Unit - 5

Historical Development of Ports Harbours & Docks.

Roadways & Railways are common means of transportation on land while waterways are common since hundreds of years for travelling b/w different countries connected by seas & oceans.

Air travel is common through airways. & it is high cost to travel.

In world two-third of entire earth-surface is covered by water which proves importance of waterways (or) water Transportation.

Water Transportation

Inland water Transportation

either in the form of river transportation or canal transportation

River transportation became popular in our country since 1855

Ocean water Transportation

Adopted for Trade & Commerce. It is estimated that about 75% of International Trade is carried out by shipping.

The development of navy force is intended for national defence.

Terms

Break water:- a construction in or around a harbour designed to break the force of the sea & to provide shelter for vessels lying inside.

Berth:- A space for a ship to moor or a vehicle to park.

Pier:- A raised platform built from the shore out over water supported on piles

A similar structure especially at a seaside resort, used to provide entertainment.

Quay:- A stone or concrete structure on navigable water used for loading & unloading vessels.

Jetty:- A structure of wood or stone extended into the sea to influence the current or tide or to protect a harbor

Wharf:- A man-made landing place for ships on a shore or river bank.

Classification of harbour depending upon the utility

(i) Harbours of refuge
(ii) commercial harbours
(iii) fishery harbours
(iv) military harbours
(v) marina harbours.

Harbours of Refuge :-

(i) Ready accessibility from the high seas.
(ii) Safe & convenient anchorage against the sea.
(iii) facilities for obtaining supplies & repairs.

It is also called as fastened in the river or offshore area

on dangerous coast-lines, disabled (or) damaged ships, under stress of weather conditions will need quick shelter & immediate repairs.

All types of naval craft, small & big, will need refuge in an emergency & hence such refuge harbours should provide commodious accommodation.

modern big ships require a lot of "elbow room" for purpose of manoeuvring (or) turning about.

Any turn or bend like that of the elbow in a wall, building, coast line.

Commercial Harbours :-

A Seaport is the centre which receives passengers & cargo from the interior (hinterland) of the country

↳ The land next to inland from, a coast

for onward transmission to other countries or other coastal towns within the country & at the same time receives cargo & passengers from other countries or other coastal towns within the country for onward transmission to the interior of the country.

1. Terminal buildings consisting of.
   (a) administrative block
   (b) Customs clearance
   (c) Warehouses & transist sheds.

A place for storing large amounts of products

act of passing across, over of people or goods

2. The docks:
3. The Harbour

Harbour which is primarily responsible for providing shelter/ Protection to the ships. There may be many harbours without associated port complex. majorly the commercial harbours, connected with the ports.

A port is a facility for receiving ships & transferring cargo. They are usually situated at the edge of an ocean, sea, river, (or) lake.

Ports often have cargo handling equipments such as

Cranes (operated by longshoremen) & forklifts.

The terms "Port" & "Seaport" are used for ports that handle ocean-going vessels & river ports is used for facilities that handle river traffic.

* "fishing port" is a type of port (or) harbour facility particularly suitable for landing & distributing fish.

* "dry port" is a term sometimes used to describe a yard used to place container.

* "warm water port" is a port where the water does not freeze in winter.

* "Port of call" is an intermediate stop.

* "heaven" is a type of harbour used in names & adds the idea of refuge.

Early Period Travellers :-

South Africa is one of the most unfortunate countries in the world regarding natural, protected harbours & navigable rivers.

The history of harbours can be divided into two parts namely ancient harbours fromm 3500 B.C to 500 A.D & modern harbours starting from 18th Century.

B/w 500 A.D & 1800 A.D. no development took place in the advancement of harbours.

In other words from the end of the Roman empire to the beginning of the 18th Century the art of harbour building was at a Standstill.

The early harbours had many interesting features which the dock engineers find it still worthy of study.

my The ancient harbours had characteristic features of Solidity & architectural grandeur which cannot be attempted in modern times.

greatness

my Such an effort could be made only in the past when there was almost unlimited supply of cheap manual labour.

Mediterranean Harbour :-

The mediterranean Sea can be considered as a huge harbour protected by land from all the four Sides.

my It is therefore not Surprising that the earliest Seafaring nations were in Zone of the mediterranean.

my This accounts for the location of all the ancient harbours in the mediterranean.

Generally, the changes of the sea level needs to be stressed.

Changes in sea level affect the Sedimentary Processes on a coast.

There are several reasons for the declining of an ancient mediterranean harbor. Besides wars & diseases as anthropogenic reasons, also environmental changes like a prograting delta, coastal dynamics, high sedimentary supply, tectonic uplift; floods, & a changing sea level could lead to the destruction of the harbour sites.

Cretan Harbours :-

Crete is a region of greece, it is the biggest Island & the most Southern one.

In Crete there are two main harbours the Heraklion harbour & the Souda Bay harbour.

The Cretans were the earliest navigators. They have established trade with Spain & England as early as 1600 B.C.

- It may be that their ancestors made long voyages even before 1600 B.C.
- This is corroborated from the fact that bronze was made in Egypt with tin derived from cornwall about 3500 BC.
- The discoveries made by Sir Arthur Evans in Crete have established that the commercial activities of the minoan dynasty dates back to about 3400 B.C.
- There was a great commerical road connecting Knossos, the minoan capital & the southern harbour at mesara. The ruins of part of this road still remain.

A-ur on the Canopic branch of the Nile, Constructed about 3000 B.C was the earliest Egyptain port with with commerce was carried out from Crete.

my The harbour, however, now is not tracable.

Pharos Harbours:- (An ancient lighthouse or beacon to guide sailors.)

B/w 1910 & 1915. Gaston Joudet, the chief engineer discovered the pre-Hellenic of Egyptian ports & lights which was constructed b/w 1900 & harbour of pharos 1800 BC.

my B/w this harbour & the rock of Abu Bakar there extends a depression in the sea bottom which is at present 6 to 10 m deep.

my This area was part of the great inner basin of the harbour.

my The entrance to this harbour by a deep sea channel is marked just off the point of Ras-el-Tin by a landing Quay 14 m wide built of rough-hewn blocks some of them 5 m long.

my The great breakwater facing the sea to the north can be traced for a distance of 2000 metres.

my Later on when Alexander the great linked up Pharos with the main land & constructed the harbour of Alexandria, his engineers had no idea of the ancient works.

Phoenician Harbours :-

Phoenician were the next nation which became prominent as a seafearing nation

- The cretan settlers on the phoenician coast gave them the required knowledge & technique.
- The cretan settlers passed the straits of gibraltar in 1250 B.C & founded the city & port of cardiz.
- These people first inhabitated the city called sidon, in consequence of its being built by the eldest son of Canaan after whom ~~the~~ city has been named.

Greek Harbours :-

The harbour of greece were of smaller magnitude than those constructed earlier.

- The original port of Athens was the small harbour of phalerum situated on the bay of the same name.
- It was a small / land locked embayment, approximately circular & about 300 metres in diameter & was protected at its mouth by two masonary moles, leaving a narrow entrance b/w the pier heads which could be slightly raised closed at will by means of chains.
- The port of piraeus was transferred to the peninsula of munychia by themistocles.
- On the east side the peninsula was the harbour of munychia a similar landlocked bay almost circular with a diameter of about 420 metres.

→ on the west side were the three ports communicating with each other & all larger than the ports of phalerum & munychia.

→ The outer port was flanked by rocky head lands, & moles or piers of masonry ran out b/w them.

→ In order to protect the communication b/w the ports & Athens & the ports themselves, from landward attack, the Athenians in & after 458 B.C. built the long walls uniting Athens & piraeus, & fortified the whole peninsula of munychia.

Roman Harbours:-

The Roman Harbours were surrounded by breakwaters of solid masonary, which was brought up from the sea bed & frequently supported on piles driven down to a solid foundation.

→ The use of famous Hydraulic Cement ↳ mixture of lime with Pozzolana, a volcanic tufta obtained from the disticts round contributed most to the success of Roman works.

Rock ejected from vent during volcanic

→ This hydraulic cement was the predecessor of the present day port land cement.

replaced

→ The arched moles at Puteoli. These were three semicircular Roman arches.

