UNIT VI PLANNING, LAYOUT, CONSTRUCTION & MAINTENANCE OF DOCKS & HARBORS

Dock: the enclosed area provided for berthing ships to keep them afloat at a uniform level to facilitate loading and unloading is called the dock.

Harbor: The sheltered area of the sea in which vessels could be launched, built or repaired, or could seek refuge during storm time and provide loading and unloading facilities of cargo and passengers is called harbor.

PORT: A port is a location on a coast or shore containing one or more harbors where ships can dock and transfer people or cargo to or from land. ... A port is usually located inside a harbor.

CLASSIFICATION OF PORTS

1.Inland port
2.Fishing port
3.Dry port
4.Warm-water port
5.Seaport
→Cruise home port
→Port of call
→Cargo port

1. Inland port: An inland port is a port on an inland waterway, such as a river, lake, or canal, which may or may not be connected to the ocean. The term "inland port" is also used to refer to a dry port, which is an inland extension of a seaport, usually connected by rail to the docks.

2. Fishing port: A fishing port is a port or harbor for landing and distributing fish. It may be a recreational facility, but it is usually commercial. A fishing port is the only port that depends on an ocean product, and depletion of fish may cause a fishing port to be uneconomical.

3. Dry port: A dry port (sometimes inland port) is an inland intermodal terminal directly connected by road or rail to a seaport and operating as a centre for the transshipment of sea cargo to inland destinations.

4. Warm-water port: A "warm water port" is a port where the water does not freeze in winter. Because they are available year-round, warm water ports can be of great geopolitical or economic interest, with the ports of Saint Petersburg and Valdez being notable examples.

5. Seaport: a port, harbor, or town accessible to seagoing ships

→ **Cruise home port**: A cruise home port is the port where cruise ship passengers board (or embark) to start their cruise and disembark the cruise ship at the end of their cruise.

→**Port of call**: A port where a ship docks in the course of a voyage, especially to load or unload passengers or cargo, to obtain supplies, or to undergo repairs.

→**Cargo port**: A port is a maritime commercial facility which may comprise one or more wharves where ships may dock to load and discharge passengers and cargo. Although usually situated on a sea coast or estuary, some ports, such as Hamburg, Manchester and Duluth, are many miles inland, with access from the sea via river or canal.

REQUIREMENTS OF A GOOD PORT:

1. It should be centrally situated for the hinterland. For a port, the hinterland is that part of the country behind it which can be served with economy and efficiency by the port.
2. It should get good tonnage i .e. charge per ton of cargo handled by it. It should have good communication with the rest of country.
3. It should be populous
4. It should be advance in culture, trade and industry.
5. It should be a place of defense and for resisting the sea-borne invasion it should command valuable and extensive trade.
6. It should be capable of easy, smooth and economic development. It should afford shelter to all ships and at all seasons of the years
7. It should provide the maximum facilities to all the visiting ships including the servicing of ships.

Harbor:
→It is a sheltered area
→Used for loading and unloading of cargo
→Vessels are also built, repair and launch
→It protects ships naturally or artificially from fury of sea
→Ships, boats, and barges can seek shelter from stormy weather, in navigable waters well
→protected naturally or artificially
→Situated along sea shore or river estuary or lake or canal connected to sea

CLASSIFICATION OF HARBORS:

1. **Natural harbors**
2. **Semi-natural harbors**
3. **Artificial harbors.**

1. **Natural harbor:** A natural harbor is a landform where a part of a body of water is protected and deep enough to furnish anchorage. Many such harbors are rias. Natural harbors have long been of great strategic naval and economic importance, and many great cities of the world are located on them.
   →Natural formations affording safe discharge facilities for ships on sea coasts, in the form of creeks and basins, are called natural harbors.
   →With the rapid development of navies engaged either in commerce or war, improved accommodation and facilities for repairs, storage of cargo and connected amenities had to be provided in natural harbors.
   →The size and draft of present day vessels have necessitated the works improvement for natural harbors.
   →The factors such as local geographical features, growth of population, development of the area, etc. have made the natural harbors big and attractive. Bombay and Kendal are, examples of natural harbors
2. **Semi natural:** This type of harbor is protected on sides by headlands protection and it requires man-made protection only at the entrance
3. **Artificial harbor:** An artificial harbor can have deliberately constructed breakwaters, sea walls, or jetties or they can be constructed by dredging, which requires maintenance by further periodic dredging. In contrast, a natural harbor is surrounded on several sides by prominences of land.

