

**UNIT V HARBOUR ENGINEERING****2 MARK QUESTIONS AND ANSWERS****1.What is dredging**

In order to maintain the required level of water in harbor the external material deposited in the bed has to be removed from time to time. This operation of removal of material from the sea or river bed is called dredging

**2.What is a break water**

Break water is a Structure constructed to reflect and dissipate the force of the wind generated waves. If a natural environmental is not available to build a harbor and if it is to be Constructed on an open sea, it is necessary to protect the harbor walls artificially by breakwater

**3.What is meant by Sounding? Name equipment used for sounding**

For planning any maritime Structure the depth of water some distance along the coast and in the area to be developed Should be known. Measurement of depth water the Surface of water is called Sounding

For most engineering equipment works, a boat is used for finding the Sounding using one of the following equipment

1. Sounding cables
2. Sounding rods
3. Eco sounder
4. Fathometer

**4.What is water transportation?**

Among the three modes of transportation, Viz., Land, air and water, water transportation has a signified historic importance. It is the main transportation which was the responsible for cultural relation and growth of civilization. Ocean water transported and inland water transportation

**5.List the various features of harbor**

Features of harbors are

1. Harbor entrance
2. Turning basin
3. Approach channel
4. Break water
5. Lock and locked basin
6. Dry docks and Spillways
7. Piers
8. Berthing basin

**6.How to decide the entrance of the harbor**

A harbor Should be Easily accessible Which is based on the location. The entrance of harbor Should be designed Such that it is Easily negotiate during the Storms. The entrance is generally placed of the sea Such that the effect of rough sea is minimum

**7. Sand dunes**

Sand dunes are formed along the coast Which prevent the the free movement of tides and waves into the area behind it. Sand dunes with time may to the Adjacent areas and damages the property

**8.What is a Wharf? Name it's types**

A wharf is a wall build along the bank or a Shore to berth vessels for working cargo. This may be a sheet pile wall or a gravity wall. The types are Sheet pile walls and Gravity walls.

**9.What is meant by Fog Signal?**

Fog signals are the signals to be provided at places likely to be seriously affected by fog. These are ordinary bells Struck by hand mechanically operated submarine bells, sirens or Whistles

**10. What is meant by Audible Signal?**

Audible signals are to be used at the time of the Emergency in order to attract the immediate attention of marine. They may be Explosive Signals, sirens, bells, diaphones, Electric oscillation, Etc

**11.What are tidal Basins?**

Basins are constructed at the entrance gate position. These basins are partially enclosed areas of water Which are subjected to tidal variation. These basins are also called as tidal basins

**12. What is a dock? List the various types of rocks.**

Docks are enclosed areas of berthing ships in order to keep them afloat at the uniform level. Docks are classified as follows

**Types of docks**

- (a) Dry dock
- (b) wet dock

**13. What do you understand by littoral drift**

As a result wind effect the sand is carried in a zig zag from along the Shore such process of movement and deposition is complex. Such sand drifting forming at the proximity of foreshores are called a littoral drift

So this has to be named as an littoral Drifting.

**14. List the various mooring accessories**

**Mooring accessories are**

1. Mooring port
2. Bollard
3. Capstan
4. Moving buoys
5. Cables
6. Anchors

**16 MARK QUESTIONS AND ANSWERS****1. Write a detailed note on break water. Explain all essential Aspects**

Break water is a Structure constructed to reflect and dissipate the force of the wind-generated waves. If a natural environmental is not available to build a harbour and if it is to be constructed on an open sea, it is necessary to protect the harbour walls, artificially by breakwater

**Classification**

1. Mound or heap break water
2. Mound with superstructure breakwater
3. vertical wall break water

**1. Mound or heap break water**

Where durable rock material is available at economic cost mound or heap break water is the best. this type of breakwater is a heterogeneous assemblage of natural rubble, undressed Stone blocks

