabilised.

(ii) Plasticity index
The maximum plasticity index of the natural material shall be 6% and that for material to be stabilised shall not exceed 6% after treatment with the selected stabilising agent.

(iii) California Bearing Ratio
The minimum soaked CBR of the natural material shall be 80% at 98% Mod AASHTO density.

(iv) Quality/durability
The quality of the natural base course material shall comply with the following requirements:

Durability Mill Index (DMI)  
(See Subclause 7107(d)) ................. 125*

Maximum percentage passing 0.425 mm sieve after any DMI treatment ............... 35

Flakiness index ................................ 30%

* This may be relaxed to 420 for acid crystalline, high silica and pedogenic materials.

(e) Shoulder and wearing course
Shoulders will either be constructed from the same material as the base course or imported gravel. Imported gravel for shoulders shall conform with the requirements for wearing course gravels as follows:

Maximum size .............................. 37.5 mm
Maximum percentage retained on 37.5 mm sieve ....... 5
Shrinkage product ......................... 100 - 365
Grading coefficient ......................... 16 - 34
Minimum soaked CBR at 95% mod AASHTO ....... 15

(Shrinkage product = Bar linear shrinkage x per cent passing 0.425 mm)
Grading coefficient = (per cent passing 26.5 mm - per cent passing 2.0 mm) x per cent passing 4.75 mm/100

Note: all grading parameters must be normalised for 100% passing 37.5 mm.

(f) Compaction requirements
The minimum in situ compaction of gravel material shall be as specified hereinafter for the respective layers in terms of a percentage of modified AASHTO density.

Lower selected layer .............. 90% or 93%, as required.  
Sands: 100%

Upper selected layer ............. 93% or 95%, as required  
Sands: 100%

Subbase ...................... 95% or 97%, as required for material not chemically stabilised.

95% or 97%, as required for material chemically stabilised

Base ......................... 98% or 100%, as required for material not chemically stabilised.

97% or 98% as required for material chemically stabilised.

Shoulder & wearing course ...... 93% or 95% as required.

(g) Electrical conductivity
When specified in the Project Specifications, the requirements of Subclause 3602(d) shall apply.

3403 CONSTRUCTION

(a) Requirements applying prior to the construction of the layer
Pavement layers shall be constructed only where the underlying layer meets all the specified requirements and has been approved by the Engineer. Before the construction of any pavement layer, and also before any material for a pavement layer is dumped on the road, the Contractor shall check the underlying layer to establish whether there is any damage, wet spots or other defects, which shall be rectified in accordance with the instructions of the Engineer before the next layer is constructed.

(b) Placing and compacting
The material for a pavement layer shall be placed, spread, broken down, watered if necessary and mixed, and oversize material shall be removed and the layer compacted, all in accordance with the requirements of Section 3200.

The following additional requirements in regard to placement and compaction shall apply to specific pavement layers:

(i) Gravel base
Coarse gravel containing non-plastic or slightly plastic soil fines and used in the construction of the gravel base will usually require slushing and rolling in addition to the compaction specified in Clause 3208, in order to obtain a firm, well-knit surface. If so directed by the Engineer, the base, after being processed and compacted as specified above, shall be well watered by the Contractor over short sections at a time, slushed and rolled with compactors and/or heavy flatwheel rollers of a mass of not less than 10 tonnes each. Watering and rolling shall continue over a section until all excess fines have been brought to the surface of the layer. Such excess fines shall be uniformly spread over the entire surface of the layer by means of stiff brooms, and watering, rolling and brooming shall continue until all areas deficient in fines have been suitably corrected. All excess fines shall finally be removed from the surface of the layer.

(ii) Shoulders
Where the shoulders are to be constructed from the same material as the base, they shall be constructed simultaneously with the base. Where a base is to be constructed from crushed stone, the shoulders shall first be constructed and then neatly cut to the required line to provide lateral support for the crushed stone. Care shall be taken not to pollute the base material with the shoulder material. In the case of asphalt bases, the shoulders may be constructed after completion of the base.
Shoulder material shall be spread, broken down, watered, processed and compacted in accordance with the provisions of Section 3200, and shall be compacted to a density of not less than 93% of modified AASHTO density or 95% modified AASHTO density if specified in the Drawings or by the Engineer.

Work shall be so constructed that the road will be adequately drained at all times by means of temporary drainage pipes passing through the shoulders. The Contractor shall not start constructing the final bituminous surfacing of any part of the road before he has completed the shoulders of such section and the Engineer has approved it.

(c) Crushing and screening

Where pavement material cannot be suitably broken down to the required size in excavation and during processing on the road, the Engineer may prescribe that the material be crushed and screened or crushed only, all as specified in Section 3200.

(d) Stabilisation

When specified or required by the Engineer, pavement layers shall be stabilised as specified in Section 3500.

(e) Upgrading of existing base

Where an existing gravel layer is to be improved by the addition of a layer of material less than 100 mm thick, the existing surface shall be scarified to the depth instructed by the Engineer, mixed with the imported material to form a homogeneous layer of a minimum 100 mm depth, recompacted to the dry density specified in Subclause 3402(f) and formed to the lines and levels shown on the Drawings or as ordered by the Engineer.

Any surplus existing material shall be bladed off and removed to spoil or incorporated elsewhere in the base as directed by the Engineer.

(f) Classification of layers for payment purposes

Payment for pavement layers constructed from gravel material shall distinguish between layers constructed with material from borrow pits, cuts or existing pavement layers, and in situ recompacted layers with or without the use of additional materials.

Layers constructed from crushed-stone material recovered from existing crushed-stone pavement layers shall be placed and paid for as gravel material, unless otherwise determined by the Engineer. Where the Engineer determines in writing, that the material shall be processed and placed as crushed stone, Section 3600 shall apply in respect of the placing of and payment for the material.

3404 PROTECTION AND MAINTENANCE

The Contractor shall protect and maintain the completed pavement layers. Protection includes protection against rain and flood water and against any undue wear and tear of or damage to unsealed layers by construction or other traffic. Maintenance shall include, inter alia, the immediate repair of any damage or defects that may occur, excluding the normal wear and tear of bases and wearing courses, and shall be repeated until the end of the maintenance period.

3405 CONSTRUCTION TOLERANCES

The completed pavement layers shall comply with the construction tolerances given below:

(a) Level

The level tolerances referred to in Clause 7205 shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>( H_{90} )</th>
<th>( H_{\text{max}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected layer</td>
<td>25 mm</td>
<td>33 mm</td>
</tr>
<tr>
<td>Subbase</td>
<td>20 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>Base</td>
<td>15 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>Shoulders and wearing course</td>
<td>-</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

(b) Layer thicknesses

The thickness tolerances referred to in Clause 7205 shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>( D_{90} )</th>
<th>( D_{\text{max}} )</th>
<th>( D_{\text{average}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected layer</td>
<td>30 mm</td>
<td>40 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>Subbase</td>
<td>21 mm</td>
<td>27 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td>Base</td>
<td>21 mm</td>
<td>27 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td>Wearing course</td>
<td>-</td>
<td>30 mm</td>
<td>0 mm</td>
</tr>
<tr>
<td>Shoulders</td>
<td>-</td>
<td>30 mm</td>
<td>0 mm</td>
</tr>
</tbody>
</table>

(c) Grade

Deviations from the specified longitudinal grade shall not exceed that listed in Table 3404/1 in respect of the specified grades on the completed base.

<table>
<thead>
<tr>
<th>Length (L) of section under review (m)</th>
<th>Maximum deviation (g) of specified slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.354</td>
</tr>
<tr>
<td>5</td>
<td>0.224</td>
</tr>
<tr>
<td>10</td>
<td>0.158</td>
</tr>
<tr>
<td>20</td>
<td>0.112</td>
</tr>
<tr>
<td>30</td>
<td>0.091</td>
</tr>
</tbody>
</table>

Note: Use the following formula for other lengths

\[ g(\%) = \frac{0.5}{\sqrt{L}} \]

(d) Width

The average width of the layer shall not be less than the specified width, and nowhere shall the outer edge deviate by more than the following from the edge lines shown on the Drawings:
Selected layer ............................ 80 mm
Subbase ................................ 75 mm
Base ................................... 50 mm
Shoulders and wearing course ........... 75 mm

(e) Cross-section
When tested with a 3 m straight-edge laid at right angles to the road centre line, the surface shall not deviate from the bottom of the straight-edge by more than 6 mm.

At any cross-section the difference in level between any two points shall not vary from their difference in level computed from the cross-sections shown on the Drawings by more than 15 mm.

(f) Surface regularity
When testing the base with a rolling straight-edge as described in Subclause 7110(c), the number of surface irregularities shall not exceed those given below:

(i) Average number of irregularities per 100 m equal to or exceeding 6 mm when taken over 300 m - 600 m lengths ................. 4
(ii) Number of irregularities equal to or exceeding 6 mm when taken over 100 m sections ................. 6

The maximum value of any individual irregularity measured with the rolling straight-edge or a 3 m straight-edge laid parallel to the road centre line shall not exceed 10 mm.

(g) Construction tolerances for rehabilitation work
The construction tolerances of Clause 3405 shall be applicable to rehabilitation work, except where a gravel layer is placed on top of an existing layer without it being required that the existing layer be trimmed first to prescribed levels, the thickness tolerances of Subclause 3405(b) shall not apply.

3406 ROUTINE INSPECTION AND TESTS
The Engineer will do routine inspections and conduct routine tests to determine whether the quality of material and workmanship provided comply with the requirements of this Section.

The test results and measurements will be assessed in accordance with the provisions of Section 7200.

3407 MEASUREMENT AND PAYMENT

Item ........................................... Unit
34.01 Pavement layers constructed from gravel taken from cut or borrow, including free-haul up to 1.0 km:

(a) Gravel selected layer compacted to:

(i) 90% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 93% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(iii) 95% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)

(b) Sand selected layer compacted to 100% of modified AASHTO density (fraction sand < 0.075 mm less than 20%) (specify compacted layer thickness) ............. cubic metre (m³)

(c) Gravel subbase (unstabilised gravel) compacted to:

(i) 95% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 97% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)

(d) Gravel subbase (chemically stabilised material) compacted to:

(i) 95% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 97% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)

(e) Gravel base (unstabilised gravel) compacted to:

(i) 98% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 100% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)

(f) Gravel base (chemically stabilised material) compacted to:

(i) 97% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 98% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)

(g) Gravel shoulders compacted to:

(i) 93% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
(ii) 95% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m³)
Gravel wearing course compacted to:

- 93% of modified AASHTO density (specify compacted layer thickness) ............... cubic metre (m³)
- 95% of modified AASHTO density (specify compacted layer thickness) ............... cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted pavement layer, and the quantity shall be calculated from the authorised dimensions of the completed layer.

The tendered rates shall include full compensation for procuring, as if from soft excavation or pits, breaking down, placing and compacting the material, including transporting the material for a distance of 1.0 km and its removal, disposal and transporting for a distance of 1.0 km, of up to 5% by volume of oversize material, and the protection and maintenance of the layer and the conducting of control tests, all as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.02 Extra over Item 34.01 for excavation of material in:</td>
<td></td>
</tr>
<tr>
<td>(a) Intermediate excavation ........ cubic metre (m³)</td>
<td></td>
</tr>
<tr>
<td>(b) Hard excavation ............... cubic metre (m³)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material obtained from intermediate or hard excavation.

The tendered rates shall include full compensation for the additional costs involved for taking material from classes of material harder than soft excavation and for the additional costs, if any, for processing such material in the pavement layers.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.03 Pavement layers constructed from gravel obtained from existing layers:</td>
<td></td>
</tr>
</tbody>
</table>
| (a) Gravel selected layer compacted to 93% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (b) Gravel selected layer compacted to 95% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
</table>
| (c) Sand selected layer compacted to 100% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (d) Gravel subbase compacted to 95% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (e) Gravel subbase compacted to 97% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (f) Gravel base compacted to 98% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (g) Gravel base compacted to 100% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (h) Gravel shoulder compacted to 93% of modified AASHTO density, using:
- non-cemented material (specify compacted layer thickness) ............... cubic metre (m³)
- cemented material (specify compacted layer thickness) ............... cubic metre (m³)
| (i) Gravel shoulder compacted to 95% of modified AASHTO density, using:
(i) non-cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(ii) cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(i) non-cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(ii) cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(i) non-cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(ii) cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(j) Gravel wearing course compacted to 93% of modified AASHTO density, using:

(i) non-cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(ii) cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(k) Gravel wearing course compacted to 95% of modified AASHTO density, using:

(i) non-cemented material (specify compacted layer thickness) ................. cubic metre (m³)

(ii) cemented material (specify compacted layer thickness) ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted pavement layer, the quantity of which shall be calculated from the authorised dimensions of the completed layer if the underlying layer has also been reconstructed or reworked. Where the underlying layer has not been reconstructed or reworked but only rolled, or where no work has been done on it, quantities shall be calculated with the aid of cross-sections taken of the layer before and after construction, subject to the provisions of Clause 1220. Where the material consists of recovered pavement material in part and imported material in part, the quantity of imported material obtained from cut or borrow shall be paid for under Item 34.01, calculated in accordance with the volume relation of the respective materials.

The tendered rates shall include full compensation for breaking up the existing pavement layer, excavating the material in the existing pavement, procuring, breaking down, placing and compacting the material, including haul for a free-haul distance of 1.0 km and for the protection and maintenance of the layer as well as for the performance of control tests, all as specified.

Where excavation is executed over sections of the road, payment will also include compensation for the proper measuring and marking-off of the excavation, and the protection of the adjacent existing pavement and its repair should it be damaged.

The tendered rate for cemented material shall include full compensation for breaking down the material to comply with the specified grading requirements.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.04 In situ reconstruction of existing pavement layers as:</td>
<td></td>
</tr>
<tr>
<td>(a) Gravel selected layer compacted to 93% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Gravel selected layer compacted to 95% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(c) Gravel subbase compacted to 95% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(d) Gravel subbase compacted to 97% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(e) Gravel base compacted to 98% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(f) Gravel base compacted to 100% of modified AASHTO density, using:</td>
<td></td>
</tr>
<tr>
<td>(i) non-cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) cemented material (specify compacted layer thickness)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(g) Gravel shoulder compacted to 93% of modified AASHTO density, using:</td>
<td></td>
</tr>
</tbody>
</table>
(i) non-cemented material
(specify compacted layer thickness) ................. cubic metre (m$^3$)

(ii) cemented material
(specify compacted layer thickness) ................. cubic metre (m$^3$)

(h) Gravel shoulder compacted to 95% of modified AASHTO density, using:

(i) non-cemented material
(specify compacted layer thickness) ................. cubic metre (m$^3$)

(ii) cemented material
(specify compacted layer thickness) ................. cubic metre (m$^3$)

(i) Gravel wearing course compacted to:

(i) 93% of modified AASHTO density (specify compacted layer thickness) ............. cubic metre (m$^3$)

(ii) 95% of Modified AASHTO density (specify compacted layer thickness) ................. cubic metre (m$^3$)

The unit of measurement shall be the cubic metre of compacted pavement layer, the quantity of which shall be calculated from the authorised dimensions of the completed layer if the underlying layer has also been reconstructed or reworked. Where the underlying layer has not been reconstructed or reworked but only rolled, or where no work has been done on it, quantities shall be calculated with the aid of cross-sections taken of the layer before and after construction, subject to the provisions of Clause 1220. Where the material consists of recovered pavement material in part and imported material in part, the quantity of imported material obtained from cut or borrow shall be paid for under Item 34.01, calculated in accordance with the volume relation of the respective materials. The tendered rates shall include full compensation for breaking up the existing pavement layer, excavating the material in the existing pavement, procuring, breaking down, placing and compacting the material, including haul for a free-haul distance of 1.0 km and for the protection and maintenance of the layer as well as for the performance of control tests, all as specified.

Where excavation is executed over sections of the road, payment will also include compensation for the proper measuring and marking-off of the excavation, and the protection of the adjacent existing pavement and its repair should it be damaged.

The tendered rate for cemented material shall include full compensation for breaking down the material to comply with the specified grading requirements.

Note: Where the following items of work are required in connection with constructing the pavement layers, the appropriate payment items shall appear in Section 3400 of the Schedule of Quantities.

Item 16.02 Overhaul of material for a distance exceeding 1.0 km
Item 31.01 Excess overburden
Item 31.03 Finishing-off borrow pits
Item 32.01 Provision of crushing and/or screening plant
Item 32.02 Re-erection of crushing and/or screening plant
Item 32.03 Crushing and screening
Item 32.04 Removal of oversize material
Item 35.01 Chemical stabilisation
Item 35.02 Chemical stabilising agent
Item 35.03 Mechanical modification
Item 35.04 Provision and application of water for curing
Item 35.05 Curing by covering with the subsequent layer
SERIES 3000 : EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CRUSHED STONE

SECTION 3500 : STABILISATION

CONTENTS
3501 SCOPE
3502 MATERIALS
3503 CHEMICAL STABILISATION
3504 MECHANICAL MODIFICATION
3505 TOLERANCES
3506 QUALITY OF MATERIALS AND WORKMANSHIP
3507 MEASUREMENT AND PAYMENT

3501 SCOPE

This Section covers the stabilisation of materials used in the construction of the roadbed, fill or pavement layers by the addition of a chemical stabilising agent or by the mechanical modification of the material by mixing various materials or by treating the material with a bituminous stabilising agent. It includes the furnishing, spreading and mixing-in of the stabilising agent or soil binder. In the case of chemically stabilised material the layer is given a curing treatment.

3502 MATERIALS

(a) Chemical stabilising agents

The stabilising agent shall be either one or more of the following agents specified on the Drawings, in the Schedule of Quantities or in the Project Specifications or ordered by the Engineer.

(i) Road lime

Road lime shall comply with the requirements of the national specification for lime or AASHTO M 216 or SABS 824 where no local standard exists.

(ii) Ordinary Portland cement

Ordinary Portland cement shall comply with the requirements of the national specification or AASHTO M 85 or SABS 471 where no local standard exists. The use of rapid-hardening Portland cement shall not be permitted.

(iii) Portland blast-furnace cement

Portland blast-furnace cement shall comply with the requirements of the national specification or AASHTO M 240 or SABS 626.

(iv) Milled blast-furnace slag

Milled blast-furnace slag shall comply with the requirements of AASHTO M 240 or national specifications as specified and have a specific surface of not less than 0.35 m²/g and the residue on a sieve with 75 micron openings shall not exceed 10% by mass.

Milled blast-furnace slag shall not be used on its own as a stabilising agent but shall be mixed either with Ordinary Portland cement to form a cement-slag mixture, or with lime to form a lime-slag mixture. The ratio by mass of the ingredients of each mixture shall be indicated by the Engineer.

Cement-slag and lime-slag mixtures shall be intimately mixed by means of approved mixers and/or spreaders prior to their application onto any layers to be stabilised, or they may be mixed on the road, at the discretion of the Engineer.

(v) Other chemical stabilising agents

Other chemical stabilising agents such as fly-ash may be used if specified in the Special Specifications or if approved or so instructed by the Engineer.

(b) General

From the time of purchase to the time of use, all stabilising agents shall be kept under proper cover and be protected from moisture.

Consignments of these materials shall be used in the same sequence as that in which they are delivered at the Works. Stocks which have been stored on the site for periods longer than three months shall not be used in the work, unless authorised by the Engineer.

(c) Soil binder

Soil binder for mechanical modification shall be taken from within the limits of an approved source and shall be subject to such requirements regarding grading, plasticity index or other properties as may be indicated on the borrow-pit plans, or prescribed by the Engineer.

(d) Material properties

The properties of the material after stabilisation will be specified in the Drawings and design. In order to ensure that a durable stabilisation reaction occurs, the amount of stabiliser added should not be less than the initial consumption of lime (ICL) as determined using the method described in Subclause 7109(d) plus 1%. A stabiliser content in excess of 5% is not normally specified in order to avoid excessive shrinkage cracking.

3503 CHEMICAL STABILISATION

(a) Preparing the layer

The material to be stabilised shall be prepared and placed as specified in Section 3200, and given at least one pass with a flatwheel roller. The material shall be damp.

(b) Applying the stabilising agent

After the layer of soil or gravel has been prepared, the stabilising agent shall be spread uniformly over the full area of the layer at the prescribed rate of application by means of an approved type of mechanical spreader in a continuous process, or it may be spread by hand.

When spreading is done by hand, pockets or bags of stabilising agent shall be accurately spaced at equal intervals along the section to be stabilised so that the specified rate of application can be achieved. The stabilising agent shall be spread as evenly as possible, and shall then be uniformly distributed over the entire surface to
be treated by levelling off the stabilising agent by means of hand rakes and/or screeds.

The Engineer may permit spreading of the hand-spaced stabilising agent by motor grader, provided that he is satisfied that an even distribution of the stabilising agent is obtained.

(c) Mixing in the stabilising agent

Immediately after the stabilising agent has been spread, it shall be mixed with the loose gravel for the full depth of treatment. Care shall be taken not to disturb the compacted layer underneath, nor to mix the stabilising agent in below the desired depth. Mixing shall be continued for as long as necessary and repeated as often as required to ensure a thorough, uniform and intimate mix of the soil or gravel and the stabilising agent over the full area and depth of the material to be treated and until the resulting mixture is homogeneous and of uniform appearance throughout.

Mixing shall be done by grader, disc harrow, rotary mixer or equivalent plant, working over the full area and depth of the layer to be stabilised by means of successive passes of the equipment.

Mixing may also be done in central batch-mixing plants, but the Contractor will not be entitled to payment for additional overhaul or incidentals resulting from such procedure, unless such mode of operation has been prescribed.

(d) Watering

Immediately after the stabilising agent has been properly mixed with the soil or gravel, the moisture content of the mixture shall be determined, and the required amount of water as specified in Section 3200 shall be added.

Each application or addition of water shall be well mixed with the gravel or soil so as to avoid the concentration of water near the surface or the flow of water over the surface of the layer.

Particular care shall be taken to ensure satisfactory moisture distribution over the full depth, width and length of the section being stabilised and to prevent any portion of the work from getting excessively wet after the stabilising agent has been added. Any portion of the work that becomes too wet after the stabilising agent has been added and before the mixture has been compacted, will be rejected, and such portions shall be allowed to dry out to the required moisture content and shall then be scarified, restabilised, recompacted and again finished off in accordance with the requirements specified herein, all at the expense of the Contractor. The water supply and watering equipment shall be adequate to ensure that all the water required will be added and mixed with the material being treated within a short enough period to enable compaction and finishing to be completed within the period specified in Subclause 3503(h).

(e) Compaction

The provisions of Section 3200 shall apply. During compaction the layer shall be continuously bladed by motor grader, and loss of moisture by evaporation shall be corrected by further light applications of water.

During compaction of the stabilised layers, the Contractor shall lightly harrow or scarify the crust before final rolling, if so required by the Engineer, in order to prevent the formation of laminations near the surface of the layer. Final rolling shall be done with equipment that will give a smooth surface finish which conforms to the surface tolerances specified. Low patches on the surface may not be filled after compaction. The minimum compaction requirements shall be as specified for the particular layer in the various Sections of these Specifications.

A sufficient number of compacting units shall be employed on the work to ensure that, from the time the stabilising agent is first applied to the layer, the mixing process, watering, compacting, shaping and final finishing will be completed within the periods specified in Subclause 3503(h) below.

(f) Finishing at junctions

Any finished portion of the stabilised layer adjacent to new work, which is used as a turn-round area by equipment in constructing the adjoining section, shall be provided with a protective cover of soil or gravel of at least 100 mm thick over a sufficient length to prevent damage to work already completed. When the adjoining section is being finally finished, such cover shall be removed to permit the making of a smooth vertical joint at the junction of the different sections. Material in the vicinity of the joint which cannot be processed satisfactorily with normal construction equipment shall be mixed and compacted by hand or with suitable hand-operated machines.

(g) Curing the stabilised work

The stabilised layer shall be protected against rapid drying-out for at least seven days following completion of the layer.

The methods of protection may be any one or more of the following:

(i) The stabilised layer shall be kept continuously wet or damp by watering at frequent intervals. This method will be permitted for up to a maximum period of 24 hours, but one of Methods (ii), (iii), or (iv) shall be applied as soon as the moisture content of the stabilised layer so permits. Work which is not kept continuously wet or damp but is subjected to consecutive wet-dry cycles, may be rejected by the Engineer should he consider the layer to have been adversely affected.

(ii) The stabilised layer shall be covered with the material required for the following layer while the stabilised layer is still in a wet or damp condition. The material forming the protective layer shall be watered at such intervals as may be required to keep the stabilised layer continuously wet or damp, and in dry weather this shall be done at least once in every 24 hours.

(iii) The stabilised layer shall be covered with a curing membrane consisting of a spray-grade emulsion or cutback bitumen applied at the rate instructed by the Engineer. The provisions of Section 4100 shall apply mutatis mutandis to the application of a curing membrane.

(iv) Where a prime coat is specified on top of the stabilised base or subbase, the prime coat may be utilised as a curing membrane and shall be applied as specified in Section 4100.

No additional payment will be made for curing as described above, except that the application of a curing membrane when ordered by the Engineer shall be paid for separately.
and the application of a prime coat shall be paid for under Section 4100.

(h) Construction limitations

For cemented layers, the stabilising agent shall be applied only to an area of such size that all processing, watering, compacting and finishing can be completed within the period given in Table 3503/1.

<table>
<thead>
<tr>
<th>Stabilising agent</th>
<th>Maximum time for completion after stabilising agent comes into contact with the material to be stabilised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary Portland cement mixed with milled slag or fly-ash</td>
<td>8 hours</td>
</tr>
<tr>
<td>Slaked lime</td>
<td>10 hours</td>
</tr>
</tbody>
</table>

For modification, the maximum period allowed from the time the binder comes into contact with the layer being modified until the completion of compaction shall be 48 hours in the case of lime. The starting time shall be the median time taken to complete the spreading of the lime. Modification of materials should only be carried out to improve the properties of the material prior to chemical stabilisation. Modification alone will usually be lost rapidly through carbonation.

No stabilisation shall be applied when the moisture content of the material to be stabilised exceeds the optimum moisture content by more than 2% of the dry mass of material. No stabilisation shall be done during wet weather or when, in the opinion of the Engineer, windy conditions may adversely affect the stabilisation operations. Any rain falling on the working area during the process of stabilisation may be sufficient cause for the Engineer to order any affected areas to be reconstructed at the Contractor's own cost.

No traffic nor any equipment not actually used for processing the layer may be allowed to pass over the freshly spread stabilising agent. Only equipment required for curing or priming may be allowed over the treated layers during the specified curing period. Where water spraying equipment causes damage to the layer, the Engineer may direct that watering shall be done by side-spraying tankers travelling off the stabilised layer.

3504 MECHANICAL MODIFICATION

Mechanical modification shall consist of the addition of an approved soil binder to material to improve its properties, or the mixing of material originating from various sources, as described hereafter.

(a) Modifying soil and gravel by the addition of a soil binder

This process involves the addition and mixing of an approved soil binder, which shall not exceed 20% by mass of the total mixture, to the material to be improved. The material to be treated shall be prepared, broken down and spread to the required loose thickness, all as specified in Section 3200. An approved binder material shall then be spread over the prepared material at the required rate, and the materials shall be mixed by a suitable method by motor grader, harrow and/or other suitable plant until the binder material is uniformly and intimately mixed with the material being treated. The mixed materials shall then be watered, mixed and compacted as described in Section 3200.

(b) Mixing materials from various sources

The mixing of materials from various sources requires the material from the first source to be dumped onto the road, prepared, broken down and spread in a layer of uniform thickness, after which it is lightly rolled with a steel-wheeled roller. The material from the second source shall then be dumped onto the road, prepared, broken down and evenly spread, after which the two materials shall be thoroughly mixed as described in Subclause 3208(a): Spraying and mixing.

The mixing of materials from different sources will apply only when the smallest component of the mixture exceeds 20% of the total mass of the mixture. If not, the process will be regarded as the addition of a soil binder as described above in Subclause 3504(a).

3505 TOLERANCES

(a) Rate of application

The average rate of application of a chemical stabilising agent, when applied by mechanical bulk-spreading equipment and measured by the canvas-patch method, shall be equal to the specified rate of application ± 5% of the rate of application measured over any section not exceeding 1.0 km in length. No single measurement shall show a value deviating by more than 20% from the specified rate.

When hand spotted, stabilising agents shall be spread exactly to the specified rate of application.

(b) Uniformity of mix

The cementitious binder content of the mixed material as determined from 50 samples per lot, when sampled and tested as specified in Subclause 7109(a), shall be within the following limits.

(i) The average cementitious binder content of all 50 samples shall not be less than 93% of the specified binder content.

(ii) Not more than nine samples out of the 50 shall show a cementitious binder content lower than 70% of the specified binder content.

As described in Subclause 7109(a), test results shall be adjusted to make allowance for the presence in the material to be stabilised, of minerals which affect the test results. The above requirements for uniformity of mix shall be
applied only on condition that the variation in these adjustments falls within the limits specified in Clause 7109.

3506 QUALITY OF MATERIALS AND WORKMANSHPH

(a) Process control

(i) Stabilising agent

The Contractor shall keep detailed records of the quantities of stabilising agent applied to the road and the volume of material stabilised, and shall make these records available to the Engineer. He shall also monitor the rate of application when using bulk spreading equipment, by taking a canvas patch or tray test every 200 metres, unless the Engineer has permitted that the number of tests may be reduced. When using a bulk spreader on site for the first time or after it has been adjusted or repaired, the spread rate shall be checked by at least five tests over as short a distance as is practicable, with the equipment running at normal speed without stops. Spreading shall not continue on a large scale until the spread rate is within permissible tolerances.

(ii) Compaction

The requirements for process control in respect of compaction shall be the same as those stated for the unblasted layers in each section. Modified AASHTO densities shall be determined.

(b) Routine inspection and testing

Routine inspection and testing will be made by the Engineer to determine the quality of materials and workmanship for compliance with the requirements of this Section.

The test results and measurements will be judged in accordance with the provisions of Section 7200.

Only the lower limits and not any upper limits for cementitious binder content have been laid down in Clauses 7205 and 7207. Nevertheless, the binder content as determined by the sample mean of a lot shall be not more than 0.5% above the value specified or ordered by the Engineer.

Compliance with the requirements for the compaction of stabilised materials shall be as specified in the relevant section for each layer, or in the Project Specifications.

The requirements for uniformity of mix and rate of application shall be deemed to have been complied with if the mixture meets the requirements of Clause 3505.

When the tests for uniformity of mix are not applicable as stated in Subclause 3505(b), the material shall be visually appraised for uniformity of mix.

(c) Defective work or materials

Any material or work which does not comply with the requirements specified shall be removed and replaced with new materials or work complying with the specified requirements or, if the Engineer permits, be repaired as specified in Clause 1220, so that it will comply with the specified requirements after having been repaired.

3507 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.01 Chemical stabilisation</td>
<td>( \text{cubic metre (m}^3)</td>
</tr>
</tbody>
</table>

The tendered rates for chemical stabilisation shall be paid as extra over the rates tendered for constructing the unblasted layers. The tendered rates for chemical stabilisation shall therefore include full compensation for spreading and mixing the stabilising agent, curing the stabilised sections, any extra water required, and all materials, supervision, labour, plant, equipment, tools and incidental fees (extra over those provided for in the rates tendered for constructing the unblasted layer) necessary for completing the specified work, but excluding the cost of supplying the stabilising agent. No distinction shall be made in respect of the type of stabilising agent used, the time for completion or the specific layer being stabilised, and the extra over rate tendered shall apply to any combination of these. The Engineer reserves the right to vary the thickness of the layer to be stabilised by up to 20 mm, and the contract rate for this work shall not be amended by such change. The Contractor will, however, not be called upon to stabilise any layer less than 100 mm nor more than 200 mm in thickness.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.02 Chemical stabilising agent:</td>
<td></td>
</tr>
</tbody>
</table>

(a) Ordinary Portland cement \( \text{tonne (t)} \)

(b) Portland blast-furnace cement \( \text{tonne (t)} \)

(c) Slaked road lime (type indicated) \( \text{tonne (t)} \)

(d) Milled granulated blast-furnace slag \( \text{tonne (t)} \)

(e) Other stabilising agents (specify type) \( \text{tonne (t)} \)

The tendered rates for chemical stabilisation shall be paid as extra over the rates tendered for constructing the unblasted layers. The tendered rates for chemical stabilisation shall therefore include full compensation for spreading and mixing the stabilising agent, curing the stabilised sections, any extra water required, and all materials, supervision, labour, plant, equipment, tools and incidental fees (extra over those provided for in the rates tendered for constructing the unblasted layer) necessary for completing the specified work, but excluding the cost of supplying the stabilising agent. No distinction shall be made in respect of the type of stabilising agent used, the time for completion or the specific layer being stabilised, and the extra over rate tendered shall apply to any combination of these. The Engineer reserves the right to vary the thickness of the layer to be stabilised by up to 20 mm, and the contract rate for this work shall not be amended by such change. The Contractor will, however, not be called upon to stabilise any layer less than 100 mm nor more than 200 mm in thickness.

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<tbody>
<tr>
<td>35.02 Chemical stabilising agent:</td>
<td></td>
</tr>
</tbody>
</table>

(a) Ordinary Portland cement \( \text{tonne (t)} \)

(b) Portland blast-furnace cement \( \text{tonne (t)} \)

(c) Slaked road lime (type indicated) \( \text{tonne (t)} \)

(d) Milled granulated blast-furnace slag \( \text{tonne (t)} \)

(e) Other stabilising agents (specify type) \( \text{tonne (t)} \)

The unit of measurement shall be the cubic metre of stabilised material, the quantity of which shall be determined in accordance with the authorised dimensions of the layers treated as instructed by the Engineer.

Subject to the provisions of Clause 1220, the quantity will be determined in accordance with the authorised rate of application or actually provided within the layer concerned, whichever is the lesser quantity, provided, however, that any tests for stabiliser content which indicate an average stabiliser content below that specified, but within the tolerance allowed, shall not be construed as an indication of insufficient stabiliser quantity.
The right of the Engineer to accept work not containing the full quantity of stabiliser specified or ordered, subject to payment of only the actual amount of stabiliser provided, shall not mean that he waives the right to condemn such work.

The tendered rates shall include full compensation for providing the stabilising agent at the Works, irrespective of the rate of application specified or ordered by the Engineer, but shall make allowance for the differences in mixing and compaction times specified for various stabilising agents. The rate for milled granulated blast-furnace slag shall include full compensation for premixing the blast-furnace granulated slag with other stabilising agents in the required proportion.

### Item Unit

#### 35.03 Mechanical modification
(extra over untreated layer):

- (a) By adding a soil binder ............ cubic metre (m³)
- (b) By mixing materials from different sources ............ cubic metre (m³)

The unit of measurement shall be the cubic metre of compacted material that has been mechanically modified as specified in Clause 3504, and the quantity shall be calculated in accordance with the authorised dimensions of the mechanically modified layer.

The tendered rates for mechanical modification shall be paid as extra over the rate for the construction of an untreated layer and shall include full compensation for all the work, plant and other incidentals necessary for supplying and hauling the material for a distance of 1.0 km, and for spreading the soil binder and mixing it with the material to be treated or for mixing materials from different sources as specified.

The addition of material during a crushing or screening process, whether it is specially imported material which is not the product of the crushing process or whether it is crushed material screened out and then replaced in part or as a whole, will not be regarded as treatment with soil binder for measurement and payment purposes, but will be regarded as part of the process of producing crushed stone for subbase, base or other construction work, the cost of which shall be included in the tendered rates for those items of work.

### Item Unit

#### 35.04 Curing by covering with the subsequent layer

The unit of measurement shall be the square metre of stabilised pavement layer being cured by covering it with the subsequent layer as specified in Subclause 3503(g)(ii). The quantity will be determined by the authorised dimensions of the layer to be treated.

The tendered rate shall include full compensation for incidentals in respect of applying the subsequent layer for curing as specified, including the cost of regularly supplying and applying water.

### Item Unit

#### 35.05 Application of a curing membrane consisting of

- (a) MC 30 cut-back bitumen ............ litre (l)
- (b) MC 70 cut-back bitumen ............ litre (l)
- (c) Invert bitumen emulsion ............ litre (l)
- (d) 60 % spray grade anionic bitumen emulsion litre (l)
- (e) 60 % spray grade cationic bitumen emulsion litre (l)

The unit of measurement for payment for applying a curing membrane shall be the litre of bituminous material conforming to the relevant standards measured at spraying temperature and sprayed as required in Section 4100.

The tendered rate shall include full compensation for supplying the material, preparation of the surface before applying the bituminous membrane, applying the material and maintaining the surface as specified.
SERIES 3000 : EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CRUSHED STONE
SECTION 3600 : CRUSHED-STONE BASE OR SUBBASE

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3601 SCOPE
3602 MATERIALS
3603 REQUIREMENTS BEFORE THE CRUSHED-STONE LAYER MAY BE CONSTRUCTED
3604 CONSTRUCTION
3605 PROTECTION AND MAINTENANCE
3606 CONSTRUCTION TOLERANCES
3607 ROUTINE INSPECTION AND TESTS
3608 MEASUREMENT AND PAYMENT

3601 SCOPE

This Section covers the procuring, furnishing and placing of approved crushed stone on top of the completed selected layer or subbase, and constructing a crushed-stone subbase or base, as the case may be, in accordance with the requirements of these Specifications.

3602 MATERIALS

The aggregate used for crushed-stone base or subbase shall be derived from hard, sound, durable and unweathered parent rock. It shall contain no deleterious material such as decomposed rock, clay or shale. The crushed aggregate shall comply with the following requirements:

(a) Crushing strength (10% FACT)

The aggregate crushing strength (10%FACT), determined in accordance with TMH 1 Method B2, shall not be less than 110 kN. The materials when tested after 24 hours immersion, followed by draining, shall have a wet crushing strength of not less than 75% of the value obtained in the dry test.

(b) Atterberg limits

The material shall comply with the requirements of Table 3602/1 and Clause 7102 in regard to Atterberg limits.

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid limit (maximum)</td>
<td>25</td>
</tr>
<tr>
<td>Plasticity index (maximum) (%)</td>
<td>6</td>
</tr>
<tr>
<td>Bar linear shrinkage (maximum) (%)</td>
<td>3</td>
</tr>
</tbody>
</table>

In addition the arithmetic mean of the PI’s for a lot (min 6 tests) shall not exceed 4.5.

(c) Flakiness index

The weighted average flakiness index determined for the minus 26.5 mm, plus 19.0 mm and minus 19.0 mm plus 13.2 mm fractions shall not exceed 35%.

(d) Electrical conductivity

(i) Unstabilised material

The maximum electrical conductivity of the minus 6.7 mm fraction of the aggregate when dumped on the road in the case of untreated aggregate or before adding cement in the case of cement-treated aggregate, shall not exceed 0.15 Sm⁻¹ at 25°C when tested in accordance with TMH 1 Method A-21T. If the conductivity of the material exceeds 0.15 Sm⁻¹ and the pH is less than 6 the Contractor shall add lime at his own expense, under controlled conditions, preferably during crushing and screening to raise the pH to at least 10 (any later decrease which will occur later on, shall be ignored).

(ii) Material being stabilised (for example with lime or cement)

Where the pH > 6 and the electrical conductivity < 0.15 Sm⁻¹ and the qualitative test shows that sulphates do not pose a problem, the material may be used. If not, the material shall be further analysed by the Engineer in accordance with the Employer's instructions, and the proposals for its use shall be submitted to the Employer for approval.

The tests conducted for evaluating whether sulphates pose a problem shall be the following:

Acid-soluble sulphate content ............... BS 1377, Test No 9, made on a full sample crushed to < 2.00 mm Water-soluble sulphate content ............... BS 1377, Test No 10

Where the salinity of the water used for compaction purposes is so high as to cause a considerable increase in the salinity of the material, the Engineer shall be entitled to determine the soluble salinity from samples taken from the compacted layer within 24 hours, and before the prime coat is applied.

(e) Grading requirements

The grading of the crushed aggregate shall conform to the grading limits given in Table 3602/2.

Where, due to factors beyond the control of the Contractor, the grading of the material available from commercial sources or obtainable by normal crushing methods is consistently above or below the average of the grading limits given above, the Engineer may fix a target grading to suit the average grading of the available material, provided that the target grading shall fall within the grading limits in the above table, shall follow a smooth curve without any marked gaps or excessive quantities at any particular size, and shall preferably not be near the finer limits of the above grading limits. The material shall then conform to the target grading within the tolerances given in Table 3602/3.
Table 3602/2
Grading limits for crushed stone

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing (by mass)</th>
<th>Nominal maximum size 37.5 mm</th>
<th>Nominal maximum size 26.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>26.5</td>
<td>94 – 100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>19.0</td>
<td>71 – 84</td>
<td>85 – 95</td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>59 – 75</td>
<td>71 – 84</td>
<td></td>
</tr>
<tr>
<td>4.75</td>
<td>36 – 53</td>
<td>42 – 60</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>23 – 40</td>
<td>27 – 45</td>
<td></td>
</tr>
<tr>
<td>0.425</td>
<td>11 – 24</td>
<td>13 – 27</td>
<td></td>
</tr>
<tr>
<td>0.075</td>
<td>4 – 12</td>
<td>5 – 12</td>
<td></td>
</tr>
</tbody>
</table>

Table 3602/3
Tolerances for target grading

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Permissible deviations for individual values (% by mass)</th>
<th>Nominal maximum size 37.5 mm</th>
<th>Nominal maximum size 26.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.5</td>
<td>± 5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>19.0</td>
<td>± 7</td>
<td>± 7</td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>± 7</td>
<td>± 7</td>
<td></td>
</tr>
<tr>
<td>4.75</td>
<td>± 7</td>
<td>± 7</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>± 5</td>
<td>± 5</td>
<td></td>
</tr>
<tr>
<td>0.425</td>
<td>± 5</td>
<td>± 5</td>
<td></td>
</tr>
<tr>
<td>0.075</td>
<td>± 3</td>
<td>± 3</td>
<td></td>
</tr>
</tbody>
</table>

Tests to determine whether the crushed stone material complies with the specified grading requirements shall be conducted after the material has been mixed on the road and spread out.

The aggregate shall be produced entirely by the crushing of rock. Single stage crushing will not be allowed and the crusher installation shall be capable of producing material complying with the specified requirements. If, however, the nature of the parent rock is such that despite every effort made, the material remains deficient in the finer fractions, the Engineer may allow the addition of fines obtained from crushing of the same parent rock. Where the grading is such that the specified density cannot be achieved, the Engineer may allow the addition of a non-plastic sand, on condition that it shall not exceed 10% by mass.

(f) Quality/durability

The quality of the natural base course material shall comply with the following requirements:

- Durability Mill Index (DMI) .................... 125*  
- Maximum percentage passing 0.425 mm sieve after any DMI treatment .................... 35  
- Flakiness index .............................30%  

* This may be relaxed to 420 for acid crystalline and high silica materials.

(g) Compaction requirements

The minimum dry density to which the material shall be compacted shall be 102% of modified AASHTO density or as may be specified or instructed. Field dry density shall be determined by nuclear methods (direct radiation) with the moisture content being confirmed gravimetrically.

Where it is required that the material be compacted to the higher density and the Contractor is unable to achieve the required compaction, the Engineer may, in his discretion, accept such sections at the rate tendered for compaction to the lower value, provided that this density at least is obtained.

3603 REQUIREMENTS BEFORE THE CRUSHED-STONE LAYER MAY BE CONSTRUCTED

Before any crushed-stone layer is constructed, the following requirements shall be met:

The underlying layer shall comply with the requirements for the layer concerned.

The crushed-stone base shall, where possible, be supported along the outer edge during construction by placing, compacting and trimming the adjacent shoulder before the base is constructed. Excess material resulting from the trimming of the shoulders shall be removed from the area where the base is placed, to beyond the shoulders.

No crushed-stone layer shall be rolled if the underlying layer, either on account of rain or by any other cause, is so wet as to constitute a danger of the underlying layers being damaged.

3604 CONSTRUCTION

(a) Spreading and mixing

Crushed-stone material complying with the requirements specified above shall be dumped in quantities sufficient to ensure that the completed layer will comply with all the requirements in regard to layer thickness, level, cross-section and density. Allowance shall also be made for sufficient extra material to enable the layer to be properly trimmed.

The maximum compacted thickness of any layer of crushed-stone base or subbase compacted in one process shall be 150 mm, unless otherwise specified or permitted by the Engineer.

The dumps of material shall be spread out to a flat-surfaced layer with a thickness which will be suitable for mixing. The required quantity of water shall then be added and the material mixed until a homogeneous mixture is obtained.

(b) Compaction

After mixing, the crushed-stone material shall be placed to the correct thickness and level and thoroughly compacted by suitable equipment so that the specified density is obtained throughout the entire layer after slushing.

The finally compacted layer shall be free from surface laminations, portions exhibiting segregation of the fine and
coarse aggregate, corrugations, or other defects that may adversely affect the performance of the layer.

(c) Watering and slushing

Where specified, after completion of the compaction described above, short sections of the surface shall be thoroughly watered, rolled and slushed by means of steel-wheeled rollers with a mass of not less than 12 tonnes each, and/or with pneumatic-tyred rollers. The process shall continue until all excess fines are brought to the surface. The grout thus formed shall be uniformly broomed over the surface with stiff brooms to correct any areas still deficient in fines, whereupon the excess fines shall be broomed from the surface of the layer. This process shall continue until all excess fines in the mixture have been brought to the surface of the layer and its specified density has been reached. Excess fines and loose aggregate shall then be swept from the surface while the surface is still damp, and the layer shall then be allowed to dry out.

During slushing operations, care shall be taken not to roll the surface out of shape.

The slushing process shall be carried out on each section in one continuous process, and each section shall be completed before the next is proceeded with.

The completed layer shall be firm and stable with a closely-knit surface of aggregate exposed in mosaic and free from nests of segregated material, laminations or corrugations.

The Engineer may permit omission of the slushing process in the lower layer of a two-layer base or subbase, provided that the specified density is obtained in each of the layers.

(d) General

(i) Kerbs and gutters

Care shall be taken during rolling to ensure that concrete edging, kerbs and gutters already laid are not displaced or damaged. Any concrete edging, kerbs or gutters damaged during construction shall immediately be replaced or repaired by the Contractor at his own expense.

(ii) Excess crushed-stone material

Excess crushed-stone material shall not be spread over the shoulders or side fills, but shall be loaded and removed from the road. It shall not be re-used unless it has been re-screened, re-tested and again approved for use. It shall not be mixed with approved material unless screened, tested and again approved for use on its own.

(iii) Junctions with existing bituminous surfaces

At junctions with existing bituminous surfaces, the new base shall not be feathered-off to obtain continuity of grade, but the existing work in the vicinity of the joint shall be cut back so as to ensure an overall compacted thickness of new base and surfacing of not less than 100 mm.

3605 PROTECTION AND MAINTENANCE

The Contractor shall protect and maintain the completed crushed-stone layer at his own expense until the next layer or the seal or surfacing is applied. Maintenance shall include the immediate repair of any damage to or defects in the layer and shall be repeated as often as is necessary. Repairs shall be so made as to ensure an even and uniform surface to be restored after completion of the repair work. Traffic shall not be allowed direct on any unprimed crushed-stone layer unless so authorised or directed by the Engineer.

The crushed-stone base shall be primed as soon as possible and, where so ordered by the Engineer, traffic may have to be routed across completed and primed layers as specified in Section 4100.

3606 CONSTRUCTION TOLERANCES

The completed crushed-stone layer shall comply with construction tolerances specified in Clause 3405.

Where a base is to be constructed in two layers, the requirements for grade, thickness, cross-section and smoothness shall not apply to the lower layer, but the lower layer shall be constructed with sufficient accuracy to enable the construction of the combined layer to be carried out to the tolerances specified.

3607 ROUTINE INSPECTION AND TESTS

Routine inspections and tests will be made by the Engineer to determine whether the quality of material and workmanship complies with the requirements of this Section.

Test results and measurements shall be assessed in accordance with the provisions of Section 7200.

3608 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.01 Crushed-stone base:</td>
<td></td>
</tr>
<tr>
<td>(a) Constructed from crushed stone obtained from commercial sources and compacted to 102 % of modified AASHTO density (nominal maximum size of stone indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Constructed from crushed stone obtained from approved borrow pits, crushed by the Contractor, and compacted to 102 % of modified AASHTO density by the Contractor (nominal maximum size of stone indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.02 Crushed-stone subbase:</td>
<td></td>
</tr>
<tr>
<td>(a) Constructed from crushed stone obtained from commercial sources and compacted to 102 % of modified AASHTO density (nominal maximum size of stone indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>
(b) Constructed from crushed stone obtained from approved borrow pits, crushed by the Contractor, and compacted to 102% of modified AASHTO density (nominal maximum size of stone indicated) ................. cubic metre (m³)

The unit of measurement shall be the cubic metre of completed crushed-stone base or subbase in place as the case may be, and compacted to the specified density. The quantity shall be calculated from the authorised dimensions of the layer as shown on the Drawings or prescribed by the Engineer.

The tendered rates shall include full compensation for procuring, furnishing and placing all materials, including the crusher fines or sand (if approved) necessary for correcting the grading of the crushed stone, for hauling the material over an unlimited free-haul distance where material is obtained from commercial sources, and over a 1.0 km free-haul distance where material is obtained from approved borrow pits, for rolling, slushing and correcting the layers, and for testing, protecting and maintaining the work as specified.

Item Unit
36.03 Establishing the crushing plant and opening borrow pits where stone is obtained from approved borrow pits and crushed by the Contractor .......... number (No)

Where the material for crushed-stone base or subbase is obtained by the Contractor from approved borrow pits, whether indicated on the borrow-pit plans or approved after construction has started, the Contractor shall be entitled to the compensation provided by this Item (36.03), provided that prior instructions have been obtained from the Engineer to crush such material.

No payment shall be made under this item if the crushed-stone material is supplied from commercial sources or from a crusher that had been erected or was in operation prior to the award of the Contract, or from a crusher that is not completely or directly under the control of the Contractor. In such cases payment under Subitems 36.01(a) and 36.02(a) shall be in full compensation for the work performed in accordance with this Section.

The unit of measurement for establishing the crushing plant and opening the borrow pits shall be the number of times when the plant is set up and dismantled, with the approval, in writing, of the Engineer, at approved sources of supply, for the purpose of supplying crushed-stone material for base and subbase.

The tendered rate shall include full compensation for the provision and erection of the crusher ready for crushing, its later dismantling and removal after completion of the crushing operations, and the work involved in opening the borrow pits, including clearing, establishing a working face, and finishing-off the borrow pit upon completion of the operations.

Where Item 36.03 applies in circumstances as described above, and only where such circumstances shall apply, payment shall also be made for removing excess overburden and for overhaul in excess of 1.0 km as indicated below.

Crushed stone stockpiled on the site will only qualify for payment as “material on the site” where the Engineer is satisfied that the material complies with all the specified requirements. Where the Contractor himself produces the crushed stone, its value per cubic metre, measured loose in stockpile, will be taken as not exceeding 45% of the tendered rate per cubic metre of compacted material.

Item Unit
36.04 Additional compaction:

(a) Extra over Subitems 36.01(a) and (b) and 36.02(a) and (b) for compaction greater than 102% of modified AASHTO density as specified ......................... cubic metre (m³)

The tendered rates shall include full compensation for all additional costs for compacting the material to the higher density.

Note: Where material has been obtained from approved borrow pits on the site, whether indicated on the plans or approved after work has started and the Engineer has instructed that the borrow pits be used, the following payment items from other sections shall apply to crushed stone, but shall be listed under this Section in the Schedule of Quantities.

Item 16.02 Overhaul for material hauled in excess of 1.0 km.
Item 31.02 Excess overburden in borrow pits for obtaining crushed stone for pavement layers.
Item 31.03 Finishing-off borrow pits
Item 32.06 Stockpiling of material.
SERIES 3000 : EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CRUSHED STONE

SECTION 3700: WATERBOUND MACADAM BASE

CONTENTS
3701 SCOPE
3702 COARSE MATERIALS
3703 FINE MATERIALS
3704 REQUIREMENTS BEFORE THE WATERBOUND MACADAM LAYER MAY BE CONSTRUCTED
3705 PLACING OF COARSE AGGREGATE
3706 PLACING OF FINE AGGREGATE
3706 PROTECTION AND MAINTENANCE
3708 CONSTRUCTION TOLERANCES
3709 ROUTINE INSPECTION AND TESTS
3710 MEASUREMENT AND PAYMENT

3701 SCOPE
This Section covers the procuring, furnishing and placing of a waterbound macadam (a combination of approved crushed stone (coarse material) and crusher fines or soil filler (fine material)) base on top of the completed subbase, constructed in accordance with the requirements of these specifications.

3702 COARSE MATERIALS

The coarse aggregate used for waterbound macadam base shall be derived entirely by the crushing of hard, sound, durable and unweathered parent rock. It shall contain no deleterious material such as decomposed rock, clay or shale. The crushed aggregate shall comply with the following requirements:

(a) Crushing strength (10% FACT)
The aggregate crushing strength (10% FACT), determined in accordance with TMH 1 Method B1, shall not be less than 110 kN. The materials when tested after 24 hours immersion, followed by draining, shall have a wet crushing strength of not less than 75 per cent of the value obtained in the dry test.

(b) Atterberg limits
No Atterberg limits requirements are specified as there are no fines in the coarse aggregate and the source shall be as defined in 3702 above.

(c) Flakiness index
The average flakiness index determined on the material crushed to minus 26.5 mm plus 19.0 mm fractions shall not exceed 35%.

(d) Electrical conductivity
The maximum electrical conductivity of material crushed to pass the 6.7 mm sieve of the aggregate when dumped on the road shall not exceed 0.15 Sm⁻¹ at 25°C when tested in accordance with TMH 1 Method A-21T.

(e) Grading requirements
The grading of the crushed aggregate shall conform to the grading limits given in Table 3702/1.

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing (by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>100</td>
</tr>
<tr>
<td>53.0</td>
<td>85 - 100</td>
</tr>
<tr>
<td>37.5</td>
<td>35 - 70</td>
</tr>
<tr>
<td>26.5</td>
<td>0 - 15</td>
</tr>
<tr>
<td>19.0</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

Grading (a) is recommended but grading (b) has been found to give satisfactory performance.

Tests to determine whether the coarse aggregate complies with the specified grading requirements shall be conducted after the material has been placed, spread out and compacted on the road.

3703 FINE MATERIALS

(a) Atterberg limits
The fine material shall comply with the requirements of Table 3703/1 in regard to the Atterberg limits.

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid limit (maximum)</td>
<td>25</td>
</tr>
<tr>
<td>Plasticity index (maximum)</td>
<td>6</td>
</tr>
<tr>
<td>Bar linear shrinkage (maximum)</td>
<td>3</td>
</tr>
</tbody>
</table>

(b) Electrical conductivity
The maximum electrical conductivity of the -6.7 mm fraction of the aggregate when dumped on the road shall not exceed 0.15 Sm⁻¹ at 25°C when tested in accordance with TMH 1 Method A-21T.

Where the salinity of the water used for compaction purposes is so high as to cause a considerable increase in the salinity of the material, the Engineer shall be entitled to determine the soluble salinity from samples taken from the compacted layer within 24 hours, and before the prime coat is applied.
(c) Grading requirements

The grading of the crushed aggregate shall conform to the grading limits given in Table 3703/2.

Table 3703/2
Grading of fine aggregate for waterbound macadam

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing (by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5</td>
<td>100</td>
</tr>
<tr>
<td>4.75</td>
<td>85 - 100</td>
</tr>
<tr>
<td>0.075</td>
<td>10 - 25</td>
</tr>
</tbody>
</table>

3704 REQUIREMENTS BEFORE THE WATERBOUND MACADAM LAYER MAY BE CONSTRUCTED

Before any waterbound macadam layer is constructed, the following requirements shall be met:

(a) The underlying layer shall comply with the requirements for the layer concerned. It is recommended that a stabilised subbase be used for waterbound macadam to avoid deformation of the lower layers during rolling and slushing.

(b) The coarse aggregate component of the waterbound macadam base shall be supported along the outer edge during construction by placing, compacting and trimming the adjacent shoulder or by placing edging before the base is constructed. Excess material resulting from the trimming of the shoulders shall be removed from the area where the base is placed, to beyond the shoulders.

(c) No waterbound macadam layer shall be rolled if the underlying layer, either on account of rain or by any other cause, is so wet as to constitute a danger of the underlying layers being damaged.

(d) Where labour-based construction of waterbound macadam is planned, it is recommended that a 25 mm thick layer of sand is placed in order to provide an even layer and also to assist with drainage of water in the waterbound macadam layer.

3705 PLACING OF COARSE AGGREGATE

(a) Spreading

There are differences in the placement process for coarse aggregate between labour-based and mechanised construction.

(i) Labour-based construction

Crushed stone complying with the requirements specified above shall be dumped in quantities sufficient to ensure that the completed layer will comply with all the requirements in regard to layer thickness, level, cross-section and density adjacent to the road to avoid segregation. This is then moved onto the road by barrow and placed between shuttering to give the correct uncompacted depth. Before any further processing is carried out the layer shall be carefully examined and high and low points shall be corrected manually using ballast-forks.

The maximum compacted thickness of any layer of coarse material for waterbound macadam base compacted in one process shall be 150 mm, unless otherwise specified or permitted by the Engineer. Trial rolling to determine the bulking factor is necessary. The coarse aggregate shall be laid at a thickness of 1.3 times the compacted layer thickness and compacted. Levels shall be established accordingly for laying of the loose aggregate.

(ii) Mechanised construction

The coarse crushed stone shall be dumped in heaps on the subbase as for conventional crushed stone construction. The heaps are then spread using a large, heavy grader such that an even finish will be obtained after levelling of the heaps of gravel. The material is then spread to the specified depth (making allowance for bulking).

The use of manual labour with ballastforks and rakes is still necessary to correct high and low areas in the spread material.

It is recommended that the coarse aggregate is placed using pavers in the mechanised construction process. As various types of paver exist, each with different characteristics, the process to be used with these should be approved by the Engineer.

(b) Compaction

Static or vibrating, flat or steel-wheel rollers or pedestrian vibrating rollers should be used for compaction. Ten to 15 tonne static three-wheel rollers should, however, be used for the final rolling action. Labour based projects should make use of a Bomag 76 or equivalent roller. Plate vibration is not recommended.

Rolling shall commence at the edges of the layer until the edges are well compacted before gradually compacting towards the centre of the road. This shall be continued until the material is both compacted and keyed. Once the material is keyed so that no further movement occurs and no "roller marks" are evident in the finished surface, the rolling is sufficient.

The final compacted layer shall be free from surface laminations, portions exhibiting segregation of the fine and coarse aggregate, corrugations, or other defects that may adversely affect the performance of the layer.

3706 PLACING OF FINE AGGREGATE

Placing of the fine aggregate shall be carried out simultaneously with compaction, watering and slushing as follows.

(a) Spreading, watering and rolling

(i) Labour-based construction

Fine aggregate complying with the requirements specified above shall be placed directly from heaps alongside the road onto the road using spades. The fine material shall be dry and shall be spread evenly in thin, successive layers and distributed using brooms. The flat-wheeled roller shall be used after each layer to ensure that the fine material penetrates voids within the coarse aggregate.
When it becomes apparent that the voids are filling, water can be sprayed onto the surface and the brooming and rolling action continued. Once the voids appear to have been filled, the surface shall be sprayed with a heavy application of water and brooming and rolling shall be continued as described for the slushing process in Subclause 3604(c).

Slushing shall continue until a smooth mosaic is obtained. All excess fines shall be broomed off. Just before the layer is completely dry, it shall be broomed again to remove all loose fines.

(ii) Mechanised construction

The fine aggregate shall comply with the requirements specified above and shall be dry. This material shall be spread using chip-spreaders in thin layers. After each layer is spread one or two passes with a vibrating roller shall be applied. Once this is completed the final layer shall be broomed, usually manually but towed brooms can be used, to ensure that all voids are filled.

The layer shall then be slushed as described for labour-based construction above using static rolling, and brooms. Pneumatic tyred rollers can also be used for the slushing.

(b) General

(i) Kerbs and gutters

Care shall be taken during rolling to ensure that concrete edging, kerbs and gutters already laid are not displaced or damaged. Any concrete edging, kerbs or gutters damaged during construction shall immediately be replaced or repaired by the Contractor at his own expense.

(ii) Excess material

Excess crushed-stone material shall not be spread over the shoulders or side fills, but shall be loaded and removed from the road. It shall not be re-used unless it has been re-screened, retested and again approved for use. It shall not be mixed with approved material unless screened, tested and again approved for use on its own.

(iii) Junctions with existing bituminous surfaces

At junctions with existing bituminous surfaces, the new base shall not be feathered-off to obtain continuity of grade, but the existing work in the vicinity of the joint shall be cut back so as to ensure an overall compacted thickness of new base and surfacing of not less than 100 mm.

3707 PROTECTION AND MAINTENANCE

The Contractor shall protect and maintain the completed waterbound macadam layer at his own expense until the seal or surfacing is applied. Maintenance shall include the immediate repair of any damage to or defects in the layer and shall be repeated as often as is necessary. Repairs shall be so made as to ensure an even and uniform surface to be restored after completion of the repair work. Traffic shall not be allowed on any unprimed waterbound macadam layer unless so authorised or directed by the Engineer.

The waterbound macadam base shall be primed as soon as possible and, where so ordered by the Engineer, traffic may have to be routed across completed and primed layers as specified in Section 4100.

3708 CONSTRUCTION TOLERANCES

The completed waterbound macadam layer shall comply with the following construction tolerances.

(i) Longitudinal profile

Maximum deviation under a 3 metre straight edge .......................... 10 mm

(ii) Transverse profile

Maximum deviation under a 3 metre straight edge .......................... 20 mm

3709 ROUTINE INSPECTION AND TESTS

Routine inspections and tests shall be made by the Engineer to determine whether the quality of material and workmanship complies with the requirements of this Section.

3710 MEASUREMENT AND PAYMENT

Item Unit

37.01 Waterbound macadam base:

(a) Constructed from crushed stone obtained from commercial sources and compacted to the specified density (nominal maximum size of stone indicated) ....................... cubic metre (m³)

(b) Constructed from crushed stone obtained from approved borrow pits, crushed by the Contractor, and compacted to the specified density by the Contractor (nominal maximum size of stone indicated) ....................... cubic metre (m³)

The unit of measurement shall be the cubic metre of completed waterbound macadam base in place and compacted to the specified density. The quantity shall be calculated from the authorised dimensions of the layer as shown on the Drawings or prescribed by the Engineer.

The tendered rates shall include full compensation for procuring, furnishing and placing all materials, including the fine material, for hauling the material over an unlimited free-haul distance where material is obtained from commercial sources, and over a 1.0 km free-haul distance where material is obtained from approved borrow pits, for rolling, slushing and correcting the layers, and for testing, protecting and maintaining the work as specified.
37.02 Sand layer:

(a) Provision and placement of sand layer, obtained from commercial sources, on prepared subbase ........................ cubic metre (m³)

(b) Provision and placement of sand layer, obtained from approved borrow pits, crushed by the Contractor, on prepared subbase ........................ cubic metre (m³)

The unit of measurement shall be the cubic metre of sand in place. The quantity shall be calculated from the authorised dimensions of the layer as shown on the Drawings or prescribed by the Engineer.

37.03 Establishing the crushing plant and opening borrow pits where stone is obtained from approved borrow pits and crushed by the Contractor .............................. number (No)

Where the material for waterbound macadam base is obtained by the Contractor from approved borrow pits, whether indicated on the borrow-pit plans or approved after construction has started, the Contractor shall be entitled to the compensation provided by this Item (37.03), provided that prior instructions have been obtained from the Engineer to crush such material.

No payment shall be made under this item if the crushed-stone material is supplied from commercial sources or from a crusher that had been erected or was in operation prior to the award of the contract, or from a crusher that is not completely or directly under the control of the Contractor. In such cases payment under Subitems 37.01(a) shall be in full compensation for the work performed in accordance with this Section.

The unit of measurement for establishing the crushing plant and opening the borrow pits shall be the number of times when the plant is set up and dismantled, with the approval, in writing, of the Engineer, at approved sources of supply, for the purpose of supplying crushed-stone material for waterbound macadam base.

The tendered rate shall include full compensation for the provision and erection of the crusher ready for crushing, its later dismantling and removal after completion of the crushing operations, and the work involved in opening the borrow pits, including clearing, establishing a working face, and finishing-off the borrow pit upon completion of the operations.

Where Item 37.03 applies in circumstances as described above, and only where such circumstances shall apply, payment shall also be made for removing excess overburden and for overhaul in excess of 1.0 km as indicated below.

Coarse and fine aggregate stockpiled on the site will only qualify for payment as "material on the site" where the Engineer is satisfied that the material complies with all the specified requirements. Where the Contractor himself produces the crushed stone, its value per cubic metre, measured loose in stockpile, will be taken as not exceeding 45% of the tendered rate per cubic metre of compacted material.

Note: Where material has been obtained from approved borrow pits on the site, whether indicated on the plans or approved after work has started and the Engineer has instructed that the borrow pits be used, the following payment items from other sections shall apply to coarse and fine aggregate, but shall be listed under this Section in the Schedule of Quantities.

- Item 16.02 Overhaul for material hauled in excess of 1.0 km.
- Item 31.02 Excess overburden in borrow pits for obtaining crushed stone for pavement layers.
- Item 31.03 Finishing-off borrow pits
SERIES 3000 : EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CRUSHED STONE

SECTION 3800 : BREAKING UP EXISTING PAVEMENT LAYERS

CONTENTS
3801 SCOPE
3802 SELECTING THE MATERIAL
3803 CLASSIFYING THE MATERIAL
3804 PLANT AND EQUIPMENT
3805 CONSTRUCTION
3806 STORING RECOVERED PAVEMENT MATERIAL
3807 MEASUREMENT AND PAYMENT

3801 SCOPE

This Section covers the breaking up and excavation of existing pavement layers by conventional means or by milling, selecting the material, and the removal thereof to spoil dumps or to stockpiles for later reprocessing or recycling.

3802 SELECTING THE MATERIAL

Material from existing pavements may only be used for purposes approved by the Engineer. The material shall be so excavated that material from the various pavement layers will not be mixed unless so permitted by the Engineer, in writing.

3803 CLASSIFYING THE MATERIAL

Material from existing pavements shall be classified as follows for excavation and processing purposes:

(a) Existing bituminous material

Existing bituminous material shall be asphalt or other bituminous seal or base material removed separately from the existing layers on the instruction of the Engineer. Where underlying material is broken down or excavated together with bituminous materials, the mixture will not be classified as bituminous material for payment purposes.

(b) Non-cemented material

Non-cemented material shall be existing pavement material which can be ripped with the teeth of a 140G Caterpillar or similar grader.

(c) Cemented material

Cemented material shall be existing pavement material which cannot be ripped with a Type 140G Caterpillar or similar grader. Existing stabilised material will not necessarily be classified as cemented material.

(d) Cemented crushed stone

Cemented crushed stone shall be existing cemented material consisting of crushed stone. Unless specified as such in the Project Specifications, cemented crushed stone will not be classified as concrete.

(e) Milled material

Milled material shall be bituminous material and/or cemented crushed stone excavated with an approved milling machine. Milled material will be classified as such only when milling is specified or ordered by the Engineer, in writing. Payment will normally distinguish between milling of asphalt and of cemented crushed stone.

3804 PLANT AND EQUIPMENT

(a) Milling equipment

Only approved milling plant may be used. The plant shall be so equipped that it will be able to mill out asphalt and/or cemented material to the prescribed depth in one operation over the width specified in the Project Specifications. The milling depth shall be controlled electronically.

The direction and speed of the milling machine and the speed of rotation of the milling drum shall be adjustable so as to obtain the required grading of the milled material. The machine shall be capable of making a neat vertical cut at the outer edges when milling the layer and to leave the floor of the cut level and with a uniform texture.

Unless otherwise specified in the Project Specifications, the milling machine shall be equipped with a self-loading conveyor belt which can be easily removed and installed and adjusted for slope and direction.

(b) General

The equipment to be used for the conventional breaking-up and excavation of existing pavement layers will be determined by the size and depth of the pavement section to be processed or excavated, taking consideration of the fact that work may have to be carried out in restricted areas.

Only approved cutting or sawing equipment may be used for cutting or sawing the asphalt layers. The equipment shall be capable of cutting the asphalt layers to the specified depth in one operation without fragmenting the material, and in straight lines within the required tolerances.

3805 CONSTRUCTION

(a) General

Where all or a part of the existing surfacing material is to be reprocessed together with the underlying layer, the surfacing shall be properly broken down and mixed through the full depth of the existing base material to the satisfaction of the Engineer. Fragments of bituminous material shall be broken down to sizes not exceeding 37.5 mm.

Where specified in the Project Specifications or ordered by the Engineer, the existing bituminous material shall first be removed before the underlying layers are broken up.
Bituminous material may be milled out or otherwise broken up and removed to approved stockpile sites for recycling or to spoil sites, whichever is required. The exposed surface shall be cleaned to the satisfaction of the Engineer after removal of the bituminous material. Not more than 5% of the surface may be covered with bituminous material.

The existing pavement material shall be broken down to the specified depth and removed, or reprocessed in place, whichever may be required. The underlying layers may not be damaged, and material from one layer may not be mixed with that of another layer. Where such mixing occurs or where the material is contaminated in any other way by the actions of the Contractor, he shall remove such material and replace it with other approved material, all at his own cost.

Where a layer or layers require to be broken down over part of the pavement width only, the limit of the work shall be clearly demarcated, which limit shall not be exceeded by the Contractor by more than 100 mm. Pavement layers broken down outside the specified limits shall be repaired by the Contractor at his own cost, to the satisfaction of the Engineer.

Where so ordered by the Engineer, asphalt and cemented layers shall be cut or sawn through to the specified depth along the measured limit with approved equipment. Payment will be made for sawing only where specified on the Drawings or ordered, in writing, by the Engineer.

Payment will not be made for sawing or cutting work where the existing layer requires removal by milling.

Where existing roads have to be widened, the existing pavement layers shall be cut back to a firm, well-compacted or cemented material. Material so broken up, if acceptable, may be used together with imported material in the widening process, except in the case of crushed-stone base.

Where pavement layers are broken down over a section of the road width or where pavement layers are widened, the Engineer may order, in writing, that the various pavement layers be excavated in benches in accordance with his instructions. No additional payment will be made for excavating benches.

Where underlying layers are still structurally sound and are included as structural layers in the new design drawings, care must be taken not to break them up during removal of the surfacing or underlying layers.

(b) Milling

(i) Preparing the pavement surface

Before milling may be commenced, the pavement surface shall be clean and free from soil or other deleterious material. Where only part of the pavement is to be milled out, the milling area shall be properly demarcated. Milling may not exceed the required width by more than 50 mm. Payment will not be made for milling beyond the required width, which shall be backfilled with approved material in accordance with the provisions for the specified pavement material at the cost of the Contractor.

(ii) Trial milling

Where ordered by the Engineer, the Contractor shall execute trial milling on the various materials to be milled. During the trial work, the Contractor will be expected to vary the direction and speed of the milling machine, the speed of rotation of the milling drum, and also the milling depth, in order to obtain milled material of the required grade. No payment will be made for trial milling.

(iii) Asphalt

Where the asphalt and/or the cemented base must be reused, the asphalt shall be removed separately. Where the asphalt consists of layers of various mixes or grades, the Engineer may instruct the separate removal of the layers to different stockpiles. Where the milled material is not conveyed directly by conveyor belt and then loaded, and the Engineer so approves, the material shall first be cut to windrow and then loaded. During loading, the floor of the excavation or the underlying material shall not be damaged.

The milled material shall be inspected and classified in accordance with the various types of asphalt and its suitability for recycling. Different stockpiles shall be used for the different types of material as ordered by the Engineer. Contamination of the asphalt with underlying material will not be permitted, and the Contractor shall adjust the depths of milling in accordance with the thickness of the layer.

(iv) Milling in restricted areas

Extra over payment shall only apply to milling widths of less than 1.0 m.

(v) Cemented material

Unless otherwise specified milled cemented material to be reprocessed on the road shall first be windrowed with a view to inspecting the underlying surface for any patches of poor or unsuitable material. Where unsuitable material is encountered in the floor of the excavation, such material shall first be removed by further milling (where the underlying layer also consists of the cemented material), or by other approved methods, all to the satisfaction of the Engineer. The unsuitable material shall be replaced with approved material of the required type, which shall be placed in accordance with the specifications for the relevant underlying layer.

Where in the opinion of the Engineer it may be necessary, he may instruct the Contractor to taper the ends or edges of a milled excavation for which payment will be made, provided that the tapering is not the result of defective work. Payment for the milling-out of cemented crushed stone will distinguish between the various strengths of the cemented layer. Where the Engineer is of the opinion that the existing cemented layer has a compressive strength exceeding 10 MPa, he may instruct the Contractor to drill cores from the layer and have them tested for compressive strength in accordance with the provisions of SABS Method 685 or equivalent. The number of cores to be drilled out and the drilling locations will be determined on site by the Engineer.

(vi) General

The floor of the milled excavation shall be level and with an even texture. Any loose patches or patches of unsuitable material shall be remedied in accordance with the instructions of the Engineer. Payment for removing and replacing unsuitable material and remediating loose patches shall be as specified elsewhere in these Specifications. Where such remedial work is done in restricted areas, the extra over payment concerned shall be in accordance with the provisions of the appropriate clauses.

Where the floor of an excavation is tested in the longitudinal direction with a 3 m straight-edge, and in other directions with a 3 m straight-edge or a straight-edge of such shorter length as fits in between the longitudinal sides of the
excavation, the surface shall not deviate by more than 7 mm from the bottom edge of the straight-edge.

Payment for milling will distinguish between various types of milled material and between various milling depths.

(c) Treatment of pavement excavation floor

The floor of any pavement excavation where material is not milled out, shall be treated and paid for as specified in the relevant clauses of Sections 3400 and 3600. Milled surfaces shall be treated and paid for as specified in the Project Specifications.

3806 STORING RECOVERED PAVEMENT MATERIAL

Excavated pavement material intended for reprocessing but which cannot be reprocessed in place or, in the opinion of the Engineer, cannot be windowed next to the excavation, nor placed in position directly at any other place, and material intended for recycling or reprocessing in a plant, shall be transported to approved stockpiles with the written permission of the Engineer.

Stockpile sites for material intended for recycling or reprocessing in a plant shall be set out at the corresponding mixing or crushing plant or at such other locations as approved by the Engineer.

The stockpile site shall be cleaned, and all loose stones, vegetation and other materials which may cause contamination shall be removed. The site shall be graded smooth with an adequate slope to ensure proper drainage of water. Where so instructed by the Engineer, the surface shall be watered and compacted to a depth of at least 150 mm to a density of 90% of modified AASHTO density. The compacted surface shall be firm without any loose patches. Where asphalt is recovered for recycling, the Engineer may order the surface to be chemically stabilised to a depth of 150 mm. Upon completion, this surface shall be swept clean.

Stockpile sites shall be sufficiently large to allow the placing of stockpiles of different types of material or types of recovered asphalt without the stockpiles overlapping or the limits of the prepared site being exceeded. The enlargement of the stockpile site after the stockpiles have already been placed will not be permitted without the approval of the Engineer.

Stockpiles of milled material shall be shaped in a manner which will limit segregation to a minimum. The stockpiling of asphalt shall be done in a manner that will limit consolidation to a minimum. Adequate approved covers shall be provided for recovered asphalt stockpiles to prevent them from becoming wet, or being contaminated by dust.

Upon completion of the work, the stockpile sites shall be broken up in accordance with the instructions of the Engineer.

The stockpiling of excavated material will not be paid for directly, but full compensation therefore shall be included in the rates for the various items of work in which the stockpiled material will be used. Separate payment will be made for the preparation of storage sites.

3807 MEASUREMENT AND PAYMENT

(a) General

(i) Material to be reprocessed

Direct payment will not be made for breaking up and excavating existing payment material that is reprocessed and re-used, except when:

(1) The material is milled out in accordance with the provisions of the Project Specifications or upon the written instruction of the Engineer.

(2) Bituminous surfacing or other bituminous pavement layers are removed separately from the underlying material in accordance with the Project Specifications or the written instructions of the Engineer.

Full compensation for excavating existing pavement material, where the excavation thereof is not payable separately, shall be included in the rates tendered for the various pavement layers and items or work in which the material is used, as provided in the relevant specifications.

(ii) Removal of bituminous layers (except milled material)

Separate payment will be made for removing existing bituminous material separately from the underlying layer, when it is not milled out in accordance with the Project Specifications or the instructions of the Engineer, irrespective of whether or not it requires recycling.

(iii) Material from an existing pavement which is not reprocessed

Existing gravel pavement material, or existing bituminous material not intended for reprocessing, shall be used for other specified purposes or taken to spoil. Dumping shall only occur in an approved waste site. Payment for the excavation of such material will be made directly under Item 38.04 unless it is used for other purposes.

(iv) Milling

Milling will be paid for directly irrespective of whether or not the material will be re-used.

(v) Measurement for excavating existing pavement material and underlying fill

Where payment is made separately for the excavation of existing pavement material and underlying fill, the quantity will be calculated in accordance with the authorised horizontal dimensions of the excavated layer and the average depth of excavation. The average depth of excavation will be determined in accordance with the test holes made or cores drilled at intervals not exceeding 10 m, and which are so distributed over the surface that a realistic estimate of the depth can be obtained.

(b) Overhaul

The distance for calculating overhaul on material intended for recycling or reworking in a plant will be measured from the point of excavation on the road up to the plant. Where the plant is situated outside the site of the Works, the distance will be measured to a suitable location for setting up a plant closest to the centre of the site.
Item 38.05 is applicable solely to rehabilitation work that has to be executed in a restricted area of which the width is less than 3 m or length is less than 150 m.

Item Unit

38.01 Excavating and removing existing bituminous material (except milled material):

(a) Material intended for recycling with the average depth of excavation:

(i) Not exceeding 30 mm ........ square metre (m²)

(ii) Exceeding 30 mm but not exceeding 60 mm ........ square metre (m²)

(iii) Exceeding 60 mm ........ square metre (m²)

(b) Material to be disposed of with the average depth of excavation:

(i) Not exceeding 30 mm ........ square metre (m²)

(ii) Exceeding 30 mm but not exceeding 60 mm ........ square metre (m²)

(iii) Exceeding 60 mm ........ square metre (m²)

The unit of measurement shall be the square metre layer of bituminous material excavated from existing pavements separately from the underlying material on the instruction of the Engineer, and removed to approved stockpiles or spoil sites.

The tendered rate shall include full compensation for determining the average thickness of the layer of bituminous material to be excavated, including the excavation of holes or the drilling of cores, if so instructed, for breaking down, excavating, loading and transporting the material to approved stockpile or spoil sites for a free-haul distance of 1.0 km and for loading and properly placing the material in stockpile or spoil dumps.

The volume used for calculating overhaul shall be taken as 70% of the loose volume of the material measured in the hauling vehicles.

Item Unit

38.02 Milling out existing bituminous material with an average milling depth:

(a) Not exceeding 30 mm ........ cubic metre (m³)

(b) Exceeding 30 mm but not exceeding 60 mm ........ cubic metre (m³)

(c) Exceeding 60 mm ........ cubic metre (m³)

The unit of measurement shall be the cubic metre of asphalt milled out and removed to approved stockpiles.

Item Unit

38.03 Milling out cemented crushed stone:

(a) Average milling depth not exceeding 50 mm:

(i) Compressive strength of 10 MPa and less ........ cubic metre (m³)

(ii) Compressive strength exceeding 10 MPa up to and including 20 MPa ........ cubic metre (m³)

(iii) Compressive strength exceeding 20 MPa ........ cubic metre (m³)

(b) Average milling depth exceeding 50 mm and less than 100 mm ........ cubic metre (m³)

(i) Compressive strength of 10 MPa and less ........ cubic metre (m³)

(ii) Compressive strength exceeding 10 MPa up to and including 20 MPa ........ cubic metre (m³)

(iii) Compressive strength exceeding 20 MPa ........ cubic metre (m³)

(c) Average milling depth exceeding 100 mm:

(i) Compressive strength of 10 MPa and less ........ cubic metre (m³)

(ii) Compressive strength exceeding 10 MPa up to and including 20 MPa ........ cubic metre (m³)

(iii) Compressive strength exceeding 20 MPa ........ cubic metre (m³)

The provisions of Item 38.02 shall apply mutatis mutandis. No payment will be made under the subitems in regard to material with compressive strengths exceeding 10 MPa unless the higher strength has been proven by tests.
### Excavating and spoiling material from an existing pavement and/or the underlying fill:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.04</td>
<td>Excavating and spoiling material from an existing pavement and/or the underlying fill:</td>
</tr>
<tr>
<td>(a)</td>
<td>Non-cemented material ...... cubic metre (m³)</td>
</tr>
<tr>
<td>(b)</td>
<td>Cemented material ........... cubic metre (m³)</td>
</tr>
<tr>
<td>(c)</td>
<td>Cemented crushed stone ...... cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material, with or without existing bituminous material, excavated from the existing pavement and/or fill and removed to spoil dumps.

The tendered rate shall include full compensation for excavating the material from the existing pavement and/or fill, irrespective of layer thickness, for loading, transporting for a free-haul distance of 1.0 km, off-loading, and placing the material in approved spoil dumps.

Payment will not distinguish between material with or without existing bituminous material.

### Excavating material from an existing pavement and/or underlying fill in restricted areas:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.05</td>
<td>Excavating material from an existing pavement and/or underlying fill in restricted areas:</td>
</tr>
<tr>
<td>(a)</td>
<td>Extra over Item 38.01 for bituminous material excavated separately .......... square metre (m²)</td>
</tr>
<tr>
<td>(b)</td>
<td>Extra over Item 38.04 for other existing pavement and/or fill material:</td>
</tr>
<tr>
<td>(i)</td>
<td>Non-cemented material ...... cubic metre (m³)</td>
</tr>
<tr>
<td>(ii)</td>
<td>Cemented material ........... cubic metre (m³)</td>
</tr>
<tr>
<td>(iii)</td>
<td>Cemented crushed stone ...... cubic metre (m³)</td>
</tr>
</tbody>
</table>

Upon payment being made under Subitem (a) no distinction will be made between various thicknesses of bituminous material.

The tendered rates shall include full compensation for incidentals for excavating material in restricted areas.

### Extra over Items 38.02 and 38.03 for milling in restricted widths of less than 1.0 m:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.06</td>
<td>Extra over Items 38.02 and 38.03 for milling in restricted widths of less than 1.0 m ...... cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material milled out in a width of less than 1.0 m, the quantity of which will be calculated in accordance with the authorised dimensions of the area and the average depth milled.

The tendered rates shall include full compensation for the additional costs for executing the milling in the restricted width.

Payment will not distinguish between the various depths of milling or the various types of material.

### Extra over Items 38.02 and 38.03 for tapering the milled excavation edges or ends:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.07</td>
<td>Extra over Items 38.02 and 38.03 for tapering the milled excavation edges or ends ...... cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material milled out in a tapered area, the quantity of which shall be calculated in accordance with the authorised dimensions of the taper.

The tendered rate shall include full compensation for all additional measurements, adjustments and costs for milling out the taper to the satisfaction of the Engineer. Payment will not distinguish between the taper at the ends or along the edge of the milled excavation. No payment will be made for tapering resulting from the normal routine level adjustments of the machine neither for the taper necessitated by defective work by the Contractor.

Payment will not distinguish between various depths of milling or various types of material milled.

### Sawing or cutting asphalt or cemented pavement layers:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.08</td>
<td>Sawing or cutting asphalt or cemented pavement layers:</td>
</tr>
<tr>
<td>(a)</td>
<td>Sawing asphalt ............... square metre (m²)</td>
</tr>
<tr>
<td>(b)</td>
<td>Cutting asphalt ................ metre (m)</td>
</tr>
<tr>
<td>(c)</td>
<td>Sawing cemented layers:</td>
</tr>
<tr>
<td>(i)</td>
<td>Cemented material ............ square metre (m²)</td>
</tr>
<tr>
<td>(ii)</td>
<td>Cemented crushed stone ...... square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for Subitems (a) and (c) shall be the square metre of sawcut area calculated in accordance with the authorised length of sawcut and the average saw depth measured after excavation of the material. The unit of measurement for Subitem (b) shall be the metre of cut measured in accordance with the authorised saw length.

The tendered rate shall include full compensation for all material and sawing or cutting costs and for all incidentals for cutting or sawing the pavement in accordance with instructions of the Engineer.

Payment will not distinguish between the various depths of sawing or cutting work, irrespective of the number of separate cuts which may be required for sawing or cutting the layer to the required depth. Where surfacing of less than 30 mm thickness is sawn together with a cemented pavement, the surfacing section shall be deemed to be cemented material for payment purposes.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.09</td>
<td></td>
</tr>
<tr>
<td>Removing the remaining asphalt from the underlying layer</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of excavation floor cleaned on the instruction of the Engineer.

The quantity will be calculated in accordance with the authorised dimensions of the surface from which the remaining bituminous material will have to be removed after the existing bituminous layer has been taken off. Only surfaces of existing layers to be reprocessed as base will be paid for and only if so instructed by the Engineer.

The tendered rate shall include full compensation for the removal of any remaining bituminous material from the excavation floor as specified and the disposal thereof, all to the satisfaction of the Engineer.

<table>
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<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.10</td>
<td></td>
</tr>
<tr>
<td>Preparing stockpile sites</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of stockpile site prepared on the instruction of the Engineer.

The tendered rate shall include full compensation for demarcating, clearing, levelling and draining the stockpile site as specified.

Payment will not be made for preparing the sites for spoil dumps unless such preparation has been instructed, in writing, by the Engineer.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.11</td>
<td></td>
</tr>
<tr>
<td>Extra over Item 38.10 watering and compacting stockpile sites</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material watered and compacted on the instruction of the Engineer on the prepared storage site.

The tendered rate shall include full compensation for procuring all material, scarifying, mixing, and compacting the site as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>38.12</td>
<td></td>
</tr>
<tr>
<td>Chemical stabilisation of stockpile site:</td>
<td></td>
</tr>
<tr>
<td>(a) Chemical stabilisation</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Chemical stabilising agent</td>
<td>tonne (t)</td>
</tr>
</tbody>
</table>

The provisions of Items 35.01 and 35.02 shall apply mutatis mutandis.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>38.13</td>
<td></td>
</tr>
<tr>
<td>Drilling cores:</td>
<td></td>
</tr>
<tr>
<td>(a) In asphalt</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) In cemented material</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of cores drilled on the instructions of the Engineer.

The tendered rate shall include full compensation for setting out the core locations, and for drilling the cores.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>38.14</td>
<td></td>
</tr>
<tr>
<td>Providing the milling machine on the site</td>
<td></td>
</tr>
<tr>
<td>(size indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of milling machines provided on the site, or the number of times a milling machine is brought onto the site where it had to be removed temporarily with the approval of the Engineer.

Payment for returning the machine to the site after removal shall be made only where the removal was in accordance with the Contractor’s approved programme of work and not for any other reason. Payment will not be made for replacing any defective plant. Additional machines will be paid for only where their provision is in accordance with the Contractor’s approved programme of work and if all the milling machines are in use on the site simultaneously.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>38.15</td>
<td></td>
</tr>
<tr>
<td>Moving the milling machine on the site for a distance exceeding 1.0 km</td>
<td></td>
</tr>
<tr>
<td>(size indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of times the machine is moved for more than 1.0 km, as may be approved or instructed by the Engineer, in writing.

The tendered rate shall include full compensation for all costs involved in such moving (irrespective of whether the machine is moved to a new section of the site or returned to a previous position for further work), as well as for all delays and production losses. Payment will not be made for moving for the purpose of maintenance and repairs or for replacement with another machine.
SERIES 4000

ASPHALT PAVEMENTS AND SEALS

4100  Prime coat
4200  Asphalt base and surfacing
4300  Materials and general requirements for seals
4400  Single seals
4500  Double seals
4600  Single seal with slurry (Cape seal)
4700  Sand seals
4800  Surfacing of bridge decks
4900  Treatment of surface defects, patching, repairing edge breaks and crack sealing
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS

SECTION 4100 : PRIME COAT

CONTENTS

4101 SCOPE
4102 MATERIALS
4103 EQUIPMENT
4104 WEATHER AND OTHER LIMITATIONS
4105 PREPARATION OF THE LAYER TO BE PRIMED
4106 APPLICATION OF THE PRIME COAT
4107 MAINTENANCE AND OPENING TO TRAFFIC
4108 TOLERANCES
4109 TESTING
4110 MEASUREMENT AND PAYMENT

4101 SCOPE

This Section covers the application of a tar or bitumen prime to a prepared pavement layer.