↳ emporium was the great emporium

- The width of each pier was approximately the Same as the span of the adjoining arch.
- The port of ostia was constructed by Augustus & enlarged by claudius & Trojan. Beside the port of Trojan a canal was constructed providing communication b/w the lower reaches of the Timber & the sea.
- This Short-cut reduced the distance to be traversed by Small vessels proceeding upto Rome considerably.
- The Roman Harbours of ostia have been Silted up, but the ruins of these Still remain at some distance from the Sea.
- In order to appreciate the design of the early harbours it is necessary to Known for what type of ships they were built to accomodate.
- The merchant vessels as a rule were much larger than the war vessels.
- The merchant of thirty-oared galley, which was the Smallest war vessel, measured 21 metres in length with 4.5 m free board & the beam 4.5 to 5.4 m. This had a Single bank of oars.
- The average tonnage of commercial vessels in 250 B.C was 400 tonnes & it was 500 tonnes in A.D. 50.

Eighteenth Century Harbours :-

B/w 50 AD & 1700 A.D. No harbour works of any importance were carried out.

→ The revival of harbour construction was fostered by military reasons, primarily because of Introduction of Cannon in Ships & the necessity of protecting commerce against bombardment.

→ The engineers who designed the harbour works were military engineers & their construction involved considerable amount of land fortification.

Slipways & Dry Docks :-

Both Slipways & dry docks are used for repair to the ships. It is the typical Ship slipway on a Solid foundation.

The stem of the vessel when in the raised position does not go beyond the point G & the remaining frame work carries the winding gear.

→ The dry dock is Similar in construction to the dock with the locks.

→ When the vessel has been brought in position, the water is pumped out from the dock chamber & the required repairs Can be carried out.

Dredging Machines :-

Belidor's dredging machine dredger. It is the prototype of the modern dipper dredger.

→ The buckets on each side are provided with tip doors for emptying & are operated by men in

"Squirrel cages"

→ The larger cages are used for working the cutting stroke through the medium of chains & the smaller ones are used for working the overhauling ropes.

Slipways :-

Components of slipways :-

This technique is used for the building of ships (or) for repairs.

→ A slipway consists of inclined path of timber or stone upon which a series of rails are fixed & they run up from a sufficient depth of water to the required height above the high water level.

→ The lower end of the slip is tidal & open to the water.

~~The lower are~~ The temporary dams are sometimes constructed to increase the effective working length of the slipway.

(i) Flat footed rails :- for the construction of slipways, flat footed rails of standard sections are used.

(ii) Crane track foundation :- The main problem in slipway construction is that the crane track foundation is partly in dry, partly b/w tides & partly under water.

(iii) Cradle (or) Carriages :-

Rigid type :- These cradles are single long units & they can handle vessels upto 1000 t.
These cradles require longer slips.

Semi-rigid type :- These are comprised of a series of section closely coupled together with coupling system as simple as possible. They require shorter slips ~~are~~ as compared to the rigid type.

Collapsible type :-
These cradles require shortest possible length of slip & they reduce the expensive under water work to a minimum. These cradles are in the form of a series of bogies connected by chains.

2 Traversing slipways :-
The slipways on which the ship after being pulled up to the highest point can be traversed sideways to other berths are known as the "traversing" slipways.
Separate boggies are employed & the arrangement of rails is made in such a way that the boggies, cradle & ship can be traversed sideways to an adjacent berth.

- The Ship is transferred by Jacks to the fined berthing blocks clear of the cradle.
- The boggies & Cradle are then returned to the main Slipway line & the cradle is lowered to pick up another Ship.
- Type of Slipway is useful where the number of ships Coming for repairs is Quite large.

Graving Dry Dock :-

This Stand Still like a grave of dead body hence it is named graving dry dock.

It is an excavated chamber having, Side walls, endwalls, front opening with gate & a Solid floor.

- Side walls are two in numbers constructed in form of 2m Steps of Concrete or masonry coverted with granite Stones on exposed Surfaces.
- The Side walls house galleries at higher levels to house pumps (likely to be damaged by entry of water) & culverts at lower level to drain out unwanted liquids.
- The outer Side is provided with batter or Stepped to increase width at base to make wall Stable, against worst combination of loads.

end wall may be Square, Circular, elliptical or trapezoidal in plan. It is constructed Solid without galleries. from Side opening is covered by gate.

Indian Ports :-

In India, there are 48 major ports, 21 International ports & 144 minor ports.

→ The eight ports are calcutta, Bombay, Chennai, cochin, Visakhapatnam, Kandla, Paradeep & marmugaon.

bombay Port :-

Bombay Port has since long been the main gateway of India.

↓

It is located b/w the Island of Bombay on the west & the main land on the east.

↓

It is ideally suited for International trade because of its easy accessibility by Sea by air & by land.

↓

The history of the present Bombay port dates back to 1532 A.D when it was occupied by portuguese.

↓

Due to limited resources & lack of administrative capacity of the portuguese where was no development of the port 1 1/2 Quatar Century. (129 years)

↓

In 1661 the port & island of bombay were transferred to the King of england under a marriage treaty.

↓

In the year 1668 the port was transferred to the east India company.

docks.

Transit Sheds :-

depending upon the temporary Storage accommodati-
required.

→ ware-houses for Storing incoming & out-going Cargo requiring comparatively longer period of Storage.

→ Administration & terminal building.

Harbour depth :-

$$D = D_1 + \frac{H}{3} + D_2$$

D_1 = draft of the largest Ship to be accommodated

D_2 = allowance for Squat of the moving Ship

H = Height of Storm waves.

Max. harbour depth = loaded draft + 1.2m
(when bottom is Soft)

max harbour depth = loaded draft + 1.8m
(when bottom is rock)

The maximum harbour depth of lowest low water is achieved as above.

Harbour Planning :-

Harbour planning Should be carried out after collecting the necessary Information at proposed Site.

(i) Survey — foreshore & depth of water in the vicinity.

(ii) The borings & Soundings Should be taken to ascertain the character of the ground.

(iii) borings on land to known probable Surface conditions.

(iv) The existence of Sea insects which undermine the foundation Should be noted.

(v) Problem of Silting or erosion of coastline Should be carefully Studied.

(vii) The metreorological phenomena should be Studied at site especially with respect to Natural frequency of Storms, rainfall, range of tides, max min. temperature, direction of winds, humidity, direction & velocity of currents.

→ The Bombay Port Trust has erected 178 fire proof ferro- concrete godowns equipped with Sprinkler protection.

→ 16 open sheds on plinths & 225 open plinths. for Railway reception & despatch it has 16 covered platforms & 4 open plinths.

Services are available within the depot.

1) fire Brigade Salvage Corps Station
2) Dispensary
3) Canteen
4) grain Shop
5) warehouses & godowns.

During the Second world war & thereafter, there was rapid Commercial & Industrial development of the port.

→ The Increased traffic in oil, more than 5 times after the construction of a New marine Oil Terminal consisting of three berths.

Increase in dry tonnage

1) working the docks 20 hours a day in three shifts
2) Payment to the labour on the output bases
3) Introduction of mechanical handling of Cargo
4) maximum utilisation of berths in the docks.

Size of Harbours :-

The entrance to the harbour from the open sea should be such that the largest vessel visiting the port should be accommodated.

In addition to this some of the larger vessels, which may not be visiting the harbour should be able to get protection from rough seas in the time of emergency.

It should however be noted that an increase in the width of the entrance reduces the protection that can be given to the ships against adverse sea conditions.

width of entrance is restricted to 180 metres.

In order to protect the harbour from the sea waves, one of the pierheads should project a little beyond the other.

Inside the pierheads, the width should widen very rapidly.

The general shape of the harbour should be obtained by a series of straight lengths & no re-entrant angle should be allowed.