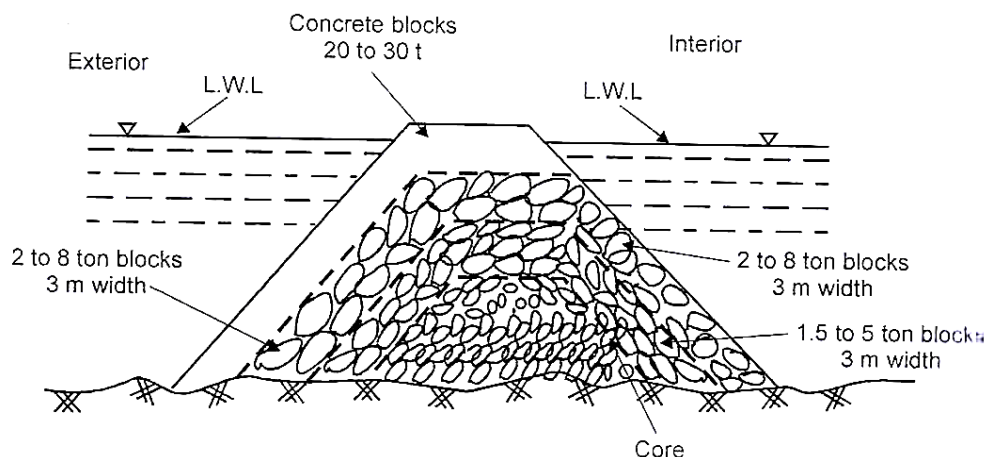
In many cases artificial blocks of huge bulk weight are used. In such depositions no care is taken of the bond or bedding

This is a simplest way of construction without any need of very Skilled labor. It is constructed by tipping or dumping of rubble Stones into the sea till the mound or heap emerges out of the water

**1. Mound formation****2. Protection of faces****1. Mound formation**

Mounds are formed using rubble of assorted weight, placed according to the sizes. In general the Smallest and the material are used in the core

The sizes of the material are to be increased gradually outwards. Such arrangement is made to withstand the action of waves by bigger Size material

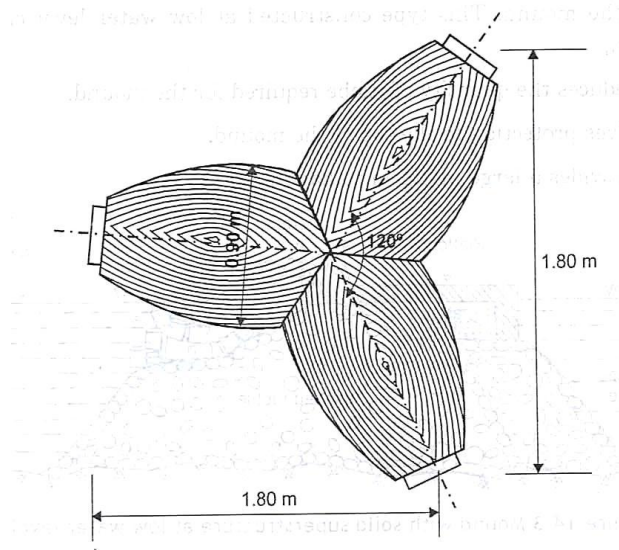


## 2. Protection of faces

On exposed surfaces the waves gradually drag down the mound giving it a flat Slope at the Exterior or sea side. Such surfaces have to be protected

There are three Approaches of protection, viz., by providing concrete blocks, Granite paving or by placing tetra pods

Heavy blocks of concrete may be dropped on the top of the front faces. This is to be great Extant prevents the flattening action of the waves. These blocks weigh about 20 to 30 tones and are dropped at the random or laid in the courses