4102 MATERIALS

(a) Priming material

The priming material shall be one of the following as may be specified or directed by the Engineer:

(i) MC-30 cut-back bitumen complying with AASHTO M 140 (SABS 308);
(ii) MC-70 cut-back bitumen complying with AASHTO M 140 (SABS 308);
(iii) RTH 3/12P tar prime complying with SABS 748 or RTL 3/12P tar prime complying with SABS 749.
(iv) RTH 1/4P quick drying tar prime complying with SABS 748.
(v) Invert bitumen emulsion complying with SABS 1260.

(b) Aggregate for blinding

The aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6.7 mm sieve and not more than 10% passing the 2.00 mm sieve. The aggregate shall be clean, hard and free from excessive dust. It shall contain no clay, loam or other deleterious matter.

4103 EQUIPMENT

The following equipment shall be available and in good working order:

(a) Binder distributor

The binder distributor used for distributing the bituminous binders shall:

(i) be in sound working condition and shall comply with the test described in Clause 7108;
(ii) not have any fuel or binder leaks;

(iii) have a straight and clean spraybar, all the spray heads of which shall be of the same type which open simultaneously and shall not leak when closed;
(iv) have its spray heads all spraying at the same angle to the spraybar and adjusted to the correct level so as to obtain the required overlapping;
(v) have its fans not interfering with one another;
(vi) have its sieve undamaged and clean;
(vii) be under the direct control of an operator approved by the Engineer on the grounds of a reference, in writing, or a certificate of competence signed by a representative of a Road Authority.

(b) Water sprinkler

The water sprinkler shall have efficient spray equipment, capable of spraying a uniform film of water over the whole area to be primed.

(c) Rotary broom

The rotary broom shall be self-propelled or supplied together with a suitable pneumatic-tyred towing vehicle.

(d) Other equipment

Other equipment shall include hand brooms, reinforced paper for joints, string, nails and all other ancillary equipment required to carry out the operation efficiently and neatly.

4104 WEATHER AND OTHER LIMITATIONS

No prime shall be applied under the following adverse conditions;

(a) during foggy or wet conditions;
(b) when rain is imminent;
(c) when wind is blowing sufficiently hard to cause uneven spraying;
(d) when the surface of the layer is visibly wet, ie more than damp;
(e) when the temperature of the surface immediately prior to commencing with the application of the prime is below or in the opinion of the Engineer likely to fall below 10° C;
(f) after sundown;
(g) when at any position the moisture content of the base layer is more than 50% of the optimum moisture content as determined by the Engineer.

The Engineer's decision on whether or not to apply the prime coat under specific conditions shall be final.
4105 PREPARATION OF THE LAYER TO BE PRIMED

Not longer than 24 hours before spraying, the layer to be primed shall be broomed and cleaned of all loose or deleterious material by means of a rotary broom and hand brooms. Sweeping shall be done carefully so as not to cause any damage to the layer. A light spray of water, sufficient to dampen the surface, shall be uniformly applied to the layer immediately before the application of the prime. If the water is over applied the layer shall be allowed to dry until a uniform damp surface is obtained.

Before any priming material is sprayed the layer to be primed shall be checked for compliance with the surface and other requirements specified. Any sections not complying with the specified requirements shall be corrected as specified in Clause 1218.

4106 APPLICATION OF THE PRIME COAT

A minimum of 1.0 m of reinforced paper or other suitable approved material shall be used at all joints at the beginning and end of all sprays in order to obtain a neat start and cut-off.

The temperatures for storage and spraying shall be in accordance with Table 4106/1.

<table>
<thead>
<tr>
<th>Type of prime</th>
<th>Maximum storage temperature °C</th>
<th>Spraying temperature range °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 24 hrs</td>
<td>Over 24 hrs</td>
</tr>
<tr>
<td>Cut-back bitumens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC-30</td>
<td>65</td>
<td>45 - 60</td>
</tr>
<tr>
<td>MC-70</td>
<td>80</td>
<td>60 - 80</td>
</tr>
<tr>
<td>Tar prime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTH/RTL 3/12P</td>
<td>60</td>
<td>54 - 68</td>
</tr>
<tr>
<td>Tar + 10% creosote</td>
<td>60</td>
<td>45 - 55</td>
</tr>
<tr>
<td>Tar + 20% creosote</td>
<td>60</td>
<td>40 - 50</td>
</tr>
<tr>
<td>Tar + 30% creosote</td>
<td>60</td>
<td>35 - 45</td>
</tr>
<tr>
<td>Quick drying tar prime</td>
<td>60</td>
<td>45 - 55</td>
</tr>
<tr>
<td>RTH 1/4P</td>
<td>40</td>
<td>45 - 55</td>
</tr>
<tr>
<td>Invert bitumen emulsion</td>
<td>-</td>
<td>10 - air temperature</td>
</tr>
</tbody>
</table>

All prime materials stored in a heated condition shall be stored in a container with a properly functioning circulation system and having a securely fitting lid.

The rate of application shall be as directed by the Engineer after trial applications to short sections if necessary.

Wherever feasible, the prime shall be applied in one or more lanes evenly over the full width of the road and allowed to penetrate and cure until traffic can pass over the surface without the wheels picking up the prime. All traffic shall be kept off the surface until this condition is obtained.

The total width of the primed surface shall be as shown on the Drawings or as prescribed by the Engineer, and the edges of the primed surface shall be parallel to the centreline of the road.

Where it is not feasible for traffic to use diversions, the prime shall be applied and allowed to penetrate for as long as is practicable before a blinding layer of aggregate is applied at a rate of approximately 0.0035 m³/m². Care shall be exercised in this operation to avoid the aggregate being applied too soon after spraying the prime. Where practicable two to four hours shall elapse as directed by the Engineer. Any “caking” of aggregate which may take place and cause problems during the surfacing process and all loose aggregate shall be removed before the final surfacing is commenced.

If the prime is applied in more than one strip, allowance shall be made for overlapping of strips by 100 mm.

Care shall be taken to protect all kerbing and guttering, guard rails and channelling from the prime by covering them with a suitable protective material when spraying. The Contractor shall, at his own cost, replace all soiled items which cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

The provisions of Clause 4309 apply to the application of the prime in areas inaccessible to mechanical equipment.

4107 MAINTENANCE AND OPENING TO TRAFFIC

Where a blinding layer has been applied to the primed surface, the Contractor shall maintain the blinding layer and the primed surface during the period when the surface is opened to traffic, and shall repair all damage caused to the blinding layer or the primed surface by such traffic, as directed by the Engineer, at no additional payment to the Contractor.

4108 TOLERANCES

The actual spray rates measured at spraying temperature shall not deviate from the required spray rate as specified or ordered by the Engineer by more than 0.06 l/m².

The edges of the primed surface shall be true to line with a maximum deviation of 25 mm from the specified edge line.

4109 TESTING

The Contractor shall give the Engineer at least 24 hours notice of his intention to spray prime material so that the actual spray rates can be prescribed and/or verified by the Engineer. Unless otherwise agreed in advance the Contractor shall only spray when the Resident Engineer or his representative is present and the section to be sprayed has been approved in writing.
4110 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.01 Prime coat:</td>
<td></td>
</tr>
<tr>
<td>(a) RTH 3/12P or RTL 3/12P tar prime</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(b) Quick drying RTH 1/4P tar prime</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(c) MC-30 cut-back bitumen</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(d) MC-70 cut-back bitumen</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(e) Invert bituminous emulsion</td>
<td>litre (l)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the litre of priming material measured at spraying temperature and sprayed as required.

The tendered rates shall include full compensation for supplying the priming material, cleaning and watering the layer to be primed, applying the priming material and maintaining the primed surface as specified.

41.02 Aggregate for blinding . . . . . square metre (m²)

The unit of measurement shall be the square metre of prime coat blinded with aggregate on the instructions of the Engineer.

The tendered rate shall include full compensation for procuring, furnishing and applying the aggregate for blinding where directed by the Engineer, and for maintenance of the blinding layer, as specified.

41.03 Extra over Item 41.01 for applying the prime coat in areas accessible only to hand held equipment . . . . . . litre (l)

The unit of measurement shall be a litre of priming material (measured at spraying temperature) sprayed in accordance with the requirements for areas accessible only to hand held equipment.

The tendered rate shall include full compensation for the additional costs for executing the work in areas accessible only to hand held equipment.
This Section covers all the work in connection with the construction of asphalt bases and surfacing. It includes the procuring and furnishing of aggregate and bituminous binder, mixing at a central mixing plant, spreading and compaction of the mixture, all as specified for the construction of:

(a) Continuously graded asphalt base;
(b) Continuously graded asphalt surfacing;

This Section also covers the widening of asphalt bases and surfacing, placing asphalt in restricted areas and placing asphalt reinforcing where specified.

This Section also covers the recycling of asphalt by reprocessing recovered materials, adding fresh aggregate, bituminous binders and other agents for obtaining an asphalt mix which will comply with the specified requirements, and placing the recycled material. The provisions of Section 4200 shall apply throughout to recycled asphalt, except where explicitly specified otherwise.

4202 MATERIALS

(a) Bituminous binders

(i) Conventional binders

The various bituminous binders specified shall comply with the relevant SABS Specifications stated below:

Road-grade bitumens ........ SABS 307 or equivalent
Bitumen emulsions ... SABS 309 (anionic) or equivalent
SABS 548 (cationic) or equivalent

(b) Aggregates

Coarse and fine aggregate shall be clean and free from decomposed materials, vegetable matter and other deleterious substances and shall meet the requirements of Sections 3600 and 4300, unless otherwise provided in this Section.

(i) Resistance to crushing

The 10% FACT of the coarse aggregate used in asphalt base and surfacing, when determined in accordance with TMH1 Method B2, shall not be less than 180. The wet/dry ratio shall not be less than 75%.

(ii) Shape of the aggregate

(1) Base

The flakiness index when determined in accordance with TMH1 Method B3 shall not exceed 35% for the minus 26.5 mm sieve plus 19.0 mm sieve and minus 19.0 mm plus 13.2 mm sieve fractions respectively.

In addition, at least 50% by mass of the individual fractions retained on each of the standard sieves with a square mesh size of 4.75 mm and larger shall have at least one fractured face.

(2) Surfacing

The flakiness index for surfacing asphalt shall not exceed the values given in Table 4202/1. The grades refer to the single-sized crushed stone grades as defined in Subclause 4302(b).

<table>
<thead>
<tr>
<th>Nominal size of aggregate (mm)</th>
<th>Surfacings</th>
<th>Grade 1</th>
<th>Grade 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0</td>
<td>25</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>25</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>30</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>30</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

In addition, at least 95% of all particles shall have at least three fractured faces.

(iii) Polishing

The Polished Stone Value (PSV) of aggregate used in continuously graded asphalt surfacing, when determined in accordance with SABS Method 848 or equivalent, shall not be less than 50.

Aggregates with polishing values below those stated above may be approved for use by the Engineer.

(iv) Adhesion

(1) Asphalt

When tested in accordance with TMH1 Method C5, the immersion index of a mixture of the binder and aggregate proposed for use shall not be less than 75%. The aggregate used for the test mixture shall have a grading within the actual limits for the mix concerned.
(2) Seals

The Reidel and Weber test (TMH1 Method B11) on the aggregate must \( > 1.0 \). Precasting of the aggregate will be required if values of \( < 1.0 \) are recorded.

(v) Absorption

When tested in accordance with TMH1 Methods B14 and B15, the water absorption of the coarse aggregate shall not exceed 1% by mass, and that of the fine aggregate shall not exceed 1.5% by mass, unless otherwise permitted.

(vi) Sand equivalent

The total fine aggregate used in all asphalt mixes shall have a sand equivalent of at least 35, when tested in accordance with TMH1 Method B19, and the sand to be mixed with the aggregate shall have a sand equivalent of at least 30.

(vii) Design requirements

The Contractor shall, by conducting the necessary tests, satisfy himself that he will be able to produce a mixture meeting the design requirements specified hereinafter, using the aggregate he proposes to supply, within the grading limits specified.

(viii) Grading

The grading of the combined aggregate including any filler added in an approved working mix as described in Subclause 4202(c) shall be within the limits stated in Tables 4202/2 and 4202/3 for the various mixes. The approved grading shall be designated as the target grading. The mean grading of each lot of the working mix (minimum of 6 tests per lot) determined from samples obtained in a stratified random sampling procedure, shall conform to the approved target grading within the tolerances specified in Subclause 4212(b).

Table 4202/2
Grading limits for combined aggregate and mix proportions for asphalt base

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Continuously Graded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>37.5 mm Max</td>
</tr>
<tr>
<td>37.5</td>
<td>100</td>
</tr>
<tr>
<td>26.5</td>
<td>84 - 94</td>
</tr>
<tr>
<td>19.0</td>
<td>71 - 84</td>
</tr>
<tr>
<td>13.2</td>
<td>59 - 75</td>
</tr>
<tr>
<td>9.5</td>
<td>-</td>
</tr>
<tr>
<td>6.7</td>
<td>-</td>
</tr>
<tr>
<td>4.75</td>
<td>36 - 53</td>
</tr>
<tr>
<td>2.36</td>
<td>25 - 42</td>
</tr>
<tr>
<td>1.18</td>
<td>18 - 33</td>
</tr>
<tr>
<td>0.600</td>
<td>-</td>
</tr>
<tr>
<td>0.300</td>
<td>9 - 21</td>
</tr>
<tr>
<td>0.150</td>
<td>6 - 17</td>
</tr>
<tr>
<td>0.075</td>
<td>4 - 12</td>
</tr>
</tbody>
</table>

Aggregate 95% 94.5%
Bitumen* 4% 4.5%
Active filler** 1.0% 1.0%

* Grade according to Project Specifications
** Active filler for tender purposes to be hydrated lime.

Table 4202/3
Grading limits for combined aggregate and mix proportions for asphalt surfacing

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Continuously Graded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coarse</td>
</tr>
<tr>
<td>26.5</td>
<td>100</td>
</tr>
<tr>
<td>19.0</td>
<td>85 - 100</td>
</tr>
<tr>
<td>13.2</td>
<td>71 - 84</td>
</tr>
<tr>
<td>9.5</td>
<td>62 - 76</td>
</tr>
<tr>
<td>4.75</td>
<td>42 - 60</td>
</tr>
<tr>
<td>2.36</td>
<td>30 - 48</td>
</tr>
<tr>
<td>1.18</td>
<td>22 - 38</td>
</tr>
<tr>
<td>0.600</td>
<td>16 - 28</td>
</tr>
<tr>
<td>0.300</td>
<td>12 - 20</td>
</tr>
<tr>
<td>0.150</td>
<td>8 - 15</td>
</tr>
<tr>
<td>0.075</td>
<td>4 - 10</td>
</tr>
<tr>
<td>Aggregate</td>
<td>93.5%</td>
</tr>
<tr>
<td>Bitumen*</td>
<td>5.5%</td>
</tr>
<tr>
<td>Active Filler</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

* Grade according to Project Specifications

Note: For recycled asphalt the nominal mix ratios of recovered asphalt, new aggregate, new bituminous binders, and active mineral filler to be used for tender purposes, shall be as specified in the Project Specifications.

The target grading requirements for crushed-stone base as specified under Subclause 3602(e) shall apply to all continuously graded asphalt bases. In addition, and for tender purposes and preliminary mix design, the target grading for 37.5 mm maximum aggregate size asphalt base shall be within the range derived from the formula:

\[ P = (100 - F)(d^n - 0.075n)/(D^n - 0.075n) + F \]

where:

- \( P \) = percentage passing a particular sieve, %
- \( d \) = sieve size, mm
- \( n \) = exponent which determines the shape of the grading curve
- \( D \) = maximum aggregate size, mm
- \( F \) = filler content, %

using values of \( F = 7\% \) with \( n = 0.45 \) and \( F = 8\% \) with \( n = 0.4 \) (1% being active filler).

The approved target grading shall be determined after laying a trial section on site.

Where mixes with coarser and/or other grading compositions are required for asphalt bases, it will be specified in the Project Specifications.

(ix) Additional requirements for asphalt bases

Crushed stone materials shall be used for 37.5 mm and 26.5 mm maximum aggregate size asphalt bases and may be produced by the crushing of stone from approved borrow pits, loose rock and/or coarse gravel, as directed by the Engineer.
If approved by the Engineer and if the specified requirements are met, it may contain natural fines not obtained from the parent rock being crushed, on condition that such added material does not exceed 10% by mass, unless otherwise specified in the Project Specifications. The added fines shall have a liquid limit not more than 25% (see Clause 7102) and a PI not more than 6% and be free of any unsound material. The Contractor shall submit full details regarding the exact quantity and nature of such fine aggregate, before such permission will be considered. In the event of such added material being natural sand, its impact on dynamic creep properties should be assessed from laboratory briquettes and cores obtained in a trial section planned well ahead of any production runs.

The Contractor shall make provision for separate cold feed bins.

(c) Fillers

If the grading of the combined aggregates for asphalt surfacing mixes show a deficiency in fines, an approved filler may be used to improve the grading. Filler may consist of active filler as defined hereinafter or of inert material such as rock dust having the required grading necessary to improve the grading of the combined aggregates. In no instance shall more than 2% by mass of active filler be used in asphalt mixes. Inert filler such as rock dust used to improve grading shall not be subject to this limitation.

The Engineer may order the use of any active filler to improve the adhesion properties of the aggregate. Active filler shall consist of milled blast furnace slag, hydrated lime, ordinary Portland cement, Portland blast furnace cement, fly-ash, or a mixture of any of the above materials. Individual materials shall comply with the requirements of the relevant Specifications for such material. Active filler shall have at least 70% by mass passing the 0.075 mm sieve and a bulk density in toluene falling between 0.5 and 0.9 g/ml. The voids in dry compacted filler shall be between 0.3% and 0.5%, when tested in accordance with British Standard BS812.

Active fillers for use in asphalt bases shall be introduced to the mix prior to wetting with the binder.

Only active filler added on the instructions of the Engineer, for the purpose of improving adhesion, will be paid for. No payment will be made for filler added to improve the grading.

(d) Asphalt reinforcing

Asphalt reinforcing shall be of the type specified in the Project Specifications and shall be obtained from an approved manufacturer.

Where the use of reinforcing for asphalt has been specified, the Contractor shall, at least three months before the material is to be used, submit samples of the type he intends to use, together with complete specifications of the material, as well as the manufacturer's instructions for use, to the Engineer for approval. Where the material does not carry the mark of an acknowledged standards authority, the Engineer may instruct the Contractor to have the material tested by an approved laboratory and to submit the results.

(e) Asphalt for recycling

(i) Recovered asphalt

The Engineer will test the existing asphalt in any part of the road and determine its suitability for recycling before removal. He may instruct the Contractor to drill additional cores at specified points. Recovered asphalt intended for recycling shall be stored separately from other asphalt, and the Engineer may also direct different types of asphalt to be stored separately.

The recovered asphalt shall be free from any underlying base material and other foreign matter.

Asphalt milled out shall be of a maximum size of 26.5 mm, unless another maximum size has been approved by the Engineer.

Asphalt not milled out shall be broken down in an approved manner so that it can be properly remixed in a plant to the satisfaction of the Engineer. Mixes of recycled asphalt containing fragments of recovered asphalt exceeding 26.5 mm in size, will not be accepted.

Payment for recovered asphalt will distinguish between milled out and non-milled out material.

Samples shall be taken from the recovered asphalt intended for recycled mixes in the stockpile and shall be tested for grading and quality of the aggregate, binder content, and properties of the binder.

(ii) Bituminous binders

The provisions of Subclause 4202(a) shall apply.

The grade of new binder used in the recycled asphalt mix shall be such that the mix of new and residual binder will comply with the requirements of the Project Specifications.

Recycling agents such as blended oils and other additives may not be used without prior approval by the Engineer.

(iii) New aggregate

New aggregate required for use in recycled asphalt mixtures shall comply with the requirements of Subclause 4202(b).

(iv) Combined aggregate

The aggregate mix obtained from new aggregate and the aggregate in the recovered asphalt, including any mineral filler, an approved quantity of which may be added in accordance with Subclause 4202(c), shall comply with the requirements specified in the Project Specifications for the relevant recycled asphalt layer.

(v) Stockpiling material for recycling

The provisions of Clause 3806 shall apply.

(f) Hot in-situ surface recycling

With regard to new binder, recycling additives, new asphalt, new aggregate or combinations of these materials, hot in-situ surface recycling shall comply with the requirements in the Project Specifications.
(g) General

All materials shall be handled and stockpiled in a manner that will prevent contamination, segregation or damage. Cement and lime shall be used in the order in which it has been received.

The Contractor shall, as often as necessary, test and control the materials produced by himself or the materials received by him from suppliers to ensure that the materials always comply with the specified requirements.

The Contractor will not be expected to construct layers of which the compacted layer thickness is less than one and a half times the maximum aggregate size.

4203 COMPOSITION OF ASPHALT BASE AND SURFACING MIXTURES

The rates of application and mix proportions of bituminous binder, aggregates and fillers which are given in Tables 4202/2 and 4202/3, are nominal rates and proportions and shall only be used for tendering purposes. The rates and proportions actually used shall be determined to suit the materials used and conditions prevailing during construction and any approved variation on a nominal mix in the bitumen content or active filler content shall be the subject of an adjustment in payment for binder or active filler variations as described in Clause 4214.

Before production or delivery of the asphalt the Contractor shall submit samples of the materials he proposes to use in the mix, together with his proposed mix design as determined by an approved laboratory, to the Engineer in accordance with Table 7104/1, so that the Engineer may test the materials and confirm the use of the proposed mix if he is satisfied that it meets the specified requirements.

As soon as the materials become available the Contractor shall produce a working mix in the plant in accordance with the design mix. The working mix shall again be tested by him for compliance with the design requirements. Samples of the working mix shall also be made available to the Engineer, who will authorise the use of the working mix proportions finally approved for use. The composition of the approved working mix shall be maintained within the tolerances given in Table 4212/2.

The nominal mix proportions (by mass) of the various asphalt mixes are set out in Tables 4202/2 and 4202/3.

The design of the asphalt mixes shall be in accordance with the relevant design guidelines and the mix properties and requirements shall be as specified in the Project Specifications. The asphalt mixes shall also comply with the requirements in Table 4203/1.

Prior to the start of the work the Contractor shall supply the Engineer with copies of the manufacturer's handbooks and copies of check lists prepared in terms of ISO 9002 where applicable pertaining to the mixing, remixing and paving plants, containing details of the correct settings and adjustments of the plant.

Any alteration which has been or is being effected to any constructional plant, and which does not comply with the specifications of the manufacturer, shall be brought to the notice of the Engineer.

(b) Mixing plant

(i) Conventional binders

Asphalt shall be mixed by means of an approved type mixer of proven suitability for producing a mixture complying with all the requirements of the Specifications.

The mixing plant may be either automatically or manually controlled but in the latter case, two control operators shall be provided.

The heating system of the tanks storing the binder shall be so designed that the binder will not be degraded during heating. A circulating system for the binder shall be provided which shall be of adequate size to ensure the proper and continuous circulation between storage tanks and mixer during the entire operating period.

Binder storage tanks shall be fitted with thermometers designed to provide a continuous record of the temperature of the binder in the tank. Copies of these records shall be supplied to the Engineer on a daily basis.

Satisfactory means shall be provided to obtain the proper amount of binder in the mix within the tolerances specified, either by weighing or volumetric measurements. Suitable means shall be provided for maintaining the specified temperatures of the binder in the pipelines, weigh buckets, spray bars and other containers or flowlines.

In the case of a drum type mixer, the system shall control the cold feeding of each aggregate fraction and of the filler by mass, by means of a load cell or another device regulating the feed automatically, and by immediately correcting any variation in mass which results from moisture or from any other cause. The cold feed shall be regulated automatically in regard to the binder feed so as to maintain the required mix proportion.

### Table 4203/1

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base (37.5 mm aggregate)</td>
</tr>
<tr>
<td>Marshall stability (kN)</td>
<td>6 - 12</td>
</tr>
<tr>
<td>Marshall flow (mm)</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Voids in mix (%)</td>
<td>3 - 6</td>
</tr>
<tr>
<td>Stability/flow (kN/mm)</td>
<td>2.5 min</td>
</tr>
<tr>
<td>Filler/bitumen ratio</td>
<td>-</td>
</tr>
<tr>
<td>Film thickness (mm)</td>
<td>-</td>
</tr>
<tr>
<td>Cores from trial sections and road during construction</td>
<td>10 min</td>
</tr>
</tbody>
</table>
Suitable dust collecting equipment shall be fitted to prevent pollution of the atmosphere in accordance with the provisions of any local Act governing pollution.

The fuel chosen and control of the burner shall be such as to ensure the complete combustion of the fuel in order to prevent pollution of the atmosphere and the aggregate.

(iv) Recycling

In addition to the requirements set out in Subclause 4204(b) the mixing equipment shall be specially adapted to deal with recycling and any such adjustments shall be in accordance with the instructions of the manufacturer of the mixing plant. The recovered asphalt portion of the mix shall not be exposed directly to the heating source whilst the feeding rate and proportioning shall be accurately controlled. Before work is commenced, the Contractor shall submit full details of his mixing equipment to the Engineer for his approval.

(c) Spreading equipment

(i) Paver

The mixture shall be laid by an approved type of selfpropelled mechanical spreader and finisher capable of laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other surface defects.

All pavers shall be fitted with automatic electronic screed controls to maintain the required levels, cambers and crossfalls. Where skids are used they shall be at least 9 m long or as specified by the Engineer.

Where levelling beams on multiple skids or sliding beams are used they shall be at least 9 m long.

(d) Rollers

(i) General requirements

Compaction shall be done by means of approved flat steelwheel, vibratory or pneumatic-tyred rollers. The frequency as well as the amplitude of vibratory rollers shall be adjustable. Vibratory rollers shall be used only where there is no danger of damage being done to the asphalt, structures of bridge decks, or other layers. It will be indicated in the Project Specifications whether vibratory compaction equipment may be used on bridge decks and what the constraining parameters will be. The rollers shall be self-propelled and in good working condition, free from back lash, faulty steering mechanism and worn parts. Rollers shall be equipped with adjustable scrapers to keep the drums clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers.

No leakages of any nature may occur in the rollers.

The mass and/or tyre pressures shall be such so as to ensure proper compaction to comply with the specifications of surface finish and density.

(e) Binder distributors

Where bituminous binders are to be sprayed onto areas before laying the asphalt is done, the binder distributors shall comply with Clause 4103.

(f) Vehicles

The asphalt shall be transported from the mixing plant to the spreader in trucks having tight, clean, smooth beds and sides which have been treated to prevent adhesion of the mixture to the truck bodies. A thin film of soapy water or vegetable oil may be used to prevent adhesion but petroleum products shall not be used for this purpose.

All vehicles used for transporting hot asphalt shall be fitted with canvas (transport in excess of 10 km or cold windy conditions prevailing) or other suitable approved covers (less than 10 km and moderate climatic conditions prevailing) to minimise temperature loss. Such covers shall be securely fixed over the hot asphalt from time of departure at the mixing plant until immediately prior to discharge of the asphalt into the paver.

(g) Mass-measuring device for asphalt mixes

Where payment per tonne is specified, the Contractor shall keep available at the mixing plant or on the site a suitable gauged mass-measuring device for measuring the asphalt mixes. The device shall be provided with a printer for printing the type of mix, the mass, the time and the date. The printed data shall be submitted to the Engineer.

(h) Plant and equipment for recycled asphalt

Plant and equipment for producing, hauling and placing the recycled asphalt shall comply with the provisions of Subclauses 4204(a) to 4204(g), as applicable, and subject to the following additional requirements:

The mixing equipment shall be capable of producing asphalt mixes with or without recovered material. Where necessary, the mixing equipment shall be specially adapted to deal with recycling, and any such adjustments shall be made in accordance with the instructions of the manufacturer. The equipment, with any necessary adjustments, shall be so designed, equipped and used that the measuring, heating and mixing of the material will give a uniform asphalt mix which complies with all the specified requirements in regard to temperatures within the limits necessary for properly placing and compacting the asphalt in accordance with the specified requirements. Before work is commenced, the Contractor shall submit full particulars of his mixing equipment to the Engineer.

4205 GENERAL LIMITATIONS AND REQUIREMENTS AND THE STOCKPILING OF MIXED MATERIAL

(a) Weather conditions

Asphalt may be mixed and placed only under favourable weather conditions, and shall not be mixed or placed when rain is imminent or during misty or wet conditions.

The following wind and temperature conditions are regarded as being suitable for paving work:

(i) While the air temperature is rising, work may be performed at temperatures of:

1. 6°C with an allowable wind velocity of less than 25 km/h
2. 10°C with an allowable wind velocity of less than 55 km/h, or for asphalt with a compacted thickness of less
than 30 mm with an allowable wind velocity of less than 25 km/h.

(ii) With falling air temperatures, work must be stopped when the temperature reaches 6°C regardless of the wind velocity and may not be restarted before the temperature is definitely rising.

(b) Moisture content

The mixing and placing of asphalt will not be allowed if the moisture content of the aggregate affects the uniformity of temperature or if free water is present on the working surface, or when the moisture content of the underlying layer, in the opinion of the Engineer, is too high.

No surfacing shall be placed unless the moisture content of the upper 50 mm of the base is less than 50% of the optimum moisture content as determined by the Engineer. No overlay shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surfacing resulting in the trapping of moisture in the pavement structure. A minimum delay of 24 hours or such extended period as ordered by the Engineer shall apply.

(c) Surface requirements

(i) Correction of base or subbase in the case of asphalt base

The base (after the prime coat has been applied) or the subbase, as the case may be, shall be checked for smoothness and accuracy of grade, elevation and cross section. Any portion of the base or subbase, as the case may be, not complying with the specified requirements, shall be corrected with asphalt at the Contractor's own expense, until the specified requirements are met. The Engineer may, however, in his sole discretion, allow minor surface irregularities to remain, provided they can be taken up in the following asphalt layer without adversely affecting that layer.

The asphalt used for the correction of the base or subbase, shall be the same mixture as specified for the surfacing or as directed by the Engineer, and the maximum size of aggregate used shall be dictated by the required thickness of the correction in each case.

Notwithstanding these provisions for the correction of the base or subbase, the Engineer reserves the right to order the removal and reconstruction of the layer or of portions of the base and subbase layers not complying with the specified requirements, instead of allowing the correction of substandard work with asphalt material.

(ii) Cleaning of the surface

Immediately before applying the tack coat, or where there is no tack coat, before the application of the asphalt, the surface shall be broomed and cleaned of all loose or deleterious material.

Where the prime coat (if any) has been damaged, it shall be repaired by handbrushing or spraying priming material over the damaged portions.

The prime coat shall be sufficiently dry before the tack coat and/or the asphalt may be applied. The Contractor’s programme shall allow for delays that are a function of the type of prime, rate of application, base porosity and moisture content, and climatic conditions.

(iii) Tack coat

Where required in these Specifications or the Project Specifications, or where indicated by the Engineer, a tack coat shall be applied to the surface to be paved.

The tack coat shall consist of a stable-grade bituminous emulsion diluted to have a 30% bitumen content and shall be applied at a rate of 0.55 l/m² or as directed by the Engineer.

The use of hand operated equipment for the application of tack costs shall be at the sole discretion of the Engineer and his approval shall be timeously obtained.

Portions of kerbing and guttering, bridge kerb and railing which will be exposed, shall be protected in terms of Section 2300 when the tack coat is applied.

The tack coat shall not be applied more than 24 hours before the paving is done.

(iv) Preparation for placing the overlays

The provisions of Section 4900 shall apply to any surface to be covered with overlays. The type of treatment to be applied, if any, will be specified in the Project Specifications or instructed in writing by the Engineer.

(v) Preparation where asphalt layers are to be widened or where surfacing over a section of the road width requires replacement

The existing asphalt shall be removed as described in Section 3800, where applicable, or as instructed by the Engineer.

Where a road has to be widened, the overlay shall be cut back not less than 100 mm from the existing edge. Unless otherwise indicated on the Drawings or instructed by the Engineer, asphalt joints may not fall within a wheel track.

(d) Storage

Mixing shall not be allowed to take place more than four hours before paving begins unless provision has been made for storage. Storage of mixed material will only be permitted in approved hoppers, which are capable of maintaining the temperature of the mix uniform throughout. In any case storage will not be permitted for a period longer than 12 hours after mixing, unless otherwise approved by the Engineer.

4206 PRODUCING AND TRANSPORTING THE MIXTURE

(a) Mixing and storage temperatures of binder

Bituminous binders shall be stored at temperatures not exceeding those given in Table 4206/1 or as specified in the Project Specifications, and the aggregate and bituminous binders shall be heated at the mixing plant to such temperatures that the mixed product shall have a temperature within the range given in Table 4206/1.
Table 4206/1  
Temperature ranges for bitumen binders

<table>
<thead>
<tr>
<th>Material</th>
<th>Max storage temp of binder °C</th>
<th>Temp range of mix °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Over 24 hrs</td>
<td>Under 24 hrs</td>
</tr>
<tr>
<td>Bitumens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40/50 pen.</td>
<td>145</td>
<td>175</td>
</tr>
<tr>
<td>60/70 pen.</td>
<td>135</td>
<td>175</td>
</tr>
<tr>
<td>80/100 pen.</td>
<td>125</td>
<td>175</td>
</tr>
<tr>
<td>150/200 pen.</td>
<td>115</td>
<td>165</td>
</tr>
</tbody>
</table>

(b) Production of the mixture

(i) Using batch plants

(1) Heating the aggregate

The aggregate shall be dried and heated so that, when delivered to the mixer, its temperature shall be between 0 °C and 20 °C lower than the maximum temperature indicated in Table 4206/1 for the mixture. The moisture content of the mix shall not exceed 0.5%.

(2) Batching

Each fraction of the aggregate and binder shall be measured separately and accurately in the proportions by mass in which they are to be mixed. If filler is used, it shall be measured separately on a scale of suitable capacity and sensitivity. The error in the weighing apparatus used shall not exceed 2% for each batch.

(3) Mixing

The aggregate, filler and binder shall be mixed until a homogeneous mixture is obtained in which all particles are uniformly coated. Care shall be taken to avoid excessively long mixing times which can cause hardening of the binder.

(ii) Using drum-type mixer plants

The aggregate and filler shall be accurately proportioned and conveyed into the drum-mixing unit. The calibrated amount of binder shall be sprayed onto the aggregates at the correct position so that no hardening of the binder shall take place. A homogeneous mixture and uniform coating of binder must be achieved and the moisture content of the asphalt mixture shall not exceed 0.5%. Once the final mix temperature has been agreed upon it may not be altered without the prior consent of the Engineer.

The moisture content of the asphalt mixture shall be tested according to Method C11 of TMH1 or equivalent.

(c) Transporting the mixture

The mixture shall be transported from the mixing plant to the works in trucks complying with the requirements of Subclause 4204(f). Loads shall be covered by waterproof canvas or metal sheets when the haul exceeds 10 km or during rainy weather. Deliveries shall be made so that spreading and rolling of all the mixtures prepared for a day’s run, can be completed during daylight, unless artificial lighting, as approved by the Engineer, is provided. Any asphalt which has become wet due to rain or any other cause will be rejected. Hauling over freshly laid material is not permitted.

(d) Small quantities of asphalt

A small quantity of asphalt shall be a quantity of less than 10 tonnes of a specified composition to be specially produced on occasion. For a small quantity of asphalt of less than 10 tonnes extra payment will be made if its use has been instructed by the Engineer, in writing, and where, in the opinion of the Engineer it is necessary:

(i) in accordance with the approved working programme of the Contractor, and/or

(ii) for the safety of the work or the travelling public on account of weather conditions or abnormal traffic conditions.

No extra payment will be made where small quantities of asphalt are required in consequence of the negligence of the Contractor, or of poor work or bad planning done by the Contractor, or because he did not execute the Works in accordance with his approved programme.

(e) Recycled asphalt

The provisions of Subclauses 4206(a) to 4206(d) shall apply mutatis mutandis.

At least four weeks before paving with recycled material will commence, the Contractor shall submit to the Engineer full particulars regarding the recycling methods he intends to use.

Where recovered asphalt material is taken from a stockpile, it shall be done by excavating from the pile over its full depth. Where segregated material is fed into the mixing plant, the Engineer will have the right to order the work to cease and to instruct the Contractor to remix the stockpile, retest the mixed material and redesign the asphalt mixture all at his own cost.

4207 SPREADING THE MIXTURE

(a) General

The mixture shall be delivered to the paver in such a manner that the paver will never be forced to stop for lack of asphalt. The temperature of the mixture shall be controlled by measuring in a random pattern in the truck immediately before emptying, and shall not be more than 10 °C below the minimum temperature specified for mixing in Table 4206/1. The adjustment of the screed tamping bars, feed screws, hopper feed, etc., shall be checked frequently to ensure uniform spreading of the mix. If segregation occurs, the spreading operations shall immediately be suspended until the cause is determined and corrected.

The addition and removal of material behind the paver shall normally not be allowed and the paver shall be capable of spreading the mixture to the correct amounts that will provide the required compacted thickness without resorting to spotting, picking-up or otherwise shifting or disturbing the mixture.

Operators shall not be permitted to walk on uncompacted asphalt.
Paving shall, if possible, commence at the bottom of the grades and the lower edges of superelevated curves. Paving shall be done upgrade on grades steeper than 5%. Spreading shall be so arranged that longitudinal joints do not coincide with joints in lower layers of asphalt base or surfacing.

Unless otherwise specified in the Project Specifications the paver shall be equipped to provide automatic control of levels and cross section. In the case of asphalt base construction, automatic control shall be run off guidewires and in the case of surfacing and overlays skids or guidewires shall be used.

On restricted areas, inaccessible to the paving equipment used, the mixture may be placed by hand or other means to obtain the specified results. Paving shall be carried out in a manner which will avoid segregation and which will allow control of levels.

The mixer capacity and the operating speed of the paver are to be so co-ordinated as to ensure continuous laying and to avoid intermittent stopping of the paver.

Paving shall cease when rain starts falling or when the surfaces to be paved are visibly wet.

(b) Overlays

In the case of overlays, guide wires will normally not be required during the placing of the mix unless specified in the Project Specifications. In all cases, including levelling courses, the paver shall be provided with skid beams with electronically controlled equipment which can ensure a constant crossfall and can even out local irregularities.

(c) Asphalt

Asphalt shall be placed in restricted areas with the aid of smaller specially equipped pavers, hand tools, or other approved equipment. The space concerned shall be properly filled with asphalt, without leaving any gaps between the fresh asphalt and the existing pavement layers.

All the provisions in regard to temperature, mix composition, uniformity, etc, shall remain applicable, but layer thickness and control shall be such that the requirements for compaction and surface tolerances can still be attained.

(d) Recycled asphalt

The provisions of Subclauses 4207(a) to 4207(c) shall apply mutatis mutandis to recycled asphalt.

Where the average thickness of a completed asphalt layer exceeds the specified thickness, and/or recovered asphalt has been wasted indiscriminately, and, if in the opinion of the Engineer it has resulted in a deficiency of recovered material, the Contractor shall supplement such deficiency at his own cost with a quantity of similar or better material equal to the quantity wasted, as determined by the Engineer.

4208 JOINTS

All joints between adjacent sections of the work shall be made by cutting back the layer against which the material is to be placed. All loose and incompletely compacted material shall be removed. A cutting wheel shall be used for cutting longitudinal joints.

Joints shall be either at right angles or parallel to the centre line, and joints in the final layer of the surfacing shall, where possible, correspond with the lane markings. Joints in lower layers shall be offset not less than 150 mm on either side of the edges of the traffic lanes.

Before a new layer is placed next to an existing layer, the cut edge of the existing layer shall be painted with a thin coat of bituminous emulsion of the same type used for the tack coat, if so directed by the Engineer, or the paver must be fitted with a gas burner to heat the cut edge of the existing layer.

Joints shall be neat and shall have the same texture and density as the remainder of the asphalt course. All joints shall be marked out with chalk lines prior to cutting.

The outside edges of the completed asphalt course shall be trimmed along the shoulder, and parallel to the centre line, to give a finished width, as shown on the Drawings, within the tolerances specified.

Any fresh mixture spread accidentally onto existing work at a joint shall be carefully removed by brooming it back with stiff brooms onto the uncompacted work, so as to avoid the formation of irregularities at the joint. Whenever the paving operation is stopped due to lack of mixture, the Contractor shall form a proper joint as specified above, if so directed by the Engineer.

The requirements of Clause 4208 shall apply mutatis mutandis to joints in recycled asphalt layers.

4209 COMPACTION

The mix shall be rolled as soon as possible after it has been laid by vibratory, steelwheel and pneumatic-tyred rollers in a sequence predetermined and approved during the laying of trial sections. Such rolling shall commence and be continued only for so long as it is effective and does not have any detrimental effect. The use of pneumatic-tyred rollers for continuously-graded non-homogeneous modified binders shall be assessed in the trial section.

As many rollers shall be used as is necessary to provide the specified pavement density and the required surface texture. During rolling of surfacing only, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.

After longitudinal joints and edges have been compacted, rolling shall start longitudinally at the sides and gradually progress towards the centre of the pavement, except on superelevated curves, or where the area to be paved has a straight cross-fall, when rolling shall begin on the low side and progress to the higher side, uniformly lapping each preceding track, covering the entire surface. During breakdown rolling, the rollers shall move at a slow but uniform speed (not to exceed 5 km/h) with the drive roller nearest the paver, unless otherwise specified on account of steep gradients.

No movement of the asphalt layer shall occur under steel-wheel rollers once the asphalt temperature has dropped to below 100°C. Three-wheeled steel rollers, with large diameter rear wheels are preferable to tandem rollers and may be used in conjunction with pneumatic tyred rollers.
provided pick-up of the asphalt on the wheels does not occur.

For non-homogeneous binder mixes it is recommended that a commercial detergent at a concentration of 1 to 3 000, be added to the water used to wet the tyres of pneumatic tyred rollers, to limit pick up.

The sequence of rollers used in compaction is at the discretion of the Contractor provided the completed pavement shall have a density as measured on recovered core equal to or greater than 97%, minus the percentage voids in the approved production mix, of the theoretical maximum density, determined as described in TMH1 Method C4 or equivalent.

For thin layer asphalt (less than 20 mm) the compaction requirements shall be specified in the Project Specifications.

The Contractor shall utilise a calibrated nuclear gauge for process control during compaction operations. Notwithstanding this requirement, the acceptance control carried out for compaction by the Engineer, shall still be based on cores taken from the compacted layer.

The nuclear device shall:

(a) Be operated by a suitably trained technician.
(b) Comply with all the safety regulations of the Regulatory Authority (Radiation Control).
(c) Be certified to be suitably calibrated.

The portion of trial section having the desired surface texture shall be designated as a reference for what is required in the permanent work.

The following requirements shall apply to rolling and compacting generally:

(a) The material shall not be excessively displaced in a longitudinal or transverse direction especially when changing gears, stopping or starting rollers.
(b) No cracks or hair cracks shall be formed and the bond with the underlying layer shall not be broken.
(c) The density shall be uniform over the whole area of the layer and extend over the full depth of the layer.
(d) Rollers shall not be left standing on the asphalt layer before it has been fully compacted.
(e) In restricted areas where the specified rollers cannot be used, compaction shall be carried out with hand-operated mechanical compaction equipment or approved smaller vibratory rollers. The prescribed density requirements remain applicable throughout, over the full layer thickness, irrespective of the method of compaction.

The provisions of Clause 4209 shall apply mutatis mutandis to recycled asphalt.

4210 LAYING TRIAL SECTIONS

Before the Contractor commences with the construction of any asphalt base or surfacing, he shall demonstrate, by laying a trial section 300 m² in area, that the equipment and processes that he proposes to use, will enable him to construct the particular asphalt course in accordance with the specified requirements.

The Engineer may require that up to three different binder contents be incorporated in one such trial section to verify the laboratory design phase.

The specified requirements shall include dynamic test results obtained from briquettes prepared from material obtained in a stratified randomly sampled manner at the manufacturing plant or behind the paver as directed by the Engineer and/or cores extracted from the completed trial section and in locations determined in a stratified randomly sampled manner.

A maximum period of 10 days shall be allowed to verify dynamic test results unless otherwise specified in the Project Specifications.

Only when such a trial section has been satisfactorily laid and finished, and complies with the specified requirements, will the Contractor be allowed to commence with construction of the permanent work.

If the Contractor should make any alterations in the methods, processes, equipment or materials used, or if he is unable to comply consistently with the Specifications, the Engineer may require that further trial sections be laid before allowing the Contractor to continue with the permanent work.

The intention of this Clause is to avoid any experimentation by the Contractor on the permanent work.

The trial sections shall be laid where indicated by the Engineer. The Contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surfaces on which it was constructed.

Provision is made for payment of the first trial section of any particular mix type, but subsequent trial sections with the same mix shall be at the Contractor's own cost. Payment will be made for 300 m² of each trial section and the Contractor fail to produce a satisfactory product for at least a continuous 100 m² he shall lay additional areas, at his own cost and no additional payment, until a satisfactory product is obtained for a continuous 100 m².

4211 PROTECTION AND MAINTENANCE

The Contractor shall protect the asphalt base and asphalt surfacing from all damage until the work is finally accepted by the Employer and he shall maintain the surfacing work until the issue of the maintenance certificate. Any damage occurring to the completed base or surfacing, excepting fair wear and tear on surfacing during the maintenance period, or any defects which may develop due to faulty workmanship, shall be made good by the Contractor at his own expense and to the satisfaction of the Engineer.

4212 CONSTRUCTION TOLERANCES AND FINISH REQUIREMENTS

(a) Construction tolerances (The application to overlays is specified in Subclause 4212(d))

The completed sections of asphalt base and surfacing shall comply with the requirements for grade, width, thickness, cross section and smoothness stated below.
(i) Level and grade

The level tolerances referred to in Clause 7205 shall be as follows:

\[ H_{90} \quad \pm 15 \text{ mm} \]
\[ H_{\text{max}} \quad \pm 20 \text{ mm} \]

Deviations from the specified longitudinal grade due to deviations from the specified levels shall not exceed the values given in Table 4212/1.

<table>
<thead>
<tr>
<th>Length of section under review (m)</th>
<th>Maximum deviation (g) of specified slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.354</td>
</tr>
<tr>
<td>5</td>
<td>0.224</td>
</tr>
<tr>
<td>10</td>
<td>0.158</td>
</tr>
<tr>
<td>20</td>
<td>0.112</td>
</tr>
<tr>
<td>30</td>
<td>0.091</td>
</tr>
</tbody>
</table>

(ii) Width

The average width of both asphalt base and surfacing shall be at least equal to that shown on the Drawings and nowhere shall the outer edge of the layer be inside the lines shown on the Drawings by more than 20 mm in the case of asphalt base or more than 15 mm in the case of asphalt surfacing.

(iii) Thickness

The thickness tolerances referred to in Clause 7205 shall be as follows:

\[ D_{90} \quad \text{base} = 15 \text{ mm/surfacing} = 5 \text{ mm} \]
\[ D_{\text{max}} \quad \text{base} = 20 \text{ mm/surfacing} = 8 \text{ mm} \]
\[ D_{\text{ave}} \quad \text{base} = 5 \text{ mm/surfacing} = 2 \text{ mm} \]

Thickness shall be determined from carefully controlled levels taken before and after construction in exactly the same position and/or from cores drilled from the completed layer.

(iv) Cross section

When tested with a 3 m straight-edge laid at right angles to the road centre line the surface shall not deviate from the bottom of the straight-edge by more than 6 mm for freeways and more than 10 mm for other roads.

At any transverse section the difference in level between any two points shall not vary from their difference in level computed from the cross section shown on the Drawings by more than 15 mm for freeways and 20 mm for other roads.

(v) Surface regularity

When tested with a rolling straight-edge as described in Clause 7110 the number of surface irregularities shall not exceed those given below (applied to base and surfacing).

(1) Average number of irregularities per 100 m equal to or exceeding the specified value when taken over 300 m - 600 m lengths of asphalt surfacing:

Freeways (4 mm irregularities) ................... 3
Other roads (6 mm irregularities) ................. 2

(b) Grading

The combined aggregate and filler grading shall not deviate from the approved target grading for the working mix by more than that given in Table 4212/2.

<table>
<thead>
<tr>
<th>Size of aggregate: Material passing through the following sieves (mm)</th>
<th>Permissible deviation from the approved target grading (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>0</td>
</tr>
<tr>
<td>26.5</td>
<td>± 4.0</td>
</tr>
<tr>
<td>19.0</td>
<td>± 4.0</td>
</tr>
<tr>
<td>13.2</td>
<td>± 5.0</td>
</tr>
<tr>
<td>9.5</td>
<td>± 5.0</td>
</tr>
<tr>
<td>6.7</td>
<td>± 5.0</td>
</tr>
<tr>
<td>4.75</td>
<td>± 5.0</td>
</tr>
<tr>
<td>2.36</td>
<td>± 4.0</td>
</tr>
<tr>
<td>1.18</td>
<td>± 4.0</td>
</tr>
<tr>
<td>0.600</td>
<td>± 4.0</td>
</tr>
<tr>
<td>0.300</td>
<td>± 4.0</td>
</tr>
<tr>
<td>0.150</td>
<td>± 3.0</td>
</tr>
<tr>
<td>0.072</td>
<td>± 1.5</td>
</tr>
</tbody>
</table>

(c) Binder content

The binder content shall be controlled to within the limits given in the statistical judgement scheme specified in Clause 7206.

(d) Construction tolerances for overlays

When overlay construction is carried out to specified levels, the tolerance requirements of Subclause 4212(a) shall be applicable. In all other cases the relevant tolerance requirements of Clause 7205 shall be applicable.
4213 TESTING

(a) Sampling

Sampling of asphalt mixes shall be carried out according to Method MB7 of TMH5 or equivalent, or as prescribed by the Engineer.

(b) Coring of asphalt layers

The Contractor shall provide suitable coring machines capable of cutting 100 mm diameter cores from the completed asphalt layers. The Contractor will be paid in accordance with the relevant pay item for cutting cores ordered by the Engineer. The cost of extracting cores for process control shall be included in the Contractor's prices for the construction of asphalt pavement layers and will not be paid for separately.

All core holes shall be neatly repaired with asphalt and compacted to the specified density. The cores shall be filled with the same mix as used for the layer tested.

4214 MEASUREMENT AND PAYMENT

Item | Unit
--- | ---
42.01 Asphalt base (specified thickness indicated):
   (a) Using bitumen (state type of bitumen and maximum size of aggregate):
      (i) Continuously graded ........ square metre (m²)
   (b) Using tar (state type of tar and maximum size of aggregate):
      (i) Continuously graded ........ square metre (m²)
   (c) Dense gravel asphalt ........ square metre (m²)

The unit of measurement shall be the square metre of asphalt base constructed to the thickness specified. When specified in the Project Specifications and/or indicated in the Schedule of Quantities, the unit of measurement shall be the tonne of asphalt constructed as specified and measured according to certified weighbridge tickets issued in respect of mixture used. No payment will be made for material wasted.

The tendered rates shall include full compensation for procuring, furnishing, heating, mixing, placing and compaction of all materials as specified as well as process control testing, protecting and maintaining the work as specified.

When the unit of measurement is a tonne of asphalt, the tendered rate shall also include full compensation for supplying and installing a weighbridge, and for weighing the material.

Item | Unit
--- | ---
42.02 Asphalt surfacing (state specified thickness and type of bitumen):
   (a) Continuously graded (grade stated) ........ square metre (m²)

The unit of measurement shall be the square metre of asphalt surfacing constructed to the thickness specified. When specified in the Project Specifications and/or indicated in the Schedule of Quantities, the unit of measurement shall be the tonne of asphalt constructed as specified and measured according to certified weighbridge tickets issued in respect of mixture used. In the case of asphalt resurfacing, measurement by tonne shall be obligatory. No payment will be made for material wasted.

The tendered rates shall include full compensation for procuring, furnishing, heating, mixing, placing and compaction of all materials as specified as well as process control testing, protecting and maintaining the work as specified.

The tendered rate shall include for the procuring, furnishing and application of the material as specified.

Item | Unit
--- | ---
42.03 Tack coat of 30% stable-grade emulsion ........ litre (/)

The unit of measurement shall be the litre of 30% stable-grade emulsion applied as specified.

The tendered rate shall include for the procuring, furnishing and application of the material as specified.

Item | Unit
--- | ---
42.04 Binder variations:
   (a) Penetration-grade bitumens ........ tonne (t)
   (b) RTH/RTL road tars ............... tonne (t)

The unit of measurement in respect of increases or decreases in the bituminous binder from that specified in the nominal mix shall be the tonne.

Payment for variations shall be made as specified in Clause 1213.

Item | Unit
--- | ---
42.05 Variation in active filler content:
   (a) Cement .............. tonne (t)
   (b) Lime ............... tonne (t)
   (c) Milled granulated blast-furnace slag ........ tonne (t)
   (d) Fly-ash ........... tonne (t)
The unit of measurement in respect of increases or decreases in the active filler content for base and surfacing mixtures from that specified in the nominal mix shall be the tonne. No payment shall be made for "inert" filler added by the Contractor.

Payment for variations shall be made as specified in Clause 1213.

Item | Unit
--- | ---
42.06 Trial sections (nominal thickness indicated) | square metre (m²)

The unit of measurement shall be the square metre of asphalt trial section constructed as ordered.

The tendered rate shall include full compensation for the construction of the trial section of asphalt base or surfacing complete as specified, for the application of a prime coat as in Item 41.01

42.07 100 mm diameter cores in asphalt paving | number (No)

The unit of measurement shall be the number of 100 mm diameter cores drilled and recovered as instructed by the Engineer for his own testing. No separate payment shall be made for cores drilled as part of the Contractor's obligations under process control, the cost of which shall be included in the prices tendered for the various items of asphalt paving.

The tendered rate shall include full compensation for drilling the cores as directed, for all plant, fuel, labour and other incidentals necessary and for repairing.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS
SECTION 4300 : MATERIALS AND GENERAL REQUIREMENTS FOR SEALS

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4301 SCOPE
4302 MATERIALS
4303 PLANT AND EQUIPMENT
4304 GENERAL LIMITATIONS AND REQUIREMENTS
4305 HEATING AND STORAGE OF BITUMINOUS BINDERS
4306 STOCKPILING OF AGGREGATE
4307 CONSTRUCTION OF SEAL
4308 RATES OF APPLICATION
4309 AREAS INACCESSIBLE TO MECHANICAL EQUIPMENT
4310 DUST CONTROL
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4312 DEFECTS
4313 MAINTENANCE
4314 TOLERANCES AND FINISH REQUIREMENTS
4315 MEASUREMENT AND PAYMENT

4301 SCOPE

This Section covers the materials, construction plant, construction and requirements common to the construction of all seals detailed in these Specifications.

4302 MATERIALS

(a) Bituminous binders

(i) Conventional bituminous binders

Bituminous binders shall comply with the following specifications or suitable equivalent:

(1) Road tars
High-temperature coke-oven tars ............... SABS 748
Low-temperature tars and tars manufactured from gas works crude ........... SABS 749

(2) Bitumens
Road-grade bitumens ...................... SABS 307
Cut-back bitumens ......................... SABS 308

(3) Bitumen emulsions

Anionic emulsions ......................... SABS 309
Cationic emulsions ......................... SABS 548

The bitumen emulsions shall also be subject to viscosity requirements for spray-grade emulsions as follows:

(1) Anionic spray-grade (60%) emulsion
Minimum 12 degrees Engler at 20°C.

(2) Cationic spray-grade (65% and 70%) emulsion
Minimum 80 seconds Saybolt Furol at 50°C.

The type and grade of bituminous binder to be used shall be as specified under the appropriate Section of these Specifications for each type of bituminous seal, or in the Project Specifications.

(ii) Non-homogeneous (heterogeneous) modified binders (summer grade)

The bitumen-rubber binder shall comply with the following requirements:

(1) Base bitumen

The bituminous binder used in the production of the bitumen-rubber shall be a 60/70, 80/100 or 150/200 penetration-grade bitumen respectively that complies with the requirements of SABS 307 or equivalent, or a blend of any two or all three grades to provide a product with the required viscosity properties.

(2) Rubber

The rubber shall be obtained by processing and recycling pneumatic tyres. It shall be pulverised, free from fabric, steel cord and other contaminants. A maximum of 4% by mass of fine particle size calcium carbonate, or talc, may be added to the rubber particles to prevent the rubber particles from sticking together. At the time of use the crumbs shall be free flowing and dry and comply with the requirements of Table 4302/1.

Table 4302/1
Rubber crumbs

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing by mass</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18</td>
<td>100</td>
<td>BR6T</td>
</tr>
<tr>
<td>0.60</td>
<td>40 - 70</td>
<td>BS 903 Parts B11 and B12</td>
</tr>
<tr>
<td>0.075</td>
<td>0 - 5</td>
<td></td>
</tr>
</tbody>
</table>

* Refer to Subclause 7102(f)

Other requirements

<table>
<thead>
<tr>
<th></th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural rubber</td>
<td>BS 903 Parts B11 and B12</td>
</tr>
<tr>
<td>hydro-carbon</td>
<td></td>
</tr>
<tr>
<td>content</td>
<td></td>
</tr>
<tr>
<td>30% (minimum)</td>
<td></td>
</tr>
<tr>
<td>Fibre length</td>
<td>6 mm (maximum)</td>
</tr>
<tr>
<td>6 mm (maximum)</td>
<td>-</td>
</tr>
<tr>
<td>Relative density</td>
<td>1.10 - 1.25</td>
</tr>
<tr>
<td>(t/m³)</td>
<td>BR97</td>
</tr>
<tr>
<td></td>
<td>(Sabita)*</td>
</tr>
</tbody>
</table>

(3) Extender oils

The extender oil shall be a petroleum-derived material of high aromaticity and shall comply with the requirements of Table 4302/2.

Table 4302/2
Extender oils

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point</td>
<td>180 °C (min)</td>
</tr>
<tr>
<td>% by mass of saturated hydrocarbons</td>
<td>25% (max)</td>
</tr>
<tr>
<td>% by mass of aromatic-unsaturated hydrocarbons</td>
<td>50% (min)</td>
</tr>
</tbody>
</table>
(4) Diluent
The diluent shall be a distillate of hydrocarbon.

(5) Bitumen-rubber blend
The bitumen-rubber blend, including extender oil and/or diluent, if necessary, shall comply with the requirements of Table 4302/3.

Table 4302/3
Bitumen-rubber blend

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>% rubber by mass of total blend</td>
<td>20% - 24%</td>
</tr>
<tr>
<td>% extender oil by mass of total blend</td>
<td>6% (max)</td>
</tr>
<tr>
<td>% of diluent by mass of total blend</td>
<td>7% (max)</td>
</tr>
<tr>
<td>Blending/Reaction temperature</td>
<td>170°C - 210°C</td>
</tr>
<tr>
<td>Reaction time</td>
<td>0.5 - 2 hours</td>
</tr>
</tbody>
</table>

Prior to commencement of the work, the supplier shall state in writing the percentage of rubber and the blending/reaction temperature he intends to use for his specific product. The actual percentage of rubber shall not deviate by more than 1.0% from the stated value and the actual reaction temperature shall not deviate by more than 10% from the stated value.

A continuous record of both percentage rubber added and reaction temperatures shall be kept on site by the Contractor.

The bitumen-rubber binder shall comply with the requirements of Table 4302/4.

Table 4302/4
Bitumen-rubber binder

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression recovery: after 5 minutes</td>
<td>70% (minimum)</td>
<td>BR3T (Sabita)</td>
</tr>
<tr>
<td>after 1 hour</td>
<td>70% (minimum)</td>
<td></td>
</tr>
<tr>
<td>after 4 hours</td>
<td>48 - 55% (minimum)</td>
<td></td>
</tr>
<tr>
<td>Ring-and-ball softening point</td>
<td>55°C (minimum)</td>
<td>TMH1 Method E5</td>
</tr>
<tr>
<td>Resilience</td>
<td>13% - 35%</td>
<td>BR2T (Sabita)</td>
</tr>
<tr>
<td>Dynamic viscosity (Haake at 190°C)</td>
<td>20 - 35 dPa.s</td>
<td>BR5T (Sabita)</td>
</tr>
<tr>
<td>Flow</td>
<td>20 mm - 75 mm</td>
<td>BR4T (Sabita)</td>
</tr>
</tbody>
</table>

The Contractor shall provide the Engineer with time-temperature ratios in regard to the above properties of his specific product before work may start in order to determine the final process and the acceptance limits.

The methods of testing bitumen-rubber material have been published in Manual 3 of the Southern African Bitumen and Tar Association (SABITA).

If a supplier uses a diluent, an ageing test may be required in which the binder is placed in an oven for 5 hours at 150°C, after which time it shall comply with the above Specifications.

The Contractor shall provide the performance record for three recent projects of the materials he intends to use in order to assess the successful use of the materials. The information shall include mean values obtained for the prescribed tests as well as any relevant comments. This information shall be submitted at tender stage.

(iii) Non-homogeneous modified binders (winter grade)
If non-homogeneous modified binders (winter grade) are required, they shall comply with the requirements in the Project Specifications.

(iv) Homogeneous cold applied modified binders
If any polymer other than the elastomer polymers styrene-butadiene rubber (SBR) or styrene-butadiene-styrene (SBS) is required for the manufacture of cationic modified bitumen emulsions it shall comply with the requirements in the Project Specifications.

Where applicable the following details will be indicated in the Project Specifications:

(1) Type elastomer polymer
SBR or SBS. Unless otherwise specified SBR shall be used for tender purposes.

(2) Grade base bitumen
80/100 penetration grade or 150/200 penetration grade. Unless otherwise specified 80/100 penetration grade shall be used for tender purposes.

(3) Modified binder content
65% or 70%. Unless otherwise specified 65% shall be used for tender purposes.

The aforementioned components together with polymer content will dictate the attributes attainable.

Unless otherwise specified, the properties of cationic modified bitumen emulsion containing SBR or SBS solids shall comply with the requirements in Table 4302/5 (following page).

A volatile solvent flux content of up to 3% mass by mass of the bitumen may be added to enhance emulsion performance with regard to prevailing climatic conditions. Any expected change to specified values shall first be discussed with the Engineer prior to the addition of any such enhancer.

The properties of the recovered modified bitumen using a rotary vacuum evaporation method or simple evaporation method as described in Clause 7108 shall be required to comply with the requirements of Table 4302/6 (following page).

If there is any discrepancy in the test results on recovered modified binder, then the results on recovered binder obtained from the rotary vacuum evaporation method shall be binding.
(v) Homogeneous hot-applied modified binders (summer grades)

The requirements for any polymer other than the generic types listed in Table 4302/7 used for the manufacture of homogeneous hot-applied modified binders will be indicated in the Project Specifications.

Where applicable the following details will be indicated in the Project Specifications:

1. Generic type (plastomer or elastomer) and type polymer.
2. Grade base bitumen (80/100 or 150/200) required.

The aforementioned components together with polymer content will dictate the attributes attainable.

(vi) Homogeneous hot-applied modified binders (winter grade)

Where applicable the requirements for homogeneous modified binders (winter grade) will be specified in the Project Specifications.

(b) Aggregates

(i) Aggregates for seals

The aggregate shall consist of approved crushed stone complying with the requirements of SABS 1083 or equivalent and the grading, flakiness index and hardness shall be as follows for each nominal size of stone:

1. Grading

The grading shall comply with the requirements set out in Table 4302/8 (following page) for Grades 1, 2 and 3 and in Table 4302/9 for sand. The grade or grades of aggregate specified in the Project Specifications and in the Schedule of Quantities shall be used.

Table 4302/9
Sand

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage by mass passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75</td>
<td>95 (minimum)</td>
</tr>
<tr>
<td>0.425</td>
<td>50 (minimum)</td>
</tr>
<tr>
<td>0.075</td>
<td>20 (maximum)</td>
</tr>
</tbody>
</table>

Plasticity Index: Non-Plastic

2. Hardness

When tested in accordance with TMH1 Method B2 the 10% FACT value (dry) shall be at least 210 kN and the wet to dry ratio shall be at least 75%.

The polished stone value (PSV) when tested in accordance with SABS Method 848 or equivalent shall be at least 50 unless otherwise specified or approved by the Engineer.

3. Shape

The maximum flakiness index, when tested in accordance with TMH1 Method B3, shall comply with the requirements in Table 4302/10.

Table 4302/10
Flakiness index

<table>
<thead>
<tr>
<th>Nominal size of aggregate (mm)</th>
<th>Maximum flakiness index %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Grade 2 and 3</td>
</tr>
<tr>
<td>19.0</td>
<td>25</td>
</tr>
<tr>
<td>13.2</td>
<td>25</td>
</tr>
<tr>
<td>9.5</td>
<td>30</td>
</tr>
<tr>
<td>6.7</td>
<td>30</td>
</tr>
</tbody>
</table>

If so required for special purposes, the average least dimension (ALD) shall be as indicated in the Project Specifications.

(ii) Aggregate for slurry seals

The aggregate for slurry seals shall be an approved crusher sand obtained from a parent rock having a 10% FACT of not less than 110 kN or a mixture of such crusher sand and an approved clean natural sand, where the mixture does not contain more than 25% of natural sand. The aggregate shall be clean, tough, durable, angular in shape, and shall comply with the grading requirements given in Tables 4302/11 and 4302/12 for the slurry and the grade or type of aggregate specified.

Table 4302/11
Grading limits of aggregate for slurry seals

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing sieve, by mass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fine slurry</td>
</tr>
<tr>
<td></td>
<td>Fine grade</td>
</tr>
<tr>
<td>13.2</td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>100</td>
</tr>
<tr>
<td>4.75</td>
<td>90 - 100</td>
</tr>
<tr>
<td>2.36</td>
<td>65 - 95</td>
</tr>
<tr>
<td>1.18</td>
<td>56 - 95</td>
</tr>
<tr>
<td>0.60</td>
<td>56 - 95</td>
</tr>
<tr>
<td>0.30</td>
<td>42 - 72</td>
</tr>
<tr>
<td>0.15</td>
<td>36 - 72</td>
</tr>
<tr>
<td>0.075</td>
<td>4 - 12</td>
</tr>
</tbody>
</table>

The grading shall comply with the requirements set out in Table 4302/10.
### Table 4302/5
Cationic modified bitumen emulsion

<table>
<thead>
<tr>
<th>Polymer modifier</th>
<th>Required properties</th>
<th>Grade of base bitumen</th>
<th>Minimum modified binder content (%)</th>
<th>Minimum viscosity at 50°C Saybolt Furol (seconds)</th>
<th>Maximum residue on sieving (g/100 ml)</th>
<th>Particle charge</th>
<th>Sedimentation after 60 rotations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>70</td>
<td>70</td>
<td>0.25</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>65</td>
<td>70</td>
<td>0.25</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>SBR</td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>70</td>
<td>80</td>
<td>0.25</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>SBS</td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>65</td>
<td>80</td>
<td>0.25</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>Test Method</td>
<td></td>
<td></td>
<td>-</td>
<td>ASTM D244</td>
<td>ASTM D244</td>
<td>SABS 548</td>
<td>SABS 548</td>
</tr>
</tbody>
</table>

Note 1: Modified binder is bitumen plus polymer.

### Table 4302/6
Recovered modified bitumen

<table>
<thead>
<tr>
<th>Polymer modifier</th>
<th>Required properties</th>
<th>Grade of base bitumen</th>
<th>Minimum softening point (°C)</th>
<th>Minimum dynamic viscosity at 135°C (Pa.S)</th>
<th>Minimum ductility at 10°C (mm)</th>
<th>Elastic recovery (%)</th>
<th>Minimum adhesion at 5°C (%)</th>
<th>Minimum adhesion at 50°C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>55</td>
<td>1.3</td>
<td>1.0</td>
<td>1000</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>45</td>
<td>1.0</td>
<td>1.0</td>
<td>1000</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>60</td>
<td>1.2</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>47</td>
<td>1.0</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td>SBR</td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>60</td>
<td>1.2</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>47</td>
<td>1.0</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td>SBS</td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>60</td>
<td>1.2</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80/100 150/200</td>
<td>47</td>
<td>1.0</td>
<td>1.0</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td>Test Method</td>
<td></td>
<td></td>
<td>-</td>
<td>ASTM D36</td>
<td>ASTM D4402</td>
<td>DIN 52013</td>
<td>DIN 52013</td>
<td>TMH Method B11</td>
</tr>
</tbody>
</table>

Note (1): The dust content criteria shall be according to Table 4302/8 Grade 2 stone for the adhesion test.
### Table 4302/7
Hot-applied modified binders

<table>
<thead>
<tr>
<th>Generic type of modified binder</th>
<th>Grade of base bitumen</th>
<th>Minimum softening point (°C)</th>
<th>Minimum dynamic viscosity at 135°C (Pa.S)</th>
<th>Minimum ductility at 10°C (mm)</th>
<th>Minimum elastic recovery (ductilometer) at 10°C (%)</th>
<th>Maximum stability difference (°C)</th>
<th>Minimum adhesion at 5°C (%)</th>
<th>Minimum adhesion at 50°C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastomerpolymer (EVA)</td>
<td>150/200</td>
<td>48</td>
<td>0.5</td>
<td>300</td>
<td>45</td>
<td>2</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Elastomer polymer</td>
<td>SBR 80/100</td>
<td>47</td>
<td>1.0</td>
<td>1000</td>
<td>55</td>
<td>2</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SBS 80/100</td>
<td>49</td>
<td>1.0</td>
<td>500</td>
<td>60</td>
<td>2</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SBR 150/200</td>
<td>45</td>
<td>0.5</td>
<td>1000</td>
<td>55</td>
<td>2</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SBS 150/200</td>
<td>47</td>
<td>0.5</td>
<td>500</td>
<td>60</td>
<td>2</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Test Method</td>
<td>-</td>
<td>-</td>
<td>ASTM D36</td>
<td>ASTM D4402</td>
<td>DIN 52013</td>
<td>DIN 52013</td>
<td>TMH1 Method B11</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4302/8
Single-sized crushed aggregate Grades 1, 2 and 3

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Grade</th>
<th>Percentage by mass passing</th>
<th>26.5 mm nominal size</th>
<th>19.0 mm nominal size</th>
<th>13.2 mm nominal size</th>
<th>9.5 mm nominal size</th>
<th>6.7 mm nominal size</th>
<th>2.36 mm nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>26.5</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>19.0</td>
<td>13.2</td>
<td>85 - 100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>9.5</td>
<td>6.7</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5**</td>
<td>85 - 100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75</td>
<td>2.36</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0 - 100</td>
</tr>
</tbody>
</table>

**Grades 1 & 2**

**Grade 3** Grading shall comply with the requirements for Grades 1 and 2 with the following exceptions:

- Fines content: 0 - 50
- Dust content: 0 - 10

<table>
<thead>
<tr>
<th>Material passing a 0.425 mm sieve (max)</th>
<th>Grade</th>
<th>Fines content</th>
<th>Dust content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>0.5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Grade 2</td>
<td>1.5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Grade 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material passing a 0.075 mm sieve (max)</th>
<th>Grade</th>
<th>Fines content</th>
<th>Dust content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>0.5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Grade 2</td>
<td>0.5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Grade 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Table 4302/12
Grading limits of aggregate for slurry used for texture improvement only

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage passing sieve by mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18</td>
<td>100</td>
</tr>
<tr>
<td>0.600</td>
<td>82 - 100</td>
</tr>
<tr>
<td>0.300</td>
<td>50 - 70</td>
</tr>
<tr>
<td>0.150</td>
<td>20 - 35</td>
</tr>
<tr>
<td>0.075</td>
<td>7 - 15</td>
</tr>
</tbody>
</table>

The sand equivalent determined in accordance with TMH1 Method B19 (SABS 838) shall be at least 35.

The immersion index of briquettes made with slurry aggregate and 80/100 penetration-grade bitumen at the specified net bitumen content for the slurry shall be not less than 75 when tested in accordance with Method C5 of TMH1.

(c) Filler for slurry

Ordinary Portland cement shall comply with AASHTO M85, SABS 471 or equivalent and Portland blast-furnace cement (PBFC) with the requirements of AASHTO M240, SABS 626 or equivalent.

Road lime shall comply with the requirements of AASHTO M216, SABS 824 or equivalent (Lime for Soil Stabilisation).

Only one of the above materials shall be used throughout, in order to prevent undesirable colour differences in the surface.

(d) Hydrophilic aggregates

Where hydrophilic or other aggregates which may cause problems are encountered, the Engineer may order that the stone chips be precoated, as described below, or that a fog spray be applied, as specified in Subclause 4403(d).

(i) Precoating of aggregate for stockpiling or for immediate use

This method may be used for aggregate intended for immediate use or for stockpiling.

The untreated stockpile of aggregate shall be thoroughly sprayed with water, which shall be allowed to drain off. The damp aggregate shall then be loaded into the bucket of a front-end loader and 10 to 12 l of an approved precoating fluid shall be sprayed evenly over the aggregate by means of a watering can.

The wetting agent approved by the Engineer shall be added to the precoating fluid at a rate of 0.5% of the volume of precoating fluid.

The mixture of aggregate and precoating fluid shall then be dumped on a site prepared as specified in Clause 4306. This process shall be repeated until a stockpile of approximately 15 m³ to 20 m³ has been built up.

This stockpile shall then be turned over with the front-end loader until the aggregate is uniformly coated with the precoating fluid. Three complete turnings of the stockpile will probably be required.

The time between the precoating and the placing of the aggregate shall not exceed the time specified in the Project Specifications or agreed on by the Engineer and the Contractor.

All aggregates used with hot-applied homogeneous and non-homogeneous modified binders, shall be precoated.

(ii) Precoating constraints

No precoating shall be applied where conventional and modified emulsion binders are used unless specifically specified or ordered by the Engineer.

4303 PLANT AND EQUIPMENT

(a) General

All plant and equipment used on the Works shall be of an adequate rated capacity and in a good working condition.

All plant and equipment that will be operated on the road during construction of the seal shall be free from any binder, fuel or oil leaks, and no refuelling or servicing of any equipment will be allowed to take place while such equipment is on the road.

(b) Binder distributor

The binder distributor shall comply with all the provisions of Subclause 4103(a).

The binder distributor used for non-homogeneous modified binder shall be adapted to spray the rubber modified binder satisfactorily. The Contractor shall provide proof by way of a test on the site that the binder distributor has sufficient reserve power to maintain the required constant speed up the steepest incline to which spray has to be applied, and to obtain a uniform distribution of the mix. The optimal spray-bar level shall be determined during testing, and the spray-bar level shall be adjusted accordingly before each spray. The uneven application of binder will be unacceptable.

(c) Chip spreaders

The chip spreaders shall be capable of spreading stone of the specified size uniformly over widths varying between 2.4 m and 4 m and shall be capable of adjustment to permit variation of the rate of application within the specified tolerances, and uniform spreading in both the transverse and longitudinal directions.

At least two chip spreaders shall be provided, one of which shall be self-propelled.

Spreaders which are not self-propelled, shall be of a type that can be attached quickly to the rear of trucks, and operated while backed over the stone chippings being spread.

(d) Rollers

Sufficient operational rollers of each of the following types shall be available on the Works to maintain the required tempo of work:
(i) Pneumatic-tyred rollers

Pneumatic-tyred rollers shall be of a self-propelled type equipped with smooth flat profile pneumatic tyres of uniform size and diameter. The mass of the roller shall not be less than 20 tonnes (unloaded).

The wheels of the roller shall be so spaced that one pass of the roller will provide one complete coverage equal to the rolling width of the machine. The total operating mass and tyre pressure may be varied by the Engineer at his discretion. Individual tyre pressures shall not differ by more than 35 kPa from one another.

(ii) Rubber-soled steel-wheeled rollers

Rubber-soled steel-wheeled rollers shall be self-propelled, and have a mass of between 6 and 8 tonnes. It shall be equipped with suitable devices for cleaning and moistening the wheels. The wheels of the roller shall be so arranged as to give one complete coverage, by one passage of the roller, over a width equal to the rolling width of the roller.

(iii) Steel-wheeled rollers

Steel-wheeled rollers shall be self-propelled three-wheel or tandem rollers of between 6 and 8 tonnes mass and shall be equipped with suitable devices for cleaning and moistening the wheels. The mass of the roller required shall be determined by the Engineer. No steel-wheeled rollers shall be used without the consent of the Engineer.

(iv) Additional requirements

The type and number of rollers shall be subject to the approval of the Engineer for each type of seal and the proposed programme.

No seal work shall continue if the required rollers are not on site or in an operational condition.

(e) Brooms

(i) Drag broom

The drag broom shall be of a size, type and mass which will enable the chips to be distributed evenly over the surface without dislodging any chips from the binder.

(ii) Rotary broom

An approved rotary broom, complete with towing vehicle fitted with smooth pneumatic tyres, shall be available at all times on the Works.

(f) Mixer for slurry

A mobile mixer of a type approved by the Engineer shall be provided. It may be either a batch mixer or a continuous type mixer. The paddles of the mixer shall be so designed as to ensure a complete blending of the constituents of the slurry.

For the rapid setting slurry types, the mixing and application of the slurry shall be done by a mixer designed to provide a rapid mixing time, and sufficient agitation within the spreading system to prevent segregation or premature hardening. The mixer shall be capable of continuous mixing and application.

The purpose designed mixer for continuous type mixing of either conventional or rapid setting slurries, shall be equipped with precise metering systems to enable the various constituents to be combined continuously to the prescribed formulation.

No central mixing plant will be allowed. Details of the type of mixer shall be submitted in advance of actual construction, for approval by the Engineer.

(g) Loader for slurry

A loader, or equivalent capacity labour force where so required in the Project Specifications, compatible with the needs and capacity of the mixer unit shall be available at the stockpiling site.

(h) Spreader box for slurry

The type of spreader box used for spreading the slurry shall be submitted to the Engineer, in advance, for approval. The spreader box for rapid setting slurry shall be of a proven and approved type, fitted with a proven and approved device to ensure sufficient agitation within the spreader system.

The spreader box shall be so constructed as to distribute the weight onto metal skids in such a way that no damage shall be done to the surface when the box is in operation.

Soft rubber belting shall be attached to the framework in such a manner as to prevent slurry from being spilt past the sides of the spreader box when the box is in operation.

The spreader box shall be capable of spreading a uniform application of the slurry in adjustable widths from 1.5 m to 4 m, at specified rates, and it shall have efficient mechanical means of adjusting the rates and widths of application specified.

(i) Precoating plant

The precoating of chips may be done in any suitable plant capable of uniformly coating the chips.

(j) Mass-measuring device

Where payment per tonne is specified, the Contractor shall keep available on the site as directed by the Engineer, a suitable gauged mass-measuring device. The device shall be provided with a printer for printing the mass, the time and date. The printed data shall be submitted to the Engineer on a daily basis.

(k) Miscellaneous equipment

Sufficient equipment for handling and hauling aggregate, binder and slurry, and blending units for non-homogeneous modified binders, shall be provided to ensure prompt and continuous placing and application of bituminous materials as specified. The Contractor shall have available all the necessary ancillary equipment and hand tools to carry out the work efficiently.

Suitable fire-fighting equipment for dealing with bitumen fires shall be available on site, together with suitable first aid equipment.
equipment for dealing with bitumen burns. (Refer to Sabita Manual 8 : Bitumen Safety Handbook.)

The Engineer shall be entitled to request reserve plant, should there be any doubt as to the efficiency or capability of the equipment provided.

4304 GENERAL LIMITATIONS AND REQUIREMENTS

(a) Weather limitations

The minimum road-surface temperatures at which the spraying of the different types and grades of binder may be done are:

(i) Conventional binders

(1) Road tars

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Binder Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°C</td>
<td>40/45 EVT tar</td>
</tr>
<tr>
<td>16°C</td>
<td>45/50 EVT tar</td>
</tr>
<tr>
<td>21°C</td>
<td>50/55 EVT tar</td>
</tr>
</tbody>
</table>

(2) Bitumens

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Binder Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>21°C</td>
<td>150/200 penetration-grade bitumen</td>
</tr>
<tr>
<td>25°C</td>
<td>80/100 penetration-grade bitumen</td>
</tr>
<tr>
<td>10°C</td>
<td>MC-800 cut-back bitumen</td>
</tr>
<tr>
<td>10°C</td>
<td>MC-3000 cut-back bitumen</td>
</tr>
</tbody>
</table>

(3) Bitumen emulsions

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Binder Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°C</td>
<td>Bitumen emulsion</td>
</tr>
</tbody>
</table>

(ii) Non-homogeneous modified binders (summer grade)

<table>
<thead>
<tr>
<th>Binder Type</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen-rubber</td>
<td>20°C</td>
</tr>
</tbody>
</table>

(iii) Non-homogeneous modified binders (winter grade)

As specified in the Project Specifications.

(iv) Homogeneous cold applied modified binders

<table>
<thead>
<tr>
<th>Binder Type</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBR modified cationic emulsion</td>
<td>10°C</td>
</tr>
<tr>
<td>SBS modified cationic emulsion</td>
<td>10°C</td>
</tr>
</tbody>
</table>

(v) Homogeneous hot-applied modified binders

<table>
<thead>
<tr>
<th>Binder Type</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified binder 150/200 penetration grade base bitumen</td>
<td>20°C</td>
</tr>
<tr>
<td>Modified binder 80/100 penetration grade base bitumen</td>
<td>25°C</td>
</tr>
</tbody>
</table>

(vi) Homogeneous hot-applied modified binders (winter grade)

As specified in the Project Specifications.

Whenever the temperature of the road surface falls below the aforesaid temperature for the binder in question, or, in the opinion of the Engineer, will probably fall below the required temperature before spraying the binder, no binder shall be sprayed.

No bituminous work shall be done during foggy or rainy weather, and, when a cold wind is blowing, the above temperatures shall be increased by 3°C to 6°C as directed by the Engineer.

Conventional slurry shall not be applied at an air temperature of less than 7°C when temperatures are rising, or less than 13°C when temperatures are dropping. Rapid setting slurry shall be sufficiently versatile to be laid in air temperatures of 4°C to 40°C, as well as capable of being laid under damp conditions.

During hot weather slurry operations shall be suspended when aggregate is being displaced by the spreader box or squeegee.

When the breaking process accelerates to such an extent that it renders the product unworkable to attain the required end result, for instance when the surface temperature is in excess of 60°C, or as otherwise prescribed by the Engineer, no sealing shall be done.

When strong winds are blowing which are likely to interfere with the proper execution of the work, no sealing, especially spraying of binder, shall be done.

(b) Moisture content

No seal shall be placed unless the moisture content of the upper 50 mm of the base is less than 50% of the optimum moisture content as determined by the Engineer. No reseal shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surfacing resulting in the trapping of moisture in the pavement structure. A minimum delay of 24 hours or such extended period as ordered by the Engineer shall apply.

(c) Other constraints

(i) The following curing periods shall apply to the various treatments listed, prior to applying a seal/reseal unless otherwise specified in Project Specifications:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Curing Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texturing using fine slurries</td>
<td>6 weeks</td>
</tr>
<tr>
<td>Rapid setting slurry (rut filling, etc)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Crack sealing</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Repair of distressed patches</td>
<td>6 weeks</td>
</tr>
</tbody>
</table>

(ii) Unless otherwise agreed by the Engineer, and subject to the outcome of a trial section, the Contractor shall programme all spraying to cease each working day at 15:00 hours.

(d) Preparation of areas to be sealed

(i) General

The areas to be sealed shall be cleaned of all dust, dirt, dung, oil or any other foreign matter that may be deleterious to the seal.

(ii) Newly constructed seals

Where newly constructed base or shoulder areas are to be sealed, the surfaces shall be checked for compliance with the surface tolerances and all other requirements specified. Any portions that do not meet these requirements shall first be either corrected or removed and reconstructed before they are sealed.

(iii) Existing surfaces to be resealed

Existing roads that require resealing shall, if so specified or ordered by the Engineer, be given a pretreatment in
accordance with one or more of the methods described in Section 4900.

Any failures shall be repaired as specified in the Project Specifications.

(e) Demarcation of working area

(i) New work

The Contractor shall demarcate the area of the primed base to be sealed by means of setting out wire lines down each edge of the specified seal width.

(ii) Reseal work

Immediately before the tack coat or bituminous binder is sprayed, the centre line of the road shall be marked by a 3 mm thick sisal or hemp twine, secured by nails driven, at 15 m intervals on straights and 5 m intervals on curves, into the existing surface. This twine shall be left in position during all subsequent operations.

4305 HEATING AND STORAGE OF BITUMINOUS BINDERS

(a) Conventional binders

The temperature ranges between which bituminous binders are to be heated shall be as given in Tables 4305/1 and 4305/2.

<table>
<thead>
<tr>
<th>Table 4305/1 Maximum storage temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Road tars</td>
</tr>
<tr>
<td>40/45 EVT</td>
</tr>
<tr>
<td>45/50 EVT</td>
</tr>
<tr>
<td>50/55 EVT</td>
</tr>
<tr>
<td>Road grade bitumens</td>
</tr>
<tr>
<td>150/200 pen grade</td>
</tr>
<tr>
<td>80/100 pen grade</td>
</tr>
<tr>
<td>Cut-back bitumens</td>
</tr>
<tr>
<td>RC-250</td>
</tr>
<tr>
<td>MC-800</td>
</tr>
<tr>
<td>MC-3000</td>
</tr>
<tr>
<td>Bituminous emulsions</td>
</tr>
<tr>
<td>60%</td>
</tr>
<tr>
<td>65%</td>
</tr>
<tr>
<td>70%</td>
</tr>
</tbody>
</table>

Binders stored in a heated condition shall be kept in a container with a securely fitting lid, the circulatory system of which is functioning properly. The container shall be provided with a built-in thermometer.

Binders which have been heated above the maximum temperatures indicated in this table shall not be used and shall be removed from the site. Every effort shall be made to maintain the binder temperature for spraying to within 5°C of the recommended temperature.

For single seals the temperature limits for 150/200 penetration-grade bitumen, cut back with the indicated amounts of power paraffin in parts per 100 parts of bitumen by volume as described in Section 4400, shall be as set out in Table 4305/3 to prevent degradation of the bitumen.

<table>
<thead>
<tr>
<th>Table 4305/3 Temperature limits for single seals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity of power paraffin added (parts per 100 parts of bitumen by volume)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2.5</td>
</tr>
<tr>
<td>5.0</td>
</tr>
<tr>
<td>7.5</td>
</tr>
<tr>
<td>12.5</td>
</tr>
<tr>
<td>15.0</td>
</tr>
<tr>
<td>17.5</td>
</tr>
<tr>
<td>22.5</td>
</tr>
</tbody>
</table>

(b) Non-homogeneous (heterogeneous) modified binders (summer grade)

After completion of the bitumen-rubber reaction, the binder shall be cooled to below 160°C. The binder mixture may not be kept for more than 2 days. The mix may only be stored in tanks with circulation systems.
The spray and storing temperatures of the bitumen-rubber binder shall comply with the following requirements:

Spray temperature (°C) ........... Provided by supplier
Max storing time at spray temperature (hours) ................................. 4
Max storing temperature (up to 2 days), (°C) .... 35 below spray temperature but not more than 160

Stored binder heated to a temperature above 160°C shall not be used and shall be removed from the site.

(c) Non-homogeneous modified binders (winter grade)

The Contractor shall comply with the requirements specified in the Project Specifications with regard to the storage, heating and spraying temperatures, and with regard to the information to be provided in the tender stage, unless otherwise approved by the Engineer.

(d) Homogeneous cold applied modified binders

Modified bitumen emulsions may be stored at ambient temperature for long periods, provided that some circulation/mixing takes place from time to time. The spraying temperatures of these emulsions are the same as for conventional bitumen emulsions.

(e) Homogeneous hot-applied modified binders (summer grade)

The heat stability of modern modified bitumens is remarkably good. However, excessive temperature over extended periods will degrade all modified bitumens and negatively affect the enhanced properties of these binders.

The temperature limits for the storage and spraying of modified hot-applied binders shall be as set out in Table 4305/4 unless otherwise approved by the Engineer.

<table>
<thead>
<tr>
<th>Bitumen grade used in manufacture</th>
<th>Polymer type</th>
<th>Maximum storage temp °C</th>
<th>Spraying temp °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Up to 24 hours</td>
<td>24 to 48 hours</td>
</tr>
<tr>
<td>80/100 pen</td>
<td>EVA</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>150/200 pen</td>
<td>EVA</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>80/100 pen</td>
<td>SBR</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>150/200 pen</td>
<td>SBR</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>80/100 pen</td>
<td>SBS</td>
<td>175</td>
<td>150</td>
</tr>
<tr>
<td>150/200 pen</td>
<td>SBS</td>
<td>175</td>
<td>150</td>
</tr>
</tbody>
</table>

Modified binders stored in a heated condition shall be kept in a container having a properly functioning circulation system and a securely fitting lid.

Note: Many long chain polymers have low shear stability and can be degraded by the action of a high shear rate pump such as a close tolerance gear pump.