Accomodation required :-

The harbour complex starts at the entrance of the breakwater in the case of artificial harbours & at a well-defined distance in case of Natural harbours

Features of a port :-

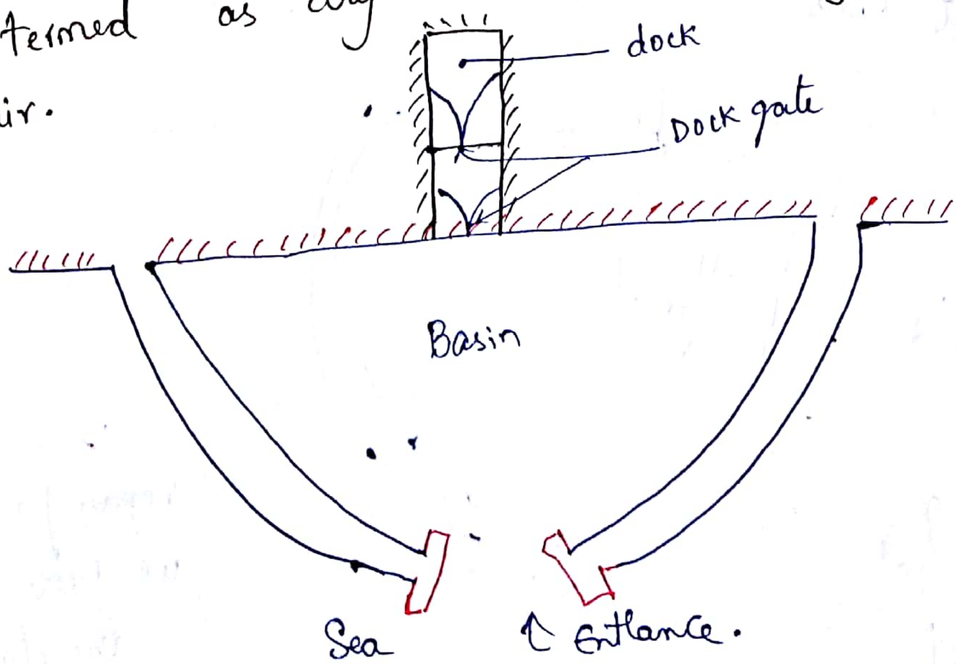
(i) entrance channel (ii) approach channel (iii) turning basin to allow gradual turning of the ship (iv) berthing basin (v) breakwaters (vi) Quays & wharves (vii) Jetties & piers (viii) docks, (ix) slipways (x) godowns, Sheds, fire protection towers, etc.

A dock is a marine structure for berthing of vessels for loading & unloading cargo & passengers.

→ Sometimes Jetties, Quays, Piers, wharves & bulkheads are also called docks.

→ Term dock denotes an artificial basin for vessels where the variation of levels of the water in the shore does not affect the level of water. It is termed as wet dock.

→ when the water in the basin is pumped out it is termed as dry dock for berthing vessels under repair.



Open Berths :-

The harbour & approach channel for ideal operating condition should have adequate depth to permit navigation at the lowest low water when ships are fully loaded.

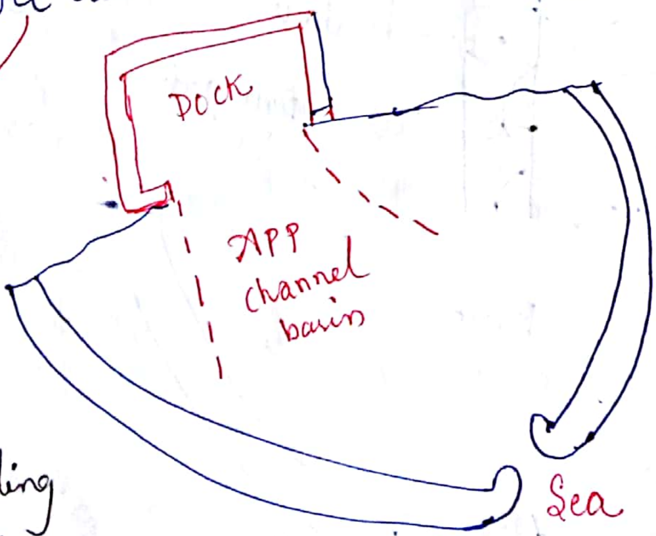
- This depth includes an allowance for the surge of the ship, which is about one half the wave height for 0.60m to 1.2m clearance under the keel.
- Higher value of clearance is used when bottom is hard.
- minimum required depth cannot be maintained at the sea shore & the water is maintained.

open berths may however be used when the basin is naturally protected & the tidal variations of water level do not create any problems of minimum water level.

Docks

wet docks — loading & unloading of passenger & cargo are known as wet docks ↳ Also called Harbour ~~dry docks~~ docks.

Dry docks — repair facilities we take it has dry docks.



The wet docks are required to ensure minimum required depth of water for the vessels.

The dock system requires entrance locks with massive gates.

- Locks are operated by means of heavy bascule bridge & connected machinery.
- In addition to this pumping equipment, other accessories are also required for daily operation of the system.
- As the cost of construction of the docks & connected structures are quite heavy the limiting range of tides at the shore is taken as the deciding factor.
- Generally 3 to 5m of tidal range is taken as deciding point for the natural working of the parts without recourse to enclosed docks.
- If tidal variations are less than 5m tidal basins are formed by partially enclosing the area.
- The provision of such basin dispenses with the costly arrangements like the lock gates & at the same time vessels can come in the basin & leave at all times.
- Dock facilities required to be provided vary widely from port to port.
- Number of ships which are expected at that place & occupancy of the berths are taken into consideration.

Scanned by CamScanner

→ The Ship will not be in the port for more than 48 hours.

→ Cargo ships normally are loaded within 24 hours.

The level of the wet docks is maintained at a uniform level by means of entrance lock.

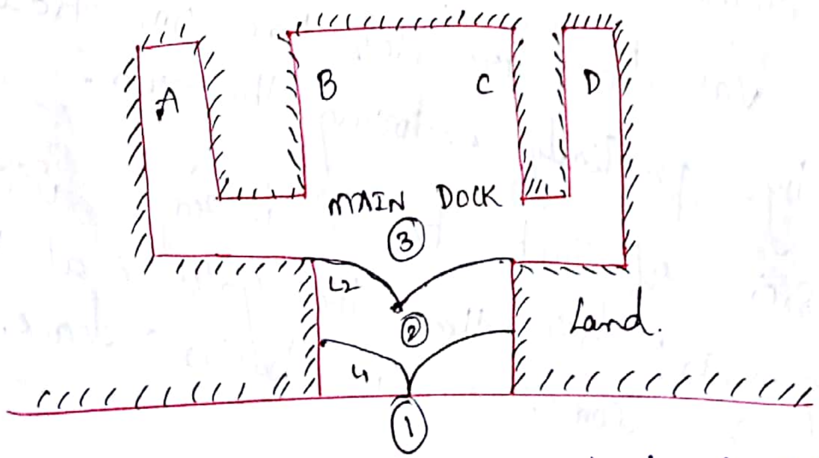
Advantages:-

→ A uniform level of water is maintained.

→ The dock is made to meet the requirements of the largest Passenger Ship (or) Cargo vessel.

→ Rubbing of Ship against the Quay walls is avoided.

→ The disturbances in the open Sea do not have any effect on the working of the dock system.



Ship is in the position (1) which is open Sea. The level of water at A is that required for achorage & berthing of the Ship. This level is maintained inside the dock shown as Number (3).

→ When the vessel is to be brought inside, the lock remains closed & the Lock (L1) is opened

So that the levels of water at (1) & (2) are the same & the ship is brought to the position (2).

→ water is then pumped into the chamber (2) so that the level of water in (2) & (3) is the same.

→ Gate L_2 is then opened & the vessel towed to one of the berths A, B, C, D as required.

→ The operations are so arranged that when lock L_2 is open & levels of water at (2) & (3) are the same all the movements b/w (2) to (3) & (3) to (2) are completed.

→ ||ly when gate L_1 is opened & L_2 is closed, the level of water at (2) will become the same as at (1) & all the desired movements b/w (1) & (2) & b/w (2) & (1) are completed in this position.

Classification of wet docks :- wet docks in tidal basins

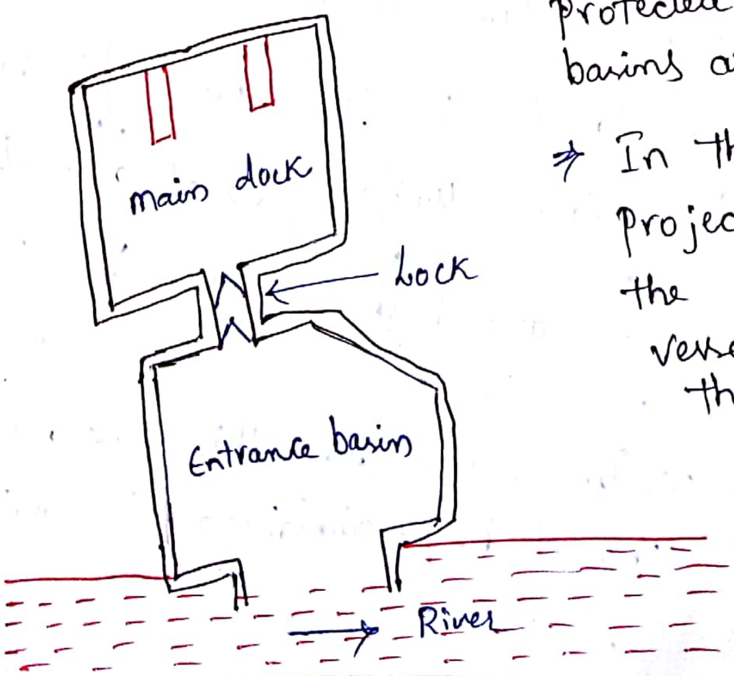
Harbours are prone to be affected by tides, which may causes change in the water level.