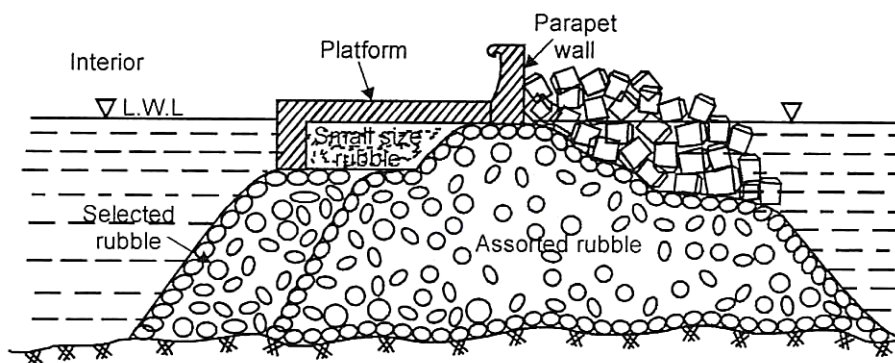


## 2. Mound with Super Structures

**Mound with Superstructure Break water are founded at two levels.**

1. At low level
2. Below low water table

### 1. Founded at low water level

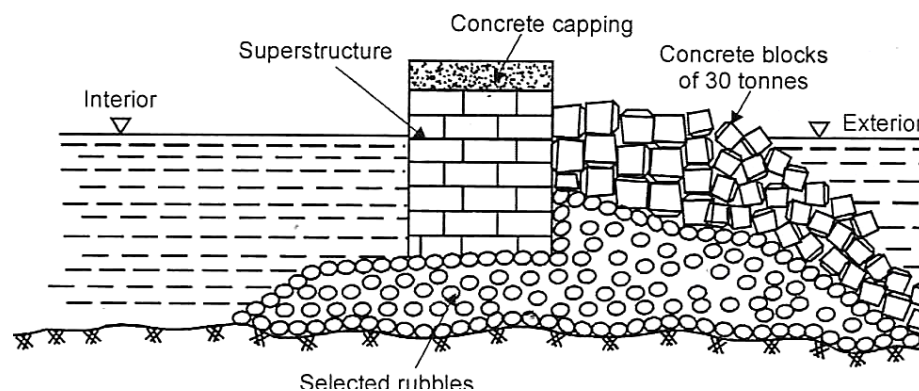


In mound with Super Structures founded at low water table, A solid Structure consisting of a quay protected by a parapet on the sea ward side is Constructed on the top of the mound

- (a) It reduces the quantity of rubble required for the mound
- (b) It gives protection to the top of the mound
- (c) It provides a large platform to handle

## 2. Founded below low water level

In this type of construction the superstructure is founded below low water level and thereby reducing the disturbance of waves, this the type of construction is very economical



## 3. Vertical wall breaker

Upright wall breaker are preferred when the following field condition Existing

1. Sea bed is resistant to erosion
2. Foundation are not Subjected to differential settlement

An upright breakwater is designed to withstand the failure due to the following

1. Failure by Overturning
2. Failure by Shearing of bed joints by Sliding of one block against
3. Failure by uplift of horizontal layer
4. Failure by fracture

### 1. Failure by Overturning

In order to prevent the overturning the resultant of the weight of the wall and the horizontal pressure Should fall within the middle third of the base

It has been estimated Experimentally that the Horizontal Forces causing Shear and the overturning has been the maximum value of 30 t/cm considering an average waste height as 8m.

### 2. Failure by Shearing of bed joints by Sliding of one block against

Shearing of bed joints due to horizontal pressure of the wave may not be prevented by motor of the frictional resistance offered during signal

Hence to prevent failure by Shear caused by the horizontal forces due to the wave, the mortar joint Should be adequate Strong and of the Stone

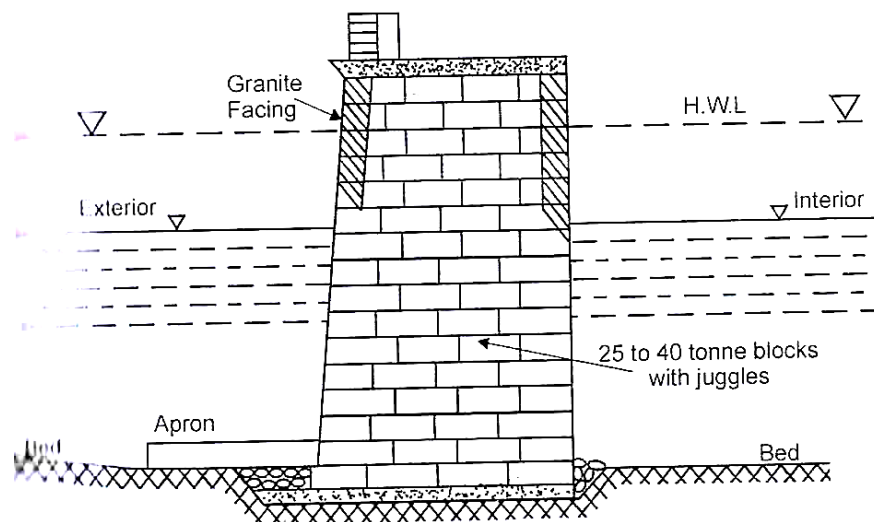
The co-efficient of friction available in concrete or Stone blocks is 0.7.. Hence a resistance of  $0.7 W$

### 3.Failure by Uplifting

This is due to hydrostatic pressure underneath the mass. The only opposing force sustain this is the weight of the masonry

### 4.Failure by Fracture

This is not caused by wave action. This may be due to dislocated blocks knocking against each other to wave and making the joint loose. This may be avoided by providing proper bonding in the masonry or by providing joggles



## 2.Enumerate the various types of Harbors with neat Sketch

As defined earlier the harbor is a place Where the Ships get Shelter and the protection Against adverse natural and the other destruction element of the sea. The water transportation has improved and the other Significant way and the vessels gradually increased in Size, number and also the importance

### Classification

#### Harbors are Broadly Classified into

- 1.Natural Harbors
- 2.Semi- natural Harbors
- 3.Artificial Harbors

#### 1.Natural Harbors

Natural harbors are those Which are located in places Where the topography of the coast is in such a way that a part of the sea is protected by land.