(f) Homogeneous hot-applied modified binders (winter grade)

The Contractor shall comply with the requirements specified in the Project Specifications with regard to the storage, heating and spraying temperatures, and with regard to the information to be provided in the tender stage, unless otherwise approved by the Engineer.

4306 STOCKPILING OF AGGREGATE

(a) General

Sites for the stockpiling of aggregates shall be prepared in such a manner that no grass, mud, dirt or other deleterious material will be included when the aggregates are loaded for use.

Access roads to stockpile sites shall be prepared and maintained in such a way that no dirt is conveyed by vehicle wheels onto the areas to be sealed or resealed whilst aggregate is being transported to or from the stockpiles.

Stockpiles shall be so sited that they will not be exposed to excessive contamination with dust arising from traffic on the road or access roads. Aggregates contaminated to the extent that it contains more than the allowable percentage of material passing through the 0.425 mm sieve and 0.075 mm sieve shall not be used for sealing.

(b) Precautions

Areas used for stockpiling precoated aggregate shall be so sited that dust deposited on the chips is reduced to a minimum. Where necessary, temporary diversions and access roads in the immediate proximity shall be watered, sprayed with a suitable chemical dust suppressant, or sealed.

During the wet season when there is danger of the precoating fluid being washed off the aggregate, the stockpiles shall be covered with tarpaulins or similar protective coverings.

During cooler periods the Engineer may order that stockpiles be covered with tarpaulins to ensure that the aggregate temperature remains compatible with the limiting temperature applicable to the specified binder type.

4307 CONSTRUCTION OF SEAL

(a) General

Adequate advance notice shall be given to the Engineer before the Contractor proceeds with any seal work.

(b) Single and double aggregate seals

(i) Application of tack coat and aggregate

A bituminous tack coat consisting of the type and grade of binder specified in these Specifications under each of the appropriate Sections for each type of bituminous seal, or in the Project Specifications, shall be sprayed on the properly cleaned and prepared base or existing surface over the full specified width of the seal.
Where the tank of the binder distributor could become empty during spraying against inclines, the spraying shall be done while the binder distributor is moving uphill. Should the Engineer be of the opinion that the Contractor is unable to place the sealant over the full specified width in one movement, the Contractor shall execute the spraying and the distribution of the chips in strips. The spraying of adjacent strips shall overlap by 100 mm. Chips may not be placed on the 100 mm overlap before the adjacent strip has been sprayed. The adjacent strip may not be sprayed before the preceding strip, excluding the 100 mm overlap, has been covered satisfactorily with chips in compliance with the Specifications. In so far as is practicable, the Contractor shall so place the strips that the joint between two adjacent chip applications shall fall on the centre line of the road.

Immediately after the binder has been sprayed, it shall be covered with clean, dry aggregate of the size specified in these Specifications under each of the appropriate Sections for each type of seal.

The actual rates of application of binder and aggregate to be used in the construction will be determined by the Engineer, after he has tested the aggregates the Contractor proposes to use for the seal and prior to any sealing being carried out.

The aggregate shall be applied uniformly by means of self-propelled chip spreaders, unless otherwise specified. In the case of single seals, the use of a self-propelled chip spreader shall be obligatory. The immediate application of the chips is of prime importance. The chip spreader shall be so operated that the tack coat shall be covered with aggregate before the wheels of the chip spreader or truck pass over the uncovered tack coat.

The quantity of bitumen sprayed in any single spray operation shall be governed by the quantity of aggregate, and the number of trucks available shall be sufficient to ensure the continuous application of stone behind the distributor. In addition the available roller capacity at normal operating speed shall also govern the extent of the tack coat and aggregate that may be applied.

(ii) Initial rolling of aggregate

Immediately after the aggregate has been applied, rolling shall be commenced. A self-propelled 15 tonne pneumatic-tyred roller only shall be used in the case of single seals, and a steel-wheeled roller may also be used in the case of double seals, on condition that excessive crushing of the aggregate shall not take place. Rollers shall operate parallel to the centre line of the road, from the shoulders inwards towards the crown of the road, until the entire surface has been covered at least three times with the wheels of the roller.

(iii) Broom drag and final rolling of aggregate

After the bituminous binder has set-up sufficiently to prevent any aggregate from being dislodged, the surface shall be slowly dragged with a broom drag to ensure even distribution of the aggregate. If there are areas which are deficient in stone chips, additional material shall be added by hand so as to leave a single layer of chips lying shoulder to shoulder.

If there are areas with an excess of stone chips, such excess shall be removed by hand so as to leave a single layer of chips lying shoulder to shoulder. The importance of applying only a single layer of chips is stressed. Every care shall be taken to avoid an over-application of stone.

After completing the spreading of the aggregate, the surface shall be rolled with a 15 tonne pneumatic-tyred roller for three to four coverages. Except in the case of single seals final rolling shall then be done with a steel-wheeled roller with a mass of 6 to 8 tonnes working parallel to the centre line of the road from the shoulders towards the crown of the road, until every portion of the surface concerned has been covered by at least two to four passes of the roller, provided that only a limited degree of crushing of the aggregate will take place, but if, in the opinion of the Engineer, general crushing occurs under the rollers, such rolling shall be stopped regardless of the number of passes completed by the roller.

The surface shall be well knit and have a uniform appearance, free of roller-tyre marks; all aggregate contaminated by fuel, oil or grease shall be removed and replaced with clean aggregate.

(iv) Joints between binder sprays

In order to prevent overlapping at junctions of separate binder applications the previous work along the joint shall be covered with twine-reinforced building paper for a sufficient distance back from the joint to ensure that the sprayer is operating at the required rate before the untreated surface is reached, and also to prevent additional binder application onto the previously treated section. The same method shall be used to ensure a neat joint at the end of the run.

(v) Protection of kerbs, channels, etc

Kerbs, channels, guttering, manholes, guard rails, bridge railings and any other structures which may be soiled by bituminous binders during spraying operations shall be protected in terms of Section 2300 during spraying operations.

The Contractor shall replace at his own cost any items that have been soiled and cannot be cleaned entirely. The painting of soiled surfaces will not be accepted as a suitable remedy.

(c) Slurry seals

Slurry seals shall be applied as specified in Clauses 4603 and 4604.

4308 RATES OF APPLICATION

Whenever the terms “net bitumen” or “net quantity of bitumen” are used in these Specifications to specify the rate of application of the binder for conventional or homogeneous modified binder (hot and cold), they shall mean viscosity grade (penetration-grade) bitumen net cold. Non-homogeneous modified binders, however, shall be specified at spraying temperature.

All binders, aggregates and slurry used in the various types of seals shall be applied at the rates of application as determined by the Engineer after tests on the materials proposed for use.

No payment will be made for bituminous binder applied in excess of the rate ordered plus the permitted tolerance or at a rate lower than the specified rate, minus the permitted tolerance, unless, in the opinion of the Engineer, such overspray or any shortages can be satisfactorily corrected in the case of a first application by the adjustment of the application rate of the second spray, and if such correction is effected.
Unless otherwise specified, the nominal rates of application of bituminous binders given in further sections, and also the variations in application rate, shall be measured at spraying temperature.

The nominal rates of application are for tendering purposes only and will not necessarily be used in construction. The actual rates of application to be used on the site shall in all cases be as instructed by the Engineer.

The appropriate conversion factors given in Table 4308/1 or specified in the Project Specifications shall be used for calculating net bitumen (cold) from conventional and homogeneous modified binders at spraying temperature.

### 4309 AREAS INACCESSIBLE TO MECHANICAL EQUIPMENT

Areas inaccessible to mechanical equipment shall be constructed as follows:

(a) **Prime**

Prime shall be applied to the base by hand-spraying under the supervision of an experienced person. The total application of prime shall be controlled in order to determine whether the application rate specified is being obtained.

<table>
<thead>
<tr>
<th>Binder</th>
<th>Conversion factor</th>
<th>Average spray temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road tar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35/40 RTH/RTL</td>
<td>1.24</td>
<td>100</td>
</tr>
<tr>
<td>40/45 RTH/RTL</td>
<td>1.21</td>
<td>106</td>
</tr>
<tr>
<td>45/50 RTH/RTL</td>
<td>1.18</td>
<td>111</td>
</tr>
<tr>
<td>50/55 RTH/RTL</td>
<td>1.15</td>
<td>117</td>
</tr>
<tr>
<td>35/40 RTH with 1.5% PVC</td>
<td>1.24</td>
<td>100</td>
</tr>
<tr>
<td>40/45 RTH with 1.5% PVC</td>
<td>1.21</td>
<td>106</td>
</tr>
<tr>
<td>45/50 RTH with 1.5% PVC</td>
<td>1.18</td>
<td>111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bitumen</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>150/200 pen bitumen</td>
<td>1.10</td>
<td>165</td>
</tr>
<tr>
<td>80/100 pen bitumen</td>
<td>1.11</td>
<td>180</td>
</tr>
<tr>
<td>MC 800</td>
<td>1.33</td>
<td>114</td>
</tr>
<tr>
<td>MC 3000</td>
<td>1.23</td>
<td>138</td>
</tr>
<tr>
<td>Bitumen emulsion (60% bitumen content)</td>
<td>1.67</td>
<td>53</td>
</tr>
<tr>
<td>Bitumen emulsion (65% bitumen content)</td>
<td>1.56</td>
<td>60</td>
</tr>
</tbody>
</table>

(b) **Bituminous mixture**

A premixed bituminous mixture shall be prepared, consisting of 9.5 mm nominal sized aggregate, 6.7 mm nominal sized aggregate, and crusher sand which complies with the requirements of Subclause 4302(b), together with a 60% stable mix-grade emulsion prepared from 80/100 penetration-grade bitumen, in the following proportions by volume:

- 9.5 mm nominal sized aggregate .............. 1 part
- 6.7 mm nominal sized aggregate .............. 1 part
- Crusher sand (fine grade) ................. 1 part

Net quantity of bitumen between 75 and 90 t/m² aggregate mix.

The ingredients shall be mixed in a suitable concrete or other type of mixer. It should be possible to heat the aggregate in the mixer, while it is rotating, by a gas flame or other means.

The aggregate shall be placed in the mixer and heated to 100°C while mixing, after which the bituminous emulsion shall be added. Mixing shall continue until the aggregate is uniformly coated with bitumen.

Before spreading the mixture, the surface shall be prepared by painting it with one layer of bituminous emulsion, which must be allowed to dry.

The mixture shall then be placed on the areas to be sealed, and screeded off in a layer of uniform thickness.

After the emulsion has broken and the layer has attained sufficient stability, it shall be rolled with a small steel-wheeled roller to obtain compaction.

The surface shall comply with the requirements specified in Clause 4314. The thickness of the layer shall be the same as that of the adjacent seal.

(c) **Slurry**

Where the sealing layer consists of an application of aggregate with slurry, the slurry shall be applied to the surface of the layer constructed as described above, at a rate of between 0.003 and 0.004 m³/m², or as the Engineer may direct. This shall be done simultaneously with the final slurry application on the other portions of the work to obtain a uniform appearance.

(d) **Binders for seals**

Binder for seals, and particularly bitumen-rubber binder, shall be sprayed with mechanical equipment, which, where necessary, has been specially adjusted for accurately applying the binder in restricted areas in accordance with the specified requirements. Hand-spray equipment may be used only with the written approval of the Engineer, and then only in accordance with approved methods under the strict supervision of experienced personnel and with equipment suitable for performing the work in accordance with specified requirements.

### 4310 DUST CONTROL

Any temporary diversions and construction roads shall be kept watered and damp, or sprayed with a suitable chemical dust suppressant, during all sealing operations and all dust shall be removed from surfaces before any binder, aggregate or slurry is applied.

The supply and application of water or chemical dust suppressants on temporary diversions will be paid for separately as specified in Section 1500, but payment for dust control on the haul and construction roads shall be included in the unit rates tendered for the various types of seals used.
4311 OPENING TO TRAFFIC

The Engineer shall be responsible for determining when any sealing layer is to be opened to public traffic.

The road shall not be opened to traffic until the binder has set sufficiently to retain the aggregate, or in the case of slurry seals, the slurry has set sufficiently so as not to be picked up by the wheels of passing traffic.

The Contractor shall not allow any construction equipment, which is likely to cause damage, over the completed seal. The Contractor shall display speed restriction signs in accordance with Section 1500 and the instructions of the Engineer.

4312 DEFECTS

Where, in the opinion of the Engineer, any unacceptable loss of stone from or bleeding of the road surface that may occur during the course of the Contract or during the maintenance period can be attributed to the Contractor not observing any of the requirements of the Specifications, not using the correct rates of application, or to any other omission or fault on the part of the Contractor, any corrective work ordered by the Engineer shall be at the Contractor's cost, including the supply, precoating, stockpiling at selected sites and later removal if not used, of any aggregate reserved for corrective work during the period of maintenance or thereafter.

Where the reason for bleeding or loss of stone, in the opinion of the Engineer, cannot be attributed to any fault or neglect on the part of the Contractor, the Employer shall pay at the tendered rates for the cost of any remedial measures taken on the instructions of the Engineer.

(a) Bleeding

Bleeding shall be corrected by one or more of the methods described below, as may be ordered by the Engineer:

(i) Method 1: Single seal with slurry: Light bleeding

Nominal 6.7 mm aggregate conforming to the requirements of Clause 4302 shall be used. The aggregate shall be coated as described in Subclause 4302(d) with an approved precoating fluid by using 10 to 12 /m².

If the binder of the existing surface has an oxidised film or if the road has been used by traffic for some time, it shall be treated either by brushing in power paraffin to soften the surface of the binder, or the surface shall be softened up with gas burners. This work shall only be done on hot days.

The aggregate shall be applied to the surface immediately at the rate of 0.004 m³/m² and rolled with a heavy pneumatic-tyred roller until the aggregate is firmly embedded. All loose aggregate not embedded shall be broomed off the road before it is opened to traffic. When opening the road to traffic, the affected areas shall be demarcated with traffic cones and speed limit signs for the first two days, care being taken to remove all loose aggregate daily.

Areas where whip-off is excessive after the above treatment has been carried out, shall be retreated in accordance with the Engineer's instructions.

(ii) Method 2: Single seal with slurry: Severe bleeding

The method to be used shall be the same as Method 1, except that the aggregate shall be nominal sized 9.5 mm or 13.2 mm and they shall be spread at the rate of 0.007 m³/m² and 0.010 m³/m² respectively. If only half the road width is to be treated, the application of aggregate shall be finished in a neat line on the centre line of the road.

(iii) Method 3: Bleeding single or multiple seals

If the surface is non-uniform, ie partly bleeding and partly coarse-textured, the surface shall be rectified by pretreating the coarse areas in accordance with Clause 4904 (Type 2 treatment) to obtain a uniform surface, which shall then be covered with a single seal in accordance with the standard Specifications. The type of aggregate to be used shall be determined by the Engineer. The pretreated surface shall be inspected and the size of aggregate and the rates of application of the tack coat and aggregate, which the surface can accommodate, shall be established. Methods 1 or 2 shall be used if so ordered by the Engineer.

(iv) General

All operations to correct bleeding shall be carried out only when the surface temperature is high enough to promote adherence.

This work shall be effected as soon as possible after bleeding occurs.

Before opening any rectified work to traffic, all the loose aggregate shall be swept off the surface.

It is essential to use a heavy pneumatic-tyred roller on all work. Rolling shall continue until the Engineer is satisfied that all the aggregate has been properly embedded. No rolling shall be done in wet weather, cold weather or early in the morning when the surface is cold.

Notwithstanding the above methods of treatment, the Engineer may order any seal which has not been properly constructed to be removed and replaced. The removal of the seal shall be done so as not to damage the existing base. All aggregate and binder shall be removed either by grader or by hand tools and any damage done to the surface shall be repaired to the satisfaction of the Engineer.

(b) Loss of stone

Loss of stone shall be corrected in accordance with the requirements of the Engineer, with the aid of a fog spray. The surface to be repaired shall be clean and dry, and a 30% anionic or cationic spray-grade emulsion shall be applied at a rate of 0.6 /m² or such other rate as may be approved by the Engineer.

4313 MAINTENANCE

The Contractor shall maintain the bituminous surface until the work is finally accepted by the Employer. Any damage done to the surface or any defects which may develop before the issue of the maintenance certificate, fair wear and tear excepted, shall be corrected by the Contractor at his own cost and to the requirements of the Engineer.
4314 TOLERANCES AND FINISH REQUIREMENTS

Whenever the terms "net bitumen" or "net quantity of bitumen" are used in these Specifications to specify the rate of application of the binder for conventional or homogeneous modified binder (hot or cold), they shall mean viscosity grade (penetration-grade) bitumen net cold. Non-homogeneous modified binders, however, shall be specified at spraying temperature.

The completed bituminous work shall comply with the following requirements regarding surface tolerances and finish:

(a) New work

(i) Level and grade

The requirements relating to the base on which the seal is constructed shall apply.

(ii) Width

The edges of the seal shall be true to line with a maximum deviation of 15 mm from the specified edge line.

(iii) Cross section

The requirements relating to the base on which the seal is constructed shall apply.

(iv) Surface regularity

The requirements relating to the base on which the seal is constructed shall apply.

(v) General

Any areas which show signs of bleeding after the section has been opened to traffic shall be corrected as specified in Clause 4312. Corrective work shall be carried out in such a manner as to blend in colour, texture and finish with adjacent work.

The completed seal shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depression.

(b) Resealing work on existing surfaces

The completed seal shall be of uniform texture without gaps or patches and shall be free from any loose aggregate or bitumen spillage.

Any areas which show signs of bleeding after the section has been opened to traffic shall be corrected as specified in Clause 4312. Corrective work shall be carried out in such a manner as to blend in colour, texture and finish with adjacent work.

The completed seal shall be free from corrugations or any other wave effect where depressions are preceded and followed by humps or ridges no matter how small the distance between the top of the hump to the bottom of the preceding or following depressions.

The edges of the completed seal shall be continuously true to line with a maximum allowable deviation from the specified edge line of 15 mm.

(c) The rate of application

The maximum permissible variation from the rates of application of bituminous binders, aggregates or slurry, as ordered by the Engineer, shall be plus or minus 5% of the rate of application required for the aggregate, and plus or minus 0.06 /m² net cold bitumen for conventional or homogeneous modified binders, and within a tolerance of 5% for non-homogeneous modified binders at spraying temperature.

(d) Conditional acceptance

The provisions of Clause 7207 shall apply to conditional acceptance.

4315 MEASUREMENT AND PAYMENT

Measurement and payment will be made under the various sections where the different seals are described.

The following items of work shall also be measured and paid for as stated below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.01 Treating areas inaccessible to mechanical equipment with premixed bituminous material:</td>
<td></td>
</tr>
<tr>
<td>(a) 19.0 mm thick</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) 13.2 mm thick</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(c) 4.75 mm thick</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of aggregate supplied. The tendered rates shall include full compensation for procuring and furnishing the aggregate, plant, transport and other incidentals necessary for completing the work as specified, including application of a tack coat and the slurry.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.02 Correction for bleeding:</td>
<td></td>
</tr>
<tr>
<td>(a) Aggregate:</td>
<td></td>
</tr>
<tr>
<td>(i) 13.2 mm</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) 9.5 mm</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(iii) 4.75 mm</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Precoating of aggregate</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(c) Treatment of surface</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for aggregate shall be the cubic metre of aggregate supplied. The tendered rates shall include full compensation for procuring and furnishing the aggregate.
materials, including all transport and, if required, for stockpiling the aggregate at selected sites indicated by the Engineer.

The unit of measurement for precoating the aggregate shall be the cubic metre of material precoated. The tendered rate shall include full compensation for precoating the material as specified, for procuring and furnishing the precoating material irrespective of the type of precoating material used, and for all handling, loading and off-loading of all materials.

The unit of measurement for treatment of the surface shall be the square metre of surface treated. The tendered rate shall include full compensation for all labour, plant, equipment and transport required to treat the surfaces as specified, including maintenance and all incidentals necessary for completing the work. This item shall apply only to Methods 1 or 2 as described in Clause 4312. Treatment according to Method 3 shall be paid for in accordance with the provisions of Sections 4400 and 4700 according to what may be required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.03 Application of a fog spray of 30% spray-grade or equivalent diluted stable grade emulsion:</td>
<td></td>
</tr>
<tr>
<td>(a) Spray-grade emulsion ................ litre (lt)</td>
<td></td>
</tr>
<tr>
<td>(b) Stable-grade emulsion ............... litre (lt)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the litre of 30% spray-grade or equivalent diluted stable grade emulsion measured at spraying temperature.

The tendered rate shall include full compensation for providing the material and for applying the fog spray as specified.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS

SECTION 4400 : SINGLE SEALS

CONTENTS
4401 SCOPE
4402 MATERIALS
4403 CONSTRUCTION
4404 MEASUREMENT AND PAYMENT

4401 SCOPE

This Section covers the supplying and furnishing of all materials for the repair of existing surfaces and for the construction of new single seals.

Note: Section 4300: Seals : Materials and general requirements shall apply to this Section.

4402 MATERIALS

(a) Bituminous binders

(i) Tack coat

The specified bituminous binders shall comply with the conditions of Subclause 4302(a).

(ii) Fog spray

30% or 60% spray-grade emulsion of the anionic or cationic type, as specified or ordered by the Engineer.

(iii) Cutting back of bitumen

The maximum amounts of cutter given in Table 4402/1 shall be added to the basic 150/200 penetration-grade bitumen depending on the road surface temperature at the time of spraying. Lesser amounts than those indicated in the Table may be used if conditions on the site allow the development of sufficient adhesion between binder, aggregate and existing surface.

The temperature of the bitumen, when the power paraffin is introduced, shall not be higher than 140°C.

The power paraffin shall be sucked in measured quantities from 200 litre drums through the bitumen pump and circulated with the bitumen for a minimum of 45 minutes. During this process all burners shall be shut off and no open flames allowed near the distributor.

The power paraffin shall not be introduced into the distributor through the manhole, which shall be kept closed. Each distributor shall at all times have two fire extinguishers in a working order available.

(b) Aggregate

(i) Coarse aggregate

Coarse aggregate shall comply with the requirements of Subclause 4302(b).

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Min temp for} & \text{Road} & \text{Approx} & \% \text{Cutback} \\
\text{24 hours} & \text{temp} & \text{air} & \text{in 80/100} \\
\text{(°C)} & \text{(°C)} & \text{temp} & \text{pen bitumen} \\
\hline
0 - 3^{(a)} & 16 - 24 & 10 - 16 & 9 - 7 & 100 - 118 \\
3 - 6 & 24 - 32 & 16 - 21 & 7 - 5 & 115 - 135 \\
6 - 9 & 32 - 40 & 21 - 26 & 4 - 3 & 121 - 138 \\
9 - 12 & 40 - 48 & 26 - 31 & 2 - 1 & 132 - 149 \\
>12 & >48 & >31 & 0 & 150 - 175 \\
\hline
\end{array}
\]

Notes:

(a) Experience in the central parts of South Africa indicates that the addition of 9% cutback is still appropriate for conditions of Minimum temperatures for 24 hours = -4°C

(b) During the rainy season it is recommended that 1 - 2% be added as a safety factor (not in addition to the above percentages). Chemical analysis of the binder and cutter should be carried out before bitumen from other sources are cut back. If the weather is predictably dry for the months November, December and January, and the road temperature exceeds 31°C, additives may be omitted.

(ii) Fine aggregate

Fine aggregate may be sand obtained from the natural disintegration of stone or sand obtained from the crushing or grinding of stone. Fine aggregate shall comply with the requirements of the Project Specifications (eg SABS 1083 or equivalent).

4403 CONSTRUCTION

(a) Application of tack coat and aggregate

The tack coat and aggregate, of the size specified in the Project Specifications or ordered by the Engineer, shall be applied as specified in Subclause 4307(b).

The nominal rates of application given in Table 4403/1 shall be used for tendering purposes only.

\[
\begin{array}{|c|c|c|}
\hline
\text{Nominal size of aggregate} & \text{Tack coat} & \text{Aggregate} \\
\text{mm} & \text{(litres of tar or net bitumen per m²)} & \text{(m³ per m²)} \\
\hline
19.0 & 1.80 & 0.015 \\
13.2 & 1.50 & 0.010 \\
9.5 & 1.10 & 0.007 \\
6.7 & 0.80 & 0.005 \\
\hline
\end{array}
\]

4400-1
The actual rates of application shall be as determined by the Engineer.

(b)  Initial rolling
Initial rolling shall be carried out as specified in Subclause 4307(b).

(c)  Final rolling
Any areas deficient in aggregate shall have additional material added so as to leave the carpet with a single layer of chippings lying shoulder to shoulder. It is essential to ensure that only one layer of chippings is applied and every care shall be taken to avoid over-application of chippings.

The final rolling shall be done with a pneumatic-tyred or a rubber-soled steel-wheeled roller only, applying a minimum of four coverages.

The finished surface shall be well-knit and have a uniform appearance free of roller-tire marks. All aggregate contaminated by oil, fuel or grease shall be removed and dumped in an approved waste site and replaced by clean aggregate.

All loose aggregate shall be broomed off the surface with a rotary broom or hard brooms as directed by the Engineer.

(d)  Fog spray
When required by the Project Specifications or, if so directed by the Engineer in writing, a fog spray of 60% or 30% anionic or cationic emulsion shall be applied to the surface of the aggregate by means of a pressure distributor at the required rate.

(e)  Blinding
If required in the Project Specifications or as may be directed by the Engineer, a light blinding layer of natural or crusher sand shall be applied by the Contractor to prevent chippings from being picked up by traffic. The blinding layer shall be spread evenly over the full indicated surface. Should it be required by the Engineer, the layer shall be spread evenly by means of hand brooms.

(f)  Precoating of aggregate
If required in the Project Specifications or as may be directed by the Engineer, the aggregate shall be precoated with a precoating fluid as specified in Subclause 4302(d).

4404 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.01 Single seals (indicate type of binder):</td>
<td></td>
</tr>
<tr>
<td>(a) using 6.7 mm aggregate ........ square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(b) using 9.5 mm aggregate ........ square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(c) using 13.2 mm aggregate ........ square metre (m²)</td>
<td></td>
</tr>
</tbody>
</table>

(d) using 19.0 mm aggregate .... square metre (m²)

The unit of measurement shall be the square metre of completed and accepted seal.

The tendered rates shall include full compensation for furnishing all materials, marking the centre or reference lines, spraying of binder, spreading of aggregate, rolling and all other incidentals necessary for completing the work as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.02 Single seals: Bituminous binder variations:</td>
<td></td>
</tr>
<tr>
<td>(a) 150/200 penetration-grade bitumen ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(b) 80/100 penetration-grade bitumen ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(c) 70% spray-grade emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(d) 65% spray-grade emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(e) 60% spray-grade emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(f) PVC tar ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(g) Precoating fluid ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(h) Other binders (indicate type) ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(i) Power paraffin ................. litre (l)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement of bituminous binder in respect of an increase or a decrease in the specified rates of application shall be the litres measured at spraying temperature.

Payment for variations shall be made as specified in Clause 1213.

Where power paraffin is used to cut back the penetration-grade bitumen, the rate for power-paraffin variation under Subitem (i) shall include full compensation for providing the power paraffin and mixing it with the bitumen.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.03 Aggregate variations:</td>
<td></td>
</tr>
<tr>
<td>(a) 6.7 mm aggregate ........ cubic metre (m³)</td>
<td></td>
</tr>
<tr>
<td>(b) 9.5 mm aggregate ........ cubic metre (m³)</td>
<td></td>
</tr>
<tr>
<td>(c) 13.2 mm aggregate ........ cubic metre (m³)</td>
<td></td>
</tr>
<tr>
<td>(d) 19.0 mm aggregate ........ cubic metre (m³)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of increased or decreased aggregate applied, as compared to the amounts required at the specified nominal rate of application.

Payment for variations shall be made as specified in Clause 1213.
### Item 44.04 Application of fog spray:

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 60% spray-grade emulsion</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(b) 30% spray-grade emulsion</td>
<td>litre (l)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the litre, measured at spraying temperature.

The tendered rate shall include full compensation for furnishing the material and applying the fog spray as specified.

### Item 44.05 Precoating the aggregate

**Precoating fluid**

<table>
<thead>
<tr>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement for the precoating of aggregate shall be the cubic metre of aggregate so treated measured in hauling vehicles and used on the surfacing.

The tendered rate shall include full compensation for furnishing the equipment and materials and precoating the aggregate as specified, including the handling, stockpiling and protecting of the stockpiles against inclement weather.

### Item 44.06 Addition of Duomene T or any other similar approved wetting agent:

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Providing and supplying</td>
<td>prime cost sum</td>
</tr>
<tr>
<td>(b) Handling, applying, profit and all other costs</td>
<td>percentage of prime cost sum</td>
</tr>
</tbody>
</table>

Prime-cost sum will be paid for in terms of the General Conditions of Contract for providing and supplying an approved wetting agent to the precoating fluid as specified or as directed by the Engineer.

The tendered percentage of the prime cost sum shall include full compensation for handling the material, storing and introducing it into the mix, including any equipment required, and for all other charges and profit.

### Item 44.07 Aggregate for blinding:

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Natural sand</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Crusher sand</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of sand measured in the hauling vehicles or in stockpile.

The tendered rate shall include full compensation for providing the material and applying the blinding coat complete as specified, and, should it be required, stockpiling the sand at an approved locality.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS
SECTION 4500 : DOUBLE SEALS

CONTENTS
4501 SCOPE
4502 GRADES OF BINDER TO BE USED
4503 CONSTRUCTION
4504 MEASUREMENT AND PAYMENT

4501 SCOPE
This Section covers the supplying and furnishing of materials for the construction of a bituminous double seal. The seal shall be constructed using either 19.0 mm plus 9.5 mm aggregate or 13.2 mm plus 6.7 mm aggregate, whichever is shown in the Schedule of Quantities.

Note: Section 4300 : Seals : Materials and general requirements shall apply to this Section.

4502 GRADES OF BINDER TO BE USED
The tack coat and second coat of binder shall consist of one of the following binders, whichever is specified in the Project Specifications or the Schedule of Quantities or ordered by the Engineer:
(i) RTH 45/50 or RTL 45/50 road tar;
(ii) 150/200 penetration-grade bitumen, 80/100 penetration-grade bitumen;
(iii) 60%, 65% or 70% spray-grade emulsion;
(iv) MC-3000 or MC-800 cut-back bitumen;
(v) PVC tar.

4503 CONSTRUCTION
(a) Application of tack coat and aggregate
The binder of the type and grade required, and the aggregate of the size specified in the Schedule of Quantities or ordered by the Engineer, shall be applied as specified in Clause 4307.

The nominal rates of application given in Table 4503/1 shall be for the purposes of tendering only and the actual rates of application shall be as determined by the Engineer.

Table 4503/1
Nominal rates of application

<table>
<thead>
<tr>
<th>Nominal size of aggregate (mm)</th>
<th>Tack coat (litres of tar or net bitumen per m²)</th>
<th>Aggregate (m³ per m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0</td>
<td>1.2</td>
<td>0.014</td>
</tr>
<tr>
<td>13.2</td>
<td>1.0</td>
<td>0.009</td>
</tr>
</tbody>
</table>

(b) Initial rolling
Initial rolling shall be carried out as specified in Subclause 4307(b).

(c) Broom drag and final rolling of aggregate
Dragging and final rolling of aggregate shall be carried out as specified in Subclause 4307(b).

(d) Second application of bituminous binder and aggregate
The bituminous binder specified by the Engineer shall be applied and followed by the second layer of aggregate of the size specified in the Project Specifications or as ordered by the Engineer.

The nominal rates of application given in Table 4503/2 shall be for purposes of tendering only and the actual rates of application shall be as determined by the Engineer.

Table 4503/2
Nominal rates of application

<table>
<thead>
<tr>
<th>Nominal size of aggregate (mm)</th>
<th>Nominal rates of application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Binder (litres of net bitumen per m²)</td>
</tr>
<tr>
<td>9.5</td>
<td>0.8</td>
</tr>
<tr>
<td>6.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The second application of binder shall preferably take place within 48 hours of the application of the tack coat when bitumen is used for the tack coat and not less than ten days of the application of the tack coat when tar or cut-back bitumen is used in the tack coat (ie new work).

(e) Initial rolling of second layer
Initial rolling of the second layer of aggregate shall be carried out as specified in Subclause 4307(b).

(f) Broom drag and final rolling of second layer
Dragging and final rolling of the second layer of aggregate shall be carried out as specified in Subclause 4307(b).

(g) Fog spray
When required by the Project Specifications or if so directed by the Engineer in writing, a fog spray of 30% or 60% bitumen emulsion shall be applied to the surface of the second layer of aggregate by means of a pressure sprayer at the rate of application specified by the Engineer.

(h) Precoating of aggregate
When required by the Project Specifications or if so directed by the Engineer, the second application of aggregate shall be precoated with precoating fluid as specified in Subclause 4302(d).
**4504 MEASUREMENT AND PAYMENT**

**Item**

**45.01 Double seals using:**

(a) 19.0 mm and 9.5 mm aggregate (state types of binders to be used) ............... square metre (m²)

(b) 13.2 mm and 6.7 mm aggregate (state types of binder to be used) ............... square metre (m²)

The unit of measurement shall be the square metre of completed and accepted surface treatment.

The tendered rate shall include full compensation, inter alia, for furnishing all materials, marking the centre line or reference lines, spraying of binder, spreading of aggregate, rolling, removing of dust or deleterious material, supplying of water and spraying of haul roads and construction roads, trimming the edges of the completed surface, and all other incidentals necessary for completing the work as specified, except the application of a fog spray and precoating of aggregate, which shall be paid for separately.

**Item**

**45.02 Bituminous binder variations:**

(a) RTH 45/50 or RTL 45/50 road tar .............................. litre (l)

(b) 150/200 penetration-grade bitumen .......................... litre (l)

(c) 80/100 penetration-grade bitumen .......................... litre (l)

(d) 70% spray-grade emulsion .................. litre (l)

(e) 65% spray-grade emulsion .................. litre (l)

(f) 60% spray-grade emulsion .................. litre (l)

(g) 30% anionic spray-grade emulsion .................. litre (l)

(h) Precoating fluid .............................. litre (l)

(i) PVC tar .............................. litre (l)

(j) MC-3000 cut-back bitumen .................. litre (l)

(k) MC-800 cut-back bitumen .................. litre (l)

The unit of measurement of bituminous binder in respect of variations in the specified rates of application shall be a litre, measured at spraying temperature.

The tendered rate shall include full compensation for procuring and furnishing the binder and applying the fog spray as specified.

**Item**

**45.03 Aggregate variations:**

(a) 19.0 mm aggregate ............. cubic metre (m³)

(b) 13.2 mm aggregate ............. cubic metre (m³)

(c) 9.5 mm aggregate ............. cubic metre (m³)

(d) 6.7 mm aggregate ............. cubic metre (m³)

The unit of measurement with respect to variations in application of aggregate shall be the cubic metre of aggregate measured in the truck.

Payment for variations shall be made as specified in Clause 1213.

**Item**

**45.04 Application of fog spray consisting of:**

(a) 60% spray-grade emulsion .................. litre (l)

(b) 30% spray-grade emulsion .................. litre (l)

The unit of measurement shall be the litre of emulsion sprayed as specified and measured at the application temperature.

The tendered rate per litre of emulsion shall include full compensation for procuring and furnishing the binder and applying the fog spray as specified.

**Item**

**45.05 Precoating second application of aggregate (indicate precoating fluid) ........ cubic metre (m³)**

The unit of measurement for the precoating of aggregate shall be the cubic metre of aggregate so treated measured in hauling vehicles and used on the surfacing.

The tendered rate shall include full compensation for furnishing the equipment and materials and precoating the aggregate as specified, including the handling, stockpiling and protecting of the stockpiles against inclement weather.

**Item**

**45.06 Addition of Duomene T or any other similar approved wetting agent:**

(a) Providing and supplying ................ prime cost sum

(b) Handling, applying, profit and all other costs ................ percentage of prime cost

The prime cost sum will be paid for in terms of the General Conditions of Contract for providing and supplying an approved wetting agent to the precoating fluid as specified or as may be directed by the Engineer.

The tendered percentage of the prime cost sum shall include full compensation for handling the material, storing and introducing it into the mix, including any equipment required, and for all other charges and profit.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS

SECTION 4600 : SINGLE SEAL WITH SLURRY (CAPE SEAL)

CONTENTS
4601 SCOPE
4602 GRADES OF BINDER TO BE USED
4603 CONSTRUCTION BEFORE SLURRY APPLICATION
4604 SLURRY
4605 MEASUREMENT AND PAYMENT

4601 SCOPE

This Section covers the construction of a seal consisting of the application of a tack coat, spreading of 19.0 mm or 13.2 mm aggregate, a further application of bituminous binder coat and the application of the slurry in one or two coats.

Note: Section 4300 : Seals : Materials and general requirements shall apply to this Section.

4602 GRADES OF BINDER TO BE USED

(a) Tack coat

The tack coat shall consist of one of the following binders, whichever is specified in the Project Specifications or the Schedule of Quantities or as ordered by the Engineer:

(i) RTH 45/50 or RTL 45/50 road tar;
(ii) 150/200 penetration-grade bitumen, 80/100 penetration-grade bitumen;
(iii) PVC tar;
(iv) MC-3000 or MC-800 cut-back bitumen;
(v) 60%, 65% or 70% spray-grade emulsion.

(b) Second application of binder

The second application of binder shall consist of either 30% or 60% spray-grade emulsion, whichever is specified in the Project Specifications or the Schedule of Quantities or as ordered by the Engineer:

Where dilution by water is applied, the requirements of TRH3 shall be complied with.

4603 CONSTRUCTION BEFORE SLURRY APPLICATION

(a) Application of tack coat and aggregate

The binder of the type and grade required, and the aggregate of the size specified in the Schedule of Quantities or ordered by the Engineer, shall be applied as specified in Subclause 4307(b) at the rates as ordered by the Engineer.

The nominal rates of application given in Table 4603/1 shall be used for the purposes of tendering.

<table>
<thead>
<tr>
<th>Nominal size of aggregate (mm)</th>
<th>Nominal rates of application for tender purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Binder (litres of tar or net bitumen per m²)</td>
</tr>
<tr>
<td>13.2</td>
<td>0.6</td>
</tr>
<tr>
<td>19.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

(b) Initial rolling

Initial rolling shall be carried out as specified in Subclause 4307(b).

(c) Broom drag and final rolling of aggregate

Dragging and final rolling of aggregate shall be carried out as specified in Subclause 4307(b).

(d) Second application of bituminous binder

The required binder shall be sprayed at the rate prescribed by the Engineer. This shall be done at least two days after application of the tack coat and the aggregate if bitumen is used in the tack coat, and at least 14 days in summer and 21 days in winter after application of the tack coat and the aggregate if tar is used in the tack coat.

For tender purposes a nominal rate of 0.33 /m² (net bitumen) shall be used for 13.2 mm aggregate and for 19.0 mm aggregate.

4604 SLURRY

(a) Condition of surface

The surface shall be rolled once with a light flat-wheeled roller early in the morning on the day of sealing to depress any loose stones that may have been displaced.

The surface shall be cleaned to remove all dust, mud, leaves, etc, and shall have a uniform closely knit appearance, with edges trimmed correctly to the specified width.

(b) Timing of slurry application

The slurry shall be applied only after the final spray has cured or dried out (which usually takes at least two days).

(c) Composition of slurry

The slurry shall consist of a mix of the grade of slurry aggregate ordered by the Engineer and specified in Subclause 4302(b) together with a 60% stable-grade emulsion, filler and water in the proportions as directed by the Engineer. The following proportions shall apply for tendering purposes only:

4600-1
Slurry aggregate (saturated volume) ........................................ 1 m³
Stable-grade emulsion .................................................. 260 l
Cement ................................................................. 0.01 m³
Water (as directed by the Engineer) ................................... approx 235 l

If specified in the Project Specifications, the composition of the slurry shall be based on the following mass proportions for tender purposes:

Slurry aggregate (dry) ........................................... 100
Stable-grade emulsion ............................................. 20
Cement ................................................................. 1 - 1.5
Water ................................................................. ± 15

The saturated volume of slurry shall be determined by applying a correction for bulking of moist aggregate, as described in Item 46.05.

(d) Mixing of slurry

A mixer of a type approved by the Engineer shall be provided in a good working order capable of producing a uniform slurry of the constituent materials. It may either be a batch mixer or a continuous type mixer.

Material which, in the opinion of the Engineer, is not properly mixed or in which the emulsion shows signs of having broken during mixing shall not be applied to the road.

(i) Batch mixer

The slurry shall be mixed in an approved type of mixer as specified in Subclause 4303(f).

All the constituents of the slurry shall be accurately proportioned and due care and attention shall be given to the sequence in which the ingredients are introduced into the mixer and to the period of mixing. Mixing shall be continued until the materials in each batch are thoroughly blended.

(ii) Continuous mixer

Aggregate and filler contained in separate bins shall be fed through metering devices at controlled rates to the mixer. Water and bitumen emulsion contained in separate tanks shall similarly be pumped to the mixer at controlled rates through metering devices. The mixing of the slurry shall be at a suitable rate adjusted to ensure complete blending of the ingredients and uniformity of mix.

(e) Application of slurry

Before slurry is applied, the road surface shall be thoroughly cleaned and lightly sprinkled with water but no free water shall be present on the surface when the slurry is applied.

The slurry shall be applied in two layers in the case of fine aggregate (saturated volume) contained in the slurry applied, per square metre of surfacing.

The nominal rates of application given above are intended for tendering purposes only and the actual rates of application on the site shall be as directed by the Engineer.

When the slurry is applied in two layers, the first layer of slurry shall be struck off level with the tops of the stones in the aggregate layer so that, after application, the tops of the stones will be just visible.

The second layer of slurry shall not be applied until the first layer has dried. If required by the Engineer, the Contractor shall open the road to traffic before the second layer of slurry is applied. The surface shall be well-rolled with a pneumatic-tyred roller. The second layer shall be applied only after sufficient time has been allowed for the first layer to cure. The Engineer will decide on the time necessary for proper curing, which will in any case be not less than 24 hours.

The surface shall be thoroughly cleaned of all dust, dirt or foreign materials before the second layer of slurry is applied.

For seals using 13.2 mm nominal sized chippings, the slurry shall be applied in one layer only. The slurry shall also be struck off so that the tops of the stone chippings will be just visible after the emulsion has set and cured.

Where slurry is spread by hand, the squeegee squad shall be allowed to complete the spreading of each batch discharged onto the road, using squeegees, before the next is discharged.

Where spreading is carried out by means of the spreader box, the slurry shall be discharged into the spreader box by means of a chute, which shall be so directed that an even supply of slurry is maintained against the full width of the strike-off blade of the spreader box. Areas where an excess of slurry has been applied by the spreader box shall be corrected by squeegees being used immediately after the passage of the spreader box. Should breaking of the emulsion, segregation of the mix or formation of lumps occur during the application of the slurry, the slurry operations shall be discontinued at once and any defective material removed from the road. Successive strips of slurry shall overlap transversely by not less than 25 mm nor more than 150 mm. Any overlapping on the longitudinal joints and any omitted areas shall be rectified with squeegees.

The Contractor shall ensure that either edge of the road surface is finished to the specified widths and lines. All stones dislodged in the process of applying the slurry shall be removed on the same day on which the slurry seal has been applied. All spillage of slurry or excess slurry shall be neatly removed from the road and buried in an approved waste site.

If the slurry is spread with a spreader box, a moist burlap drag shall be drawn behind the spreader box to ensure an overall even texture.

If applied by hand, the slurry shall be worked from side to side and criss-cross with the aid of squeegees so as to fill as many spaces as possible. In this case the final layer of
slurry shall be struck off flush with the tops of the stone chippings so as to leave the chippings to be visible after the emulsion has stiffened and hardened.

The work must be so programmed, that the two half road widths of slurry shall be applied on two successive days to complete a full road width section in two days.

Any damage to the slurry seal by rain or traffic before the slurry has cured shall be rectified by the Contractor at his own expense.

4605 MEASUREMENT AND PAYMENT

Item | Unit
--- | ---
46.01 Bituminous single seal with 19.0 mm aggregate and slurry (indicate type and grade of binder) | square metre (m²)

The unit of measurement for the complete bituminous single seal with aggregate and slurry shall be the square metre.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, spraying the binders, spreading the aggregates, rolling, mixing and applying the slurry, and all other incidentals necessary for completing the work as specified, including the watering of haul and construction roads in and about the site.

Item | Unit
--- | ---
46.02 Bituminous single seal with 13.2 mm aggregate and slurry (indicate type and grade of binder) | square metre (m²)

The unit of measurement for the complete bituminous single seal with aggregate and slurry shall be the square metre.

The tendered rates shall include full compensation, for furnishing all materials, demarcating the working area, spraying the binders, spreading the aggregates, rolling, mixing and applying the slurry, and all other incidentals necessary for completing the work as specified, including the watering of haul and construction roads in and about the site.

Item | Unit
--- | ---
46.03 Bituminous binder variations:
(a) RTH 45/50 or RTL 45/50 road tar | litre (l)
(b) 150/200 penetration-grade bitumen | litre (l)
(c) Spray-grade emulsion (30% or 60% bitumen) (indicate type) | litre (l)
(d) Spray-grade emulsion (65% bitumen) | litre (l)
(e) Anionic stable-grade emulsion (60% bitumen) | litre (l)
(f) PVC tar | litre (l)

The unit of measurement in respect of variations shall be the litre of binder measured at spraying (or mixing) temperature.

Payment for variations shall be made as specified in Clause 1213.

Item | Unit
--- | ---
46.04 Aggregate variations:
(a) 13.2 mm nominal sized aggregate | cubic metre (m³)
(b) 19.0 mm nominal sized aggregate | cubic metre (m³)

The unit of measurement in respect of variations shall be the cubic metre of aggregate, measured loose in the truck.

Payment for variations shall be made as specified in Clause 1213.

Item | Unit
--- | ---
46.05 Variation in the rate of application of the slurry | cubic metre (m³)

The unit of measurement for slurry variations shall be the cubic metre of saturated fine aggregate.

Payment for variations shall be made as specified in Clause 1213.

Every load of fine aggregate used for the slurry shall be struck off with a straight-edge at the stockpile, and the volume shall then be measured, and corrected for bulking. The following method shall be used for calculating the corrected volume of fine aggregate when determining the application rate of slurry:

(a) The volume of a truck hopper filled with fine aggregate shall be carefully measured in cubic metres (A m³).

(b) A representative sample of aggregate shall be obtained from the conveyor belt feeding the mixer. 1 000 m³ of the sample shall be placed in a plastic measuring cylinder and dropped ten times through a height of 50 mm onto a wooden table, after which the volume of aggregate in the cylinder shall then be measured in m³ (B m³).

(c) The sample in the cylinder shall then be saturated with water and water shall be added until it covers the aggregate by 50 mm. The mixture shall be shaken well, and the cylinder containing the aggregate and water placed on a horizontal surface allowing the aggregate to settle until the liquid above the aggregate clears sufficiently for a reading to be taken of the volume of the saturated aggregate, in m³ (C m³).

(d) The saturated volume of the aggregate in the hopper of the truck shall be calculated from the following formula,
and payment for the slurry application variations shall be made in accordance with this formula:

True (saturated) volume carried by the truck hopper:

\[
A \times \left(1 - 0.72 \times \frac{(B - C)}{C}\right)
\]

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.06 Slurry application rate variations</td>
<td>tonne (t)</td>
</tr>
</tbody>
</table>

The unit of measurement for variations in the slurry application rate shall be a tonne of mixed slurry.

Payment for variations shall be made as specified in Clause 1213.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS

SECTION 4700 : SAND SEALS

CONTENTS
4701 SCOPE
4702 GRADES OF BINDER TO BE USED
4703 SAND
4704 CONSTRUCTION
4705 MEASUREMENT AND PAYMENT

4701 SCOPE

This Section covers the supply and application of all materials used for constructing sand seals on new pavings.

Note: Section 4300 : Materials and general requirements shall apply to this Section.

4702 GRADES OF BINDER TO BE USED

The following grades of binder shall be used as specified in the Project Specifications or the schedule of quantities or as ordered by the Engineer:

(i) RTH 45/50 or RTL 45/50 road tar
(ii) RTH 50/55 or RTL 50/55 road tar
(iii) MC-800 cut-back bitumen
(iv) MC-3000 cut-back bitumen
(v) Spray-grade cationic emulsion (65% or 70% of net bitumen)
(vi) 150/200 penetration-grade bitumen.

4703 SAND

As this specification is essentially for use in low-cost construction, the grading of the sand may vary to a fair degree, but the following conditions must be met:

(a) Grading

The grading shall conform with Table 4703/1.

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>Percentage by mass passing through sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7</td>
<td>100</td>
</tr>
<tr>
<td>0.300</td>
<td>0 - 15</td>
</tr>
<tr>
<td>0.150</td>
<td>0 - 2</td>
</tr>
</tbody>
</table>

The sand shall be screened to ensure the removal of all material exceeding 6.7 mm. Water shall be used to assist the screening process and to clean the sand of dust and foreign matter.

(b) Sand equivalent

The sand equivalent shall be at least 35.

4704 CONSTRUCTION

(a) Equipment

The following equipment shall be readily available on the site:

(i) Pneumatic-tyred rollers
(ii) A rotary broom
(iii) A drag broom
(iv) Mechanical aggregate spreaders.

(b) Preparation of surface before application of seal

The surface of the base shall be watered, rolled and swept until a smooth fine texture has been achieved. The base shall then be primed in accordance with the provisions of Section 4100 and as instructed by the Engineer.

The road shall be cleaned of all loose or deleterious material before the sand seal is applied.

(c) Application of sand seal

The tack coat shall be applied at 0.8 m² net bitumen, and, immediately after the coat has been spread, the aggregate shall be distributed thereon at a rate of 0.007 m³/m² and rolled with pneumatic-tyred rollers. Where emulsions are used, the aggregate shall be applied only after the emulsions have broken partially.

Note: The maximum rate of application when using an emulsion is approximately 0.7 m² before the binder tends to flow off the surface.

During the rolling process, any uneven application of sand shall be rectified with a light broom drag or other suitable apparatus.

Where the binder is required to be applied in two applications, the surface can be opened to controlled traffic after the first application of binder and sand, as soon as it is convenient to do so. The second application of binder and sand may be applied when the first application has cured sufficiently for it to take the traffic without requiring brooming back of the sand. All loose sand and deleterious material shall be removed from the surface and any damaged or defective areas rectified before the second application of binder and sand. While the traffic is using the road, the sand shall be continuously broomed back onto the road until the binder has cured sufficiently to retain the sand and until traffic does not damage the surface. The sweeping-back process shall be done with a rotary broom and may take as long as two months before the surface finally retains all of the sand. Tenders shall be based on brooming back for up to 10 times.

As wet sand is difficult to apply, the preparation of the sand should be done well ahead of the actual construction to allow the sand to be fairly dry when it is applied. If the sand is not cleaned to the Engineer's satisfaction by one screening and washing operation, it shall be washed again at no extra payment.
### Measurement and Payment

**Item** | **Unit**
---|---
47.01 Application of tack coat:
(a) RTH 45/50 or RTL 45/50 road tar | litre (l)
(b) RTH 50/55 or RTL 50/55 road tar | litre (l)
(c) MC-800 cut-back bitumen | litre (l)
(d) MC-3000 cut-back bitumen | litre (l)
(e) Spray-grade emulsion (65% net bitumen) | litre (l)
(f) Spray-grade cationic emulsion (70% net bitumen) | litre (l)
(g) 150/200 penetration-grade bitumen | litre (l)

The unit of measurement shall be the litre, measured at spraying temperature.

The tendered rates shall include full compensation for procuring and furnishing the material and applying the binder, including all preparatory work to the surface prior to application of the binder.

**Item** | **Unit**
---|---
47.02 Sand | cubic metre (m³)

The unit of measurement for the sand shall be the cubic metre of sand applied to the road as specified, measured in the trucks or in the stockpiles.

The tendered rate shall include full compensation for supplying the sand, washing, screening and preparing the sand, applying the sand as specified, as well as brooming the sand back onto the surface as often as is required.
This Section covers the construction of a bituminous surfacing on bridge decks where shown on the Drawings or ordered by the Engineer.

Bituminous binders and aggregate shall comply with the requirements of Clauses 4202 and 4302 for asphalt surfacing and seals respectively.

Before the surfacing is constructed, the concrete deck shall be thoroughly cleaned by washing and brushing to remove all loose material. After drying, a tack coat consisting of 30% bituminous cationic emulsion shall be applied to the surface at a rate of 0.4 \text{}/m^2. The tack coat shall then be allowed to dry.

The type and nominal thickness of the surfacing shall be as indicated on the Drawings and specified in the Schedule of Quantities.

Before commencing with the construction of the surfacing, the actual levels of the bridge deck shall be determined by means of accurate levelling. The levels and grades to which the surfacing is to be constructed shall be as shown on the Drawings or as indicated by the Engineer. If the levels of the concrete deck as constructed by the Contractor deviate by more than the specified tolerances from the specified levels, he shall construct a levelling layer at his own cost. The nominal size of the aggregate in the levelling layer shall be 9.5 mm.

Irrespective of the type of seal applications on the road on both sides of the bridge, asphalt surfacing shall be constructed in accordance with Section 4200, and seals in accordance with Section 4300.

The completed surfacing shall comply with the requirements for base of Clause 3405 in respect of surface tolerances for grade, smoothness, cross section and width.

The unit of measurement shall be the tonne of surfacing completed to the nominal thickness indicated.

The tendered rate shall include full compensation for procuring and furnishing all materials, heating the binder and aggregate, mixing, transporting, placing and compacting the material, and the provision and application of the surfacing. The rate shall also include full compensation for variations in thickness within the specified tolerance for bridge deck levels and for the application of a tack coat.
SERIES 4000 : ASPHALT PAVEMENTS AND SEALS

SECTION 4900 : TREATMENT OF SURFACE DEFECTS, PATCHING, REPAIRING EDGE BREAKS AND CRACK SEALING

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4901 SCOPE
4902 MATERIALS
4903 PLANT AND EQUIPMENT
4904 TREATMENT OF SURFACE DEFECTS
4905 PATCHING
4906 REPAIRING EDGE BREAKS
4907 CRACK SEALING
4909 OPENING TO TRAFFIC
4910 JOINTS AND THE PROTECTION OF KERBS
4911 MEASUREMENT AND PAYMENT

4901 SCOPE

This Section covers the work in connection with the treatment of existing road surfaces prior to the application of a seal or asphalt surfacing, patching, repairing edge breaks and crack sealing.

Provision is made for treating existing seals exhibiting any of the following defects:

(a) The existing surface is deficient in binder.
(b) Marked differences in texture occur over the surface.
(c) The existing surface is open-textured.
(d) The surface is uneven on account of bumps, slacks, etc.
(e) Edges require trimming and/or repairs.

Patching shall be any work to existing pavement layers (and in exceptional cases to fills and the roadbed) with the purpose of repairing local failures, and which is carried out in an area having a width of less than 1.0 m, or a length of less than 25 m or an area of less than 100 m². This does not include the repair of edge breaks, pretreatment of the road surface, or the rehabilitation of concrete pavements.

Patching involves excavating the existing failed sections and reconstructing the excavated fills and pavement layers with the specified pavement material. Backfilling with asphalt will be measured and paid for under Section 4200.

Compensation for work in restricted areas shall not be applicable to patching and repairing edge breaks.

Note: Section 4300 : Seals: Materials and general requirements shall apply to this Section.

4902 MATERIALS

The material shall comply with the requirements specified for the various types of material in the appropriate sections of the Specifications and the Project Specifications.

The following grades of binder may be used. The actual type or grade used shall be as specified in the Project Specifications or the Schedule of Quantities or as ordered by the Engineer.

(a) Binder for fog spray (Treatment Type 1)
30% or 60% cationic or anionic spray-grade bituminous emulsion.

(b) Tack-coat binder (Treatment Type 2)
60% bituminous emulsion (Treatment Type 2)
30% bituminous emulsion (Treatment Types 3 and 4).

(c) Slurry binder (Treatment Type 3)
60% stable-grade bituminous emulsion.

(d) Binder for asphalt skim coat (Treatment Type 4)
80/100 penetration-grade bitumen.

(e) Screed (Treatment Type 5)
30% bitumen emulsion shall be used for the tack coat, and the binder for the asphalt shall be 80/100 penetration grade bitumen unless otherwise specified.

(f) Binder for asphalt used in reconstructing pavement edges
60% stable-grade bituminous emulsion for tack coat and 80/100 penetration-grade bitumen in asphalt.

(g) Rubber pellets
Rubber pellets for crack sealing shall be obtained by processing rubber tyres. The rubber shall be granulated and free from fibres, steel wire and other impurities. The rubber crumbs shall pass through a 2.00 mm sieve.

(h) Herbicide
Herbicide shall be a non-selective environmentally compatible herbicide approved by the Engineer.

4903 PLANT AND EQUIPMENT

All equipment shall be suitable for the specified use and working areas and shall be capable of obtaining the specified results.

(a) Planing machine
The machine shall be of a design which will be suitable for planing the existing surfacing in order to remove any irregularities and to leave an even surface without tearing the underlying material. An approved milling machine may be used.

Before planing may start, the Contractor shall demonstrate to the Engineer that the machine is capable of executing the work in accordance with the Project Specifications.
(b) Patching and repairing edge breaks

Only approved cutting or sawing equipment may be used for cutting or sawing asphalt layers. The equipment shall be capable of cutting asphalt layers to depths of 200 mm in one operation without fragmenting the material, and in straight lines within the required tolerances.

The following items of plant and equipment shall also be available and in good working order:

(i) A vibratory roller having a mass approximately equal to that of a Bomag 765 or similar vibratory roller, with an adjustable amplitude and frequency of vibration.

(ii) A mobile compressor capable of producing at least 3 m³/minute compressed air at 750 kPa.

(iii) Appropriate paving breakers.

(iv) Manually-operated pneumatic compactors as required.

(v) Appropriate concrete mixers.

(c) Crack sealing

Over and above the equipment normally used for surface treatments, the following additional equipment shall be available for crack sealing:

(i) Special spraying equipment with 2 mm nozzle openings and provided with spare nozzles.

(ii) Special heating equipment where appropriate for cleaning cracks, and custom-built applicators for applying sealants to cracks.

4904 TREATMENT OF SURFACE DEFECTS

Before any treatment is carried out, the area to be treated shall be cleaned and prepared and any major failures shall be repaired as specified in the Project Specifications.

(a) Treatment Type 1

This treatment shall be applied where the existing surface is deficient in binder.

The treatment shall consist of the application of a fog spray of the specified grade of emulsion to the existing surface by means of a pressure distributor at the rates of application as directed by the Engineer, in widths that may vary from 0.5 m to 4.0 m.

(b) Treatment Type 2

This treatment, or a sand seal as specified in Section 4700, is intended for application where marked differences in texture occur in the existing surfacing, in order to obtain a uniform texture before resealing.

A tack coat of the specified type and grade of emulsion shall be applied to the surface as specified in Subclause 4307(b) followed by an application of double-washed crusher sand. The crusher sand shall be the medium grade specified for slurry in Clause 4302, but shall be on the coarse side of the grading envelope.

The nominal rates of application shall be:

- Emulsion ......................... 0.7 ℓ net bitumen/m²
- Aggregate ......................... 0.0035 m³/m²

The actual rates of application shall be as instructed by the Engineer.

It can be anticipated that spraying and spreading will have to be carried out in narrow bands varying in width from 0.5 m to 4.0 m. The emulsion shall be allowed to break before the aggregate is applied.

As soon as the aggregate has been applied, the distribution thereof shall be corrected by light handbrooming or by means of a light broom drag.

Rollings shall be carried out as specified in Subclause 4307(b). Any excess aggregate remaining on the road after it has been opened for two days or more shall be removed.

(c) Treatment Type 3

This treatment shall be used when an existing surface treatment, which is open-textured or exhibits cracking, requires treatment with bituminous slurry.

Prior to treatment with a slurry, the surface shall be sprayed with a tack coat of 30% bitumen emulsion at the rate prescribed by the Engineer.

A distinction shall be made in respect of the payment for the following two methods of construction:

(a) Where the slurry can only be applied by hand methods or where the Engineer so directs or where it is specified that the slurry shall be applied by hand methods.

(b) Where the slurry can be applied mechanically with a spreader box.

The slurry shall be prepared, mixed and applied as specified in Subclauses 4604(c), (d), and (e), with the following exceptions:

(a) Slurry to be applied by hand may be mixed in a suitable concrete mixer.

(b) The slurry shall, in the case of application by spreader box, be applied in a single layer at a nominal rate, for tendering purposes, of 0.004 m³/m². When applied by hand with brooms or rubber squeegees, the slurry shall be worked into cracks and other open areas until a sound, uniform surface is obtained.

(d) Treatment Type 4

This treatment is intended for use where the road surface is uneven or contains slacks, bumps or minor rutting caused by deformation of the pavement layers, but not by failure of these layers.

The surface to be treated shall, after having been cleaned and prepared, be given a tack coat of 30% bitumen emulsion at rates directed in the field by the Engineer.

Asphalt used shall consist of a medium or fine-grade asphalt-surfacing mix manufactured as specified in Table 4202/3 and with 6% of 80/100 penetration-grade bitumen and 1.0% active filler. The actual composition of the mix
used shall be as directed by the Engineer or as dictated by the required thickness of the asphalt layer.

The asphalt shall be applied as specified in Section 4200 in thicknesses varying between 6 mm and 25 mm depending on the nature of the irregularities that occur so that the final surface will conform to the surface tolerances for cross section and smoothness as specified in Clause 4212. Where the thickness of asphalt required exceeds 25 mm, it shall be laid in separate layers each not exceeding 25 mm thickness.

If the final surfacing shows signs of ravelling, disintegration, or an uneven surface, the surface shall be given a Type 3 Treatment or removed and replaced, all at the Contractor’s cost.

(e) Treatment Type 5

This treatment is used where the road surface is uneven and where depressions, humps or small grooves occur, which, in the opinion of the Engineer, are the result of the deformation of the pavement layers, but not of structural failure of the pavement.

Where both planing and screening are specified, the screed shall be placed after the planing has been completed.

Where milling is required, it shall be done in accordance with the requirements of Section 3800.

The existing surface shall be swept clean or cleaned by other approved methods to be free from dust, soil, gravel, loose stones or any other undesirable material. A tack coat of 30% anionic stable-grade emulsion shall then be applied at a rate prescribed by the Engineer.

The bituminous material used for the screed shall be asphalt or course slurry as specified in the Project Specifications.

The slurry shall be prepared in accordance with Subclause 4904(c).

The asphalt shall be prepared in accordance with Subclause 4904(d).

4905 PATCHING

(a) Demarcation

The Engineer will demarcate any failed areas to be repaired, and shall instruct the Contractor in regard to the repair work to be done.

The Contractor shall give adequate notice to the Engineer of his intention to commence with repair work on any specific section of the road so that the Engineer will have sufficient time to demarcate the areas to be patched and repaired.

In addition to his specified responsibilities for the accommodation of traffic, the Contractor shall also be responsible for traffic accommodation during the demarcation work.

In addition to the provisions of Section 4900 the various provisions of Sections 3200, 3400, 3500, 3600, 3800, 4100 and 4200 amongst others shall apply mutatis mutandis.

(b) Excavating pavement material

Unless otherwise instructed by the Engineer, the patching shall have a neat rectangular shape. The existing material shall be excavated and removed to the full specified depth. Asphalt layers and surfacing shall be cut with approved sawing equipment.

Excavation for patching shall be cut with sideslopes of approximately 60° to the horizontal.

Where required, excavation shall be done with an approved milling plant in accordance with Section 3800.

Excavated material from each pavement layer shall be placed in separate stockpiles adjacent to the patch. The stockpiled material shall be re-used or spoiled in an approved manner in accordance with the Engineer’s instructions. Stockpiled material shall not be spoiled next to the road.

After completion of the excavation to the specified depth, the Engineer shall be afforded the opportunity to examine it. Where required, the floor of the excavation shall be compacted to the specified density for the layer concerned.

(c) Backfilling excavations

(i) Excavations shall be backfilled with pavement material as specified in the Project Specifications or as ordered by the Engineer, and the backfilling shall be compacted and finished to the required levels. The requirements for material quality, density and finish specified in other appropriate Sections shall remain applicable. Untested material from the sides of the road shall not be used.

Stabilised materials shall be mixed in concrete mixers or by other approved equipment.

Subbase and base materials shall be permitted.

(ii) Unless otherwise specified in the Project Specifications, the base shall be backfilled in accordance with the following requirements.

1. The base material shall be placed in a concrete mixer, and water shall be added to moisten the material.

2. A suitably diluted 60% stable-grade anionic bitumen emulsion shall be added at the specified rate.

3. Ordinary Portland cement shall be added at a rate of 1.0% by mass to the dry aggregate before adding water, unless otherwise specified.

4. During mixing the fluid content (water plus emulsion) shall not exceed the optimum fluid content (optimum moisture content + percentage residual bitumen) of the base. Mixing shall continue until a uniform mix of the base material and the emulsion is obtained.

5. The Contractor shall place and spread the stabilised material by hand in layers of appropriate thickness. Each layer shall be compacted with a hand-operated self-propelled vibratory roller to the specified density. The process of placing, spreading and compacting shall be repeated until the required total thickness of base is obtained.

The stabilised materials shall be placed at a fluid content not exceeding the optimum fluid content for the base.
The cracks shall be blown clean with compressed air, and

(ii) Preparation

cases.

regarding the type of treatment to be used in the various

Specifications. The Engineer will instruct the Contractor

The types of cracks treated will be specified in the Project

Specifications. The Engineer will instruct the Contractor

regarding the type of treatment to be used in the various

(i) General

The types of cracks treated will be specified in the Project

Specifications. The Engineer will instruct the Contractor

regarding the type of treatment to be used in the various

(i) General

The types of cracks treated will be specified in the Project

Specifications. The Engineer will instruct the Contractor

regarding the type of treatment to be used in the various

The cracks shall be blown clean with compressed air, and

(iii) Cracks narrower than 3 mm

Cracks narrower than 3 mm shall be treated with an

emulsion or by means of resealing the surface.

(iv) Cracks 3 mm and wider

After the primer has been applied, anionic stable-grade

eulsion shall be mixed with synthetic modifiers, as

specified in the Project Specifications, and applied by

means of pneumatic spraying equipment or other approved

equipment at the rate specified in the Project Specifications.

Where the cracks are to be rolled, the Contractor, in

accordance with the Project Specifications or the

prescriptions of the Engineer, shall treat the cracks as

described below.

Where “volcano” cracks occur and these require to be

flattened, in accordance with the Project Specifications or

the prescriptions of the Engineer, the Contractor shall treat

the cracks as follows:

(1) The cracks shall initially be treated for cleaning out

and priming the crack as described above.

(2) The surface on either side of the crack shall be

sprayed with an approved rejuvenator for a width of 300 mm

on either side of the crack and allowed to soften the existing

surface.

(3) The crack shall then be filled with cold rubber slurry

which shall be worked in with rubber squeegees. Any

excess slurry shall be removed from the sides of the crack.

(4) Once the emulsion has broken, the crack can be

rolled with a pedestrian vibratory roller until a smooth finish

is obtained.

For other cracks, the instructions of the Engineer shall be

implemented. Cracks shall be treated with cold rubber

slurry, hot bitumen rubber, or any other approved sealant.

Where, in the opinion of the Engineer, the above treatments

are not suitable for the existing cracks, the Contractor shall

treat the cracks in accordance with the instructions of the

Engineer.

Rubber slurry

The rubber slurry mixture shall be proportioned as follows

(by volume):

10.0 parts of rubber crumbs
4.5 parts of 60% anionic stable-grade bitumen emulsion
0.2 parts of ordinary Portland cement
1.1 parts of SBR (net rubber)(anionic emulsified rubber)

Water may be added to improve workability. The mixture

shall be neatly worked into the cracks by rubber squeegees.
Excess slurry shall be removed from the surface as soon as

the emulsion has broken.

Bitumen rubber

Bitumen rubber may be used only where the Contractor is

able to convince the Engineer that he is able to mix, heat

and apply the material satisfactorily.
The bitumen rubber shall be mixed on the site or at another approved locality on condition that the Contractor is able to propose efficacious methods for controlling both the mixing process and the end product.

Approved heating equipment and mechanical equipment for mixing and applying the mixture shall be used.

The rubber content of the mix shall be at least 25% by mass of the total bitumen-rubber mix.

Other sealants

Other approved sealants shall comply with and be applied in accordance with the requirements of the Project Specifications.

(v) Restrictions

Cracks may be sealed only where the temperature of the road surface exceeds 10°C. Crack sealing may not be done within three days after rain has fallen on the site, unless otherwise instructed by the Engineer.

The Contractor shall note that a single application of crack sealant is usually insufficient and that the application will have to be repeated.

4909 OPENING TO TRAFFIC

The road shall be left open to traffic for such period as the Engineer may direct before further surface treatment work is carried out.

4910 JOINTS AND THE PROTECTION OF KERBS

The requirements of Subclause 4307(b) regarding joints between sprays and the protection of kerbs, channels, etc, shall be observed.

4911 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>49.01 Treatment Type 1 (fog spray):</td>
<td></td>
</tr>
<tr>
<td>(a) 30% bitumen emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(b) 60% bitumen emulsion ................. litre (l)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement for Treatment Type 1 (fog spray) shall be the litre of bituminous emulsion sprayed, measured at spraying temperature. The tendered rates shall include full compensation for cleaning and preparing the existing surface, for furnishing the material and applying the fog spray and for all other incidentals necessary for completing the work as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>49.02 Treatment Type 2 (crusher-sand seal):</td>
<td></td>
</tr>
<tr>
<td>(a) 60% bitumen emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(b) Application of double-washed slurry aggregate ........ cubic metre (m³)</td>
<td></td>
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</tbody>
</table>

The unit of measurement for binder application shall be the litre, measured at spraying temperature. The unit of measurement for the double-washed slurry aggregate shall be the cubic metre of aggregate applied, measured loose in the truck and corrected for bulking as described in Item 46.05. The tendered rates shall include full compensation for furnishing all materials, demarcating the areas to be sprayed, spraying the binder and applying the aggregate, rolling, sweeping and all other incidentals necessary for completing the work as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>49.03 Treatment Type 3 (slurry):</td>
<td></td>
</tr>
<tr>
<td>(a) Tack coat using 30% bitumen emulsion ................. litre (l)</td>
<td></td>
</tr>
<tr>
<td>(b) Slurry applied by hand ........ cubic metre (m³)</td>
<td></td>
</tr>
<tr>
<td>(c) Slurry applied by spreader box ........ square metre (m²)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement for tack coat shall be the litre of emulsion measured at spraying temperature and applied as specified. The unit of measurement for slurry applied by hand shall be the cubic metre of saturated fine aggregate used, measured as described in Item 46.05. The unit of measurement for slurry applied by spreader box shall be the square metre of area to which the slurry is applied as specified. The tendered rates shall include full compensation for procuring and furnishing all the materials, for mixing and applying the slurry, demarcating all areas to be treated and for all plant, labour and incidentals necessary to complete the work as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.04 Variation in rate of application of slurry (variations apply to Subitem 49.03(c) only) ........ cubic metre (m³)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of additional or reduced slurry applied, measured as specified for Item 46.05. Payment for variations shall be made as specified in Clause 1213.
Item 49.05 Treatment Type 4: (asphalt skim coat):

(a) Tack coat using 30% bitumen emulsion .................. litre (l)

(b) Continuously-graded asphalt ............................ tonne (t)

The unit of measurement for the tack coat shall be the litre of emulsion applied, measured at spraying temperature. The unit of measurement for asphalt shall be the tonne of asphalt laid according to the Specifications.

The tendered rate for tack coat shall include full compensation for procuring, furnishing and applying the tack coat and demarcating the areas to be sprayed, and for all incidentals necessary for completing the work as specified.

The tendered rate for asphalt shall include full compensation for procuring, furnishing and mixing all the materials required for applying the asphalt, and for all transport and other incidentals necessary to complete the work as specified.

Item 49.06 Treatment Type 5: (screed)

(a) Tack coat using 30% bitumen emulsion .................. litre (l)

(b) Continuously-graded asphalt (specify grade) ............ tonne (t)

(c) Course grade slurry .......................... cubic metre (m³)

The unit of measurement for the tack coat shall be the litre of emulsion applied, measured at spraying temperature. The unit of measurement for course grade slurry shall be the cubic metre of aggregate mix used in the slurry.

The tendered rate for tack coat shall include full compensation for procuring, furnishing and applying the tack coat and demarcating the areas to be sprayed, and for all incidentals necessary for completing the work as specified.

The tendered rate for asphalt shall include full compensation for procuring, furnishing and mixing all the materials required for applying the asphalt, and for all transport and other incidentals necessary to complete the work as specified.

The tendered rate for slurry shall include full compensation for all materials, equipment and labour for producing and applying the slurry, irrespective of the number of applications required to attain the required thickness.

Item 49.07 Sawing asphalt or cemented pavement layers for patching:

(a) Sawing asphalt to an average depth:

(i) Not exceeding 50 mm ........ square metre (m²)

(ii) Exceeding 50 mm but not exceeding 100 mm ........ square metre (m²)

(iii) Exceeding 100 mm ........ square metre (m²)

(b) Sawing cemented pavement layers to an average depth:

(i) Not exceeding 50 mm ........ square metre (m²)

(ii) Exceeding 50 mm but not exceeding 100 mm ........ square metre (m²)

(iii) Exceeding 100 mm ........ square metre (m²)

The unit of measurement shall be the square metre of sawcut area calculated in accordance with the authorised length of sawcut and the average saw depth measured after excavation of the material.

The tendered rate shall include full compensation for all plant, equipment, labour, supervision, materials, transport and for all incidentals for sawing the asphalt and the cemented pavement layers, complete as specified and prescribed by the Engineer.

Item 49.08 Excavation in existing pavements for patching in:

(a) Asphalt layers .......................... cubic metre (m³)

(b) Cemented layers .......................... cubic metre (m³)

(c) Other layers (specify type) ........ square metre (m²)

The unit of measurement shall be the cubic metre of material excavated from the existing pavement. The quantity shall be computed in accordance with the authorised dimensions of the excavation.

The tendered rate shall include full compensation for demarcating the excavation, excavating the material, placing the excavated material in temporary stockpiles, spoiling of material in the stockpiles where ordered by the Engineer, including haul over a free-haul distance of 1.0 km, complete as specified.

Payment will distinguish between the different types of pavement material excavated.
**Item** | **Unit** | **Item** | **Unit**  
--- | --- | --- | ---  
49.09 Backfilling of excavations for patching with:  
(a) Chemically stabilised pavement material (specify the pavement material and the stabilising agent) for a patch with a surface area:  
(i) Not exceeding 5 m² ............ cubic metre (m³)  
(ii) Exceeding 5 m² but not exceeding 100 m² ........... cubic metre (m³)  
(iii) Exceeding 100 m² ........... cubic metre (m³)  
(b) Base material stabilised with bituminous emulsion (specify the emulsion) for a patch with a surface area:  
(i) Not exceeding 5 m² ............ cubic metre (m³)  
(ii) Exceeding 5 m² but not exceeding 100 m² ........... cubic metre (m³)  
(iii) Exceeding 100 m² ........... cubic metre (m³)  

The unit of measurement shall be the cubic metre of the specified chemically or bituminously stabilised pavement material placed in accordance with the specified requirements. The quantity will be computed in accordance with the authorised dimensions of the layer.  
The tendered rates shall include full compensation for providing all the material, irrespective of its origin, including gravel (notwithstanding the provisions of Section 1600), for all mixing, placing, compacting and finishing as specified in this Section and other appropriate Sections of the Specifications, for all transport, work in restricted areas, and also for all machinery, equipment, labour, supervision and other incidentals for executing the work as specified.  
The tendered rate shall also include full compensation for chemical or bituminous stabilisation, including amongst others the provision and application of the stabilising agents.

49.10 Compacting the floor of excavations for patching ............... square metre (m²)  
The unit of measurement shall be the square metre of excavation floor compacted on the instruction of the Engineer, and the quantity shall be computed in accordance with the authorised dimensions of the excavation floor.  
The tendered rate shall include full compensation for compacting the floor of excavations complete as specified.  
Payment will not distinguish between the various methods of compaction or various density requirements.

49.11 Edge breaks:  
(a) Trimming edges of existing surfacing ............... metre (m)  
(b) Reconstructing edges from continuously-graded asphalt ............... tonne (t)  
The unit of measurement for trimming edges shall be the metre of pavement edge cut back and trimmed as specified.  
The unit of measurement for reconstructing pavement edges shall be the tonne of continuously-graded asphalt furnished and compacted as specified.  
The tendered rate for trimming the edges shall include full compensation for cutting back the edges as directed, and removing and dumping of all excavated and loose material in an approved waste site.  
The tendered rate for reconstructing pavement edges shall include full compensation for compacting the surface on which the new edge is to be constructed and procuring, furnishing and mixing all materials and compacting and trimming the asphalt to the required lines and levels. It shall also include full compensation for applying a tack coat of emulsion to the surface to be treated.  
The tendered rates shall include full compensation for all transport, handling, labour, material and all incidentals necessary to complete all the work specified in the treatment of edge breaks.

49.12 Cleaning the cracks with compressed air ............... kilometre (km)  
The unit of measurement for cleaning the cracks with compressed air shall be the kilometre of road along which all the cracks have been blown clean.  
The tendered rate shall include full compensation for providing all equipment, labour, supervision and incidentals for blowing clean the cracks over the full width of the road to the satisfaction of the Engineer.

49.13 Applying bituminous binders, herbicides and insecticides for sealing cracks  
(a) Herbicides ............... litre (l)  
(b) Insecticides ............... litre (l)  
(c) MSP/1 or similar primer ............... litre (l)  
(d) Anionic stable-grade emulsion mixed with synthetic modifiers ............... litre (l)  
(e) Hot bitumen rubber ............... litre (l)  
(f) Other specified agents (Type indicated) ............... litre (l)
The unit of measurement shall be the litre of material applied as specified or as instructed by the Engineer. The tendered rates shall include full compensation for providing, mixing, heating (where required) and applying all the materials specified, and for all equipment, labour, supervision and incidentals for completing the work. No additional payment shall be made for multiple applications of material, and payment will not distinguish between the various types, widths or lengths of cracks.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>49.14 Cold rubber-slurry for sealing cracks</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement for crack treatment with rubber slurry shall be the cubic metre of fine rubber crumbs used for preparing the mix.

The tendered rate shall include full compensation for procuring and providing all the material, including emulsion, synthetic modifiers, cement and water, and for mixing and applying the mixture, and for all equipment, labour, supervision, and incidentals for executing the work in accordance with the Specifications.

Payment will not be made for redundant rubber pellets or redundant mixture or for mixture which, in the opinion of the Engineer, has been wasted.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>49.15 Rolling the cracks</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be a metre of crack rolled to the satisfaction of the Engineer.
## SERIES 5000

### ANCILLARY ROADWORKS

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SERIES 5000 : ANCILLARY ROADWORKS
SECTION 5100 : MARKER AND KILOMETRE POSTS

CONTENTS
5101 SCOPE
5102 MATERIALS
5103 FABRICATING
5104 SPACING THE MARKER AND KILOMETRE POSTS
5105 ERECTING
5106 MEASUREMENT AND PAYMENT

5101 SCOPE

This Section covers the supply and erection of marker posts in positions and in accordance with the dimensions shown on the Drawings or as directed by the Engineer.

5102 MATERIALS

(a) Concrete

Concrete work shall be carried out in accordance with the provisions of Sections 6200, 6300 and 6400.

(b) Paint

Paint for marker and kilometre posts shall be non-reflectorised road-marking paint as specified in Section 5500. Paint for the recess in the marker posts shall be Codit or a similar approved retro-reflective paint.

5103 FABRICATING

Marker and kilometre posts shall be fabricated to the dimensions shown on the Drawings. A mixture of four parts of concrete sand to one part of Portland cement shall be used. The forms shall be smooth and shall have accurate dimensions. The mixture shall be placed in the forms and vibrated on a vibrating table or by other approved means. The posts shall be reinforced as shown on the Drawings and shall have an F3 surface finish.

The posts shall be true to shape, smooth, and without any honeycombing or other blemishes.

The recess near the top of the marker post shall be painted with the reflective paint specified, while the remainder of the exposed portion of the post shall be painted with white road-marking paint.

5104 SPACING THE MARKER AND KILOMETRE POSTS

The marker posts shall be spaced as shown on the Drawings or as directed by the Engineer.

5105 ERECTING

Marker posts shall be erected after the seal has been completed. They shall be located at such spacing as the Engineer directs with their outside edges in line with the shoulder breakpoint. The edge on which the recess is located is the inner edge. The tops of the marker blocks shall be at a constant height above the centreline of the road.

Holes shall be excavated in the shoulder and the marker posts placed vertically and square to the road centre line.

Backfilling shall be compacted in 100 mm layers right from the bottom of the hole. Surplus excavated material shall be disposed of as directed.

The marker posts shall be painted immediately after having been placed.

Marker posts shall be maintained and protected during the entire construction period and any that are damaged or broken before the certificate of completion has been issued, shall be repaired or replaced, as may be required, at the Contractor's own cost.

5106 MEASUREMENT AND PAYMENT

Item                      Unit
51.01 Marker posts        number (No)
The unit of measurement shall be the number of marker posts supplied and erected in accordance with the Specifications.

The tendered rate shall include full compensation for supplying all materials and labour, making and transporting the marker posts, setting out, excavating and backfilling all the holes and disposing of surplus excavated material, including a free-haul of 1.0 km, placing and painting the marker posts and all the equipment, the tools and incidentals necessary for completing and maintaining the Works described in this Section.

Item                      Unit
51.02 Kilometre posts     number (No)
The unit of measurement shall be the number of kilometre posts supplied and erected in accordance with the Specifications.

The tendered rate shall include full compensation for supplying all materials and labour, making and transporting the kilometre posts, setting out, excavating and backfilling all the holes and disposing of surplus excavated material, including a free-haul of 1.0 km, placing and painting the kilometre posts and all the equipment, the tools and incidentals necessary for completing and maintaining the Works described in this Section.
5201 SCOPE

This Section covers the supplying, installing and maintaining of metal guardrails at locations and in accordance with the details, dimensions and design shown on the Drawings or as directed by the Engineer.

5202 MATERIALS

(a) Guardrails

Guardrails shall comply with the requirements of SABS 1350 or equivalent.

The dimensions of guardrails and end units shall be in accordance with the details shown on the Drawings.

Guardrails shall be supplied together with all the bolts, nuts, washers and fixing materials required, including the bolts for fixing the guardrails to the posts.

(i) Galvanising

Unless specified in the Project Specifications, all guardrails shall be galvanised with a hot-dip (galvanised) zinc coating which complies with the requirements of SABS 763 or equivalent for the coating of Type A1 articles.

All bolts, nuts and washers shall have a hot-dip (galvanised) zinc coating which complies with the requirements of SABS 763 for the coating of Type C1 articles or equivalent. Galvanised guardrails shall not be nested when stacked for storage.

(b) Guardrail posts

(i) Timber posts

Timber posts shall be supplied in lengths as shown on the Drawings and shall comply with the requirements of SABS 457 or equivalent.

Posts shall have a top diameter of not less than 150 mm. Posts with a top diameter up to 230 mm will be acceptable, provided that posts with widely varying diameters shall not be used together in the same length of guardrail.

Posts shall be drilled and shaped as shown on the Drawings and provided with the necessary bolts, nuts, washers and spacer blocks for fixing.

Timber posts and spacer blocks shall be treated in accordance with SABS 05 or equivalent with a copper-chrome-arsenic compound for timber preservation, which complies with SABS 673 or equivalent, or with a creosote which complies with SABS 538 or SABS 539 or equivalent. The preservative specified in the Project Specifications shall be used. After the posts have been treated, they shall not be sawn, drilled or shaped.

Where, however, the cutting of posts is unavoidable after having been treated, the Engineer may permit the required length to be cut off from the bottom of a post, provided that the exposed area is subsequently thoroughly treated with creosote.

Timber posts shall not exhibit excessive cracking at the ends, particularly cracks aligned at an angle to the guardrail exceeding 45°. Posts which, in the opinion of the Engineer, exhibit a degree of cracking that would render them unfit for service during a much shorter than normal life shall not be used.

(ii) Steel posts

Normally only timber posts shall be used for supporting the guardrails, but under certain circumstances, eg where guardrails are placed on concrete retaining walls, steel posts shall be used. Steel posts shall be of the type and size shown on the Drawings or described in the Project Specifications.

(c) Reflective plates

V-shaped reflective plates shall be manufactured from 1.5 mm thick mild steel plate to the dimensions shown on the Drawings. When supplied with galvanised guardrails, they shall also be galvanised, and when supplied with painted guardrails, they shall be finished in white baked enamel. The outer surfaces shall be coated with engineering-grade retro-reflective material which complies with the provisions of CKS 191 in the colours shown on the Drawings. Holes for fixing shall be drilled before the reflective plates may be galvanised or painted.

5203 CONSTRUCTION

(a) Erection

The holes for the timber posts shall be of sufficient size to permit the proper setting of the posts and to allow sufficient room for backfilling the hole and tamping the filling. At least 1.0 m of a post shall be embedded in the ground.

The holes for the timber posts shall be spaced to suit the standard length of the guardrail supplied. Where shown on the Drawings or directed by the Engineer, posts shall be set at half the normal spacings. The hole for the concrete block at the end of a length of guardrail shall be neatly excavated and the top 120 mm shuttered.

The posts, spacer blocks (if applicable) and guardrails shall be completely erected and set true to line and level, so that the guardrails will be at the required height above the level of the completed road shoulder. Where jointed, the end of the guardrails which overlaps on the side of the traffic shall point in the direction of the traffic movement. The guardrail shall be suitably braced to prevent any movement, and all bolts shall be tightened prior to any holes being backfilled.

After the Engineer has signified his approval of the guardrails so erected, the holes shall be backfilled with a 12:1 soil cement mixture. The material shall be mixed with
the correct quantity of water to ensure that the mixture will be placed while at or near the optimum moisture content.

The mixture shall then be placed and thoroughly rammed in layers not exceeding 100 mm of compacted thickness. The approach ends, where the guardrail has to be bent down and anchored, shall be constructed as shown on the Drawings.

When the backfilling has been completed and the bracing removed, the posts shall be rigid and vertical, and the guardrail shall be true to line and level and firmly fixed to the posts. Excess excavated material shall be disposed of as directed by the Engineer.

Steel posts shall be erected and fixed as shown on the Drawings.

All guardrails shall be so erected as to have no projecting ends which might interfere with or endanger traffic. The edges and the centre of the guardrails shall touch either the spacer block or the post where no spacer blocks are used. Guardrails, if specified, shall be provided with end units as shown on the Drawings. All splices of guardrails shall be at posts, and guardrails shall make contact over the entire area of the splice.

Reflective plates shall be fixed in accordance with the details shown on the Drawings. The reflective surfaces shall be arranged with the colours as shown on the Drawings.

(b) Painting

The following instructions shall apply where guardrails are to be painted:

(i) Before being fixed, the guardrails shall be cleaned, primed and painted as specified in Clause 5908. After erection, all abraded or damaged surfaces shall be repainted as specified in Clause 5908. Galvanised guardrails shall not be painted.

(ii) When existing guardrails are required to be repainted, they shall be thoroughly cleaned with wire brushes and descaled with suitable tools to remove all rust and loose and oxidised paint. They shall then be washed down and all exposed steel surfaces shall be given a coat of zinc based primer.

(iii) The entire prepared surface shall then be given a full coat of zinc based primer and two coats of paint as specified in Clause 5908.

5204 REQUIREMENTS

The completed guardrail shall have a neat appearance, and shall not show any visible deviations from line and grade. The posts shall be straight and vertical. The guardrails shall not be warped but shall be in a vertical plane parallel to the road centre line except at flared terminal sections. The painted or galvanised surface on the guardrail shall be smooth and continuous and free from abrasions or scratches. Any damage to the surface shall be repaired at the Contractor's expense.

Guardrails which do not comply with the prescribed requirements shall be replaced or otherwise repaired at the Contractor's expense.

5205 REMOVING, RENOVATING AND RE-ERECTING EXISTING GUARDRAILS

Every effort should be made to reuse existing guardrails rather than dispose of them and purchase new units.

Where existing guardrails have to be removed, or removed and re-erected, or removed, renovated and re-erected, the three processes of removal, renovation and re-erection shall be carried out as follows:

(a) Removing the guardrails

All guardrails, reflective plates and end units shall be loosened. Posts shall be carefully dug out and the holes shall be filled and compacted in 150 mm layers. Items used for fixing, such as bolts, nuts and washers, together with the reflective plates, shall be placed into bags, after which all the material shall be transported to a store approved by the Engineer and all stored in groups by type.