→ If at low tides, the level is sufficient as not to ground the ships, the ships could be berthed in these areas.

→ In ports on the open sea coast protected by an outlying breakwater, basins are formed within its shelter.

→ In these basins, Pier walls are projected at right angles to the shore alongside which vessels can lie & discharge their cargoes.

→



1) **Advantages of Tidal Basins:-**

1) Vessels can come in & berth at [illegible] all times. There is Speedy & constructional [illegible] & operations of Ships.

2) Costly arrangements like lock gates for the closing of the entrance are avoided.

2) **Disadvantages of Tidal Basins:-**

1) The range of tide is more, the operations of loading & unloading are seriously affected.

→ fluctuations of water level will cause the rubbing of sides against the berths.

→ **wet docks are useful:-**

Some basins, there may be heavy silting. The wet docks area is kept free by keeping out the turbid water & supplying clean water.

→ where there is considerable difference of level in tides, the ships can enter the dock.

Wet docks in enclosed (or) Impounded Basins:-

wet docks are enclosed & are shut off by entrances by locks by fairly uniform level of water.

→ where tidal ranges are high, docks are formed by enclosures. → water level in this enclosures should be maintained at constant level.

Basins are partially enclosed areas of water, which are approached by open entrances & are subjected to fluctuations of levels, due to tidal variations.

These are also known as tidal basins.

The permissible tidal range is about 4.5m.

Advantages:-

uniform level of water is maintained which is very convenient for handling cargo.

It prevents the rubbing of the sides of ships against the Quay walls.

It obviates the necessity of constant attention to alternation of mooring. → Securing a vessel with a Cable.

Effect of storms in the outer sea & harbour do not obstruct the dock enclosure

Disadvantages:-

wet docks will be costly arrangements will have to be provided for locks & lock gates & more time will be required for entry & exit for ships.

River ports:-

These are formed with Quays alongside the river banks, where the tidal effect is small.

The river in this case serves as the basin.

tidal ranges are large in such rivers, wet docks are constructed, with locks & entrances, which retains the water level.

Shock of contact with the vessels at the top. The thickness at the top should be adeauate to withstand the impact of the shock.

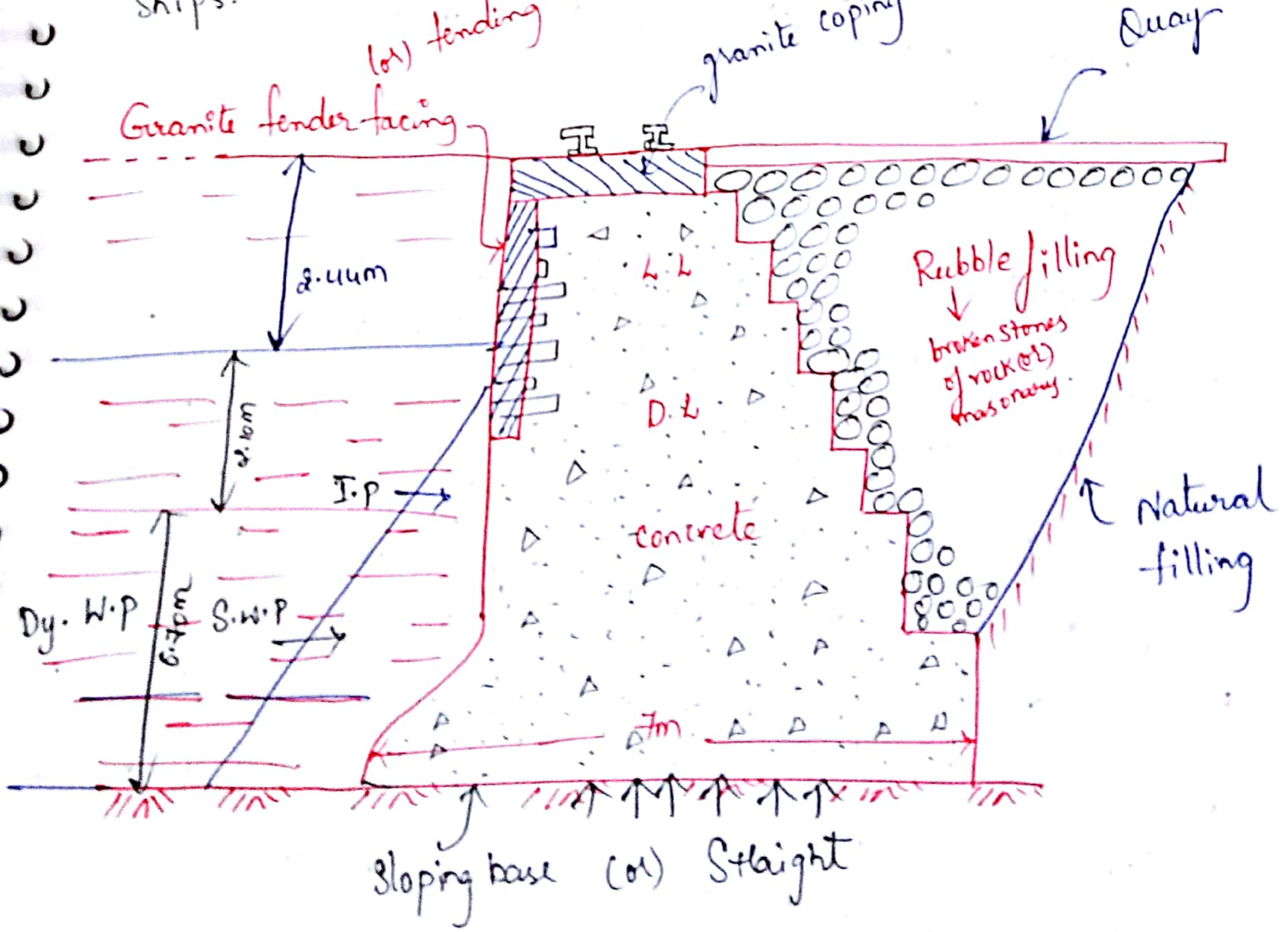
4) Effect of concentrated loads like crane foundation, Capstansor bollard jintures for mooring ships.

5) The load surcharge transferred to the dock walls by the movements of loaded vehicles or trains on the Quay.

These walls are constructed of brick masonry, stone masonry, concrete (or) of composite masonry.

6) water front side of dock wall must have fenders to protect the wall structure from impacts of loaded ships.

support, made by materials like polymers, rubber, wood



Design Loads:-

L.L — Live Load

D.L — Dead Load

E.P — Earth pressure

S.W.P — Static water pressure

Dy. W.P — Dynamic water pressure

U.P — uplift pressure

I.P — Impact pressure due to ship

Effect of Loads:-

It may be noted that if water accumulates at the back of the wall, the material will exert a pressure corresponding to a fluid whose density is equal to the density of the mixture of silt & water.

Pressure behind the wall may cause

(i) To slide forward

(ii) to rotate about the front toe,

(iii) To sink at the toe due to Increase in pressure above the bearing capacity of the Soil.

(iv) To develop tension in the Joint.

→ It is also evident that there is no counter-acting pressure exerted at right angles to the wall during its construction because the water is to be admitted after the completion of wall.

→ The wall will have to resist the earth pressure at the back with its own dead weight

(i) The opposing force exerted by the earth infront of the toe.

(ii) The strength of soil.

Other Aspects of Construction details

(i) Basin walls have to be of much greater height than dock walls to allow for the variation in water levels due to tides.

→ The floor of the basin will have to be lowered to admit vessels at low water level.

(ii) As the water level has to be kept constant, the sides & bottom should be made impervious & arrangements must be made to supply any loss of water by leakage.

(iii) The front face is generally straight or has a very slight batter for ships to stand close to the wall. The section usually adopted for walls is one with a moderate thickness at top, stepping at the back & vertical face. Sometimes the back of walls is curved.