Such a coastal land is capable to afford safe Shelter and discharge facilities for the Ships in the form of the creeks and the basins

Rapid development of an navies, both the commerce and the war, have to demanded accommodation, facilities for repair, Storage and the cargo and the other connected amenities to be provided in natural basins

Further other factors Such that as local geographical features, new vessels, Growth of population, facilities for repair, Work of extension and the improvement for the natural Harbors

### **2.Semi-natural harbors**

If a geographical topography is available but to be modified at the entrance only id referred to as a semi-conductor. Visakhapatnam is a Semi-natural harbor

### **3.Artificial Harbors**

If a natural Topography does not afford naturally protected area, and the same is created by Construction of protective works by making engineering Skills and the methods, Such a harbor is Known as an Artificial Harbors.

### **3. What are Navigational Aids. Explain the various Navigational Aids in Detail**

During the time of the navigation of the Ships Should be provided with some Guidance for the following reasons

- 1.To locate the primarily the port
- 2.To identify proper harbor approaches
3. To avoid the dangerous Spot in the like hidden rocky outcrops and sand dune

### **1.Light Stations**

Light Stations are general lights are the aids to navigation along the cost, and through river as approaches to harbors. These light Station are of two types., viz., Fixed light Station of floating light Stations

The light Station which are build on land are called fixed light Stations. These are permanent Structures Which are build hinter-land close to the Shore or in the sea on Submerged outcrops.

Floating light Station in the form of a light vessels may be adopted. Such Structures area also called Which is a type of a Signal

### **2.Light House**

It is a tall Structure Constructed with or reinforced concrete in the shape of a tall-tower on a high ground on land or on rocky outcrops in the water..The tower is partitioned into the number of floors. The top most floor is provided with powerful lighting device.

The lower floors are used as a service room, floors.., the lighthouse, either on land or an island has to be connected with the nearest village or township by proper communication



The lights at the top most floor may be Fixed or flashing for easy identification by the navigator. Each lighthouse has a Specific type of lighting or flashing, accordingly they are easily identified

The illumination of the light is both refracted through powerful lenses and prisms and refracted or flashed by highly polished hyperbolic concave mirrors. Such an arrangement provides a high visibility from long distances.

#### 4. What is meant by signaling. Explain the various types of signaling with neat Sketch

Signals are the device used to guide the approach channel of the port. the main requirement of marine signals are

1. To be simple for easy identification
2. To be positively recognized
3. To be clear visible from a long distance
4. To be single character without ambiguity

#### Types of Signals in Harbors

##### 1. Light signal

Light Signals are been Classified into following three types

- (a) Light Ships
- (b) Beacons
- (c) Buoys

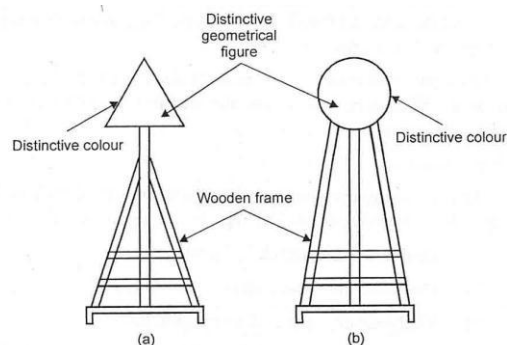
##### (a) Light Ships

If it is not feasible to locate Suitable place on land or on land or on sea to build a lighthouse, light Ships are used. these are Small Ships provided with a lantern on an open Steel tower of about 10m Above the water level. the lighting apparatus consists of four pairs of mirror reflector placed around the light

It is designed to resolve at a suitable speed emitting a predetermined number of flashes

Light Ships reflect more Steady lights Which is an important factor a marine and the Ships are more Stable. The Ships is painted in red colour with in the Ships for hoisting at the time of the need

