Dredging is the operation of removing material from under water. In all situations the operation is undertaken by specialist floating plant, known as a dredger.
Reasons for dredging?

1. Recover material which as some value or use (form of mining)
2. To create greater depth for navigation (initial or maintenance)
3. Creation of new land by hydraulic fill (airports of Hongkong and Macau.
4. Beach nourishment.
5. Civil engineering construction works (pipelines,...)
6. Environmental dredging (some sediment are highly contaminated)
The dredging project.

1. Dredging Project must be adequately designed and supervised.
2. Economically feasible.
3. Dredgers are expensive and rely in high utilisation and production.
4. Geotechnical investigation to determine the nature of the material to be dredged.
5. Every cubic meter of material has to be relocated.
6. Due to environmental constraints it is difficult to find places to dispose of the material in case of contamination.
Types of dredger

Depending upon the method used to transport loosened material from the sea-bed to the surface they may be classified as:

a) Mechanical dredgers

b) Hydraulic dredgers

c) Other types
Mechanical Dredgers.

a) Bucket ladder dredger
b) Grab dredger
c) Backhoe/dipper dredger
Figure 7.46  Main features of bucket dredger
Figure 7.48 Working method of bucket dredger
Figure 7.49 Statistical distribution of bucket dredgers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum water depth to operate</td>
<td>5.0 metres</td>
</tr>
<tr>
<td>Maximum water depth to dredge</td>
<td>35 metres</td>
</tr>
<tr>
<td>Maximum cut width (single pass)</td>
<td>150 metres</td>
</tr>
<tr>
<td>Maximum wave height</td>
<td>1.5 metres</td>
</tr>
<tr>
<td>Maximum swell</td>
<td>1.0 metre</td>
</tr>
<tr>
<td>Maximum cross current</td>
<td>2.0 knots</td>
</tr>
<tr>
<td>Maximum ice thickness</td>
<td>100 millimetres</td>
</tr>
<tr>
<td>Maximum particle size</td>
<td>1500 millimetres</td>
</tr>
<tr>
<td>Maximum compressive strength (intact rock)</td>
<td>10 MPa</td>
</tr>
</tbody>
</table>

7.12.4 ANCILLARY EQUIPMENT
Figure 7.33 Main features of pontoon mounted grab dredger
Figure 7.36 Examples of various types of rope operated grab buckets
Production cycle for pontoon mounted grab

Diagram:

1. Change barge
2. Swing to mark
3. Discharge
4. Swing to discharge
5. Close grab
6. Raise grab
7. Lower grab

Flow:
- Change barge → Swing to mark → Discharge → Swing to discharge → Close grab → Raise grab → Lower grab → Change barge
Figure 7.34 Statistical distribution of grab dredgers
Backhoe dredger

Figure 7.40 Main features of backhoe dredger
Hydraulic Dredgers

a) Profile or plain suction dredger
b) Cutter suction dredger
c) Trailing suction hopper dredger
Suction hopper dredger

Figure 7.12 Main features of stationary suction hopper dredger
Cutter suction dredger

Figure 7.14 Main features of cutter suction dredger
The main advantages of the dredger are:

- the ability to dredge a very wide range of materials, including rock, and to convey the dredged material by pumping with water directly to the disposal, or reclamation area;
- the ability to operate in shallow water and to produce a uniform level bottom with high rates of production;
- the ability, in the case of some modern dredgers to dredge to a pre-defined profile, e.g. in channels.

The disadvantages include the following:

- a sensitivity to sea conditions;
- limited distance through which dredged material can be economically conveyed;
- dilution of the dredged material;
- limited dredging depth;
- high mobilisation costs.
Figure 7.15 Statistical distribution of cutter suction dredgers
Figure 7.21 Examples of crown cutter action when (a) undercutting and (b) overcutting
Plate 2 The cutter section dredger ‘Leonardo da Vinci’ (27,524 HP) dredging glacial till for reclamation for the Storebaelt bridge in Denmark (courtesy of Jan de Nul; copyright: Ivan Svendsen)
Figure 7.2 Main features of trailing suction hopper dredgers
Figure 7.1 Statistical distribution of trailing suction hopper dredgers
Figure 7.3 Suction pipe of trailing suction hopper dredger, fitted with submerged pump
The main advantages of the trailing suction dredger are:

- relative immunity to weather and sea conditions;
- independent operation;
- minimal effect on other shipping;
- the ability to transport dredged material over long distances;
- relatively high rate of production;
- simple, and hence inexpensive, mobilisation procedure.