→ The normal pressure on basin walls is greater than dock wall due to the fluctuations of tide level in a basin. The basin walls are of bigger sections as compared to those of dock walls.

(iv) The front face is given a granite fending surface or timber or steel fender to protect the face of the wall from abrasion by ships.

(v) Dock walls are constructed of masonry, brick work or concrete or a combination of these materials (with construction joints as in the case of concrete walls). Concrete walls are liable to abrasion & Hence, they are to be protected by fenders or granite facing.

(vi) The walls ~~are~~ must include tunnels & passages for hydraulic compressed air & electric mains.

(vii) They must be provided with anchorages for bollards & crane foundations.

(viii) During construction, it should be seen that the filling behind the wall is composed of materials which are unaffected by water.
* They should be laid in thin layers & well consolidated. The wall then have less chances to slip forward.

(ix) Pipes should be laid in the wall during construction to drain off accumulated water from rear & they will have to be plugged up before water is admitted into the dock.

(X) Boring will have to be taken to ascertain the nature of soil on which the dock walls will have to rest.

Generally, hard Strata will be available at some reasonable depth below the surface. The dock wall can then be placed on a broad layer of foundation concrete.

It must be seen that the intensity of bearing pressure under the worst condition does not exceed the bearing pressure of the soil on which the dock wall is resting.

Dock Entrances & Entrance Locks :-

Vessels can enter docks either directly or through locks. In either case, gates are provided for the dock entrances.

Docks are entered directly or by means of locks. In both the cases gates are provided in the entrance. These gates may be of Caisson type or they may be of iron or timber in case of locks.

They are three types

1) Caissons type
2) Lock type entrance
3) wooden (or) iron gates.

Caissons:-

(i) Sliding Caisson
(ii) Ship Caisson

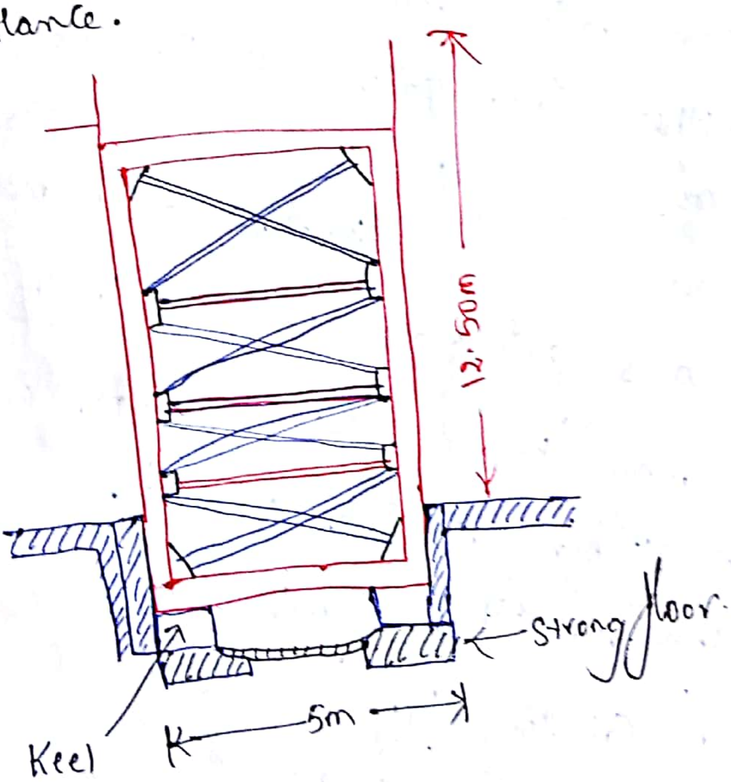
Sliding Caissons:-

It consists of a box shaped steel structure stiffened internally with proper bracing. It is provided with steel keels sliding on smooth granite floor.

→ Instead of the keels, the caissons could be moved on rollers & rails.

→ The entrance is opened by hauling (To pull or draw something heavy) the caisson into a recess provided in the side wall of the dock.

→ The caisson also serves as a bridge across the dock entrance.



Ship Caisson:-

It resembles the outline of a ship in cross-section & is constructed of steel with stiffness at proper intervals.

It is floated into position & sunk into specially prepared grooves in the dock sides & sill.

→ The sinking & raising of this caisson is done by ballasting & unballasting respectively.

→ This type does not require any gate recess or machinery for moving.

→ The frame work of the caisson is made of steel with suitable stiffness.

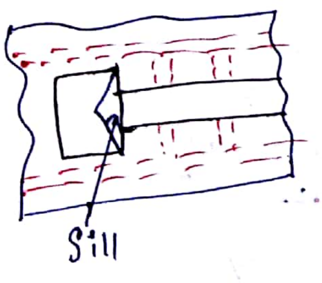
→ It is fabricated on the shore, floated to the position & sunk into special grooves in the sill dock side.

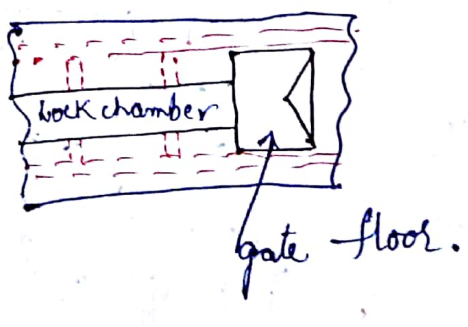
→ The caisson is sunk or raised by means of ballasting & unballasting & therefore in this system gates are not required.

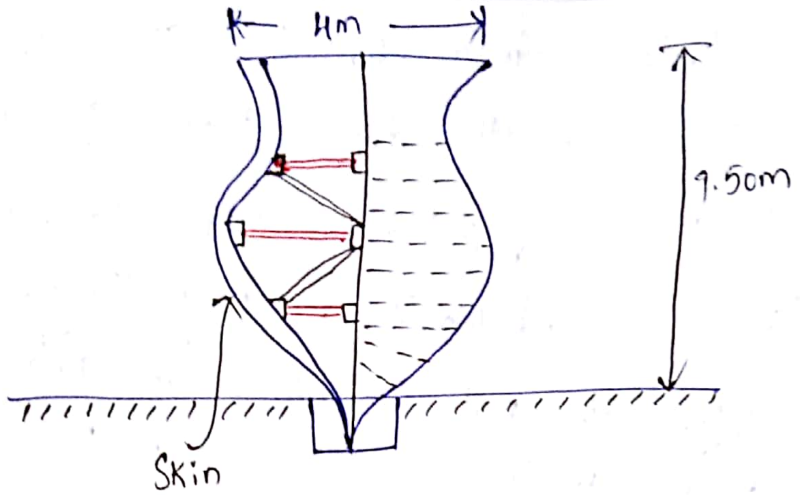
→ The ship caisson when unballasted will float & is towed away & put along the adjoining wall to clear the passage for ships.

Lock type entrance:-

These entrances are operated by two sets of chains. One is used for opening & the other for closing.