##### (b) Beacons

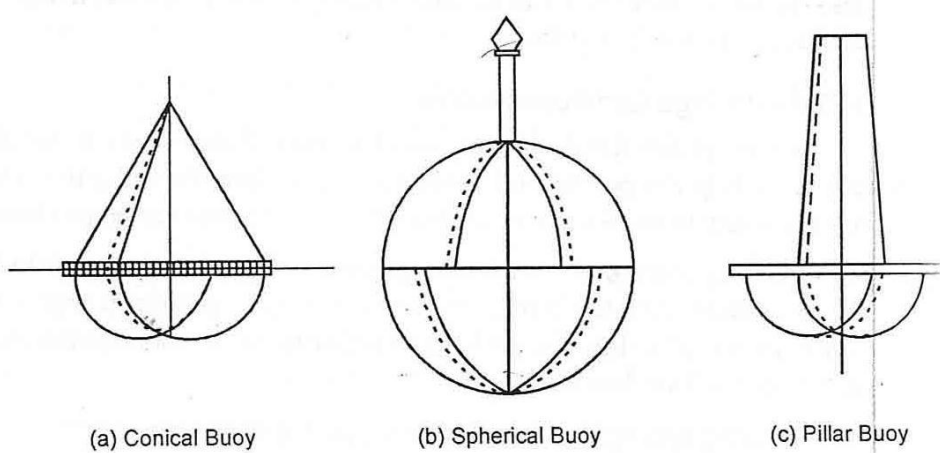


Any natural or artificially made prominent object Which could be easily identifiable and the used as a guide in navigation is called a beacon

### (c) Buoys

Buoys are of different patterns. The design is made is such that it Supported it is own weight and the weight of the cable or chain. They are made out of Steel and iron plates of minimum 6mm thickness

They are hollow Structures so as to make them to float. The diameter of buoys vary from 1.80 to 3.0 m. buoys are also classified accordingly to their Size, Shape, Colour, weight, purpose, etc



### 2.Fog Signal

As the very name Signifies that there are the Signal to be provided at places likely to be Serious affected by fog. Following are the forms of Signal used

1. Ordinary bells Struck by Hand
2. Mechanically operated ordinary bells
3. Mechanically operated Submarine bells
4. Sirens or Whistles blown using compressed air or Stream

### 3. Audible Signals

These Signals are to be used at the time of the Emergency in order to attract the immediate attention of marines. They may be Explosive, Signals, Sirens, Bells, Diaphones, Electrical oscillations.

These audible Signals are very useful during thick mists or flogs. However, the Signals Should be made in Such a way that correct direction is properly notified

### 5. What is meant Docks. Explain the dry docks and wet docks with neat Sketch

Ships are subjected to vertical movement by tide which may cause inconvenience for loading and unloading of cargo. In order to facilitate this, special arrangements have to be made every time. In order to circumvent this difficulty docks are constructed.

Docks are enclosed areas for berthing ships in order to keep them afloat at a uniform level

**Docks are classified as****1. Wet Docks****2. Dry docks**

Docks which are used for loading and unloading of passengers and cargo are known as wet docks. Docks which are used for repair of vessels are known as dry docks.

**1. Wet docks**

Wet dock may be more precisely defined as a dock in which the water is kept at high tide level by dock gates which are opened only at high tide. A lock is usually provided to enable vessels to pass in or out at all the sites of the tide and to maintain the water level

**Tidal Basins**

Basins are constructed at the entrance gate position. These basins are partially enclosed areas of water which are approached by open entrance which are subjected to the tidal basins. These basins are also called as tidal basins

In the tidal basins vessels can come in and berth or leave at the times. This enables a speedy and unrestricted arrival and departure of the ships. In such a situation locks are not needed

But if the range of the tide is more there is a necessity for lock gates which forms a wet dock. Wet docks have several advantages

1. uniform level of water is maintained which enables easy handling of cargo
2. prevents the building of the side of ships against the quay
3. Avoid the necessity of constant attention as mooring
4. Adverse weather condition at the outer sea has no effect on the wet docks

**Approaches**

The approaches to basins and DOCKS should be of adequate length and should be sheltered. Further, so as to keep approaches portion navigation dredging should be done periodically. Maintenance of approach channel is costly only at the time of high tides

**Depth**

The depth of the docks and basin should be capable of accommodating the largest vessel likely to visit the port. Deepening can be done as and when needed without disturbing the docks and quay walls

**Shape**

As ships cannot stand along side of a curve, it is advised to have shape formed by straight lines. Three types, viz., rectangular, diamond and inclined quay type are done

**Location**

Docks are generally located on inland ports of the river, at estuaries, or on open sea coast. A site on the sea coast is highly preferred. On the other hand a site on the estuary of a river, if sheltered and broad is preferable

