EARTHWORKS

PROPOSAL FOR NATIONAL STANDARD METHOD OF MEASUREMENT

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INTRODUCTION

The attempt to constitute rules of measurement in Portugal had its beginning in the end of 60’s decade, with the elaboration, by LNEC\(^1\), of a document that intended to define norms capable of assuring the standardization of measurement methods.

The measurement rules have direct consequences in any constructive process phase. Since the planning to the execution, the measurement criteria is always present and many times they are the cause of conflicts between the intervening ones. Normally these conflicts are generated by misinterpretation or even by lack of objective criteria for measuring such work.

Consequently, the existence of official rules of measurement is a necessity for some public and private entities, assuming itself as a requirement of the national regulation too. Currently, the national Construction Industry needs an official standard method of measurement that includes the majority Civil Engineering works.

OBJECTIVES

This dissertation aimed to develop a proposal for national standard method of measurement for earthworks. Therefore, to permit the preparation of a measurement rules model, that had into account the national reality and the existing national and international legislation on the matter, the following items were considered:

1. Legislation and bibliography research of standard methods of measurement in current use, applicable in earthworks;
2. Numbering and codification of items described in the Bill of Quantities;

3. Identification of measurement units and general and specific rules on different kinds of works;

4. Characterization of important technical and constructive aspects, like the quality guarantee and control, or the security precautions;

5. Illustrative examples of the above mentioned items.

**THE MEASUREMENT RULES MODEL**

The following stages were developed in order to reach the proposed objectives:

1. **National research**

   In this stage was done the contextualization of the measurement rules research’s past and the survey of existing publications and current underway studies about measurement rules in Portugal. Thus, not having knowledge of other publications, it was considered the “Curso Sobre Regras de Medição na Construção” [5].

2. **International research**

   Giving greater emphasis to the Europe and North American countries, particularly France, United Kingdom, Germany, Belgium, Spain, Italy, Canada and USA, it sought to know which documents about the measurement rules were used around the world.

   The results of a survey done by the Royal Institution of Chartered Surveyors (RICS) [9] about standard methods of measurement in current use were found and it was considered relevant the analysis of the following documents:

   a) “CESMM2” [10];
   
   b) “SMM7” [11];
   
   c) NBN B 06-001 [8].
3. Comparative analysis

The content of the above referred documents were compared and, on Table 1, were verified the differences between the following features:

   a) The scope of measurement rules;
   b) The structure of information;
   c) The coding and numbering of items;
   d) The illustrative examples of the rules.

<table>
<thead>
<tr>
<th>Features</th>
<th>CESMM2</th>
<th>CSRMC&lt;sup&gt;1&lt;/sup&gt;</th>
<th>NBN B 06-001</th>
<th>SMM7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Works of civil engineering construction</td>
<td>Building works</td>
<td>Building works</td>
<td>Building works</td>
</tr>
<tr>
<td>Information structure</td>
<td>Rules set out in tables</td>
<td>Rules set out in text</td>
<td>Rules set out in text</td>
<td>Rules set out in tables</td>
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<tr>
<td>Coding and numbering</td>
<td>Work classes, divisions, subdivisions and sub-subdivisions</td>
<td>Work chapters, subchapters, sub-subchapters and sub-sub-subchapters</td>
<td>Work chapters, subchapters, sub-subchapters and sub-sub-subchapters</td>
<td>Work classes, divisions, subdivisions and sub-subdivisions</td>
</tr>
<tr>
<td>Illustrative examples of the rules</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<sup>1</sup> “Curso Sobre Regras de Medicação na Construção” [5].

From this analysis were selected, from each document, the features that are considered relevant to the model of measurement rules to be used in Portugal.

4. Contact with national companies

After the analysis mentioned above, the idea was to know if the principles laid down in the several documents had practical validity and if they should be used as criteria for the work measurement in Portugal.
Thus, for the enrichment of this study, the following companies were contacted:

a) EP – Estradas de Portugal, S.A.

b) Grupo Metropolitano de Lisboa, E.P.

c) Instituto Portuário e dos Transportes Marítimos, IP.

Some conclusions were drawn from the contact with the national companies, namely that their criteria is based on the extensive experience gained over the various works undertaken and that some of their basic principles do not apply the measurement methods of the publications analysed.