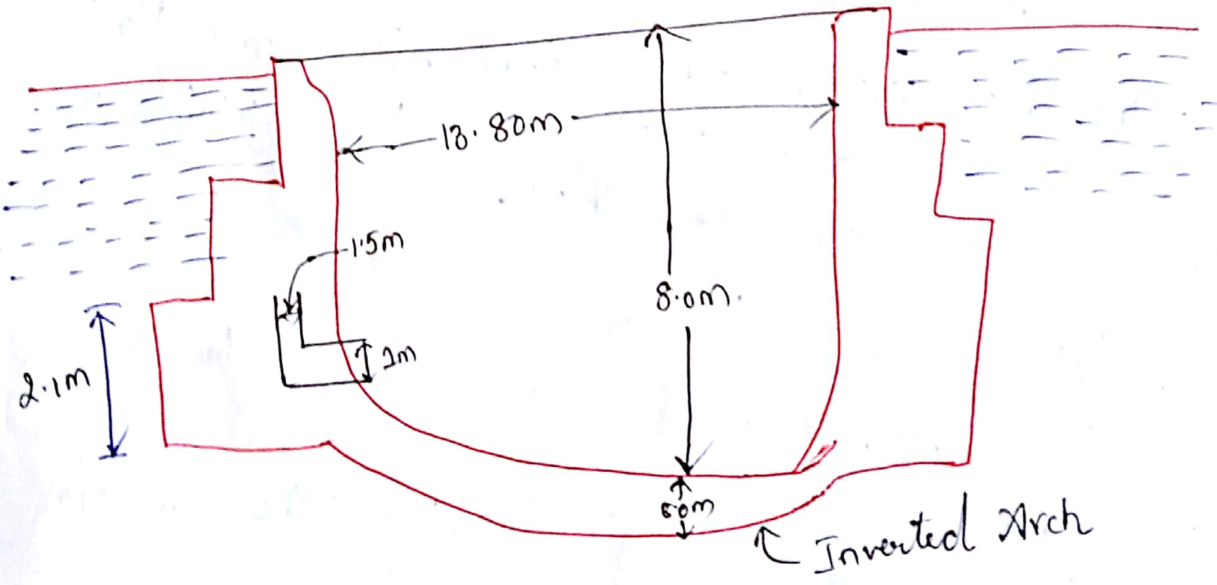


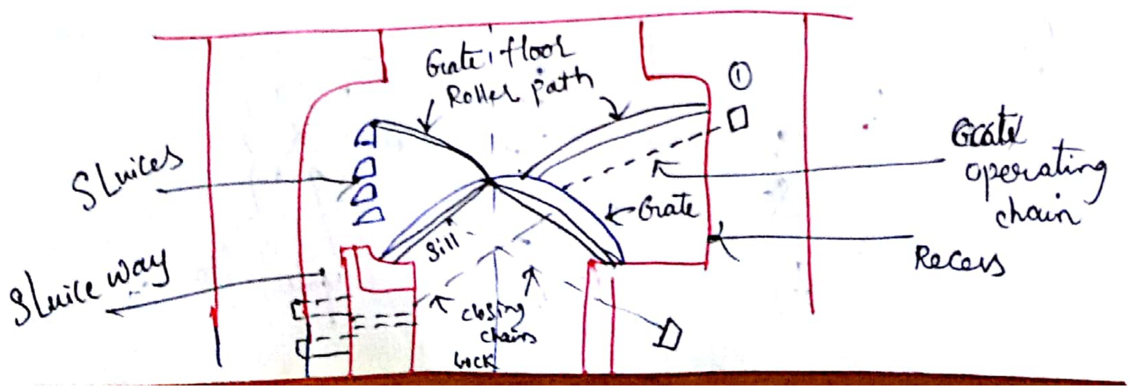


Ship Caisson

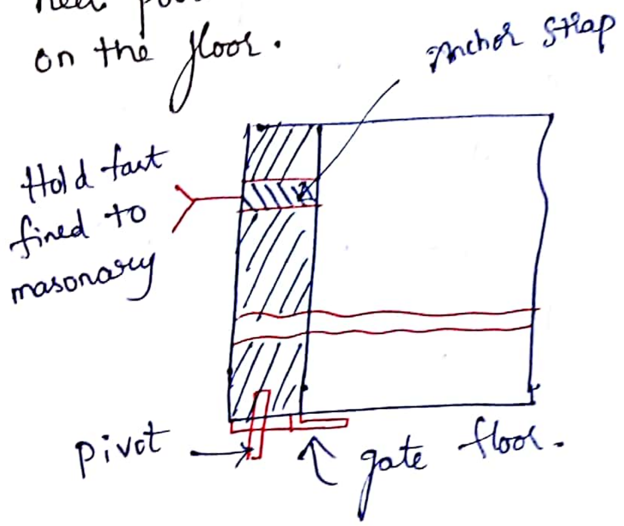
Size of entrance of locks:-

The Size of the lock depend upon the maximum dimension (width & water displacement).
From the consideration of modern Ships the width is from 8 to 12 metres.
above 25m & depths minimum 250 m length is provided.





The gates fit into pivot cap at the bottom of the heel post which rests & revolves on a steel pivot embedded on the floor.



Heel post

→ modern ships have beam width upto 30m & to accommodate the largest ship, the entrance will have to be sufficiently wide for this purpose. The beam of a vessel means the width of vessel.

Wooden or iron gates :-

wooden or iron gates are adopted for locks. The former type is described in detail under lock gates. An entrance to a dock takes less space than a lock & it requires only one pair of gates instead of two.

Also, the lock requires a special chamber. An entrance restricts the admission of vessel to periods round about high tides only.

On the other hand, a lock enables vessels to enter the dock whenever required, provided approach channel permits them to do so.

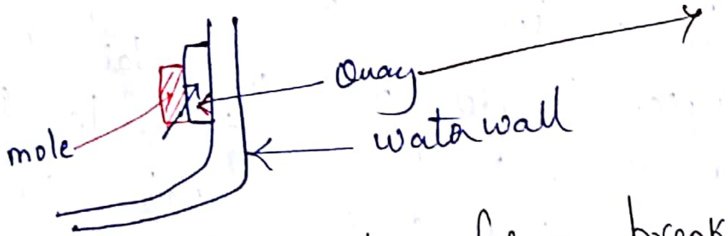
Breakwater

One of the essential requirements of a harbour is the shelter or protection from the hazards of the open sea to which vessel is subjected to.

→ Construction of artificial barriers b/w the sheltered area of the harbour & the open sea.

→ Such construction makes it possible to use the area thus enclosed as a safe anchorage for ships & to facilitate loading & unloading of cargo in calm waters.

The main function of Break water is to break the momentum of water by means of wave breakers.



→ A good alignment for a breakwater is to have straight converging arms, the angle of intersection does not exceed 60 degrees.

→ It is desirable to avoid straight parallel or diverging arms running out to sea.

i) Classification of Breakwaters

There are three classes of break waters namely.

Excavation for docks & basins:-

If the site of dock or basin is inland, the excavation is generally carried out by land wagons,

→ It is also be necessary. to provide the embankment by rubble pitching to prevent the waves from scouring out the embankment.

Shape of Docks & basins:-

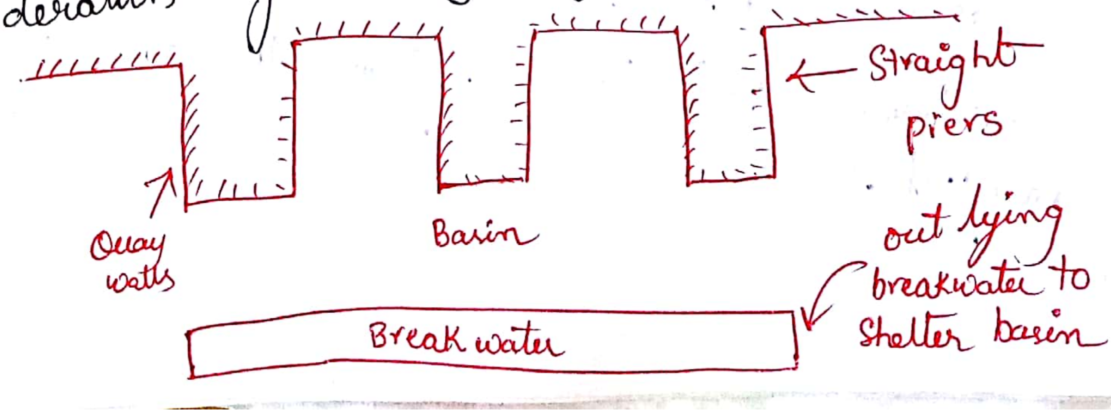
These should be of shapes formed by straight lines as curved lines are not suitable for ships to stand along side.

The shape of docks & basins should be such that maximum Quayage, berthing length is available within the given area.

Rectangular Dock (or) Shape:-

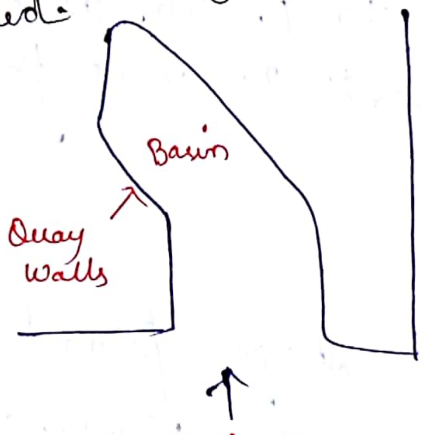
The length & breadth could be adjusted to give the maximum quayage.

The length of the Quay wall is governed by the length of the largest vessel likely to be berthed while the breadth is governed by the requirement of working space including space for operating lifting & transportating equipments & machines as well as from the consideration of stability of the structure.