## **2.Dry docks**

Dry docks is a dock into the Ships floats. The dock gates closed behind it, the water is pumped out, and the Strip rests on the docking blocky ready for it's hull to be repaired or cleaned

### **Method of Dry Docking**

**The sequence of separation of a dry is given below**

1. Keel from and bilge blocks are arranged to receive the vessel
2. Water from the sea side is allowed to flood the docks. This is preformed by permitting the entry of water from the outside through the valves.
3. Gate is then opened and the water from outside through the valves
4. When water level in the docks has risen enough so as to clear the vessel with adequate margins over the cell
5. The vessel to be dry-docked is manoeuvred in
6. Sides of the vessels are supported with the help of Shores on either side

### **Components of a dry docks**

Dry docks is called a gravity docks is a

- 1.Long excavated Chamber having**
- 2.Side wall**
- 3.A semi-circular end wall**
- 4.A floor**

The approximate Size of the typical dry docks is 30cm\*15\*300cm. However the Size varies with the Maximum Size of the vehicle to be accommodated in the dry docks

The dock floor is made out of the rich concrete and it is very heavy. Keel and the bilge blocks are fixed on the floor so as to reset Ships on them after emptying the docks. The floor a cross fall to the side drains which have a longitudinal slope to carry wash water, other accessories include large capacity pumps, lifting and hoisting machineries and repair equipment

### **Design Aspect**

Forces which are to be encountered in the design of a dry-docks are given below

1. At the docks empty condition, the weight of Ship is resisting along the centre line of the docks floor
  2. Weight of the water on the floor When docks is flooded
  3. Uplift pressure under the floor of water when it is being emptied
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4. Earth pressure and the hydrostatic pressure behind the side wall
5. Surcharges on the wall due to the cranes and the heavy Stationary and moving applications

### 1.Docks empty condition

Under no vessel condition, the uplift pressure will be more than the weight of the floor. The unbalanced excess pressure will be transmitted to the side walls by actual or virtual inverted arch action. this is being resisted by the weight of the side wall and the horizontal the pressure behind it.

The weight of the Ships resting on the floor transfer large concentrated load at the load centre line of the floor. Thus a heavily reinforced floor section is necessary. It is generally assumed that 5/8 of such that loads are borne by keel blocks and the rest equally by bilge blocks

### 2.Docks filled with water

This the condition improves the greatest load on the foundation. The horizontal pressures behind the side are balanced by the inside hydrostatic pressure. Under this condition, there will be the no arch action and the load on the side walls is due to Self weight plus Surcharge less the buoyancy

### 3.Construction Aspect

Construction of the Dry-Docks has to be done with utmost care and the following construction procedure is Adopted

1. Excavated is done partly and the side wall portion Shown a is constructed
2. The core portion b is Excavated to lay the floor is Short lengths, keeping the core c constant
3. After Exacting the core c floor the flooring in the central portion is placed
4. Then the upper portion of the side wall marked are constructed
5. The back fill e placed to complete the work

### 6.Explain the layout concept on harbor With neat Sketch

#### *Harbour Planning And Layout*

#### 1. Planning

Planning of a harbour has to be done in a meiculous manner after collecting all the required information at the proposed site. The most important factors which are to be considered during the planning are discussed below.

- i) A survey of neighbourhood including the foreshore and the depth of water in the site are to be carried out.
- ii) In order to get the details of the substrata below the water brings and soundings should be taken.

- iii) It is also necessary to make borings on the landside to know the subsurface conditions on the land.
- iv) Nature of harbour, whether sheltered or not has to be studied.
- v) Possibility of undermining of structures and foundations by insects have to be studied.

### **Layout**

There is no set rules governing the layout of a harbour. There are two main considerations in harbour layout, viz., the problem of littoral drift and protection from storm waves.

In any harbour where there is shipping, there is bound to be siltation either due to littoral drift or otherwise. The amount of siltation depends on the depth of water. In deep water the effect of siltation is not noticeable. It is erroneous to conclude the amount of silt based on the previous hydrographic charts.

In the approach channel a moderate current is desirable. Harbours which are inland and protected naturally are safe from sea waves. Otherwise artificial protection in the form of breakwaters is necessary.

Selection of location of the harbour approach is very important. It is preferable to protect the entrance by a longer breakwater on the wharveside. As a general rule the width of the entrance may not be less than the length of the biggest vessel using the harbour.

High amplitude waves create a possibility of the entering vessel touching the bottom. In general, the surface of the trough of a wave is about one - thirds the wave height below the still - water level.