Thus, it was verified that the measurement methods defined in the companies’ technical documents are generally used as reference in the whole of their works. Therefore, in drafting the proposed measurement method, the information contained in the following references was considered:

1. Especificações Técnicas do Grupo Metropolitano de Lisboa [6];
2. Caderno de Encargos Tipo da EP – Estradas de Portugal, S.A.[4];
3. Despacho Conjunto dos Ministérios do Ambiente e Recursos Ambientais e do Mar N.º 141 de 21 de Junho de 1995 [2];
4. Lei n.º 49/2006 de 29 de Agosto [7];
5. Despacho n.º 13 433/2003 (2ª série), de 9 de Julho [3];

The analysis results of above mentioned documents have been relevant in the preparation of the method of measurement proposal for earthworks, because they show the companies' practical experience and, in some situations, there are legal aspects that can affect the work execution, or part of them.
Thus, the above references have contributed to this study, especially in regard following aspects:

a) Introduction of work not covered previously;

b) Establishing the basis for the review and update of the previously defined criteria;

c) Clarification of technical terms translated to other documents.

5. Comparative analysis

After complementing the conducted bibliography search with the obtained information by contact with the national companies, a new comparison was established. It was checked if the criteria used in the national documents were still updated and valid and if other countries’ methods of measurement could be considered in work’s measurement in national construction reality.

At this stage it was also done the list of works to be measured. Thus, it is considered that such works are covered by the following construction activities:

a) Site clearance;

b) General excavation;

c) Infrastructure excavation;

d) Filling;

e) Dredging;

f) Surfaces treatment;

g) Ancillary works;

h) Tunnel excavation.
6. Method of measurement

The researched information was considered adequate for the preparation of the method of measurement model. The gathered information and item 3 features were taken into account on the elaboration of the measurement rules and resulted in the following aspects:

a) Initial chapter: where the document general principles were done, namely:
   i. Definitions;
   ii. Objectives;
   iii. Application of Work Classification;
   iv. Coding and numbering of items;
   v. Basic measurement principles.

b) Rules set out in tables (Figure 1): compared to rules set out in text, this was considered the appropriate layout;

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**CHAPTER $$: EARTHWORKS**

<table>
<thead>
<tr>
<th>First division</th>
<th>Second division</th>
<th>Third division</th>
<th>Measurement rules</th>
<th>Definitions</th>
<th>Coverage rules</th>
<th>Additional description rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 General excavation</td>
<td>1</td>
<td></td>
<td>Excluded: Excavation for: Site investigation (chapter **) Deep foundations (chapter **)</td>
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<td></td>
<td></td>
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<tr>
<td>2 Excavation for infrastructures</td>
<td>2</td>
<td></td>
<td>1) By means of powered mechanical equipment</td>
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<tr>
<td>3 Filling</td>
<td></td>
<td></td>
<td>2) By means of explosives</td>
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<td></td>
<td><strong>M1</strong> The quantities of earthworks shall be computed net from drawings with no allowance for bulking, shrinkage or waste.</td>
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<td><strong>M3</strong> An item shall be given for each separate stage of excavation.</td>
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<td><strong>D1</strong> Excavation from within borrow pits: excavation outside of the site...</td>
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<td><strong>I1</strong> The following operations are included: a) Excavation; b) ...</td>
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<td><strong>D7</strong> Filling of foundations refers to the back filling...</td>
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<td></td>
<td><strong>I7</strong> The following operations shall be deemed to be included: a) Spread; b) Compaction.</td>
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</tbody>
</table>

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Figure 1: Rules set out in table.
c) Work Classification: divides earthworks commonly encountered in civil engineering contracts into classes, divisions, subdivisions and sub-subdivisions;

d) Method of measurement for earthworks: compatible and appropriate rules were set out by updating the current criteria;

e) Illustrative examples: illustrating the application of the proposed method of measurement in preparation of the Bill of Quantities.

Finally, five groups of measurement rules were assigned to the works listed in Work Classification for Earthworks, like in “CESMM2” [10], or in “SMM7” [11]. They refer to different kind of criteria, which are the following:

a) Units of measurement: they state the unit in which each item shall be measured;

b) Measurement rules: they set out the conditions under which work shall be measured and the method by which the quantities shall be computed;

c) Definition rules: they define the extent and limits of the work represented by a word or expression;

d) Coverage rules: they provide that the work stated is deemed to be included in the appropriate items that such work is included in the Contract.

e) Additional description rules: they identify the required information that shall be given in addiction to items description.
Main Conclusions

The study carried out in this dissertation is considered a step forward in the establishment of LNEC official measurement rules, giving one more contribution to the investigation about methods of measurement. Then, the following progress is considered:

1. The scope of measurement rules was expanded to other earthworks beyond building construction;

2. A “rules set out in tables” structure was adopted because this new arrangement is considered to have more advantages, especially the connection with other Construction Industry surveys;

3. The current criteria was reviewed and updated, taking into account the following:

   a) The considered scope;
   b) National practices;
   c) Document ease of use.
REFERENCES


[8] NBN B 06-001, mai 1982


¹ Laboratório Nacional de Engenharia Civil