Diamond Shape :-

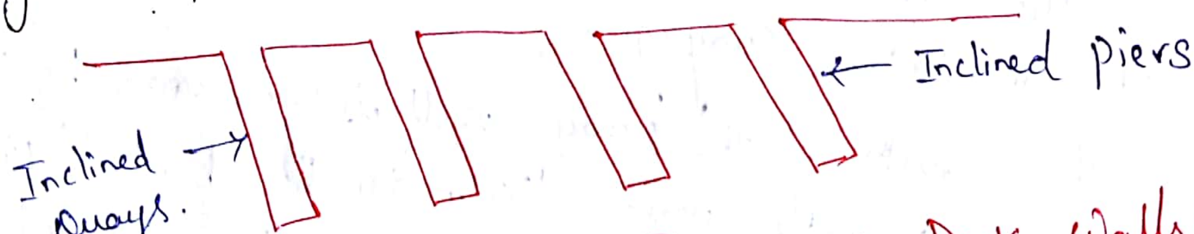
For the Same Perpendicular distance b/w the long sides, the long sides could be conveniently extended.



In this type of construction the length of the Quay walls can be made to suit the requirement of different vessels.

Inclined Pier type :- It consists of a number of projecting piers into the basin or dock.

The effective berthing lengths can be increased for the given projection from the shore.



Design & Construction of Basin or Dock Walls :-

The dockwall is designed as a gravity retaining wall.

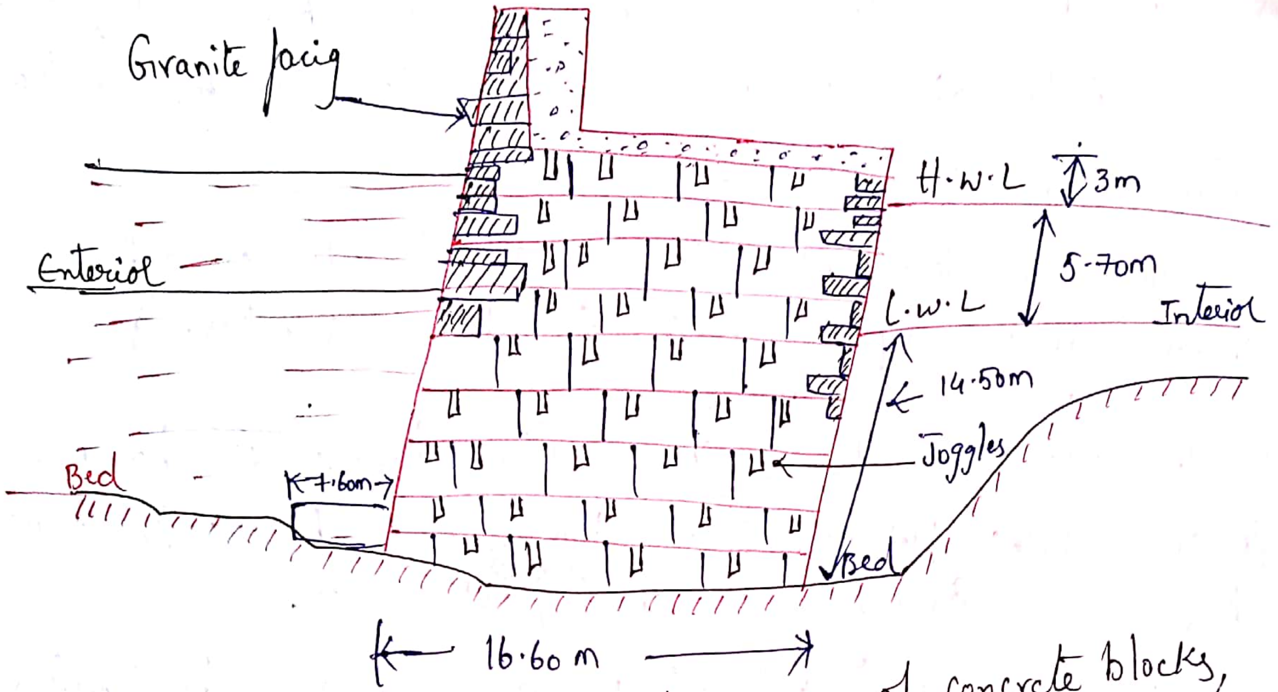
1) Backfill pressure when the dock is empty.
2) maximum water pressure from the dock without any backfill.

1) upright wall breakwater
2) mound width superstructure breakwater
3) Heap (or) mound breakwater

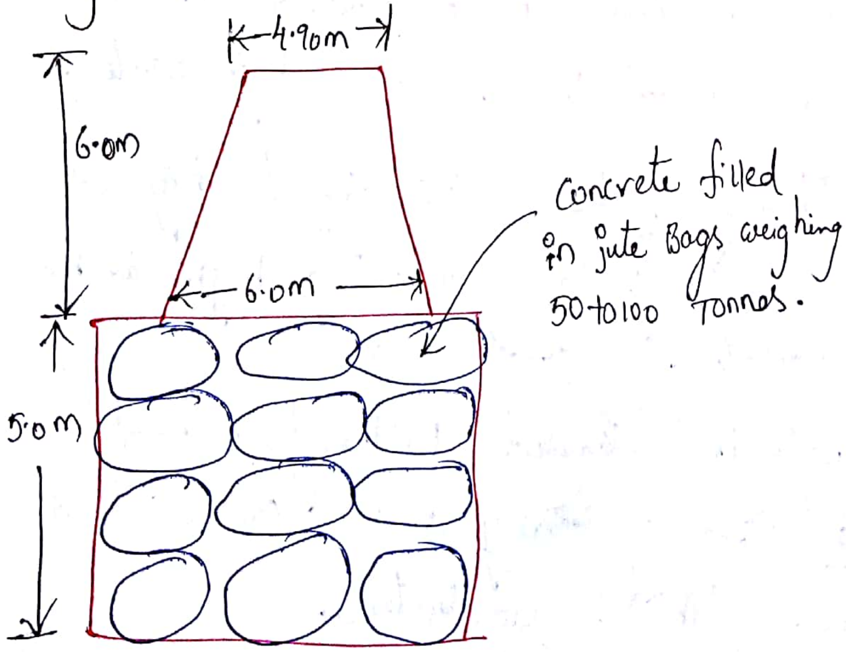
Upright wall Breakwater :-

Essential Points :-

1) This Type of construction is not suited & not reliable for very heavy seas.
2) when the depth is not great & the bottom is firm, upright wall breakwater could be built.
3) breakwater should not be constructed in a depth of water less the 2 (twice storm visit the structure.
4) The sea bed at the site should be resistant to erosion & the foundation should be free from uneven settlement.
5) for sea bed locations having low bearing capacity, a rubble base may be provided to distribute the load on a wider base.
6) for locations having top bed material like silt, soft clay, etc. it is desirable to remove strata with the dredgers.
7) Sheet piles may also be driven to improve the bearing capacity in locations having low bearing capacity, upto moderate depths.
8) The design should be such that no portion of the breakwater may overturn due to wave pressure exerted on its surface.



- The vertical wall breakwaters are of concrete blocks, rock filled steel sheet pile cells, concrete or steel caissons, rock filled timber crib & concrete or steel sheet pile walls.
- In the western hemisphere concrete block type vertical wall breakers have been extensively used.
- In the great lakes & in Europe concrete caissons have been very popular.



The main advantage in adopting concrete caissons is that the under water construction is considerably reduced.

- This is a very great advantage & it is particularly so where the sea is rough & the working time of floating equipment is limited.

- The bulk of the work is done on shore & a period of relatively good weather & Calm water can be selected for actual Installation.
- The concrete block Caissons are founded on a bare rubble if the depth of water is below 18 metres.
- The use of Cellular sheet pile breakwaters has not become very popular even though such breakwaters have been used successfully on the great lakes.
- The main difficulty in the Case of such breakwaters is Constructing them in exposed locations. These break waters are constructed in such a way that each Cell is stable by itself when filled with rock or other suitable material.
- To prevent under mining of the cell by erosion of the bottom of the bed of the sea unless the bottom is rocky or of other hard material, the depth of penetration below the bed should not be less than 3 metres.
- The top of the Sheeting should extend to twice the height of the maximum wave above high water.
- The sheeting may, however be discontinued beyond the mean high water level & the remaining high can be of Cast in place concrete.
- When sheet piling is extended to the full height a top capping consisting of heavy rock, concrete blocks or Cast-in-place slab is constructed.

Mound Breakwaters

Characterstics of mound Breakwater:-

(i) Dissipation of Kinetic energy of incoming waves of water is done in parts or in stages by different layers provided to the mound.