A geometrical shape of the harbour is prone to develop resonance. It is advisable to break the geometry. This can be done by providing breakwaters or berths in the harbour.



**6.Enumerate the various Site investigation involved in harbour construction*****Site Investigation***

After selecting a site based on the above factors, data necessary for planning, and design of harbour should be collected. Site investigation work comprises of following steps:

- i) Topographical surveys
- ii) Hydrographic surveys
- v) Geological data
- vi) Soil investigation
- vii) Seismic data
- viii) Local resources
- ix) Model tests

**Topographical Surveys**

Lan topography of the harbour and terminal area should be obtained along with contour plan of the ground. Further it is to be noted, the location of borings, test pits, buildings, utilities and local landmarks.

**Hydrographic Surveying**

For planning any maritime structure the depths of water some distance along the coast and in the area to be developed should be known. Measurement of depth of water below the surface of water is called sounding. The science of measuring sounding depths and currents and plotting them as charts comprise hydrographic, surveying. Compared to land surveying, hydrographic surveying plays a great role in the planning and design of marine structures.

The main aim of making soundings is to determine the configuration of the seabed. For most of the engineering works, a boat is used for finding the soundings using one of the following equipments:

- i) Sounding rods or Poles
- ii) Sounding cables or Lead lines
- iii) Eco-sounder or Fathometer

### i) Sounding Rod or Pole

It is a wooden or bamboo pole of 5 cm diameter and 2.5 m length. A disc of 10 cm diameter is fixed at the bottom of the pole. The pole is graduated in metres and centimetres. The sounding pole is suitable for measurement for depths up to 2.5 m. In order to measure the depth, the sounding pole is slowly dipped vertically from the boat at the required place such that the disc rests on the bed of the river. Then the depth of water is noted from the graduation on the pole (Figure 13.12)

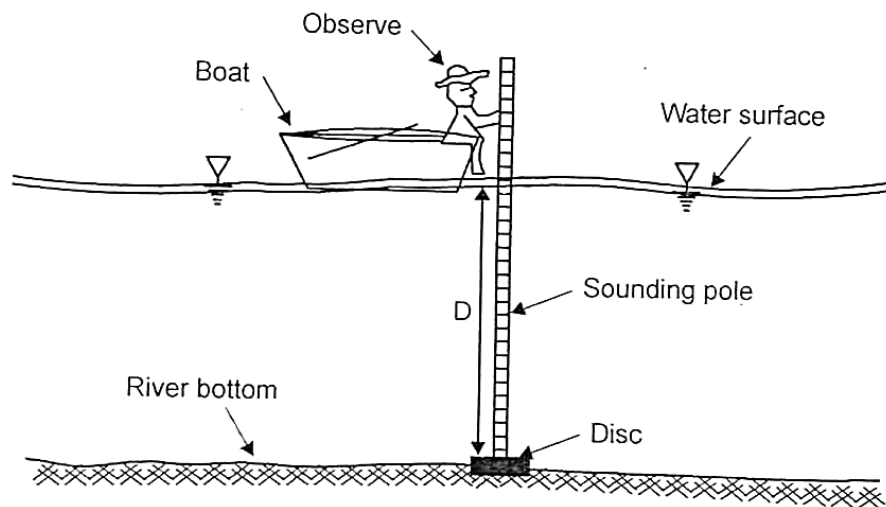
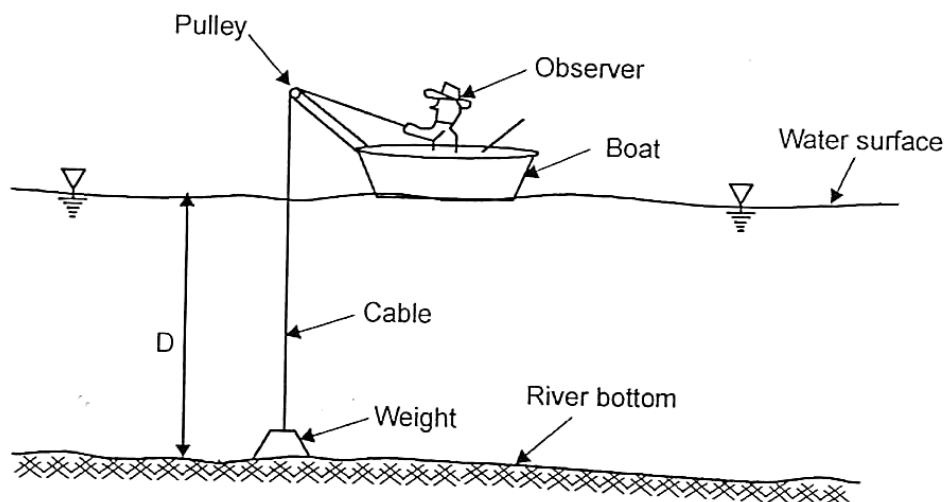


Figure 13.12 Sounding pole method

### ii) Sounding Cable

Use of sounding pole can not be effectively used if the depth of water is more than 2.5 m and water current is high. In such a case a cable or rope is used.