Where material is intended for re-use, it shall first be unpacked for inspection by the Engineer for deciding which material will be suitable for re-use. Suitable material shall then be stored separately from material which is unsuitable for re-use.

(b) Renovating the guardrails

Guardrails and end units suitable for re-use shall be taken to the workshop for cleaning and painting. Rust and existing paint shall be completely removed and minor indentations hammered out. The guardrails shall then be regalvanised or receive surface treatment and be painted as described in Clause 5908.

Posts suitable for re-use shall be cleaned and treated with a timber preservative as described in Subclause 5202(b). Bolts, nuts and washers to be re-used shall be cleaned and all rust removed, and shall then be oiled.

(c) Re-erection

The guardrails shall be erected in the positions as indicated, and all the removed material suitable for re-use and as much supplementary new material as may be necessary shall be used. Re-erection shall be as specified for new guardrails, including fixing the retro-reflective plates.

5206 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.01 Guardrails on timber posts:</td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Galvanised ...................... metre (m)</td>
</tr>
<tr>
<td>(b)</td>
<td>Painted ......................... metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of guardrail as erected, excluding end units.

The tendered rates shall include full compensation for furnishing all materials and labour and for erecting and painting and galvanising the guardrails, complete with posts,
spacer blocks, bolts, nuts, washers and reinforcing plates, and excavating and backfilling the post holes and removing any surplus excavated material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.02 Guardrails on steel posts:</td>
<td></td>
</tr>
<tr>
<td>(a) Galvanised</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Painted</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of guardrail erected, excluding end units.

The tendered rates shall include full compensation for furnishing all materials and labour and erecting and painting and galvanising the guardrail, complete with posts, spacer blocks, bolts, nuts, washers and reinforcing plates and excavating and backfilling the post holes, including concrete backfill, and removing any surplus excavated material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.03 Extra over Items 52.01, 52.02 and 52.11 for horizontally curved guardrails factory bent to a radius of less than 45 m</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of curved guardrail erected and measured in place.

The tendered rate extra over the rates tendered for Items 52.01, 52.02 and 52.11 shall include full compensation for incidentals in respect of supplying and erecting curved guardrails.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.04 End units:</td>
<td></td>
</tr>
<tr>
<td>(a) End wings</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Terminal sections in accordance with the Drawings where single guardrail sections are used</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) Terminal sections in accordance with the Drawings where double guardrail sections are used</td>
<td>number (No)</td>
</tr>
<tr>
<td>(d) Cable stays complete with anchor block</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of end units of each type erected.

The tendered rates shall include full compensation for all labour, constructional plant and materials required for installing the end units as shown on the Drawings, including posts and fittings and the bending of turned-down sections, excavations, concrete, backfilling and the removal of surplus backfilling.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.05 Additional guardrail posts:</td>
<td></td>
</tr>
<tr>
<td>(a) Timber</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Steel</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement for additional guardrail posts shall be the number erected over and above those erected in accordance with the normal spacing shown on the Drawings.

The tendered rates shall include full compensation for supplying additional posts, excavating the necessary holes, erecting the poles, and backfilling the holes.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.06 Reflective plates</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of reflective plates installed.

The tendered rate shall include full compensation for supplying all materials and labour required for manufacturing, painting and fixing the reflective plates as specified and as shown on the Drawings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.07 Removing existing guardrails</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of guardrail removed, and the quantity shall be measured between the terminal points of the sections removed, including the end units, but excluding the anchor blocks and anchor cables, if any, projecting beyond the end units.

The tendered rate shall include full compensation for the work as described in Subclause 5205(a), including loading, transporting to any point on the site, and off-loading and stacking the material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.08 Renovating guardrail material:</td>
<td></td>
</tr>
<tr>
<td>(a) Guardrails and end units</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Posts</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement for Subitem (a) shall be the metre of single guardrail, whether straight or bent, or end units renovated as specified, the length of which shall be measured in accordance with the measurements of the guardrail after dismantling.

The unit of measurement for Subitem (b) shall be the number of treated posts.

The tendered rates shall include full compensation for the work as specified in Subclause 5205(b), including the loading, transporting to and from the workshops, off-loading and storing the material.
52.09 Re-erection of guardrails with recovered material:

(a) Single guardrail .................. metre (m)
(b) Double guardrail .................. metre (m)

The unit of measurement shall be the metre of single or double guardrail re-erected with used material and measured between the points where they are joined to the end units.

The tendered rates shall include full compensation for re-erecting the guardrails as specified in Subclause 5205(c), including the loading, transporting between any two points on the site and off-loading the material, and providing new fixing material. Payment shall be made separately for any new material required, including spacer blocks, but not for other fixing materials. Where sections are made entirely from new material, payment therefor shall be made under the appropriate items for new guardrails.

52.10 Re-erection of end units with recovered material:

(a) End wings .................... number (No)
(b) Terminal sections with single guardrails ..................... number (No)
(c) Terminal sections with double guardrails ..................... number (No)
(d) Terminal sections complete with anchor block ................ number (No)

The unit of measurement shall be the number of end units erected with recovered and, in part, new material.

The tendered rates shall include full compensation for erecting the end units and for providing all anchors, fixing materials and anchor blocks.

Apart from anchors, anchor blocks and fixing materials, payment will be made separately for all new materials. End units made completely from new materials shall be paid for in accordance with the appropriate rates for new end units.

52.11 New material required for the re-erection of guardrails with recovered materials:

(a) Guardrails ...................... metre (m)
(b) Timber posts .................. number (No)
(c) Steel posts ................... number (No)
(d) Reflective plates ............... number (No)
(e) Spacer blocks ................. number (No)

The unit of measurement for Subitem (a) shall be the metre of guardrail provided, measured in accordance with the measurements of the loose guardrail.

The tendered rates shall include full compensation for supplying the material as specified. Item 52.03 shall also apply to horizontally bent guardrail factory bent to a radius of less than 45 m.

52.12 Drilling and blasting holes for guardrail posts

The unit of measurement shall be the number of holes drilled and blasted with explosives in hard material which cannot be removed by auger.

The tendered rate shall include full compensation for all drilling, explosives, materials, labour and equipment and all incidentals to be incurred for making holes in hard materials.
SERIES 5000 : ANCILLARY ROADWORKS

SECTION 5300 : FENCING

CONTENTS
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5303 TYPES OF FENCING
5304 PROTECTING LIVESTOCK
5305 CLEARING THE FENCE LINE
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5307 ERECTING FENCE WIRES
5308 ERECTING DIAMOND MESH OR WIRE NETTING
5309 CLOSING OPENINGS UNDER FENCES
5310 EXISTING FENCES
5311 ERECTING GATES
5312 TEMPORARY FENCING, GATES AND MOTOR GATES
5313 GENERAL REQUIREMENTS
5314 MEASUREMENT AND PAYMENT

5301 SCOPE

This Section covers the moving of existing fences where necessary and erecting new fences along the boundaries of the road reserve and where elsewhere indicated on the Drawings or as directed by the Engineer.

It shall also include the erection and later removal of temporary fences. Except when the Engineer allows otherwise, new and temporary fences shall be erected before construction on a particular section of the road is commenced with, or before temporary bypasses are opened to traffic.

This Section also covers the dismantling of existing fences and the stacking of the fencing material.

5302 MATERIALS

(a) Straining posts, stays, standards and droppers

Straining posts, stays, standards and droppers shall be of the type and size indicated on the Drawings. Steel sections shall comply with the requirements of CKS 82 or equivalent and timber posts with the requirements of SABS 457 or equivalent. Timber posts shall be treated with a preservative in accordance with the requirements of Subclause 5202(b).

Unless otherwise specified or shown on the Drawings, rolled steel posts shall be 15 or 22 kg/m rails as shown on the Drawings. Standards shall be 2.5 kg/m Y-sections or timber standards according to SABS 457 or equivalent.

Droppers shall be 0.56 kg/m ridgeback-pattern droppers or timber droppers according to SABS 457 or equivalent.

Tubular straining posts and stays shall be galvanised in accordance with SABS 763 or equivalent for Class B1 articles, or shall be painted as specified in Section 5900 and shall have a wall thickness of at least 2.95 mm. Unless otherwise shown on the Drawings, all tubular posts shall be provided with at least a 200 mm x 200 mm footplate and a pressed-steel or cast-iron cap. Tubular stays shall have a nominal bore of at least 50 mm.

Rolled steel sections shall be provided with a protective coating of tar or other approved material.

(b) Bolts for stays

Bolts shall be galvanised steel bolts of the required length and a diameter which shall not be less than 12 mm. All the necessary bolts, nuts and washers, shall be supplied with each post.

(c) Wire

(i) Barbed wire

Barbed wire shall comply with the requirements of SABS 675 or equivalent and shall be one or more of the following types:

(1) High-tensile-grade single-strand 3.15 mm x 2.5 mm oval-shaped wire, with a 2.81 mm equivalent diameter and fully galvanised.

(2) High-tensile-grade single-strand fully galvanised (first-class coating), 2.8 mm x 1.9 mm in diameter, oval-shaped wire, with a 2.31 mm equivalent diameter. This wire shall not be used within 500 mm above ground level where veld fires are common.

(3) Mild-steel-grade double-strand uni-directional twist wire, each strand 2.5 mm in diameter, for use at any height above ground. The wire shall be fully galvanised.

Barbs shall be manufactured from 2 mm galvanised wire and shall be spaced at not more than 152 mm.

(ii) Smooth wire

Smooth wire shall comply with the requirements of SABS 675 or equivalent and shall be of the types specified below:

(1) Straining wire shall be 4 mm in diameter and fully galvanised.

(2) Fencing wire shall be high-tensile-grade not less than 2.24 mm in diameter wire fully galvanised.

(3) Tying wire shall be not less than 2.5 mm in diameter mild-steel galvanised wire for tying fencing wire to standards and droppers and 1.6 mm mild-steel galvanised wire for tying netting and mesh wire to the fencing wire.

(d) Diamond mesh

Diamond mesh (chain-link fencing material) shall comply with the requirements of SABS 1373 or equivalent. The width shall be shown on the Drawings and the edge finish shall be both sides clinched or barbed.

The nominal diameter of the wire shall be 2.5 mm and the mesh size shall be 64 mm x 64 mm.

The wire shall be fully galvanised.

(e) Wire netting

Wire netting shall be fully galvanised mild-steel wire with a minimum diameter of 1.8 mm, with 75 mm hexagonal mesh.

The width shall be as shown on the Drawings.
(f) Barbed-tape concertina wire

Barbed-tape concertina wire shall comply with the requirements of CKS 592 Type A or equivalent. The high-tensile steel wire shall be heavily galvanised (Class A), and the barbed tape and concertina clamps shall also be heavily galvanised (Class Z600). The diameter of the roll shall be 950 mm or 700 mm according to requirements.

(g) Gates

Gates shall be manufactured to the dimensions shown on the Drawings.

Gates shall be complete in every respect, including hinges, washers, bolts and locking chains attached to the gate.

Gate posts shall not be used as straining posts and shall be according to SABS 457 or equivalent.

(h) Timber posts for wire mats

Timber posts for holding down wire mats where the fence crosses streams shall comply with the requirements of SABS 457 or equivalent and shall be in accordance with the requirements of Subclause 5202(b).

(i) Manufacturing tolerances for wire

The actual diameter of wire supplied shall nowhere be less than the specified diameter minus the following tolerances:

<table>
<thead>
<tr>
<th>Specified diameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 - 1.8 mm</td>
<td>0.05 mm</td>
</tr>
<tr>
<td>2.0 - 2.8 mm</td>
<td>0.08 mm</td>
</tr>
<tr>
<td>3.15 - 4.0 mm</td>
<td>0.10 mm</td>
</tr>
</tbody>
</table>

5303 TYPES OF FENCING

The following types of fences shall be erected in accordance with the dimensions shown on the Drawings:

(a) Stock-proof fences
(b) Vermin-proof fences
(c) Pedestrian fences
(d) Security fences

Where existing fences have to be dismantled and re-erected, they shall be erected either to the same design as the original, but with such modifications as may be required by the Engineer, or they shall be erected up to one of the standards specified above, all as ordered by the Engineer.

5304 PROTECTING LIVESTOCK

From the time of occupancy up to the date of the final maintenance certificate being issued to the Contractor, he shall take all measures necessary for preventing the ingress of vermin, and for protecting and controlling livestock, etc, on the sections of the properties affected by his operations. He shall provide gates at the positions in existing fences cut by him for gaining access and shall ensure that all gates are kept closed except when they are opened for admitting his traffic. No fences shall be cut without the approval of the Engineer, and consultation with the Owner of the fence.

Where alternative arrangements cannot be made, the Engineer may direct the Contractor to erect temporary fencing where necessary to protect livestock that may be lost or are exposed to vermin through his operations. Such fencing shall be of an adequate standard and shall be erected ahead of construction operations. The fencing shall be maintained in a good order during construction operations and, on completion of the work, it shall be removed from the site and all surfaces shall be restored. The Engineer may order that any permanent fencing which is required to be erected ahead of construction operations, where practicable, instead of erecting temporary fencing.

Payment for the protection of livestock, excluding the erection of temporary fences, shall be included in the amounts tendered for the Contractor’s establishment on the site, as specified in Section 1300.

5305 CLEARING THE FENCE LINE

The fence line shall be cleared over a width of at least 1.0 m on each side of the centre line of the fence and surface irregularities shall be graded so that the fence will follow the general contour of the ground. Clearing the line shall include the removal of all trees, scrub, stumps, isolated boulders or stones and other obstructions which will interfere with the construction of the fence. Stumps within the cleared space shall be grubbed as described in Section 1700. The bottom of the fence shall be located at a uniform distance above the ground line in accordance with the requirements shown on the Drawings. All material removed shall be burnt or disposed of in disused borrow pits.

Any areas outside the road reserve where clearing is not permitted by the Owner or is impracticable shall not be cleared if so directed by the Engineer.

5306 ERECTING STRAINING POSTS AND STANDARDS

Straining posts shall be erected at all terminal points, low points (as required), corners and bends in the fencing and at all junctions with other fences. Straining posts shall not be spaced further apart than shown on the Drawings. The length of posts above ground shall be such that the correct clearance between the lowest wire and the ground can be obtained.

Straining posts shall be accurately set in holes and shall be provided with concrete bases to the dimensions shown on the Drawings.

Holes shall be dug to the full specified depth. Where, on account of the presence of rock, the holes cannot be excavated by hand or by pneumatic tools and the Contractor has to resort to the use of explosives, he will be paid separately for the drilling and blasting operations required.

All straining posts shall be braced by means of stays or anchors as shown on the Drawings or as directed by the Engineer. Tubular stays shall be bolted to the posts. Gate posts shall not be used as straining posts but at each gate post a straining post shall be placed as shown on the Drawings.

Standards shall be firmly planted into the ground at the spacings shown on the Drawings or as directed by the
Engineer. The spacing of standards between any two successive straining posts shall be uniform and not greater than that shown on the Drawings. In rock or hard material standards shall be either driven or set in holes drilled into the rock. The size of drilled holes shall provide a tight fit to the standards. Care shall be taken when driving standards to prevent their buckling or being damaged.

All straining posts and standards shall be accurately aligned and set plumb. Where verandah-type security fencing is used, the posts shall be planted with the overhang on the road side and perpendicular to the direction of the fence. After the straining posts and standards have been firmly set in accordance with the foregoing requirements, fence wires shall be attached thereto at the spacings shown on the Drawings.

5307 ERECTING FENCE WIRES

All fencing wire shall be tied to the sides of standards or posts to prevent the wires from being displaced or becoming loose. The wire shall be carefully tensioned without sagging, and true to line, care being exercised not to tension the wire to such an extent that it will break, or that end, corner, straining or gate posts will be pulled out, or that it will be easily damaged during fires.

Each strand of fencing wire shall be securely tied in the correct position hard up to each standard with soft galvanised tying wire. The tying wire for each strand shall pass through a hole or notch in the standard, while the ends of the tying wire shall be wound at least four times around the fencing wire to prevent it from moving in a vertical direction.

At end, corner, straining and gate posts the fencing wire shall be securely wrapped twice around the post and secured against slipping by tying the end tightly around the wire by means of at least six neat tight twists.

Where high-tensile wire is used, two long twists may first be made followed by the six tight, neat twists around the post to prevent the wire from breaking at the first twist. When smooth wire is used, the loose end shall preferably be bent over and hooked into the notch between the fencing wire and the first twist.

Splices in the fencing wire shall be permitted if made in the following manner with a splicing tool. The end of each wire at the splice shall be taken at least 75 mm past the splicing tool and wrapped around the other wire by not less than six complete turns with the two separate wire ends being turned in opposite directions. After the splicing tool has been removed, the space left by it in the spliced wire shall be closed by pulling the wire ends together. Unused wire ends shall be cut close so as to leave a neat splice.

The gaps between gate posts and the adjacent straining posts shall be fenced off with short lengths of fencing wires.

Droppers shall be tied to each fence wire with soft tying wire in the required position as specified for standards to prevent slippage in a vertical direction. The spacing of droppers between any two straining posts shall be uniform. Anchoring to structures shall be done as shown on the Drawings.

Barbed-tape concertina wire shall be attached to the fence as shown on the Drawings at maximum spaces of 1.0 m between tying points. Barbed-tape concertina wire rolls shall be spliced by overlapping for one full circle and tied at four evenly spaced points along the circumference. Spliced ends shall coincide with the positions of the standards.

5308 ERECTING DIAMOND MESH OR WIRE NETTING

Where vermin-proof, pedestrian or security fences are erected, or where instructed by the Engineer, wire netting or diamond mesh shall be stretched against the fence and properly tied to the fencing wire as shown on the Drawings. The diamond mesh or wire netting shall be secured by soft tying wire at 1.2 m centres along the top and bottom wires and at 3 m centres along each of the other fencing wires, unless otherwise shown on the Drawings.

In the case of vermin-proof fencing, vermin shall be prevented from creeping under the fence by either one of the two methods described below as ordered by the Engineer:

(a) By folding back the bottom 130 mm of the wire netting so that it lies flat on the ground and by tightly packing stones (having a minimum dimension of 200 mm) end to end on this flap to secure it in position.

(b) By embedding the lower 130 mm of the wire netting in the ground and thoroughly compacting the earth around it on both sides, to secure the netting.

5309 CLOSING OPENINGS UNDER FENCES

At ditches, streams, drainage channels or other depressions where the fence cannot be erected so as to follow the general ground contour, the Contractor shall close the opening under the fence with horizontal barbed wires at 150 mm spacings, stretched between additional posts or straining posts as shown on the Drawings or as directed by the Engineer. In the case of pedestrian, vermin-proof and security fences the opening shall be covered with strips of wire netting or diamond mesh 1 000 mm wide, fixed to the barbed wires.

In the case of larger streams where damming of debris against the fence would constitute a hazard, the opening below the bottom fencing wire shall be closed with loose-hanging wire nets. For this purpose additional straining posts shall be planted on both sides of the stream with a cable consisting of at least five strands of smooth fencing wire stretched between them. Onto this cable vertical strips of diamond mesh hanging down to ground level shall be fixed. The edges of the various strips of diamond mesh shall be tied to each other so that the entire mat will be raised by water flowing underneath to leave a free stream area. These mats at streams shall be erected only when instructed by the Engineer. If it should be necessary to keep the bottoms of the mats on the ground, the Engineer may order that timber posts or pipes be fixed horizontally to the bottom ends of the diamond-mesh strips.

5310 EXISTING FENCES

Where a new fence joins an existing fence whether in line or at an angle, the new fence shall be erected with a new straining post positioned at the terminal point of the existing fence.

Existing fences that require to be taken down or moved to a new location shall be dismantled. Material not required for
re-erection or unsuitable for re-use shall be neatly stacked at approved locations in accordance with the Engineer's instructions. Fencing wire and wire netting shall be stacked clear of the ground. Payment will be made only for fences removed in accordance with the written instruction of the Engineer.

Where fences require moving, the Contractor shall re-use all the material, declared to be suitable for this purpose by the Engineer, plus such new material as may be required to erect the fence again to the standard specified for new fences. The Engineer shall not be responsible for any delays or costs arising from the breaking of re-used wire during straining.

5311 ERECTING GATES

Gates shall be erected at the positions indicated by the Engineer. The gates shall be hung on gate fittings in accordance with the requirements shown on the Drawings. Gates shall be so erected as to swing in a horizontal plane at right angles to the gate posts, clear of the ground in all positions. In pedestrian and security fences the double swing gates shall leave a gap not exceeding 25 mm between them when closed and other gates shall not be further than 25 mm from the gate post when closed.

Gates shall be stock-proof to the same extent as the adjoining fence. The clearance below the gates shall not exceed 75 mm with the gates closed. Where the gate crosses a public road, it shall be fitted with a disc or other device easily visible at night, as instructed by the Engineer.

5312 TEMPORARY FENCING, GATES AND MOTOR GATES

If required, the Contractor shall erect temporary fencing, gates and motor gates in accordance with the Drawings, Project Specifications or the Engineer's instructions. The material and erection shall be in accordance with the provisions of this Section, but the material need not necessarily be new. Where used materials are offered, they shall be in a good condition and approved in advance by the Engineer.

When no longer required, the temporary fencing, gates and motor gates shall be dismantled and removed.

5313 GENERAL REQUIREMENTS

The completed fence shall be plumb, taut, true to line and ground contour, with all posts, standards and stays firmly set. The height of the lower fencing wire above the ground at posts and standards shall not deviate by more than 25 mm from that shown on the Drawings. Other fencing wires shall not deviate by more than 10 mm from their prescribed vertical positions.

The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or netting so as not to create a hazard to grazing animals or a nuisance to the Owners of the ground.

5314 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.01 Clearing the fence line, 2 m wide strip</td>
<td>kilometre (km)</td>
</tr>
</tbody>
</table>

The unit of measurement for clearing the fence line shall be the kilometre of fence line measured along each fence line.

The tendered rate shall be in full compensation for clearing the fence line as specified, including the removal of trees, stones, and other obstructions and the disposal of all waste material resulting from clearing operations, as may be directed.

The removal of trees and stumps with a girth exceeding 1.0 m shall be paid for as specified in Section 1700.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.02 Supplying and erecting new fencing material for new fences and for supplementing material in existing fences which are being repaired or removed: (a) Barbed wire (grade, size and type of galvanising indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(b) Smooth wire (grade, size and type of galvanising indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(c) Diamond mesh</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(d) Wire netting</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(e) Barbed-tape concertina wire</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(f) Steel and timber straining posts, including anchors (type, size and length and whether galvanised, treated or painted indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(g) Steel and timber standards (length and type indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(h) Steel and timber droppers (length and type indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(i) Timber posts to be fixed to the bottom of wire mesh in streams (diameter indicated)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The quantity of material used shall be determined by measuring the quantities of individual items of material used in the completed fence. The linear measurement of the completed fence shall not apply.
The appropriate units of measurement are as follows:

(i) Fencing wire (Subitems (a) and (b))

The unit of measurement shall be the kilometre of each type of fencing wire measured between end posts. Tying wire and wire used for anchoring the posts shall not be measured for payment.

(ii) Diamond mesh and wire netting (Subitems (c) & (d))

The unit of measurement shall be the square metre of diamond mesh or wire netting, the quantity of which shall be calculated according to the prescribed width and the length between straining posts or gate posts, or the length of strips used for covering openings under fences, or the length used for covering the gates.

(iii) Barbed-tape concertina wire (Subitem (e))

The unit of measurement shall be the kilometre of fence provided with barbed-tape concertina wire of which each concertina is opened to the maximum effective open concertina length as specified in the Drawings.

(iv) Straining posts (Subitem (f))

The unit of measurement shall be the number of posts, as follows:

1. All straining posts erected in accordance with the maximum specified spacing or such lesser spacing as authorised by the Engineer, all corner posts authorised by the Engineer, and all end posts. Gate posts for new gates shall not be measured for payment.

(v) Standards and droppers (Subitems (g) and (h))

The unit of measurement shall be the number of standards and droppers erected to the maximum specified spacing or such lesser spacing as authorised by the Engineer.

(vi) Timber posts to be fixed to the bottom of wire mesh in streams (Subitem (i))

The unit of measurement shall be the metre of timber post of every diameter erected in accordance with the Drawings and the instructions of the Engineer.

The tendered rate for each straining post, standard, dropper, each kilometre of fencing wire and barbed-tape concertina wire, and each square metre of diamond mesh or wire netting and for each metre of timber post, shall include full compensation for providing all the materials, including all concrete, tying wire, straining wire, bolts, washers and nuts, for excavating or drilling holes for standards, for erecting the posts, standards and droppers and the complete putting up of the fence as specified and as shown on the Drawings. No separate payment will be made in respect of stone packing and/or trenching in the case of wire netting. The tendered rate for posts shall include full compensation for erecting the stays of the types shown on the Drawings.

Item Unit

53.03 New gates:

(a) Single leaf (size and type indicated) ...................... number (No)

(b) Double leaf (size and type indicated) ...................... number (No)

The unit of measurement shall be the number of new gates erected. At pedestrian and security fences the pair of gates shall be measured as one.

The tendered rates shall include full compensation for procuring and furnishing all material, including gates, gate posts, hinges, bolts, disks, concrete and straining wire, and for erecting the gates as specified and as shown on the Drawings. It shall not include compensation for any fencing wire or mesh fitted onto the gate.

Item Unit

53.04 Moving existing fences and gates:

(a) Fences:

(i) Stock-proof fences ............... kilometre (km)

(ii) Vermin-proof fences ............... kilometre (km)

(iii) Pedestrian fences ............... kilometre (km)

(iv) Security fences ............... kilometre (km)

(b) Gates ......................... number (No)

The unit of measurement for moving existing fences shall be the kilometre of fence, the quantity of which shall be taken as the length of fence which has been put up permanently with material obtained from fences which have been dismantled elsewhere. Additional new material used during the re-erection of existing fences shall be measured under Item 53.02. The unit of measurement for moving gates shall be the number of gates moved.

The tendered rate for each kilometre of existing fence moved or for each existing gate moved shall include full compensation for dismantling the old fence, coiling and stacking the material unsuitable for re-use, moving all material, including posts and wire and again putting up the fence or gate at the new position and the provision of binding, tying and straining wire. New material used for re-erection of old fences shall be paid for under Item 53.02.

The tendered rate for each gate moved shall include full compensation for taking down the gate and re-erecting it where required, including all new bolts, nuts and other accessories required but excluding new gate posts.

Item Unit

53.05 Dismantling existing fences ............... kilometre (km)

The unit of measurement shall be the kilometre of existing fencing and gates taken down and dismantled on the instruction of the Engineer.

The tendered rate shall include full compensation for taking down existing fences and gates, coiling wires, rolling netting into rolls, transporting the material to designated sites and stacking the material.
53.06 Providing temporary fences and gates:

(a) Stock-proof fence .................. kilometre (km)
(b) Vermin-proof fence ................. kilometre (km)
(c) Pedestrian fence .................. kilometre (km)
(d) Temporary gates (type and size indicated) .................. number (No)
(e) Temporary motor gates ................ number (No)

The unit of measurement for Subitems (a), (b) and (c) shall be the kilometre of each type of temporary fencing erected on the instructions of the Engineer.

The tendered rates shall include full compensation for providing all labour, new or suitable second-hand material, putting up the temporary fence and when no longer required, dismantling and removing it from the site to any new locality where it is required.

The unit of measurement for Subitem (d) shall be the number of temporary gates provided by the Contractor.

The tendered rate shall include full compensation for procuring, supplying and erecting new or second-hand gates, their later removal, and replacing the fence.

The unit of measurement for Subitem (e) shall be the number of temporary motor gates provided by the Contractor.

The tendered rate shall include full compensation for erecting the motor gates in accordance with the Drawings, by using new or second-hand material, and, if required, dismantling and removing the motor gates and again putting up any fencing removed from the positions where the motor gates have been erected.

General

Where new or second-hand material is used which has been provided by the Employer, eg material obtained from taking down existing fences, such material obtained from taking down the temporary fences or gates shall remain the property of the Employer. Material provided by the Contractor for temporary fences will similarly become the Contractor’s property after the temporary fences have been dismantled.

53.07 Ringbolts for anchoring fencing to structures ................... number (No)

The unit of measurement shall be the number of ringbolts supplied and fixed to the structure.

The tendered rate shall include full compensation for supplying and fixing ringbolts of the type shown on the Drawings to the structure, including, where necessary, drilling holes, anchorage, grouting ringbolts in with epoxy resin, and for all incidentals.

53.08 Drilling and blasting holes for posts and anchors .................. number (No)

The unit of measurement shall be the number of holes for posts and anchors made by drilling and/or blasting where excavation by hand or by pneumatic tools cannot be done economically.

The tendered rate shall include full compensation for drilling and blasting the holes and for all other expenses in connection with providing, storing, transporting and using explosives.
SERIES 5000 : ANCILLARY ROADWORKS

SECTION 5400 : ROAD SIGNS

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5401 SCOPE
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5403 MANUFACTURING OF ROAD SIGN BOARDS AND SUPPORTS
5404 ROAD SIGN FACES AND PAINTING
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5406 ERECTING ROAD SIGNS
5407 PROTECTION AND MAINTENANCE
5408 DISMANTLING, STORING AND RE-ERECTING EXISTING ROAD SIGNS
5409 MEASUREMENT AND PAYMENT

5401 SCOPE

This Section covers the supply and erection of permanent and temporary road traffic signs alongside and over the carriageway, ramps and cross roads at intersections and interchanges and at the locations indicated on the Drawings or as directed by the Engineer.

The signs shall be of the standard regulatory, warning and information signs as detailed on the Drawings and shall be fabricated in accordance with the SATCC Road Traffic Signs Manual, except where otherwise indicated on the Drawings.

5402 MATERIALS

(a) Structural steel

Structural steel shall comply with the requirements of BS 4360 for the type of steel specified or shown on the Drawings. Where specified, all structural steel, including tubes shall be coated in accordance with Subclause 5202(a).

Where specified, all structural steel shall be galvanised in accordance with the requirements of SABS 763 or equivalent. Steel tubes shall comply with the requirements of SABS 657 or equivalent.

(b) Bolts, nuts and rivets

Steel bolts and nuts shall comply with SABS 135 or SABS 1143 or equivalent. Aluminium bolts and nuts shall be manufactured from alloy B51S or D65S.

All steel bolts, nuts and washers shall have a hot-dip (galvanised) zinc coating which complies with the requirements of SABS 763 or equivalent for coatings on Type C1 articles.

Blind rivets used for fixing road sign boards to square-tubing framework shall be 4.76 mm rivets manufactured from or coated with a material that will not cause corrosion through electrolytic action. Hardened blind or aluminium rivets shall be used for attaching aluminium sections.

(c) Steel plate and steel profiles

(i) Steel plate

Steel plate for road signs shall comply with SABS 1519 or equivalent and shall be 1.4 mm thick galvanised steel plate or approved equivalent, which has been treated on both sides with an epoxy primer followed by a silicon polyester top coat. The total dry thickness of the treatment shall be at least 25 µm.

Where a reflectorised road sign is required, its reverse side shall be painted with a dull grey prime coat and the face with only the specified top coat.

(ii) Steel profiles

Standard sign profiles shall be 200 mm sections with a thickness of 1.0 mm, manufactured from prepainted galvanised mild steel, and shall comply with the details on the Drawings.

(d) Other plate material

Temporary roadworks delineator signs shall be manufactured from a flexible material and shall comply with the requirements of SABS 1555 or equivalent. Other plate material shall be as specified in the Project Specifications.

(e) Aluminium

Aluminium sections shall be of the sizes detailed on the Drawings, shall be manufactured from Grade 6063.T.5 alloy and shall comply with the provisions of BS 1474.

Aluminium plate shall be manufactured from Grade 5251.H.3 alloy and shall conform to the requirements of BS 1470 and shall be 2 mm in thickness.

(f) Paint and inks

All paints used shall comply with the requirements of SATCC Road Traffic Signs Manual, and also with the standards mentioned therein. All inks used shall comply with the requirements of SABS 1519 or equivalent. Except where RETRO-reflecting surfaces are specified, the surface of painted road signs shall be semi-mat. The 60° specular gloss measured in accordance with SABS 134 or equivalent shall not exceed 50. No thinners shall be added to the paint. The colours of paints and inks shall comply with the requirements of ordinary colours in SABS 1519 or equivalent. The reference numbers of the colours to be used for paints are:

B49 golden yellow, A11 signal red G13 dark grey, F04 national flag blue, E08 flag green, B03 dark brown, and G80 cloud white as detailed in SABS 1091 or equivalent.

(g) Retro-reflective material

Retro-reflective material shall be supplied in the following grades and shall comply with the requirements of SABS 1519 or equivalent:

(i) Class I - Engineering-grade retro-reflective material 7 year warranty grade.
(ii) Class II - Super-engineering-grade retro-reflective material 10 year warranty grade.
(iii) Class III - High-intensity grade retro-reflective material 10 year warranty grade.

The material shall be supplied with a pressure sensitive or heat applied adhesive backing protected by a removable lining. No material from different manufacturers shall be overlaid without approval of the Engineer.

(h) Timber posts for road sign supports

Timber posts for road sign supports shall conform to the requirements of SABS 754 or equivalent, shall be equal to or better than strength Group B timber posts. The posts shall be treated as specified in Subclause 5202(b). The exposed surface of the cut shall be given two coats of the applicable preservative. Any holes drilled in the timber posts after creosote treatment shall be re-treated with two coats of creosote.

(i) Corrosion-protection tape

Corrosion-protection tape used between aluminium and steel shall be a black PVC tape not less than 0.25 mm in thickness, shall be resistant to ultra-violet rays, and shall have an adhesive backing. The breaking strength of the material shall be not less than 3.5 kN/m.

(j) Silkscreening of inks

Silkscreening is permissible and shall be done strictly in accordance with the requirements of the approved ink manufacturer.

(k) Non-retro-reflective sheeting

Non-retro-reflective sheeting of a 7 year outdoor warranty grade may be used. This material shall comply with SABS 1519 or equivalent.

5403 MANUFACTURING OF ROAD SIGN BOARDS AND SUPPORTS

(a) Road sign boards

Road sign boards shall be manufactured strictly in accordance with the details tabulated on the Drawings. They shall be manufactured from either steel plate, steel profiles and aluminium plate or aluminium sections according to what is specified on the Drawings.

Road sign boards shall be manufactured by a recognised manufacturer of road signs.

In so far as is possible, road sign boards shall be manufactured as one unit. Where road signs are manufactured in more than one unit, the completed units shall be assembled in the workshop prior to delivery to ensure that all sections and legends fit together properly. Joints in road sign boards shall be provided only at locations and to details as shown on the Drawings. Where rivets are used, their spacing shall not exceed 150 mm, and the rivet heads shall be painted in the same colour as the sections which are being joined.

The surface of the rear of the sign board and its stiffening structure shall be painted dark grey. The sign board and its stiffening structure shall be constructed to comply with SABS 1519 or equivalent. Direct contact between the aluminium and any supporting steel framework shall be avoided by adhering corrosion-protection tape to the parts of the board in contact with the steel frame.

(b) Welding

All welding of steelwork shall be carried out in accordance with the standards laid down in BS 5135. All welding shall be done before painting.

(c) Structural steel

The relevant provisions of Section 6700, Structural Steelwork, shall apply to all steel-supporting structures for road signs.

(d) Aluminium sections

Aluminium sections for road sign boards shall be joined together by blind aluminium rivets or bolts. They shall not be joined longitudinally.

Where aluminium sections are to be faced with retro-reflective background material, it shall be applied in advance to individual sections before assembly, with the material folded around the face edges of each section for at least 10 mm. Retro-reflective material shall be heated to facilitate adhesion around the edges and to prevent damage being caused to the material.

Where possible, letters across the joint between two sections should be avoided. If it cannot be avoided, the letters concerned shall be bisected on the joint.

(e) Galvanising

Where the galvanising of structural-steel frames and signboard supporting structures is specified, it shall be done as far as is practicable after welding. Where this is not practicable, the steel sections shall be galvanised before assembly and then welded. All welds shall be thoroughly cleaned, loose material removed and dressed, after which the welds shall be coated with two coats of an approved zinc based paint.

Unless otherwise specified in the Schedule of Quantities or the Project Specifications, galvanised steel shall not be painted.

(f) Road sign supports

Road sign supports shall be constructed in accordance with the details shown on the Drawings.

(g) General

Where details for the construction of road sign boards, the framework of the road sign boards and their attachment to the supporting steel framework are not shown on the Drawings, the Contractor shall design them and submit the details to the Engineer for approval before manufacture.
5404 ROAD SIGN FACES AND PAINTING

(a) Colours, symbols and legends

Paint colours, symbols, legends and borders used on road signs shall comply with the applicable statutory provisions, and also with the requirements of the SATCC Road Traffic Signs Manual.

The colours and shades shall conform to the colours and shades specified in the SATCC Road Traffic Signs Manual.

(b) Preparing surfaces and applying paint and retro-reflective sheeting

The preparation of surfaces and painting shall be carried out as specified in Section 5900.

The surface of structural steel for the frames and supports of road signs shall be prepared by it being cleaned with a wire brush and shall then be painted as specified in Clause 5907.

Unless otherwise specified, aluminium road signs and galvanised frameworks, with the exception of painted road sign boards shall not be painted. Care shall be taken to treat all holes and cutting edges. The preparation of surfaces and application of retro-reflective sheeting shall be done in strict accordance with the requirements of the sheeting manufacturer.

(c) Time of manufacture

The faces and backs of road sign boards and the legend shall not be painted more than six months prior to their erection. Each road sign shall be marked as required by SABS 1519 or equivalent.

5405 STORAGE AND HANDLING

All road signs or parts of road signs shall be transported and handled so as to prevent any damage and deformation. All road signs shall be stored in a vertical position in a weather-proof storeroom. There shall be sufficient space between the road signs to permit free air circulation and moisture evaporation. Contact of road signs with treated timber, diesel, dirt or water shall not be permitted.

When required, existing or newly erected road signs shall be fully or partially covered with burlap or other approved adequately ventilated material to obscure destinations that are temporarily inapplicable or irrelevant.

5406 ERECTING ROAD SIGNS

(a) Position

Road signs shall be erected in the positions shown on the Drawings or indicated by the Engineer.

(b) Excavation and backfilling

Excavations for the erection of road signs shall be made according to the dimensions shown on the Drawings. Where the excavations are to be backfilled with soil, a 12:1 soil-cement mixture shall be made if required by the Engineer.

The soil or soil-cement mixture shall then be compacted by tamping at optimum moisture content in 100 mm thick layers in the excavation.

Where posts or structures are to be fixed in concrete, or where concrete footings are to be cast, the concrete, formwork and reinforcement shall comply with the requirements of Sections 6200, 6300 and 6400. The holes shall be completely filled with concrete up to the level shown on the Drawings or indicated by the Engineer. The upper surface of the concrete shall be neatly finished with sufficient fall to ensure proper drainage.

(c) Erection

Road signs shall be erected as shown on the Drawings or as directed by the Engineer. During erection the structural steelwork shall be firmly bolted and protected to prevent buckling or damage during erection, or by the equipment used for erection.

Posts to which road signs are to be fixed shall be vertical and the undersides of road signs shall be horizontal after having been erected.

Where timber posts are used for erecting the signs, all holes that are drilled in the timber shall be impregnated with creosote.

(d) Field welding

All welding done during erection shall comply with the requirements for welding during manufacture.

(e) On-site painting

All painting done after the road signs have been erected shall comply with the requirements for painting during manufacture.

All places where the paintwork has been damaged during erection shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

(f) Time of erection

Road signs shall be erected immediately prior to the road being opened to public traffic, unless otherwise directed by the Engineer.

(g) General

All destinations and route numbers shown on the Drawings shall be subject to amendment, and confirmation of the details shall be obtained from the Engineer before any particular signs are made. Such particulars may be available only at a late stage, for which allowance shall be made by the Contractor in his programme.

5407 PROTECTION AND MAINTENANCE

The Contractor shall protect the completed road signs against damage until they have been finally accepted by the Employer, and he shall maintain the road signs until the maintenance certificate has been issued. Damage or
Defects caused by negligence or faulty workmanship shall be rectified by the Contractor at his own cost to the satisfaction of the Engineer.

5408 DISMANTLING, STORING AND RE-ERECTING EXISTING ROAD SIGNS

Where ordered by the Engineer, the Contractor shall dismantle existing road signs, store them, and re-erect them at new positions indicated.

Where required by the Engineer, the signs shall be repainted or repaired and new materials shall be used for part or all of the supporting structure.

5409 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.01 Road sign boards with painted or coloured background. Symbols, lettering and borders in Class 1 retro-reflective material, where the sign board is constructed from:</td>
<td></td>
</tr>
<tr>
<td>(a) Aluminium sheet (2 mm thick):</td>
<td></td>
</tr>
<tr>
<td>(i) Area not exceeding 2 m² . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(ii) Area exceeding 2 m² but not 10 m² . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(iii) Area exceeding 10 m² . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(b) Aluminium sections (type indicated) all sizes . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(c) Sheet steel:</td>
<td></td>
</tr>
<tr>
<td>(i) Area not exceeding 2 m² . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(ii) Area exceeding 2 m² but not 10 m² . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(iii) Area exceeding 10 m² . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(d) Other sheeting (details indicated):</td>
<td></td>
</tr>
<tr>
<td>(i) Area not exceeding 2 m² . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(ii) Area exceeding 2 m² but not 10 m² . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of completed road sign board.

Payment shall distinguish between road sign boards made from the various materials specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.02 Extra over Item 54.01 for using:</td>
<td></td>
</tr>
<tr>
<td>(a) Background of retro-reflective material of:</td>
<td></td>
</tr>
<tr>
<td>(i) Class 1 - Engineering grade . . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(ii) Class 3 - High-intensity grade . . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(iii) Class 2 - Super-engineering grade . . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(b) Lettering, symbols and borders of retro-reflective material of:</td>
<td></td>
</tr>
<tr>
<td>(i) Class 3 - High-intensity grade . . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
<tr>
<td>(ii) Class 2 - Super-engineering grade . . . . . . . . . . . . square metre (m²)</td>
<td></td>
</tr>
</tbody>
</table>

The area measured for payment shall be the full area of the road sign board as measured in Item 54.01.

The tendered rates paid extra over suites 54.01(a), (b), (c) and (d) shall include full compensation for the additional cost of providing retro-reflective background, symbols, lettering and borders of the types specified in each case.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.03 Road sign supports (overhead road sign structures excluded):</td>
<td></td>
</tr>
<tr>
<td>(a) Steel tubing . . . . . . . . . . . . . . . . . . . . tonne (t)</td>
<td></td>
</tr>
<tr>
<td>(b) Timber (diameter and type indicated) . . . . . . . . . . . . . . metre (m)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement of supporting structures manufactured from steel tubing shall be the tonne of steel tubing used. Bolts and other accessories shall not be measured.

(b) The unit of measurement for timber supporting structures shall be the metre of each diameter post used. Bolts and other accessories shall not be measured.

The tendered rates shall include full compensation for manufacturing and erecting the road sign supports, including all bolts, screws, rivets, welding and accessories, together with the painting required and the provision of breakaway holes in timber supports.

Overhead road sign supporting structures shall not be measured and paid for under this Item, but under the appropriate Items of Series 6000.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.04 Excavation and backfilling for road sign supports</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of excavation measured in place according to the neat dimensions of the footings or excavations as shown on the Drawings or directed by the Engineer. In the case of timber posts not in concrete, the plan area of the excavated hole shall be taken as 0.15 m², irrespective of the actual size of the excavated hole.

The tendered rate shall be in full compensation for excavating, backfilling and compacting the backfill material, for the disposal of all surplus excavated material, and for providing the backfill material and mixing it with cement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.05 Extra over Item 54.04 for cement-treated soil backfill</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The tendered rate shall include full compensation for the additional cost of providing and mixing in cement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.06 Extra over Item 54.04 for rock excavation</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The tendered rate shall include full compensation for the additional cost of excavating in rock.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.07 Dismantling, storing and re-erecting road signs with a surface area of:</td>
<td>number (No)</td>
</tr>
<tr>
<td>(a) Up to 2 m²</td>
<td></td>
</tr>
<tr>
<td>(b) Exceeding 2 m² but not 10 m²</td>
<td></td>
</tr>
<tr>
<td>(c) Exceeding 10 m²</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of signs dismantled, stored and re-erected in each size group.

The tendered rates shall include full compensation for dismantling and storing the road signs and supporting structures, transporting the material to a new location, re-erecting the road signs, and restoring the location where they were dismantled.

Payment for excavations, and the new material and concrete required for re-erecting the road signs shall be made under the appropriate Item, and any repairs and painting which may be necessary, shall be paid for as "extra work". No separate payment shall be made for new bolts and nuts required for such re-erection, the cost of which shall be included in the rates tendered above.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.09 Dismantling and storing road signs with a surface area of:</td>
<td>number (No)</td>
</tr>
<tr>
<td>(a) Up to 2 m²</td>
<td></td>
</tr>
<tr>
<td>(b) Exceeding 2 m² but not 10 m²</td>
<td></td>
</tr>
<tr>
<td>(c) Exceeding 10 m²</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number in each size group dismantled and stored.

The tendered rates shall include full compensation for carefully dismantling and disassembling the road signs, loading, transporting, off-loading and carefully stacking all the materials as required by the Engineer. It shall also include compensation for restoring the site where the road signs have been dismantled.

**Note:** Concrete, formwork and reinforcing steel for road sign footings shall be measured and paid for in accordance with the provisions of Sections 6200, 6300 and 6400, but such payment Items shall appear under this Section in the Schedule of Quantities.
SERIES 5000 : ANCILLARY ROADWORKS

SECTION 5500 : ROAD MARKINGS

CONTENTS

5501 SCOPE
5502 MATERIALS
5503 WEATHER LIMITATIONS
5504 MECHANICAL EQUIPMENT FOR PAINTING
5505 SURFACE PREPARATION
5506 SETTING OUT THE ROAD MARKINGS
5507 APPLYING THE PAINT
5508 APPLYING THE RETRO-REFLECTIVE BEADS
5509 ROADSTUDS
5510 TOLERANCES
5511 GENERAL
5512 FAULTY WORKMANSHIP OR MATERIALS
5513 PROTECTION
5514 MEASUREMENT AND PAYMENT

5501 SCOPE

This Section covers the permanent marking of the road surface with white, red or yellow painted lines or symbols and the supply and fixing of retro-reflective roadstuds as indicated on the Drawings or as specified by the Engineer.

All road markings shall be of the standard regulatory, warning and guidance markings as detailed on the Drawings and in accordance with the SATCC Road Traffic Signs Manual.

5502 MATERIALS

(a) Paint

(i) Road-marking paint

Road-marking paint shall comply with the requirements of SABS 731 or equivalent for Type 1, Type 2 or Type 4 as specified in the Project Specifications. The no-pick-up time of road marking paint shall comply with the Class 1 requirement in SABS 731-1 or equivalent.

The paint shall be delivered at the site in sealed containers bearing the name of the manufacturer and the type of paint.

The viscosity of the paint shall be such that it can be applied without being thinned.

(ii) Retro-reflective road-marking paint

Retro-reflective road-marking paint shall comply with the requirements of Subclause 5502 and CKS 192.

(iii) Plastic road-marking material

Where specified in the Project Specifications, hot-melt plastic road-marking material shall comply with the requirements of BS 3662. The binder shall be plasticised synthetic resin and the material shall be reflectorised by mixing in 20% by mass Class A glass beads in accordance with BS 6088.

(iv) Colour

The colours to be used shall be bright white, red or yellow.

The colour of the yellow and red paint shall be as specified in the SATCC Road Traffic Signs Manual.

(v) Skid resistance

The skid resistance of all types of marking material shall comply with the requirements of SABS 731-1 or equivalent.

(b) Roadstuds

Roadstuds shall comply with the requirements of SABS 1442 or equivalent and shall be of the size and type indicated on the Drawings or specified in the Project Specifications. The Contractor shall, prior to delivery, submit to the Engineer for approval, samples of the type of roadstuds he proposes to use.

5503 WEATHER LIMITATIONS

Road-marking paint shall not be applied to a damp surface or at temperatures lower than 10°C, or when, in the opinion of the Engineer, the wind strength is such that it may adversely affect the painting operations.

5504 MECHANICAL EQUIPMENT FOR PAINTING

The equipment shall consist of an apparatus for cleaning the surfaces, a mechanical road-painting machine and all additional hand-operated equipment necessary for completing the work. The mechanical road-marking machine shall be capable of painting at least two parallel lines simultaneously and shall apply the paint to a uniform film thickness at the rates of application specified. The machine shall be so designed that it will be capable of painting the road markings everywhere to a uniform width with sides within the tolerances specified, without the paint running or splashing. The machine shall further be capable of painting lines of different widths by adjusting the spray jets on the machine or by means of additional equipment attached to the machine.

Machines which apply the beads by means of gravity only shall not be used. The beads shall be sprayed onto the paint layer by means of a pressure sprayer.

The machine shall be provided with clearly visible amber warning flashing lights which shall always be in operation when the machine is on the road.

5505 SURFACE PREPARATION

Road markings shall be applied to bituminous surfaces only after sufficient time has elapsed to ensure that damage will not be caused to the painted surface by volatiles evaporating from the surfacing.

Before the paint is applied, the surface shall be clean and dry and completely free from any soil, grease, oil, acid or any other material which will be detrimental to the bond between the paint and the surface. The surface where the paint is to be applied shall be properly cleaned by means of watering, brooming or compressed air if required.
5506 SETTING OUT THE ROAD MARKINGS

The lines, symbols, figures or marks shall be premarked by means of paint spots of the same colour as that of the final lines and marks. These paint spots shall be at such intervals to ensure that the road markings can be accurately applied, and in no case shall they be more than 1.5 m apart. Spots of approximately 10 mm in diameter should be sufficient.

The dimensions and positions of road markings shall be as shown on the Drawings or as specified in the appropriate statutory provisions and the SATCC Road Traffic Signs Manual.

After spotting, the positions of the proposed road markings shall be indicated on the road. These premarkings shall be approved by the Engineer prior to any painting operations being commenced.

The positions and outlines of special markings shall be produced on the finished road in chalk and shall be approved by the Engineer before they are painted. Approved templates may be used on condition that the positioning of the marking is approved by the Engineer before painting is commenced.

The position of roadstuds shall be marked out on the road and shall be approved by the Engineer before they are fixed in position.

5507 APPLYING THE PAINT

The figures, letters, signs, symbols, broken or unbroken lines or other marks shall be painted as shown on the Drawings or as directed by the Engineer.

Where the paint is applied by machine, it shall be applied in one layer. Before the road-marking machine is used on the permanent Works, the satisfactory operation of the machine shall be demonstrated on a suitable site which is not part of the permanent Works. Adjustments to the machine shall be followed by further testing. Only when the machine has been correctly adjusted and its use has been approved by the Engineer after testing, may the machine be used on the permanent work. The operator shall be experienced in the use of the machine.

After the machine has been satisfactorily adjusted, the rate of application shall be checked and adjusted if necessary before application on a large scale is commenced.

Where two lines are required parallel to each other, the lines shall be applied simultaneously by the same machine. The paint shall be stirred before application in accordance with the manufacturer's instructions. Paint shall be applied without the addition of thinners.

Where painting is done by hand, it shall be applied in two layers, and the second layer shall not be applied before the first layer has dried. As most road-marking paint reacts with the bitumen surface of the road, the paint shall be applied with one stroke only of the brush or roller.

Ordinary road-marking paint shall be applied at a nominal rate of 0.42 l/m² or as directed by the Engineer and proprietary brand paints shall be applied at the rates specified in the Project Specifications.

Unless otherwise prescribed by the Engineer, the road marking shall be completed before a particular section of the road is opened to traffic. Each layer of paint shall be continuous over the entire area being painted.

5508 APPLYING THE RETRO-REFLECTIVE BEADS

Where retro-reflective paint is required, the retro-reflective beads shall be applied by means of a suitable machine in one continuous operation, immediately after the paint has been applied. The rate of application of the beads shall be 0.8 kg/l of paint or such other rate as may be directed by the Engineer.

5509 ROADSTUDS

Roadstuds shall be of the type indicated on the Drawings and shall be fixed in the positions indicated and approved by the Engineer.

The roadstuds shall be fixed by means of an approved epoxy resin in accordance with the manufacturer's instructions, subject to such amendments to the method as may be required by the Engineer. The studs shall be protected against impact until the adhesive has hardened. Before fixing the roadstuds, the surface shall be thoroughly cleaned as specified in Clause 5505.

Roadstuds must be protected during painting of any lines and application of any surface treatments.

5510 TOLERANCES

Road markings shall be painted to an accuracy within the tolerances given below:

(a) **Width**

The width of lines and other markings shall not be less than the specified width, nor shall it exceed the specified width by more than 10 mm.

(b) **Position**

The position of lines, letters, figures, arrows, retro-reflective roadstuds and other markings shall not deviate from the true position by more than 100 mm in the longitudinal and 20 mm in the transverse direction.

(c) **Alignment of markings**

The alignment of the edges of longitudinal lines shall not deviate from the true alignment by more than 10 mm in 15 m.

(d) **Broken lines**

The length of segments of broken longitudinal lines shall not deviate by more than 150 mm from the specified length.
5511 GENERAL

The length of segments and the gap between segments in broken lines shall be as indicated on the Drawings. If these lengths are altered by the Engineer, the ratio of the lengths of the painted section to the length of the gap between painted sections shall remain the same. Lines shall not be painted more than 3 months prior to the road being opened to public traffic.

Lines on curves, whether broken or unbroken, shall not consist of chords but shall follow the correct radius.

Where plastic road-marking material is used, the manufacturer shall produce an approved guarantee as specified in the Project Specifications. Where specified by the Engineer, the Contractor shall remove existing painted markings from the road surface by means of sand blasting or other approved method. The use of black paint or chemical paint remover to obliterate existing markings will not be permitted, except where it is ordered by the Engineer as a temporary measure.

5512 FAULTY WORKMANSHIP OR MATERIALS

If any material which does not comply with the requirements is delivered to the site, or is used in the Works, or if any work of an unacceptable quality is carried out, such material or work shall be removed, replaced or repaired as required by the Engineer at the Contractor's own cost. Rejected road markings and paint which has been splashed or dripped onto the pavement, kerbs, structures or other such surfaces, shall be removed by the Contractor at his own cost, in an approved manner so that the markings or split paint will not show up at all.

5513 PROTECTION

After the paint has been applied, the road markings shall be protected against damage by traffic or other causes. The Contractor shall be responsible for erecting, placing and removing all warning boards, flags, cones, barricades and other protective measures which may be necessary in terms of any statutory provisions and/or as may be recommended in the SATCC Road Traffic Signs Manual.

5514 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.01 Road-marking paint:</td>
<td></td>
</tr>
<tr>
<td>(a)  White lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(b)  Yellow lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(c)  Red lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(d)  White lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(e)  Yellow lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(f)  Traffic-island markings (any colour)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(g)  Kerb markings (any colour)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for painting the lines shall be the kilometre of each specified width of line and the quantity paid for shall be the actual length of line painted in accordance with the instructions of the Engineer, excluding the length of gaps in broken lines.

The unit of measurement for painting the lettering, symbols or traffic-island markings shall be the square metre, and the quantity to be paid for shall be the actual surface area of lettering, symbols or traffic-island markings completed.

The tendered rate per kilometre or per square metre as the case may be for painting the road markings shall include full compensation for procuring and furnishing all material and the necessary equipment, and for painting, protecting and maintenance as specified, including the setting-out of lettering, symbols and traffic-island markings, but excluding setting out and premarking the lines.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.02 Retro-reflective road-marking paint:</td>
<td></td>
</tr>
<tr>
<td>(a)  White lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(b)  Yellow lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(c)  Red lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(d)  White lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(e)  Yellow lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(f)  Traffic-island markings (any colour)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for painting the lines shall be the kilometre of each specified width of line and the quantity paid for shall be the actual length of line painted in accordance with the instructions of the Engineer, excluding the length of gaps in broken lines.

The unit of measurement for painting the lettering, symbols or traffic-island markings shall be the square metre, and the quantity to be paid for shall be the actual surface area of lettering, symbols or traffic-island markings completed.

The tendered rate per kilometre or per square metre as the case may be for painting the road markings shall include full compensation for procuring and furnishing all material, including the retro-reflective beads, and the necessary
equipment, and for painting, protecting and maintenance as specified, including the setting-out of lettering, symbols and traffic-island markings, but excluding setting out and premarking the lines.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.03 Hot-melt plastic road-marking material (particulars stated):</td>
<td></td>
</tr>
<tr>
<td>(a) White lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(b) Yellow lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(c) Red lines (broken or unbroken) (width of line indicated)</td>
<td>kilometre (km)</td>
</tr>
<tr>
<td>(d) White lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(e) Yellow lettering and symbols</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(f) Traffic-island markings (any colour)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for painting the lines shall be the kilometre of each specified width of line and the quantity paid for shall be the actual length of line painted in accordance with the instructions of the Engineer, excluding the length of gaps in broken lines.

The unit of measurement for painting the lettering, symbols or traffic-island markings shall be the square metre, and the quantity to be paid for shall be the actual surface area of lettering, symbols or traffic-island markings completed.

The tendered rate per kilometre or per square metre as the case may be for painting the road markings shall include full compensation for procuring and furnishing all material, and the necessary equipment, and for painting, protecting and maintenance as specified, including the setting-out of lettering, symbols and traffic-island markings, but excluding setting out and premarking the lines.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.04 Variations in rate of application:</td>
<td></td>
</tr>
<tr>
<td>(a) White paint</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(b) Yellow paint</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(c) Red paint</td>
<td>litre (l)</td>
</tr>
<tr>
<td>(d) Retro-reflective beads</td>
<td>kilogram (kg)</td>
</tr>
<tr>
<td>(e) Plastic road-marking paints (specify)</td>
<td>litre (l)</td>
</tr>
</tbody>
</table>

The unit of measurement for variations in the rate of applying of the paint and retro-reflective beads shall be the litre and the kilogram respectively.

Payment for variations shall be made as specified in Clause 1213.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.05 Roadstuds (type stated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement for roadstuds shall be the actual number of approved roadstuds placed.

The tendered rate shall include full compensation for procuring and furnishing all the necessary material, labour and equipment, and for fixing and maintenance as specified. Distinction shall be made between various types of roadstuds.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.06 Setting out and pre-marking the lines (excluding traffic-island markings, lettering and symbols)</td>
<td>kilometre (km)</td>
</tr>
</tbody>
</table>

The unit of measurement for setting out lines shall be the kilometre of lines set out and marked. Where two or three lines are to be painted next to each other, the setting-out of lines shall be measured only once.

The tendered rate shall include full compensation for setting out and premarking the lines as specified, including all materials.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.07 Re-establishing the painting unit at the end of the maintenance period</td>
<td>lump sum</td>
</tr>
</tbody>
</table>

The tendered lump sum shall include full compensation for the re-establishment on the site and for later removal of all special equipment, personnel, etc, as may be required for repainting the road markings at the end of the maintenance period. The Contractor will be paid at tender rates for repainting the road markings.

The re-establishment during the construction period shall not be paid for specially, and allowance therefor shall be made by the Contractor in his programme and his rates for painting.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.08 Removal of existing, temporary or permanent road marking by:</td>
<td></td>
</tr>
<tr>
<td>(a) Sandblasting</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) Overpainting as a temporary measure</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of road marking removed.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.09 Removal of existing roadstuds</td>
<td>number (no)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the actual number of roadstuds removed.
SERIES 5000 : ANCILLARY ROADWORKS

SECTION 5600 : CATTLE GRIDS

CONTENTS

5601 SCOPE
5602 MATERIALS
5603 CONSTRUCTION
5604 MEASUREMENT AND PAYMENT

5601 SCOPE

This Section covers the construction of cattle grids in conformity with the details, dimensions and design shown on the Drawings, and at locations shown on the Drawings or as directed by the Engineer.

A cattle grid is a structure constructed across a road which is designed to prevent the passage of cattle while permitting other traffic to pass.

Fencing and gates are as given in Section 5300.

5602 MATERIALS

(a) Cement

Cement shall comply with the requirements of Subclause 6402(a).

(b) Aggregate

Aggregate shall comply with the requirements of Subclause 6402(b).

(c) Water

Water shall comply with the requirements of Subclause 6402(d).

(d) Admixtures

Admixtures shall not be used in the concrete mix without the approval of the Engineer who may require tests to be performed before their use. Admixtures, if allowed, shall comply with the requirements of Subclause 6402(e).

(e) Reinforcement

Reinforcement shall conform to the requirements of Section 6300.

(f) Structural steel

Structural steel shall conform to the requirements of Section 6700.

5603 CONSTRUCTION

(a) Excavation

Excavation shall be made large enough to permit construction of the base slab to the dimensions in the Drawings. Excavation shall be made in accordance with the requirements of Section 2100. All excavations for cattle grids shall be classified as provided in Clause 2105.

(b) Formwork and concrete finish

Formwork and concrete finish shall conform to the requirements of Section 6200. Formed surfaces shall have Class F2 finish and unformed surfaces shall have Class U2 finish.

(c) Concrete

Concrete shall be Class 30/19 and shall be as specified in Section 6400.

(d) Steel reinforcement

Steel reinforcement shall be as shown on the Drawings and as specified in Section 6300.

(e) Structural steel

Structural steel shall be as shown on the Drawings. Painting of structural steel shall be in accordance with Section 5900 or as directed by the Engineer.

5604 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.01 Cattle grids</td>
<td>number (No.)</td>
</tr>
<tr>
<td>(a) Cattle grids</td>
<td>number (No.)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of cattle grids supplied, the type as indicated in the Drawings.

The tendered rate shall include full compensation for providing the materials and constructing the cattle grids, but shall not include compensation for excavating the in situ material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.02 Excavation for cattle grids</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(a) Excavating soft material to the depth required for the construction of the cattle grid</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Extra over Subitem 56.02(a) for excavation in hard material</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of material excavated.
SERIES 5000 : ANCILLARY ROADWORKS
SECTION 5700 : LANDSCAPING AND GRASSING

CONTENTS
5701 SCOPE
5702 MATERIALS
5703 LANDSCAPING AREAS
5704 PREPARING AREAS FOR GRASSING
5705 GRASSING
5706 MAINTAINING THE GRASS
5707 TREES, SHRUBS AND HEDGING PLANTS
5708 GENERAL
5709 MEASUREMENT AND PAYMENT

5701 SCOPE

(a) Scope
This Section covers the landscaping of designated areas, the establishing of vegetation for functional and aesthetic purposes on cut and fill slopes, landscaped areas and such other areas where it may be required.

(b) Definition
Any declared weeds, as well as any exotic tree, shrub, herb, grass or water plant which, in the opinion of the Engineer, may pose any problems in specified areas at certain times, is regarded as being undesirable.

5702 MATERIALS

(a) Fertiliser/soil-improvement material
The type of fertiliser/soil-improvement material to be used shall be one or more of the following types and any other type of fertiliser/soil-improvement material specified in the Project Specifications or prescribed by the Engineer.

(i) Soil-improvement materials such as dolomitic lime, basic slag, gypsum, superphosphate and agricultural lime.

(ii) Fertilisers such as limestone ammonium nitrate, 2:3:2 (22) and 3:2:1 (25).

(b) Grass cuttings
Grass cuttings shall be fresh cuttings of an approved type of grass with sufficient root material to ensure good growth.

(c) Grass seeds
Only fresh certified seed shall be used and the types of seeds in the seed mixture shall be as specified in the Project Specifications.

Mixing the various types of grass seeds for obtaining the prescribed grass-seed mixture shall be done on the site in the presence of the Engineer. Storing and identifying the grass seeds and the grass-seed mixtures on the site shall be the responsibility of the Contractor.

(d) Trees, shrubs and hedge plants
Plants shall be of the variety and size shown on the Drawings or in the Project Specifications.

The Contractor shall supply the number of plants as shown on the Drawings or in the Project Specifications and/or Schedule of Quantities. The Contractor shall give at least six week's advance notice of his requirements to the Employer.

Upon receipt of the plants, the Contractor shall ensure that the plants are in a good condition and free from plant diseases and he shall accept full responsibility for maintaining the plants in a good condition throughout the Contract and the maintenance periods. The plants shall be fully maintained and watered during this period and any losses of plants on account of lack of care or disease during the Contract and maintenance periods, shall be replaced at the Contractor's own cost.

Each plant shall be handled and packed in the approved manner for that species or variety, and all the necessary precautions shall be taken to ensure that the plants will arrive at the site of the Works in a suitable condition for successful growth. Trucks used for transporting plants shall be equipped with covers to protect the plants from windburn.

Containers shall be in a good condition.

Plants supplied by the Contractor shall be healthy, correctly shaped, and well rooted. The plants must be hardened off and be exposed to direct sunlight for at least 6 months prior to planting in the road reserve. Roots shall not show any evidence of having been restricted or deformed at any time. Plants shall grow well and shall be free from insect pests and diseases.

(e) Grass sods
Grass sods shall be either nursery-grown or veld sods as described below. Both types shall be harvested, delivered, planted and watered within 36 hours unless otherwise authorised by the Engineer. The grass sods shall be free from noxious weeds and diseases. Sods obtained from a nursery shall be in moist soil not less than 30 mm deep, and sods taken from the veld in moist soil not less than 50 mm deep.

(i) Nursery-grown sods
These sods shall be of the variety of grass specified in the Project Specifications, unless the use of an alternative has been approved by the Engineer. The grass shall have been grown specifically for sod purposes, mown regularly and cared for to provide an approved uniformity to the satisfaction of the Engineer.

(ii) Veld sods
These sods may be obtained from approved areas within or near the site where a suitable type and density of grass and type of soil are found.

(f) Anti-erosion compounds
Anti-erosion compounds shall consist of an organic or inorganic material to bind soil particles together and shall be a proven product able to suppress dust and form an encrustation. The application rate shall conform to the manufacturer’s recommendations. The materials used shall be of such a quality that grass seeds may germinate and penetrate the crust.
levelled cross-sections. before and after shaping or else it may be determined by means of a grid system of levels taken at 10 m intervals. Section 3300, except that quantities may be measured by measurement and payment therefor shall be made under such work shall be regarded as being earthworks and contoured areas at interchanges and intersections and rest areas which require shaping by means of bulk earthworks such as large roots, stones, refuse, stiff or heavy clays and the seeds of noxious weeds, which will adversely affect its suitability for grass being planted. Topsoil stripped from areas infested with weeds shall be stockpiled separately.

Topsoil shall be obtained from wherever suitable material occurs either in the road reserve or from areas where cuts and fills are to be constructed. Topsoil stripped from borrow areas may not be removed from that site for topsoiling of other areas, but must be used to rehabilitate the borrow pit itself. The Engineer shall communicate his requirements to the Contractor regarding the quantity of topsoil which is necessary and the areas from which it shall be selected and removed by the Contractor. Unless otherwise specified, topsoil shall be taken from not deeper than 400 mm from the surface. If the Contractor fails to conserve the topsoil as instructed, he shall obtain suitable substitute material from other sources at his own cost.

Where so specified, the Contractor shall procure and furnish topsoil from his own sources outside the site, after such sources have been approved by the Engineer.

Topsoil shall be stockpiled in separate loose heaps as tipped from the trucks and shall not be stockpiled in heaps exceeding 2 m in height. Care shall be taken to prevent the compaction of the topsoil in any way, especially by trucks being driven over such material.

Manure shall, unless another type has been approved by the Engineer, be pure kraal manure free from soil, weed seeds or other undesirable material. It shall not contain any particles that will not pass through a 50 mm screen and shall be approved by the Engineer before being delivered to the site.

Compost shall be well decayed, friable and free from weed seeds, dust or any other undesirable materials. It shall not contain any particles that will not pass through a 50 mm screen and shall be approved by the Engineer before being delivered to the site.

Topsoil shall consist of fertile loamy soil, obtained from areas with a good soil coverage of natural vegetation, preferably grasses. It shall be free from deleterious matter such as large roots, stones, refuse, stiff or heavy clays and the seeds of noxious weeds, which will adversely affect its suitability for grass being planted. Topsoil stripped from areas infested with weeds shall be stockpiled separately.

Trimming shall consist of trimming the existing or previously shaped ground to an even surface with the final levels generally following the original surface. Trimming shall normally be done by grader, or in more confined or steep areas by bulldozer. Where machine operations are not practicable, because of confined spaces or steep slopes, or when approved by the Engineer, trimming shall be done with hand tools. When trimming is done on slopes steeper than 1:3, the ridges shall be made parallel to the contour. Such ridges shall be approximately 100 mm wide, and the centres between the ridges approximately 400 mm. Trimming shall be done where instructed by the Engineer to areas inside the road reserve but outside the road prism, ie normally outside the tops of cuts or the toes of fills, but trimming of rock outcrops will not be required.

Trimmed surfaces shall be left slightly rough to facilitate a better binding with topsoil or the natural establishing of vegetation.

When subsequent grassing is required or when it is ordered by the Engineer, areas previously shaped shall be trimmed as described above to within a tolerance of plus or minus 100 mm with all undulations following a smooth curve. The above tolerance shall apply only to areas where the final contours are given on the Drawings.

During trimming, all stones in excess of 100 mm in size and all excess material shall be removed. Areas which require grassing shall be trimmed in such a way that, after cultivation and the application of topsoil, the finished surface of the area shall be approximately 25 mm below the top of adjacent kerbing, channelling or pavement.

The Engineer shall be entitled to pay for shaping and trimming as described above on the basis of hourly plant rates. The motor grader and bulldozer to be provided shall each have a flywheel power of not less than 93 kW. All machines shall be in a good condition. Any labour or other plant required shall be paid for as extra work as specified in the General Conditions of Contract.

The various areas to be grassed shall be prepared as follows:

Areas within the road reserve but outside the road prism which require shaping by means of bulk earthworks such as contoured areas at interchanges and intersections and rest areas which require earthworks shall be excavated, filled and compacted when required, and shaped to the correct contours to within a tolerance of plus or minus 150 mm. Such work shall be regarded as being earthworks and measurement and payment therefor shall be made under Section 3300, except that quantities may be measured by means of a grid system of levels taken at 10 m intervals before and after shaping or else it may be determined by levelled cross-sections.

Where soil is too hard to be ploughed with a light tractor, the soil shall be ripped up to a depth of 300 mm before it is loosened by plough to a depth of 150 mm.

Areas which require grassing shall be trimmed in such a way that, after cultivation and the application of topsoil, the finished surface of the area shall be approximately 25 mm below the top of adjacent kerbing, channelling or pavement.
(c) **Areas which require topsoil**

Where areas to be grassed consist of organically unsuitable material, the surface shall be roughened to ensure a proper bond between the topsoil and the subsoil. If required, the area shall be scarified as described in paragraphs (a) or (b) above.

Topsoil shall be placed on the prepared surfaces and trimmed to the uniform thickness required. The topsoil shall be scarified by means of handraking or light rotavators and all stones removed as specified for areas not requiring topsoil in subparagraph (b) above.

Areas inaccessible for topsoil being placed after the construction works have been completed shall be covered with topsoil and protected against erosion during construction works.

(d) **Fertilising**

For all areas to be planted, the Contractor shall have the top 150 mm of the prepared surface tested to determine the quantity and type of fertiliser which will be required for establishing proper growth conditions for the grass. The location of the soil sample taken shall be indicated on plans by the Contractor. The Engineer shall be furnished with the test results. Only after approval by the Engineer of the nature and quantity of the fertiliser, may its application proceed. The fertiliser shall be evenly applied over all surfaces where grass is to be planted, and shall then be thoroughly mixed with the soil to a depth of 100 mm either mechanically or manually. Where hydroseeding is to be performed, the fertiliser may be mixed with the cellulose pulp and water used in hydroseeding.

(e) **General**

After an area has been prepared for grassing, the grassing shall be completed before crusting. Where a crust has been formed before grassing is done, the Contractor shall, at his own cost, loosen the crust by ploughing to a depth of 150 mm.

5705 **GRASSING**

The method of establishing grass shall depend on the circumstances relating to each case, and the Engineer shall decide which method is to be used. Provision is made for the following methods:

(a) **Planting grass cuttings**

(b) **Sodding**

(c) **Hydroseeding**

(d) **Topsoiling only, using, where available, topsoil selected for the presence of natural grass seeds**

(e) **Grassing with an approved grading machine**

(f) **Hand seeding**

(g) **The use of any other method specified in the Project Specifications.**

(a) **Planting grass cuttings**

The areas to be grassed shall, unless already wet, be thoroughly watered before the cuttings are planted to ensure that the soil will be uniformly wet to a depth of at least 150 mm when the planting is done.

An approved variety of grass cuttings shall be evenly planted by hand or mechanically at a rate of at least 600 kg of cuttings per hectare. Fresh cuttings only shall be used. Any grass cuttings that have been allowed to dry out shall be discarded. Immediately after having been planted, the grass cuttings shall be given a copious watering, and, when sufficiently dry, shall be rolled with a light agricultural roller.

(b) **Sodding**

Areas to be grassed by sodding shall be given a layer of topsoil of at least 50 mm in thickness unless, where suitable soil is present, the Engineer orders the topsoil to be omitted. The areas to be sodded shall be thoroughly watered beforehand so that it will be wet to a depth of at least 150 mm during sodding. The surface shall be roughened slightly to ensure a good penetration of roots into the soil. Sods shall be protected against drying out and kept moist from the time of harvesting until they are finally placed.

The first row of sods shall, where possible, be laid in a straight line, and if on a slope, laying the sods shall start at the bottom of the slope. The sods shall be butted tightly against each other, and care shall be taken not to stretch or overlap the sods. Where a good fit cannot be obtained, any intervening spaces shall be filled with topsoil. The next row shall be similarly placed tightly against the bottom row with staggered joints, and so on until the entire area has been covered with sods. On steep slopes, when instructed by the Engineer, the sods shall be held in position by a sufficient number of wooden stakes approximately 300 mm long by 20 mm in thickness and these stakes shall be knocked into the subsoil to a depth of 100 mm.

The Contractor shall water the sods directly after they have been placed to prevent undue drying out. As sodding is completed, each section shall be lightly rolled and thoroughly watered.

(c) **Hydroseeding**

Where it is specified that hydroseeding is to be carried out on topsoil, the thickness of the topsoil shall be as specified in the Project Specifications or as directed by the Engineer.

The types and mixtures of seeds to be used shall be as specified in the Project Specifications or, if not so specified therein, shall be agreed on by the Engineer and the Contractor before any seed he may wish to use is ordered by the Contractor. The Contractor shall be solely responsible for establishing an acceptable grass cover, and any approval by the Engineer of seed or seed mixtures intended for use by the Contractor shall not relieve him of this responsibility.

A mulch shall be added to the hydroseeding mix at an approved rate.

Hydroseeding shall then be carried out with an approved hydroseeding machine at a rate of application of not less than 38 kg of seed mixture per hectare, unless otherwise specified in the Project Specifications.

When the use of anti-erosion compounds is required and such compound is to be applied simultaneously with the hydroseeding, it shall be mixed with the hydroseeding mixture before application.
(d) **Topleveling only**

Where, in the opinion of the Engineer, the planting of grass or hydroseeding can be dispensed with on account of favourable climatic and other conditions, he may attempt to establish grass by topsoiling only. Topsoil shall be selected for the presence of natural grass and seeds and shall be removed and placed whenever possible at a time that would favour the establishing of grass. These areas shall be treated with an anti-erosion compound, if so instructed by the Engineer.

After the topsoil has been placed, it shall be lightly rolled and well watered, and afterwards watered and mown whenever instructed by the Engineer.

The Contractor will not be held responsible for establishing an acceptable grass cover as defined in Subclause 5706(b) when this procedure is followed, but will be responsible for the consequences of any omission to water, weed or mow the grass as instructed by the Engineer.

No payment for grassing shall be made other than for placing topsoil, and for mowing and watering the grass, which will be paid for at the tendered rates, and for any replanting of grass on bare patches, repairs caused by erosion, and similar work, which will be paid for as extra work in terms of the General Conditions of Contract.

(e) **Grassing with an approved grassing machine**

Grassing shall be done with an approved grass planter which plants the seeds in rows spaced not more than 250 mm apart. The planter shall plant the seeds approximately 6 mm deep and shall lightly compact the soil. The prescribed fertiliser may be distributed simultaneously with the grass planting.

(f) **Hand seeding**

If approved by the Engineer, sowing may be done by hand. The seed shall be spread uniformly over the surfaces and then lightly raked into the soil.

(g) **Other methods**

Whenever specified in the Project Specifications, other methods of grassing may be employed.

(h) **The grassing of borrow pits, temporary bypasses, camp sites, access roads and stockpile sites**

Prior to any grassing that may be required on such areas, the finishing-off of borrow pits as described under Clause 3105, obliterating the bypasses and access roads as described in Clauses 1516 and 5803 respectively, and the clearing of camp sites as described in Section 1300, shall have been carried out as specified in the relevant Sections.

**Note:** With regard to Subclauses 5705 (e) and (f), the areas to be grassed shall be prepared as described in Clause 5704 and the areas shall be thoroughly watered after completion of the operation. Also if so instructed by the Engineer, an anti-erosion compound shall be applied.

5706 **MAINTAINING THE GRASS**

(a) **Watering, weeding, mowing and replanting**

All sodded and grassed areas shall be adequately watered at regular and frequent intervals to ensure the proper germination of seeds and growth of grass until the grass has established an acceptable cover and thereafter until the beginning of the maintenance period of the grass. The quantity of water and the frequency of watering shall be subject to the Engineer’s approval. With hydroseeding the commencement of watering may be postponed until a favourable time of the year, but watering shall in any case commence and continue as soon as the seeds have germinated and growth has started.

The Contractor shall further mow the grass on all areas where grass has been established whenever so instructed by the Engineer, until the end of the maintenance period. All grass cuttings shall be collected and disposed of if so directed by the Engineer. Weeds shall be controlled by approved means. Any bare patches where the grass has not taken or where it has been damaged or has dried out shall be recultivated, planted, sodded or hydroseeded at the Contractor’s own expense.

All grassed areas shall have an acceptable cover as defined below at both the beginning and the end of the maintenance period.

(b) **Acceptable cover**

An acceptable grass cover shall mean that not less than 75% of the area grassed or hydroseeded shall be covered with grass and that no bare patches exceeding 0.25 m² in any area of 1.0 m x 1.0 m shall occur. In the case of sodding, acceptable cover shall mean that the entire area shall be covered with live grass at the end of any period not less than three months after sodding.

(c) **Maintenance period**

The maintenance period in respect of grass shall commence when an acceptable grass cover as defined in (b) above has been established and shall be one year. This means that the maintenance period in respect of grass can commence earlier or later than the maintenance period for other parts of the Contract.

If the maintenance period in respect of grass expires before the end of the maintenance period for the other roadworks, the Contractor shall further mow the grass on such areas as instructed by the Engineer up to the end of the maintenance period for the other roadworks. For mowing that is executed after the maintenance period in respect of grass has expired, the Contractor shall be paid under Item 57.07.

5707 **TREES AND SHRUBS**

(a) **Positions of trees and shrubs**

The localities where trees and shrubs are to be planted are as follows:

(i) Trees and shrubs shall be planted at locations shown on the Drawings.
(ii) Plants in the median shall be planted in a line 1.5 m from the centre line of the median or as directed by the Engineer.

(iii) When the carriageways are at different levels, the plants in the median shall be planted 2 m from the edge of the shoulder on the high side of the median or as directed by the Engineer.

(iv) Where the road curves, the plants in the median shall be planted on the inside of the median centre line.

(v) Where the carriageways are at different levels as well as on a curve, the plants in the median shall be planted on the high side, provided they do not impede on sight distance, or as directed by the Engineer.

(vi) At freeway crossings over roads or rivers, shrubs shall be planted in the positions shown on the Drawings.

(vii) At the headwalls of culverts or similar structures, trees and/or shrubs shall be planted to indicate the positions of these structures. The locations for planting the plants shall be as shown on the Drawings or as directed by the Engineer.

(viii) Care shall be taken not to obscure traffic signs by plants.

(ix) Trees shall not be planted closer than 10 m from the yellow line on the outside shoulder.

(b) Preparing plant holes

Unless otherwise directed by the Engineer, holes shall be spaced and prepared as follows:

(i) All holes shall be square in plan.

(ii) Holes for hedge plants and shrubs shall be at least 500 mm square by 600 mm deep and 1.5 m from centre to centre. Alternatively a 500 mm wide trench 600 mm deep may be dug.

(iii) Holes for trees shall be at least 600 mm square by 700 mm deep.

(iv) The holes for plants shall be refilled with selected and approved topsoil thoroughly mixed with manure or compost (one heaped spadeful added to every plant hole) and, depending on soil-test reports, the required quantity and type of fertiliser.

(v) The holes shall be thoroughly watered before plants are planted. Where the soil is poorly drained, 150 mm of crushed stone shall be placed at the bottom of the hole before it is filled with soil.

(c) Planting

Before trees, shrubs and hedging plants are removed from their containers for planting, they shall be well watered.

Directly after having been planted, each plant shall be well watered with a view to settling the soil. After the soil has settled, additional soil shall be added where necessary to bring the replaced soil in the hole to within 150 mm of the ground surface, so as to ensure that sufficient water can be retained in the hole around the plant. All trees shall be tied to a suitable creosote-treated timber stake with a minimum diameter of 35 mm or other suitable stake as approved by the Engineer and firmly planted in the ground. The stake shall be 300 mm longer than the planted tree, and its maximum length shall be 1.5 m above ground level. After planting, the ground surface around the plant shall be covered with straw or grass or any other type of mulch to minimise evaporation.

(d) Maintenance

During the period of maintenance, which shall be twelve months after completion of the actual planting of trees, shrubs and hedges, the Contractor shall be responsible for watering the trees, shrubs and hedges and keeping the plants free from weeds and pests.

Every hedge plant, tree or shrub, which is not healthy or shows unsatisfactory growth shall be replaced by the Contractor at his own expense, within one month of having been notified by the Engineer, in writing.

5708 GENERAL

(a) Time of planting

Grass, trees and shrubs shall be planted as far as is practicable during periods of the year most likely to produce best growing results. The Contractor shall make every effort to programme his operations in such a manner that grass, trees and shrubs shall, as far as is possible, be planted during this period.

(b) Traffic on grassed areas

The Contractor shall not plant any grass until all operations which may require road-building equipment to be taken over grassed areas have been completed. No road-building equipment, trucks or water carts shall be allowed onto areas which have been grassed and only equipment required for the preparation of areas, application of fertiliser, spreading of topsoil, watering and mowing will be allowed to operate on areas to be grassed. All damaged areas shall be reinstated by the Contractor at his own expense.

(c) Erosion prevention

During construction the Contractor shall protect all areas susceptible to erosion by installing all the necessary temporary and permanent drainage works as soon as possible and by taking such other measures as may be necessary to prevent the surface water from being concentrated in streams and from scouring the slopes, banks or other areas.

Any runnels or erosion channels developing during the construction period or during the maintenance period shall be backfilled and compacted, and the areas restored to a proper condition. The Contractor shall not allow erosion to develop on a large scale before effecting repairs and all erosion damage shall be repaired as soon as possible and in any case not later than three months before the termination of the maintenance period. All topsoil or other material accumulated in side drains shall be removed at the same time. Topsoil washed away shall be replaced.
(d) Proprietary brand materials used for erosion prevention

Certain proprietary brands of materials which may be necessary for erosion prevention to enable natural grass to become established, shall, if required, be specified in the Project Specifications. The method according to which the material is to be applied, the surface preparation required, the type of material to be provided and the method of payment shall be as specified in the Project Specifications.

(e) Responsibility for establishing an acceptable cover

Notwithstanding the fact that the Engineer will determine the method of grassing and that the type of seed or grass used and the rate of application of the seed may be specified or agreed on by the Engineer, and that the frequency of mowing will be as ordered by him, the Contractor shall be solely responsible for establishing an acceptable grass cover and for the cost of replanting grass or re-hydroseeding where no acceptable cover has been established. Where however, in the opinion of the Contractor, it is doubtful from the outset if it will be possible to establish an acceptable cover he may inform the Engineer of his reasons therefor, and the Engineer may, if he agrees, either adopt another method of grassing or agree to accept whatever cover can be obtained, provided that all reasonable efforts shall be made to establish a good grass cover by the proposed method. Any such agreement shall be valid only if given in writing by the Engineer beforehand.

In the case of grassing by topsoiling only the Contractor will not be held directly responsible for establishing an acceptable grass cover but will be held responsible for the consequences of supplying workmanship which does not conform to the Specifications, or for lack of proper care.

(f) Re-fertilising

Should it become necessary, the Engineer may instruct the Contractor to undertake a Re-fertilising programme on grassed areas during the twelve month maintenance period. Payment for re-fertilisation will be made under Subitem 57.03(e).

5709 MEASUREMENT AND PAYMENT

Item | Unit
--- | ---
57.01 Trimming:
(a) Machine trimming ........ square metre (m²)
(b) Hand trimming ............ square metre (m²)

Note: All bulk earth-moving operations as described under shaping in Subclause 5703(a) shall be measured and paid for under Section 3300.

The unit of measurement for trimming shall be the square metre of area trimmed on the instruction of the Engineer, including areas trimmed after having been shaped. No trimming within the road prism shall be measured for payment.

The tendered rates shall include full compensation for trimming the areas to the specified finishing requirements, including the moving of a small quantity of material which would be inherent in this process and the removal of surplus material and stones. Payment shall distinguish between machine trimming which can reasonably be done by bulldozer or motor grader, and hand trimming.

Item | Unit
--- | ---
57.02 Using machines for trimming or shaping (alternative to Subitem 57.01(a)):
(a) Bulldozer ....................... hour (h)
(b) Motor grader ..................... hour (h)

The unit of measurement shall be the hour actually worked by each machine in trimming or shaping areas. Standing time will not be measured.

The tendered rates shall include full compensation for furnishing and using the machines, including the cost of fuel, operators, maintenance, transporting the machine to and from the point where it is to be used, and for all other incidentals necessary for carrying out the work.

Item | Unit
--- | ---
57.03 Preparing the areas for grassing:
(a) Ripping ................... hectare (ha)
(b) Ploughing ................... hectare (ha)
(c) Topsoiling within the road reserve, where the following materials are used:
   (i) Topsoil obtained from within the road reserve or borrow areas (free-haul 1.0 km) ........ cubic metre (m³)
   (ii) Topsoil obtained from other sources by the Contractor (including all haul) ........ cubic metre (m³)
   (d) Topsoiling of borrow pits by using topsoil obtained from borrow areas or from the road reserve (free-haul 1.0 km) ........ cubic metre (m³)
   (e) Providing and applying chemical fertilisers and/or soil-improvement material:
      (i) Lime ......................... tonne (t)
      (ii) Superphosphate .............. tonne (t)
      (iii) Limestone ammonium nitrate ...... tonne (t)
      (iv) 2:3:2(22) .................... tonne (t)
      (v) 3:2:1(25) .................... tonne (t)
(vi) Other fertilisers and/or soil-improvement materials if required (type stated) ................. tonne (t)

(f) Stockpiling topsoil ............... cubic metre (m³)

(a) Ripping

The unit of measurement for ripping shall be the hectare of soil ripped. Only areas ripped on the written instructions of the Engineer shall be measured for payment.

The tendered rate shall include full compensation for ripping, complete as specified.

Ploughing for loosening the soil will be paid for under Subitem 57.03(b).

(b) Ploughing

The unit of measurement for loosening the topsoil by ploughing shall be the hectare of soil loosened and prepared in accordance with the Specifications. Only areas loosened by ploughing on the written instructions of the Engineer shall be measured for payment.

The tendered rate shall include full compensation for loosening the topsoil by ploughing, removing stones, and levelling and trimming the surface.

(c) and (d) Placing the topsoil

The unit of measurement shall be the cubic metre of topsoil applied at the specified thickness or as directed by the Engineer, measured in situ after the topsoil has been placed. The quantity shall be calculated from the net area of the topsoiled surface multiplied by the average thickness of the topsoil but before the grass sods are placed. Any topsoil placed in excess of the average thickness specified or prescribed will not be measured for payment.

Payment shall distinguish between topsoil obtained from designated areas within the road reserve or borrow areas and topsoil obtained by the Contractor from outside sources when sufficient topsoil is not available from the designated areas mentioned above. Payment shall further distinguish between topsoil applied to slopes, at interchanges and at other areas within the road reserve and topsoil applied at borrow areas.

The tendered rates shall include full compensation for excavating and loading the topsoil, any royalties or compensation that may be payable in the case of topsoil under Subitem 57.03(c), transport (except overhaul), off-loading, placing and spreading it to the required thickness, levelling it off to a smooth surface, for removing any stones as specified and for roughening the surface to be topsoiled.

The free-haul distance of topsoil obtained from the road reserve or borrow areas shall be 1.0 km. The tendered rate for topsoil under Subitem 57.03(c) shall also include full compensation for transporting the topsoil to the point of eventual use.