The main disadvantages are:

- inability to dredge strong materials;
- inability to work in very restricted areas;
- sensitivity to concentrations of debris;
- dilution of dredged materials during the loading process.

The trailer dredger is normally rated according to its maximum hopper capacity, which is typically in the range 750 to 10 000 cubic metres, but exceptionally may be larger. The statistical distribution by size of hopper is shown in Figure 7.1.
Plate 7 The trailing hopper dredger ‘J F J De Nul’ (11,750 m³) ‘rainbowing’ material ashore during reclamation works for Hong Kong’s Chek Lap Kok airport (courtesy Jan de Nul)
## Transport pipelines

<table>
<thead>
<tr>
<th>Material type</th>
<th>Velocity range (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>Fine sand</td>
<td>3.0 to 4.0</td>
</tr>
<tr>
<td>Medium sand</td>
<td>3.5 to 4.5</td>
</tr>
<tr>
<td>Shell</td>
<td>3.5 to 4.5</td>
</tr>
<tr>
<td>Very soft clays</td>
<td>4.0 to 5.0</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>4.0 to 5.0</td>
</tr>
<tr>
<td>Sand with fine gravel</td>
<td>4.5 to 5.0</td>
</tr>
<tr>
<td>Sand with medium gravel</td>
<td>4.5 to 5.5</td>
</tr>
<tr>
<td>Stiff clays</td>
<td>4.5 to 5.5</td>
</tr>
<tr>
<td>Sand with coarse gravel</td>
<td>5.0 to 5.5</td>
</tr>
<tr>
<td>Sand, gravel and cobbles</td>
<td>5.5 to 6.5</td>
</tr>
</tbody>
</table>

**Note:** Higher velocities than those listed above may be possible. This may result in higher production rates but at the expense of increased power demand and pipe wear.
Figure 7.22 Example of ball-joint connector used in discharge floating pipelines

Pontoons

Ball joint

Swing angle

Ball joint swivel
Ancillary equipment

1. Barges
2. Booster stations
3. Tugs
4. Survey launches
5. The rockbreaker
Cost and Production Estimating
### Environmental Considerations

#### Table 4.1: Potential impacts of dredging

<table>
<thead>
<tr>
<th>Issue</th>
<th>Impact</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short term</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity: settlement of particulates</td>
<td>Blanketing</td>
<td>Navigation</td>
</tr>
<tr>
<td>Turbidity: water column</td>
<td>Water quality</td>
<td>Bioavailability of contaminants</td>
</tr>
<tr>
<td>Removal of benthos and bottom-living species</td>
<td>Disturbance of archaeological sites</td>
<td>Nature conservation</td>
</tr>
<tr>
<td>Removal of artefacts</td>
<td>Physical presence of dredger/dredging equipment</td>
<td>Loss of archaeological remains</td>
</tr>
<tr>
<td>Direct interference and operational effects</td>
<td>Oil spill</td>
<td>Navigation</td>
</tr>
<tr>
<td>Noise</td>
<td>Coastal defence</td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>Inter-tidal/sub-tidal habitats</td>
<td></td>
</tr>
<tr>
<td><strong>Long term</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altered bathymetry</td>
<td>Currents</td>
<td>Nature conservation</td>
</tr>
<tr>
<td></td>
<td>Waves</td>
<td>Fish resources, fisheries</td>
</tr>
<tr>
<td></td>
<td>Sediment erosion/deposition</td>
<td>Archaeological sites</td>
</tr>
<tr>
<td></td>
<td>Salinity penetration</td>
<td>Navigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amenity</td>
</tr>
</tbody>
</table>
Design (Example of navigation Channel)

- Allowance for variations created by winds, waves, and tides
- Vessel under-keel clearance to ensure manoeuvrability
- Allowance for survey inaccuracy
- Siltation buffer
- Dredging tolerance
Site Investigation

1. Characterization of the material to be dredged
2. Determination of the total volume to be dredged
3. The hydrography of the dredging and disposal locations
4. Bathymetric surveys to determine bed levels
5. Geothecnical investigations to assess the nature of the material
6. Environmental surveys to identify factors which may affect the dredging and disposal of the completed works.
Measurements

In principle, the three ways of measuring quantities are:

1. At the dredging site
2. In the means of conveyence
3. At the disposal site
How many cubic meters inside the hoper?