4. It is a more sensitive instrument.
5. The measurements are taken with more speed and continuous
6. It can be used in any sea or river bottom condition.

### 3. Meteorological Data

Wind velocity, duration and direction at the selected site should be recorded at least for one year. Wind rose diagrams are drawn for aligning different elements of the harbour. All details of wind such as wind velocity, radius of wind, wind duration etc are collected. Further, details of cyclonic storm, frequency, pressure drop are collected.

Other meteorological data such as temperature (daily, monthly, average), barometric pressure, monthwise rainfall, relative humidity, should be collected and compiled for necessary use. All such data available from a neighbouring existing or upcoming harbour site may also be collected.

### 4. Oceanographic Data

Oceanographic data comprises of data pertaining to tides, waves, currents, surface salinity and sea bed details. Tide tables concerned to a site should be available. If the details are not available tide gauge stations have to be established to find the various tidal levels. The details needed are diurnal high waters and low waters and maximum and minimum tide levels expected at a particular place. These data are needed for optimum design depth of channel, turning circle and sometimes even berths.

During tidal cycles at maximum spring and neap tides, it is necessary to collect information concerning the direction, velocity and duration of currents. In case of fresh water discharge current characteristics, particularly at highest flood discharge should be assessed. Further pattern of current at important locations of structures are to be studied. In the proposed harbour and channel areas, the feasibility of existence of under water cross currents should also be investigated.

Based on the available information the quantity of siltation and littoral drift should be accurately assessed. Further information of sea bed materials, suspended load, salinity of sea water, and average temperature are to be gathered.

### Geological Data

The subsoil and rock below the sea bed should be known to take care of the structure planned to be constructed over the site. The details required are the layer of soil and their thickness, underlying bed rock. Type and strength of bed rock, fissures, faults and folds. Presence of any active fault has to be ascertained.

### Soil Investigation

Structures to be constructed on shore or off-shore need a through soil investigation. For examples structures for harbours, channels, breakwater, pier, waves, need a detail soil investigation.

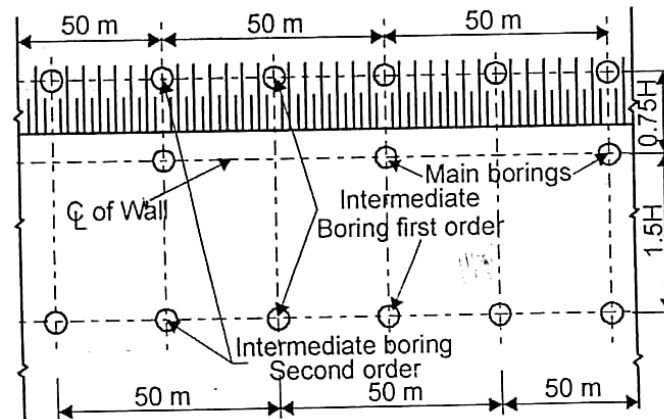


Figure 13.15 Layout of borings for waterfront structure in docks and harbours

Adequate borings have to be made and boring logs are to be plotted. Main borings should be along the top edge of shore at every 50 m. In reclaimed areas large diameter bores should be used. Soil profile is ascertained after probing in between the bores.

Based on the findings of main bores, intermediate borings are made to a depth at which the known uniform soil layer, as identified in the main bore-log, is encountered. These intermediate borings are called as intermediate borings of first order. If considerable change in the upper layer is noticed, intermediate borings of second order may be made (Fig. 13.15).

The depth of boring in general should be taken at least 3.0 m in hard strata or to a depth equal to twice the difference in ground elevation on either side of a structure.

### 9. Model Testing

In developing a harbour project, hydraulic model testing has been considered a necessity. These models could be of tidal models or wave models. A properly conducted hydraulic model yields so many useful results such as

- i) protection of docks from wave action
- ii) effects of diffraction and refraction on waves
- iii) effects on littoral drift and possible erosion and deposition
- iv) effects of tidal currents.