(e) Providing and applying fertiliser and/or soil-improvement material

The unit of measurement for fertiliser shall be the tonne of each type of fertiliser and/or soil-improvement material ordered and applied.

The tendered rates shall include full compensation for furnishing the fertiliser and/or soil-improvement material, transporting it to the point of use, spreading and mixing it into the scarified soil or topsoil, irrespective of the method of application.

(f) Stockpiling the topsoil

The unit of measurement shall be the cubic metre of topsoil stockpiled on the written instructions of the Engineer where this operation is unavoidable despite proper advance planning. Only material actually loaded, transported to and stockpiled on sites designated for stockpiling will be measured, but not any material merely pushed or bladed into heaps next to the area from which it is taken, unless it was done with the prior approval of the Engineer, and the material was stockpiled in an approved area.

The tendered rate shall include full compensation for loading the topsoil, placing it in stockpile and for any payments to private Owners for the use of stockpile areas.

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</table>

(a) Planting grass cuttings

The unit of measurement for planting grass cuttings shall be the hectare of established grass with an acceptable grass cover.

The tendered rate shall include full compensation for furnishing and planting the cuttings, watering, weeding, and replanting if necessary, and all other incidentals which may
be necessary for establishing an acceptable cover and maintaining the grass, except mowing.

(b) **Sodding**

The unit of measurement for sodding shall be the square metre covered with sods, which has an acceptable cover.

The tendered rates shall include full compensation for procuring, excavating, loading, transporting, off-loading, placing and watering the sods, for replanting dead areas, for watering and weeding the grass, for supplying and placing timber stakes and for all other incidentals, except for mowing, which may be necessary for establishing an acceptable cover, and maintaining the grass. Payment shall distinguish between nursery-grown sods and veld sods obtained from within the road reserve or borrow areas. In the case of veld sods the tendered price shall include levelling-off and trimming areas from which the sods are taken.

(c) **Hydroseeding**

(i) The unit of measurement for providing seed shall be the kilogram of seed of the specified seed mixture. The mass of any pulp added shall not be measured.

The tendered rate shall include full compensation for procuring and furnishing the seeds.

(ii) The unit of measurement for hydroseeding shall be the hectare of grass established by hydroseeding, which has an acceptable cover.

The tendered rate shall include full compensation for furnishing cellulose pulp and mixing it with seed and water and with any anti-erosion compound if required, applying the mixture, watering, weeding, re-hydroseeding bare patches, and for any other work, except mowing, which may be necessary for establishing an acceptable cover and maintaining the grass.

(d) **Grassing with an approved grass planter**

The unit of measurement for planting any grass seeds by using an approved planter shall be the hectare of grass with an acceptable cover, where the seed has been planted with an approved planter.

The tendered rate shall include full compensation for all labour, material, equipment, weeding, and all incidentals which may be necessary for planting the grass seeds and establishing an acceptable grass cover. The tendered rate shall also include full compensation for watering the planted areas until an acceptable grass cover has been established. Payment for the grass seed will be separate under Subitem 57.04(c).

(e) **Hand-sowing**

The unit of measurement for hand-sowing the grass seeds shall be the square metre of grass with an acceptable covering on surfaces instructed by the Engineer to be hand-sown.

The tendered rate shall include full compensation for all labour, material, equipment, weeding, and all incidentals which may be necessary for planting the grass seeds and establishing an acceptable grass covering. The tendered rate shall also include full compensation for watering the planted areas until an acceptable grass covering has been established. Payment for the grass seeds shall be separate under Subitem 57.04(c).

(f) **Other methods**

Whenever other methods of grassing are specified in the Project Specifications, measurement and payment shall be as specified.

(g) **General**

Half the payments under Item 57.04 will become due when the grassing or hydroseeding has been done, and the remainder will become due when satisfactory cover has been established.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>57.05</td>
<td>kilolitre (kL)</td>
<td>Watering the grass when established by topsoiling only.</td>
</tr>
<tr>
<td>57.06</td>
<td>kilolitre (kL)</td>
<td>Watering the already planted grass, trees and shrubs planted during periods of drought experienced during the growing season.</td>
</tr>
<tr>
<td>57.07</td>
<td>hectare (ha)</td>
<td>Mowing the grass.</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the hectare measured each time when the grass has been cut on the instructions of the Engineer.
The tendered rate shall include full compensation for all plant, equipment and labour, required for every cutting of the grass and disposing of the grass cuttings, i.e., payment will be made every time the grass has been cut on the instructions of the Engineer.

**Item**

**57.08 Anti-erosion compound**

(specific) ................................ kilogram (kg)

The unit of measurement shall be the kilogram net mass of anti-erosion compound used with the approval of the Engineer.

The tendered rate for each kilogram of anti-erosion compound applied with the hydroseeding or by itself shall include full compensation for furnishing the material and mixing and applying it during hydroseeding or by itself.

**Item**

**57.09 Trees and shrubs**

(a) Providing the trees and shrubs (types indicated) ...................... number (No)

The unit of measurement shall be the number of each species or variety of tree and shrub furnished and established.

The tendered rate shall include full compensation for furnishing the plants at the point of final use, including substitutes for plants which may become diseased or die.

(b) Planting and establishing:

(i) Trees ................................ number (No)

(ii) Shrubs ................................ number (No)

The unit of measurement shall be the number of each type planted and established.

The tendered rates shall include full compensation for excavating the holes to the specified dimensions, furnishing topsoil, wooden stakes, crushed stone, manure and compost and mixing them together with any fertiliser required for planting and refilling each hole with the topsoil mixture and other soil, for watering the plants until the end of the maintenance period, furnishing and planting substitutes for plants that have died and for maintaining the plants as specified until the end of the maintenance period, including any other incidentals which may be necessary for properly executing the work. Where the Employer furnishes the plants, the above rates shall also include full compensation for taking delivery of the plants, maintaining them until required, transporting them to point of final use, and for providing substitutes for plants which die or become diseased during storage.

Any chemical fertiliser and/or soil-improvement material required will be measured and paid for under Subitem 57.03(c).

**Item**

**57.10 Extra work for landscaping** .......................... provisional sum

The provisional sum allowed shall be expended at the discretion of the Engineer to cover the cost of work in addition to the scheduled Items which may be required in respect of shaping and trimming areas where plant is used at hourly rates, e.g., the cost of loading and transporting surplus material, establishing grass by topsoiling only, repairing erosion damage after topsoil has been applied, or any other Items of work required for which no pay Items have been provided.

Payment shall be made as specified in Subclause 1209(f).

**Item**

**57.11 Weeding all grass-seeded areas and the grass when established by topsoiling only** .......................... hectare (ha)

The unit of measurement for weeding all grass-seeded areas that have been topsoiled on the instruction of the Engineer (but have not been hydroseeded or planted with grass), shall be the hectare.

The tendered rate shall include full compensation for weeding the prescribed areas in accordance with the Specifications.

**Note:** Measurement and payment for overhaul shall be as specified in Item 16.02, but no overhaul shall apply to topsoil paid for under Subitem 57.03(c).
SERIES 5000 : ANCILLARY ROADWORKS

SECTION 5800 : FINISHING THE ROAD AND ROAD RESERVE AND TREATING OLD ROADS

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5801 SCOPE
5802 FINISHING THE ROAD AND ROAD RESERVE
5803 TREATING OLD ROADS
5804 MEASUREMENT AND PAYMENT

5801 SCOPE

This Section covers the final finishing and cleaning up of the road and road reserve after construction, and scarifying and treating old roads and temporary diversions.

The Contractor shall note that this Section does not cover the finishing which has to be done under Sections 1700, 3100, 3300 and Section 5700.

5802 FINISHING THE ROAD AND ROAD RESERVE

After completing the seal or surfacing, or gravel surface on gravel roads, the road and road reserve shall be cleared of all excess earth, stones, boulders, debris and other waste material resulting from the construction of the Works and disposed in an approved waste site. All finishing and clearing not previously done or completed as specified in the Sections of the Specifications set out in Clause 5801 above shall be completed. This specification, however, does not intend the finishing, clearing and maintenance which must be done as provided for in other Sections of these Specifications, to be postponed until the final finishing operations provided for in this Section.

Culvert inlets and outlets, culvert barrels, and open drains shall be cleared of all debris, soil, silt and other material. The surfacing shall be cleared of all dirt, mud and foreign objects. Dragging, pushing or scraping material across the finished surfacing shall not be permitted.

All junctions, intersections, islands, kerbing and other elements making up the completed Works shall be neatly finished off.

The Contractor shall ensure that all declared noxious weeds have been removed from the road-reserve and borrow-pit areas. All noxious weeds shall be burnt to prevent the spread of the seed and cut stumps or coppice shall be sprayed with a suitable herbicide.

All soil, stones, boulders and indigenous plant material resulting from the finishing operations shall be disposed of at locations not visible from the road, and where they will not pollute water sources or create a hazard for livestock or wildlife (eg old borrow pits). All other waste such as drums, excess steel, litter, etc which cannot be sold or recycled shall be dumped in an approved waste site. The Contractor himself shall make his own arrangements with the Owners of properties on which such materials are to be deposited. Disposal shall be carried out in a neat and uniform manner. Any borrow pits used for material disposal shall be finished off as described in Clause 3106. Any other areas used for material disposal shall be shaped so as to blend with the surrounding area and to permit the re-establishment of vegetation. Should the Engineer require landscaping and grassing to be performed, it shall be done in accordance with Section 5700.

5803 TREATING OLD ROADS

All old roads, temporary diversions, haul roads and construction roads shall, in so far as is practicable, be levelled with the original ground. Surfaces shall be scarified and broken up to a depth of 150 mm for promoting plant growth. The old roads shall be rehabilitated as shown in the Drawings or as directed by the Engineer and shall be revegetated in accordance with Section 5700.

Where required by the Engineer, in order to prevent soil erosion, banks, dykes or ditches shall be constructed over the old road to dimensions ordered by the Engineer. All roads and temporary diversions treated as above, shall be left in a neat and tidy state.

5804 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>58.01 Finishing the road and road reserve:</td>
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</tr>
<tr>
<td>(a) Dual carriageway road ............... kilometre (km)</td>
<td></td>
</tr>
<tr>
<td>(b) Single carriageway road ............... kilometre (km)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the kilometre of road measured along the centre line. No separate measurement shall be made of ramps at interchanges.

The tendered rates shall include full compensation for clearing, trimming, disposing of material, tidying and all other work to be done for finishing off the road and road reserve as specified.

Any landscaping and grassing shall be measured and paid for under Section 5700.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>58.02 Treatment of old roads and temporary diversions ............. kilometre (km)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the kilometre of old road or temporary diversion treated.

Any landscaping and grassing shall be measured and paid for under Section 5700.

The construction of banks, dykes or ditches shall be measured and paid for under Section 2100.

The tendered rate shall include full compensation for levelling and scarifying any surfaces and tidying old roads and diversions as specified.

No payment will be made in regard to treating haul roads and construction roads, for which the Contractor shall make allowance in his rates for constructing the relevant items of work for which such roads are necessary.

5800-1
This Section covers the painting of structural steel, guard rails, overhead road sign supports and other structures according to the requirements of the various Sections of these Specifications where painting is called for. It does not include the treatment of timber posts which are included under Subclause 5202 (b).

Paints shall comply with the requirements of the following Specifications:

(a) Primers

Zinc-chromate primers for steel ........................................... SABS 679 (Type 1 or Type 2, Grade II) or equivalent
Wash primer (metal etch primer) ................................. SABS 723 or equivalent
Calcium-plumbate primer ................................................. SABS 912 or equivalent
Two-pack Zinc-rich epoxy primer .......................... SABS 926 or equivalent

(b) Undercoats

Undercoat ............................................................. SABS 681 (Type II) or equivalent

(c) Finishing coats

Decorative enamel for interior and exterior use ....................... SABS 630 or equivalent
High-gloss paint ......................................................... 684 (Type A) or equivalent

Micaceous iron-ore-pigmented paint ........................................ SABS 684 or equivalent
Baking enamels ............................................................ SABS 783 or equivalent
Emulsion paint for exterior use (polyacrylic) .......................... SABS 634 or equivalent
Chloro-rubber paint ...................................................... SABS 1413 or equivalent
Bituminous aluminium paint .......................................... SABS 802 or equivalent
Epoxy-tar paints .......................................................... SABS 801 (Type I) or equivalent
Bonding liquid for concrete surfaces ............................. CKS 564 or equivalent

Bituminous-emulsion paint shall consist of a stable bituminous emulsion with a minimum of 45% of bitumen and about 5% of approved fibre.

No paint shall be applied to surfaces containing physically adhering contaminants such as oil, grease, dirt, marking material, water-soluble salts, wax, paint and temporary protectives, or to surfaces containing chemically bonded contaminants such as rust, mill scale, slag and flux.

All surfaces which are to be painted shall be dry. Unless otherwise stated, subsequent coats of paints shall be applied over dry paint surfaces.

All traces of soluble salts and corrosive airborne contaminants shall be thoroughly washed from the surface prior to painting, and the surface shall be dried and painted immediately afterwards.

Where surfaces are to be welded, unless otherwise specified, any paint shall not be applied within 75 mm of the weld position.

After the welding has been completed, the welds and adjacent parent metal shall be completely deslagged, and the surfaces shall then be inspected and approved by the Engineer. All spatter shall be removed prior to the surfaces being painted. The weld area shall be abrasive-blasted and/or ground and all contaminants such as flux shall be removed prior to the surface being painted.

Surfaces which are to rest on concrete or other floors shall receive all the prescribed coats of paint prior to the member being erected.

Damaged paint areas shall be cleaned, rust spots removed and the surface again be primed so that the patch painting covers the damaged areas and extends over a strip of 20 mm beyond each damaged area.

Where the shop coat is allowed to age for a few months before the next layer of paint is applied, light sanding with...
sandpaper or rubbing with steel wool and scrubbing with clean water with a bristle brush shall be carried out. Steel to be embedded in concrete shall be entirely painted to a distance of 50 mm within the concrete measured from the concrete outer surface.

The paint manufacturer’s instructions shall be strictly adhered to. Painted steel members shall be stacked so as to be off the ground. Friction-grip surfaces shall not be painted but shall be treated in accordance with the Project Specifications.

5904 APPLYING THE PAINT

Unless otherwise specified, paint may be applied either by brush, spray or roller method, or by any combination of these three methods.

Where brushes are used, they shall have sufficient body and length of bristle for spreading the paint in a uniform coat. Paint shall be evenly spread and thoroughly brushed out. If brush marks are visible, it will be considered that the paint has been improperly applied, and the paint will not be accepted.

On all surfaces which are inaccessible to painting by regular painting equipment, the paint shall be applied by bottle brushes, sheepskin daubers, or by any other acceptable method so as to render the required coating of paint.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, skips, or where air bubbles have formed or the paint has delaminated, shall be considered as being unsatisfactory, and the Contractor will be required to repaint the surface by brush.

A water trap and an air-regulating valve acceptable to the Engineer shall be furnished and installed on the equipment used for spray-painting.

Mechanical mixers shall be used for mixing paint properly when no ready-mixed paints are used. Prior to application, the paint shall be remixed for a sufficient length of time to mix the pigment and vehicle thoroughly. Paint shall be constantly kept well stirred to keep the pigments in suspension during its application. All skins in the paint shall be removed by screening. If it cannot be removed effectively, the paint and paintwork already completed may be condemned at the discretion of the Engineer.

Paint shall not be applied when the temperature of the surface to be painted is not at least 3°C above dew point or when the temperature of the steel is below 5°C or above 35°C, unless otherwise prescribed by the Engineer.

Paint shall not be applied in fog or mist, when it is raining or when rain is expected, or when the relative humidity is above 90%.

5905 PROTECTING THE WORKS DURING PAINTING OPERATIONS

The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes and/or smirches of paint or of paint materials. The Contractor shall be responsible for any damage to or paint on or contamination to vehicles, persons or property, including plants and animals, as a result of his operations, and he will be required to provide protective measures at his own cost to prevent such damage.

Any unsightly paint stains shall be removed by the Contractor at his own cost.

If passing traffic creates sufficient dust to harm or spoil the appearance of painted surfaces, the Contractor shall sprinkle the adjacent roads and shoulders with water at his own cost, for a sufficient distance on each side of the location where the painting is being done, to keep the dust away from freshly painted surfaces. The Contractor shall, at his own cost, also furnish and post DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from adhering onto freshly painted surfaces.

5906 PREPARING SURFACES FOR PAINTING

Before paint is applied to any surface, the appropriate specified surface preparation shall be carried out in accordance with the paint manufacturers recommendations.

5907 PAINTING STRUCTURAL STEEL

(a) General

This Section includes the painting of steel guard rail posts, steel road sign supports and steel sign face frames, where required.

The surface preparation, priming and application of an undercoat shall be carried out under cover at the fabricator's works. Where possible, all painting shall be done at the fabricator's works but, where this is not feasible, the Engineer may permit the application of the finishing coats on the site, in which case an undercoat shall be applied at the fabricator's works prior to the members being despatched to the Works.

Unless otherwise specified, the protection described in Subclauses 5907(c), (d) and (e) shall be applied to all steel work. Corrosion protection of steel work exposed to aggressive or severe conditions shall comply with the requirements of the Project Specifications.

(b) Surface preparation

(i) New structures

After all cutting, drilling, welding and punching have been completed, it shall be ascertained that all sharp edges have been uniformly rounded off and smoothed down. All physically adhering contaminants shall be removed and the surface shall then be abrasive-blasted to Sa 2½ finish in accordance with the Swedish Standard SIS 05/59/00 or equivalent. The profile limit of the surface finish shall be between 30 and 60 µm. The abrasive-blasting profile shall be measured in accordance with SABS Method 772 or equivalent and shall comply with SABS Code of Practice 064 or equivalent.

No abrasive-blasting shall be done during rainy weather or when corrosive air conditions prevail.
Unless the application of a primer follows within four hours of abrasive blasting and before any oxidation of the prepared surface takes place, the abrasive-blasted surface shall immediately after abrasive blasting be given one coat of a wash primer.

(ii) Existing structures
The surface preparation of existing structures shall be carried out on site in accordance with SABS 064 or equivalent.

(c) Primer
The prepared surface shall be given two coats of a zinc-chromate primer in accordance with SABS 679, Type 1, Grade II or equivalent. The first coat shall be applied within 12 hours in the case of wash-primed surfaces and within four hours, but before any oxidation of the surface takes place, in the case of abrasive-blasted surfaces that have not been wash-primed. A fast-drying zinc chromate in accordance with SABS 679, Type II, Grade II or equivalent, may be used as primer. In all cases the dry-film thickness shall not be less than 30 µm per coat.

When steel has to be welded after the primer has been applied, the steel shall be left unpainted for a distance of 75 mm from the weld joint unless a weldable type of paint has been used. The welds shall be treated in accordance with the instructions of Clauses 5903 and 5907.

(d) Undercoat
Where the finishing coats are to be applied on the site, the primed surfaces shall be given one coat of a universal undercoat with a suitable colour in the fabricator's shop before despatch. The undercoat shall be applied as soon as the prime coat has dried sufficiently. The dry-film thickness shall not be less than 25 µm.

(e) Finishing coat
Two finishing coats of high-gloss structural paint (SABS 684, Type A or equivalent) of the specified colour shall be applied to leave a dry-film thickness of not less than 25 µm per coat.

Where the finishing coats are applied on the site, the undercoat shall be lightly sanded and the members washed and cleaned of all contaminants. The first finishing coat shall be applied as soon as the structural members are dry.

Where specified in the Project Specifications, the second finishing coat shall consist of a micaceous iron-ore-pigmented structural paint of the specified colour to a dry-film thickness of not less than 30 µm. Unless otherwise specified, the second finishing coat shall be applied within 48 hours of the application of the first finishing coat.

The dry-film thickness of the total paint system shall not be less than 110 µm when no undercoat is used and not less than 135 µm when an undercoat is used. Where the second finishing coat is an iron-ore-pigmented paint, these thicknesses shall be increased by 5 µm.

(f) Mating surfaces
When mating surfaces are brought together, both surfaces shall already have been covered with all the specified coats of paint, but, where this is impossible, each surface shall be given a copious coating of primer and the surfaces drawn up while the paint is still wet.

(g) Back-to-back members and areas not easily accessible
Back-to-back members and areas not easily accessible shall be fully coated with all the specified coats of paint up to and including the finishing coats before erection.

(h) Damaged areas
Damaged areas shall be treated as follows:
Sand down to bright metal and clean. Spot prime with two coats and sand down lightly when hard. Rinse off with water and allow to dry. Apply two finishing coats.

(i) Structural steel to be embedded below ground
Those parts of structural-steel members to be embedded in soil and all bases to a height of 500 mm shall be given two coats of an epoxy-tar prime instead of the zinc-chromate prime specified for other surfaces.

5908 PAINTING GUARD RAILS

(a) General
This Section covers the painting of guardrails, should it be prescribed. The painting of steel guardrail posts is covered in Subclause 5907 and the treatment of timber guardrail posts is covered in Subclause 5202 (b).

(b) Surface preparation and priming
All dirt, loose mill scale and loose corrosion products shall be removed by hand or power tools and all rust and mill scale by pickling, after which the surface shall be rinsed. A neutralising rinse shall also be applied, or the surface shall be phosphated.

(c) Priming
Apply two coats of zinc-chromate primer to a dry-film thickness of not less than 20 µm per coat.

After the prime coats have hardened, the guard rails may be transported to the site.

(d) Storage on the site
The primed guard rails shall be stored off the ground under cover and protected against rain and weather until erection. Guard rails shall be stacked individually and not nested so as to prevent corrosion during storage. The finishing coats shall be applied as soon as possible and the primed surfaces shall not be allowed to corrode as a result of prolonged exposure to the weather. Any guard rails showing signs of rust before the application of the finishing coats shall be rubbed down with steel wool or fine sandpaper until all rust is removed, and it shall then be recoated with a zinc-chromate primer.
Before the first finishing coat is applied, the guard rails shall be thoroughly washed down to remove all traces of salt and/or other air-borne corrosive materials and all dirt or other contaminants.

As soon as the rinsed guard rails are dry, a finishing coat of aluminium paint in accordance with SABS 802 or equivalent or a white high-gloss enamel in accordance with SABS 684 or equivalent shall be applied to a dry-film thickness of not less than 25 µm. Within 48 hours this shall be followed by a second coat as described before.

The guard rails shall preferably be given both finishing coats before erection, but, where this is impossible, the Engineer may permit the finishing coats to be applied after the guard rails have been erected, provided that all mating surfaces and spots which are not easily accessible shall be painted with the finishing coats before the guard rails may be erected.

The total dry-film thickness of all coats of the paint shall not be less than 90 µm. All damaged spots shall be treated as specified in Subclause 5907(h).

5909 PAINTING CONCRETE

(a) Surface preparation

The surface of the concrete to be painted shall be cleaned of all dust, loose particles, laitance, impurities and other deleterious materials, and then washed and allowed to dry.

Unless the surface is to be covered with a bituminous paint, all cracks, holes and cavities shall be filled with grout or an acrylic filler.

(b) Sealing and priming

The surface shall be sealed with an approved clear sealer which complies with CKS 564 or equivalent and then primed with a primer consisting of an undercoat diluted to 50%.

(c) Undercoat and finishing

An undercoat shall be applied after priming, followed by two finishing coats of the prescribed paint.

(d) Bituminous paint

The surface shall be prepared in accordance with the requirements of Subclause 5909(a). Before it dries out, a primer shall be applied in accordance with the instructions of the fabricator of the bituminous paint.

After the primer has been applied, two coats of bituminous paint shall be applied at the rate of 0.75 dl/m²/coat. No paint coat shall be applied unless the previous coat has dried out completely, and no paint shall be applied to the paintwork for so long as any moisture occurs on the surface.

Galvanised surfaces shall be painted as specified in this Section for steel surfaces, except that the surface preparation and priming shall be as follows:

(a) Surface preparation

Freshly galvanised surfaces shall be thoroughly scrubbed down with an approved galvanised-iron cleaner to remove all traces of the resin protective coating.

The surface shall be washed down and scrubbed to remove all traces of grease, oil, dirt, etc.

(b) Priming

Two coats of calcium-plumbate primer shall be applied to a dry-film thickness of at least 25 µm.

The undercoat shall follow within one week of the primer.

5911 MEASURING PAINT THICKNESSES

The dry-film thickness of paint shall be determined in accordance with SABS Method 141 or equivalent.

At least 90% of all thickness measurements shall comply with the minimum specified requirements. The thickness shall not in any case be less than 70% of the specified thickness.

5912 MEASUREMENT AND PAYMENT

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<th>Unit</th>
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<tr>
<td>59.01 Painting:</td>
<td></td>
</tr>
<tr>
<td>(a) (Describe structure/article)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>(b) (Describe structure/article)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(c) (Describe structure/article)</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(d) (Describe structure/article)</td>
<td>tonne (t)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of surface painted. Only the surface covered by the final finishing coat shall be measured.

The unit of measurement may also be the number of structures or articles painted, or a metre length of the structures or articles painted, or a tonne of the structures or articles painted, the quantities are calculated as specified in Item 67.01.

The tendered rates shall include full compensation for surface preparation, applying all the coats of paint, repairing any damaged surfaces, and all materials and construction plant necessary for completing the work.
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SERIES 6000 : STRUCTURES

SECTION 6100 : FOUNDATIONS FOR STRUCTURES

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6101 SCOPE

This Section covers all foundation work which, for the purposes of these Specifications, shall comprise those elements of construction below the level of the bottom surface of the footings, the pile-capping slabs or the caisson cover slabs, collectively hereinafter referred to as base or bases, which shall include all the associated temporary works. Foundations for prefabricated culverts are not included but are specified in Section 2200.

6102 MATERIALS

(a) General

Material used in the permanent foundation work shall comply with the requirements specified for the particular material in Series 6000.

(b) Rock (for rock fill)

Stones shall be hard, angular, natural or quarry stones of such quality that they will not disintegrate on exposure to water or weathering. The stones shall be free from soil, clay or organic material. Neither the breadth nor thickness of a single stone shall be less than one-third its length. Not more than 10% of the total volume of rock fill shall consist of stones with a mass of less than 0.5 times the specified mass and not more than 10% of the total volume of rock fill shall consist of stones with a mass of more than 5 times the specified mass. At least 50% of the total volume of rock fill shall consist of stones the mass of which exceeds the specified mass.

(c) Crushed stone

Crushed stone used for the construction of crushed-stone fill shall originate from sound unweathered rock approved by the Engineer.

(d) Granular fill

Granular material used for constructing the compacted granular fill shall be approved granular material of at least gravel subbase quality.

(e) Sand fill

Sand used for filling the caissons shall be clean, hard sand free from lumps of clay or organic or other deleterious matter.

(f) Structural steel

Steel in the steel piles shall comply with the requirements of BS 4360 or SABS 1431 or equivalent, BS EN 10113 and BS EN 10155 for the grade of steel specified on the Drawings. I and H sections shall comply with the requirements of BS 4: Part 1.

Fabricated sections shall comply with the details shown on the Drawings and the requirements of Section 6700.

(g) Permanent pile casings

Permanent pile casings shall be sufficiently rigid so as not to deform permanently or damage during handling and construction. The casings shall be sufficiently dense to prevent the fluid components of the concrete from leaking during the placing of the concrete or thereafter. Where steel casings contribute to the strength of the pile, the casings shall have a minimum wall thickness of 4.5 mm and shall comply with the requirements of ASTM A 252-68. Welded joints shall comply with the requirements of Section 6700.

(h) Driven pile casings

Driven pile casings shall have sufficient strength to permit their being driven and not being distorted by the driving of adjacent piles, and they shall be sufficiently watertight to prevent water leaking through the casing walls during the placing of concrete.

(i) Grouting

(i) Cement grout

Cement grout shall meet the appropriate requirements of Subclause 6503(g).

(ii) Proprietary-brand grout

Proprietary-brand grout shall be prepared and used strictly in accordance with the instructions of the manufacturer.

6103 GENERAL

(a) Subsurface data

The provisions of Clause 1216 shall apply in regard to any information supplied regarding any subsurface conditions likely to be encountered.

If it is found during the course of excavating, founding-pile or caisson work that the soil or founding conditions differ
greatly from those shown on the Drawings, the Contractor shall immediately notify the Engineer.

The Engineer shall, as often as he may deem necessary during the course of excavation, be entitled to call on the Contractor to conduct additional foundation investigations and/or tests at or below the respective founding levels in view of establishing safe bearing pressures and founding depths.

(b) Channel preservation

The flow of the stream and the conservation of marine and freshwater life shall be maintained at all times. Access to cofferdams, artificial islands and piling platforms shall be effected without unnecessarily disrupting the flow of the stream at the point of crossing, unless otherwise specified.

Precautions shall be taken by the Contractor to maintain water quality standards. Water contaminated with silt shall be settled in ponds before being pumped into streams. Water contaminated with chemicals shall be purified before being returned to the stream or disposed of in an appropriate manner as directed by the Engineer. Precautions shall be taken by the Contractor to ensure that the natural pH, electrical conductivity and other indicators as prescribed of the water are not raised or lowered.

On completion of the work, surplus excavated materials, including materials excavated from caisson compartments and holes for piles, materials used in cofferdams and other temporary works, as well as in situ material, shall be removed and disposed of by the Contractor to the level of the original bed or such elevation as agreed to by the Engineer or required for stream channelisation.

6104 ACCESS AND DRAINAGE

(a) General

This Clause covers the provision of access, including the construction of cofferdams, and draining the excavations. Where it is unnecessary to provide access in terms of Subclause 6104(b), the Contractor shall be paid separately for draining the excavations.

After completion of the permanent works, all temporary works shall be completely removed, the ground levelled and the site left neat. Where this is impracticable, such portions as have not been removed, shall be dealt with in accordance with the Engineer's instructions.

(b) Access

Where temporary banks or artificial islands are constructed in view of affording access to the location where structural members, piles or caissons are to be constructed, the banks or islands shall be adequately compacted in view of supporting any plant and material without any undue settling, which may have a harmful effect on the end product.

The Contractor may use any material deemed by him to be suitable for constructing the islands, but he shall note that no separate payment will be made in terms of Items 61.02(b), 61.21, 61.22, 61.23 and 61.47(b) for any obstructions or hard material occurring in the material used for constructing temporary banks or artificial islands.

Designing and constructing any cofferdams shall comply with the requirements of BS 8004. Before starting with construction, the Contractor shall submit drawings to the Engineer, which show details of the cofferdams and the method of construction.

(c) Drainage

The Contractor shall apply suitable, effective drainage methods for preventing the ingress of water into excavations and to keep them dry.

The drainage measures, with the exception of pumping, shall be maintained until the backfilling has been completed. Between the various construction stages pumping may be interrupted in consultation with the Engineer.

Any draining or pumping of water shall be done in a manner that will preclude the concrete or materials or any part thereof from being carried away.

6105 EXCAVATION

(a) General

This work shall include excavations not provided for elsewhere in these Specifications, which are required for founding the structures as well as for the excavating required in respect of the demolition, extension or modification of existing bridges and culverts.

Excavation required for diverting, channelling or widening streams within 5 m of concrete structures shall be measured and paid for under Item 61.02. Excavations beyond the 5 m limit shall be measured and paid for under the appropriate Items of Sections 2100 and 3300.

(b) Surface levels agreed on for excavations

Prior to commencing with any excavation, the Contractor shall notify the Engineer in good time to ensure that levels be taken of the undisturbed ground surface for determining a ground surface from where the excavation can be measured, and this ground surface shall be agreed on by the Engineer and the Contractor.

(c) Excavation

Where, in the opinion of the Engineer, the casting of concrete against the excavated earth faces is not permissible, or where formwork has to be provided, the extremities of the excavation, for purposes of measurement and payment, shall be deemed to be the vertical planes parallel to and 0.5 m outside the perimeter of the member for which formwork is to be provided.

Where suitable stable material is encountered during excavating, that part of the trench or foundation pit shall be excavated to the neat dimensions of the base unless otherwise directed by the Engineer. Over-excavation (overbreak) in hard material shall be backfilled with the same class of concrete as that in the base or with mass concrete fill as specified or as directed by the Engineer.

Where blasting is required, the Contractor shall complete the entire foundation excavation before he commences with the construction of any permanent concrete work, unless otherwise approved by the Engineer.

Boulders, logs or any other unsuitable material excavated shall be spoiled.
When hard material suitable for founding is encountered at the founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as may be required.

Where, in the opinion of the Engineer, unsuitable material is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with Clause 6109 and as directed by the Engineer.

(d) Classification of excavated material

For payment purposes distinction shall be made between excavation in hard and soft material. All excavation for the foundations of structures shall be classified in accordance with the following classification:

(i) Hard material

Boulders with a volume of 0.1 m³ or more;

or

material which cannot be excavated except by drilling and blasting or by using pneumatic tools or mechanical breakers shall be classified as hard material.

(ii) Soft material

All material not classified as hard material shall be classified as soft material.

(e) Blasting

Where blasting is permitted, it shall be carried out in accordance with the requirements of Clause 1222.

(f) Deterioration of foundation excavations

Where soft material, or hard material which quickly deteriorates when exposed, is found at founding level, the excavation shall be excavated to the final slope and level immediately before the screed is placed.

Where the bottoms or sides of excavations, in which bases are to be cast, are softened on account of negligence on the part of the Contractor in allowing storm or other water to enter the excavations, the softened material shall be removed and replaced with foundation fill as directed by the Engineer, at the Contractor's expense.

(g) The safety of excavations

The Contractor shall take the necessary precautions to safeguard the stability and safety of the excavations and adjacent structures.

The personal safety of no person shall be jeopardised neither any situation be allowed to arise which may result in damage of whatsoever nature. Precautionary measures taken by the Contractor shall comply with the appropriate legal provisions.

(h) Inspection

No concrete shall be placed before the excavation has been properly cleaned by the Contractor and inspected and approved by the Engineer.

(i) Excavation by hand

Where circumstances prevent the use of mechanical excavators and material can be removed only by hand implements, the Engineer shall authorise the supplementary payment to the Contractor for such work at the tendered rates for excavation by hand should he be satisfied that the Contractor had been unable to prevent the necessity for excavation by hand by proper planning and precautionary measures. The supplementary rate for excavation by hand shall not apply to minor finishing or clearing jobs in excavations which are otherwise being done by mass excavation plant.

6106 FOUNDING

In consequence of possible variations of the anticipated founding conditions, the dimensions and founding levels specified or shown on the Drawings may have to be varied during construction.

The Engineer has full and absolute power to order such variations and to specify the actual founding level for each foundation fill, base or caisson during construction.

The Contractor shall not be entitled to any additional payment in consequence of any such variation in the dimensions or founding depths over and above that provided for in Clause 6115, irrespective of the stage of construction at which the instruction to alter the dimensions or founding depths is given. However, if in consequence of such order to alter the Contractor is compelled to substitute other machines and equipment for machines and equipment for successfully completing the work, the Engineer may reimburse the Contractor at a fair price for incidentals incurred, provided that the original machines and equipment had been suitable for the work required prior to the order to alter having been issued. No bases, caissons or piles shall be founded unless authorised by the Engineer. Each founding level shall be accurately measured and recorded and agreed on.

The term "founding level" used in these Specifications shall be deemed to have the following meanings in respect of:

(i) Foundation fill

The surface of the in situ material that has been prepared to receive foundation fill.

(ii) Bases

The underside of the base.

(iii) Piles

The underside of the underream, bulbous base or rock socket; the tip of the pile shoe or lower pile end, as may be relevant.

(iv) Caissons

The underside of the cutting edge.
6107 UTILISATION OF EXCAVATED MATERIAL

Excavated material and material recovered from temporary works shall, if suitable, be utilised for backfill. Material unsuitable for use as backfill or in excess of the required quantity, shall be spoiled or utilised as directed by the Engineer.

Excavated material not used for backfill or not taken to spoil but used in the construction of embankments or other parts of the work, as directed by the Engineer, will be paid for under foundation excavation as well as under the relevant item for the purpose for which it is used.

The free-haul distance on excavated material and imported material for backfill shall be 1.0 km.

Excavated and stockpiled material shall be so dumped as not to endanger the uncompleted structure either by direct pressure or indirectly by overloading the fills contiguous to the structure, or in any other way.

6108 BACKFILL AND FILL NEAR STRUCTURES

(a) General

When backfill and fill are placed, the following precautionary measures shall be taken:

(i) The material shall be placed simultaneously, in so far as is possible, to approximately the same elevation on both sides of an abutment, pier, or wall where appropriate. If conditions require the backfill or fill to be placed appreciably higher on one side than on the other, the additional material on the higher side shall not be placed until authorised by the Engineer, and preferably not until the concrete has been in place for 14 days, or until tests show that the concrete has attained sufficient strength to safely withstand any pressure extended by the backfill or fill or by the method of construction.

(ii) The material behind abutments directly restrained at the top by the superstructure, eg portal type of structures, shall be placed as shown on the Drawings or as directed by the Engineer.

(iii) The material behind the portal walls of portal structures shall not be placed until the top slab has been placed and cured, unless otherwise authorised by the Engineer.

(b) Backfill

Excavated areas around structures shall be backfilled with approved material in horizontal layers not exceeding 150 mm in thickness after compaction, to the level of the original ground surface. Each layer shall be moistened or dried to the optimum moisture content for the material and then compacted to a density of not less than 90% of modified AASHTO density for soils and gravels, and not less than 100% of modified AASHTO density for cohesionless sands, or the density of the surrounding soil, whichever shall be the less, except that, in the road prism, the material shall be compacted to a density of not less than 93% of modified AASHTO density.

(c) Fill

Before the space between the structure and the approach fill, or between the structure and the faces of the surrounding excavation is backfilled, the slope of the approach fill, or the faces of the excavation shall be shaped by benching or serrations to prevent wedge action from occurring between the structure and the approach fill or the excavation faces.

The distance between the exposed face of the structure and the toe of the approach fill or the excavation face shall not under any circumstances be less than the height of the exposed face of the structure.

(d) Fill within restricted area

That part of the fill within a horizontal distance of 3 m from the vertical and inclined concrete faces of the structure and that part between the pillars of the spill-through abutments or that part shown on the Drawings, shall be termed "fill within restricted area".

Fill within the restricted area shall comply with the requirements of Section 3300, except that it shall be compacted to a density of not less than 93% of modified AASHTO density. In order to achieve the specified density, the Contractor shall, where necessary, import material of suitable quality.

Unless otherwise directed by the Engineer, only mechanical compaction equipment that is pushed or drawn by hand shall be used to achieve the required density within a horizontal distance of 3 m from any concrete structure. Fill in spaces below concrete softits that are inaccessible for mechanical compaction equipment shall be constructed by methods specified or approved by the Engineer.

Payment in accordance with Item 61.05 for the construction of fill within restricted areas shall be made only when specifically provided for in the Schedule of Quantities.

6109 FOUNDATION FILL

If it is found during the course of excavation that the material at the indicated founding depth does not have the required bearing capacity as specified on the Drawings, the excavations shall be extended at the discretion of the Engineer until satisfactory founding material is encountered.

The Engineer may order the Contractor to make up the difference in levels with foundation fill.

Where the foundation fill consists of rock or crushed stone, it shall be constructed in accordance with the requirements of the Project Specifications or as directed by the Engineer.

Foundation fill consisting of granular material shall be constructed in layers not exceeding 150 mm in thickness after compaction. Each layer shall be moistened or dried to the optimum moisture content for the material and compacted to a density of not less than 95% of modified AASHTO density for soils and gravels, and not less that 100% modified AASHTO density for cohesionless sands.

Mass concrete fill to be used shall be of the class or mix of concrete fill as specified or directed by the Engineer.

Unless otherwise specified or directed by the Engineer, the foundation fill constructed from rock, crushed stone or compacted granular material shall be defined by a prism with vertical sides. The base of the prism lies in the founding
shall be mixed in the ratio of 50 kg of cement to 20

A concrete screed which complies with the requirements shown on the Drawings shall be placed underneath all bases except where mass concrete fill is used or where authorised by the Engineer that this need not be done.

Where mass concrete fill is constructed under a base it shall be constructed accurately to the final levels of the underside of the base.

6110 GROUTING OF ROCK FISSURES

Where specified, fissures in the rock below and around the bases shall be sealed by pressure grouting with a neat cement or sand-cement grout or with a proprietary brand grout as specified.

The cement:water ratio of the grout shall be approved in advance by the Engineer.

The extent of the fissuring shall be established by means of water testing under pressure.

Holes of at least 40 mm in diameter shall be drilled at places indicated by the Engineer and grout shall then be pumped into these holes under suitable pressures. Grouting shall be done in 3 m stages to the maximum depth ordered. Care shall be taken to avoid further fracturing of the rock strata by excessive grouting pressures.

Grouting of the rock fissures shall be done by specialised operators with adequate experience in this class of work.

6111 FOUNDATION DOWELS

Where required, foundation dowels of specified material, diameter and length shall be installed at the positions and to the dimensions shown on the Drawings or as directed by the Engineer. After exposing, clearing and trimming the rock formation, holes with specified diameters and depths shall be drilled in the rock. After the holes have been cleared and prewetted, they shall be filled with grout. Within 15 minutes of having been filled with grout, the dowels shall be carefully driven into the holes. The cement and water in the grout shall be mixed in the ratio of 50 kg of cement to 20 l of water, and an approved expanding additive which complies with the requirements of Subclause 6402(e) shall be added.

The dowels shall comply with the requirements of Clause 6305.

6112 FOUNDATION LINING

Where specified or directed by the Engineer, foundation linings shall be installed as described hereafter. The Engineer shall have the right to order the use of linings against the sides of excavations and the undersides of bases and slabs in lieu of formwork and concrete blinding.

All surfaces to be lined shall be covered with an approved sheeting to provide a clean impervious layer. The material shall be of sufficient strength to provide a durable working surface and to support the concrete and reinforcement without tearing. The joints of the material between strips shall have a 150 mm overlap and the lining shall be held firmly in position by nails, pegs, etc.

Polyethylene sheeting with a thickness of 0.150 mm is generally considered to be adequate for use below bridge approach slabs and bases.

6113 FOUNDATION PILING

(a) General

This Section covers the construction of bearing piles of concrete or steel or a combination of these materials.

(b) Piling layout

The piling layout, the minimum pile size and/or bearing capacity and type together with the steel reinforcement and class of concrete required shall be as detailed and specified on the Drawings unless otherwise specified in the Project Specifications.

(c) Alternative designs for piling and piling layouts

(i) Submission

The priced Schedule of Quantities submitted for alternative designs shall be compiled strictly in accordance with the relevant measurement and payment clauses of these Specifications.

Where pay items defined in these Specifications have been omitted, it shall mean either that the items do not apply, or that where the Engineer requires work falling under such items to be done, it shall be done without any cost to the Employer. The inclusion of “rate-only” items will not be permitted.

Where pay items not defined in these Specifications are used, the measurement and payment requirements for such items shall be specified in detail by the Contractor. In the absence of such definitions, or in the case of any ambiguity, the interpretation of the Engineer shall be final and binding.

Except in piling-only Contracts or where otherwise provided in the Project Specifications, the Contractor shall price the Schedule of Quantities for the original design irrespective of whether or not an alternative design is offered.

(ii) Design

The critical design-load combinations acting upon the underside and the centre of gravity of the pile-capping slab, the maximum permissible set of the pile-capping slab, and the technical data required for designing alternative piles and/or piling layouts will be indicated on the Drawings. Alternative designs shall comply with the provisions of Clause 1212 and the prescriptions set out below.

For alternative designs submitted the Contractor shall submit with his tender a detailed description of the method of analysis used in the design of the piles and the pile-group layouts. The average length of pile and/or of the piles per group on which the quantities in the Schedule of Quantities for the alternative designs are based shall be stated in each case. The type of pile offered shall be defined in terms of size, materials, working and breaking load.
The Contractor shall be responsible for and shall bear the cost for redesigning, drafting and submitting the detail drawings for any structural element affected by the alternative pile design. Any economy or incidental caused by constructing such element as compared to the original design shall be for the account of the Contractor.

The Contractor shall, as specified in Clause 1212 for alternative designs, submit to the Engineer at least three months prior to work being commenced, drawings detailing the piling-group layout and piles, incorporating such amendments to his original design as may be required by the Engineer, and drawings detailing the amendments required to the pile-capping slab dimensions and reinforcement as a result of the layout of the piles, all as applicable.

No work of whatsoever nature shall be commenced on the piling until the Drawings have been submitted to and have been approved by the Engineer, in writing.

After approval of the Drawings, no departure therefrom shall be made without authorisation by the Engineer.

Final working drawings shall comply with the provisions of Clause 1221.

Where the alternative piles fail in regard to the load test specified in Subclause 6113(u), the Contractor shall be responsible for the cost of the work required for improving the piles and pile layout so as to comply with the design requirements.

(iii) Basis of payment

Where the quantities in the Schedule of Quantities referred to in Subclause 6113(c), on the one part, differ from the number of piles and the average pile length given in the submission for the alternative pile design, on the other part, the Engineer shall accept the sum in the said Schedule of Quantities, correct the quantities, and adjust the rates for the applicable pay items accordingly.

In addition to these corrections, the Employer shall be justified in using one of the following methods for paying for piles constructed in accordance with the alternative design:

(1) Method 1

The Employer may check the alternative designs, calculate the quantities and adjust the rates as set out in the first paragraph of Subclause 6113(c). The Employer will then pay for the work in accordance with the actually measured quantities.

(2) Method 2

The Employer may use the following formulae for calculating the quantities under Items 61.16 to 61.34 for payment:

\[
\begin{align*}
N_p &= N_d \\
L_p &= N_d \cdot L_d + N_b (L_b - L_d)K \\
L_p &= N_d \cdot L_d + N_b (L_b - L_d)K
\end{align*}
\]

where:

\[
\begin{align*}
P &= \text{paid}, \quad D = \text{designed} \quad \text{and} \quad B = \text{built.}
\end{align*}
\]

The term "units" means items of work measured and paid for in the respective pay items such as piles, raking piles, casings, underreams, concrete, etc.

\[
\begin{align*}
N_p &= \text{number of "units" measured and finally paid for in a particular pile group.}
N_b &= \text{number of "units" provided for in the tender for the alternative design in the same pile group.}
L_p &= \text{length of the "units" measured and paid for or the length to be used in calculating quantities which are a direct function of the length of the "units" for the same pile group.}
L_d &= \text{the average length of the "units" provided for in the tender for the alternative design in the same pile group.}
L_b &= \text{the average length of the Nb "units" actually installed in the same pile group.}
\end{align*}
\]

The values Nd and Ld for each pile group for which an alternative design has been offered shall be supplied with his tender by the Contractor for the respective "units".

The values of Nd, Nb, Ld and Lb for each pile to be used is left to the Contractor, full particulars, specifications, calculations and drawings of the piles proposed for use by the Contractor shall be submitted with the tender.

The Contractor shall submit the following information to the Engineer, two weeks before any piles are driven or holes are formed:

(i) How the piles and casings will be installed or the holes will be formed;
(ii) How the piles and casings will be installed or the holes will be made through identified obstructions;
(iii) The mass of the hammer;
(iv) The set during the last ten blows;
(v) The expected size of the bulbous base, underream, rock socket, etc, if any;
(vi) How concrete or grout is to be placed and compacted in the case of cast in situ piles;
(vii) How reinforcing steel is to be placed and held in place during placing and compacting the concrete in cast in situ piles;
(viii) Details of permanent casing, if any;
(ix) The mix design for the concrete together with an adequate quantity of cement and aggregate to enable the Engineer to conduct the necessary tests.

(d) Details to be furnished by the Contractor

In all cases where the choice of the type of pile to be used is left to the Contractor, full particulars, specifications, calculations and drawings of the piles proposed for use by the Contractor shall be submitted with the tender.

The Contractor shall submit the following information to the Engineer, two weeks before any piles are driven or holes are formed:

(i) How the piles and casings will be installed or the holes will be formed;
(ii) How the piles and casings will be installed or the holes will be made through identified obstructions;
(iii) The mass of the hammer;
(iv) The set during the last ten blows;
(v) The expected size of the bulbous base, underream, rock socket, etc, if any;
(vi) How concrete or grout is to be placed and compacted in the case of cast in situ piles;
(vii) How reinforcing steel is to be placed and held in place during placing and compacting the concrete in cast in situ piles;
(viii) Details of permanent casing, if any;
(ix) The mix design for the concrete together with an adequate quantity of cement and aggregate to enable the Engineer to conduct the necessary tests.

(e) Pile-installation frames and equipment

The pile-installation frames and equipment used for driving the piles or forming the holes or for other methods of sinking
the piles shall be in a good working condition and to the prior approval of the Engineer and shall comply with the relevant legal provisions.

The Contractor shall supply the necessary equipment, gear and instruments required for the prescribed investigations and inspections.

The installation frames shall be so designed as to ensure that piles can be installed in their proper positions and true to line and slope.

(f) Piling platforms

Piling platforms shall include the prepared in situ material or artificial islands or any structure (excluding the piling equipment) constructed for gaining access to the position where the pile is to be installed and for carrying out the piling operations.

Structural piling platforms shall be rigid, and floating barges used for piling operations shall afford sufficient stability to enable piles to be properly installed.

On completion of the piling, the Contractor shall remove all the artificial, constructed platforms and reinstate the site to the satisfaction of the Engineer.

(g) Setting out

The Contractor shall set out the pile positions and shall stake these positions with a durable marker. Where the level from which the piling is undertaken is above the underside of the pile-capping slab, due allowance shall be made for the offset of raking piles so that the pile at the underside of the pile-capping slab will be in the correct position.

(h) Ground surface for foundation piling

Before starting any piling work, the Contractor shall notify the Engineer in good time to ensure that levels of the ground surface be taken in order that an average ground surface from which the piling is to be measured can be established and agreed on by the Engineer and the Contractor. Where foundation piling at a site is preceded by excavation or the construction of fill, the surface from which the piling is to be done shall be formed as near as possible to the underside of the pile-capping slab as directed by the Engineer.

(i) Cast in situ concrete piles

(i) Reinforcement

Reinforcement shall not be placed in the pile holes until immediately before concreting. Before the reinforcement is placed in position, all mud, water, and any loose or soft material shall be removed from the hole.

Steel reinforcing shall be accurately maintained in position without damage being done to the sides of the hole or the reinforcing itself. Spacers shall be used to keep the reinforcing steel at the required distance from the inside face of the pile casing and wall of the pile hole but shall not cause zones through which aggressive ground water may penetrate to the reinforcement.

Pile reinforcement will not be shown in the bending schedules. Only the number, diameter and type of bars and their arrangement will be shown on the Drawings. The Contractor, with the permission of the Engineer, may replace the bars shown on the Drawings with bars with different diameters and spacing and of different types, on a basis of equivalent strength.

The reinforcement shall be assembled in cages, which shall be sufficiently robust to prevent their permanent deformation during handling. In the case of cast in situ piles, the inner sides of the cages shall be kept open in view of the unrestricted placing of concrete therein.

The longitudinal bars shall project above the cut-off point by the distance shown on the Drawings, or by 40 times the bar diameter if no dimension has been given.

Splicing the reinforcing may be ordered, and the Contractor shall keep available on the site sufficient steel reinforcing so that an additional length of pile reinforcing can be assembled whenever necessary.

The assembly of this additional reinforcing shall be carried out expeditiously and before any concreting of any specific pile commences. If splices have to be provided, the longitudinal bars shall overlap for a distance of 40 bar diameters, as that required by the Engineer.

(ii) The concreting of piles

The concreting of the piles shall not be commenced before the Engineer has given his permission therefor.

Except in self-supporting pile holes, a temporary or permanent casing shall be installed for the full depth of the hole to prevent lumps of material from falling from the sides of the hole into the concrete. Where concrete is to be placed under the drilling mud, the temporary casing may be omitted, except at the top end of the hole.

The concrete shall be so proportioned as to be of sufficient strength, but shall be sufficiently workable to enable it being properly placed, and, where self-compacting concrete is not used, it shall be thoroughly compacted by approved means. Extraction of the temporary casing during placement of the concrete shall be such that no damage is caused to the pile and the advancing concrete level is at all times kept considerably above the temporary casing’s trailing edge. Concrete shall generally be placed in the dry, but where this is impracticable, it shall be placed by tremie.

The requirements of Subclause 6407(c) together with the following requirements shall apply when concrete is placed under water by tremie:

1. The cement content shall be not less than 400 kg/m³ and the slump shall be such that the concrete of the specified strength and desired density can be obtained.

2. The hopper and tremie shall be a closed unit which cannot be penetrated by water.

3. The tremie shall be at least 150 mm in diameter for 19.0 mm aggregate and larger for larger aggregates.

4. The concrete shall be so placed as to prevent the mixing of water and concrete. The tremie shall at all times penetrate into the concrete.

5. Placing the concrete in that part of the pile below the water level in the casing shall be done in one operation, and the same method of placing the concrete shall be maintained throughout.
(6) All tremies shall be scrupulously cleaned before and after use.

(7) Before placing the concrete in the water, the Contractor shall ensure that no silt or other materials have collected at the bottom of the hole, and where drilling mud is used, the Contractor shall ensure that no drilling mud suspension with a relative density exceeding 1.3 has collected at the bottom of the hole.

Whenever practicable, concrete shall be placed in a manner that will prevent segregation.

(i) Precast concrete piles

The piles shall be of reinforced or prestressed concrete and shall be manufactured, handled, stored and installed in accordance with BS 8004, unless otherwise specified.

(ii) Manufacture

The piles may be manufactured in a factory or a casting yard on the site of the Works. The Contractor shall ensure that the factory or casting yard will at all reasonable times be accessible for inspection by the Engineer.

The relevant requirements of Section 6400 shall apply to the concrete work.

Transverse reinforcement shall comply with the requirements of BS 8004.

The piles shall be cast on a rigid horizontal platform in approved moulds. Particular care shall be taken to keep the reinforcement, coupler sockets and pile shoes accurately in position. Adequate provision shall be made for lifting the piles.

Each pile shall be clearly marked with the date of casting, a reference number, and from the tip of the pile at 1.0 m intervals, with distance marks.

Piles shall be cured for a period sufficient to develop the strength required to withstand, without damage to the pile, the stresses caused by handling, transporting, storing and driving. The piles shall not be driven before the concrete in the pile has attained the specified strength.

(iii) Handling, transport and storage

Care shall be taken at all stages of lifting, handling and transporting to ensure that the piles are not damaged or cracked.

Piles shall be stored on firm ground which will not settle unequally under the weight of the stack of piles. The piles shall be placed on timber supports which are truly level and spaced so as to avoid undue bending in the piles. The supports in the stack shall be located vertically above one another.

(iv) Lengthening of precast piles

Piles shall be lengthened where required by such means and methods as approved by the Engineer. Care shall be taken to ensure that the additional length of pile joined is truly axially in line with the original pile within the tolerance requirements for straightness set out in Subclause 6803(a).

Driving shall not be resumed until the pile extension and any bonding agent used has attained the required strength.
(iv) **Heaving of piles**

In soils in which the installation of piles may cause previously installed piles to heave, accurate level marks shall be placed on each pile immediately after installation and all piles that have heaved shall be redriven to the required depth, unless redriving tests on neighbouring piles have shown this to be unnecessary. Piles shall not be concreted unless they shall be driven and any pile-capping slab be constructed until the piles within a heave-influence zone have been redriven as required.

(v) **Bulbous bases**

Where required, bulbous (enlarged) bases shall be formed after the driven casing has reached the required depth. The base shall be formed by progressively displacing the surrounding subsoil with concrete placed by the repeated action of a gravity hammer. The size of the base will depend on the compressibility of the surrounding subsoil but shall in no case have a diameter of less than 1.5 times the diameter of the pile.

(vi) **Piling alignment**

Where the inclination of a precast concrete pile deviates from the correct slope during installation, the pile shall not be forced into the correct position. The slope of the guiding frame shall be adjusted so as to coincide with the actual inclination of the pile to preclude the bending of the pile. Where the verticality or the inclination of the installed pile falls outside the specified tolerances, the pile will be classified as being defective.

(m) **Augering and boring**

(i) **Auger and bore pile holes**

The augering and boring of pile holes shall be carried out as expeditiously as local conditions permit taking due account of services or other restrictions on the site.

Holes shall be cleaned after augering and boring to obtain a clean and level surface.

Where indicated by the Engineer, suitable casing shall be installed in those parts of the augered holes where the sides are in danger of caving in before the concreting has been completed.

During extraction of the casing, care shall be taken to avoid lifting the concrete and damaging the pile.

The use of water for augering and boring holes shall not be permitted unless approved by the Engineer.

Surface water shall not be allowed to enter the hole.

(ii) **Underreaming**

Where required, the holes shall be enlarged or belled out to form an underream. The earth excavated shall be removed in a manner which will not damage the walls of the hole.

The shape of the underream shall be a truncated cone of which the base diameter depends on the bearing capacity of the founding material, but it shall be not less than twice the shaft diameter. The base angle of the cone between the inclined face and horizontal plane shall be not less than 60°.

Full safety measures shall be enforced to protect workmen working at the bottom of the pile hole.

(iii) **Bulbous bases**

Bulbous bases shall comply with the requirements of Subclause 6113(l).

(iv) **Inspecting preformed holes**

Equipment for inspecting the pile shafts shall be provided and operated in accordance with the latest amendment or edition of the Code of Practice Relating to the Safety of Men Working in Small Diameter Vertical and Near Vertical Shafts for Civil Engineering Purposes, obtainable from the South African Institution of Civil Engineers, or similar document.

Immediately before the reinforcement is to be installed or the concrete placed, the Engineer shall be informed thereof with a view to inspecting the pile holes. When piles are to be underreamed, the excavation shall be inspected twice by the Engineer, firstly to ascertain that suitable founding material has been obtained before underreaming may start, and, secondly, after the underreaming has been completed for approval to be given by the Engineer for casting the pile.

(n) **Rock sockets**

Where required, rock sockets to the required dimensions shall be formed in rock formations of adequate strength, quality and thickness for transmitting the specified load.

(o) **Obstructions**

(i) **Definitions**

(1) **Identified obstructions**

Identified obstructions shall mean any obstruction described on the Drawings or in the Project Specifications and for which provision for payment has been made in the Schedule of Quantities in respect of penetrating the obstructions.

(2) **Unidentified obstructions**

Where provision has been made in the Schedule of Quantities in terms of Item 61.21 for penetrating identified obstructions and obstructions not described are encountered, such obstructions shall be classified as unidentified obstructions and the penetration of such obstructions shall be paid for under Item 61.22 subject to the condition that the rate of penetration drops to below that achieved for identified obstructions when the same method and effort are used, or subject to additional methods and effort over and above those required for identified obstructions being required for penetrating the obstruction.

OR

Where no provision has been made in the Schedule of Quantities for penetrating identified obstructions and obstructions are encountered and, after resorting to the methods specified in the submission in terms of Subclause 6113(d), it is found to be impossible to form the holes in the proper positions and at the proper inclinations and depths, and the Contractor has to resort to additional methods for forming the pile holes successfully, such obstructions shall be classified as unidentified obstructions.

(ii) **Classification of materials**

For piling, only the following classification of materials shall apply to the identification and description of obstructions.
(1) **Matrix**

The matrix shall comprise that part of the material which will pass through a sieve with 50 mm x 50 mm openings.

(2) **Coarse gravel**

Coarse gravel shall comprise that part of the material (stones, pebbles, cobbles, etc) which will pass through a 200 mm x 200 mm opening, but will not pass through a 50 mm x 50 mm opening. The gravel shall be obtained from material with at least a Class R2 hardness.

(3) **Boulders**

Boulders shall mean any rock mass with a hardness of at least Class R2 which will pass through a square opening with dimensions equal to the maximum size boulder specified in the Schedule of Quantities but will not pass through a 200 mm x 200 mm opening.

(4) **Rock formation**

A rock formation shall be any rock mass with a hardness of at least Class R2 which will not pass through a square opening with dimensions equal to the maximum size boulder specified in the Schedule of Quantities.

Where a boulder is cut through and part of it is left imbedded in the wall of the hole, such boulder obstruction shall be classified as rock formation.

For the identification of rock in terms of this Clause, the classification in Table 6113/1 (at the end of the Section) shall apply.

(iii) **Driven displacement and prefabricated piles**

Where obstructions make it difficult to install driven displacement and prefabricated piles in the positions and at the inclinations shown and to the proper lengths by the methods specified in the submission in terms of Subclause 6113(d), the Contractor shall resort to additional methods which are suitable for the type of pile. If the successful installation of a pile proves to be impossible after such methods have been tried, the Engineer may order an additional pile or piles to be installed.

All such work and additional piles shall be paid for in accordance with the tendered rates where applicable, or where they do not apply, under Item 61.23.

(iv) **Auger and bore pile holes**

Where identified or unidentified obstructions are encountered when shaping holes for piles, payment for penetrating the obstructions shall be made against the appropriate pay items.

(p) **Determining pile lengths**

The design of the piles and pile groups, and the quantities in the Schedule of Quantities are based on the subsurface data shown on the Drawings.

The Engineer will determine the depth of piles as work proceeds.

Where variations in the subsurface conditions occur as regards the material and height of the water table, the Engineer shall be informed immediately.

If the Contractor is not satisfied that the piles will be capable of carrying the specified loads at the depth determined by the Engineer he may, in consultation with the Engineer, lengthen the piles to reach a suitable founding depth. Where the Engineer and the Contractor cannot agree on the founding depth, the Engineer may require the Contractor to:

(i) undertake additional foundation investigations and/or core drilling in accordance with Subclauses 6103(a) and 6113(t) respectively, and/or

(ii) install one or more test piles and conduct a load test in accordance with 6113(u). The Engineer will prescribe the positions for each test pile. Test piles shall comply with the specified requirements for piling.

(q) **Piling data**

The following data on each pile installed shall be recorded in a form prescribed by the Engineer:

(i) The effort used for driving the pile and the resistance to penetration at founding level.

(ii) A description of subsurface material, the presence of ground water and the quality of material on which the pile is founded.

(iii) The quality of the materials used in the construction or manufacture of the pile, as well as of the permanent casing if used. The method of placing and compacting the concrete in cast in situ piles.

(iv) The method of founding of the piles eg bulbous bases, underram, rock sockets, etc, and their dimensions.

(v) The maximum working load of the pile.

(vi) The length of the pile and the accuracy of installation in respect of position and inclination.

(vii) Nominal dimensions and type of pile.

(viii) Length and details of any temporary and permanent casings used.

(r) **Stripping the pile heads**

Precast piles shall be installed to a level of at least 1.0 m above the cut-off level, and cast in situ piles shall be cast to a level of at least 150 mm above the cut-off level. The excess concrete shall be so stripped off that only sound concrete will project into the pile-capping slab.

Before a pile head is stripped, the cut-off plane shall be marked by cutting a 20 mm deep groove with a grinding-machine along the full circumference of the pile. Heavy concrete demolishing equipment may not be used for the stripping of pile heads. All loose aggregate shall be removed from the cut-off plane.

The concrete shall be so stripped off that the pile below the cut-off level will not be damaged, or, should defective concrete be found in the completed pile, the damaged or defective concrete shall be cut away by the Contractor at his own cost and replaced with new concrete well bonded to the old concrete, or the pile shall be replaced as directed by the Engineer.

The main reinforcement of the piles shall extend at least 40 times the diameters of the reinforcing bar beyond the cut-off level into the pile-capping slab. This reinforcement shall be left straight unless otherwise directed by the Engineer.

The cut-off level for piles shall be the level shown on the Drawings.
(s) Construction of pile-capping slab

The Contractor shall not construct the pile capping slab before the Engineer has confirmed, in writing, that all the relevant load tests have been completed and the piles have been accepted.

(t) Core drilling

The Engineer may instruct core drilling to be done with a view to obtaining cores of the founding formation and/or of the concrete in the completed structural member. In the case of piling, the core drilling may precede the piling or may be done through the completed pile, as specified, or as instructed by the Engineer.

The Contractor shall supply the necessary construction plant on the site for drilling under the above conditions. The plant and techniques used shall be suitable for ensuring 100% core recovery. The diameters, depths and lengths of the cores shall agree with the specifications or the instructions of the Engineer.

The Contractor shall keep accurate records of the drilling, which, together with the cores, shall be handed over to the Engineer. The cores shall be placed in the correct sequence in a clearly identified wooden core box with a lid.

(u) Load test

(i) General

The Engineer may order certain selected piles to be load tested. The procedure for loading tests shall comply with the requirements of Subclause 7111(c). During the period of testing, driving of other piles which may affect the testing shall cease.

No working pile shall be used as an anchor pile. Where anchor piles or earth anchors are required for providing reaction, they shall be so placed as to have a minimal effect on the test results.

The Contractor shall provide the complete testing assembly, the necessary plant, equipment, instruments and labour for carrying out the test and for determining accurately the settlement of the piles under each increase or decrease of the load. The test assembly, plant, equipment and instruments used shall be subject to the approval of the Engineer.

Within two days of having completed the tests, the Contractor shall supply the Engineer with the test results and neatly plotted load against settlement, load against time, and settlement against time graphs.

(ii) Loading

The maximum test load applied shall be equal to twice the specified working load or the ultimate test load, whichever shall be the smaller.

The maximum working load shall be half of the maximum test load or the test load which corresponds with the allowable settlement, whichever shall be the smaller.

The allowable settlement shall be as specified on the Drawings.

(iii) Ultimate test load

The ultimate test load in the compression-load test shall be the load where settlement suddenly increases disproportionately to the load applied.

The ultimate test load in the tension-load test shall be the load where the upward movement suddenly increases disproportionately to the load applied or the load producing a permanent rise of 10 mm at the top of the pile, whichever is the smaller.

(v) Defective piles

The test pile and the piles represented by the test pile shall be classified as defective if shown in terms of Subclause 6113(u) to have a maximum working load of less than the specified working load, or to exhibit excessive settlement. Defective piles shall also include piles damaged beyond repair, piles with structural defects, or piles which do not comply with the tolerance requirements of Subclause 6803(a).

If required, the defective piles shall be corrected by the Contractor at his own cost, by applying one of the following methods approved by the Engineer:

(i) Extracting the pile and replacing it with a new pile.
(ii) Installing a new pile adjacent to the defective pile.
(iii) Lengthening the pile to the correct length if defective in length only.
(iv) Altering the design to fit in with the new conditions caused by the defective pile(s).

(w) Standing time in respect of pile-installation frames

Standing time shall only be paid for pile-installation frames standing during normal working hours as laid down in the General Conditions of Contract for such periods during which the pile-installation work has come to a standstill following an action by the Employer.

As soon as the pile-installation frames have come to a standstill, the Contractor shall inform the Engineer, in writing, that he intends to claim standing time, and shall also furnish:

(i) full particulars of the action which gave rise to the claim
(ii) a list of pile-installation frames in respect of which standing time will be claimed, complete with date and time.

The period in respect of which a claim is lodged shall become operative from the moment when the notice has been handed over to the Engineer and shall continue until the restriction has been removed and normal procedure may be resumed.

(x) Nuclear integrity

Integrity tests using both the nuclear and neutron method shall be performed on all bored piles. The purpose of these tests is to prove that the technique used in constructing the piles is satisfactory, by checking for necking of concrete in the pile shafts, checking concrete cover to reinforcement and by checking for honeycombing, grout loss and segregation of aggregates.
6114 CAISSONS

(a) General

Caissons shall, for the purposes of these Specifications, be hollow concrete vessels which are wholly or partly constructed at a higher level and lowered by internal excavation or kentledge to the desired founding level to form structural bearing members. Caissons may be of circular, rectangular or any other shape and may contain one or more excavation compartments, all as detailed on the Drawings.

Unless otherwise specified hereafter, the provisions of BS 8004 shall apply in regard to the construction of caissons.

(b) Construction and sinking

A firm horizontal base shall be prepared on which the cutting edge of the caisson shall be laid truly horizontally. The level of the base shall be determined and shall be agreed on by the Engineer and the Contractor and shall serve as the ground surface from which the excavation inside the caisson will be measured.

Successive stages of the caisson shall be of convenient height, or as directed by the Engineer, and shall be lined up accurately with the preceding stages.

All precast elements shall have properly constructed joints in accordance with the Drawings to ensure that they fit snugly together.

For in situ phase construction, all construction joints in the walls shall be reinforced and the joints shall be made as specified in Clause 6408.

The lowest element of every caisson, which contains the cutting edges, shall be cured for at least four days or shall have reached a strength of at least 50% of the specified strength before sinking is commenced. Subsequent elements shall be cast in sufficient good time to ensure adequate strength for safely resisting the applied forces.

During constructing and sinking, the caissons shall be maintained truly vertically and kept in their correct positions.

The position and inclination of each caisson shall be determined accurately by measurement after every 2 m of sinking, or after sinking through the depth of one element, whichever distance is the smaller.

With a view to eliminating excess friction, the Contractor may use bentonite or a similar lubricant, or a water-jet system.

Excavation inside caisson compartments shall, unless otherwise specified herein, comply with the provisions of Clause 6105.

In multi-compartmented caissons, the excavation in any one compartment shall not be taken deeper than 0.6 m below that in any other compartment, except where necessary for correcting deviations.

Cutting edges shall be frequently inspected or probed to locate obstacles, which shall be removed immediately.

The Contractor shall supply all grabs, pumps, diving gear and other plant required for sinking and founding all caissons and shall allow the Engineer to use the diving suit and equipment for inspection purposes.

The Contractor shall employ a competent diver to carry out work under water and shall make provision in the rates tendered for the respective items for this cost.

Where the caisson strikes a hard inclined layer and work has to be carried out below the cutting edge, such work shall be measured and paid for under the relevant items of Clause 6115, and, where no applicable items exist, such work shall be paid for as extra work.

Should the Contractor wish to apply the pneumatic caisson method (with a compressed air chamber) for construction, he shall furnish the Engineer with full details of the plant, equipment and method for approval.

(c) Founding

The material at the founding level, if sloping and/or irregular, shall in so far as is possible be cut to as nearly level a surface as possible until the entire cutting edge is evenly and firmly supported on the material. Subject to the approval of the Engineer, blasting may be used for this purpose. If blasting should be resorted to, only light charges may be used and the caisson shall be protected against damage by suitable cushioning being provided.

Should the sloping surface be of hard rock which cannot be cut or broken by any safe and feasible means, the foundation shall be built up by means of a solid wedge of concrete which fills the entire space between the bedrock surface and the horizontal plane through the cutting edge. This concrete shall be of the same class as that specified on the Drawings or in the Schedule of Quantities for the concrete seal.

The rock or hard material on which the structure is to be founded shall be completely uncovered. The founding surface shall be cleared of all loose material before inspection by the Engineer immediately prior to casting the concrete seal.

No concrete shall be placed in the wedge or the seal before the Engineer has inspected and approved the foundation. For this purpose the Contractor shall adequately dewater the caisson to enable the Engineer to conduct the inspection.

In the event of a caisson not being vertical or in its correct position when it has reached the required depth, or in the event of a caisson being cracked during the sinking process, the Contractor shall at his own cost carry out the necessary remedial work to the satisfaction of the Engineer.

(d) Data

The Contractor shall provide the Engineer with a complete record of the types of material excavated during sinking, together with the level at which each type of the material was found. In addition, a log showing the rate of sinking shall be kept by the Contractor and furnished to the Engineer.

(e) Filling the caissons

(i) Concrete seal

The seal shall be constructed of mass concrete of the class specified and shall be placed in accordance with the dimensions and levels shown on the Drawings or as prescribed by the Engineer.
If this seal cannot be placed in the dry and has to be placed under water, the method of placing this concrete shall be approved by the Engineer. The Contractor shall cease placing the concrete under water when sufficient concrete has been placed to seal the foundation effectively.

After the concrete has been placed, the concrete seal and the head of water over it shall remain undisturbed for a period of at least seven days after which the caisson shall be dewatered by pumping for inspection. If more water is still leaking into the caisson, the process of sealing as specified herein shall be continued until the water level within the caisson does not rise at a rate exceeding 10 mm per hour.

The relevant requirements of Subclauses 6407(c) and 6113(i) shall apply for placing the concrete under water. For concrete placed under water by methods other than by tremie, the cement content shall be 20% more than the quantity required for ordinary concrete of the same mix but shall be not less than 450 kg/m³ of concrete.

(ii) Filling

Subsequent to inspection of the caisson compartments above the concrete seal, the compartments shall be filled with sand. The sand shall be sufficiently wetted to obviate bulking.

The first 2 m of filling above the concrete seal shall be lowered gently into position. The sand may then be poured from the top and compacted sufficiently to prevent settlement while the cover slab concrete is being placed.

The top of the sand fill within the caisson shall be finished off to the level specified below the underside of the caisson cover slab.

(f) Stripping

Where the walls of the caisson have been overbuilt, the concrete shall be stripped to the required level without damage being done to the concrete below the cut-off level. The longitudinal reinforcement of the caisson shall project above the cut-off level by a distance of at least 40 times the bar diameter.

(g) Concrete screed below the caisson cover slabs

A concrete screed of the specified thickness and class of concrete shall be provided to the level shown on the Drawings over the area covered by the cover slab, including the area within the caissons on top of the sand filling, except where the underside of the cover slab is being formed with formwork.

(h) General

Water quality and marine life shall not be adversely affected in any way during operations.

### 6115 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.01 Additional foundation investigations</td>
<td>provisional sum</td>
</tr>
</tbody>
</table>

A provisional sum shall be provided in the Schedule of Quantities to cover the cost of this work.

The work authorised by the Engineer shall be paid for in accordance with the provisions of the General Conditions of Contract.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>61.02 Excavation:</td>
<td></td>
</tr>
<tr>
<td>(a) Excavating soft material situated within the following successive depth ranges:</td>
<td></td>
</tr>
<tr>
<td>(i) 0 m up to 2 m</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) Exceeding 2 m and up to 4 m</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(iii) Etc in increments of 2 m</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

(b) Extra over Subitem 61.02(a) for excavation in hard material irrespective of depth | cubic metre (m³) |

(c) Extra over Subitem 61.02(a) for additional excavation required by the Engineer after the excavation has been completed | cubic metre (m³) |

(d) Extra over Subitem 61.02(a) for excavation by hand | cubic metre (m³) |

The limits for the successive depth ranges shall be measured down from the surface levels agreed on (Subclause 6105(b)) to the founding level (Clause 6106) agreed on.

In the case of excavations that are required for diverting, channelling or widening streams, the successive depth ranges for those portions of the excavations that are within 5 m of a concrete structure shall be measured from the surface levels agreed on to the invert level of the channel or stream.

The unit of measurement shall be the cubic metre of material, measured in the original position before excavation. The quantity of excavation for each depth range shall be calculated from the neat outlines of the base or floor and the depth of excavation completed within each range.

Irrespective of the total depth of the excavation, the quantity of material within each depth range shall be measured and paid for separately.

Supplementary payment for excavation by hand as specified in Subclause 6105(i), shall be the full compensation for incidentals for hand-excavating the materials instead of with mass-excavating equipment.

At the concrete faces for which formwork has to be provided, additional excavation shall be measured to 0.5 m outside the concrete perimeter to make provision for a working space.

Where foundation fill is constructed in an excavation, the quantity of excavated material measured for payment shall be the material excavated between the average ground level, as described in Subclause 6105(b), and the founding level, from a prism with vertical sides, as described in Clause 6109 or as prescribed by the Engineer.
In no case shall any of the following excavations be included in the measurement for payment:

(i) The volume of excavation in excess of the above-mentioned limits.

(ii) The volume included within the excavated road prism, contiguous channels, ditches, etc, for which payment is provided elsewhere in the specifications.

The tendered rates shall include full compensation for excavation in each class of material, the spoiling or stockpiling of material, the hauling of excavated material for the free-haul distance of 1.0 km, any additional excavation the Contractor may require for additional working space outside the authorised limits, trimming and cleaning the bottoms and sides of excavations, and strutting, shoring and safeguarding the excavations.

If, after a foundation excavation has been completed, cleaned and trimmed ready for concrete screeding, the Engineer orders further excavations to be made on account of changed dimensions and/or founding conditions, an extra over payment (Subitem 61.02(c)) on the additional excavation measured for payment shall be payable in full compensation for any incidentals to the Contractor over and above the normal excavation costs.

Item Unit
61.03 Access and drainage:

(a) Access .......................... lump sum
The tendered lump sum shall include full compensation for providing access, which, inter alia, shall include constructing temporary banks, artificial islands and/or cofferdams, their protection, safeguarding and maintenance, draining and keeping dry the working areas and draining the excavations within the access, and any incidentals in respect of work to be done below standing water.

75% of the lump sum will be paid when the access has been constructed. The remaining 25% will be paid after the access has been removed.

(b) Drainage where no access has been provided .......................... lump sum
Payment will be made for this work by way of a lump sum for each structure or series of structures appearing separately in the Schedule of Quantities. The lump sum shall be paid on a pro rata basis as the work progresses.

The tendered lump sum shall include full compensation for draining by pumping or in any other way and for any other work necessary for keeping the excavation dry or for working in the dry.

Item Unit
61.04 Backfill to excavations utilising:

(a) Material from the excavation .................. cubic metre (m³)

(b) Imported material .................. cubic metre (m³)

(c) Soil cement .................. cubic metre (m³)

The unit of measurement shall be the cubic metre of backfill material measured in the excavation. The quantity measured shall be calculated from within the neat outlines defined for the excavation under Item 61.02 and the height to which the backfilling is constructed. The volume occupied by the structure shall be subtracted when calculating the volume of backfilling. The volume occupied by the structure shall be subtracted when calculating the volume of backfilling.

The height shall be determined by the upper surface of the road prism or the reference ground surface (Subclause 6105(b)), whichever is the lower.

The tendered rates shall include full compensation for furnishing and placing all materials within the entire excavation, transporting the material within the free-haul distance of 1.0 km, and preparing, processing, shaping, watering, mixing and compacting the material to the specified densities.

Item Unit
61.05 Fill within a restricted area (extra over Item 33.01)  .... cubic metre (m³)

The unit of measurement shall be the cubic metre and the quantity shall be taken as the total volume of material within the restricted area as defined in Subclause 6108(d). The quantity shall not include the volume of backfill which is measured and paid for under Item 61.04 above.

The tendered rate shall include full compensation for all additional work necessitated by working in the restricted area and for the increased density required in the restricted area.

Item Unit
61.06 Overhaul in excess of 1.0 km on excavated material and on material imported for backfill, foundation fill and fill for caissons  .... cubic metre-kilometre (m³-km)

Overhaul shall be measured and paid for as specified in Clause 1603 and shall apply only to that portion of the material qualifying for payment under Items 61.02, 61.04(b), 61.08(a) and (c), and 61.47.

Overhaul shall not apply to concrete used in the foundation fill.

Item Unit
61.07 Overbreak in excavation in hard material  .... square metre (m²)

The unit of measurement shall be the square metre of surface area of the vertical outer faces of the base.

The tendered rate shall include full compensation for the overbreak material removed from the excavation, for the concrete fill in accordance with Subclause 6105(c), and any additional screeding concrete required.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.08 Foundation fill consisting of:</td>
<td></td>
</tr>
<tr>
<td>(a) Rock fill</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Crushed-stone fill</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(c) Compacted granular material</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(d) Mass concrete (class indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(e) Concrete screed (thickness and class of concrete indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of approved material placed and compacted below the bases as specified or where directed by the Engineer.

The quantity of foundation fill to be measured for payment shall be the material contained within the prism specified in Clause 6109 or shall otherwise be the quantity to the outlines shown on the Drawings or as directed by the Engineer.

The tendered rates shall include full compensation for procuring, furnishing, transporting, placing and compacting the material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.09 Establishment on the site for the drilling of holes (type of drilling indicated)</td>
<td>lump sum</td>
</tr>
</tbody>
</table>

The tendered lump sum shall include full compensation for establishment on the site and the subsequent removal of all special plant for drilling the holes and additional plant for carrying out operations, the cost of which does not vary with the actual amount of work to be done.

This work will be paid for by way of a lump sum, 75% of which will become payable when all the equipment is on the site and the first hole has been drilled. The remaining 25% will become payable after all the holes have been drilled and the equipment has been removed from the site.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.10 Moving to and setting up the equipment at each hole to be drilled</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of positions to which the equipment has to be moved and set up in position. The number to be measured shall equal the number of holes to be drilled as instructed by the Engineer.

The tendered rate shall include full compensation for all the costs involved in moving and setting up the equipment.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.11 Drilling of holes (diameter and type of drilling indicated)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of hole drilled.

The tendered rate shall include full compensation for drilling and clearing the holes as specified. Where no provision has been made for payment in the Schedule of Quantities under Items 61.09 and 61.10, the tendered rate shall also include full compensation for work falling under these items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>61.12 Grouting (type of grout and for which purpose it is required indicated)</td>
<td>kilogram (kg)</td>
</tr>
</tbody>
</table>

The unit of measurement for grouting shall be the kilogram of cement or proprietary brand of grout as may be applicable used in the grouting operation.

The tendered rate shall include full compensation for providing the equipment and all the material, and mixing and pumping the grout into the prepared holes in accordance with the instructions of the Engineer, and also for the water-pressure tests.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.13 Dowel bars (type, diameter and length of dowel bars, together with type of grout, indicated)</td>
<td>kilogram (kg)</td>
</tr>
</tbody>
</table>

The unit of measurement for the dowel bars shall be the kilogram of bars provided and secured in position.

The tendered rate shall include full compensation for supplying all the material and positioning and grouting the dowel bars as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.14 Foundation lining (type of material and thickness indicated)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement for foundation lining shall be the square metre of concrete surface lined.

The tendered rate shall include full compensation for procuring, furnishing and placing all material and for all labour and incidental required for completing the work as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.15 Establishment on the site for piling</td>
<td>lump sum</td>
</tr>
</tbody>
</table>

The tendered lump sum shall include full compensation for generally levelling the piling site, establishing on the site and subsequently removing all structural platforms, rafts, and all special constructional plant and equipment for foundation piling and for carrying out operations, the cost of which does not vary with the actual amount of piling done.
This work will be paid for by way of a lump sum, 50% of which will become payable when all equipment is on the site and the first pile has been installed. The second installment of 25% of the lump sum will become payable after half the total number of piles have been installed, and the final installment of 25% after all the piles have been completed and the equipment has been removed from the site.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.16 Moving to, and setting up the equipment at each position for installing the piles</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of positions to which the installation equipment has to be moved and set up in position. The quantity measured shall be the number of piles installed plus the number of piles redriven on the instruction of the Engineer, plus any piles provided in addition for load tests, which do not form part of a specific pile group.

The tendered rate shall include full compensation for all costs involved in moving and setting up any equipment.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.17 Augered or bored holes for piles with a diameter of (diameter indicated) through material situated within the following successive depth ranges:</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

(a) Augered holes:

(i) 0 m up to 10 m

(ii) Exceeding 10 m and up to 15 m

(iii) Etc in increments of 5 m

(b) Bored holes:

(i) 0 m up to 10 m

(ii) Exceeding 10 m and up to 15 m

(iii) Etc in increments of 5 m

The limits for the successive depth ranges shall be measured down from the average ground surface (Subclause 6113(h)) to the agreed founding level (Clause 6106).

The unit of measurement shall be the metre of hole, including the depth of the bulbous base formed, as may be applicable. The depth of the bulbous base shall be deemed to be equal to the diameter of a sphere, the volume of which shall be equal to the quantity of compacted concrete in the bulbous base. Irrespective of the total depth of the hole, the quantity within each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for augering and disposing of surplus material resulting from the hole having been formed.

The tendered rates for forming bored holes shall include full compensation for boring, supplying, installing and extracting the driven temporary casing as well as for disposing of surplus material resulting from the hole having been formed.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.19 Manufacturing, supplying and delivering prefabricated piles (type and size indicated)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of accepted prefabricated pile delivered on the site in accordance with the Engineer's written instructions.

The tendered rate shall include full compensation for supplying all the materials, manufacturing, transporting and delivering to the point of use and handling the prefabricated piles.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.20 Installation of prefabricated piles (type and size indicated) through material situated within the following successive depth ranges:</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>
The limits for the successive depth ranges shall be measured down from the average ground surface (Subclause 6113(h)) to the founding depth agreed on (Clause 6106).

The unit of measurement shall be the metre of prefabricated pile installed. That part of the prefabricated pile projecting above the average ground surface shall not be measured and paid for.

Irrespective of the total length of pile installed, the quantity installed within each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for hoisting and driving the pile.

Item | Unit
--- | ---
61.21 Extra over Item 61.17, irrespective of the depth, to form augered and bored pile holes through identified obstructions consisting of:

(a) Coarse gravel with a matrix content of less than (maximum percentage indicated) ................ metre (m)
(b) Boulders (description of and maximum size indicated) ................ metre (m)
(c) Rock formation (description and class of rock indicated) ................ metre (m)

The unit of measurement shall be the metre of pile hole formed through the identified obstruction, measured from the depth at which the identified obstruction is encountered to the depth at which normal auger drilling or boring can be resumed or another type of identified obstruction is encountered.

The tendered rates shall include full compensation for all additional work and incidentals required for forming the pile hole through the identified obstruction.

Notes:

(a) Subitem 61.21(a): The matrix content indicated shall be the percentage by volume of matrix in material containing coarse gravel. Where the maximum percentage indicated is exceeded, payment for forming holes through such material shall be made under Item 61.17. Unless otherwise specified, the maximum percentage of matrix shall be accepted to be 60%.

(b) Where obstructions other than those provided for in Item 61.21 can be identified, they shall be described on the Drawings and/or in the Project Specifications. Provision therefor shall be made in the Schedule of Quantities under extensions to Item 61.21.

Item | Unit
--- | ---
61.22 Forming augered and bored pile holes through unidentified obstructions ................ provisional sum

A provisional sum shall be allowed in the Schedule of Quantities for covering the cost of this work.

Payment for the work authorised by the Engineer shall be in accordance with the provisions of the General Conditions of Contract.

Item | Unit
--- | ---
61.23 Driving temporary casings for driven displacement piling systems or installing prefabricated piles through identified or unidentified obstructions ................ provisional sum

A provisional sum shall be allowed in the Schedule of Quantities for covering the cost of this work.

The method of payment for the work authorised by the Engineer shall be in accordance with the provisions of the General Conditions of Contract.

Item | Unit
--- | ---
61.24 Extra over Items 61.17, 61.18 and 61.20 for raking piles:

(a) Holes for piles of (diameter and rake indicated) ................ metre (m)
(b) Temporary casing for driven displacement pile systems (diameter and rake indicated) ................ metre (m)
(c) Prefabricated piles (type, size and rate indicated) ................ metre (m)

The tendered rates shall include full compensation for all additional work and incidentals for forming the pile holes or for driving and later extracting the temporary casing, or for installing prefabricated piles to the rake shown.

Item | Unit
--- | ---
61.25 Forming underreams for piles of (diameter indicated) ........ number (No)

The unit of measurement shall be the number of pile holes underreamed.

The tendered rate shall include full compensation for all work to be done in forming the underreams.

Item | Unit
--- | ---
61.26 Forming the bulbous bases for piles of (diameter indicated) ........ number (No)
The unit of measurement shall be the number of bulbous bases formed.

The tendered rate shall include full compensation for all work to be done in forming the bulbous bases but shall exclude the concrete work.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.27</td>
<td><strong>Socketing piles into rock formation</strong></td>
</tr>
<tr>
<td>(class of</td>
<td>rock and length of socket indicated)</td>
</tr>
<tr>
<td>(No)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of sockets, the length of which shall be not less than the specified length, formed in rock, the hardness of which shall be not less than that of the specified class of rock.

The tendered rate shall include full compensation for all work to be done for socketing into the rock formation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.28</td>
<td><strong>Installing and removing temporary casings</strong></td>
</tr>
<tr>
<td>in augered</td>
<td>holes for piles of (diameter indicated)</td>
</tr>
<tr>
<td>(m)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of temporary casing installed as directed by the Engineer or shown on the Drawings. Only the installed temporary casing below the average ground surface (Subclause 6113(h)) shall be measured for payment.

The tendered rate shall include full compensation for supplying, installing and removing the temporary casings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.29</td>
<td><strong>Installing permanent pile casing for piles</strong></td>
</tr>
<tr>
<td>of (diameter indicated)</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre of permanent casing installed as instructed by the Engineer or shown on the Drawings.

The tendered rate shall include full compensation for supplying and installing permanent pile casing.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.30</td>
<td><strong>Steel reinforcement in cast in situ piles:</strong></td>
</tr>
<tr>
<td>(a)</td>
<td>Mild-steel bars</td>
</tr>
<tr>
<td>(t)</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>High-yield-stress-steel bars (type indicated)</td>
</tr>
<tr>
<td>(t)</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement for steel bars shall be the tonne of reinforcement in place in accordance with the Drawings as authorised.

Ties and other steel used for keeping the reinforcing steel in position shall be measured as steel reinforcing under the appropriate subitem.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.31</td>
<td><strong>Cast in situ concrete</strong></td>
</tr>
<tr>
<td>in piles, underreams, bulbous bases and sockets (class of concrete indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of concrete placed in the cast in situ piles, underreams, bulbous bases and sockets. The quantity shall be calculated from the nominal pile diameter and length of pile from the founding level to the specified cutting-off level, plus the additional quantity of concrete in the underream and bulbous base as may be relevant.