(ii) Natural foundation is unprepared.

(iii) layers construction are arranged in Special bond.

(iv) No binding construction materials are used in Construction.

(v) No possibity of sliding.

(vi) No Possibility of overturning uplift though part of Construction it will remain permanently.

(vii) The construction is porous or pervious.

(ix) gaps are filled with new stones

(x) unskilled labour are used in this construction.

There are of two types of generally Preferred

1) Rubble mound breakwater
2) Concrete blocks mound breakwater.

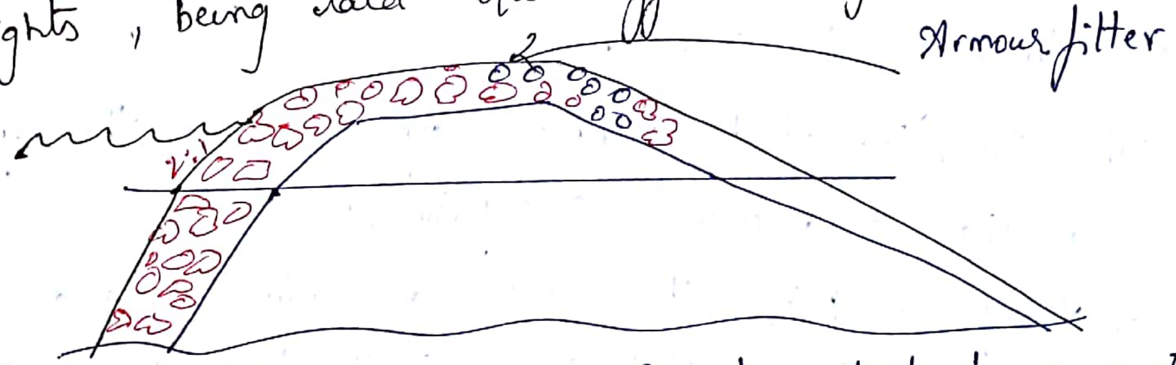
Rubble mound breakwater:-

This type of construction the top of core of mound breakwater is above mean sea level.

large volume of core is used to make mound construction economical.

→ Core is protected from all sides by filter & armour layers.

→ Armour stones are such construction have different weights, being laid b/w different weights.



Rubble mould Breakwater Supplemented by concrete Blocks

Blocks of concrete can be moulded to any shape & to any strength (by adjusting mix) as can be designed to take more force than natural rubble stones, by adding reinforcement.

→ These type of construction concrete blocks are laid towards sea side of mound to act as extra armour blocks over the usual armour blocks of rubble stones, which are heavy (20 to 25 tonnes) & irregular in shape.

→ Heap or mound breakwater is a heterogeneous assemblage of natural rubble undressed stone blocks, rip-rap, supplemented in many cases by artifical blocks of huge bulk & weight, the whole being deposited without any regard to bond or binding materials. It is also called as pellmell construction.

Rocks or other materials used to shore up an embankment

→ This is the Simplest type & is constructed by tipping or dumping of rubble stones into the sea till the heap or mound emerges out of the water, the mound being consolidated & its side slope regulated by the action of the waves.

→ The Quantity of the rubble depends upon the depth, rise of tides & waves & exposure.

→ on exposed sites, the waves gradually drag down the mound giving it a flat slope on the sea face. As far as possible such flattening has to be protected.

→ The disturbing action of the waves is the most b/w the high & low water levels. Consequently all Protective methods are adopted above the low water level.

→ Protection is also necessary at top as well as to the front face exposed to sea.

Mound Breakwaters :-

where durable rock material is available at economic cost the rock- mound break water is the best. usually this type of breakwater consists of three parts namely.

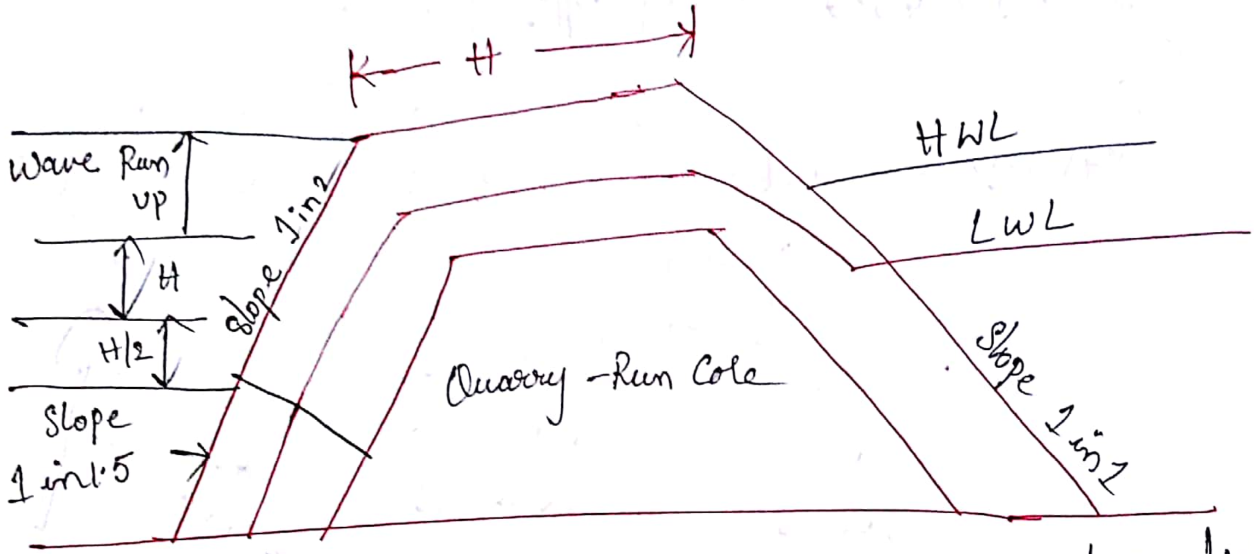
(i) The armour

(ii) first underlayer

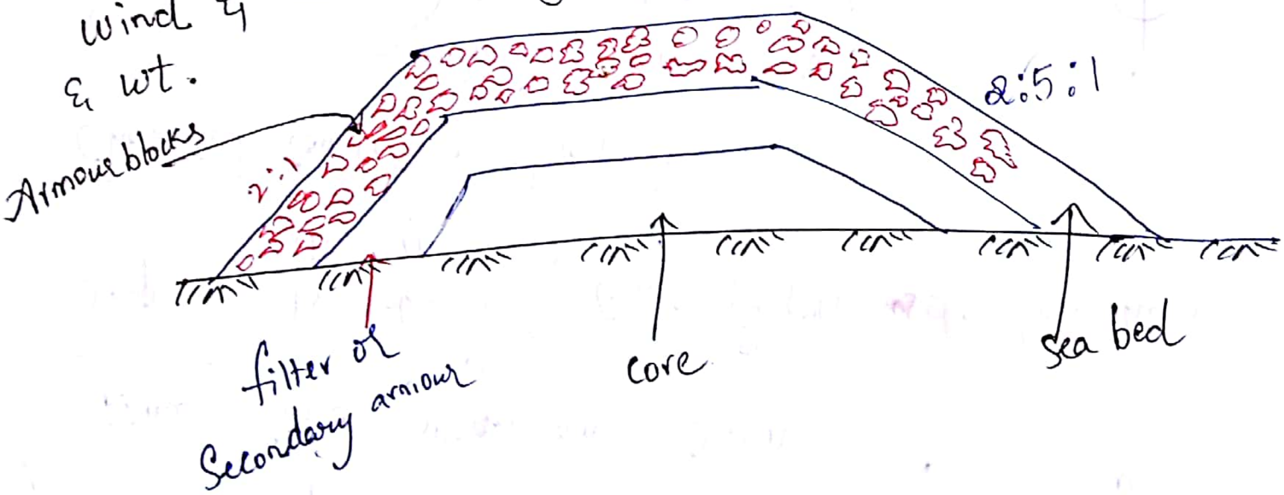
(iii) Second underlayer or Core.

when natural rock is not available or where it cannot be produced economically or in sizes large enough for armouring the breakwatery

Concrete blocks, or irregular concrete shapes such as tetrapods, tribars, Quadripods or hexapods may be used as armour.



Armour blocks :- These stones or blocks are like fighters in army, hence the name is given armours. They resist major part of force (kinetic energy) of wind & waves. They will be the largest in size & wt.



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