The tendered rate shall include full compensation for supplying and storing all material, providing all plant, mixing, transporting, placing and compacting the concrete, curing the concrete and repairing defective concrete. Payment shall distinguish between the different classes of concrete.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.32</td>
<td>Extra over Item 61.31 for concrete cast under water</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of concrete cast under water, the quantity being calculated as for Item 61.31.

The tendered rate shall include full compensation for all additional work, incidentals and extra cement required for placing the concrete under water.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.33</td>
<td><strong>Splicing/coupling prefabricated piles for lengthening</strong></td>
</tr>
<tr>
<td>(size of pile indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of splices/couplings in prefabricated piles for each size of pile.

The tendered rate shall include full compensation for all work required for splicing/coupling the piles in accordance with the specifications.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.34</td>
<td><strong>Stripping/cutting the pile heads</strong></td>
</tr>
<tr>
<td>(type and diameter/size of pile indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of heads of each type and diameter/size of pile stripped/cut.

The tendered rate shall include full compensation for providing all tools and stripping/cutting the pile heads.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.35</strong> Establishment on the site for the load testing of piles</td>
<td>lump sum</td>
</tr>
<tr>
<td>The tendered lump sum shall include full compensation for the establishment on the site and subsequently removing all the special plant and equipment required for conducting the load tests on piles. This cost does not vary with the number of load tests to be conducted.</td>
<td></td>
</tr>
<tr>
<td>Payment for this work shall be made by way of a lump sum, 100% of which will be paid after the testing assembly has been completely assembled and the first load test has been started.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.36</strong> Load tests on piles (compression/tension test, diameter/size, specified working load indicated)</td>
<td>number (No)</td>
</tr>
<tr>
<td>The unit of measurement shall be the number of load tests conducted on the instruction of the Engineer, for each specified working load.</td>
<td></td>
</tr>
<tr>
<td>Test piles, but not anchor piles and anchors, shall be measured as specified above for permanent piles. Anchor piles and anchors shall be deemed to form part of the testing equipment under this Item.</td>
<td></td>
</tr>
<tr>
<td>The tendered rate shall include full compensation for installing the anchor piles and anchors where necessary; conducting load tests, and processing and submitting the results.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.37</strong> Establishment on the site for core drilling</td>
<td>lump sum</td>
</tr>
<tr>
<td>The tendered lump sum shall include full compensation for the establishment on the site and subsequently removing all the equipment required for conducting the core drilling. This cost does not vary with the quantity of work to be done.</td>
<td></td>
</tr>
<tr>
<td>This work shall be paid for by way of a lump sum, 100% of which will become payable when the equipment has been set up at the first location and drilling has started.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.38</strong> Moving the equipment to and assembling it at each location where cores are to be drilled</td>
<td>number (No)</td>
</tr>
<tr>
<td>The unit of measurement shall be the number of locations to which the core-drilling equipment is to be moved and at which it has to be assembled.</td>
<td></td>
</tr>
<tr>
<td>The tendered rate shall include full compensation for the cost of moving and assembling the equipment.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.39</strong> Drilling the cores (diameter indicated) in:</td>
<td></td>
</tr>
<tr>
<td>(a) Concrete</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Founding formation</td>
<td></td>
</tr>
<tr>
<td>(i) irrespective of hardness</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(ii) with a hardness of (hardness indicated)</td>
<td>metre (m)</td>
</tr>
<tr>
<td>The unit of measurement shall be the metre of hole drilled.</td>
<td></td>
</tr>
<tr>
<td>The tendered rate shall include full compensation for drilling, recovering and packing the cores, keeping the drilling records, providing core boxes, providing and installing the casings, and backfilling the holes with grout.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.40</strong> Standing time for pile-installation frame</td>
<td>hour (h)</td>
</tr>
<tr>
<td>The unit of measurement for the standing time of a pile-installation frame shall be the hour during which the pile-installation frame is standing in terms of Subclause 6113(w).</td>
<td></td>
</tr>
<tr>
<td>The tendered rate shall include full compensation for all fixed costs for the pile-installation frame, which is not connected with its operation and the quantity of work done.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.41</strong> Establishment on the site for constructing the caissons</td>
<td>lump sum</td>
</tr>
<tr>
<td>The tendered lump sum shall include full compensation for the establishment on the site and later removing all special plant and equipment necessary for constructing the caissons. This cost shall not vary in accordance with the number of caissons constructed.</td>
<td></td>
</tr>
<tr>
<td>This work shall be paid for by way of a lump sum, 50% of which will be paid when all the equipment is on the site and the first caisson has been constructed. The second payment of 25% of the lump sum will be paid after half the number of caissons have been completed, and the final instalment of 25% after all the caissons have been completed and the equipment has been removed from the site.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>61.42</strong> Formwork for caissons (class of finish indicated)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td>The unit of measurement shall be the square metre of formwork, and only the area of formwork in contact with the finished face of the concrete shall be measured. Formwork for construction joints shall be measured for payment under Class F1 surface finish but shall be measured only for construction joints shown on the Drawings or as prescribed by the Engineer.</td>
<td></td>
</tr>
</tbody>
</table>

6100-19
The tendered rate shall include full compensation for supplying all the materials, erecting the falsework and formwork, constructing the forms, forming the grooves, fillets, chamfers, stop ends for construction joints, treating the forms, all accessories, and stripping and removing the formwork after completion of the work. Payment for formwork shall be made only after the formwork has been stripped and the surface finish approved.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.43 Steel reinforcement for caissons:</td>
<td></td>
</tr>
<tr>
<td>(a) Mild-steel bars</td>
<td>tonne (t)</td>
</tr>
<tr>
<td>(b) High-yield-stress-steel bars (type indicated)</td>
<td>tonne (t)</td>
</tr>
</tbody>
</table>

The unit of measurement for steel bars shall be the tonne of reinforcement in place in accordance with the Drawings or as may have been authorised.

Ties and other steel used for positioning the reinforcing steel shall be measured as steel reinforcing under the appropriate subitem.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, trial welding joints, placing and fixing the steel, including all tying wire, spacers and waste.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.44 Cast in situ concrete in caissons and concrete seals (class of concrete indicated)</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement for cast in situ concrete shall be the cubic metre of concrete in place. Concrete quantities in the caissons shall be calculated from the dimensions shown on the Drawings or authorised by the Engineer, and the length of the caisson from the founding level to the specified cut-off level. The quantity of concrete in the concrete seal shall be calculated in accordance with the dimensions shown on the Drawings or authorised by the Engineer.

The tendered rate shall include full compensation for procuring and furnishing all the materials, storing the material, providing all plant, mixing, transporting, placing and compacting the concrete, all sealing, curing the concrete and repairing defective concrete. Payment shall distinguish between the different classes of concrete.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.45 Cutting edge for (diameter/size indicated) caissons</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of caissons provided with cutting edges, irrespective of the material they have been constructed of.

The tendered rate shall include full compensation for manufacturing, supplying, delivering and installing the complete cutting edge as well as for joining the cutting edge to the caisson unit. Where the cutting edge is of concrete and forms part of the bottom element, the tendered rate shall include full compensation for all additional work required for completing the element.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.46 Sinking (diameter/size indicated) caissons through material situated within the following successive depth ranges:</td>
<td></td>
</tr>
<tr>
<td>(a) 0 m up to 5 m</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(b) Exceeding 5 m and up to 10 m</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(c) Etc in increments of 5 m depths</td>
<td>metre (m)</td>
</tr>
</tbody>
</table>

The limits of the successive depth ranges shall be measured down from the firm horizontal base (Subclause 6114(b)) to the agreed founding level (Clause 6106).

The unit of measurement shall be the metre of caisson sunk.

Irrespective of the length of caisson sunk, the quantity for each depth range shall be measured and paid for separately.

The tendered rates shall include full compensation for locating and holding in position, dewatering, pumping, kentledge and lubricating the sides of the caisson, and for all work in connection with the sinking of the caisson which is not paid for elsewhere.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.47 Excavation for caissons:</td>
<td></td>
</tr>
<tr>
<td>(a) Excavating soft material situated within the following successive depth ranges:</td>
<td></td>
</tr>
<tr>
<td>(i) 0 m up to 2 m</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(ii) Exceeding 2 m and up to 4 m</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(iii) Etc in increments of 2 m depths</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

(b) Extra over Subitem 61.47(a) for excavation in hard material irrespective of depth | cubic metre (m³) |

The limits for the successive depth ranges shall be measured down from the firm horizontal base (Subclause 6114(b)) to the excavated level inside the caisson.

The unit of measurement shall be the cubic metre of material, measured in the original position before excavation. The quantity of excavation for each depth range shall be calculated from the gross area of the caisson in plan and the depth of excavation completed within each depth range.

Irrespective of the total depth of excavation, the quantity of material within each depth range shall be measured and paid for separately.
The tendered rates shall include full compensation for excavation in the classified material, spoiling or stockpiling the material, hauling the excavated material for the free-haul distance of 1.0 km, trimming the bottom of the excavation, dewatering, pumping and removing the material leaking into the caisson before sealing.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.48 Filling the caissons</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of sand placed above the concrete seal in the caisson compartments.

The tendered rate shall include full compensation for supplying and placing the sand, transporting the material within a free-haul distance of 1.0 km, and compacting the material as specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.49 Stripping the (size of caisson indicated)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of caissons of each size stripped.

The tendered rate shall include full compensation for cutting away, trimming and disposing of the concrete removed.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.50 Nuclear integrity testing on bored piles:</td>
<td></td>
</tr>
<tr>
<td>(a) Constructing 5 m long calibration piles of (indicate diameter)</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Installing 65 mm internal diameter steel ducts in the piles</td>
<td>metre (m)</td>
</tr>
<tr>
<td>(c) Performing integrity tests using:</td>
<td></td>
</tr>
<tr>
<td>(i) The nuclear method</td>
<td>number (No)</td>
</tr>
<tr>
<td>(ii) The neutron method</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement for Subitem (a) shall be the number of calibration piles constructed. The unit of measurement for Subitem (b) shall be the metre of 65 mm internal diameter steel duct installed. The unit of measurement for Subitem (c) shall be the number of integrity tests performed by each method.

The tendered rates shall include full compensation for procuring and furnishing all materials, constructional plant, equipment, labour and incidentals for forming the bored holes, constructing the calibration piles, installing the steel ducts, and performing the prescribed integrity tests, complete as specified.
<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Field indicator tests</th>
<th>Unconfined compression strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Very soft rock</td>
<td>Material crumbles under firm (moderate) blows with the sharp end of geological pick and can be peeled off with a knife; it is too hard to cut a triaxial sample by hand. SPT refusal.</td>
<td>1 to 3</td>
</tr>
<tr>
<td>R2</td>
<td>Soft rock</td>
<td>Can just be scraped and peeled with a knife, firm blows of the pick point leave indentations 2 mm to 4 mm in specimens.</td>
<td>3 to 10</td>
</tr>
<tr>
<td>R3</td>
<td>Medium hard rock</td>
<td>Cannot be scraped or peeled with a knife; hand-held specimen can be broken with the hammer end of a geological pick with a single firm blow.</td>
<td>10 to 25</td>
</tr>
<tr>
<td>R4</td>
<td>Hard rock</td>
<td>Point load tests shall be conducted for distinguishing between these categories. These results may be verified by means of uniaxial compressive-strength tests.</td>
<td>25 to 70</td>
</tr>
<tr>
<td>R5</td>
<td>Very Hard rock</td>
<td></td>
<td>70 to 200</td>
</tr>
<tr>
<td>R6</td>
<td>Extremely hard rock</td>
<td></td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>

SERIES 6000 : STRUCTURES

SECTION 6200 : FALSEWORK, FORMWORK AND CONCRETE FINISH

CONTENTS
6201 SCOPE
6202 MATERIALS
6203 GENERAL
6204 DESIGN
6205 CONSTRUCTION
6206 REMOVING THE FALSEWORK AND FORMWORK
6207 FORMED SURFACES : CLASSES OF FINISH
6208 REMEDIAL TREATMENT OF FORMED SURFACES
6209 UNFORMED SURFACES : CLASSES OF FINISH
6210 MEASUREMENT AND PAYMENT

6201 SCOPE

This Section covers the design, supply and erection of all falsework and formwork used in the construction of permanent work.

This Section also describes the classes of surface finishes on formed and unformed concrete surfaces.

6202 MATERIALS

(a) General

The materials used in the construction of falsework and formwork shall be suitable for the purpose for which they are required and be of such quality as to produce the specified standard of work. The type, grade and condition of the material shall be subject to the Engineer's approval.

(b) Falsework

The timber, structural steel and scaffolding used shall be free from defects that may prejudice the stability of the falsework. The jacks, devices, clamps and fittings shall all be in a good working order and of adequate design and strength.

(c) Formwork

(i) Tongue-and-groove boarding

Tongue-and-groove boarding shall be of suitably dried timber which will not warp, distort or cause discoloration of the concrete. The widths of the boards shall be as specified on the Drawings or in the Schedule of Quantities or as prescribed by the Engineer. Boards shall be supplied in lengths not shorter than 3 m.

(ii) Steel forms to exposed surfaces

For classes F2 and F3 surface finish the individual panels shall be assembled sufficiently rigidly and so clamped as not to deform or kick during handling or under the pressure of the wet concrete.

The surfaces of forms which are to be in contact with the concrete shall be clean, free from deposits or adhering matter, ridges or spatter which will impart irregularities and blemishes to the concrete surface, and shall also be free from indentations and warps.

(iii) Void formers

Void formers used in permanent work shall be subject to the approval of the Engineer.

Where void formers of a special design are required, details thereof will be specified.

Void formers shall be manufactured from material which will not leak, tear or be damaged during the course of construction and shall be of such tight construction as to prevent undue loss of the mortar component of the concrete through leakage. The units shall be sufficiently rigid so as not to deform during handling or under the pressure of the wet concrete.

For mild-steel spiral-lock-formed void formers, the metal thickness shall be as follows, unless otherwise specified:

(1) Unbraced void formers

- 0.6 mm for diameters of up to 600 mm.
- 0.8 mm for diameters exceeding 600 mm and up to 800 mm.
- 1.0 mm for diameters exceeding 800 mm and up to 1 000 mm.

(2) Braced void formers

- 0.6 mm for diameters of up to 800 mm.
- 0.8 mm for diameters exceeding 800 mm and up to 1 000 mm.
- 1.0 mm for diameters exceeding 1 000 mm and up to 1 200 mm.
- 1.2 mm for diameters exceeding 1 200 mm.

The thickness specified for braced void formers shall apply to formers internally braced with timber or equivalent braces. The braces shall be at spacings not exceeding 2 m and not further than 1.0 m from the end of each unit. Timber cross braces shall consist of members with cross-sectional dimensions of at least 50 mm x 50 mm.

All hollow void-former units shall be provided with a 12 mm diameter drainage hole at each end.

(iv) Chamfer and recess fillets

Timber fillets used for forming chamfers and recesses on exposed surfaces shall be made from new material unless otherwise authorised.

(v) Jack rods for sliding formwork

The jack rods, base plates and couplers shall be strong enough to carry the design load under all operating conditions without buckling, distorting or causing damage to the concrete. Jack rods which are to remain permanently embedded in the concrete shall comply with the requirements of Clauses 6303 and 6305. Under no circumstances shall bent rods be used in the work.

The jack rods used shall have a diameter of at least 25 mm.

6203 GENERAL

Notwithstanding approval given by the Engineer for the design and drawings prepared by the Contractor for the
falsework and formwork, and the acceptance of the falsework and formwork as constructed, the Contractor shall be solely responsible for the safety and adequacy of the falsework and formwork and shall indemnify and keep indemnified the Employer and Engineer against any losses, claims or damage to persons or property whatsoever which may arise out of or in consequence of the design, construction, use and maintenance of the falsework and formwork and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

For Works on, over, under or adjacent to any railway line which is controlled by a Rail Authority, the Contractor shall comply, inter alia, with the requirements for the preparation and submission of drawings for falsework and formwork, and the submission of certificates for the proper construction thereof, all in accordance with the relevant Rail Authority Specification.

After having constructed the falsework and formwork, and prior to placing the reinforcing steel and/or the concrete, the Contractor shall inspect the falsework and formwork. Dimensions shall be checked, unevenness of surface shall be corrected, and special attention paid to the adequacy and tightness of all bolts, ties and bracings as well as to the soundness of the foundations.

The Contractor shall give the Engineer at least 24 hours notice of his intention to place the concrete to enable the Engineer to inspect all aspects of the completed work. However, before notifying the Engineer, the Contractor shall satisfy himself that the work complies in all respects with the specifications.

Concrete sections with dimension of smaller than 200 mm shall not be formed with sliding formwork unless authorised by the Engineer.

Where no provision has been made in the Schedule of Quantities for sliding formwork, the Contractor may, in a covering letter to the Tender, submit a lump sum which reflects a saving in the cost for the use of sliding formwork in lieu of conventional formwork. The tendered lump sum quoted shall be accompanied by rates for pay Items 62.07, 62.08, 62.09 and 63.03, all in accordance with Clauses 6210 and 6310.

6204 DESIGN

(a) General

The Contractor’s design and drawings of the falsework and formwork shall comply amongst others with all statutory requirements.

The Engineer may require the Contractor to submit to him for consideration and approval the design and drawings of the falsework and formwork for any structure. The Contractor shall submit his design criteria and calculations and detail drawings of the falsework and formwork to the Engineer at least 14 days before the Engineer’s approval is required.

(b) Falsework

The Contractor shall make his own assessment of the allowable bearing pressure on the foundation material and shall design the footings and falsework to prevent overloading, differential settlement and unacceptable overall settlement. In assessing the allowable bearing pressure, due account shall be taken of the effect of wetting on the foundation material.

In designing the falsework, cognisance shall also be taken of the redistribution of load which may occur on account of the effect of temperature, wind force, the prestressing of curved and skewed structures, stage construction, flooding and debris.

Particular attention shall be given to providing transverse and diagonal bracing as well as rib stiffeners on cross bearers.

(c) Formwork

(i) General

Formwork shall be so designed as to be sufficiently rigid to ensure that the specified dimensional tolerances can be achieved under the combined action of self-weight, dead load and imposed loads as well as the additional loads resulting from the rate of concreting, the layer thickness of the concrete cast in one operation and the method of placing and compaction.

(ii) Sliding formwork

The Contractor shall be responsible for the design of the sliding formwork. Prior to fabrication or bringing the sliding formwork and any additional equipment to the site, the Contractor shall submit drawings of the complete sliding formwork assembly to the Engineer for approval. The drawings shall show full details of the forms, jacking frames, access ladders, hanging platforms, safety rails and curing skirts as well as details of the jacks and jack layouts.

The Contractor shall be required to submit to the Engineer, before slide casting commences, an instruction manual in which the sliding techniques, jacking procedure, methods of keeping the formwork level, the procedure to be adopted to prevent bonding of the concrete to the forms and a method for releasing the forms in the event of bonding, the instrumentation and monitoring of the slide casting and correcting for verticality, twisting and levelness are described in detail.

The formwork panels shall be inclined to give a small taper, the forms being slightly wider at the bottom than at the top. The taper shall be so designed as to produce the specified concrete thickness at the mid-lift level of the form.

The spacing of the jacks with their jack rods shall be so designed that the dead load of the sliding-formwork assembly, the frictional load, and the mass of materials, personnel and equipment will be evenly distributed and within the design capacity of the jacks used.

6205 CONSTRUCTION

(a) Falsework

Falsework shall be erected in accordance with the approved drawings incorporating such modifications as required by the Engineer.

The Contractor shall take precautions to prevent deterioration of the foundations during the course of construction.
The formwork for bridge decks shall be erected to levels calculated from the information given on the plans for roadworks and bridges. The levels shall be adapted to make provision for the specified precamber as well as for the expected deflection and settlement of the fully loaded falsework and formwork. The levels shall be set out and checked at intervals not exceeding 2.5 m.

For constructing the formwork, the Contractor may, subject to the provisions of Clause 6202, use any material suitable for and compatible with the class of surface finish and dimensional tolerances specified for the particular member.

Formwork shall be sufficiently rigid to maintain the forms in their correct position, shape and profile and shall be of such tight construction that the concrete can be placed and compacted without undue loss or leakage of the mortar component of the concrete.

The formwork construction shall permit accurate erection and easy stripping without shock, disturbance or damage to the cast concrete. Where necessary, the formwork assembly shall permit the removal or release of side forms independently of the soffit forms.

Metal supports, ties, hangers and accessories embedded in the concrete shall be removed to a depth of not less than the cover specified for the reinforcement. No wire ties shall be used.

All external corners shall be chamfered by fillet strips being fixed into the corners of the formwork to form 25 mm x 25 mm chamfers. Re-entrant angles need not be chamfered unless specified.

Where polystyrene or similar material, susceptible to damage is used, it shall be lined with a hard surface on the side to be concreted. The hard material shall be sufficiently resilient to ensure that the required quality of work can be achieved.

Where it is specified, all formwork ties shall be provided with recoverable truncated cones between sleeve ends and formwork faces to ensure that sleeve ends are not exposed on concrete surfaces. The cones shall have a minimum depth of 15 mm.

Opening and wall chases shall be provided only where indicated on the Drawings or as authorised by the Engineer.

Frames for openings shall be rigid and firmly secured in position to prevent their moving. Temporary holes shall be so formed that they will not create an irregular pattern in relation to the rest of the exposed formed concrete surface.

The formwork at construction joints shall be braced to prevent marks from forming on the concrete surface.

Where moulding or recess strips are specified, they shall be neatly butted or mitred.

The requirements for formwork for open joints shall, unless otherwise specified, apply only to cases where the distance between opposite concrete surfaces is equal to or less than 150 mm.

Formwork for open joints shall be constructed to produce a Class F1 surface finish to concealed surfaces or a Class F2 or F3 surface finish corresponding to the in-plane surface finish of the bordering concrete surfaces. The material used and construction of the formwork shall permit its complete removal to form the open joint.

No solvent shall be used to remove formwork unless approved by the Engineer.

The formwork shall incorporate features which will permit adjustment to the alignment of the formwork to neutralise the expected settlement and deflection under load.

(b) Formwork

(i) General

The formwork for bridge decks shall be erected to levels calculated from the information given on the plans for roadworks and bridges. The levels shall be adapted to make provision for the specified precamber as well as for the expected deflection and settlement of the fully loaded falsework and formwork. The levels shall be set out and checked at intervals not exceeding 2.5 m.

For constructing the formwork, the Contractor may, subject to the provisions of Clause 6202, use any material suitable for and compatible with the class of surface finish and dimensional tolerances specified for the particular member.

Formwork shall be sufficiently rigid to maintain the forms in their correct position, shape and profile and shall be of such tight construction that the concrete can be placed and compacted without undue loss or leakage of the mortar component of the concrete.

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Where polystyrene or similar material, susceptible to damage is used, it shall be lined with a hard surface on the side to be concreted. The hard material shall be sufficiently resilient to ensure that the required quality of work can be achieved.

Where it is specified, all formwork ties shall be provided with recoverable truncated cones between sleeve ends and formwork faces to ensure that sleeve ends are not exposed on concrete surfaces. The cones shall have a minimum depth of 15 mm.

(ii) Formwork to exposed surfaces

The formwork and boards shall be so arranged as to form a uniform and regular pattern in line with and perpendicular to the main axis of the member, unless otherwise approved or directed by the Engineer.

Joints between contiguous members shall, after caulking, taping or sealing, be treated to prevent blemishes, stains and undue marks from being imparted to the concrete surface.

Bolt and tie positions shall be so arranged that they conform to the symmetry of the formwork panels or boards. Bolt and rivet heads which will be in contact with the formed surface shall be of the countersunk type and shall be treated to prevent marks from forming on the concrete surface.

The formwork at construction joints shall be braced to prevent steps from forming in the concrete surfaces at the joints between successive stages of construction.

Where moulding or recess strips are specified, they shall be neatly butted or mitred.
verticality, levelness and twisting at regular distances. The equipment used, its utilisation and the frequency of recording any readings shall be approved by the Engineer.

The Contractor shall be responsible for all monitoring work and shall ensure that records of all readings and measurements taken are filed systematically and are at all times available to the Engineer and the person in control of the sliding operation.

Unless otherwise specified, the verticality of the structure shall be controlled with laser alignment apparatus or optical plummetts, and the levelness of the sliding forms with a water-level system with reference control points placed at strategic locations.

Height and verticality shall be monitored at intervals not exceeding four hours. The readings shall be plotted immediately on graphs. When the structure is more than 10 mm out of vertical, the Engineer shall be notified immediately.

(3) Supervision

During the entire period of the sliding operation, a competent person who is fully acquainted with the sliding technique and the Contractor's methods of construction shall be in attendance on the sliding platform and in control of the sliding operations.

(4) Construction

The jacking frame shall be constructed with adequate clearance between the underside of the cross members and top of the formwork to allow the horizontal reinforcement and embedded items to be correctly installed. A control procedure shall be agreed on by the Contractor and the Engineer to ensure that all the reinforcement is placed. At all times there shall be horizontal reinforcement above the level of the top of the formwork panel.

Guides shall be provided to ensure that the vertical reinforcement can be correctly placed and the specified concrete cover over the reinforcement maintained.

Where the jack rods are to be recovered, adequate precautions shall be taken in respect of their removal without damage being caused to the concrete.

Where jack rods occur at openings or wall chases, adequate lateral support shall be provided to prevent their buckling.

Equipment and material shall be so distributed on the working platforms that the load will be evenly distributed over the jacks.

Guard plates shall be provided at the tops of the forms to the outside walls to prevent the concrete from falling down the outside.

The framework, forms and platforms shall be regularly cleared and the accumulation thereon of redundant concrete prevented.

The Contractor shall take all precautions to prevent contamination of the concrete by leaking oil or other causes.

(5) The sliding process

The Contractor shall give the Engineer 24 hours' notice of his intention to commence with slide casting. Permission to commence with the sliding shall not be given by the Engineer before the sliding-formwork assembly is fully operative and the complete stock of all materials required for the slide casting as well as back-up plant and equipment are on the site.

The Contractor shall ensure that the rate of sliding is such that the concrete at the bottom of the formwork has obtained sufficient strength to support itself and all loads which may be placed on the concrete at the time, and that the concrete does not adhere to the sides of the forms.

The slide-casting operation shall be continuous, without any interruptions, until the full height of the structure has been reached, and shall be geared and organised so as to maintain an average rate of sliding of 350 mm per hour.

(6) Interruptions

When the sliding operations are delayed for more than 45 minutes, the Contractor shall prevent adhesion of the setting concrete to the formwork panels by easing the forms or moving them slightly every 10 minutes, or alternatively, where reversible jacks are used, by lowering the forms by 10 mm to 25 mm. Wherever interruptions occur, emergency construction joints shall be formed and treated in accordance with Clause 6408. Before concreting is restarted, the form shall be adjusted to fit snugly onto the hardened concrete so as to prevent steps from being formed on the exposed concrete surface. When slide casting is recommenced, care shall be taken to prevent the fresh concrete from being lifted off from the old concrete.

(vi) Permanent formwork

Void formers shall be secured in position at regular intervals to prevent displacement and distortion during concreting. The void formers shall be supported on precast concrete blocks or rigid welded steel cradles, all subject to approval by the Engineer. The ties securing the void formers shall be attached to the formwork and cross bearers of the falsework. The void formers shall not be tied to or supported on the reinforcement.

Fibre-cement plates shall be supported so that the plate spans in the direction parallel to the orientation of the asbestos fibres.

(vii) Preparing the formwork

The surfaces of forms which are to be in contact with fresh (wet) concrete shall be treated to ensure non-adhesion of the concrete to the forms and easy release from the concrete during the stripping of the formwork.

Release agents shall be applied strictly in accordance with the manufacturer's instructions, and every precaution shall be taken to avoid the contamination of the reinforcement, prestressing tendons and anchorages. In the selection of release agents, due regard shall be given to the necessity for maintaining a uniform colour and appearance throughout on the exposed concrete surfaces.

Before the concrete is placed, all dirt and foreign matter shall be removed from the forms and the forms shall be thoroughly wetted with water.

6206 REMOVING THE FALSEWORK AND FORMWORK

Falsework and formwork shall not be removed before the concrete has attained sufficient strength to support its own mass and any loads which may be imposed on it. This condition shall be assumed to require the formwork to
remain in place after the concrete has been placed, for the appropriate minimum period of time given in Tables 6206/1-6206/3, unless the Contractor can prove, to the satisfaction of the Engineer, that shorter periods are sufficient to fulfill this condition. In such case the formwork may be removed after the shorter periods of time agreed on by the Engineer.

Table 6206/1
Removing falsework and framework—Ordinary Portland cement

<table>
<thead>
<tr>
<th>Falsework and formwork for:</th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Beam sides, walls and unloaded columns</td>
<td>1</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

2 Soffits of slabs and beams

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Spans up to 3 m</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>b) Spans 3 m to 6 m</td>
<td>10</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>c) Spans 6 m to 12 m</td>
<td>14</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>d) Spans over 12 m</td>
<td>21</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

Falsework and formwork shall be carefully removed without exposing the cast concrete to damage, disturbance or shock.

Weather may be regarded as being "normal" when atmospheric temperatures adjacent to the concrete, as measured by a maximum-and-minimum thermometer, do not fall below 15°C, and as "cold" when temperatures, similarly measured, fall below 5°C. When the minimum temperatures fall between these values, the length of the period after which the formwork may be removed, shall be between the periods specified for normal and cold weather.

Any period during which the temperature remains below 2°C shall be disregarded in calculating the minimum time which shall elapse before the forms are removed.

On continuously reinforced concrete structures the formwork shall not be removed before the concrete of the last pour has reached the appropriate minimum age given in Table 6206/1 or the appropriate minimum strength. Where the structure is constructed in stages, the formwork shall be removed as specified or authorised.

Table 6206/2
Removing falsework and framework—Rapid hardening ordinary Portland cement

<table>
<thead>
<tr>
<th>Falsework and formwork for:</th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Beam sides, walls and unloaded columns</td>
<td>0.5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

2 Soffits of slabs and beams

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather*</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Spans up to 3 m</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>b) Spans 3 m to 6 m</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>c) Spans 6 m to 12 m</td>
<td>10</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>d) Spans over 12 m</td>
<td>18</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

* Shorter periods may be used for sections thicker than 300 mm

Table 6206/3
Removing falsework and framework—Cements with more than 15% blast furnace slag or flyash

<table>
<thead>
<tr>
<th>Falsework and formwork for:</th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Beam sides, walls and unloaded columns</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

2 Soffits of slabs and beams

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>Normal weather</th>
<th>Cold weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Spans up to 3 m</td>
<td>6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>b) Spans 3 m to 6 m</td>
<td>14</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>c) Spans 6 m to 12 m</td>
<td>21</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>d) Spans over 12 m</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
Unless specified to the contrary, steel forms may be used to form surfaces with a Class F3 surface finish.

(e) Board surface finish
This finish shall be that obtained by using tongue-and-groove timber boarding arranged in an approved regular pattern. The finish is intended to be left as struck but surface defects shall be remedied in accordance with Subclause 6208(b) and large fins trimmed where directed by the Engineer.

(f) Protecting the surfaces
The Contractor shall ensure that permanently exposed concrete surfaces are protected from rust marks, spillage and stains of all kinds and other damage during construction.

6208 REMEDIAL TREATMENT OF FORMED SURFACES

(a) General
Agreement shall be reached between the Engineer and the Contractor regarding any remedial treatment to be given after the surfaces have been inspected immediately after the formwork has been removed, which treatment shall be carried out without delay. No surfaces may be treated before inspection by the Engineer.

(b) Repairs to surface defects
Surface defects such as small areas of honeycombing, cavities produced by form ties, large isolated blow-holes, broken corner edges, etc, shall be repaired with mortar having a cement and sand ratio equal to that of the concrete being repaired.

For the repair of large or deep areas of honeycombing and defects, special approved methods and techniques, such as pneumatically applied mortar, pressure grouting, epoxy bonding agents, etc, may be used.

Where, in the opinion of the Engineer, the extent of the honeycombing or defects is of such a degree that doubt exists about the effectiveness of repair work, the Contractor shall at his own cost perform a load test in accordance with Subclause 6414(b) to prove that the structural safety of the repaired member has not been prejudiced, failing which, the structure shall be rebuilt in part or in full at the Contractor's cost.

Where the concrete has been damaged by adhesion to the formwork panel, the cracked and loose concrete shall be removed; or where the fresh concrete has lifted off at construction joints, the crack shall be scraped out immediately on both sides of the wall to a depth of at least 50 mm. The cavities so formed shall then be repaired as described above.

(c) Rubbing the surfaces
If the finish of exposed formed surfaces does not comply with the requirements for uniformity of texture, appearance and colour, the Contractor shall, when so instructed by the Engineer, rub down the exposed surfaces of the entire structure or of any part of it as specified below.

The surface shall be saturated with water for at least one hour. Initial rubbing shall be done with a medium-coarse carborundum stone, where a small amount of mortar, having a sand and cement ratio equal to that of the concrete being repaired, is used on the surface. Rubbing shall be continued until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. The paste produced by the rubbing shall be left in place. The final rubbing shall be carried out with a fine carborundum stone and water. This rubbing shall continue until the entire surface is of a smooth, even texture and is uniform in colour. The surface shall then be washed with a brush to remove surplus paste and powder.

Where the concrete surfaces formed by sliding formwork require treatment to achieve the surface finish specified for the member, the concrete shall, as soon as the surfaces under the formwork are exposed, be floated with rubber-lined floats to the desired finish.

6209 UNFORMED SURFACES : CLASSES OF FINISH

(a) Class U1 surface finish (rough)
This surface finish is required on those portions of bridge decks or culvert decks which are to receive bituminous or concrete surfacing or which are to be covered by backfilling material.

Where the placing and compacting of the concrete have been completed as specified in Clause 6407, the top surface shall be screeded off with a template to the required cross-section and lamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, so as to leave the surface slightly rough but generally at the required elevation.

(b) Class U2 surface finish (floated)
This surface finish is required on sidewalks; the tops of wing walls and retaining walls; exposed concrete shoulders and unsurfaced areas on bridge decks, and the inverts of box culverts.

The surface shall first be given a Class U1 surface finish and after the concrete has hardened sufficiently, it shall be wood-floated to a uniform surface free from trowel marks. For non-skid surfaces such as on sidewalks and bridge decks, the surface shall then be given a broom finish. The corrugations so produced shall be approximately 1.0 mm deep, uniform of appearance and width and shall be perpendicular to the centre line of the pavement.

(c) Class U3 surface finish (smoothly finished)
This surface finish shall be required at bearing areas and the tops of concrete railings. The surface shall first be given a Class U1 surface finish, and after the concrete has hardened sufficiently, it shall be floated with a steel float to a smooth surface to within the dimensional tolerances specified in Subclause 6803(h).

Rubbing with carborundum stone after the concrete has hardened shall be allowed but under no circumstances will plastering of the surface be permitted.
6210 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62.01</strong> Formwork to provide (class of finish indicated as F1, F2, F3 or board) surface finish to (description of member to which applicable)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td><strong>62.02</strong> Vertical formwork to provide (class of finish indicated as F1, F2, F3 or board) surface finish to (description of member to which applicable)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td><strong>62.03</strong> Horizontal formwork to provide (class of finish indicated as F1, F2, F3 or board) surface finish to (description of member to which applicable)</td>
<td>square metre (m²)</td>
</tr>
<tr>
<td><strong>62.04</strong> Inclined formwork to provide (class of finish indicated as F1, F2, F3 or board) surface finish to (description of member to which applicable)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre, and only the actual area of formwork in contact with the finished face of the concrete shall be measured. Formwork for the different classes of finish shall be measured separately. Formwork for construction joints shall be measured for payment under Class F1 surface finish, but only formwork for mandatory construction joints shall be measured for payment.

The tendered rates shall include full compensation for procuring and furnishing all materials required, erecting the falsework and formwork, constructing the forms, forming the grooves, fillets, chamfers and stop-ends for construction joints, treating and preparing the forms, all bolts, nuts, ties, struts and stays, stripping and removing the formwork after completion of the work, all labour, equipment and incidentals, and rubbing and surface treatment. Payment of 80% of the amount due for formwork will be made when the formwork has been removed, and payment of the remaining 20% will be made on approval of the concrete surface finish.

Note: Vertical and horizontal formwork shall be the formwork of which inclination of the finishing surface in relation to the horizontal level shall be larger and smaller than 40° respectively. Inclined formwork shall be the formwork described as such in the Schedule of Quantities.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62.05</strong> Permanent formwork:</td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>To form voids of (diameter/size of void indicated) in (description of member to which applicable)</td>
</tr>
<tr>
<td>(b)</td>
<td>Of (description of material and member to which applicable)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of concrete area formed with permanent formwork.

The tendered rates shall include full compensation for procuring and furnishing all the materials required, installing the formwork, and labour, equipment and incidentals.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62.06</strong> Formwork to form open joints (description of applicable, and location)</td>
<td>square metre (m²)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of concrete area formed.

Surfaces formed prior to the construction of the final surface for completing the joint, shall be measured under Items 62.01, 62.02, 62.03 or 62.04, as may be applicable.

The tendered rate shall include full compensation for procuring and furnishing all the materials required, constructing the formwork and subsequently removing all the material within the joint space, as well as labour, equipment and incidentals. Payment for formwork to open joints shall be made only after the forms and filler material have been completely removed and approval of the surface finish has been obtained.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62.07</strong> Establishment on the site for sliding formwork operations</td>
<td>lump sum</td>
</tr>
</tbody>
</table>

The tendered lump sum shall include full compensation for the establishment on the site and the subsequent removal of the complete sliding-formwork assembly, special plant and equipment, and incidentals for the sliding work, the cost of which does not vary with the actual amount of sliding work done.

This work will be paid for by way of a lump sum, 75% of which will become payable when the sliding-formwork assembly, plant and equipment have been fully installed at the first structural member on the site, and the remaining 25% will become payable after all sliding work has been completed and the said items have been removed from the site.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62.08</strong> Transporting to and setting up the sliding formwork assembly at (description of each structure)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>
The unit of measurement shall be the number of structures to which the complete sliding-formwork assembly has to be transported and set up in position ready to be commissioned.

The tendered rate shall include full compensation for all costs involved in dismantling, transporting and erecting of the complete sliding-formwork assembly.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.09</td>
<td>Forming the concrete by sliding formwork for (description of each structure and class of surface finish to exposed surfaces indicated)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the metre height of each structure formed by sliding formwork. The quantity measured shall be the actual height of each structure formed by the sliding technique.

The tendered rate shall include full compensation for sliding, instrumentation and monitoring, the maintenance of the complete sliding-formwork assembly, plant and equipment, supplying, installing and recovering the jack rods, floating, repairing and treating the concrete surfaces, forming the emergency construction joints, and all labour, equipment and incidentals.
SERIES 6000 : STRUCTURES

SECTION 6300 : STEEL REINFORCEMENT FOR STRUCTURES

CONTENTS

6301 SCOPE
6302 MATERIALS
6303 STORING THE MATERIALS
6304 BENDING THE REINFORCING STEEL
6305 SURFACE CONDITION
6306 PLACING AND FIXING
6307 COVER AND SUPPORTS
6308 LAPS AND JOINTS
6309 WELDING
6310 MEASUREMENT AND PAYMENT

6301 SCOPE

This Section covers the furnishing and placing of reinforcing steel in concrete structures.

6302 MATERIALS

(a) Steel bars

Steel reinforcing bars shall comply with the requirements of SABS 920 or equivalent. For each consignment of steel reinforcement delivered on the site, the Contractor shall submit a certificate issued by a recognised testing authority to confirm that the steel complies with the specified requirements.

The type of bar required shall be indicated on the Drawings by the symbols R, Y or Z in accordance with SABS 82 or equivalent.

(b) Welded steel fabric

Welded steel fabric shall comply with the requirements of SABS 1024 or equivalent.

(c) Mechanical couplers

The tensile properties determined on a test sample with a maximum gauge length of 610 mm, and which consists of reinforcing bars butt-jointed by a mechanical coupler shall comply with the following requirements:

(i) When tested in accordance with the relevant requirements of Clause 5.3 of SABS 920 or equivalent, the tensile properties of the test sample shall show an improvement of at least 10% on the requirements of Clause 3.7 of SABS 920 or equivalent.

(ii) Where the test sample is subjected to a load equal to 0.58 of the specified minimum yield force of the bar, the elongation measured on the gauge length shall not exceed the calculated theoretical elongation for a 610 mm length of the bar, based on a stress of 0.58 of the specified minimum yield stress of the bar and a Young's modulus of 200 GPa.

The Contractor shall submit to the Engineer test certificates from a recognised testing authority to confirm that the tensile couplers offered comply with the specified requirements.

All mechanical couplers used shall be subject to the approval of the Engineer.

6303 STORING THE MATERIALS

Reinforcing steel shall be stacked off the ground and, in aggressive environments, shall be stored under cover.

6304 BENDING THE REINFORCING STEEL

Reinforcement shall be cut or cut and bent to the dimensions shown on the bending schedules and in accordance with SABS 82 or equivalent.

No flame-cutting of high-tensile steel bars shall be permitted except when authorised.

Except as described below, all bars shall be bent cold and bending shall be done slowly, a steady, even pressure being exerted without jerking or impact.

If approved, the hot bending of bars of at least 32 mm in diameter will be permitted, provided that the bars do not depend on cold working for their strength. When hot bending is approved, the bars shall be heated slowly to a cherry-red heat (not exceeding 840°C) and shall be allowed to cool slowly in air after bending. Quenching with water shall not be permitted.

Already bent reinforcing bars shall not be re-bent at the same spot without authorisation.

6305 SURFACE CONDITION

When the concrete is placed around the reinforcing steel and/or dowels, the reinforcing steel and/or dowels shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance which could have an adverse chemical effect on the steel or concrete, or which could reduce the strength of bond.

6306 PLACING AND FIXING

Reinforcement shall be positioned as shown on the Drawings and shall be firmly secured in position within the tolerance given in Subclause 6803(f) by being tied with 1.6 mm or 1.25 mm diameter annealed wire or by suitable clips being used, or, where authorised, by tack welding.

Any cover and spacer blocks required to support the reinforcement shall be as small as may be consistent with their use and shall be of an approved material and design.

The concrete cover over the projecting ends of ties or clamps shall comply with the specifications for concrete cover over reinforcement detailed in Table 6306/1 (at the end of the Section).

Where protruding bars are exposed to the elements for an indefinite period, the bars shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.
In members which are formed with sliding formwork, spacer ladders for placing and fixing the wall reinforcement shall be used at spacings indicated on the Drawings or as prescribed by the Engineer. The spacer ladders shall consist of two bars 3.7 m in length with ties 4 mm in diameter welded to them to resemble a ladder. The ties shall be spaced at multiples of the horizontal bar spacing in the wall, and shall be used to secure the horizontal reinforcement. The laps in the horizontal reinforcement shall be staggered to ensure that no part of two laps in any four consecutive layers lie in the same vertical plane.

6307 COVER AND SUPPORTS

The term "cover" in this context shall mean the minimum thickness of concrete between the surface of the reinforcement and the face of the concrete.

The minimum cover shall be as shown on the Drawings. Where no cover is indicated, the minimum cover provided shall be at least equal to the appropriate values shown in Table 6306/1.

The cover shall be increased by the expected depth of any surface treatment, eg when concrete is bush hammered or when rebates are provided.

Additional cover as prescribed by the Engineer shall be provided if porous aggregates are used.

The cover blocks or spacers required for ensuring that the specified cover is obtained shall be of a material, shape and design acceptable to the Engineer.

Concrete spacer blocks shall be made with 5 mm maximum sized aggregate and shall be of the same strength and material source as those of the surrounding concrete. The blocks shall be formed in specially manufactured moulds and the concrete compacted on a vibratory table, and cured under water for a period of at least 14 days, all to the satisfaction of the Engineer.

Ties cast into spacer blocks shall not extend deeper into the spacer block than half the depth of the spacer block.

The Contractor shall provide stools as shown on the Drawings, or where they are not detailed on the Drawings, wherever the Engineer requires them to be installed. The stools shall be suitably robust, and fixed securely so that they can not swivel or move. The stools shall have sufficient strength to perform the required functions, taking into account amongst others temporary loads such as the weight of workmen and wet concrete, and forces caused by vibrators and other methods of compacting the concrete.

6308 LAPS AND JOINTS

Laps, joints, splices and mechanical couplings shall be applied only by the specified methods and at the positions shown on the Drawings or as authorised.

6309 WELDING

Reinforcement shall be welded only where shown on the Drawings or as authorised.

Flash butt welding shall be done only with the combination of flashing, heating, upsetting and annealing to the satisfaction of the Engineer, and only those machines which control this cycle of operations automatically shall be used.

Metal-arc welding of reinforcement shall be done in accordance with BS 5135, and with the recommendations of the reinforcement manufacturers, subject to approval by the Engineer and the satisfactory performance of trial joints. Hot-rolled high-yield-stress steel shall be preheated to between 240°C and 280°C and low-hydrogen electrodes only may be used.

Trial welding joints shall be made on the site in circumstances similar to those which will govern during the making of production welding joints by the person who will be responsible for the production welding joints.

Other methods of welding eg resistance welding, may be used subject to approval by the Engineer and to their satisfactory performance in trial joints.

Welded joints shall be full-strength welds and their strength shall be assessed by destruction tests on samples selected by the Engineer.

6310 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.01 Steel reinforcement for:</td>
<td></td>
</tr>
<tr>
<td>(a) (Description of portion of structure to which applicable):</td>
<td></td>
</tr>
<tr>
<td>(i) Mild-steel bars ................. tonne (t)</td>
<td></td>
</tr>
<tr>
<td>(ii) High-yield-stress-steel bars (type indicated) ................. tonne (t)</td>
<td></td>
</tr>
<tr>
<td>(iii) Welded steel fabric ............ kilogram (kg)</td>
<td></td>
</tr>
<tr>
<td>(b) Etc for other structures or parts of structures</td>
<td></td>
</tr>
</tbody>
</table>

The unit of measurement for steel bars shall be the tonne of reinforcing steel in place in accordance with the Drawings or as authorised.

The unit of measurement for welded steel fabric shall be the kilogram of welded steel fabric in place, the quantity of which shall be calculated from the area of the mesh used in accordance with the Drawings or as authorised.

Ties, stools and other steel used for positioning the reinforcing steel shall be measured as steel reinforcement under the appropriate Subitem.

The tendered rates shall include full compensation for supplying, delivering, cutting, bending, welding, trial weld joints, placing and fixing the steel reinforcement, including all tying wire, spacers and waste.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
</table>
| 63.02 Mechanical couplers  
(type of coupler and diameter of bar indicated) | number (No) |

The unit of measurement shall be the number of mechanical couplers for each bar diameter installed.

The tendered rate shall include full compensation for supplying all the material, preparing and modifying the bar ends to be joined, and all tools, equipment and labour required for completing the work.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
</table>
| 63.03 Spacer ladders for  
(description of part of structure to which applicable) | tonne (t) |

The unit of measurement for spacer ladders shall be the tonne of steel in place in accordance with the Drawings or as authorised.

The tendered rate shall include full compensation for supplying, delivering, cutting, bending, welding, placing and fixing the ladders, including all tying wire, spacers and waste.
<table>
<thead>
<tr>
<th>Condition of exposure</th>
<th>Description of member/surface to which the cover applies</th>
<th>Min cover (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class of concrete</td>
</tr>
<tr>
<td>1. MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete surfaces above ground level and protected against alternately wet and dry conditions caused by water, rain and sea-water spray.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Surfaces protected by the superstructure, viz the sides of beams and the undersides of slabs and other surfaces not likely to be moistened by condensation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Surfaces protected by a waterproof cover or permanent formwork not likely to be subjected to weathering or corrosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 Enclosed surfaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4 Structures/members permanently submerged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Railway structures:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Surfaces of precast elements not in contact with soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) Surfaces protected by permanent formwork not likely to be subjected to weathering or corrosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iii) Surfaces in contact with ballast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iv) All other surfaces</td>
<td></td>
</tr>
<tr>
<td>2. SEVERE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete surfaces exposed to hard rain and alternately wet and dry conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 All exposed surfaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Surfaces on which condensation takes place</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 Surfaces in contact with soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4 Surfaces permanently under running water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 Railway structures:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Surfaces of precast elements not in contact with soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) Surfaces protected by permanent formwork not likely to be subjected to weathering or corrosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iii) Surfaces in contact with ballast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iv) All other surfaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.6 Cast in situ piles:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Wet cast against casing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) Wet cast against soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iii) Dry cast against soil</td>
<td></td>
</tr>
<tr>
<td>3. VERY SEVERE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete surfaces exposed to aggressive water, sea-water spray or a saline atmosphere</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1 All exposed surfaces of structures within 30 km from the sea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2 Surfaces in rivers polluted by industries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3 Cast in situ piles, wet cast against casings</td>
<td></td>
</tr>
<tr>
<td>4. EXTREME</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concrete surfaces exposed to the abrasive action of sea water or very aggressive water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 Surfaces in contact with sea water of industrially polluted water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.2 Surfaces in contact with marshy conditions</td>
<td></td>
</tr>
</tbody>
</table>
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SERIES 6000 : STRUCTURES

SECTION 6400 : CONCRETE FOR STRUCTURES

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6403 STORING THE MATERIALS
6404 CONCRETE QUALITY
6405 MEASURING THE MATERIALS
6406 MIXING
6407 PLACING AND COMPACTING
6408 CONSTRUCTION JOINTS
6409 CURING AND PROTECTING
6410 ADVERSE WEATHER CONDITIONS
6411 PIPES AND CONDUITS
6412 APPLIED LOADING
6413 PRECAST CONCRETE
6414 QUALITY OF MATERIALS AND WORKMANSHIP
6415 DEMOLITION AND REMOVAL OF EXISTING STRUCTURAL CONCRETE
6416 MEASUREMENT AND PAYMENT

6401 SCOPE

This Section covers the manufacture, transport, placing and testing of concrete used in the Works where plain, reinforced or prestressed concrete is specified.

6402 MATERIALS

(a) Cement

Cement used for concrete shall be any of the following:

(i) Ordinary Portland cement or rapid-hardening Portland cement complying with the requirements of SABS 471 or equivalent.

(ii) Portland blast-furnace cement complying with the requirements of SABS 626 or equivalent.

(iii) Ordinary Portland cement 15 or rapid-hardening Portland cement 15 which complies with the requirements of SABS 831 or equivalent.

(iv) Sulphate-resistant cement, but only where shown on the Drawings or instructed by the Engineer.

(v) In prestressed concrete members or units the use of Portland blast-furnace cement will not be permitted. A 50/50 mixture of ordinary Portland cement and ground granulated blast-furnace slag may be used only if authorised in the Project Specifications or by the Engineer, in writing.

(b) Aggregates

Both coarse aggregate (stone) and fine aggregate (sand) shall comply with the requirements of SABS 1083 or equivalent, subject to the following:

(i) The drying shrinkage of both the fine and coarse aggregate when tested in accordance with SABS 836 or equivalent shall not exceed the following limits:

1. For use in prestressed concrete, concrete bridge decks and slender columns the shrinkage of both fine and coarse aggregate shall not exceed 130% of that of the reference aggregate.

2. For use in other reinforced concrete members the shrinkage of the fine aggregate shall not exceed 175% and of the coarse aggregate 150% of that of the reference aggregate.

3. For use in mass concrete substructures and unreinforced concrete head walls and wing walls, the shrinkage of both the fine and coarse aggregate shall not exceed 200% of that of the reference aggregate.

Where there is any doubt about the shrinkage characteristics of aggregates, the Contractor shall submit a certificate by an approved laboratory which gives the shrinkage characteristics of the aggregate.

(ii) The flakiness index of the stone as determined by TMH 1 Method B3 shall not exceed 35%.

(iii) Aggregates shall not contain any deleterious amounts of organic materials such as grass, timber or similar materials.

(iv) Where there is any danger of a particular combination of aggregate and cement giving rise to a harmful alkali-aggregate reaction, the particular combination shall be tested in accordance with the testing method as described in Clause 7105, and, where the result points to such reaction, either the aggregate or the cement or both shall be replaced so that an acceptable combination may be obtained.

(v) The fineness modulus of the fine aggregate shall not vary by more than ±0.2 from the approved modulus.

(c) Plums

Plums used in concrete shall comply with the following requirements:

(i) The plums shall be clean, durable and inert.

(ii) The aggregate crushing value may not exceed 25%.

(iii) The mass of each plum shall be between 15 kg and 55 kg.

(iv) No dimension of any plum shall be less than 150 mm or exceed 500 mm.

(d) Water

Water shall be clean and free from detrimental concentrations of acids, alkalis, salts, sugar and other organic or chemical substances that could impair the durability and strength of the concrete or the imbedded steel. The Contractor shall prove the suitability of the water by way of tests conducted by an approved laboratory. The water used for concrete shall comply with the requirements in Clause 7113 unless otherwise approved by the Engineer. For reinforced and prestressed concrete the chloride content of the mixing water shall not exceed 500 mg/l when tested in accordance with SABS 202 or equivalent.
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6403 STORING THE MATERIALS

(a) Cement

Cement stored on the site shall be kept under cover which provides adequate protection against moisture and other factors which may promote deterioration of the cement.

When the cement is supplied in bags, the bags shall be closely and neatly stacked to a height not exceeding 12 bags and arranged so that they will not be in contact with the ground or the walls, and can be used in the order in which they were delivered to the site.

Cement in bulk shall be stored in waterproof containers so designed as to prevent any dead spots from forming, and the cement drawn for use shall be measured by mass.

Cement shall not be kept in storage for longer than eight weeks without the Engineer's permission, and different brands and/or types of the same brand of cement shall be stored separately.

(b) Aggregates

Aggregates of different nominal sizes shall be stored separately and in such a manner as to avoid segregation occurring. Intermixing of different materials and contamination by foreign matter shall be avoided. Aggregates exposed to a marine environment shall be covered to protect them from salt contamination.

Where concrete is batched on site, the aggregates shall be stored in bins with a 3 m wide concrete apron slab constructed around the outer edge of the aggregate stockpile area to prevent contamination during the process of tipping and hoisting the aggregate. The aggregates shall be tipped on the concrete apron slab. The storage bin shall have a concrete floor of 150 mm thickness.

(c) Storage capacity

The storage capacity provided and the quantity of material stored (whether cement, aggregates or water) shall be sufficient to ensure that no interruptions to the progress of the work will be occasioned by any lack of materials.

(d) Deteriorated material

Deteriorated or contaminated or otherwise damaged material shall not be used in concrete. Such material shall be removed from the site without delay.

6404 CONCRETE QUALITY

(a) General

Concrete shall comply with the requirements for strength concrete or prescribed-mix concrete, as specified in Subclauses 6404(b) and (c) below.

The total alkaline content (Na\textsubscript{2}O equivalent) of the concrete shall be limited taking into account the degree of reactivity as specified in Clause 7105.

(b) Strength concrete

The Contractor shall be responsible for the design of the concrete mix and for the proportions of the constituent materials necessary for producing concrete which complies with the requirements specified below for each class of concrete.

The class of concrete is indicated by the characteristic 28-day cube crushing strength in MPa and the maximum size of coarse aggregate in the mix, e.g., Class 30/38 concrete means concrete with a characteristic cube crushing strength of 30 MPa after 28 days and a maximum sized coarse aggregate of 38 mm.

The aggregate size shall be selected in accordance with SABS 1083 or equivalent.

The characteristic cube crushing strength of strength concrete shall be of any strength from 15 MPa, in increments of 5 MPa, up to 60 MPa, as indicated on the Drawings or in the Schedule of Quantities or as may be prescribed by the Engineer. The strengths preferred are 15, 20, 25, 30, 40, 50 and 60 MPa.

The cement content for any class of concrete shall not exceed 500 kg per cubic metre of concrete.

Where for reasons of durability or other considerations concrete is designated by the prefix “W” e.g. Class W30/19, such designations shall denote concrete having a cementitious content not less than and a water:cement ratio not exceeding the limits specified in the Project Specifications.

In such cases, characteristic cube compressive strengths should be:

(i) the specified 28-day characteristic cube compressive strength, or
(ii) a characteristic cube compressive strength corresponding to the designated maximum water:cement ratio, or

(iii) a characteristic cube compressive strength corresponding to the designated cementitious content.

Before starting with any concrete work on the site, the Contractor shall submit, for approval, samples of the constituent materials of the concrete and a statement of the mix proportions which he proposes to use for each class of concrete indicated in the Schedule of Quantities.

Where any change occurs in the material sources, the aggregate sizes, or any other components of the concrete, the above procedure shall be repeated.

The samples submitted shall be accompanied by evidence that they comply with the requirements for the various materials specified. The statement regarding the mix proportions shall be accompanied by evidence establishing that concrete made from the materials in the proposed proportions will have the specified properties.

Evidence shall be in the form of:

(i) a statement regarding the test results, which shall be furnished by an approved laboratory; or

(ii) an authoritative report on previous use of and experience in regard to the material.

The actual mix proportions used as well as any changes thereto shall be subject to the Engineer's approval, but such approval shall not in any way relieve the Contractor of his responsibility for producing concrete with the specified properties.

The Contractor is cautioned that the quality of cement may vary considerably from consignment to consignment so as to necessitate adjustments in the cement content of mixes. In order to ensure a uniform quality of concrete, the Contractor shall obtain from the manufacturer the data regarding the relevant cement quality for each consignment with a view to ascertaining the required adjustment in the cement content. This information shall be submitted to the Engineer.

(c) Prescribed-mix concrete

The Contractor shall submit samples of every constituent of the concrete in accordance with the appropriate provisions of Section 7200 and Subclause 6404(b) for approval.

The nominal mixes for prescribed-mix concrete for which no strength requirements have been laid down are shown in Table 6404/1.

The class of concrete is indicated by the mix and the maximum size of the coarse aggregate in the mix, eg Class 1:7:7/38 concrete shall mean concrete with a prescribed mix in a volume ratio of one part of cement : seven parts of sand : seven parts of stone, with a nominal stone size of 38 mm.

(d) Bleeding

The concrete shall be so proportioned with suitable materials that bleeding is not excessive.

<table>
<thead>
<tr>
<th>Constituent or property</th>
<th>Mix 1:7:7</th>
<th>Mix 1:5:5</th>
<th>Mix 1:4:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (kg)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total quantity of aggregate (m³)</td>
<td>0.46</td>
<td>0.33</td>
<td>0.26</td>
</tr>
<tr>
<td>Max total quantity of water (l)</td>
<td>62</td>
<td>46</td>
<td>37</td>
</tr>
<tr>
<td>Estimated average 28-day compressive strength (MPa)</td>
<td>8</td>
<td>17</td>
<td>24</td>
</tr>
</tbody>
</table>

(e) Consistency and workability

The concrete shall be of suitable workability without the excessive use of water so that it can be readily compacted into the corners of the formwork and around the reinforcement, tendons and ducts without the material segregating.

Slump measurements obtained in accordance with the test method described in TMH-1 Method D3 on concrete used in the Works shall fall within the ranges specified in Table 6404/2.

<table>
<thead>
<tr>
<th>Type of construction</th>
<th>Max slump (mm)*</th>
<th>Min slump (mm)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestressed concrete</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Concrete nosings and pre-fabricated units</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Mass concrete</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>Reinforced concrete footings, cast in situ piles</td>
<td>125</td>
<td>50</td>
</tr>
<tr>
<td>(except dry-cast piles), slabs, beams and columns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Where high-frequency vibrators are used, the values above shall be reduced by one-third.

(f) Sulphate content

The total water soluble sulphate content of the concrete mix, expressed as SO₄, shall not exceed 4% (m/m) of the cementitious binder content of the mix. The sulphate content shall be calculated as the total from the various constituents of the mix using the following test methods:

- Cementitious binder : SABS 741 or equivalent
- Aggregates : SABS 850 or equivalent
- Water : SABS 212 or equivalent
(g) Pumped concrete

Where pumping of the concrete is approved by the Engineer, the concrete mix to be pumped shall be so designed that:

(i) settlement will not exceed 125 mm;
(ii) graded aggregate and suitable admixtures be used, wherever necessary, with a view to improving the pumpability of the mix; and
(iii) its shrinkage capacity shall not be excessively higher than that of ordinary concrete mixes.

6405 MEASURING THE MATERIALS

(a) Cement

Where cement is supplied in standard bags, the bags shall be assumed to contain 50 kg. All cement taken from bulk-storage containers and from partly used bags shall be batched by mass, accurate to within 3% of the required mass.

(b) Water

The mixing water for each batch shall be measured, either by mass or by volume, accurate to within 3% of the required quantity. The quantity of water added to the mix shall be adjusted to make allowance for moisture in the aggregates.

(c) Aggregates

All aggregates for strength concrete shall be measured separately by mass, except as otherwise provided in this Clause, accurate to within 3% of the required quantity.

Aggregates for strength concrete may be volume batched subject to the approval of the Engineer, and to the quantity of cement being increased, at the cost of the Contractor, by 25 kg per cubic metre of concrete, over and above the quantity which would have been necessary were the aggregate to have been batched by mass.

Aggregates for prescribed-mix concrete as specified in Subclause 6404(c) may be measured separately by volume.

Batching boxes for volume batching shall be filled without any tamping, ramming or consolidating the material (other than that occurring naturally during the filling of the container), and shall be screeded off level with their topmost edges.

Any adjustment to the volume shall be made by supplementary containers of a suitable size being used. Adjustments to the volume, by the incomplete filling of batching boxes to marks on their inside faces will not be permitted.

Fine aggregate shall be tested for bulking at the beginning of and halfway through each concreting shift, and adjustment shall be made to the batch volume to give the true volume required.

The measurement of cement in gauge boxes will not be permitted and volume batching shall be so planned as to use full bags of cement.

6406 MIXING

(a) General

Mixing the material for concrete shall be conducted by an experienced operator. Unless otherwise authorised, mixing shall be carried out in a mechanical batch-mixer of an approved type which will be capable of producing a uniform distribution of ingredients throughout the batch.

(b) Charging the mixer

The sequence of charging the ingredients shall be subject to approval by the Engineer, and, unless otherwise instructed, the same sequence of charging the ingredients shall be maintained.

The volume of the mixed material by batch shall not exceed the volume recommended by the manufacturer of the mixer.

(c) Mixing and discharging

The period of mixing shall be measured from the time when all the materials are in the drum until the commencement of discharge.

The mixing period for the materials shall be 90 seconds and may be reduced only if the Engineer is satisfied that the reduced mixing time will produce concrete with the same strength and uniformity as concrete mixed for 90 seconds. The reduced mixing time, however, shall be not less than 50 seconds or the manufacturer’s recommended mixing time, whichever is the longer. A suitable timing device shall be attached to the mixer to ensure that the minimum mixing time for the materials has been complied with.

The first batch to be run when starting with a clean mixer, shall contain only 2/3 of the required quantity of coarse aggregate to make provision for “coating” the mixer drum.

Discharge shall be so carried out that no segregation of the materials will occur in the mix. The mixer shall be emptied completely before it is recharged with fresh materials.

(d) Maintaining and cleaning the mixer

If the mixer has stopped running for a period in excess of 30 minutes, it shall be thoroughly cleaned out, particular attention being given to the removal of any build-up of materials in the drum, in the loader, and around the blades or paddles. Worn or bent blades and paddles shall be replaced.

Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed.

(e) Standby mixer

When sections are cast where it is important for the casting to continue without interruption, a standby mixer shall be held in readiness to run on 15 minutes notice should the stock mixers break down.
(f) Ready-mixed concrete

Where ready-mixed concrete is delivered at the site, the requirements of SABS 878 or equivalent shall have priority over the requirements specified in this Section should inconsistencies occur.

6407 PLACING AND COMPACTING

(a) General

Concrete shall be transported and placed in a manner that will prevent segregation or loss of constituent materials or the contamination of the concrete.

Concrete shall not be placed in any part of the Works until the Engineer's approval has been given. If concreting is not started within 24 hours of approval having been given, approval shall again be obtained from the Engineer.

Concreting operations shall be carried out only during daylight hours unless proper lighting arrangements have been made and the lights are in working order by noon. Workmen shall not be allowed to work double shifts and the Contractor shall provide a fresh team for night shifts.

Placing and compacting the concrete shall at all times be under the direct supervision of an experienced concrete supervisor.

Once the casting of concrete has begun, it shall be carried out in a continuous process between construction joints. Concrete shall be placed within 60 minutes from the start of mixing. These times may be extended by the Engineer where a retarding admixture has been used. All excavations and other contact surfaces of an absorbent nature such as timber formwork shall be damp but no standing water shall be permitted to remain on these surfaces. The formwork shall be clean on the inside.

Water quality, marine life or any other sensitive environment shall not be adversely affected in any way.

(b) Placing

Whenever possible, concrete shall be deposited vertically into its final position. Where chutes are used, their length and slope shall be such as to cause segregation, and suitable spouts and baffles shall be provided at the lower end to minimise segregation. The displacement of concrete by vibration instead of by direct placing shall be done only when approved by the Engineer.

Care shall be taken when casting bridge decks of a substantial thickness to avoid layering of the concrete, and the entire thickness shall be placed in one pass. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a construction joint has been formed or unless a retarding additive has been used in the concrete.

The pumping of concrete shall be subject to approval by the Engineer. Aluminium pipes shall not be used for this purpose.

In plain concrete with a thickness of not less than 300 mm, plums may, if approved, be included to displace concrete for up to 20% of the total volume, provided that:

(i) the plums are spread evenly throughout the concrete;

(ii) no plum laid shall have a dimension exceeding one third of the smallest dimension of the concrete in any plane,

(iii) each plum is surrounded by at least 75 mm of concrete.

(c) Placing under water

Placing under water shall be allowed only in exceptional circumstances where it is not feasible to dewater the location before the concrete is placed. No concrete shall be placed in running water.

Underwater concrete shall be placed by means of tremies. Full details of the method proposed by the Contractor shall be submitted in advance for approval. Placing by skip or pipeline will also be considered in certain circumstances.

During concreting by tremie, the pipe shall be kept filled with concrete at all times to prevent air and water from entering the tremie. When the tremie is charged, an approved sliding plug shall be used. Once concreting has begun by tremie, the discharge end of the tremie shall be kept well below the surface of the concrete. Should this seal be broken, the tremie shall be lifted and plugged before concreting is recommenced. Distribution of concrete by lateral movement of the tremie will not be permitted.

The concrete mix to be placed underwater shall be specially designed and approved for this purpose to ensure good flowability, plasticity and cohesion. Increased sand and cement contents over those of normal mixes will usually be required.

(d) Compaction

Concrete shall be fully compacted by approved means during and immediately after placing. It shall be thoroughly worked against the formwork, around reinforcement bars, tendons, ducts and embedded fittings and into corners to form a solid mass free from voids.

The concrete shall be free from honeycombing and planes of weakness, and successive layers of the same lift shall be thoroughly bonded together.

Unless otherwise permitted by the Engineer, concrete shall be compacted by means of vibrators. Internal vibrators shall be capable of producing not less than 10 000 cycles per minute and external vibrators not less than 5 000 cycles per minute. Sufficient standby vibrators shall be kept available in case of breakdowns.

Vibration shall be applied by experienced labourers, and over-vibration resulting in segregation, surface water and leakage shall be avoided. Contact with reinforcement and formwork shall, in so far as is practicable, be avoided when internal vibrators are used. Concrete shall not be subjected to disturbance by vibration within 4 to 24 hours of it having been compacted.

Whenever vibration is applied externally, the design of the formwork and positioning of vibrators shall be such as to ensure efficient compaction and avoidance of surface blemishes.

Special attention shall be given to the compaction of concrete in the anchorage zones and behind the anchor plates and in all places where high concentrations of reinforcing steel or cables occur.
Where the placing and compaction of concrete is difficult, a mix containing smaller sized aggregate may be used but only with the approval of the Engineer and after a mix containing such aggregate has been designed and tested.

(e) Requirements in respect of sliding formwork

Where sliding formwork is used, the following additional requirements shall apply:

(i) The Contractor shall take all the necessary measures to ensure the continuity of operations. All the necessary lighting and standby equipment for mixing, hoisting, placing and compacting shall be provided and all the materials required for completing each structure shall be ready on the site before casting commences.

(ii) Concrete shall be cast in uniform layers in the formwork so that the level of the top surface of the concrete differs by no more than 250 mm between any two points in the formwork. In addition, the top level of the concrete shall never be so low down in the formwork as will cause structural instability in the formwork. The working platform shall be kept clean and no concrete which has dried out in part may be swept into the formwork.

(iii) The concrete shall be compacted during and immediately after placing. Care shall be taken not to damage or disturb previously placed concrete. To ensure the proper bonding of successive layers, not more than one hour shall elapse between the placing of successive layers except where an approved admixture has been applied, in which case the delay may be amended in consideration of such circumstances.

(iv) The slump of concrete may be up to 150 mm should the approved method of sliding so require.

6408 CONSTRUCTION JOINTS

(a) General

Concreting shall be carried out continuously up to the construction joints shown on the working drawings or as approved, except that if, because of an emergency (such as breakdown of the mixing plant or the occurrence of unsuitable weather), concreting has to be interrupted, a construction joint shall be formed at the place of stoppage and in the manner which will least impair the durability, appearance, and proper functioning of the concrete.

Unless otherwise shown on the Drawings, the exact position of horizontal construction joints shall be marked on the formwork by means of grout checks in order to obtain truly horizontal joints.

Stub columns, stub walls and stays on footings shall be cast integrally with the footings and not afterwards, even where another class of concrete is being used.

(b) Preparing the surfaces

When the concrete has set and while it is still green, the surface film shall be removed, without disturbing the aggregate, by means of a water jet assisted by light brushing to expose the aggregate and leave a sound, irregular surface. Where this is not possible, the surface film shall be removed after the concrete has hardened, by mechanical means appropriate to the degree of hardness of the concrete so as to expose the aggregate and leave a sound, irregular surface. The roughened surface shall be washed with clean water to remove all laitance, dirt and loose particles.

Surface retarding agents may be used only with the approval of the Engineer.

(c) Placing fresh concrete at construction joints

Where fresh concrete is placed the same day as that on which the construction joint was formed, the fresh concrete shall be cast directly against the face of the construction joint.

When concreting recommences a day or more after the construction joint has been formed, the following procedure shall be followed:

(i) The construction joint shall be kept constantly wet for a period of at least six hours. The surface shall be in a saturated, surface dry condition when concreting has to recommence.

(ii) Any dirt, excess water and loose particles shall be removed prior to reconcreting being started.

(iii) For horizontal construction joints a 25 mm thick concrete layer of the same grade of concrete made richer by reducing the coarse aggregate content by 25% shall be placed on the joint plane immediately before concreting.

(iv) For vertical construction joints the fresh concrete shall be placed against a surface prepared in accordance with Subclause 6408(b), which is in a saturated, surface-dry condition.

Epoxy resins specially designed for bonding old concrete to new shall be used at construction joints where so specified. The preparation of the construction joint surface and the application of the epoxy resin shall be strictly in accordance with the manufacturer’s recommendations and the Engineer’s instructions. The actual brand and type of resin used shall be subject to the Engineer’s approval.

6409 CURING AND PROTECTING

Formwork shall be retained in position for the appropriate times given in Clause 6206, and, as soon as may be practicable, all exposed concrete surfaces shall be protected from loss of moisture by one or more of the following methods:

(a) Retaining formwork in place for the full curing period.

(b) Ponding the exposed surfaces with water, except where atmospheric temperatures are low, ie less than 5°C.

(c) Covering it with sand or mats made from a moisture-retaining material, and keeping the covering constantly wet.

(d) Constantly spraying the entire area of the exposed surfaces with water (only on surfaces where sand cover or ponding is impossible).

(e) Covering with a waterproof or plastic sheeting firmly anchored at the edges.

(f) Using an approved curing compound applied in accordance with the manufacturer’s instructions, except that, where the surface has to be subsequently...
waterproofed, coated or gunited, this method may not be used.

(g) Steam curing the concrete (precast units).

The method of curing adopted shall be subject to the Engineer's approval and shall not cause staining, contamination, or marring of the surface of the concrete.

The curing period shall be continuous for at least seven days for concrete made with ordinary Portland cement or ordinary Portland cement 15, rapid-hardening Portland cement or rapid-hardening Portland cement 15, and at least 10 days if Portland blast-furnace cement or a 50/50 mixture of Portland cement and ground granulated blast-furnace slag is used. When the temperature of concrete falls below 5°C, these minimum curing periods shall be extended by the period during which the temperature of the concrete was below 5°C.

When sliding formwork is used, the concrete shall be protected against the weather and rapid drying out by means of a 4 m wide skirt attached to the lower perimeter of the formwork and hanging over the working platform. The skirt shall consist of hessian in summer months and of canvas or other suitable material in winter. The skirt shall be weighted at the bottom to prevent it flapping in windy conditions.

The concrete shall be cured by means of a fog spray to keep it wet constantly for the periods stated above or until a curing compound is applied. Wetting the concrete by spraying shall be by means of a fixed spraybar along the full length of the sliding formwork. The spraybar shall be connected to a suitable high-pressure water supply. Wetting shall be discontinued when the ambient air temperature drops below 5°C, and care shall be taken by the Contractor to ensure that the water will not erode the surface of the fresh concrete.

6410 ADVERSE WEATHER CONDITIONS

(a) Cold weather

Concrete shall not be placed during falling temperatures when the ambient air temperature falls below 7°C or during rising temperatures when the ambient air temperature is below 3°C. When concrete is placed at air temperatures below 5°C the concrete temperature shall not be below 10°C, for which purpose heating of the water and/or the aggregate shall be permitted. The Contractor shall make all the necessary arrangements for heating the material. Heated water and aggregate shall first be mixed and the cement shall then be added only while the temperature is below 30°C.

The temperature of placed concrete shall not be allowed to fall below 5°C until the concrete has attained a strength of at least 5 MPa, and the Contractor shall be responsible for all protective measures necessary to this end. All concrete damaged by frost or by the formation of ice in the concrete shall be removed and replaced by the Contractor at this own expense.

(b) Hot weather

When the ambient air temperature exceeds 30°C during concreting, the Contractor shall take measures to control the temperature of the concrete ingredients so that the temperature of the placed concrete will not exceed 30°C unless otherwise determined by the Engineer. Such measures include spraying aggregate stockpiles with water to promote cooling down by evaporation and, where feasible, shading the stockpiles and the area where concreting is carried out. Curing shall commence immediately after concrete has been placed to prevent an excessive loss of moisture.

(c) Precautionary measures for using sliding formwork

During sliding operations in cold weather, the water only, or the water and the aggregate, shall be heated to ensure that the concrete temperature will not drop below 10°C until it has attained a strength of 5 MPa.

During cold weather the rate of sliding shall be suitably decreased to ensure sufficient strength in the concrete which leaves the bottom of the formwork.

6411 PIPES AND CONDUITS

No pipes and conduits other than those shown on the Drawings shall be embedded in the concrete without the Engineer's approval. The clear space between such pipes or between such pipes and any reinforcing steel shall be at least 40 mm or the maximum size of the aggregate plus 5 mm, whichever is the greater. The thickness of the concrete cover over pipes and fittings shall be at least 25 mm.

The ends of all ferrules used for bracing formwork shall be neatly finished off to the details shown on the Drawings. Where no details are given on the Drawings, ferrules shall be cut back to a depth of at least the specified cover, and the holes shall be filled in with mortar and finished off flush with the concrete surface.

6412 APPLIED LOADING

No load shall be applied to any part of a structure until the specified curing period has expired, after which applied loading shall be allowed only when approved by the Engineer. The Engineer's decision will be based on the type of load to be applied, the age of the concrete, the magnitude of stress induced and the propping of the structure.

No structure shall be opened to traffic until test cubes made from the concrete in all parts of the structure have attained the specified minimum 28-day compressive strength.

6413 PRECAST CONCRETE

This Clause applies to all reinforced and prestressed concrete members other than precast concrete piles, culverts and pipes in so far as they are dealt with separately elsewhere in these Specifications.

All precast members shall be manufactured in accordance with the requirements specified for cast in situ members in so far as these requirements are relevant. In addition, the following shall apply:

(a) The Contractor shall take all necessary safety and precautionary measures during the handling and erection of precast members and for ensuring the stability of members as positioned and prior to their being cast in.
the mix proportions to obtain the required strength. Immediately take the required remedial action by changing
comply with the strength requirements, the Contractor shall
In all cases where concrete has been supplied which fails to
tests.
be for the Contractor's account regardless of the outcome of
member can be left in position. The cost of such tests shall
shall be conducted in accordance with SABS 0100 Part II or
Engineer will evaluate these cores in accordance with SABS
exceeding 56 days. Thereafter the Contractor shall drill
core in place. Quantities shall be calculated from the
diameter embedded in the concrete. The tendered rate shall include full compensation for
(2) The concrete may be left in position at further reduced
and contraction joints, curing and protecting the concrete,
repairing defective surfaces, and finishing the concrete
where partial demolition is required for extension work to
concrete lot on the basis of cores for full or conditional
characteristic compressive strength shall be as specified in
Clause 7205 for full acceptance, and as specified in Clause
The re-submission of concrete lots on the basis of cores for full or conditional
be rejected or, where so allowed, repaired to the
requirements specified for 28-day
Any lot represented by test cubes failing to comply with the
criteria specified for the characteristic strength shall be
following tests to be conducted in order to decide whether
(ii) Where the Engineer so directs, full-scale load
tests shall be conducted in accordance with SABS 0100 Part II or
equivalent to determine whether any particular structure or
member can be left in position. The cost of such tests shall
be for the Contractor's account regardless of the outcome of
the tests.
In all cases where concrete has been supplied which fails to
comply with the strength requirements, the Contractor shall
immediately take the required remedial action by changing
the mix proportions to obtain the required strength.
For the purposes of identification, all members shall
be marked with paint in neat lettering with the member
number shown on the Drawings or as agreed on and an
identification number relating to the manufacturing records.
Letters etc shall be so positioned as not to be visible when
the structural member is placed in its final position in the
completed structure.
All precast members which have been chipped,
cracked, warped or otherwise damaged to the extent that
such damage will, in the opinion of the Engineer, prejudice
the appearance, function or structural integrity of the
members shall be rejected or, where so allowed, repaired to
the satisfaction of the Engineer.

6414 QUALITY OF WORKMANSHIP AND MATERIALS

(a) Criteria for compliance with the requirements
Routine inspection and quality control will be done by the
Engineer as specified in Section 7200. The criteria for
compliance with the requirements specified for 28-day
characteristic compressive strength shall be as specified in
Clause 7205 for full acceptance, and as specified in Clause
7207 for conditional acceptance. The re-submission of
core in place. Quantities shall be calculated from the dimensions shown on the Drawings or
as authorised. No deduction in volume measured for
payment shall be made for the volume of any reinforcing
core in place. Quantities shall be calculated from the dimensions shown on the Drawings or
as authorised. No deduction in volume measured for
payment shall be made for the volume of any reinforcing
steel, inserts and pipes or conduits under 150 mm in
diameter embedded in the concrete.
The tendered rate shall include full compensation for
procuring and furnishing all the materials, storing the
materials, providing all plant, mixing, transporting, placing
and compacting the concrete, forming the inserts,
and contraction joints, curing and protecting the concrete,
repairing defective surfaces, and finishing the concrete
surfaces as specified. Payment shall distinguish between
the different classes of concrete.

(b) Procedure in the event of non-compliance with
the requirements
Any lot represented by test cubes failing to comply with the
criteria specified for the characteristic strength shall be
rejected, or the Engineer may at his discretion allow the
following tests to be conducted in order to decide whether
the concrete may be left in position at further reduced
payment:
(i) The Engineer may allow the elements or units
concerned to be cured for an additional period not
exceeding 56 days. Thereafter the Contractor shall drill
cores in accordance with SABS 865 or equivalent, and the
Engineer will evaluate these cores in accordance with SABS
0100 - Part II or equivalent.
(ii) Where the Engineer so directs, full-scale load
tests shall be conducted in accordance with SABS 0100 Part II or
equivalent to determine whether any particular structure or
member can be left in position. The cost of such tests shall
be for the Contractor’s account regardless of the outcome of
the tests.

6415 DEMOLITION AND REMOVAL OF EXISTING
CONCRETE

Where partial demolition is required for extension work to
existing structures the first three paragraphs of Clause 2214
shall apply. In addition the following shall apply:
(a) The Contractor shall take great care to ensure that
the reinforcement required to tie in the extension work is not
cut off or damaged in the demolition process. Where
reinforcement has been cut off, or where in the opinion of
the Engineer, the reinforcement has been damaged to such
an extent that it will not adequately perform its function, the
Contractor shall, at his own expense, install dowel bars of
the same diameter as the bar cut off or damaged, all to the
satisfaction of the Engineer.

6416 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.01 Cast in situ concrete:</td>
<td></td>
</tr>
<tr>
<td>(a) (Class of concrete and part of structure or use indicated)</td>
<td>cubic metre (m³)</td>
</tr>
<tr>
<td>(b) Etc for other classes of concrete and other uses or parts of the structure</td>
<td>cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement for cast in situ concrete shall be the cubic metre of concrete in place. Quantities shall be calculated from the dimensions shown on the Drawings or as authorised. No deduction in volume measured for payment shall be made for the volume of any reinforcing steel, inserts and pipes or conduits under 150 mm in diameter embedded in the concrete.

The tendered rate shall include full compensation for procuring and furnishing all the materials, storing the materials, providing all plant, mixing, transporting, placing and compacting the concrete, forming the inserts, construction joints (except mandatory construction joints), and contraction joints, curing and protecting the concrete, repairing defective surfaces, and finishing the concrete surfaces as specified. Payment shall distinguish between the different classes of concrete.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.02 Manufacturing precast concrete members</td>
<td></td>
</tr>
<tr>
<td>(description of member with reference to drawing)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>
The unit of measurement shall be the number of complete members or elements of each type and size in position in the Works.

The tendered rate for each precast member shall include full compensation for concrete work, formwork, reinforcing steel and prestressing as required for manufacturing the member complete, excluding only prestressing in connection with in situ concrete cast subsequent to the placing of the precast members for which prestressing separate payment is provided elsewhere in the Schedule of Quantities.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.03</td>
<td>Transporting and erecting precast concrete members (description of member and approximate mass to be given)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of precast concrete members of each type and size placed into position.

The tendered rate for each precast member shall include full compensation for all work, costs and equipment required for transporting, erecting and placing into position the precast concrete members.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.04</td>
<td>Epoxy bonding of new concrete surfaces to old</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the square metre of new concrete surface bonded to old by means of an approved epoxy bonding agent as set out in the Specifications.

The tendered rate shall include full compensation for preparing the surfaces and for furnishing and applying the bonding agent and for chamfering the concrete on visible joints, complete as shown on the Drawings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.05</td>
<td>Extra over Items 61.08, 61.31 and 64.01 for the use of sulphate-resistant cement in concrete</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of concrete manufactured with sulphate-resistant cement and placed in accordance with the details on the Drawings, or as instructed by the Engineer.

The tendered rate shall be extra over each of the rates tendered for Items 61.08, 61.31 and 64.01, and shall include full compensation for all additional costs for procuring, furnishing and using sulphate-resistant cement in the concrete.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>64.06</td>
<td>Demolishing existing concrete:</td>
</tr>
<tr>
<td>(a)</td>
<td>Plain concrete in:</td>
</tr>
<tr>
<td>(i)</td>
<td>(Member indicated) cubic metre (m³)</td>
</tr>
<tr>
<td>(b)</td>
<td>Reinforced concrete in:</td>
</tr>
<tr>
<td>(i)</td>
<td>(Member indicated) cubic metre (m³)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the cubic metre of plain or reinforced concrete demolished for each member or portion thereof scheduled separately in the Schedule of Quantities.

The tendered rate shall include full compensation for all labour, plant and equipment required to demolish the existing concrete and disposal of the product of the demolition to an approved disposal site. The tendered rate shall also include full compensation for any necessary measures to ensure no debris falls into rivers and for any debris that has fallen into rivers to be recovered.
6501 SCOPE

This Section covers the materials, equipment and work required for prestressing structural concrete members.

6502 DEFINITIONS

The following definitions shall apply to these Specifications:

(a) Anchorage
Anchorage is the device comprising all the components and materials required for retaining the force in a tensioned tendon and to transmit this force to the concrete of the structure.

(b) Anchorage reinforcement
Anchorage reinforcement is the spiral and other reinforcement which forms part of the anchorage and is required for strengthening the anchorage and/or assisting in transmitting the tendon force to the concrete.

(c) Bursting reinforcement
Bursting reinforcement is the reinforcing steel required in and adjacent to the anchorage zones to resist the tensile stresses induced in the concrete by the anchorage(s).

(d) Cable
Cable is the tendon, together with the anchorage, sheathing and all fittings.

(e) Characteristic strength
Characteristic strength of prestressing steel is the manufacturer’s guaranteed tensile strength below which no more than 5% of the test results in a statistical population shall fall.

(f) Duct
Duct is the void formed to house the tendon(s) and may be formed by coring, or by using sheaths or by way of extractable cores.

(g) Prestress
Prestress is the stress induced in concrete by tensioned tendons.

(h) Prestressed concrete
Prestressed concrete is structural concrete in which effective internal stresses are induced by means of tensioned tendons.

(i) Pre-tensioned concrete
Pre-tensioned concrete is prestressed concrete where the tendon is tensioned before the concrete has been cast.

(j) Post-tensioned concrete
Post-tensioned concrete is prestressed concrete where the tendon is tensioned after the concrete has hardened.

(k) Pull-in
Pull-in is the elastic shortening of the tendon caused by relative movement between the anchorage or coupler components on account of seating and gripping action during or immediately after transfer.

(l) Release
Release is the specified elastic shortening of the tendon at the anchorage achieved before or during transfer.

(m) Sheath
Sheath is the tube or casing enclosing the tendon and which temporarily or permanently allows a relative movement between the tendon and the surrounding concrete.

(n) Tendon
Tendon is the prestressing steel consisting of the bar, wire or strand individually placed, or of bars, wires or strands placed in a duct, all of which are tensioned to impart prestress to a concrete member.

(o) Tensioning
Tensioning is the action of inducing and regulating the force in a tendon by means of tensioning and measuring equipment.
Transfer in the case of post-tensioned concrete is the action of transferring the tensioning force from the tensioning equipment (jack) to the anchorage.

Transfer in the case of pre-tensioned concrete is the action of transferring the force in the tensioned tendon(s) to the concrete.

Bond breaker is the coating or sheath placed on a tendon to prevent it from bonding to the surrounding concrete.

Coupler is the device comprising all components required to join two tendons.

Deflector is the device used to deflect a tendon alignment within a structural element.

Transmission length is the tendon length required to transmit via bond stresses the full force in the tendon to the concrete.

6503 MATERIALS

(a) General

All materials and prestressing systems used in the prestressing of structural concrete members shall be subject to approval by the Engineer.

(b) Prestressing steel

(i) General

The type of prestressing steel shall be designated in accordance with the requirements of Subclause 6503(b).

The Contractor shall keep proper records of all material analyses and test certificates for the batches of prestressing steel used in the Works. Where required by the Engineer, the Contractor shall produce certificates from recognised testing authorities certifying compliance of the prestressing steel with the specified requirements.

Where prestressing steel is available in weld-free lengths (production lengths) and lengths containing welds (standard lengths), the batches delivered at the site shall be clearly labelled for identification purposes.

In no circumstances shall prestressing steel after manufacture be subjected to heat treatment other than provided for in these Specifications.

(ii) Bars

Cold-worked high-tensile alloy steel bars for prestressed concrete shall comply at least with the requirements of BS 4486.

The type of prestressing steel shall be indicated in accordance with the requirements of Clause 4.2 of BS 4486, eg BS 4486-RR-32-1230 for 32 mm diameter double-ridged bar with a characteristic strength of 1 230 MPa.

(iii) Wires and seven-wire steel strand

Steel wire and seven-wire steel strand for prestressed concrete shall comply at least with the requirements of BS 5896.

The type of prestressing steel shall be indicated in accordance with the requirements of Clauses 14 and 20 of BS 5896 for wire and strands respectively, eg:

1. BS 5896/2 wire 1770-7-PE-relax 1 for a 7 mm diameter plain wire of Class 1 relaxation with a characteristic strength of 1 770 MPa; and

2. BS 5896/3 superstrand 1860-12.9-relax 2 for a 12.9 mm diameter superstrand of Class 2 relaxation with a characteristic strength of 1 860 MPa.

(iv) Straightness

Prestressing bars delivered at the site shall be straight. Only small adjustments for straightness may be made, which shall be done by hand on the site at a temperature above 5°C and under the supervision of the Engineer. Where heating of the bars is required, this shall be by means of steam or hot water. Bars bent in the threaded portion shall not be used.

Prestressing wire and strand shall be supplied in coils with a sufficiently large diameter to ensure that the wire and strand will pay off straight.

(v) Surface condition

Prestressing steel shall be clean, free from faults or defects, and without any harmful films and matter which may impair adhesion to the grout or concrete. A film of rust is not necessarily harmful and may improve the bond. It may, however, increase the friction between the tendon and duct.

The depth of imperfections or pits on the surface of prestressing steel shall not exceed 0.1 mm for wire with a diameter up to and including 8 mm, or 0.2 mm for bars or wire with a diameter exceeding 8 mm.

Tendons may be cleaned by wire brushing or by passing through a pressure box containing carborundum powder. Solvent solutions shall not be used for cleaning without the approval of the Engineer.

Prestressing steel shall be delivered at the site suitably protected against damage and corrosion. Such protection or the use of a corrosion inhibitor where allowed by the Engineer, shall not have any deleterious effect on the steel or concrete or impair the bond between the two.

(vi) Galvanising

Galvanised prestressing steel shall not be used unless specified. In no circumstances shall prestressing steel be subjected to galvanising after manufacture.
(vii) Welds

Prestressing steel used in structural prestressed concrete shall be weld-free. Where the steel is supplied in standard lengths, the welds shall be cut out and delivered to the Engineer.

(c) Anchorages and couplers

Anchorages and couplers to be used in prestressed concrete shall comply with the requirements of BS 4447 and shall be of a proved and approved type, constructed from durable material completely free from imperfections and shall not damage, distort or kink the prestressing steel in a manner that will result in ultimate tensile strength reduction. They shall resist, without failure and/or excessive deformation or relaxation of the force in the tendons, the full ultimate tensile strength of the tendons. The characteristic value for anchorages and couplers, determined in accordance with BS 4447, shall not be less than 90%.

The anchorages shall effectively distribute the force in the tendon to the structural member, and the resulting local stresses and strains in the member shall be so limited as to prevent damage. Unless otherwise approved by the Engineer, all anchorages and couplers shall be provided with anchorage reinforcement.

Wedges and the insides of barrels or cones shall be clean to allow the free movement and seating of the wedges inside the taper.

The threads of bars, nuts, anchorages and couplers shall be suitably protected against damage and corrosion. The protection shall be removed at the last moment and the threads properly lubricated before use.

(d) Sheaths

Sheaths shall be grout-tight and of such material and configuration that bond forces can be transferred from the grout to the surrounding concrete. The properties of the sheath material shall be such that no corrosion attack of the prestressing steel will be induced. The sheath shall be sufficiently flexible to accept the required curvature without kinking, and strong enough to retain its cross-section and alignment and to resist damage on account of handling, transporting, lifting and contact with vibrators during concreting. Unless otherwise approved by the Engineer, the thickness of the metal of steel sheaths shall not be less than 0.4 mm.

Metal sheathing shall be delivered at the site suitably protected against damage and corrosion. At the time of incorporation into the structural member, the sheathing shall be free from loose mill scale, loose rust, lubricants and harmful matter.

Galvanized sheathing shall not be used unless specified.

Unless otherwise specified, the internal diameter of the sheath shall be at least 10 mm greater than the diameter of the tendon. For vertical tendons and where tendons are to be drawn into cast-in sheaths, the cross-sectional duct area shall be at least three times the cross-sectional area of the tendon.

(e) Cable supports

Supports of reinforcing steel or structural steel suitably braced to prevent buckling under load shall be used to support the cables. The cable saddles shall be rigid and secured in position by welding or by equivalent mechanical means to resist both gravitational and buoyancy forces.

Normal web reinforcement shall not be utilised to support cables.

Saddles for external cables shall be of special design and material to ensure low friction and to prevent the tendon or parts thereof from grooving the surface. The saddle plates shall be curved to the requisite radius to prevent the tendon or part thereof from bearing on the end of the plate and shall incorporate features to ensure that individual bars, wires and strands are seated separately.

(f) Tendon spacers

Tendon spacers used inside the ducts to separate individual bars, wires or strands of the tendon shall be of a proved and approved type and manufactured from material which will not induce corrosion of the prestressing steel.

(g) Grout

(i) Materials

In addition to the requirements of Subclause 6402(d), water shall not contain more than 500 mg of chloride ions per litre of water.

Only ordinary Portland cement which complies with the requirements of SABS 471 or equivalent and ordinary Portland cement 15 which complies with the requirements of SABS 831 or equivalent shall be used. The temperature of the cement shall be less than 40°C, and the cement shall be stored in accordance with the requirements of Subclause 6403(a).

Fine aggregate shall consist of siliceous granules, finely ground limestones, trass or very fine sand. The aggregate used shall pass through a 0.6 mm sieve. The use of fine aggregate shall be subject to the approval of the Engineer and shall be restricted to grout for ducts with a diameter exceeding 150 mm. The aggregate content in the grout shall not exceed 30% of the mass of the cement.

The use of admixtures shall be subject to tests having shown that their use improves the properties of the grout, eg by increasing workability, reducing bleeding, entraining air, or expanding the grout. Admixtures shall be free from any product liable to damage the steel or the grout itself, such as halides, nitrates, sulphides, sulphates, etc. The quantity of admixture to be used shall be in accordance with the manufacturer's instructions.

(ii) Properties of the grout

The mixed grout shall have the following properties:

1. The chloride ions content shall not exceed 750 mg per litre.

2. The viscosity of the grout measured in accordance with Subclause 7111(b) for horizontal cables shall be 500 to 2 500 cP and for vertical cables 400 to 1 500 cP. The viscosity of the grout, 20 minutes after mixing, shall not
exceed 2 500 cP and 1 500 cP for horizontal and vertical cables respectively.

(3) Bleeding at 20°C measured in accordance with Subclause 7112(b) shall not exceed 2% by volume three hours after the grout has been mixed, and the maximum bleeding shall not exceed 4%. In addition, the separated (bleed) water must be reabsorbed after 24 hours.

(4) The compressive strength of 100 mm cubes made of the grout and cured in a moist atmosphere for the first 24 hours and then in water at 20°C shall exceed 20 MPa at seven days.

(h) Protecting agents for unbonded tendons

The material used for permanent protection of unbonded tendons shall have the following properties:

(i) It shall remain free from cracks and shall not become brittle or fluid within the temperature range of -20°C to 70°C.

(ii) It shall be chemically stable for the entire life of the structure.

(iii) It shall be non-reactive with the surrounding materials, ie concrete, tendons, wrapping or sheathing.

(iv) It shall be non-corrosive or corrosion-inhibiting.

(v) It shall be impervious to moisture.

(vi) It shall be sufficiently tough to withstand the abrasion caused when a tendon, precoated with the material, is drawn into the sheath.

(vii) It shall have no appreciable shrinkage or excessive volume increase.

(viii) It shall have a suitable viscosity at ambient temperature or require only moderate preheating to permit injection.

(i) Testing

Prestressing steel, anchorages and couplers, and grout shall be tested in accordance with the requirements of Subclause 7111(b). Testing shall be carried out at the frequencies as directed by the Engineer.

6504 EQUIPMENT

(a) General

All equipment used shall be in a good working order and properly maintained.

(b) Tensioning and measuring equipment

Tensioning and measuring equipment shall be such that the tendon force can be established to an accuracy of ± 2% during any stage of the tensioning operation.

Unless otherwise authorised by the Engineer, the tensioning equipment shall be power driven and capable of gradually applying a controlled total force without inducing dangerous secondary stresses in the tendon, anchorage or concrete.

The force in the tendon during tensioning shall be measured by a direct-reading dynamometer or obtained direct from pressure gauges fitted in the hydraulic system to determine the pressure in the jacks.

Pressure gauges shall have concentric scale dials which comply with the requirements of BS 1780. The dials shall not be less than 150 mm in diameter and the gauges shall be used within the range of 50 - 90% of their full capacity at maximum service pressure.

When pressure gauges not using glycerine are used, a snubber or similar device shall be fitted to protect the gauge against any sudden release of pressure. Provision shall also be made for T-connections for the attachment, when required, for supplementary control gauges.

Only self-sealing connections shall be used in the hydraulic circuit. Where the pressure input pipe is connected to the jack, a pipe rupture valve shall be installed in the circuit.

Tensioning equipment shall be calibrated before the tensioning operation and thereafter at frequent intervals, as directed by the Engineer, with a master gauge or proving ring, and the Engineer shall be furnished with a calibration chart. The load-measuring devices shall be calibrated to an accuracy of ±2%.

The extension of tendons shall be measured to an accuracy of ±2% or ±2 mm, whichever is the more accurate, and pull-in and release to an accuracy of ±2 mm.

(c) Grouting equipment

(i) Mixer

Mechanically operated mixers only, of a type capable of producing high local turbulences while imparting only a slow motion to the body of the grout shall be used.

The mixer shall be equipped with a screen with openings not exceeding 1.0 mm and shall be capable of consistently producing grout with a colloidal consistency.

(ii) Agitator

Where the capacity of the mixer is insufficient to fill the duct completely with grout, an agitator shall be used.

Mechanical agitators only shall be used, which are capable of maintaining the colloidal condition of the grout fill during the storing and injection processes. The grout shall be delivered at the structure from the agitator, and the system shall make provision for recirculating the grout from the pump back to the agitator.

(iii) Injection equipment

The pump shall be of the positive displacement type (piston, screw or similar type), capable of exerting a constant pressure of at least 10 bars on completely grouted cables and shall incorporate a safety device for preventing the build-up of pressure above 20 bars. The pump shall be fitted with a pressure gauge and a valve which can be locked-off without loss of pressure in the cable.

The pump shall be capable of delivering grout at a speed that will produce a speed of the grout in the cable of between 6 and 12 m per minute.
All connections in the pipes and between the pipe and the cable shall be airtight. Only bayonet, threaded, or similar types of connectors shall be used.

6505 TECHNICAL DATA

The following technical data for pre-tensioned and post-tensioned structural members required for the Contract will be furnished on the Drawings:

(a) Tendon alignment

A diagram showing the alignment of each tendon or group of tendons in both the horizontal and vertical planes, together with the horizontal and vertical coordinates, and curve equations of the centroid of the tendon(s), as may be relevant.

(b) Tendon system

The design shall be based on the system shown on the Drawings, but the Contractor may use any suitable system which will meet all the specified requirements, subject to approval by the Engineer.

(c) Tensioning the tendons

Full particulars regarding the partial tensioning of the tendons, the stage during which the tendons shall be tensioned, and the sequence of tensioning to be followed.

(d) Tensioning force

The maximum tensioning force and the effective force at the live anchorages, after transfer, as well as the corresponding stress level in the prestressing steel, for each tendon or group of tendons. The forces will be given in MN units, and the stress levels will be expressed as a percentage of the characteristic strength.

(e) Extension

The extension per tendon or group of tendons under the maximum tensioning force, together with the modulus of elasticity (E) on which it has been based. The release to be attained at each live anchorage as well as the pull-in for which provision has been made.

The Contractor shall show on his drawings the expected extension based on the actual modulus of elasticity of the strand as well as the expected wedge pull-in and any provision for shimming.

(f) Prestressing losses in tendons

The losses allowed for in the design from the causes listed below will be given as follows:

(i) Friction loss

The formula used for determining the tendon/duct friction loss together with the values adopted for the friction coefficient (μ) caused by curvature, and the wobble factor (k) caused by unintentional variation from the specified alignment.

(ii) Elastic deformation of concrete

The elastic factor, which, when multiplied by the compressive stress in the concrete adjacent to the tendon, will give the loss caused by the deformation of the concrete.

(iii) Creep of the concrete

The creep factor, which, when multiplied by the compressive stress in the concrete adjacent to the tendon, will give the loss caused by the creep of the concrete.

(iv) Shrinkage of the concrete

The stress loss in MPa caused by the shrinkage of the concrete.

(v) Relaxation of prestressing steel

The stress loss in MPa at a stress level of 70% of the characteristic strength of the prestressing steel caused by the relaxation of the prestressing steel.

(g) Anchorages

The positions where loop or fan-type dead-end anchorage may be used.

(h) Bursting reinforcement

The bursting reinforcement for the prestressing system on which the design is based.

(i) Precamber

The precamber at intervals not exceeding 0.25 times the span length.

(j) Compressive strength of the concrete during transfer

The compressive strength to be attained by the concrete in the relevant member before transfer may be effected.

6506 PRESTRESSING SYSTEM

The use of all prestressing systems will be subject to approval by the Engineer. Tenderers are advised to obtain approval for the prestressing system they intend using, prior to submitting their tenders.

Within one month of the tender having been awarded, or within a period agreed on with the Engineer, the Contractor shall submit full details regarding the prestressing system(s), materials and equipment he intends using, as well as regarding the methods he proposes to adopt in the prestressing and related operations.

The Engineer, at his own discretion, may call for further information in the form of detailed drawings, proof of successful previous use, performance certificates from an approved independent testing authority, and calculations substantiating the adequacy of the system. The Contractor
shall furnish such information within two weeks of being called upon to do so or within a period agreed on with the Engineer. If, after investigating all the information, the Engineer is not satisfied that the prestressing of the structural member can be carried out satisfactorily with the prestressing system offered by the Contractor, the Engineer reserves the right to order the Contractor to use any system which is suited to the work and which is readily available to the Contractor.

Only minor alterations to the concrete dimensions shown on the Drawings will be considered in order to accommodate the prestressing system finally selected. Major alterations occasioned by the prestressing system offered by the Contractor and which is at variance with the tendon system specified in Subclause 6505(b) shall be treated as alternative designs and shall be dealt with as specified in Clause 1212.

6507 DRAWINGS PREPARED BY THE CONTRACTOR

All drawings prepared by the Contractor and submitted to the Engineer for consideration shall comply with the requirements of Clause 1221.

The Contractor shall submit to the Engineer at least two months before he intends commencing with the prestressing work, drawings detailing the layout and alignment for the individual tendons, the cable supports, modifications to the bursting and other reinforcement, anchorage recesses, tensioning sequence, tensioning loads and extensions, as well as requirements for controlling the tensioning operations. For the prestressing system finally selected, the technical data which are at variance with the information given on the Drawings shall be shown on the Drawings. Each tendon shall be separately numbered for identification.

Where required, the Contractor shall submit calculations in respect of the variation of the tendon force along the length of the tendon, the expected extension and the bursting forces.

After approval by the Engineer of the Drawings and calculations prepared by the Contractor, no departure shall be permitted from the forces, stresses and extensions shown thereon, without authorisation by the Engineer.

The prestressing work shall not be commenced before the relevant drawings have been accepted by the Engineer.

The Contractor shall make full allowance in his tendered rates for all costs in connection with the furnishing of information, making calculations, and preparing and submitting the Drawings. However, no allowance need be made for the cost of checking, undertaken by the Engineer, of drawings and calculations for work which does not qualify as an alternative design.

Alternative designs shall comply with the requirements of Clause 1212 and the relevant provisions of this Section.

6508 PRECASTING

(a) Casting yard on the site

Subject to approval by the Engineer, precast work may be done at any location selected by the Contractor.

Before the casting yard is established, the Contractor shall submit plans to the Engineer which demarcate the site and detail the layout of the Works, together with a flow diagram of the construction stages and storage.

(b) Manufacture off the site

The Contractor shall notify the Engineer in advance of the dates when tensioning of tendons, casting of members and transfer, will be undertaken.

Within seven days of transfer, the Contractor shall submit to the Engineer a certificate giving the tendon force(s) and extension(s) attained as well as records of the cube crushing strength and age of concrete at transfer.

Test results relating to all aspects of the work shall be sent to the Engineer immediately upon their becoming available.

Where the Engineer requires tests to be conducted on completed members, no member to which the tests relate shall be dispatched to the site until the tests have been satisfactorily completed and the members accepted by the Engineer.

(c) Manufacture

Before work is commenced, details of the manufacture and phasing of the work shall be submitted to the Engineer for approval. After approval no changes shall be made to the methods or systems without approval by the Engineer.

The Contractor shall ensure that the specified precamber is incorporated in the formwork. The magnitude of the precamber shown on the Drawings shall be subject to variation depending on the Contractor's construction programme, and the Contractor shall, before manufacture, ascertain in writing from the Engineer, the increase or decrease in precamber. This procedure shall also apply to the cases where no precamber has been specified.

Lifting and supporting the precast members shall be made only at the points marked and provided on the members.

Precast members which have not been fully tensioned or fully stage-tensioned or which have ungrouted tensioned tendons shall not be handled without authorisation by the Engineer.

Where members with ungrouted tensioned tendons are handled, control shall be exercised to guard against possible slip of the tendon at the anchorage.

Prestressed precast concrete members shall also comply with the requirements of Clause 6413.

6509 PRE-TENSIONING

During the period between tensioning and transfer, the force in the tendon shall be fully maintained by some positive means. At transfer, detensioning shall take place slowly to minimise any shock which could adversely affect the transmission length of the tendon.

In the long-line method of pre-tensioning, sufficient locator plates shall be distributed through-out the length of the bed to ensure that the straight tendons are maintained in their proper position during concreting. Where a number of units are manufactured in line, they shall be free to slide in the direction of their length so as to permit transfer of the tendon force to the concrete along the entire line.
In the individual-mould system, the moulds shall be sufficiently rigid to provide the reaction to the tendon force without distortion.

Where possible, the mechanism for holding down or holding up deflected tendons shall ensure that the part in contact with the tendon will be free to move in the line of the tendon so that friction losses are eliminated. If, however, a system is used which develops a frictional force, this force shall be determined by test and due allowance made therefor.

For single tendons, the deflector in contact with the tendon shall have a radius of not less than 5 times the tendon diameter for wire, or 10 times the tendon diameter for a strand, and the total angle of deflection shall not exceed 15°.

Transfer of the tendon force to the concrete shall be effected in conjunction with the release of hold-down and hold-up forces in accordance with an approved method.

Transfer shall not be effected until compressive-strength tests on the concrete show that the concrete of the particular member has attained a compressive strength of at least the compressive strength shown on the Drawings. The transmission length is affected by the concrete strength, and the necessary modification for the concrete strength at transfer shall be made in conjunction with the Engineer.

The tendons shall be cut off flush with the end of the member and the exposed ends covered with a heavy coat of approved bituminous material or epoxy resin. The cutting of the prestressing steel shall be performed with a high-speed abrasive cutting wheel. Flame cutting will not be permitted.

6510 POST-TENSIONING

(a) Storage, handling and protection

During storage, transit, construction and after installation the sheaths, prestressing steel, anchorages and couplers shall be protected against corrosion, damage or permanent deformation. The manner and extent of protection required will depend on the environmental factors and the length of time before permanent corrosion protection is applied, and shall be to the satisfaction of the Engineer. Under severe corrosive conditions in coastal, damp and wet areas and under aggressive conditions the materials shall be stored in weatherproof sheds. All materials shall be stored clear of the ground and while in storage shall not be exposed to the weather.

When prestressing steel has been stored for a prolonged period and there is evidence of its deterioration, the Contractor may be called on to prove by tests that the quality of the steel has not been significantly impaired and that the prestressing steel still complies with the provisions of these Specifications.

Suitable protection shall be provided to the threaded ends of bars.

After fabrication, the cable ends shall be covered with protective wrapping to prevent the ingress of moisture into the duct.

When the tendon is to be left untensioned for a prolonged period after installation, precautions shall be taken to protect the tendon against corrosion. Corrosion inhibitors, oils or similar materials used as lubrication or to provide temporary protection shall be such that they can be completely removed before permanent protection is effected.

(b) Fabrication

All cutting of prestressing steel shall be performed with a high-speed abrasive cutting wheel or by a method approved by the Engineer. Flame cutting will not be permitted.

Care shall be taken to prevent the prestressing steel or anchorages from coming into contact with splashes from flame-cutting or welding processes in the vicinity.

Where possible, all bars, wires or strands tensioned in one operation shall be taken from the same parcel of prestressing steel. The tendon or cable shall be labelled to show the tendon or cable number, as well as identify from which parcel the steel has been taken.

Where bars, wires or strands in a tendon are not tensioned simultaneously, tendon spacers shall be used in accordance with the recommendations for the prestressing system or, in the absence thereof, as directed by the Engineer.

Cables shall be fitted at both ends with pipes with a diameter of at least 10 mm for the injection of grout or protection agents. The ends of the injection pipes shall be fitted with a clamp, valve or device capable of withstanding a pressure of at least 15 bars without loss of grout or protection agent.

Vent pipes with a diameter of at least 25 mm shall be provided in the duct at every high point, change of sheath cross-section and at such intermediate positions as may be shown on the Drawings or required by the Engineer. The vent pipes shall extend to at least 500 mm above the concrete and shall comply with the requirements for injection pipes.

Connections to, and joints in sheaths shall be made grout-tight by using special sheathing couplings and taping. With bonded cables, the length of taping shall not exceed six sheath diameters. Where oversleeves are used, equal overlaps shall be provided over each length of sheathing. Joints in adjacent sheaths shall be spaced at least 300 mm apart.

(c) Installation

The installation of tendons shall not commence until the requirements of Clause 6507 have been complied with.

The cable, sheath or extractable core shall be accurately installed to the specified alignment and securely held in position both vertically and horizontally at intervals appropriate to its rigidity and so as not to be displaced during concreting, either by the weight of the concrete or by buoyancy. The spacing of the cable supports shall furthermore ensure that the tendon can be installed to a smooth alignment without kinks and within the tolerance specified in Subclause 6803(g). Cable sheaths shall be supported and held in position by means of separate reinforcing steel supports with a diameter of not less than 16 mm. The transverse bars must be welded to the vertical bars or must rest on lugs welded to the vertical bars. The spacing of the vertical supports shall not exceed 1.0 m

Extractable cores shall not be coated with release agent unless approved by the Engineer.

Unless otherwise shown on the Drawings, the alignment of the tendon within a distance of 1.0 m from the live anchorage and/or coupler shall be straight. The tendon axis shall be set perpendicular to the bearing surface of its anchorage and firmly secured in position so as not to move
during concreting. External anchorages shall be seated on a thin mortar bedding to bear evenly on the concrete bearing surface, and the tendon axis shall be perpendicular to the bearing surface of the anchorage.

Unless otherwise shown on the Drawings, the minimum concrete cover over the outside surface of the sheath or cable support shall comply with the requirements of Clause 6307, except that, for sheaths, the cover shall not be less than 50 mm.

The spacing of cables will depend on the size of the cable and shall be such that the concrete can be properly placed and compacted.

Immediately before concreting, the Contractor shall inspect the sheaths for grout-tightness and shall seal all damaged and suspect sections.

External tendons shall be installed to the same standards and accuracy specified herein for internal tendons. The tendons shall be temporarily supported at regular intervals along the straight length between saddles. The supports shall consist of rigidly constructed frames secured to the concrete face.

(d) Concrete strength

Full tensioning of all or some of the tendons shall not commence until the compressive strength of the concrete is 35 MPa or the strength shown on the Drawings, whichever is the greater.

The compressive strength of the concrete shall be determined from cubes manufactured and tested in accordance with Subclause 7106(a) which have been cured under the same conditions as the structural member which is to be prestressed. The number of concrete cubes required for this purpose shall be as agreed on with the Engineer.

Where initially all or some of the tendons are to be partially tensioned, tensioning shall not commence before the concrete has attained the compressive strength indicated on the Drawings.

(e) Tensioning

(i) Preparation

Within two hours of the concrete having been placed, the Contractor shall demonstrate that sheaths are free from obstructions, that extractable cores can be removed and, where the design permits, that all tendons are free to move in the ducts. All water in the ducts shall then be expelled with compressed air and the cables sealed until tensioning takes place.

Before tensioning is commenced, the side forms and other restraining elements shall be released or removed to give the structural member the freedom to deform under the induced force.

(ii) Tensioning sequence

The sequence of tensioning to be followed shall be as shown on the Drawings and/or on drawings prepared by the Contractor in terms of Clause 6507. The Contractor shall make allowance in his tendered rates for all incidentals which he may have to incur as a result of having to tension fully only some of the tendons at any one stage or instant.

Where partial tensioning of tendons is required, the work shall be executed in accordance with the details on the Drawings or as specified. The Contractor shall, in his tendered rates, make provision for all incidentals he may have to incur as a result of having to tension partially only some of or all the tendons at any one stage or instant.

(iii) Assembling the equipment, and safety precautions

The tensioning and measuring equipment shall be assembled for tensioning in exactly the same way as they are combined for calibration.

The Contractor shall take all the necessary safety precautions to prevent accidents caused by the malfunctioning or failure of any part of the equipment or material and shall accept full responsibility for injury sustained by persons or damage to property resulting therefrom.

(iv) Friction

The Engineer may require the Contractor to perform friction tests on designated tendons and to revise the relevant theoretical extensions to compensate for the discrepancy between the values adopted in the design and the test results. Payment for these tests shall be made under Item 71.02.

Where applicable, allowance shall be made in the tensioning force to compensate for friction loss in the jack and in the anchorage.

(v) Tensioning

Tensioning shall be carried out under the supervision of a technician skilled in the use of the prestressing system and equipment and the methods of tensioning to be adopted.

Tensioning shall not be commenced before the Engineer has been advised of each tensioning operation and has given his approval for the work to be started.

The technician and operators shall be supplied with a schedule listing the sequence of tensioning the various tendons and a tensioning record sheet showing the theoretical gauge readings, jacking forces, extensions, release and pull-in for each tensioning operation. The record sheet shall furthermore provide room for entering the corresponding information recorded and observations made during tensioning. A graph of the tensioning force and/or gauge reading versus theoretical extensions shall, where required, be appended to the record sheet and the actual extensions measured for each load increment shall be plotted on the graph. Copies of the completed record sheets and graphs shall be submitted to the Engineer within 24 hours of each tensioning operation having been completed.

The Contractor shall note that the extensions shall be regarded as an indirect measurement of the tensioning force and shall serve as a control on the tensioning force applied.

The protruding ends of all bars, wires and strands shall be clearly marked for the accurate measurement of extension, release and pull-in.

Before tensioning is commenced on external tendons, a small load shall be applied to each tendon, commencing
with the uppermost tendon. The force shall be sufficient to take up all slack and prevent entanglement of the tendons.

The jacking force shall be increased to approximately 5 to 10% of the final jacking force to take up the tendon slack and to determine the zero position for measuring the extension and to check the gripping devices and the position and alignment of the jacks. The load shall then be increased gradually to the full specified tensioning force while intermediate gauge readings and extensions are recorded at regular intervals.

The final stage of tensioning shall be deemed to have been satisfactorily accomplished when all the following requirements have been complied with:

1. The tendons have been tensioned to the required force.
2. The measured extension on individual tendons is within \( \pm 6\% \) of the theoretical extensions.
3. The average variation between the measured and theoretical extensions of all the tendons in a structural member is less than \( \pm 3\% \).
4. The release and/or pull-in is within \( \pm 2 \) mm of the theoretical values.

Where the above conditions are not met individually and collectively, the Contractor shall immediately advise the Engineer and obtain a ruling as to the procedure to be followed.

In the event of the tendon friction being too high, the Contractor may, subject to approval by the Engineer, inject an approved lubricant into the sheath after first having detensioned the tendon.

The cost of the remedial and corrective measures and of the release and retensioning of tendons, which have been occasioned by failure of the operations to meet the above requirements shall be for the Contractor's account.

After the tensioning has been accepted by the Engineer, the Contractor may cut off the tendons behind the anchorage as described in Subclause 6510(b).

(f) Permanent protection and bonding of tendons

(i) General

After tensioning, all tendons shall receive permanent protection against mechanical damage and corrosion.

Internal tendons shall be protected and bonded to the structural member by cement grout or, when permitted by the Engineer, by sand-cement grout. Where bond is not important, protection may be effected by the use of bitumen, petroleum-based compounds, epoxy resins, plastics and similar products, all complying with the requirements of Subclause 6503(h) and subject to approval by the Engineer.

Tendons located outside the structural section (i.e. external tendons) shall be encased with a dense concrete, dense mortar or material sufficiently stable and hard, all subject to approval. The encasement shall be of the thickness shown on the Drawings. Where bonding of the tendon to the structural concrete is required, this shall be achieved by bonding the concrete encasement to the structure with reinforcing steel as detailed on the Drawings.

Protection and bonding of the tendons shall be effected within seven days of the final tensioning of the tendons, or as specified on the Drawings, but shall not take place without the prior approval of the Engineer having been obtained.

After the permanent protection or bonding has been completed the anchorages shall be encased in concrete or grout which shall be bonded to the old concrete with epoxy resin designed for this purpose, or shall be completely coated with a corrosion-resistant material. The protection provided shall in all cases prevent the ingress of water or aggressive agents.

(ii) Preparation of ducts

Before permanent protection and/or bonding of tendons is effected, the following precautions shall be taken:

1. The cables shall be checked for blockages by water or compressed air being injected.
2. Unlined ducts which are to be filled with grout shall be flushed with water to wet the concrete.
3. Temporary protection or lubricants which are incompatible with the permanent protection or bonding, shall be removed by flushing the duct with water or an inert solution, or by any suitable approved method.
4. On completion of the above, any excess fluid shall be expelled from the ducts by means of compressed air or shall be displaced by the protecting agent or grout, as may be relevant.

Any blockages, leakages or factors which in any way may affect the permanent protection or bonding shall immediately be reported to the Engineer.

(iii) Mixing

1. Protecting agents

The mixing of protecting agents shall be strictly in accordance with the manufacturer's instructions.

2. Grout

The aggregate, if used, and the cement shall be measured by mass, and the water by mass or by volume.

The water:cement ratio by mass shall be as low as possible within the range between 0.36 to 0.45, and shall be consistent with the fluidity requirements of Subclause 6503(g).

Where an admixture is used, it shall be dissolved in a part of the mixing water before it is added to the grout.

Mixing shall be commenced by two-thirds of the cement being added to the greater part of the mixing water, and, if used, an additive predissolved in part of the mixing water, and finally the remainder of the cement. Mixing shall continue for not longer than four minutes after which the grout shall be continually agitated at slow speed throughout the injection operation.

Where aggregate is used in the grout mix, the word "cement" in the preceding paragraph shall be replaced by the term "cement/aggregate component".
6500-10

(iv) Injection

(1) General

The injection of permanent protecting agents or grout shall not commence before approval has been granted that the work may start.

Before injection commences all air shall be expelled from the injection equipment and hoses and all connections checked for airtightness.

Injection shall take place from the anchorage or coupler, whichever is situated at the lower end of the cable.

Grout injection shall proceed without any interruption until the cable has been completely filled and closed off.

(2) Protecting agents

The injection of protecting agents shall be strictly in accordance with the instructions, and with the equipment specified by the manufacturer.

(3) Grout

Immediately after mixing, and also during injection, the fluidity of the grout shall be tested at regular intervals in accordance with Subclause 6503(i).

Injection shall be continuous at a rate of 6 to 12 m per minute. As soon as grout with the original consistency flows from the intermediate vent pipes they shall be successively closed. Injection shall continue until the grout flowing from the vent at the free end is of the same consistency as that of the injected grout. At this stage the vent shall be closed and the final pressure or a pressure of 5 bars, whichever is the greater, shall have been maintained on the grout column for five minutes before the valve at the injection end is closed.

All vents shall be kept closed and supported vertically until the grout has finally settled. On vertical cables, a riser pipe with funnel shall be fitted to the top anchor to ensure that the separated water migrates upwards and will not remain in the cable.

If an expanding agent is used in the grout mix, the air vents shall be re-opened after grouting to release any separated water, and shall then again be closed.

Unless a retarder is used in the grout mix, the grout not used within 80 minutes of mixing shall be discarded.

During the course of grouting 100 mm cubes shall be made for testing in accordance with Subclause 6503(i). Whilst the grout is being poured into the cube mould, the sides of the mould shall be slightly tapped to permit any entrapped air to escape.

Precautions shall be taken not to discharge the escaping grout onto railway lines, public roads, water courses or private property.

If a blockage occurs during the course of grouting, the grouting shall be stopped before the maximum grouting pressure is reached. The duct shall then be flushed out immediately and the blockage cleared.

Grouting shall not be carried out during very cold weather when the ambient air temperature drops below 5°C. Care shall be taken that the ducts are completely free from frost or ice before grouting commences after frosty weather.

6511 LOSS OF PRESTRESS

Any structural member which has lost all or part of its prestress through the failure or malfunctioning of any part of the prestressing component may be rejected by the Engineer and shall be removed from the Works unless approved remedial measures have been successfully carried out on the member. No payment will be made in respect of such remedial work or loss suffered by the Contractor in this regard.

6512 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Item</td>
<td>Unit</td>
</tr>
</tbody>
</table>

65.01 Prestressing tendons:

(a) Longitudinal tendons ........ meganewton-metre (MN-m)
(b) Transverse tendons ........ meganewton-metre (MN-m)
(c) Vertical tendons ...... meganewton-metre (MN-m)

The unit of measurement shall be the meganewton-metre which is calculated as the product of the characteristic strength in megapascals of the prestressing steel, the cross-sectional area of the tendon in square metres and the length of the tendon in metres between the faces of the anchorages. In the case of fan and loop anchorages the "length of the tendon" shall include the length of tendon forming the loop or fan.

The tendered rates shall include full compensation for preparing and submitting the Drawings, supplying, storing, handling and protecting all materials (excluding anchorages and couplers), fabricating, supporting and installing the cables; lubricating, permanently protecting and bonding the tendons, for the use of all the equipment, as well as for all work and incidentals required for completing the work as specified.

65.02 Anchorages and couplers:

(a) Anchorage at jacking end ........ meganewton (MN)
(b) Anchorage at dead end ...... meganewton (MN)
(c) Coupler at jacking end .... meganewton (MN)
(d) Coupler at dead end .... meganewton (MN)

The unit of measurement shall be the meganewton which is calculated as the product of the characteristic strength in megapascals of the prestressing steel and the cross-sectional area of the tendon in square metres, effectively anchored or coupled.

The tendered rates shall include full compensation for supplying, storing, handling, fabricating and protecting the complete anchorage or coupler assembly, anchorage reinforcing, constructing the recesses for the anchorage or coupler, tensioning, anchoring and/or coupling, trimming the
tendon ends, using all the equipment, as well as for all work and incidentals required for completing the work as specified.

The coupler shall include the complete assembly consisting of the anchorage built into the first-stage construction and the part coupled to it.

The tendered rate for loop or fan anchorages shall exclude the cost of the length of tendon forming the loop or fan.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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<tbody>
<tr>
<td>65.03 Extra over Item 65.02</td>
<td>for partially tensioning the tendons</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the meganewton, which is calculated as for Item 65.02.

The tendered rate shall include full compensation for the use of all equipment, as well as for all work and incidentals required for tensioning and anchoring the tendons to the specified partial force.
6601 SCOPE

This Section covers:
(a) the manufacture and placing of no-fines concrete used in the Works;
(b) the supply and installation of all permanent joints which will permit relative movement between contiguous structural members;
(c) the construction, supply and installation of bearings for structures;
(d) the construction of parapets, railings and sidewalks on structures;
(e) the construction and/or installation of drainage works such as weep holes, drainage pipes and gulleys, no-fines concrete blocks, filter lining and concrete channelling;
(f) Bolt groups for electrification brackets.

6602 NO-FINES CONCRETE

(a) Materials

Cement, aggregate and water shall comply with the requirements of Clause 6402.

Each size of aggregate shall be a single size aggregate graded in accordance with SABS 1083 Part II or equivalent.

(b) Classes of no-fines concrete

No-fines concrete shall be classified by the prefix NF and the size of aggregate to be used. Class NF 19 means a no-fines concrete with a 19.0 mm nominal size aggregate.

The volume of aggregate per 50 kg of cement for each class of concrete shall be as detailed in Table 6602/1.

<table>
<thead>
<tr>
<th>Class of cement</th>
<th>Aggregate per 50 kg</th>
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</thead>
<tbody>
<tr>
<td>NF38</td>
<td>0.33 m³</td>
</tr>
<tr>
<td>NF19</td>
<td>0.30 m³</td>
</tr>
<tr>
<td>NF13</td>
<td>0.27 m³</td>
</tr>
</tbody>
</table>

(c) Batching and mixing

Cement shall be measured by mass or in full pockets of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows.

The aggregate shall be moist or wetted before the cement is added. Where drum mixers are used, about 20% of the water shall be poured into the drum before the aggregate and cement are loaded. The mixing time in the drum shall be about 45 to 50 seconds.

The quantity of water added shall be just sufficient to form a smooth grout which will adhere to and completely coat each and every particle of aggregate, and which is just wet enough to ensure that, at points of contact of aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 litres of water for every 50 kg of cement.

Mixing shall be done in an approved batch-type mechanical mixer, but small quantities may be hand mixed.

(d) Placing

No-fines concrete shall be placed in accordance with the procedure approved by the Engineer. It shall be placed in its final position within 15 minutes of having been mixed.

The concrete shall be worked sufficiently to ensure that it will completely fill the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping shall be avoided and the concrete shall not in any circumstances be vibrated.

(e) Protection

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:
(i) Retaining formwork in place.
(ii) Covering exposed surfaces with sacking or other approved material kept continuously wet.
(iii) Covering exposed surfaces with plastic sheeting.

No-fines concrete placed during cold weather shall be adequately protected against frost for at least three days.

6603 JOINTS IN STRUCTURES

(a) Materials

(i) General

All materials used in forming, constructing and sealing permanent joints as well as all proprietary or custom-built
expansion-joint assemblies shall be subject to the approval of the Engineer.

When required by the Engineer, the Contractor shall submit test certificates issued by an approved, independent testing authority to confirm that the respective materials comply with the specified requirements, or a certificate by the patent holder or designer certifying that the manufactured item complies in all respects with relevant product specifications.

(ii) Joint filler

Joint filler shall consist of sheets or strips of the following materials complying with the requirements of the relevant specifications listed:


(2) Resin-impregnated corkboard - US Federal Specification HH-F-341F.

(3) Flexible foams of expanded polyethylene, polyurethane, PVC or polypropylene - AASHTO Specification M-153.

(4) Rigid foams of expanded polyethylene, polyurethane or polystyrene - BS 4840 or BS 3837.

Other joint filler materials may be used if approved by the Engineer after he has been furnished with full specifications and information by the Contractor.

(iii) Sealants

Thermoplastic hot-poured sealants shall comply with the requirements of US Federal Specification SS-S-1401B, BS 2499 or AASHTO Specification M-173. The sealants shall be of the rubberised bituminous type containing a minimum of 20% natural or synthetic rubber.

Thermoplastic cold-applied sealants shall comply with the requirements of US Federal Specification SS-S-156. The sealant shall be of the rubberised bituminous type containing a minimum of 20% natural or synthetic rubber.

Thermosetting chemically curing sealants shall comply with the requirements of ASTM C-920 or BS 4254. The final IRHD (International Rubber Hardness Degree) hardness of the sealant shall be 20 ± 5.

Silicone sealants shall comply with the requirements of Subclause 7112. Other sealants may be used if approved by the Engineer after he has been furnished with full information and specifications by the Contractor.

(iv) Waterstops

Waterstops shall be of natural rubber or flexible PVC and of the type specified or shown on the Drawings.

Natural-rubber waterstops shall comply with the requirements of CKS 388.

Flexible PVC rubber waterstops shall comply with the requirements of CKS 389.

(v) Accessory material

(1) Primers

Where a primer is to be used in conjunction with the sealant, it shall be of the prescribed proprietary material.

(2) Bond breakers

Polyethylene tape, coated paper, metal foil or similar material may be used where bond breakers are required.

(3) Backup material

Backup material shall consist of a compressible material of correct width and shape to ensure that, after installation, it will be in approximately 50% compression and the sealant can be formed to the specified depth.

Backup materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

(vi) Cover plates

Steel cover plates shall be of Grade 43A steel which complies with the requirements of BS 4360, or of Grade 300W steel which complies with the requirements of SABS 1431 or equivalent. Galvanising shall comply with the requirements of SABS 783 or equivalent. Anchor bolts shall be of stainless steel Grade 302 S.21, which complies with the requirements of BS 970 Part 4.

(b) Filled and unfilled joints

(i) General

Wherever polystyrene or similar material susceptible to damage is used for forming joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

(ii) Filled joints

Filled joints shall be accurately formed to the dimensions shown and with the filler material specified on the Drawings. The filler shall be secured in position not to displace during concreting or thereafter if the filler is to remain permanently in the joint.

Where the removal of the filter is required, it shall be done prior to the installation of the proprietary joint.

(iii) Unfilled joints

Unfilled joints shall be accurately formed to the dimensions given on the Drawings, and all external corners chamfered or rounded for at least 5 mm. The concrete face against which the fresh concrete is placed shall be treated in good time with an approved bond breaker.

(c) Concrete nosings

Concrete nosings forming the edges of expansion joints shall be constructed as follows:

(i) After the concrete in the structural member has hardened sufficiently, the protruding ends of the reinforcing
steel shall be bent flat onto the concrete surface of the formed recess.

(ii) Before the asphalt surfacing is laid, the recess shall be filled with well-compacted crusher run, sand or weak mortar. The Contractor shall ensure that the concrete surfaces of the recess and the reinforcing steel are not contaminated with bituminous agents. The asphalt surfacing shall then be laid continuously over the joint.

(iii) The asphalt surfacing shall be cut with a diamond saw blade to correspond to the width of the nosing and all material shall be removed from the nosing recess. The concrete surfaces of the recess shall then be roughened to expose the aggregate and leave sound, irregular surfaces. The reinforcing steel shall then be bent, fixed and placed as shown on the Drawings.

(iv) The prepared concrete surfaces of the recesses shall be treated with an approved epoxy-resin adhesive, immediately before the concrete nosings are cast. Opposite concrete nosings, separated by a joint filler strip, shall be cast simultaneously in accordance with Subclause 6408(c), and compacted by vibrator. The nosing shall be screeded flush with the premix surfacing and be given a Class U2 surface finish.

(v) Curing shall be in accordance with Method (f) of Clause 6409.

(vi) After three days, the gap between the nosings shall be enlarged to the requisite dimensions by cutting both sides with parallel diamond saw blades. The depth of the saw cut shall be such that a ledge is formed along the lower edge of the cut on which the sealer unit can be supported.

(vii) The exposed corners of the nosings shall be ground to a 10 mm chamfer.

(viii) After the joint has been sealed, the wearing surface of the nosings shall be treated with a bituminous primer to the satisfaction of the Engineer.

Unless otherwise specified, traffic shall not be permitted to pass over the joint before the concrete in the nosing has aged for at least 10 days.

Unless otherwise indicated on the Drawings, the concrete used in the construction of the nosings shall be Class 40/13 and shall have a slump of not less than 50 mm and not exceeding 75 mm.

Concrete nosings shall be constructed under the direct supervision of experienced and skilled personnel.

(d) Plug type expansion joints

Plug type expansion joint systems, shall be constructed in accordance with the details on the Drawings and the specifications and instructions of the licences.

(e) Sealing the joints

(i) General

Sealed joints shall be made watertight over the full length of the joint, including the full height of the kerbing, unless otherwise prescribed in the Project Specifications.

Unless a waterstop is equipped with an effective watertight interlocking system for joining sections, all joints in waterstops shall be bonded or fused to have a tensile strength of at least 50% of that of the unjointed material. At intersections and abrupt changes of direction, waterstops shall be jointed with prefabricated junction pieces.

Restrictions on joint width and on the temperature at the time of installing the sealant or seal will be shown on the Drawings. In the absence of such restrictions on the Drawings, and unless otherwise specified, installation shall be carried out only within the temperature range between 5°C and 30°C.

(ii) Preparing the joints

Where required, joints shall be sawn at a suitable time so as to avoid edge spalling or ravelling.

After the temporary filler material has been removed or the excess concrete has been broken out, the inside faces of the joint shall be wire-brushed or sand-blasted to remove all laitance and contaminants. The joint shall then be cleaned and blown out with compressed air to remove all traces of dust. Solvents shall not be used for removing contaminants from the concrete and porous surfaces.

The Contractor shall ensure that primers are applied only to surfaces which are absolutely dry. The primer shall be applied strictly in accordance with the manufacturer's instructions. Unless otherwise specified, the primer shall be applied within the temperature range of 10°C and 40°C, and the sealant shall be applied after the curing period of the primer and within the period when the primer remains active.

(iii) Seals

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. Trapping of air and the forming of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance to the specified depth.

Thermoplastic hot-poured sealants shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C.

Two-part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot-life period which commences once the base and activator of the sealant have been combined.

(iv) Waterstops

Waterstops shall be securely and accurately located in position so that they will not be displaced or deformed during construction.

(f) Proprietary expansion joints

(i) General

The use of any type of expansion joint shall be subject to approval. Tenderers shall obtain approval for the type of expansion joint they intend using prior to submitting their tenders.

(ii) Dimensions

The Contractor shall note the overall dimensions of the expansion joints and the limiting dimensions of that portion of the concrete structure which is to accommodate the
joints. No alterations to the concrete which will be visible in the final structure or major re-arrangement of the prestressing anchorages will be permitted in order to accommodate joints of excessive size.

All joints to be installed skew shall be accurately dimensioned to ensure compliance with the requirements of Subclause 6603(g).

Unless otherwise specified, proprietary expansion joints shall include the complete expansion-joint assembly, traversing the entire roadway, kerbs, sidewalks and median, and shall include the coping and parapet cover plates as well as the drainage system to drain the expansion joint.

(iii) Design and manufacture

The expansion joint shall be designed to withstand the movements, displacements and rotations specified on the Drawings in conjunction with the loads described in the code of practice adopted for the design of the structure without exceeding in any member the requirement for serviceability limit state. Any strengthening of the supporting member required to resist forces imparted by the joint to the structure shall be for the Contractor’s account.

The specified movements, displacements and rotations shall be withstood without the efficacy or riding quality of the joint being impaired.

The joint shall be vibration free, resistant to mechanical wear and other forms of abrasion, and shall resist corrosion. It shall have good riding characteristics, shall be highly skid resistant, silent, and of watertight construction or have provision for the disposal of water, debris or grit collecting in the joint. It shall be of a construction that will facilitate easy inspection, maintenance and repair.

Apart from stainless steel, all steel surfaces shall be prepared in accordance with the requirements of Subclause 5907(b) and sprayed with a galvanising coat which complies with the requirements of SABS 1391 Part I or equivalent for Zn 150 coverage. All exposed surfaces sprayed with zinc shall, within four hours, be covered with a sealant suitable for use with the zinc and the subsequent layer. Two coats of chlorinated rubber paint with a combined dry-coat thickness of not less than 150 μm shall then be applied. They shall be of two different colours.

Prior to manufacture of the joints, the Contractor shall submit for approval detail drawings in accordance with the requirements of Clause 1221 of each expansion joint.

The expansion joints delivered at the site shall be suitably marked to show clearly the sequence and position of installation.

(g) Installing the expansion joints

Proprietary expansion joints shall be installed by approved specialist subcontractors only. Installed proprietary expansion joints shall have a 15 year written guarantee.

No expansion joint or part thereof shall be installed prior to the construction of the final surfacing, unless otherwise approved.

The expansion joint shall form an even surface with the road surface on either side and the deviation across and along the expansion joint shall comply with the requirements of Subclause 3405(e) and Subclause 3405(f) for surface regularity measured by ordinary straight-edge.

On completion of the installation of the proprietary expansion joints, the Contractor shall submit to the Engineer a certificate from the manufacturer or supplier of the joints, certifying acceptance of the installation. Notwithstanding the issuing of such certificate, it shall not relieve the Contractor of his responsibility under the Contract. Payment for the inspection of the joints and the issuing of the certificate by the manufacturer or supplier will be made under Item 71.02.

6604 BEARINGS FOR STRUCTURES

(a) Materials

(i) General

When requested by the Engineer, the Contractor shall submit test certificates from an approved, independent testing authority to show that the respective materials comply with the specified requirements, or a certificate from the patent holder or designer certifying that the manufactured item complies in all respects with relevant product specifications.

Unless otherwise specified, all the materials used for manufacturing the bearings shall comply with the requirements of BS 5400 : Part 9.2.

(ii) Roofing felt

Roofing felt shall be 3-ply and comply with the requirements of SABS 92 or equivalent for Type 1 roofing felt.

(iii) Elastomer

The elastomer used in the manufacture of bearings shall be natural rubber or synthetic rubber.

Natural rubber shall comply with the requirements of BS 1154 for specified IRHD hardness.

Synthetic rubber shall comply with the requirements of BS 2752 for specified IRHD hardness.

(iv) Stainless steel plate

The texture of the sliding surface of stainless steel plate used in conjunction with PTFE to form low-friction sliding surfaces shall be equal to or better than 0.2 μm Ra in accordance with the requirements of BS 1134.

(v) Stainless steel dowels and bolts

Stainless steel used for the manufacture of dowels and anchor bolts shall comply with the requirements of BS 970 : Part 4 for steel 316S16.

(vi) Mortar

Mortar beddings for seating the bearings shall be composed of an approved sand and either cement or epoxy resin, or may consist of an approved proprietary mortar. The mortar shall comply with the following strength requirements:

(1) Sand-cement mortar

The 7-day compressive strength of 150 mm cubes made from the mortar and cured in a moist atmosphere for the first 24 hours and afterwards in water at 20°C shall be not less than 1.5 times the average contact stress under the bearing or 15 MPa, whichever is the greater.
(2) Sand-epoxy resin mortar

The cured compressive cube strength of the mortar shall be not less than two times the average contact stress under the bearing, or 20 MPa, whichever is the greater.

(3) Proprietary mortar

The strength requirements for proprietary mortars shall be in accordance with either Subclause 6604(a)(vi)(1) or (2) as may be relevant.

(b) Concrete hinges

Concrete hinges shall be constructed in accordance with the details shown on the Drawings.

Construction joints shall not be formed in the throat area. Where a joint is necessary, it shall be formed as a recess below the throat, level with the top reinforcement mat. The width of the recess shall be slightly greater than that of the throat.

Care shall be taken to eliminate the formation of shrinkage cracks within the throat.

During construction, adequate bracing and support shall be provided to the satisfaction of the Engineer to prevent rotation in the throat from the time of casting to completion of the structure incorporating the hinge. During the course of construction the hinge shall not be subjected to conditions which will induce tensile stresses in the throat area.

Upon completion of the structural members incorporating the hinge, the space around the throat shall be filled and sealed with an approved compressible material.

(c) Roofing felt

Roofing felt used as bearing strips shall consist of at least three layers.

Where lubricated linings are specified, the roofing felt shall be saturated with used motor oil and then liberally dusted with graphite powder before it is laid on the bearing surface.

(d) Elastomeric bearings

(i) Technical data

The following technical data for the elastomeric bearings will be supplied on the Drawings, and shall also be supplied on drawings prepared by the Contractor for submission to the Engineer:

(1) Design loads and deformations

The critical design-load combinations and co-existing rotations and horizontal displacements for each bearing or each group of identical bearings.

(2) Size and construction of bearing

The size and construction of the bearing shall be designated by:

\[ L \times B \times n(t) \]

where:

L = length of bearing in the transverse direction, in mm
B = width of bearing in the span direction, in mm
t = thickness of individual elastomer layers, in mm
n = number of elastomer layers.

The steel plates shall be encased in a 3 mm thick elastomer layer.

(3) Hardness and type of elastomer

The IRHD hardness and type of elastomer, i.e. natural or synthetic rubber, from which the specified bearings are to be manufactured.

(4) Identification

Each bearing shall be identified by a number.

(ii) Alternative bearings

Where alternative bearings are offered by the Contractor, they shall be designed in accordance with the requirements of BS 5400 Part 9.1 for the loadings and deformations shown on the Drawings.

Where a bearing consisting of a type of rubber is offered, which differs from that which is specified, the bearing shall be redesigned to make provision for the variation in hardness and/or type of rubber.

(iii) Inspection and testing

On completion of the manufacture of the bearings, the Contractor shall submit bearings selected by the Engineer, or specially manufactured bearings to serve as samples as authorised by the Engineer, to an independent testing authority for testing.

The testing facilities of the manufacturer or supplier may be used if so approved and on condition that the tests are conducted in the presence of the Engineer.

The Engineer shall determine which tests are to be conducted, and the tests shall comply with the appropriate requirements of Subclause 7111(a). Payment will be made under Item 71.02 for these tests, for bearings damaged, and for sample bearings.

Copies of test results and certificates for the above-mentioned tests shall be submitted by the Contractor to the Engineer in good time to enable the Engineer to assess the information before the bearings are installed.

The dimensional tolerances for the bearings shall comply with the requirements of Subclause 6803(h).

Before the bearings are dispatched to the site of the Works, each bearing, with the exception of large bearings as provided for in the Project Specifications, shall be subjected simultaneously to a vertical load equal to 150% of the maximum design load, and to a shear distortion equal to 150% of the maximum design value. The bearings shall be visually inspected for defects by the Engineer or his nominee and shall not at any stage under this test show any cracks visible to the naked eye or any other defects. The cost of this testing shall be included in the rate tendered for Item 71.01.
The Engineer may instruct that one bearing of each consignment shall be cut open with a view to a visual assessment of the bonding and the thickness of layers.

(e) Proprietary bearings

(i) General

This Clause covers custom-built bearings and bearings manufactured under licence, except elastomeric bearings. Combined bearings, consisting of an assembly of an elastomeric bearing in conjunction with a low-friction sliding or mechanical component shall fall under this Clause.

The tenderer may base his tender on any bearing which complies with the specified requirements, provided that the efficacy of the bearing has been verified by tests and successful previous use. Evidence hereof as well as information on the durability and suitability of the bearings for the specified use shall be submitted to the Engineer for consideration.

Details of the product guarantee shall be submitted with the tender.

(ii) Drawings and approval

Prior to manufacturing the bearings, the Contractor or his nominee shall submit the following information to the Engineer for consideration:

(1) The manufacturer's specification containing detailed information on the design standards, materials, manufacture and technical data.

(2) Drawings complying with the provision in Clause 1221 showing the bearing construction and installation details.

(3) Friction properties based on actual tests conducted on the relevant materials.

(iii) Technical requirements

The following technical requirements will be supplied on the Drawings, and shall also be supplied on the Drawings prepared by the Contractor for submission to the Engineer:

(1) Design loads and movement

The maximum and minimum vertical loads and co-existing horizontal loads as well as the maximum horizontal load and co-existing vertical load.

The maximum values in each direction of the reversible and irreversible movements and the rotation about each axis.

(2) Identification

Identification of each bearing by a number, data on the degree of freedom of movement (fixed, multi-directional or unidirectional bearings) and the type of bearing (spherical, elastomer-pot, etc) shall appear on each bearing.

(iv) Design

The bearings shall be designed in accordance with the requirements and recommendations of BS 5400 Part 9.1. The following shall also be complied with:

(1) The average pressure on the area of the elastomer shall not exceed 25 MPa under the serviceability limit state, unless otherwise prescribed by the Engineer.

(2) The maximum average contact stress and maximum edge stress on the concrete or mortar bedding shall not exceed 0.5 and 0.6 times the 28-day cube characteristic compressive strength under the serviceability limit state respectively, unless otherwise prescribed by the Engineer.

(3) The bearing pad shall be of dimensions as will fit into the space allowed for its installation. Major alterations to the contiguous members will not be permitted.

(v) Construction

Unless otherwise specified, the following shall be complied with:

(1) The thickness of the elastomer disc shall be not less than 0.066 times its diameter.

(2) Approved lubricants only shall be used on the PTFE sliding surfaces.

(3) The bearing shall be provided with tight-fitting seals to prevent the ingress of dust or deleterious matter onto the moving parts. The seals shall be of an approved type and sufficiently durable to last in excess of 50 years.

(4) The assembled bearing shall be supplied with welded or bolted lugs or straps, temporarily securing the moving parts firmly in position to ensure that no undesirable relative movement occurs before or during construction.

(5) The bearing shall be recessed into adaptor plates or be of such construction as to facilitate removal of the bearing from the installed position without damage to any part of the bearing or the surrounding material after the relevant structural member has been raised by 15 mm or the distance specified.

(6) Anchors and holding-down bolts shall be of the specified material.

(7) Corrosion protection of all exposed steel surfaces, with the exception of the stainless-steel sliding plate, shall involve the following treatment:

- Preparing the surfaces by abrasive blasting to a finish equal to the Sa3 finish of Swedish Standard SIS 05 59 00 or equivalent.

- Spraying the surfaces with zinc to comply with the requirements of SABS 1391 Part I or equivalent for Type Zn 150 surfacing.

- Coating the zinc-sprayed surfaces within four hours with a sealer compatible with the zinc and the subsequent coats of paint.

- Applying a coat of chlorinated rubber paint with a minimum of 75 \( \mu \)m of dry-film thickness and of a colour which differs from that of the final coat of paint.

- Applying a final coat of chlorinated rubber paint with a minimum of 75 \( \mu \)m of dry-film thickness and of dark grey colour.
- Surfaces in contact with concrete shall be sprayed with zinc so that it complies with the requirements of SABS 1391 Part I or equivalent for Type Zn 150 surfacing.

(vi) Inspection and testing

The Engineer may require tests to be conducted to verify compliance of the bearing with the specifications and/or its satisfactory performance under the design loads. Payment for this testing will be made under Item 71.02.

Test certificates of all the tests conducted shall be submitted to the Engineer.

The Contractor shall give the Engineer at least seven days notice prior to final assembly of the bearings to enable the Engineer to inspect the bearings at the factory.

Under no circumstances shall bearings be taken apart and reassembled on the site, except where it is an unavoidable feature of the installation procedure, in which case the dismantling, installation and reassembly shall be under the supervision of qualified personnel.

Rehabilitation, modification and repair work to bearings shall be carried out only in the factory or in an approved engineering Works.

(f) Dowels and guides

Where dowels and guides are used in conjunction with bearings they shall not complicate or prevent the removal of the bearings.

(g) Storage and handling

The bearings shall at all times be stored under cover and clear of the ground, away from sunlight, heat, oils and chemicals deleterious to the bearings. The bearings shall not be stacked in a manner or on a surface which will cause distortion of the bearings.

The bearings shall be handled with care to ensure that they are not subjected to impact loads or any other conditions which may be harmful.

(h) Installation

The concrete surfaces of elements required to receive bearings shall comply with the requirements of Subclause 6209(c). Plastering of the surface will not under any circumstances be permitted.

Before the mortar bedding is constructed, the concrete surface shall be chipped back to expose the aggregate and leave a sound irregular surface. Bonding of the mortar bedding to the concrete surface shall be in accordance with the manufacturer's recommendations and the Engineer's instructions.

Unless otherwise shown on the Drawings, the bearings shall be installed on a horizontal plane and shall be in full contact with the concrete and bedding surfaces.

To accommodate soffit irregularities and camber in the case of precast members, the member shall be lowered onto a mortar skim on top of the bearing. The member shall then be propped until the mortar skim has hardened into a wedge.

The bearings shall be accurately installed to the specified level, alignment and orientation, all within the construction tolerances set out in Subclause 6803(h) and the details shown on the Drawings.

Where the bearing has long sliding plates, the latter shall be rigidly supported to prevent their being distorted under the weight of the wet concrete and the construction loads.

Before the bearing is incorporated into the structure, it shall be cleaned to remove all deleterious substances and adhering matter, after which it shall be wrapped in polyethylene sheeting and so sealed as to prevent the ingress of mortar and/or slush onto the bearing during the course of construction.

After installation, the polyethylene wrapping shall be removed, the bearing and the space around the bearing thoroughly cleaned and the lugs removed as prescribed by the Engineer.

On completion of installation of proprietary bearings, the Contractor shall submit to the Engineer a certificate from the manufacturer or supplier of the bearings certifying acceptance of the installation. The issuing of such a certificate shall not relieve the Contractor of his responsibility under this Contract. Payment for the inspection of the bearings by the manufacturer or supplier and the issuing of the certificate will be made under Item 71.02.

6605 PARAPETS, RAILINGS AND SIDEWALKS

(a) Materials

(i) Concrete

All concrete work shall be carried out in accordance with the requirements of Sections 6200, 6300, 6400 and Clause 6603.

(ii) Structural steel

Structural steel work shall comply with the provisions of Subclause 6702(a).

(iii) Mortar

Mortar shall comply with the requirements of Subclause 6604(a).

(b) Concrete parapets

Concrete parapets shall be either cast in situ or precast or a combination of the two as shown on the Drawings. Where possible, precast elements shall be placed with the uniformed surface downwards or outwards.

Concrete parapets shall be constructed after the removal of the falsework and the completion of the prestressing, but not before the bridge deck has been accurately measured so as to determine the final lines and levels.

Service ducts in parapets and blocks shall be fixed and cast into position in accordance with the requirements of Clause 6411 and the details shown on the Drawings.

The pipes and fittings to be used for the construction of the ducting shall be rigid PVC pipes and fittings with flexible rubber joints which comply with the requirements of SABS 967 or equivalent. Duct ends shall be provided with suitable
conical wooden stoppers to prevent dirt, concrete, etc, from entering the ducts. Two strands of 2.5 mm diameter galvanised steel wire shall be threaded through each duct. The strands shall extend 2 m beyond each end and be wedged firmly into position with the wooden stoppers. Inspection eyes for the ducts shall be constructed in accordance with the details shown on the Drawings.

No separate payment will be made for service ducts in parapets and end blocks and the rates tendered for the parapets and end blocks shall include full compensation for the provision and installation of service ducts complete with stoppers, draw wire and inspection eyes.

(c) Steel railings

All steelwork shall be manufactured in accordance with the requirements of Section 6700.

A mortar bed, not less than 10 mm in thickness, shall be provided below all steel base plates over the full dimensions of the plate. The sides of the beds shall be neatly chamfered at 45°. All open spaces between the bolt and the sides of the holes in the base plate shall be grout filled.

Steelwork which is to be cast or grouted into concrete shall be completely painted to a distance of 75 mm in the concrete or grout, and shall be cleaned of all loose rust, mill scale, oil or other material which may impair the bond between the concrete and steel.

All steelwork shall be painted in the shop and on site in accordance with the provisions of Section 5900. Surfaces which will be inaccessible after erection of the units shall be painted before erection commences. If called for on the Drawings or in the Schedule of Quantities, steelwork shall be galvanised and painted. Galvanising shall be done after fabrication, in accordance with SABS 763 or equivalent for Type A1 articles.

(d) Numbers for structures

(i) Number plates

Number plates shall be fixed in the positions and according to the method of fixing shown on the Drawings.

(ii) Painted numbers

The surface onto which the numbers are to be painted shall be prepared in accordance with the requirements of Subclause 5900(a). The background shall be of at least two coats of the prescribed paint. The letters and figures shall be in accordance with the details given on the Drawings and shall be written at the prescribed positions with a template.

(iii) Numbers shaped in concrete

Bridge numbers shall be placed and shaped in accordance with the requirements shown on the Drawings. The minimum concrete cover over the steel reinforcement behind the numbers shall not be less than the prescribed cover for the structural member in question.

(e) Concrete sidewalks

After completion of the prestressing and the removal of the formwork, the sidewalks and kerbing shall be constructed, but not before the bridge deck has been accurately surveyed to establish final lines and levels.

The previously cast bridge deck area shall be prepared as specified in Clause 6408 to receive the sidewalk concrete.

Forms shall be accurately set to the final lines and levels and shall be firmly held in position during the placing of the concrete. Stops at the ends of sections shall be accurately placed to ensure that joints between adjacent sections will be truly perpendicular to the surface of the concrete and at right angles to the edge of the road or to the skew angle of the deck at the expansion joint.

After removal of the forms, the exposed surfaces of the kerbs and copings shall be rubbed and finished in accordance with the requirements of Subclauses 6208(a) and (c) and 6209(b). All edges shall be rounded to a radius of 20 mm unless otherwise shown on the Drawings.

(f) Concrete surface finish requirements

All formed concrete surfaces shall have a Class F3 surface finish as specified in Subclause 6207(d) and all unformed concrete surfaces shall have a Class U3 surface finish in accordance with Subclause 6209(c).

(g) Transition blocks

Transition blocks shall be constructed in accordance with the details shown on the Drawings.

(h) Nose Endings

Nose endings at balustrades shall be constructed in accordance with the details on the Drawings.

6606 DRAINAGE FOR STRUCTURES

(a) Weep holes, drainage pipes and channelling

Weep holes shall not be placed within 40 mm of any reinforcement and shall be carefully cleaned and kept clean.

Drainage pipes shall be of the material prescribed on the Drawings, and the interior surface shall, on completion, be smooth and clean.

Cast in situ concrete channelling shall be provided next to the kerbing if shown on the Drawings and according to the details provided. Concrete work shall be carried out in accordance with the provisions of Section 6400 and channelling shall be given a Class U2 surface finish as specified in Subclause 6209(b). The channelling shall be bonded to the bridge deck concrete in accordance with the provisions of Clause 6408.

(b) No-fines concrete blocks

Blocks shall be of the class of prescribed no-fines concrete and to the required dimensions and shall be placed in advance of backfilling.

No-fines concrete shall comply with the requirements of Clause 6602.
(c) Synthetic-fibre filter fabric

Synthetic-fibre filter fabric shall be of the type and grade shown on the Drawings or specified in the Project Specifications. Filter fabric shall be placed as shown on the Drawings and shall be protected against sunlight and mechanical damage during storage and installation.

The fabric shall comply with the requirements of Subclause 2104(a).

(d) Crushed stone in drainage strips behind walls

The crushed stone used in drainage strips shall comply with the requirements for 19.0 mm nominal size stone as specified in SABS 1083 or equivalent. The crushed stone shall be wrapped in synthetic-fibre geotextile and placed in accordance with the details shown on the Drawings or as instructed by the Engineer.

The fabric shall comply with the requirements of Subclause 2104(a).

6607 BOLT GROUPS FOR ELECTRIFICATION BRACKETS

The Contractor shall supply and install bolt groups in bridge decks for the electrification brackets of Railway Owners. The bolt groups shall consist of stainless-steel sockets complete with stainless-steel bolts and mild-steel plates. The sockets, bolts and plates shall be manufactured in accordance with the details shown on the Drawings. The Contractor shall install the sockets in bridge decks in the positions and in the manner shown on the Drawings.

On completion of the deck, the Contractor shall ensure that the threads of the bolts and sockets are clean and that the bolts can be secured in the sockets. The Railway Owner will supply and install the brackets at a later stage.

6608 MEASUREMENT AND PAYMENT

Item | Unit
--- | ---
66.01 Cast in situ no-fines concrete | cubic metre ($m^3$)

The provisions of Clause 6415 Item 64.01 shall apply mutatis mutandis.

Item | Unit
--- | ---
66.02 Precast no-fines concrete units (class of concrete and description of unit) | number (No)

The unit of measurement shall be the number of complete units of each size and type in position in the Works.

The tendered rate for each precast concrete unit shall include full compensation for providing all the materials, labour, plant and formwork required for manufacturing the unit complete as shown on the Drawings and for transporting and placing the unit in position.

66.03 Proprietary expansion joints:

(a) Prime cost sum allowed for purchasing and taking delivery of expansion joints . . . . . . . . . . . . . . . . . . prime cost sum

(b) Percentage on prime cost sum for charges and profit . . . . . . . . . . . . . . . . per cent (%)

Payment for purchasing and taking delivery of proprietary expansion joints shall be in accordance with the provisions of the General Conditions of Contract (see Note 2 below).

Item | Unit
--- | ---
66.04 Installation of proprietary expansion joints:

(a) (Description of joint measured per metre) . . . . . . . . . . metre (m)

(b) (Description of joint measured by number) . . . . . . . . . number (No)

The unit of measurement shall be either the metre of complete joint of each type installed or the number of complete joints of each type installed.

The tendered rates shall include full compensation for supplying all materials not covered under Item 66.03, transporting, handling and storing, and all labour, equipment, shaping the recesses, and incidentals required for installing the expansion joint complete in accordance with instructions (see Notes 1 and 2 below).

The tendered rate shall be final and binding, irrespective of the type or make of joint finally installed.

Item | Unit
--- | ---
66.05 Expansion joints:

(a) (Description of joint measured per metre) . . . . . . . . . . metre (m)

(b) (Description of joint measured by number) . . . . . . . . . number (No)

The unit of measurement shall be the metre of complete expansion joint of each type installed or the number of completed joints of each type installed.

The tendered rates shall include full compensation for supplying all the materials, manufacturing the expansion joint, transporting, handling and storing, and all labour, equipment, shaping the recesses, and incidentals required for installing the expansion joint complete in accordance with instructions (see Notes 1 and 2 below).
### Filled Joints:

- **66.06**
  - **Filled joints:**
    - **(a)** Description of joint and thickness of joint filler for joints measured per square metre.
    - **(b)** Description of joint and thickness of joint filler for joints measured per metre.

  The unit of measurement shall be the square metre of filled joint calculated from the surface area of the joint. Where the filled joint is 150 mm or less in depth, the unit of measurement shall be the metre of filled joints measured along the joint centre line. Concrete surfaces formed prior to the construction of the final surface for completing the filled joint shall be measured under Items 62.01, 62.02, 63.03 or 62.04, as may be applicable.

  The tendered rates shall include full compensation for supplying and installing the joint filler and all materials not covered under Item 66.08, and for all labour and incidentals required for completing the filled joint as prescribed.

### Unfilled Joints:

- **66.07**
  - **Unfilled joints:**
    - **(a)** Description of joint for joints measured per square metre.
    - **(b)** Description of joint for joints measured per linear metre.

  The unit of measurement shall be the square metre of unfilled joint, calculated in accordance with the joint area. Where, however, the depth of the joint is 150 mm or less, the unit of measurement shall be the metre of unfilled joint measured along the joint centre line. Concrete areas formed before the final surface is constructed to complete the unfilled joint shall be measured under Items 62.01, 62.02, 62.03 or 62.04, as may be applicable.

  The tendered rates shall include full compensation for providing and applying the bond breaker and all materials not paid for under Item 66.08, as also for the labour and incidentals required for completing the unfilled joint as prescribed.

### Sealing Joints with:

- **66.08**
  - **Sealing joints with:**
    - **(a)** Sealant (description of joint, sealant and size).
    - **(b)** Seal (description of joint, seal and size).
    - **(c)** Waterstop (description of joint, waterstop and size).

  The unit of measurement shall be the metre of sealant, seal or waterstop of each type installed.

The tendered rates shall include full compensation for supplying all materials, forming or cutting the concrete to the required shape and size, all labour, equipment and incidentals required for sealing the joint complete in accordance with the prescriptions, and for all waste materials (see Note 2 below).

### Proprietary Bearings:

- **66.09**
  - **Proprietary bearings:**
    - **(a)** Prime cost sum allowed for purchasing and taking delivery of bearings.
    - **(b)** Percentage on prime cost sum for charges and profit.

  Payment for purchasing and taking delivery of proprietary bearings, complete with anchor bolts and/or dowels, shall be in accordance with the provisions of the General Conditions of Contract.

### Installing the Proprietary Bearings:

- **66.10**
  - **Installing the proprietary bearings:**
    - **(a)** Prime cost sum allowed for purchasing and taking delivery of bearings.
    - **(b)** Percentage on prime cost sum for charges and profit.

  The unit of measurement shall be the number of complete bearings of each type and class installed.

The tendered rate shall include full compensation for supplying all the materials not covered under Item 66.09, constructing the bedding, transporting, handling and storing, and all labour, equipment and incidentals required for installing the bearings complete as detailed.

The tendered rate shall be final and binding, irrespective of the type or make of bearing finally installed.

### Bearings:

- **66.11**
  - **Bearings:**
    - **(a)** Prime cost sum allowed for purchasing and taking delivery of bearings.
    - **(b)** Percentage on prime cost sum for charges and profit.

  The unit of measurement shall be the number of complete bearings of each type and class installed.

The tendered rate shall include full compensation for supplying all the materials, including anchor bolts and/or dowels, constructing the bedding, manufacturing the bearings, transporting, handling and storing, and all labour, equipment and incidentals required for installing the bearings complete as detailed.

### Concrete Hinges:

- **66.12**
  - **Concrete hinges:**
    - **(a)** Description of hinge measured per metre.
    - **(b)** Description of hinge measured by number.

The tendered rate shall include full compensation for supplying all the materials, constructing the bedding, manufacturing the bearings, transporting, handling and storing, and all labour, equipment and incidentals required for installing the bearings complete as detailed.
The unit of measurement shall be either the metre of complete hinge of each type manufactured and installed or the number of complete hinges of each type manufactured and installed.

The tendered rates shall include full compensation for supplying all materials, including formwork, manufacturing the hinges, transporting, handling and storing, sealing the hinges, and all labour, equipment and incidentals required for installing the hinges complete as detailed.

**Item** | **Unit**
--- | ---
66.13 Bearing strips | (description of the material and number of layers) square metre (m²)

The unit of measurement shall be the square metre of bearing area lined with the specified material irrespective of the number of layers placed.

The tendered rate shall include full compensation for supplying all materials, transporting, handling and storing, and all labour and incidentals required for installing the bearing strips complete as detailed.

**Item** | **Unit**
--- | ---
66.14 Dowels/guides | (description of each type) number (No)

The unit of measurement shall be the number of dowels/guides of each type installed.

The tendered rate shall include full compensation for supplying all materials, including anchor bolts, manufacturing the dowels/guides, transporting, handling and storing, and all labour, equipment and incidentals required for installing the dowels/guides complete as detailed.

**Item** | **Unit**
--- | ---
66.15 Concrete parapets | metre (m)

The unit of measurement for concrete parapets shall be the metre of concrete parapet complete in accordance with the Drawings. Concrete parapets shall include all work above the top level of the sidewalks or, where not placed on a sidewalk, above the top of the bridge deck concrete, wingwalls or retaining walls and shall also include any kerbing and coping forming an integral part of the concrete parapet.

The tendered rate for concrete parapets shall include full compensation for all concrete, formwork, service ducts, drawing wires and accessories. The rates will exclude only the cost of reinforcing steel as this will be measured and paid for under another pay item.

**Item** | **Unit**
--- | ---
66.16 Steel railings | (type described) metre (m)

The unit of measurement for steel railings shall be the metre of railing complete in accordance with the Drawings.

The tendered rate for steel railings shall include full compensation for all steelwork and corrosion protection, including fastenings, anchor bolts, mortar bedding, etc, as may be required for erecting the railings.

**Item** | **Unit**
--- | ---
66.17 End blocks | number (No)

The unit of measurement of bridge end blocks shall be the number of end blocks constructed complete in accordance with the Drawings.

The tendered rate shall include full compensation for all materials, labour, plant, and other incidentals required for constructing the end blocks complete as specified, excluding only reinforcing steel.

**Item** | **Unit**
--- | ---
66.18 Numbers for structures:
(a) | Number plates number (No)
(b) | Painted numbers number (No)
(c) | Numbers formed in concrete number (No)

The unit of measurement shall be either the number of bridge number plates provided and installed, or the number of complete numbers painted on the structures, or the number of complete numbers formed in concrete. A bridge number may consist of a combination of letters and digits, eg B1533.

The tendered rates shall include full compensation for providing and installing either the number plates, or preparing the surface and painting the numbers, or forming the numbers in concrete, and for all material, labour and equipment required in this connection.

**Item** | **Unit**
--- | ---
66.19 Drainage pipes and weep holes:
(a) | Drainage pipes:
(i) | (Type and size indicated) metre (m)
(ii) | (Type and size indicated) number (No)
(b) | Weep holes:
(i) | (Type and size indicated) metre (m)
(ii) | (Type and size indicated) number (No)

The unit of measurement shall be either the metre of pipe/weep hole or the number of pipes/weep holes of each type and size of pipe/weep hole completed.

The tendered rates shall include full compensation for supplying all the materials, manufacturing and installing the pipes and making weep holes.
The tendered rate shall include full compensation for providing all the material and manufacturing and installing the drainage inlets.

66.21 Synthetic-fibre filter fabric
(type indicated and description) ............ square metre (m²)

The unit of measurement shall be the square metre of filter fabric installed as specified, including the specified overlap.

The tendered rate shall include full compensation for supplying, cutting and installing the filter fabric, and for waste material.

66.22 Concrete channelling
(size indicated) ........................ metre (m)

The unit of measurement shall be the metre of completed concrete channelling of each size constructed.

The tendered rate shall include full compensation for providing all the material, all labour, equipment and expenses required for completing the work.

66.23 Crushed stone in drainage strips ........................ cubic metre (m³)

The unit of measurement shall be the cubic metre of crushed stone placed in position as specified, in accordance with the details shown on the Drawings or instructed by the Engineer.

The tendered rate shall include full compensation for procuring, furnishing and placing the crushed stone, and for wrapping it in synthetic-fibre geotextile as specified.

The geotextile will be measured for payment under Item 66.21.

66.24 Nose endings at balustrades ........................ number (No)

The unit of measurement shall be the number of nose endings constructed complete in accordance with the details shown on the Drawings.
SERIES 6000 : STRUCTURES

SECTION 6700 : STRUCTURAL STEELWORK

CONTENTS

6701 SCOPE
6702 MATERIALS
6703 CODES OF PRACTICE
6704 SHOP DETAILS
6705 FABRICATION AND ASSEMBLY
6706 ERECTION
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6708 MEASUREMENT AND PAYMENT

6701 SCOPE

This Section covers the manufacture, transport and erection of structural steelwork for minor structures, eg overhead road-sign structures. It does not apply to major steel structures such as steel bridges, which will be covered in the Project Specifications where work of this nature is required.

6702 MATERIALS

(a) Structural steel

Structural steel shall comply with the following requirements:

Mild steel: BS 4360, Grade 43A; or SABS 1431, Grade 300W.

High-yield stress steel: BS 4360, Grade 50B; or SABS 1431, Grade 350W.

The dimensions and properties of rolled steel sections shall comply with the prescriptions given in the structural steel tables issued by the SA Institute of Steel Construction or equivalent.

(b) Steel tubes

Steel tubes shall comply with the requirements of SABS 657, Part I or equivalent.

(c) Bolts, nuts and washers

Ordinary bolts and nuts shall be bolts and nuts used for transferring forces by tensile stress, compressive stress and shear stress without any friction-grip action being considered. Ordinary bolts and nuts shall comply with SABS 135, SABS 136 or SABS 1143 or equivalent.

Washers for ordinary bolts and nuts shall comply with the requirements of SABS 1149 or equivalent.

High-strength friction-grip bolts, nuts and washers shall comply with the requirements of SABS 1282 or equivalent.

Other approved friction-grip fasteners equal to the above may be used.

(d) Rivets

Mild-steel rivets shall comply with the requirements of SABS 435 or equivalent. High-tensile rivets shall be so manufactured that they can be driven and their heads formed satisfactorily without the physical properties of the steel being impaired.

(e) Welding consumables

Welding electrodes shall comply with the requirements of SABS 455 or equivalent.

The quality, handling and storage of all consumables shall be so as to achieve the desirable properties of the weld metal.

The welding consumables used shall be appropriate to produce weld metal which will yield all the weld-metal test specimens as specified in BS 709 having both minimum yield and minimum tensile strengths not less than those of the parent metal.

(f) Test certificates

The Contractor shall submit test certificates, as required by the Engineer, of the structural steel and anchor bolts that will be used.

6703 CODES OF PRACTICE

The design, where undertaken by the Contractor, of all work shall comply with the requirements of SABS 0162 or equivalent.

6704 SHOP DETAILS

Where shop details have not been furnished on the Drawings, the Contractor shall prepare his own shop details in accordance with the provisions of Clause 1221. Shop details shall be approved and signed by the Engineer prior to the fabrication of any items.

6705 FABRICATION AND ASSEMBLY

(a) General

All structural steel both before and after fabrication shall be within the tolerances specified in Subclause 6803(j) and shall be flat, straight (unless required to be formed to another shape) and free from twists.

(b) Marking the steel

At all stages of fabrication, all structural steel other than Grade 300W and Grade 43A steel shall be clearly marked by grade by means of a suitable marking system.

(c) Cutting

Steel shall be cut by sawing, shearing with shears, cropping, or flame-cutting.
Edges shall be free from any defects or distortions and all burrs, notches and similar defects shall be removed.

(d) Holes for fasteners

Holes for fasteners shall not be formed by flame cutting. Holes in light members not thicker than 12 mm or the diameter of the hole, whichever is the smaller, may be punched.

Holes for fasteners of up to 25 mm in diameter shall not be more than 2 mm larger than the diameter of the fastener and holes for larger fasteners not more than 3 mm larger than the diameter of the fastener.

Holes for friction-grip fasteners shall be in accordance with SABS 094 or equivalent.

All burrs shall be removed from holes before assembly.

(e) Joints in compression

The abutting surfaces of joints dependent on contact for the transmission of load shall be accurately prepared so that the full area intended for bearing will be in contact as specified in Subclause 6803(j).

(f) Hollow sections

Unless protection against corrosion is provided by other means, the interior of any hollow section shall be sealed to prevent the ingress of moisture. Where a sealed hollow member is holed for a fastener or pin, precautionary measures shall be taken to prevent the ingress of water to the interior of the member. Vent holes for galvanising shall be sealed after galvanising has been completed.

(g) Alignment of holes

All matching holes for fasteners or pins shall be accurately aligned so that the fasteners can be inserted freely through the assembled members in a direction at right angles to the faces in contact. Drifting for aligning the holes shall not distort the metal or enlarge the holes.

(h) Welding

Welding shall be done in accordance with the requirements of BS 5135.

The welding techniques shall be such as to avoid undue distortion and to minimise shrinking stresses.

All slag shall be removed.

Where required for certain welding:

(i) the manufacturer shall hold a valid welding-procedures certificate in accordance with SABS 044 Part III or equivalent for Grade B welding joints, and the welding shall be done by a welder qualified in accordance with SABS 044 Part IV or equivalent; or

(ii) the welder shall hold a valid certificate of competency in accordance with SABS 044 Part V or equivalent for the specified type of welding.

All structural welds shall be full-strength joints.

(i) Bolting

The jointed parts shall be firmly drawn together. Where necessary, tapering washers shall be used for each bolt head and nut to transfer the compressive stress over its full surface. Where bolt holes have greater than normal clearance, washers shall be placed under the bolt heads and nuts.

The length of each bolt shall be such that, after tightening, at least one full thread projects through the nut on the outside and at least one full thread (in addition to the thread run-out) remains clear between the nut and the bolt head.

(j) Friction-grip fastening

The use of friction-grip bolts shall be in accordance with SABS 094 or equivalent. Where use is made of equivalent types of friction-grip fasteners, they shall comply with the requirements of SABS 094 or equivalent fasteners and shall be installed in accordance with the appropriate requirements of SABS 094 or equivalent.

(k) Rivetting

Wherever possible, rivetting shall be done with pneumatic equipment.

Rivetted units shall have all parts firmly drawn together and aligned before rivetting. Every rivet shall, when driven, completely fill the hole and shall have a well-formed head or, if countersunk, fill the countersink completely.

All loose, eccentric-headed, badly formed, burnt or otherwise defective rivets shall be cut out and replaced.

(l) Trimming

All fabricated steel work shall be neatly trimmed so as not to show any sharp edges. Acute angles shall be rounded off to a radius of at least 1.0 mm.

(m) Corrosion prevention

(i) Painting

Before removal from the place of manufacture the steelwork shall be painted as specified in Section 5900.

Where the finishing coats are to be applied on the site, the shop painting shall include the application of an undercoat as specified in Section 5900.

Galvanised steel shall not be painted unless painting is specifically called for in the specifications.

(ii) Sprayed metal coatings

Where the sprayed metal coating of steel surfaces is called for, it shall be done in accordance with the requirements of SABS 1391 Part I or equivalent. The type of metal used shall be as specified, and, unless otherwise specified, the metal coating shall comply with the requirements of Type Al 150 or Type Zn 150.
Where the galvanising of structural steelwork is required, the members shall be hot-dip galvanised. Structural steel members shall be given an 85 \( \mu \)m coating or such other thickness as may be specified, in accordance with SABS 763 or equivalent and sheet steel and strip a Class M coating in accordance with SABS 934 or equivalent.

All nuts, bolts, screws and threaded articles shall be hot-dipped galvanised in accordance with the appropriate requirements of SABS 763 or equivalent for Type C1 or Type C2 articles.

Cut ends and small damaged areas shall be repaired by the application of a zinc-rich paint or by zinc spraying.

6706 ERECTION

(a) General

Where specified, details of the method of erection shall be submitted to the Engineer for approval. All structural steel shall be stored, transported, handled and erected so as not to subject it to undue stress or damage.

Erection over traffic is not permitted, and a temporary diversion for traffic shall be provided.

Provision for traffic accommodation will be paid for in accordance with the appropriate items under Section 1500.

(b) Safety during erection

During the erection of a structure, the steelwork shall be bolted, braced or otherwise secured so as to make adequate provision for all erection loads.

(c) Alignment

Each part of a structure shall be aligned as soon as possible after erection. Members shall not be permanently connected until sufficiently large members of the structure have been aligned, plumbed, levelled, and temporarily secured to prevent their displacement during the erection or alignment of the remainder of the structure.

(d) Corrections

Drift pins, jacking equipment and the like shall not be used for bringing improperly fabricated members into place. A moderate degree of cutting and reaming may be done to correct minor misfits if, in the opinion of the Engineer, this will not be detrimental to the appearance or strength of the structure. The burning of holes will not be permitted without written approval.

(e) Repairs to painting and site painting

Repairs to painting and site painting shall be effected in accordance with the provisions of Clause 5907.

(f) Grouting

The grout shall be poured under and around the base plates of columns after the steelwork has been finally checked for alignment and height and after the approval of the Engineer has been obtained to proceed with the grouting. The column base plates shall be supported by the top and bottom nuts and by steel wedges. The area under the steel shall be thoroughly cleaned and shall be dust and oil-free, and the concrete shall be thoroughly rinsed with water to leave the surface clean and moist.

The grout shall be an approved non-shrinking, pourable, cementitious grout. The grout shall be prepared and applied strictly in accordance with the manufacturer’s recommendations and the Engineer’s directives.

Leak-proof formwork shall be used for the pourable grout, and all corners shall be chamfered. The surface finish shall be Class F2 and Class U2 as applicable.

6707 TESTING

(a) Testing by the Engineer

The Engineer may nominate a testing authority to inspect the Works and to conduct such tests as he may deem to be necessary to test compliance with the specifications. Where required, test samples of welds shall be prepared by the Contractor, free of charge.

Payment for these tests shall be made under Item 71.02.

(b) Process control

Welds shall be regularly inspected and tested by the Contractor in terms of his obligations in regard to process control, as described in Clause 1205. This shall include visual inspection of welds to ensure that no undercutting, uneven lengths, porosity, or evidence of cracking occurs and that full fusion of the metals has been achieved. In doubtful areas, cores containing weld metal and adjacent parent material shall, if so required by the Engineer, be cut out, polished and examined and the hole repaired.

At least 30% of the welds shall be examined by ultrasonic or radiographic means. If more than 5% of the examined welds show unsatisfactory results, additional examinations covering all welds shall be performed. Certificates of the examination confirming that the steel plates and welds comply with the requirements of SABS 044 Part III or equivalent shall be submitted to the Engineer.

The cost of testing shall be deemed to be included in the rate tendered for Item 67.01 Structural steel.

6708 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.01 Structural steel:</td>
<td>(Structure/article described)</td>
<td>tonne (t)</td>
</tr>
<tr>
<td>67.01</td>
<td>Structural steel:</td>
<td>metre (m)</td>
</tr>
<tr>
<td>67.01</td>
<td>Structural steel:</td>
<td>number (No)</td>
</tr>
</tbody>
</table>
The unit of measurement shall be either the tonne or the metre of erected permanent steel structures or articles, or the number of erected permanent steel structures or articles. Where the unit of measurement is the tonne, the mass of the steel waste caused by punching, drilling, sheared edges, milling or planning, or metal cut-outs shall not be deducted, and the mass of rivets, bolts, nuts, washers, welding fillets or temporary bracing shall not be added. In computing the mass of steel, the nominal mass per unit of length or area will be used and tolerances and other permissible deviations will be ignored.

The tendered rates shall include full compensation for preparing shop details where not provided on the Drawings, the supply of all the required materials, fabrication, process control, loading, transporting to the site, off-loading, and erecting. It shall also include full compensation for all nuts, bolts, washers, rivets, cutting, waste, and any temporary bracing necessary for transporting and erecting.

The tendered rate shall also include full compensation for supplying and pouring the specified grout under and around the base plates of steel columns, for procuring and supplying all the necessary labour, constructional plant, tools and materials, as well as waste, formwork for the grout, and finishing to obtain the required surface finish for the grout under and around base plates of steel columns.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.02</td>
<td>Anchor bolts:</td>
</tr>
</tbody>
</table>

(a) (Description of each assembly, and grade/type of steel, diameter and length indicated) ....................... kilogram (kg)

(b) (Description of each assembly, and grade/type of steel, diameter and length indicated) ....................... number (No)

The unit of measurement shall be either the kilogram of installed anchor-bolt assemblies or the number of installed anchor-bolt assemblies.

The tendered rates shall include full compensation for the materials, fabrication, handling, transporting and installing the anchor-bolt assemblies, including corrosion protection.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.03  Corrosion protection:</td>
<td></td>
</tr>
</tbody>
</table>

(a) Sprayed-on metal:

(i) (Type of metal and thickness or type symbol of coating indicated) ....................... tonne (t)

(ii) (Type of metal and thickness or type symbol of coating indicated) ..................... metre (m)

(iii) (Type of metal and thickness or type symbol of coating indicated) ................... number (No)

(b) Hot-dip galvanising:

(i) (Thickness or type symbol of zinc coat indicated) ..................... tonne (t)

(ii) (Thickness or type symbol of zinc coat indicated) .................... metre (m)

(iii) (Thickness or type symbol of zinc coat indicated) .................. number (No)

The unit of measurement shall be either a tonne or a metre of steel structures or articles protected against corrosion, or the number of steel structures or articles protected against corrosion. The quantities are calculated as specified in Item 67.01.

The tendered rates shall be extra over the rates for Item 67.01 and shall include full compensation for applying the specified corrosion protection, including surface preparation, materials, labour, tools, equipment and all incidentals required.

Note: Payment for painting shall be made under Item 59.01.
This Section covers the requirements in regard to the construction tolerances applicable to the various structures and structural members.

Except where otherwise specified, the following aspects of construction to which tolerances apply shall have the meanings attributed to them below:

(a) Position
The position of a structure or structural member shall be the horizontal position of its centre line(s) and/or centre point(s) in relation to the overall layout of the Works as shown on the Drawings.

(b) Alignment
The alignment of a structure or structural member shall be the alignment of its centre line(s) in relation to the overall layout of the Works as shown on the Drawings. Deviation from true alignment shall be measured in degrees of an arc.

(c) Leading and cross-sectional dimensions
The leading and cross-sectional dimensions of a structure or structural member shall be the dimensions relating to width, length, height, thickness, etc, which collectively determine its shape, and are shown on the Drawings. Dimensional tolerances not relating to leading or cross-sectional dimensions shall be shown on the Drawings.

(d) Levels
The level of any structure or structural member shall be the level of the upper or lower surface, as may be relevant, with reference to an established datum-level on the site.

(e) Surface regularity
Surface regularity is the shape of a surface with reference to a 3 m straight-edge (or template in the case of curved surfaces) placed on the surface.

The tolerance for surface regularity is expressed as a distance by which the surface tested may deviate from a straight-edge (or template in the case of curved surfaces) held against the surface.

The tolerances given below shall be the maximum permissible deviations from the specified dimensions, levels, alignment, positions, etc, shown on the Drawings of the structures or structural members.

(a) Foundations

(i) Piles
Position: 0.167 times the diameter of the pile, or 100 mm, whichever shall be the greater

External dimensions:

- Prefabricated piles: +25 mm - 5 mm
- Cast in situ piles: plus-tolerance not specified, minus-tolerance 0 mm

- Pile-head level: Average level of trimmed/cut pile head: ±25 mm

Verticity or rake: 1.5°

(i) Caissons

- Position of top of caisson: 10% of the smallest outer dimension of the caisson, measured in plan.

- Verticity: 1.5°

- Dimensions:
  - Wall thickness: +25 mm - 5 mm
  - Outer dimension of circular, rectangular or square cross-section: ±25 mm

- Level: Upper level of trimmed/cut caisson head:
  - Maximum deviation of average level: ±25 mm
  - Maximum deviation of any individual level: ±50 mm

- Foundation fill:
  - Average level of top of fill: ±25 mm
(b) Footings, pile capping slabs, caisson cover slabs, etc

Position ............................................ 15 mm

Alignment:

Alignment of individual members ............................................. 5°

Alignment of members as they collectively determine the alignment of the structure as a whole ...................................... 1 minute

Dimensions: Leading dimensions in plan ................................. ± 25 mm

Thickness ............................................. ± 25 mm - 15 mm

Levels: Average level of slabs, footings, etc ............................. ± 25 mm

(c) Columns, walls, piers, abutments, etc

Position ............................................. 10 mm

Alignment: Alignment of walls, piers, abutments and column groups ......................................................... 2 minutes

Dimensions:

Leading dimensions of walls, piers and abutments ..................... ± 25 mm

Thickness of walls, piers and abutments and cross-sectional dimensions of columns:

Plus-tolerance ............................................ 25 mm

Minus-tolerance ............................................. 3% of the specified dimensions within the range of 5 mm to 15 mm

Levels: Average level of finished or trimmed/cut columns, piers, walls, abutments, etc ................................. ± 10 mm

Verticality:

(i) Using ordinary formwork .............................. 1 in 400. Maximum 25 mm

(ii) Using sliding formwork ............................. 1 in 200. Maximum 50 mm

Surface regularity:

(i) Using ordinary formwork ............................. 3 mm

(ii) Using sliding formwork ............................. 6 mm

(d) Bridge and culvert superstructure

Position ............................................. 10 mm

Alignment: Superstructure as a whole ................................. 1 minute

Dimensions:

Leading dimensions in plan ............................................. ± 25 mm

Thickness of slabs, width and depth of beams: plus-tolerance .................................. 15 mm

Minus-tolerance ............................................. 3% of the specified dimensions within the range of 5 mm to 15 mm

Surface regularity (all surfaces other than upper surface of deck) ............................. 3 mm

Bridge and culvert decks, surface tolerances:

The tolerances specified in Clause 3405 for the base in respect of level, grade, cross-section and surface regularity shall apply. Surface regularity shall be tested by straight-edge.

(e) Precast beams

The following tolerances shall apply to precast beams in addition to the requirements stated in Subclause 6803(d) for the superstructure.

The width of the gap between contiguous beams shall not exceed twice the width of the specified nominal gap shown on the Drawings or the width of the nominal gap plus 40 mm, whichever is the less, and the overall width between the outermost beams of the bridge deck shall be within 40 mm of the specified width.

Straightness or bow: The deviation from the prescribed line measured on the overall length of the beam shall not exceed the following:

(i) In the horizontal plane:

0.5 mm per metre length of the beam within the tolerance range of 6 mm to 15 mm.

(ii) In the vertical plane:

1. (1) T-beams: 2 mm per metre length of the beam within the tolerance range of 6 mm to 20 mm.

2. Other beams: 1.0 mm per metre length of the beam within the tolerance range of 3 mm to 20 mm.

Camber: The soffits of adjacent beams when placed side by side on the bridge deck shall not at any place differ by more than 2 mm per metre length of the beam within the tolerance range of 6 mm to 20 mm.

The lengths of precast beams before stressing shall be ± 0.1% of the total length within the tolerance range of ± 5 mm to ± 20 mm.

Surface regularity ..................................... 6 mm

(f) Reinforcing steel

Except for the requirements given below, no tolerances are given for the placing and fixing of reinforcing steel. The steel, however, shall be neatly and accurately fixed in a
manner which is consistent with proper workmanship and the structural integrity of the structural member. Specifically, the following requirements shall apply:

(i) Tension steel

The actual position of tension steel shall not deviate from the true position by a distance which would reduce the effective lever arm by more than 2% of the overall depth of the member, or 10 mm, whichever is the greater.

(ii) Concrete cover

The concrete cover on reinforcing steel shall nowhere be less than the specified cover.

(iii) Spacing between bars

The spacing between closely spaced parallel bars, especially in beams and columns, shall, unless otherwise specified, be not less than the maximum size of the aggregate used in the concrete.

(iv) Bending of reinforcement

The requirements of SABS 82 or equivalent regarding dimensional tolerances for cutting and bending of the reinforcing steel shall apply, with the proviso that the other requirements set out in this Clause shall be complied with even if the tolerances in SABS 82 or equivalent are not exceeded.

(g) Prestressing

Sheaths for prestressing tendons shall be placed and maintained in position within the following tolerances:

In the direction of the width of the member:

For members of up to 200 mm in depth . . . . ± 20 mm

For members exceeding 200 mm in depth . . . . ± 10 mm

In the direction of the depth of the member:

For members of up to 200 mm in depth . . . . . . . . . ± 0.025 x depth

For members exceeding 200 mm in depth . . . . . . . . . ± 0.01 x depth within the tolerance range of ± 5 mm to ± 25 mm.

(h) Bearings

Bearings for structures shall be installed to within 5 mm of the position shown on the Drawings and to within 2 mm of the required level.

Dimensional tolerances for elastomeric bearings shall comply with the requirements of BS 5400 Part 9.2.

(i) Miscellaneous

(i) Chamfers

Fillets used for forming chamfers shall be within a tolerance of 1.0 mm in cross-sectional dimensions, and the actual chamfer on the concrete shall not vary by more than 3 mm from the specified dimensions.

(ii) Kerbs, copings, sidewalks, bridge railings, parapets, etc

The members shall be constructed within a tolerance of ± 5 mm for all dimensions. The alignment shall not deviate from the true alignment by more than 10 mm in any place, nor shall the alignment deviate by more than 5 mm from the true alignment over any length of 5 m.

(j) Fabrication and assembly tolerances for structural steel

(i) General

The fabrication and assembly tolerances on all dimensions for structural steel shall be ± 2 mm. Holes for connections shall be drilled/punched and aligned as specified in Subclauses 6705(d) and (g) respectively.

(ii) Cross-section

The tolerances on cross-sectional dimensions of rolled sections shall be as specified in the Structural Steel Tables, published by the SA Institute of Steel Construction or equivalent.

(iii) Straightness

A structural member before erection shall not deviate from straightness (or the specified shape) by more than the following:

For compression members and beams, one-thousandth of the length between points which are laterally restrained.

For other members, one five hundredth of the overall length, but not exceeding 25 mm.

(iv) Length

The length of a member shall not deviate from its prescribed length by more than the following:

For compression members faced at both ends for bearing, ± 1.0 mm

For other members, ± 0 mm, - 4 mm

For such members as trusses and lattice girders, the above tolerances shall apply to the members as a whole. The lengths of component parts shall be such that the structural member can be properly assembled with the required accuracy.

(v) Bearing surfaces

Where two steel surfaces are required to be in contact for transferring compressive forces, the maximum clearance between the bearing surfaces shall not exceed 1.0 mm when the members in contact are aligned.

(vi) Accuracy of erection

Steelwork shall not be out of plumb over any vertical distance by more than 5 mm or one thousandth of the distance, whichever is the greater.
(k) Fabricating and construction tolerances for reinforced-earth structures

(i) Individual concrete panels:

Surface regularity:

When tested with a 1.5 m straight-edge, the deviation shall not exceed 5 mm.

Leading dimensions ...................... ± 5 mm

(ii) Completed walls:

Surface regularity:

When tested with a 3 m straight-edge, the deviation shall not exceed 20 mm.

No point of the structure shall be out of position vertically by more than 10 mm per metre height of the structure, with a maximum of 50 mm.
SERIES 7000

TESTING AND QUALITY CONTROL

7100    Testing material and workmanship
7200    Quality control
SERIES 7000 : TESTING AND QUALITY CONTROL

SECTION 7100 : TESTING OF MATERIALS AND WORKMANSHIP

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7101 SCOPE

During the progress of the work tests shall be conducted on materials and workmanship to ensure compliance with the requirements of the specifications.

Certain sampling and testing procedures not covered in the other Sections of the Specifications by reference to the standard methods mentioned in Clause 7102, are given in this Section.

7102 TESTING METHODS

All tests shall be conducted in accordance with the standard methods specified in the following, in order of precedence unless otherwise stated in the text:

(a) The Specifications of the American Association of State Highway and Transportation Officials (abbreviated as AASHTO).

(b) The Specifications of the American Society for Testing and Materials (abbreviated as ASTM).

(c) British Standards Institute Specifications (abbreviated as BS).

(d) The Technical Methods for Highways (TMH) series and the Technical Recommendations for Highways (TRH) series, published by the Committee of State Road Authorities, South Africa.

(e) South African Bureau of Standards Specifications (abbreviated as SABS).

(f) Test methods prescribed by the Southern African Bitumen and Tar Association (abbreviated as SABITA).

In addition to the above standard methods of testing, standard specifications or test methods of other bodies may also be referred to in these Specifications, or test methods may be described where no acceptable standard methods exist.

Note: Significant differences can exist between various test methods, particularly compaction efforts specified by various Authorities and the Liquid Limit carried out using the AASHTO and the BS equipment and methods. The AASHTO Liquid Limit device shall be used for all testing pertaining to these Specifications. All CBR tests relate to material compacted to the maximum dry density obtained using Modified AASHTO effort (AASHTO T-180, ASTM D1557 or TMH 1 (Test A8).

In all cases the latest amendment or revision current at the closing date of the tender is implied when reference is made to one of the above standards in the Specification.

7103 THE COSTS OF TESTING

(a) Process control

The cost of testing undertaken by the Contractor in terms of his obligations under Clause 1205 for purposes of process control, including the taking of samples, reinstating where samples have been taken, and all testing equipment, labour, materials, etc, shall be included in the rates tendered for the various items of work supplied and will not be paid for separately.

(b) Producing certificates

Where the properties of materials or manufactured products are required in these Specifications to comply with specified specifications published by a Standards Authority, the Contractor shall produce, when called upon to do so, certificates from the manufacturer confirming that the materials or products supplied comply with the relevant specifications. The cost of providing such certificates shall be borne by the Contractor.

(c) Testing materials and products covered by certificates

The Engineer shall be entitled to take samples of and order tests to be made on products and materials in respect of which certificates of compliance may be required as described in Subclause (b) above. The Contractor shall be paid at the appropriate rates if the cost of such tests are itemised in the Schedule of Quantities, and, if no appropriate rates exist, such tests shall be classed as extra work under the relevant Clause of the General Conditions of Contract, provided that such tests indicate compliance with the Specifications, otherwise the cost shall be borne by the Contractor.

7104 TAKING AND SUBMITTING SAMPLES

Where the Contractor is required in these Specifications to submit samples of materials or mixtures to the Engineer for approval prior to their being used in the Works, the use of these materials or mixtures without the Engineer's written approval shall constitute default on the part of the Contractor, who shall be liable for the consequence of such default. All samples shall be submitted in sufficient time for proper testing.
The Engineer’s approval of any materials or mixtures shall in no way relieve the Contractor of his obligation to provide materials, mixtures and workmanship which comply with the Specifications.

All samples for testing shall be taken in a random pattern or as prescribed by the Engineer. Where specified or required by the Engineer, stratified random sampling methods shall be followed. For the testing of layerwork stratified random sampling methods shall be used for obtaining all the sample portions and for determining the locations of in situ test sites.

The method of taking samples shall be as specified in the appropriate sampling and testing methods. The sampling methods described in TMH5 shall apply where no other methods are available.

The Engineer shall have full access to the Works for the purpose of taking samples. The Contractor shall render any assistance necessary for taking the samples and shall be responsible for the reinstatement of pavement layers or other structures at the positions where the samples have been taken. Full compensation for rendering assistance with sampling and for reinstatement where samples have been taken shall be included in the rates tendered for the various items of work tested, and no additional payment will be made in this respect.

Table 7104/1 (at the end of the Section) provides guidelines in respect of submitting the materials in regard to the time and quantity of material required for testing, approval and the mix design. As the time stated in this Table does not make any allowance for possible rejection and the resubmission of alternative materials, the Contractor shall submit any doubtful materials at an early stage or together with alternative materials in order to minimise any delays in final approval.

The Contractor shall note that any samples submitted direct to the Engineer’s laboratory for approval shall be accompanied by a covering letter signed by the Engineer.

### 7105 TESTING THE AGGREGATES

**(a) General**

Aggregates shall be regularly tested by the Contractor as part of his process control as they are being manufactured or brought onto the site and used or taken to stockpile.

The appropriate test methods shall be those included under Clause 7102 or any other relevant tests authorised by the Engineer.

**(b) Determining acid insolubility**

A sample of fine aggregate with an approximate mass of 1.0 kg shall be dried and weighed. The sample shall then be treated with an adequate amount of a 6 N solution of hydrochloric acid to react with all the acid-soluble particles in the sample. When the reaction is complete, the residue shall be removed from the solution by filtration (Whatman No 4 filter paper), washed with water, screened through an 0.075 mm sieve, dried and weighed. The mass of insoluble residue retained on the 0.075 mm sieve, expressed as a percentage of the total sample, shall be reported as the acid-insoluble content.

**(c) Free-water content**

The free-water content of aggregate shall be determined in accordance with SABS Method 855 or equivalent. Rapid-testing methods approved by the Engineer may also be applied.

Suitable adaptations of the above method may be used for determining the free-water content of course aggregate.

**(d) Bulking the fine aggregates**

The bulking of fine aggregates shall be determined in accordance with SABS Method 856 or equivalent.

**(e) Determining the effect of sand on the water demand of a concrete mix.**

Water demand is defined as the quantity of water per cubic metre of concrete required to give a slump of 75 mm in a concrete with an optimum quantity of stone with a nominal size of 19 mm.

The following materials are required:

- Ordinary Portland cement
- Crushed stone with a nominal size of 19 mm
- Sand or a sand mix to be tested.

**(i) Method:**

- Determine the relative density \( R_{sp} \) in accordance with SABS Method 844 or equivalent and the fineness modules (FM) of the sand or sand mix.
- Determine the compacted bulk density (CBD) of the 19 mm aggregate in accordance with SABS Method 845 or equivalent. Also determine the relative density of the stone (\( R_s \)).
- Determine the required quantity of stone (S) per cubic metre of mix (in kg/m³) in accordance with the formula:
  \[
  S = CBD \left( 0.975 - 0.1FM \right).
  \]
- Estimate the water demand (W) of the mix (in l/m³). 220 l/m³ may be used as a starting point.
- Determine the required cement content (C) for the mix (in kg/m³) by using the water content (W) as obtained from (4) and a water:cement ratio of 0.59.
- Determine the required sand content (SC) of the mix (in kg/m³) in accordance with the formula:
  \[
  SC = 1 - (C/3140 + W/1000 + S/Rst).
  \]
- Decide on the mix size which will apply to the available equipment and calculate the mix quantities in relation to the calculated quantities per cubic metre. Do not produce a mix of less than 10 l.
- Prepare the mix and determine the slump in accordance with SABS Method 862 or equivalent. Where the slump does not amount to 75 mm, repeat the test with adjusted quantities of cement, water and sand. A good rule to remember is that a change of 10 l/m³ in the water content either halves or doubles the slump.
- The water content giving a slump of 75 mm will then be the water demand for the mix.
- In view of obtaining repeatable results, the following parameters shall be kept constant in so far as is possible:
  - Material temperature
  - Mixing time
  - Source of cement and stone

(f) Accelerated-test method for determining the potential alkali reactivity of aggregates

(i) The method

Three motor prisms shall be prepared in accordance with the requirements of ASTM C 227-90. The prisms shall be removed from the mould after 24 hours and immersed in water in a closed container, placed in an oven and kept at a constant temperature of 80°C. After 24 hours in the oven, the prisms shall be taken to a room with a temperature of 23°C, where their lengths are measured with a vertical comparator (an indicator type of deformation meter) accurately to 2 \( \mu \)m before any significant cooling-down takes place.

This reading will be taken as the nil reading. After the initial reading has been taken, the prisms are immersed in a 1 N NaOH solution kept at 80°C. This solution is kept in a plastic container which seals tightly and is large enough for the prisms to be completely immersed. Plastic is used, as the caustic solution corrodes glass and metal. The prisms are measured every working day for a period of 14 days at a room temperature of 23°C, and their linear expansion is calculated. The average expansion of the three prisms for each day is then calculated. Where none of the values deviate by more than 15% from the average, the repeatability is regarded as being satisfactory. The average expansion after 10 or 12 days is taken to be the reference value for determining the potential alkali reactivity.

(ii) Criteria

The criteria proposed provisionally for the accelerated mortar-prism testing method shall be prescribed in Table 7105/1.

(iii) Interpretation

For aggregates falling in the slowly expanding group, the alkalinity per m³ of concrete shall not exceed 2.8 kg of an Na₂O equivalent.

For aggregates falling in the rapidly expanding group, the alkalinity per m³ of concrete shall not exceed a value of 2.1 kg of an Na₂O equivalent per m³, depending on the reactivity.

The dilution and palliative effect of extenders in the cementitious binders, such as slagment (where permitted in structural concrete) and fly ash, shall be taken into account in the interpretation of the results.

7106 TESTING THE CONCRETE

(a) Determining the compressive strength

The procedure for sampling and manufacturing, storing, curing and testing test cubes shall be in accordance with TMH1 Method D1.

Table 7105/1
Criteria for mortar-prism testing

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Limit</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of linear expansion after 10 days</td>
<td>&lt;0.08</td>
<td>Alkali reactivity is not harmful</td>
</tr>
<tr>
<td>but</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;0.20</td>
<td></td>
<td>Alkali reactivity is harmful and aggregate is expanding slowly</td>
</tr>
<tr>
<td>≥0.20</td>
<td></td>
<td>Alkali reactivity is harmful and aggregate is expanding rapidly</td>
</tr>
<tr>
<td>Percentage of linear expansion after 12 days</td>
<td>&lt;0.10</td>
<td>Alkali reactivity is not harmful</td>
</tr>
<tr>
<td>but</td>
<td>&lt;0.25</td>
<td>Alkali reactivity is harmful and aggregate is expanding slowly</td>
</tr>
<tr>
<td>≥0.25</td>
<td></td>
<td>Alkali reactivity is harmful and aggregate is expanding rapidly</td>
</tr>
</tbody>
</table>

Where instructed by the Engineer, the compaction of concrete specimens in the moulds by means of a vibrating table shall be obligatory. The method of compaction shall be as follows:

(i) Plastic concrete

Fill the mould halfway and vibrate it and spade it on all four sides with a suitable trowel to remove air bubbles. Stop the vibration as soon as a wet sheen appears on the surface. Fill the mould and repeat the procedure, but stop when again a wet sheen appears on the surface.

(ii) Stiff concrete

The same procedure is followed, except that the mould is filled in three to four steps instead of in two. The vibration is stopped for each layer when a wet sheen appears.

(b) Consistency

The test method described in TMH1 Method D3 shall apply in regard to the slump test, and the method described in BS 881 (Part 104) in regard to the VEBE test.

(c) Air content

The air content of the freshly mixed concrete shall be tested by the method given in TMH1 Method D5. Air-content tests shall be conducted on the same samples of concrete from which cubes were made for the 28-day compressive-strength tests.

(d) Drilling and testing the cores

Where sections of concrete which have failed to comply with the Specifications are required to be further investigated by extracting and testing concrete cores, 100 mm or 150 mm cores shall be drilled and tested. The sampling and testing procedure to be followed shall be in accordance with the publication Concrete Core Testing for Strength - Concrete
The instructions of this report shall be followed for determining the "estimated potential strength", which shall be compared with the 28-day cube strength specified for each type of concrete. Corrections to the actual core strength to allow for excess voidage, included steel and the length:diameter ratio of cores shall be as stated in this publication, and the correction for curing shall be determined by the Engineer in accordance with this publication and such other information as he may deem to be appropriate.

The Engineer's decision regarding the degree to which the concrete which is represented by the cores tested as described above, complies with the requirements and also regarding the properties and suitability of the concrete, shall be final and binding.

(e) Flexure strength test (modulus of rupture)

The procedure for sampling, making tests beams, curing, storing and testing, and the moulds used, shall be in accordance with SABS Method 864 or equivalent.

(f) Curing concrete cubes to attain accelerated strength development (55°C/20 hours)

(i) Scope

A method is described for curing concrete cubes at 55°C for 20 hours with a view to pre-estimating the 28-day compressive strength for purposes of quality control.

(ii) Apparatus

The following apparatus is required:

- Apparatus for preparing the concrete cubes in accordance with Method D1 of TMH1
- Plastic sheets of 180 mm x 180 mm
- Hessian sheets for covering the samples
- A suitable water bath with a thermostat to maintain the temperature constantly at 55°C ± 1°C, with a circulation system and adequate capacity.

(iii) Method

- Prepare the required number of concrete cubes in accordance with Method D1 in TMH1 and completely cover the exposed surface within the cube mould with small plastic sheets and then with wet hessian. Keep it covered for 3 hours ± 15 minutes.

- Place the concrete cubes into their moulds in the hot-water bath at a rate which will not allow the water temperature to drop below 54°C. Record the exact time when each cube is placed into the water and leave it in the water at a temperature of 55°C ± 1°C for 20 hours ± 15 minutes.

- Remove the cubes, in their moulds, from the water and then carefully from their moulds. Cool the cubes for 2 hours ± 15 minutes in water at 20°C ± 5°C.

- Test the compressive strength of the cubes in accordance with Method D1 of TMH1.

(iv) Calculating the compressive strength

The cube compressive strength is calculated in accordance with Method D1 of TMH1. For calculating the expected 28-day compressive strength, the ratio between the 28-day compressive strength and the strength of rapid-hardening cubes shall be determined for each type of concrete mix by correlation techniques.

For purposes of the initial work, it is mentioned that research has shown that the strength of the cubes treated and tested as described above will be approximately 0.58 times the 28-day compressive strength for concrete cubes prepared from ordinary Portland cement (for strengths between 30 and 65 MPa). For rapid-hardening cement, the corresponding factor is 0.59, and for PBFC it is 0.66.
(b) **Approximate dry bulk relative density**

The total approximate dry bulk relative density of base material shall be determined as follows:

- The -0.075 mm fraction is removed from the sample and then the sample is divided up into +4.75 mm and -4.75 mm fractions.
- For the +4.75 mm fraction the dry bulk density and water absorption are determined according to Method B1 of TMH1.

The apparent relative density only is required for the -4.75 mm fraction.

(i) **Definitions**

The definitions in Methods B14 and B15 of TMH1 are applicable.

(ii) **Apparatus**

(1) +4.75 mm fraction

The same apparatus as that required by Method B14.

(2) -4.75 mm fraction

- A 2 l pycnometer.
- A balance with a capacity of at least 5 kg and accurate to 0.5 g.
- A vacuum pump capable of maintaining a reduced pressure of 100 mm mercury.
- A water bath capable of maintaining a temperature of 25°C ± 1°C.
- A drying oven, thermostatically controlled and capable of maintaining a temperature of 105°C to 110°C.
- A 25 ml pipette.
- A 0.075 mm sieve.

(iii) **Method**

(1) +4.75 mm fraction

The method is the same as Method B14.

(2) -4.75 mm fraction

- After riffling, the volume of the sample shall be 40% ± 5% of that of the pycnometer.
- Wash the sample thoroughly to remove the -0.075 mm fraction and soak the sample for 24 hours ± 4 hours.
- After the sample has been soaked, transfer it to a clean pycnometer.
- Add distilled water to the sample in the pycnometer until the pycnometer is approximately three-quarters full. Remove any entrapped air by subjecting the sample to partial vacuum (air pressure approximately 100 mm mercury) for a few minutes. This can be done by connecting the pycnometer directly to an aspirator or a vacuum pump, or by using a bell jar. Some soils boil violently when subject to reduced air pressure, in which cases the pressure should be increased. Place the pycnometer and contents in the constant temperature bath at 25°C ± 1°C and leave it for approximately 20 minutes until the contents of the pycnometer are at this temperature.

- With a pipette, fill the pycnometer up to the mark with distilled water at 25°C. Dry the pycnometer quickly and thoroughly, and weigh it.
- Gently pour off the water without spilling any of the sample. Dry the pycnometer with its contents to a constant mass in an oven at 105°C to 110°C and weigh it.
- Clean the pycnometer, fill it with distilled water at 25°C, dry the outside, and weigh it.
- Record the mass determinations on a suitable data sheet.

(iv) **Calculations**

(1) +4.75 mm fraction

- Calculate the dry bulk relative density (25°C) to the nearest 0.001 g/cm³ from the following formula:

\[ G_{bc} = \frac{a}{b-c} \]

where

- \( a \) = mass of oven-dry sample in air
- \( b \) = mass of saturated surface-dry sample in air
- \( c \) = mass of saturated surface-dry sample in water at 25°C.

- The test shall be repeated if the duplicate results do not agree within ± 0.005. Report the result to the nearest 0.001 g/cm³.

- Calculate the percentage of water absorbed (Pwa) (mass) from the following formula:

\[ P_{wa} = 100 \frac{(b - a)}{a} \]

- Report the result to the nearest 0.1%.

(2) -4.75 mm fraction

- Calculate the apparent relative density (25°C) to the nearest 0.001 g/cm³ from the following formula:

\[ G_{af} = \frac{A - E}{(D - E) - C - A} \]

where

- \( A \) = mass of oven-dry sample and pycnometer
- \( C \) = mass of saturated sample and pycnometer filled with water at 25°C
- \( D \) = mass of pycnometer filled with water only, at 25°C
- \( E \) = mass of clean, dry pycnometer.

- The test shall be repeated if the duplicate results do not agree within ± 0.005. Report the result to the nearest 0.001 g/cm³.

- Calculate the dry bulk relative density (25°C) of the -4.75 mm fraction from the following formula:

\[ G_{bf} = \frac{G_{af}}{P_{wa} \cdot G_{af}/100 + 1} \]

- Calculate the dry bulk relative density (25°C) of the total sample less the -0.075 mm fraction from the following formula:
Gb = 100/(P1/Gbf + P2/Gbs)

where

P1 = percentage passing through the 4.75 mm sieve
P2 = percentage retained on the 4.75 mm sieve.

(v) General requirements

The standard temperature is taken as 25°C. If the test is conducted at any other temperature, this shall be stated, or the relative density shall be adjusted for a temperature of 25°C.

The relative density of material retained on the 4.75 mm sieve can also be determined by using a pycnometer. The volume of the pycnometer should not be less than 2 G52 (the volume occupied by the aggregate shall be 40% ± 5% of the pycnometer capacity).

The pycnometer may be a relative-density flask with a perforated glass stopper, or a volumetric flask, or any other glass container equipped with a suitable means of ensuring that it can be filled to a constant volume.

When the particle size of the -4.75 mm grains is widely distributed, the test may not be repeatable and more samples shall be tested.

The apparent relative density (25°C) of the +4.75 mm fraction is not called for, but if required, it can be calculated from the following formula:

\[ G_{ac} = \frac{a}{(a - c)} \]

(c) Apparent density

The apparent density of crushed-stone materials shall be determined as follows:

(i) Apparatus

- A balance to weigh 5 kg accurately to within 0.5 g.
- A pycnometer, eg a preservative jar with a smooth flat rim.
- A thermostatically controlled bath capable of maintaining a temperature of 25°C ± 1°C.
- A drying oven capable of maintaining the temperature between 105°C and 110°C.
- A thermometer marked from 0 - 100°C.
- Towels.
- Teepol (10%) solution.

(ii) Method

- Take 3 000 g - 4 000 g of the material as obtained from a density hole in the road. All the material obtained from the hole should preferably be used. If it is too much for one pycnometer, more than one pycnometer shall be used.
- Dry the material in the oven at 105°C - 110°C to a constant mass.
- Ensure that the pycnometer is clean and determine its mass together with that of a marked sheet of glass.
- Place the dried sample into the pycnometer and determine the mass of the pycnometer, glass sheet and sample together. (The sample should not take up more than half of the pycnometer's volume.)

- Add clean water at 25°C to the pycnometer until it is approximately three quarters full. Add three drops of the 10% Teepol solution to the water, close the pycnometer and shake it thoroughly for one or two minutes.

- Fill the pycnometer to near the brim with water at 25°C and place it in a thermostatically controlled bath at 25°C. Leave it for 30 minutes without disturbing or for so long as may be determined by the Engineer.

- Remove the pycnometer without shaking or jarring and place it on a spread-out towel. Fill it with water at 25°C and carefully slide the glass sheet over the brim from one side. Make sure that no air bubbles are trapped beneath the glass sheet. Dry the entire pycnometer and glass sheet carefully and determine the mass of the filled pycnometer plus the glass sheet.

- Remove the contents of the pycnometer, clean and fill it in the same manner with water at 25°C. Dry and determine the mass of the pycnometer filled with water together with the glass sheet.

(iii) Calculation

- The apparent density of the material is calculated as follows:

\[ \text{Apparent density of material} = \frac{(b - a)}{(d - a - (c - b))} \times 1000 \]

where

\( a = \) mass of pycnometer + glass sheet
\( b = \) mass of pycnometer + glass sheet + material
\( c = \) mass of material only
\( d = \) mass of pycnometer + water + glass sheet

Notes:

(i) No chemicals other than the Teepol solution may be added to the water.
(ii) No suction may be applied to the water to remove air.
(iii) The temperature of the water shall be 25°C ± 1°C and no other temperature may be used.
(iv) Where two pycnometers are used, the apparent density shall be calculated from the weighted average of the two results.
(v) The soaking period will be determined by the Engineer for aggregate, the water absorption of which exceeds 1.0%.

(d) Determining the durability of aggregate

The test method provides a measure of the ability of an aggregate to withstand degradation both during construction
and under various service conditions. It also furnishes additional data pertaining to the quality of the material and the possible change in index properties likely to occur in the road and be detrimental to its performance.

(i) Definition

The Durability Mill values are taken as the mass of dry material passing the 0.425 mm sieve after treatment, expressed as a percentage of the original dry mass of the sample. The Durability Mill Index (DMI) value is taken as the product of the highest Durability Mill Value for any treatment and the highest Plasticity index for any treatment.

(ii) Apparatus

A Durability Mill which shall conform in all its essential dimensions to the design shown in Figure 7101. The machine shall consist of a watertight steel cylinder, closed at one end, with internal dimensions of 250 mm diameter and 264 mm length. The cylinder is fitted with a removable cover and watertight gasket and is mounted on a rigid support in such a way that it may be rotated about a central axis in a horizontal position. A steel baffle, projecting 80 mm into the cylinder and 264 mm in length is welded along one element of the interior surface of the cylinder. The baffle shall be of such thickness and so mounted as to be rigid. The machine should be driven by a motor capable of maintaining a uniform speed of 60 rpm.

An abrasive charge of six steel spheres approximately 46 mm diameter and with a mass of 410-455 g. The total abrasive charge will be 2600 g ± 50 g.

- Balances
  - measuring up to 20 kg, accurate to 5 g - for sample preparation
  - measuring up to 5 kg, accurate to 1 g - for sieve analysis
  - measuring up to 100 g accurate to 0.01 g - for Atterberg limits.
- Sieves as recommended in TMH1 Method A1.
- An oven with a temperature range of 40°C to 110°C ± 5°C.
- Equipment for Atterberg limit tests to Methods AASHTO T-89 and T-90 or Methods A2, A3 and A4 of TMH1.
- A 0.425 mm sieve protected by 2.0 mm sieve is used.
- A riffler.
- A wash bottle with distilled water.
- Brushes
  - A hard-bristle brush
  - A soft-bristle paint brush, 50 mm wide.

(iii) Method

- Obtain a representative sample of not less than 20 kg and dry at a temperature not exceeding 50°C. The bulk sample should normally be material less than 37.5 mm but if oversized aggregate is present, it should be crushed to pass 37.5 mm and added back to the sample after drying. The crushing of any oversized aggregate should be noted when reporting the results.
- The bulk sample shall be reduced to 15 kg ± 1.0 kg by riffling. The sample shall then be further riffl ed to provide four representative sub-samples each weighing 3.750 kg ± 250 g. If these weight limits are exceeded, then the sub-samples should be recombined and re-riffled.
- The sub-sample obtained should then be clearly marked to avoid confusion during further testing (ie A, B, C and D).

(1) Sub-sample A (Reference)

This is a reference sample for standard grading and Atterberg limits according to TMH1 Methods A1, A2, A3 and A4.

(2) Sub-sample B (Wet Ball Mill)

- Place the sample in a pan of suitable size and measure out 2.5 l of water. Use enough of the water to cover the sample and allow to soak for one hour. The remainder of the water should be retained for washing the sample into the Durability Mill prior to testing.
- After soaking decant off the excess water and combine with the remainder of the 2.5 l for washing purposes.
- Wash the soaked sample into the Durability Mill using all the remaining water from the first step and ensure that the whole sample is transferred without loss of fines.
- Add the six steel spheres to the sample and water in the Durability Mill and secure the watertight cover.
- Operate the Durability Mill for 10 minutes (i.e. 600 revolutions at 60 rpm).
- On completion of the rotations the apparatus is tilted to the upright position and the cover is released. The steel spheres are rinsed clean in the water of the mill and removed.
- A drying container capable of holding up to 10 l of sample and washing water is placed under the mill cylinder.
- A 0.425 mm sieve protected by 2.0 mm sieve is placed in the drying container.
- Tilt the mill cylinder so that the water passes through the sieves and into the container. Using the minimum amount of excess water possible, wash the remaining sample through the sieves. This operation should be carried out incrementally so as not to damage the 0.425 mm sieve.
- The washed material retained on the 0.425 mm sieve shall be transferred to a separate drying container.
- When all the sample has been washed from the Durability Mill through the 0.425 mm sieve, the coarse, and fine fractions plus the washings, shall be placed in the oven and dried at 105°C - 110°C to constant mass.
- The dried fines should be prepared as in AASHTO T-87 or TMH1 (Method A1) for Atterberg limit tests.
- The total mass of prepared fines is recorded and is then riffled to obtain a representative sample of approximately 100 g for testing. The actual mass of fines tested is recorded, and the fraction passing 0.075 mm (Y) is obtained by wet analysis (ie AASHTO T-87 or TMH1 Method A1). The mass of
fines passing 0.075 mm is then corrected back to the actual mass using the factor $X$:

$$X = \frac{\text{Total mass of fines}}{\text{Mass of fines used}} (Y)$$

then actual % passing 0.075 mm =

$$\frac{Y}{\text{Sample mass}} \times 100 \%$$

The remaining fines are used for Atterberg limit tests to Methods AASHTO T-89 and T-90 or A2, A3 and A4 of TMH1.

- The grading of the coarse and fine fraction should be recorded together.

(3) Sub-sample C (Dry Ball Mill)
- Place the dry sample in the dry Durability Mill taking care to brush all the dust and fines into the mill.
- Add the six steel spheres, secure the cover and rotate for 10 minutes (NB do not add water to this sub-sample).
- After testing is complete, the mill is left in an upright position for five minutes to allow the dust to settle and the cover is removed.
- Remove and brush the steel spheres.
- Carefully brush the dry sample from the cylinder and retain for a dry grading of the fraction retained on the 0.425 mm sieve. A dry grading is recommended especially for moisture sensitive materials such as mudrocks and some pedocretes.
- The passing 0.425 mm fraction shall then be treated as for the previous sample to determine the Atterberg limits.

(4) Sub-sample D (Wet Mill)
The same procedure as for Sub-sample B is followed except that the six steel spheres are omitted.

(5) Results
The Durability Mill Value shall be calculated for sub-samples B, C and D, as the mass of dry material passing the 0.425 mm sieve expressed as a percentage of the original dry mass of the sub-sample.

The Durability Mill Index shall be calculated as the product of the highest Durability Mill values for any of the treatments (B, C or D) and the plasticity index.

Notes:
(i) The mass of the steel spheres should be checked periodically for loss due to wear.
(ii) If it is necessary to check the passing 0.425 mm fraction for accuracy before treatment of the sub-samples, then a dry sieving technique should be used. Variance of less than 3% between the sub-samples should be achieved.
(iii) It is important that the same operator performs all grading and Atterberg limit tests for each sub-sample.
(iv) The coarse fraction should be dried overnight to constant mass and removed from the oven for grading to TMH1 requirements. Any additional material passing 0.425 mm should be added to the dried fines. A drying time of 48 hours for the fines may be required.

7108 TESTING TAR, BITUMEN AND ASPHALT

(a) Tests described in the Standard Specifications for tars, bitumens and bituminous emulsions
The Engineer shall be entitled to order the Contractor to have materials tested by an approved laboratory for compliance with all or any of the requirements specified, and the results of such tests shall be submitted direct to the Engineer by the testing laboratory with copies, if requested, to the Contractor.

The cost of such tests shall be borne as specified in Subclause 7103(c).

(b) Determining the film thickness
The film thickness of the binder in asphalt mixes shall be determined as described in TRH8.

(c) Field calibration of distributor
(i) Apparatus
- 4 x 10 ft drums with a cross section of approximately 350 mm
- 15 kg balance accurate to 1.0 g
- asbestos gloves
- solvent for cleaning the drums for re-use
(ii) Method
- Mark each drum clearly at the bottom and determine the weight of each drum.
- Ensure that the binder and the spray bar are at the correct spraying temperature.
- Place one drum under each of the extensions of the spray bar and two drums under main portion of the spray bar.
- The drums should be on suitable stands (eg bricks), so that three nozzles can spray directly into each drum.
- Nozzles adjacent to the sides of the drums should be rotated so that binder will not be spilt outside the drums.
- Open the spray bar and spray between five and eight litres of binder into each drum. Care should be taken to ensure that the binder is at the correct temperature and is sprayed at the specified pressure.
- Weigh the drums and calculate the variation.
7109  TESTS RELATING TO CHEMICAL STABILISATION

(a)  Test for cementitious-binder content

The test method used for determining the cementitious-binder content of soils, gravels or crushed stone mixed with a chemical stabilising agent shall be determined by the Engineer and may be any test method currently recognised by the Employer as being acceptable.

Where the cementitious-binder content is determined, due allowance shall be made for the presence in the unstabilised material of naturally occurring MgO or CaO which affects the result of such tests. If the standard deviation of the natural CaO plus MgO content of the untreated material exceeds 0.35%, any determination of the cementitious-binder content shall be ignored.

Sample holes shall be randomly spaced transversely as well as longitudinally over the area to be tested, or as directed by the Engineer, and if the material is road-mixed, samples shall be taken from the top and bottom of each hole. The minimum number of samples per test shall be 10.

(b)  Canvas-patch test for the spreading rate of cementitious binder

The following method shall be used for determining the spreading rate of a chemical stabilising agent where bulk distributors are used.

At least 10 clean canvas patches, each measuring 1.0 m x 1.0 m, shall be placed flat on the road in selected positions in relation to the bulk distributor's track. After the stabilising agent has been spread by the bulk distributor, the canvas patches shall be carefully lifted and all the material on the patches transferred to a container and weighed. The total mass of stabilising agent on each patch is then recorded and the average rate of application determined. Instead of canvas patches, flat metal trays may be used for collecting the stabilising agent.

(c)  Tests for mix uniformity in chemically stabilised layers

Where required by the Engineer, the Contractor shall determine the mix uniformity in chemically stabilised layers by means of unconfined compressive strength tests, using an approved method.

The Contractor shall timeously make the necessary arrangements to take samples in accordance with the requirements of the method used.

(d)  Test for the initial consumption of lime

This test is known as the "gravel ICL" and tests the construction material as a whole (crushed to pass a 19 mm sieve).

(i)  Objective

The objective of the gravel ICL test is the control of the pH in lime and cement stabilized soil in order to allow the possible formation of cement minerals, calcium silica hydrate in particular, and for proper modification to take place. It is recommended that the stabiliser to be used during construction (or the nearest equivalent) should be used to carry out this test.

(ii)  Apparatus

- balance (accuracy : 0.1g)
- pH meter (accuracy : 0.02 units)
- six plastic beakers (150 ml, tall)
- spatula or pallet knife
- soft tissues
- glass beaker (200 ml)
- distilled water
- stabiliser to be used
- jet bottle (for cleaning electrode)
- drying oven (105 - 110°C)
- thermometer (accuracy 0.5°C)
- sample riffler of splitter (25 mm openings approx. are sufficient in general)

Coning and quartering may also be employed

(iii)  Preparation of soil samples

- The test is carried out on 2 kg of material finer than 19 mm. Any oversize material is crushed to pass 19 mm.
- Oven dry the sample at 105 - 110°C.
- The sample is further reduced to 300 g quantities by means of sample splitters or coning and quartering and placed into 150 ml (or larger) plastic containers.

(iv)  Method

- Since most materials required between 2 and 5 per cent lime, it is advisable to set up six beakers with lime percentages of 1; 2; 3; 4; 5 and 6 of the dry soil mass, i.e. 200 g soil + 2; 4; 6; 8; 10 and 12 g of Ca (OH)\textsubscript{2}. This will ensure, in most cases, that the percentage of lime required can be determined in one hour.
- Measure out the lime to the nearest 0.1 g and add it to the soil.
- Mix the soil and dry lime.
- Slightly over-saturate samples with distilled water. The material shall be judged over-saturated when the pores of the material are water filled and free water can be observed on the surface of the mix. The surface particles need not be submerged completely.
- Mix for 30 seconds every 10 minutes.
- After one hour, measure the pH by inserting the pH electrode gently into a hole made in the material with a spatula to a depth of about 20 - 30 mm and gently covering this part of the electrode with material. Tap the beaker gently for contact between electrode and material. The pH meter must be equipped with a "Hyalk" electrode and standardised with a buffer solution having a pH of 12.
- Record the pH of each of the soil/lime/water mixtures. The lowest percentage lime at which the pH remains constant is the saturation lime content of this particular gravel. It should be noted that as the pH of the lime-soil-water mixture is temperature dependent the actual saturation pH value will not be constant but at normal temperatures it will be in the order of 12.4.
(v) Recording of results

The results are recorded to the nearest 0.5 per cent lime required to produce the maximum pH in the soil/water/lime mixture as indicated by the pH of the mix. Since the pH depends on the temperature, this must also be recorded. This percentage of lime is read as the ICL of the soil.

(vi) Interpretation

The amount of lime required to satisfy the ICL when added in the field will be sufficient to permit modification to take place completely but little if any stabiliser will be available for cementation or pozzolanic action. The lime required to produce any strength in the long term must be in addition to that required to satisfy the ICL.

Note: At present most ICL tests are performed with hydrated lime (Ca(OH)₂). It may well be argued that where Portland cement or mixtures of lime and slag or cement and slag are proposed for stabilisation the ICL test should be performed with the agent proposed.

7110 TESTS ON PAVEMENTS

The following tests shall apply to pavements when specified:
- texture depth
- straight-edge
- rolling straight-edge.

(a) Determining the texture depth

The texture depth shall be determined by way of the sand-patch test as described in test Method ST1 of TMH6.

(b) Straight-edge test for surface irregularities on surfaces with a coarse surface texture

Where surface irregularities are measured on surfaces with a coarse surface texture such as grooved concrete pavements, crushed-stone pavement layers, natural gravel base, asphalt with rolled-in chippings, seals and other like surfaces, the following procedure shall be followed:

A metal wedge of 100 mm in length and 50 mm in width shall be constructed with a taper of 7.5 horizontal to 1.0 vertical and tapering to a feather edge (50 mm wide). Parallel lines spaced at 7.5 mm intervals shall be engraved on the sloping face and numbered to indicate the positions where the wedge is 1.0 mm, 2.0 mm, etc, thick.

Where surface irregularities are measured, the 3 m straight-edge, which shall have sharp right-angled corners at the bottom, shall be placed on the road and the thin edge of the wedge inserted below the straight-edge from the front at the position where a surface irregularity is to be measured. The size of the irregularity shall be determined in accordance with the marks to which the wedge can be inserted without lifting the straight-edge.

(c) Using the rolling straight-edge for measuring surface irregularities

The apparatus and testing method for this test shall be in accordance with testing Method ST3 of TMH6.

7111 STRUCTURAL TESTS

(a) Tests on elastomeric bearings

(i) General

Tests on elastomeric bearings shall be conducted in accordance with BS 5400 Part 9.2, and the bearings shall comply with the test requirements specified in the said specification.

(ii) Compression and shear-stiffness tests

When compression and shear-stiffness tests are conducted on sample bearings or on only a limited number of bearings in a consignment, the stiffness values as determined by the tests shall be within 20% of the theoretical values.

(b) Prestressed concrete: Testing prestressing steel, anchorages assemblies, couplings and grout

(i) General

Where so directed by the Engineer, the Contractor shall make arrangements for samples of the materials he intends to use in the Works to be tested by an independent testing authority. The cost of testing prestressing steel, anchorages assemblies and couplings will be paid for as specified in Subclause 7103(c). Control tests on the viscosity and bleeding of grout will be regarded as part of the Contractor’s obligations under Clauses 1205 and 7208 for process control and will not be paid for separately.

Material represented by samples which do not comply with the specified requirements shall be removed and replaced with suitable material.

(ii) Anchorages and couplers

Anchorages and couplers shall be tested in accordance with the requirements of Subclause 6503(c). The anchorages and couplers shall be assembled in accordance with their practical application on the site where all the components necessary for anchoring shall be used, but excluding the ducts.

(iii) Prestressing steel

Prestressing steel shall be tested in accordance with the requirements of Subclause 6503(b). Should any test piece fail to comply with the requirements specified for the prestressing steel, the material represented by that sample shall not be used without further testing and shall be replaced with materials conforming to the specifications if further testing confirms that they do not comply with the specifications.

(iv) Grout

The fluidity of grout shall be measured with a flow cone, immersion apparatus or viscometer. The instrument shall be accurately calibrated in a laboratory so that the specified viscosity of the grout can be controlled satisfactorily.

The procedure for conducting the flow-cone test for measuring the fluidity of grout shall be as follows:

- Unless otherwise approved, the flow cone shall be as shown in Figure 7102 (at the end of the Section).
Immediately after the grout has been mixed, the pre-wetted flow cone, which is held firmly with its top rim in a level position, shall be filled with grout to the level indicated by the pre-set pointer, whilst the bottom orifice is held closed with a finger.

As soon as the required volume of grout, (± 1 750 m³), is reached, the finger shall be released to allow the grout to flow out freely through the bottom orifice. A stop watch shall be used to determine the flow time for emptying the cone, to the nearest second.

The readings obtained during grouting shall be compared with the times determined in the laboratory for grouts of the specified viscosities.

The bleeding of grout shall be measured in a metal or glass container with an internal diameter of approximately 100 mm and a height of approximately 120 mm. The grout and water levels in the container shall be controlled with a metal bridge and a height of approximately 120 mm. The grout and water container with an internal diameter of approximately 100 mm shall be filled with freshly mixed grout and water poured onto the grout with a measuring container with the tip of stud B pointing downwards. The bridge shall be placed over the container shall be opened and the free (bleed) water poured off. The bridge shall be so placed as to limit the effect of earth movements around the test pile on the deflection readings.

The extensometers shall be supported by one or more beams kept in the shade. The supports for the beams shall be fixed to the pile and placed on both sides of the pile in a level position, shall be filled with grout to the nearest millimetre and designated as V.

The percentage of bleeding shall be calculated from the following formula:

\[ \% \text{ Bleeding} = \left(1 - \frac{V_B - V}{V_A}\right) \times 100 \]

The test load shall be applied to the top of the pile with a hydraulic jack. Where more than one jack is used for applying the load, all the jacks in the circuit shall be activated by the same pumping unit. The jack(s) shall be placed so as to ensure that the load is applied axially.

The applied load shall be calculated in accordance with the hydraulic pressure which is being monitored by two pressure meters in the circuit. The pressure meter shall be calibrated in divisions not exceeding 2% of the maximum pressure applied, and the range of the meters shall not exceed 150% of the maximum pressure. The jack(s) and meters shall be calibrated by an approved testing laboratory not more than four weeks before the tests will commence.

The deflection of the pile head shall be measured with two scale rulers and two dial extensometers. The scale rulers shall be fixed to the pile and placed on both sides of the pile on a diameter line, and the dial extensometers shall be similarly placed but on a diameter line at right angles to that in which the scale rulers have been mounted.

Level measurements shall be taken on the scale rulers, and reduced as a level mark to a similar scale ruler placed at a distance from the test pile. All three scale rulers shall be calibrated in millimetres and the level-indicating instrument shall be capable of taking readings to 0.5 mm, and approximate readings of up to 0.1 mm.

The dial extensometers shall have a range of 50 mm, and shall be marked in 0.1 mm divisions to enable measurements to 0.05 mm to be taken. The plungers of the extensometer shall rest on a machined metal or glass surface.

The extensometers shall be supported by one or more beams kept in the shade. The supports for the beams shall be placed as to limit the effect of earth movements around the test pile on the deflection readings.

The test load shall be applied in increments of 20% of the specified working load to a maximum test load equal to twice the specified working load or the ultimate test load, whichever is the smaller.

A load increment may not be applied before the subsidence or heave rate has stabilised at a rate of not more than 0.10 mm in 20 minutes under the load applied.

After the loading has been completed, the maximum test load shall be maintained until the movement is less than 0.2 mm within a period of 24 hours. The load shall be removed in decrements of 20% of the specified working load at intervals of not less than 20 minutes.

After the load has been removed, the readings on both meters registering the movement of the pile shall be recorded accurately to 0.1 mm, at intervals of 5, 10 and 20 minutes, and then every 30 minutes until the load is changed. The final recovery shall be recorded 24 hours after the maximum test load has been removed.

During the test, the pile shall be loaded with up to 100% of the specified working load, and the load shall then be removed. It shall then be loaded to the maximum test load after which the test load shall be removed.

(c) Load test on foundation piles

The head of the test pile shall be exposed for checking position and slope. Where necessary, the head shall be cut further back so as to expose a full bond length of main reinforcing steel, and a suitable pile head slab for applying an axial load to the pile shall be cast. As an alternative, the head may be cut at right angles and the load applied directly to the pile.

7112 TESTS ON SILICONE SEALANTS

The following tests on silicone sealants will apply as determined in Subclause 7102(e).
(a) **Bond to cement mortar**

Three briquettes, shaped in accordance with AASHTO T-132 and moisture-cured for at least 28 days, are sawn in half, cleaned and dried to a constant mass in an oven at a temperature of 110°C ± 5°C. After having cooled off, they are bonded with approximately 0.25 mm of silicone sealant and tested with clamps which comply with AASHTO T-132. They are tested under stress at a loading rate of 7.62 mm/min.

(b) **Non-adhesive period**

Prepare the specimens in a mould with an area exceeding that of the brass weight described below, and which is 6.35 mm thick. Place a 30 g brass weight with dimensions of 41.28 mm x 25.4 mm x 3.18 mm on a polyethylene strip applied to the sample after the specified curing period. After the weight has been removed, the polyethylene strip is removed by pulling it off at an angle of 90° to the mix and at a rate of 25.4 mm in five seconds. No material may adhere to the polyethylene while it is non-adhesive.

(c) **Deformability and adhesion**

Prepare concrete blocks of 25.4 mm x 25.4 mm x 76.2 mm in accordance with ASTM C-719. A sawn surface is used as the bonding surface. Seal 50.8 mm of the block and leave 12.7 mm at each end of the specimen unsealed. The sealant shall be 9.5 mm thick and 12.7 mm wide. Cure the specimen for seven days in air at 25°C ± 1.7°C, and for seven days in water at 25°C ± 1.7°C. Subject the sealant to deformation in accordance with ASTM C-719. The ductility or compressive rate shall be 3.18 mm per hour. One cycle is defined as extension to a width of 25.4 mm and returning to the initial width of 12.7 mm.

7113 **TESTS ON CONSTRUCTION WATER**

(a) **Compressive strength test**

The average 28 day strength of three mortar cubes made with ordinary Portland cement and the water that is to be tested shall be at least 90% of that of three similar cubes made with water of known purity.

Additional tests shall be carried out to ensure that the setting time of the cement is not adversely affected by impurities.

(b) **Inorganic impurities criteria**

The water used to manufacture concrete shall comply with the criteria in Table 7113/1 unless otherwise approved by the Engineer.

7114 **CLASSIFYING THE TESTS**

For the purposes of this Section tests are defined as follows:

(a) Ordinary tests are tests which are constantly conducted by the Contractor on a regular basis in terms of Clauses 1205 and Section 7100, for which no specified pay items have been provided, and which include the following, inter alia:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Criteria</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.5 - 8.5</td>
<td>SABS 113</td>
</tr>
<tr>
<td>Sulphates</td>
<td>Reinforced concrete and prestressed concrete : 400 ppm Mass concrete : 1 000 ppm</td>
<td>SABS 212</td>
</tr>
<tr>
<td>Chlorides</td>
<td>500 ppm</td>
<td>SABS 202</td>
</tr>
<tr>
<td>Conductivity @ 25°C</td>
<td>330 mS/m</td>
<td>-</td>
</tr>
<tr>
<td>Total dissolved solids @ 180°C</td>
<td>Mass concrete : 3 000 ppm Reinforced concrete : 1 500 ppm</td>
<td>SABS 213</td>
</tr>
<tr>
<td>Alkali carbonates and bicarbonates</td>
<td>1 000 ppm</td>
<td>SABS 841</td>
</tr>
<tr>
<td>Sugar</td>
<td>Negative</td>
<td>SABS 837</td>
</tr>
<tr>
<td>Organic impurities</td>
<td>300 ppm (applicable if pH &lt;5)</td>
<td>Chemical oxidation demand</td>
</tr>
</tbody>
</table>

(i) Tests for determining the properties of all natural materials such as, inter alia, sand, stone, water, soil and gravel, inter alia, provided by the Contractor for use in the Works.

(ii) Tests on processed natural materials such as aggregate for concrete, asphalt and seals, purchased or produced on the site by the Contractor.

(iii) Tests for determining the properties of products such as concrete and asphalt, etc, produced specially for use on the Works by the Contractor, or purchased from commercial producers or subcontractors.

(iv) Tests on completed elements of construction such as fills, pavement layers, concrete structures, etc, for establishing compliance with the specified properties.

(b) Special tests are tests which have to be conducted by the Contractor only at the specific request of the Engineer, and include the following:

(i) Tests on commercial products such as cement, lime, paint, bituminous products, pipes, valves, cranes and bridge bearings. The requirements are specified as a whole or in part by reference being made to the specifications of a recognised standards organisation.

(ii) Special tests on structures or elements of structures to determine their efficacy, for the payment of which clear provision has been made in the specifications and the Schedule of Quantities.

(iii) Any test requested by the Engineer purely for purposes of acceptance control. Such tests, however, will not be classified as a special test if the test is requested
because the Contractor has neglected to conduct sufficient or proper tests in terms of Clause 1205 and with a view to submitting the result to the Engineer for his approval of completed work or materials.

Payment will be made under the pay items of Clause 7115 only in regard to special tests. Payment for ordinary tests shall be included in the rates tendered by the Contractor for the items of work to which the ordinary tests relate.

7115 MEASUREMENT AND PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>71.01 Special tests on elastomeric bearings (150% vertical load and 150% shear distortion) as described in Subclause 6604(d)</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of elastomeric bearings tested as described.

The tendered rate shall include full compensation for having the test conducted by an approved laboratory, also for replacing the bearings which may possibly have been damaged during testing.

No payment will be made in respect of a special test should the test indicate that the bearing does not comply with the specifications.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>71.02 Other special tests requested by the Engineer:</td>
<td></td>
</tr>
<tr>
<td>(a) Cost of testing</td>
<td>prime cost sum (PC sum)</td>
</tr>
<tr>
<td>(b) Charge on prime cost sum</td>
<td>percentage (%)</td>
</tr>
</tbody>
</table>

Payment for special tests as requested by the Engineer in terms of Clause 7114 will be made in accordance with the provisions of the General Conditions of Contract. Payment will not be made for any special test should the test indicate that the specifications have not been complied with.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>71.03 Providing testing equipment:</td>
<td></td>
</tr>
<tr>
<td>(a) Rolling straight-edge</td>
<td>number (No)</td>
</tr>
<tr>
<td>(b) Core drill</td>
<td>number (No)</td>
</tr>
</tbody>
</table>

The unit of measurement shall be the number of each item provided. The rolling straight-edge shall comply with the requirements of Test Method ST3 of TMH6. The core drill shall be of an approved type capable of drilling cores with diameters of 100 mm and 150 mm in concrete and asphalt respectively. It shall be provided with the necessary drilling parts.

The tendered rates shall include full compensation for providing the apparatus on the site and making it available and using it on the site for as long as may be necessary. After the work has been completed, and subject to the provisions of the General Conditions of Contract, it shall revert to the Contractor as his property.

Note: Providing testing equipment for use by the Engineer.

Except for the equipment listed in Item 71.03, this Specification does not envisage the provision of testing equipment by the Contractor for the use of the Engineer, but, where necessary, provision shall be made therefor in the Project Specifications, and the relevant pay items shall be described.
Table 7104/1
Schedule showing quantities and times for submitting the materials for approval and mix designs

<table>
<thead>
<tr>
<th>Material submitted</th>
<th>Proposed use</th>
<th>Submission for quality approval only</th>
<th>Submission for quality approval and mix design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum time to be allowed for testing and approval</td>
<td>Minimum quantity to be submitted</td>
<td>Minimum time to be allowed for testing, approval and mix design</td>
</tr>
<tr>
<td>Crushed stone</td>
<td>Coarse aggregate for concrete</td>
<td>2 weeks</td>
<td>50 kg of each size of stone</td>
</tr>
<tr>
<td>Bituminous seals</td>
<td></td>
<td>2 weeks</td>
<td>50 kg of each size of stone</td>
</tr>
<tr>
<td>Asphalt mixes</td>
<td></td>
<td>2 weeks</td>
<td>50 kg of each size of stone</td>
</tr>
<tr>
<td>Crushed-stone base or subbase</td>
<td></td>
<td>3 weeks</td>
<td>50 kg</td>
</tr>
<tr>
<td>Crusher dust and/or sand</td>
<td>Fine aggregate for concrete</td>
<td>2 weeks</td>
<td>50 kg of each size of aggregate</td>
</tr>
<tr>
<td>Asphalt mixes</td>
<td></td>
<td>2 weeks</td>
<td>15 kg of each size of aggregate</td>
</tr>
<tr>
<td>Slurry or sand seal</td>
<td></td>
<td>2 weeks</td>
<td>15 kg of each type proposed for use</td>
</tr>
<tr>
<td>Gravel</td>
<td>Subbase and/or base</td>
<td>4 weeks</td>
<td>200 kg of each sample</td>
</tr>
<tr>
<td>Other materials eg paint, cement, additives, etc</td>
<td>As specified</td>
<td>As prescribed by the Engineer</td>
<td></td>
</tr>
</tbody>
</table>

7100-14
**Figure 7101: Durability Mill Apparatus**

- **Electric Motor Running at 60 R.P.M.**
- **Bearings Support**
- **Rubber for Watertight**
- **Removable Cover**
- **Screw for Tightening Cover**
- **Base of the Apparatus (Wood) 800 X 700 mm²**
- **Side View**
- **Plan**
- **Front View Without Lid**

- **Steel Baffle Projecting 80 mm Units Cylinder and 5 mm Thick**

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7100-15
Figure 7102: Apparatus for flow-cone test

Figure 7103: Apparatus for determination of bleeding of grout
7201 SCOPE

This Section describes the scheme used for determining, by means of tests and measurements and by applying statistical judgement plans, whether certain requirements specified in the Specifications in regard to the properties of materials and workmanship are being complied with.

It also covers the requirements in regard to the control to be exercised by the Contractor for monitoring the quality of his work and materials and the routine tests and inspections to be carried out by the Engineer.

7202 JUDGEMENT PLANS : GENERAL

Certain requirements and limit values are laid down in the Specifications in regard to the properties of materials and workmanship to be supplied. Tests shall be conducted and measurements taken for controlling the relevant properties of the workmanship and materials supplied, and the results of such tests and measurements shall be assessed on the basis of the prescribed criteria for compliance with the specified requirements.

Wherever possible, acceptance criteria shall be determined by way of statistical principles described in this Section. Wherever impracticable and where no statistical judgement criteria have been prescribed, the specified requirements and limit values shall be fully complied with.

Despite acceptance of those properties judged by these statistical methods, the materials or work submitted will be rejected when other properties (which are not controlled by statistical methods) fail to comply with the requirements of the Specifications, or where there are other causes for rejection such as obviously defective workmanship or excessively variable properties, visible signs of poor workmanship, and similar considerations which constitute sufficient grounds for rejecting the work without any further testing.

The Engineer shall be entitled to assess separately any specified portion of a lot if, in his opinion, it exhibits significant deviations as compared with the remainder of the lot.

In order not to change the Contractor's or the Employer's risks, the statistical judgement plans shall be strictly adhered to in all cases where they are used, and decisions based on these plans shall not be altered. It shall be a condition of this Contract that the theoretical validity of the various statistical judgement plans be accepted and that the validity of the decisions made on the basis of these judgement plans cannot be disputed on the grounds of statistical theory or a specified or implied producer's risk, or unjust on the grounds of enrichment.

7203 DEFINITIONS

For the purposes of this Section the following words and symbols shall have the following meanings:

(a) **Lot**

A lot is a sizeable portion of work or quantity of material which is assessed as a unit for the purposes of quality control, and selected to represent material or work produced by essentially the same process and from essentially the same materials.

(b) **Random sample**

A random sample is a group of "n" test measurements at "n" separate test positions or on "n" sample portions obtained from the lot in an unbiased manner.

Random sampling shall mean stratified random sampling, unless inconsistent with the context.

(c) **Sample mean (x̄)**

x̄ is the arithmetic mean of a set of "n" test results constituting the sample.

(d) **Sample standard deviation (S_n)**

The sample standard deviation S_n is defined by:

\[ S_n = \sqrt{\frac{\sum x^2 - n\bar{x}_n^2}{n-1}} \]

where \( \bar{x}_n \) is the sample mean

\( x \) is the value of an individual sample portion, i.e. an individual test result or measurement.

\( n \) is the sample size, i.e. the number of individual test results or measurements.

(e) **Specification limit (L_s)**

This is the limit value of the property of any product outside which not more than a specified percentage (φ) of the population of values representing an acceptable product property is allowed to lie. The specification limit may be a single lower limit L_s, or a single upper limit L'_s, or a double limit consisting of a lower limit L_s and an upper limit L'_s.
(f) Acceptance limit for sample mean ($L_a$)

This is the limit value of a product property within which the sample mean shall lie for a product to be acceptable.

For a lower-limit specification, this acceptance limit is denoted by $L_a$. For an upper-limit specification, this acceptance limit is denoted by $L'_a$. For a double-limit specification, the lower and upper limits are denoted by $L_a$ and $L'_a$.

(g) Acceptance limits for individual test values ($L_e$)

These are the limit values of a product property within which the sample values representing a product shall lie for the product to be acceptable.

The limit values will depend on the sample sizes $n$ and may be a lower limit $L_e$, an upper limit $L'_e$, or double limits $L_e$ and $L'_e$.

(h) Conditional acceptance

This is the acceptance of a lot at reduced payment in lieu of rejection. Conditional acceptance shall be subject to the provisions of Clause 7207.

(i) Outliers

Where, in a sample, one or more test results differ significantly from the other values obtained, this difference could be ascribed to an assignable cause, in which case such test result shall be regarded as an outlier and disregarded when assessing the lot.

To determine whether or not a test result is an outlier, the method given in Subclause 7204(d) shall be adopted.

(j) First submission

The submission of a lot for approval will be classified as a first submission when actually submitted for the first time or when submitted for a second time on the basis of a second set of test values which shall be regarded as a first submission in terms of Subclause 7204(e), because the properties of the first and the second sets of test values differ significantly.

(k) Resubmission

The submission of a lot for approval for a second time shall be classified as a resubmission should it be regarded as a resubmission in terms of Subclause 7204(e), as the properties of the first and second sets of test values do not differ significantly.

(l) Payment-reduction factor ($f_r$)

This is the factor by which payment at Contract rates shall be multiplied for calculating payment for conditionally accepted work.
Calculate the value of $T_i$ from

$$T_i = \frac{x_i - \bar{x}_n}{S_n}$$

where

- $x_i =$ arithmetic mean
- $S_n =$ sample standard deviations
- $x =$ value of the test result differing most from the mean.

Compare the value of $T_i$ with the value of $T$ for the applicable value of "n", from Table 7204/1.

### Table 7204/1

<table>
<thead>
<tr>
<th>No of observations (n)</th>
<th>Critical values (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1.46</td>
</tr>
<tr>
<td>5</td>
<td>1.67</td>
</tr>
<tr>
<td>6</td>
<td>1.82</td>
</tr>
<tr>
<td>7</td>
<td>1.94</td>
</tr>
<tr>
<td>8</td>
<td>2.03</td>
</tr>
<tr>
<td>9</td>
<td>2.11</td>
</tr>
<tr>
<td>10</td>
<td>2.18</td>
</tr>
<tr>
<td>11</td>
<td>2.23</td>
</tr>
<tr>
<td>12</td>
<td>2.29</td>
</tr>
<tr>
<td>13</td>
<td>2.33</td>
</tr>
<tr>
<td>14</td>
<td>2.37</td>
</tr>
<tr>
<td>15</td>
<td>2.41</td>
</tr>
<tr>
<td>16</td>
<td>2.44</td>
</tr>
<tr>
<td>17</td>
<td>2.47</td>
</tr>
<tr>
<td>18</td>
<td>2.50</td>
</tr>
<tr>
<td>19</td>
<td>2.53</td>
</tr>
<tr>
<td>20</td>
<td>2.56</td>
</tr>
</tbody>
</table>

If the absolute value of $T_i$ is greater than $T$, then $x_i$ is an outlier.

### (e) Resubmission

Where a lot has been accepted conditionally or has been rejected, the Engineer may agree to its resubmission for approval if:

(i) it has been reworked and the Engineer is satisfied that a proper attempt was made to improve the properties which were unacceptable;

or

(ii) where, in his opinion there are valid technical reasons therefore.

In both cases a fresh sample shall be taken, and a fresh (second) set of test values determined.

The first and second sets of test values shall then be compared with each other to determine whether their properties differ significantly.

Where in the opinion of the Engineer a significant difference does occur, the submission of the lot shall be regarded as a first submission and assessed as such, and only the second set of test values shall then be used for this purpose.

Where in the opinion of the Engineer no significant difference occurs, the submission of the lot shall be regarded and assessed as a resubmission. Where a lot is resubmitted, it shall be assessed on the same basis as a first submission, except that the original and the second set of sample results shall be combined for purposes of assessment.

### 7205 PROCEDURES

The statistical judgement procedures described below will apply to the corresponding product properties for purposes of acceptance control.

#### (a) Surface levels of fills and pavement layers

At least 50, but preferably more, level measurements shall be taken according to a stratified random pattern of each lot of completed layer work, and the specified levels shall then be determined. Outliers shall be identified and examined.

The lot will be considered to comply with the requirements in respect of surface levels if, before any repair work is undertaken, at least 90% of the level measurements show a deviation from the specified levels which is smaller than the $H_{90}$ tolerance specified in the relative sections in regard to each layer.

Isolated spots, where the surface levels deviate by more than the appropriate $H_{\max}$ tolerance of the specified levels shall be repaired to bring the deviation to within the $H_{90}$ tolerance.

#### (b) Layer thicknesses of pavement layers

At least 30, but preferably more, layer thicknesses shall be determined in accordance with a stratified random pattern for each lot of completed layer work. Layer thicknesses may be determined by means of level measurements taken before and after construction of the layer in exactly the same position, but may be augmented by thicknesses measurements taken by means of holes made in the layer. In the case of asphalt layers, the Engineer may require thickness determinations to be made only by means of measurements on drilled cores, in which case the minimum number of cores per lot shall be 20 instead of 30.

Outliers shall be identified, disregarded, and, if possible, replaced.

The lot will be considered to comply with the requirements for layer thicknesses if -

(i) at least 90% of all the thickness measurements taken before any thickness repairs are made are equal to or greater than the specified thickness, minus the $D_{90}$ tolerance specified in the appropriate section; and

(ii) the mean layer thickness of the lot is not less than the specified thickness, minus the $D_{\text{mean}}$ tolerance.

Isolated spots where the actual thickness is less than the specified thickness less the $D_{\max}$ tolerance shall be repaired so as to fall within the $D_{90}$ tolerance.
(c) Relative compaction of pavement layers

At least four relative density determinations shall be taken in the case of selected layers and at least six in the case of all other pavement layers in accordance with a random pattern. After outliers have been examined and replaced, compliance with the specified density requirements shall be determined as in Table 7205/1 (at end of the Section).

The sample mean \( \bar{x} \) shall be at least equal to or higher than the acceptance limit \( (L_a) \) for the sample mean as given in Table 7205/1, and no single test value shall be lower than the acceptance limit \( (L_e) \) for single values.

(d) Cementitious-binder content of stabilised layers and uniformity of mix

(i) Method

Take 50 samples according to a random pattern and determine their cementitious-binder content. Examine the results for outliers and replace them if any.

(ii) Analysis

As described in Subclause 7109(a), the test results shall be adapted to make provision for the presence of minerals, which may affect the test results, in the material to be stabilised.

The quantity of cementitious binder in the mixed material determined by taking 50 samples per lot and testing them as specified, shall fall within the following limits:

1. The mean cementitious-binder content shall be not less than 91% of the specified binder content.
2. The cementitious binder content in not more than 12 of the 50 samples may be lower than 70% of the specified binder content.

The requirements for uniformity of the mix shall apply only on condition that the variation of these adjustments fall within the limits specified in Subclause 7109(a).

(e) Binder content of asphalt

(i) Method

Take at least four specimens of asphalt in a random pattern and determine the binder content. Examine the results and replace any outliers as specified.

(ii) Analysis

Determine the sample mean and assess the lot by using the following criteria:

The binder content of asphalt mixes shall not deviate from the specified binder content by more than the values given in Tables 7205/2 and 7205/3.

(f) Concrete : 28-day cube compressive strength

(i) Method

Take at least the minimum number of samples as given in Table 7205/4 according to a random pattern and make test cubes.

The binder content of asphalt mixes shall not deviate from the specified binder content by more than the values given in Tables 7205/2 and 7205/3.

(ii) Analysis

Examine the results for outliers and disregard if any. The results are then assessed according to the criteria set out below. A lot will comply with the requirements for the characteristic strength if it meets the following requirements:

<table>
<thead>
<tr>
<th>Volume of lot (m³)</th>
<th>Minimum sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20</td>
<td>4</td>
</tr>
<tr>
<td>21 - 40</td>
<td>6</td>
</tr>
<tr>
<td>41 - 70</td>
<td>9</td>
</tr>
<tr>
<td>71 - 100</td>
<td>12</td>
</tr>
<tr>
<td>101 - 150</td>
<td>14</td>
</tr>
<tr>
<td>&gt;150</td>
<td>16</td>
</tr>
</tbody>
</table>

Test them for cube compressive strength after 28 days.
(1) \( x \geq L_s + \Delta_a \)

where

\( x \) = a mean value of the 28-day cube compressive strength tests

\( L_s \) = characteristic strength specified in the concrete-class indication (see Clause 6404)

\( \Delta_a \) = the applicable value given in Table 7205/5

(2) No single test value is lower than the value

\( L_s - \Delta_a \)

where

\( \Delta_a \) = the applicable value is given in Table 7205/5.

Table 7205/5
Acceptance factors for strength concrete

<table>
<thead>
<tr>
<th>Sample size (n)</th>
<th>( \Delta_A ) (MPa)</th>
<th>( \Delta_B ) (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.5</td>
<td>3.9</td>
</tr>
<tr>
<td>4</td>
<td>1.1</td>
<td>4.2</td>
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<tr>
<td>5</td>
<td>1.4</td>
<td>4.5</td>
</tr>
<tr>
<td>6</td>
<td>1.7</td>
<td>4.7</td>
</tr>
<tr>
<td>7</td>
<td>1.9</td>
<td>4.9</td>
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<td>8</td>
<td>2.1</td>
<td>5.0</td>
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<tr>
<td>9</td>
<td>2.2</td>
<td>5.2</td>
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<tr>
<td>10</td>
<td>2.3</td>
<td>5.3</td>
</tr>
<tr>
<td>11</td>
<td>2.4</td>
<td>5.4</td>
</tr>
<tr>
<td>12</td>
<td>2.5</td>
<td>5.5</td>
</tr>
<tr>
<td>13</td>
<td>2.6</td>
<td>5.6</td>
</tr>
<tr>
<td>14</td>
<td>2.7</td>
<td>5.7</td>
</tr>
<tr>
<td>15</td>
<td>2.7</td>
<td>5.8</td>
</tr>
</tbody>
</table>

7206 CONTROLLING MORE THAN ONE PROPERTY

Where more than one property of a lot is being controlled, the lot shall be accepted if all the properties comply with the specified requirements, but if one or more of the properties do not comply with the requirements, the lot shall be rejected, or it may be conditionally accepted subject to the provisions of Clause 7207.

7207 CONDITIONAL ACCEPTANCE

(a) General

Where a lot is rejected under a statistical judgement plan described in this Section, but the test results are such that the lot complies with the requirements for conditional acceptance specified hereafter, the Engineer may accept the lot conditionally, that is, the lot may be accepted at reduced payment in lieu of complete rejection, provided that:

(i) conditional acceptance shall be the sole discretion of the Engineer and is not an option which may be exercised by the Contractor or a right he may claim;

(ii) the lot is approved in respect of all other requirements not judged by a statistical judgement plan;

(iii) the Contractor shall have the option to remove and reinstate at his own cost conditionally accepted work with work which complies with the requirements for acceptance at full payment;

(iv) conditional acceptance and the corresponding reduced payment shall apply only in respect of the work and properties listed in Subclause 7207(b) below.

(b) Properties to which conditional acceptance applies

Conditional acceptance may be applied in respect of the properties of structures listed below in Table 7207/1.

Table 7207/1
Properties to which conditional acceptance may apply

<table>
<thead>
<tr>
<th>Property</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative compaction</td>
<td>(i) Asphalt base or surfacing</td>
</tr>
<tr>
<td></td>
<td>(ii) Chemically stabilised layers</td>
</tr>
<tr>
<td></td>
<td>(iii) Plant mixed paver laid layers</td>
</tr>
<tr>
<td>Bituminous-binder content</td>
<td>Asphalt base or surfacing</td>
</tr>
<tr>
<td>Cementitious-binder content</td>
<td>Chemically stabilised layers</td>
</tr>
<tr>
<td>28-day cube compressive strength</td>
<td>All structural concrete (excluding concrete pavements)</td>
</tr>
</tbody>
</table>

Note: Conditional acceptance shall not apply to crushed-stone layers, but, where compaction to 88% of apparent density has been specified but cannot be attained, the Engineer may accept the layer at payment at the rate for compaction to 86% of apparent density on condition that the layer complies with the requirements for this compaction standard.

The same provisions shall apply mutatis mutandis where a specified density of 102% of modified AASHTO density cannot be attained, but 100% of modified AASHTO density has in fact been attained.

(c) Criteria for conditional acceptance

In terms of the respective judgement plans relating to the properties to which conditional acceptance applies, two requirements shall always apply, viz one in relation to the sample mean \( \bar{x} \), and one in relation to individual test values \( x_n \). A lot may be conditionally accepted when it complies with one of the two requirements for acceptance, but not with the second requirement provided that it complies with the requirements for conditional acceptance in relation to the second requirement. There are therefore always two cases:
(i) Case 1

The lot complies with the requirement for sample mean, but not in all cases with the requirement for individual test values.

The lot may be accepted conditionally, subject to the following additional conditions:

(1) In regard to the relative compaction of pavement layers, the bituminous-binder content of asphalt and the concrete cube compressive strength, not more than one test value may not comply with the requirements of individual test values.

(2) In regard to the cementitious-binder content, the binder content may be below 70% of the specified binder content in not more than 13 cases.

(ii) Case 2

The lot complies with the requirements for individual test values but not with the requirements for sample mean.

The lot may be accepted conditionally on condition that the sample mean \( \bar{x}_n \) lies within the rejection limit \( L_r \) given in Table 7207/2.

Table 7207/2
Rejection limits \((L_r, L_r')\) for the sample mean \( (\bar{x}_n) \)

<table>
<thead>
<tr>
<th>Property</th>
<th>Structure</th>
<th>Rejection limits ((L_r, L_r'))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative compaction</td>
<td>(a) Chemically stabilised layers in accordance with Section 3500</td>
<td>( L_r = (L_a - 2.000)% ) relative compaction</td>
</tr>
<tr>
<td></td>
<td>(b) Asphalt base or surfacing</td>
<td>( L_r = (L_a - 1.000)% ) relative compaction</td>
</tr>
<tr>
<td>Cube compressive strength</td>
<td>All strength-concrete (excluding pavement concrete)</td>
<td>( L_r = 0.85 L_a )</td>
</tr>
<tr>
<td>Bituminous binder content %</td>
<td>Asphalt</td>
<td>( L_r = (L_a - 0.200)% ) binder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( L_r' = (L_r + 0.200)% ) binder</td>
</tr>
<tr>
<td>Cementitious-binder content</td>
<td>Chemically stabilised layers</td>
<td>( L_r = 0.80 L_a )</td>
</tr>
</tbody>
</table>

(d) Determining the payment reduction factor \((f_r)\)

Where a lot is conditionally accepted, compensation will be reduced by multiplying the tender rates for the items concerned, as set out below, with the payment reduction factor \( f_r \).

The factor \( f_r \) is determined as follows in regard to the two cases set out in Subclause 7207(c) above.

(e) Applying the payment-reduction factor

The payment-reduction factor shall be applied to the following payment items as may apply and be described in the Specifications.

(i) Chemically stabilised layers

Items 34.01, 34.02, 34.03, 35.01, 35.02, 35.05 and 35.06.

(ii) Asphalt base and surfacing

Items 42.01, 42.02 and 42.03.

(iii) Concrete

Items 64.01, 64.02 and 64.03.

No reduction shall apply to payment items for formwork, reinforcing or tendons.

(iv) General

Where payment items are incorporated in the Project Specifications or have been amended in the Schedule of Quantities, the payment-reduction factor shall apply to the payment items corresponding to the payment items mentioned above.

Where a lot is conditionally accepted in regard to more than one property, the payment-reduction factor for each property shall be calculated, and the factor giving rise to the largest reduction shall be applied.

7208 PROCESS CONTROL BY THE CONTRACTOR

The requirements of Clause 1205 shall apply in respect of the Contractor's obligation to institute and implement a control system for monitoring the quality of the work and materials supplied.
For continuous concrete and asphalt-production processes, the Engineer may order the Contractor to augment the above control system by introducing a process-control system for monitoring the various properties to be controlled. The specific system to be applied shall be subject to the Engineer's approval, and the attention of the Contractor is drawn to the systems described in TRH5, which will normally be regarded as suitable.

The Contractor shall take immediate steps to rectify any deviation from the specified requirements indicated by his process-control system, and the Engineer shall have the right to inspect and be given all details of tests and testing procedures in order to satisfy himself that the Contractor is implementing an adequate process-control system.

7209 ROUTINE TESTS AND INSPECTION BY THE ENGINEER

The Engineer will at regular intervals inspect and test materials and completed work for compliance with the specified requirements, and, where applicable, the various specified judgement plans will be applied. The testing frequencies and sample and lot sizes for routine testing shall be at the Engineer's discretion.

All sections of completed work shall be submitted to the Engineer for routine inspection and testing, and the Contractor shall not cover up or construct any work on top of sections of completed work before being advised by the Engineer of the outcome of his tests and inspection. The Contractor shall arrange the submission of work for testing in a manner as will afford the Engineer reasonable opportunity for inspecting and testing.
<table>
<thead>
<tr>
<th>Layer</th>
<th>Prescribed density</th>
<th>Unit of measurement</th>
<th>Minimum average density for the following sample sizes</th>
<th>Minimum value for any single test for the following sample sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Selected layer</td>
<td>90%</td>
<td>Mod. AASHTO density</td>
<td>90.1</td>
<td>90.4</td>
</tr>
<tr>
<td></td>
<td>93%</td>
<td>Mod. AASHTO density</td>
<td>93.1</td>
<td>93.4</td>
</tr>
<tr>
<td></td>
<td>95%</td>
<td>Mod. AASHTO density</td>
<td>95.1</td>
<td>95.4</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>Mod. AASHTO density</td>
<td>100.1</td>
<td>100.4</td>
</tr>
<tr>
<td>Subbase</td>
<td>95%</td>
<td>Mod. AASHTO density</td>
<td>95.1</td>
<td>95.4</td>
</tr>
<tr>
<td></td>
<td>96%</td>
<td>Mod. AASHTO density</td>
<td>96.1</td>
<td>96.4</td>
</tr>
<tr>
<td></td>
<td>97%</td>
<td>Mod. AASHTO density</td>
<td>97.1</td>
<td>97.4</td>
</tr>
<tr>
<td>Gravel base</td>
<td>100%</td>
<td>Mod. AASHTO density</td>
<td>100.1</td>
<td>100.4</td>
</tr>
<tr>
<td></td>
<td>98%</td>
<td>Mod. AASHTO density</td>
<td>98.1</td>
<td>98.4</td>
</tr>
<tr>
<td></td>
<td>97%</td>
<td>Mod. AASHTO density</td>
<td>97.1</td>
<td>97.4</td>
</tr>
<tr>
<td>Crushed-stone base</td>
<td>102%</td>
<td>Apparent density</td>
<td>102.1</td>
<td>102.4</td>
</tr>
<tr>
<td>Asphalt base and surfacing</td>
<td>100%</td>
<td>(97 - % voids in mix) % of theoretical density</td>
<td>100.1</td>
<td>100.3</td>
</tr>
<tr>
<td>Shoulders and wearing course</td>
<td>93%</td>
<td>Mod. AASHTO density</td>
<td>93.2</td>
<td>93.6</td>
</tr>
<tr>
<td></td>
<td>95%</td>
<td>Mod. AASHTO density</td>
<td>95.2</td>
<td>95.6</td>
</tr>
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</table>
BIBLIOGRAPHY

SPECIFICATIONS AND TEST METHODS

1 American Association of State Highway and Transport Officials (AASHTO)
2 American Society for Testing and Materials (ASTM)
3 British Standards Institute (BS)
4 Standard Coordination Specification (CKS)
5 Deutshe Ingieur Norme (DIN)
6 South African Bureau of Standards (SABS)
7 Southern African Bitumen and Tar Association (SABITA)
8 Swedish Standard (SIS)
9 Technical methods for highways (TMH)
10 Technical recommendations for highways (TRH)
11 US Federal
The AASHTO, ASTM, BS, CKS, DIN, SABS, SIS and US Federal specification and test method documents referred to in this document can be obtained from the following sources:

1. **Botswana Bureau of Standards**  
   Private Bag BO48  
   Gabarone  
   Tel +267 351 420  
   Fax +267 324 064  
   E-mail bobs.standard@info.bw

2. **Malawi Bureau of Standards**  
   PO Box 946  
   Blantyre  
   Tel +265 670 488  
   Fax +265 670 756  
   E-mail mbs@malawi.net  
   Telex 44325

3. **Mauritius Standards Bureau**  
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   Tel +230 433 3648  
   Fax +230 433 5150

4. **Mozambique National Institute of Standardisation and Quality**  
   CP 2983  
   Maputo  
   Tel +2581 303 822  
   Fax +2581 303 658

5. **South African Bureau of Standards**  
   PBag x191  
   Pretoria  
   0001  
   Tel +2712 428 6925  
   Fax +2712 428 6928  
   E-mail info@sabs.co.za

6. **South African Bureau of Standards (Namibia)**  
   PO Box 1797  
   Windhoek  
   Tel +92641 243 502  
   Fax +92641 243 502 (ask for fax)

7. **Tanzania Bureau of Standards**  
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   Dar es Salaam  
   Tel +255 514 3298  
   Fax +255 514 3583  
   E-mail tbs@costech.gn.apc.org  
   Telex 41667 tbs tz
8. **Standards Association of Zimbabwe**
   PO Box 2259
   Harare
   Tel  +2634 882 017
   Fax  +2634 882 020
   E-mail  sazinfo@samara.co.zw

The SABITA specification and test method documents can be obtained from:

1. **SABITA**
   PO Box 6946
   Roggebaai
   South Africa
   8012
   Tel  +2721 421 2577
   Fax  +2721 425 1279
   E-mail  sabita@iafrica.com

The TMH and TRH documents can be obtained from:

1. **Department of Transport (Publications Department)**
   PO Box 415
   Pretoria
   South Africa
   0001
   Tel  +2712 309 3310
   Fax  +2712 328 5102
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<th>Code</th>
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<tbody>
<tr>
<td>M-85</td>
<td>Ordinary Portland cement</td>
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<tr>
<td>M-140</td>
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### American Society for Testing and Materials (ASTM)

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Deutshe Ingineur Norme (DIN)

DIN-52013  Bitumen tests (ductility and elastic recovery)
South African Bureau of Standards (SABS)

SABS-044  Welding procedures
SABS-064  Abrasive blasting
SABS-094  Holes for friction grip fasteners
SABS-0100 Concrete cores
SABS-0142 Electrical installations
SABS-0162 Design of work/codes of practice
SABS-05  Timber treatment
SABS-82  Steel reinforcing bars
SABS-92  Roofing felt (bridge bearings)
SABS-113  pH test (water)
SABS-134  Paint
SABS-135  Bolts and nuts
SABS-136  Bolts and nuts
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SABS-802  Finishing coats (paint)
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SABS-831  Rapid hardening cement (OPC15)
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Swedish Standards (SIS)

SIS 05/59/00 Abrasive blasting
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Technical Recommendations for Highways (TRH)

TRH-3 Surfacing seals for rural and urban roads
TRH-5 Statistical concepts of quality control and their application in road construction
TRH-8 Design and use of hot mix asphalt in pavements
US Federal

HHF-341F  Joint filler
SS-S-1401B  Thermoplastic hot poured sealant
SS-S-156  Thermoplastic cold poured sealant