Requirements of a good harbor:
→The depth of a harbor should be sufficient for every type of visiting ships.
→The bottom of harbor should provide secured anchorage to hold the ships against high winds.
→To prevent destructive wave action, break water are provided.
The entrance of a harbor should be wide enough to provide the easy passage of ships.

Harbor area required depends upon the following factors:
→Size and number of ships to be accommodated in the harbor at a time
→Length and width needed for movement of ships to and from berths.
→Type of cargo carried

Classifications of docks: If ship is subjected to a vertical movement by the tides, great inconvenience will be felt in lifting the cargo from the ship and special arrangement will be needed for lifting the cargo
Docks can be classified into following two categories:

- **Wet docks.**
- **Dry docks.**

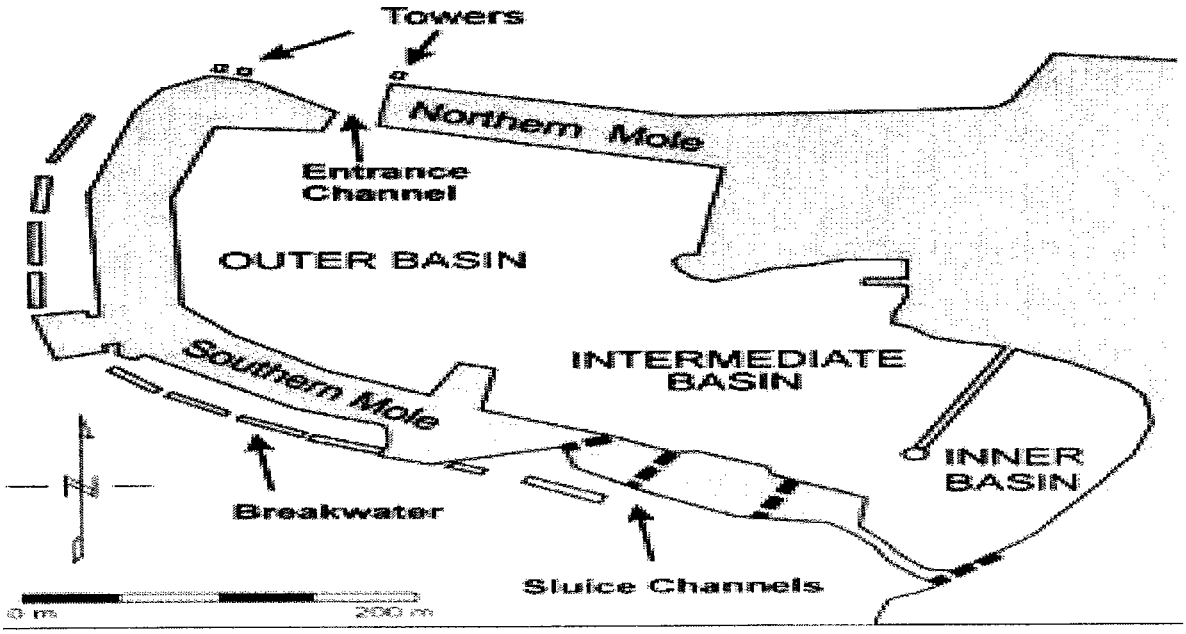
- **Wet docks:** Docks required for berthing of ships or vessels to facilitate the loading and unloading of passengers and cargo are called wet docks.
  These are also known as harbor docks.

- **Dry docks:** The docks used for repairs of ships are known as dry docks.
  It is long excavated chamber, having side walls, a semi circular end wall and a floor. The open end of the chamber is provided with a gate and acts as the entrance to the dock

Transit shed: It is a shed for goods in transit from the vessel to the consignees or from consignors to the vessel. For export cargo, to facilitate the quick loading cargo is first brought to a transit shed and collected there. In case of import cargo, it is not possible to clear all the destinations by railway and trucks. In fact for general cargo, verification of marks, quantity and safe delivery makes it necessary to take this cargo to a temporary covered storage, thus for a temporary storage, a covered arrangement is called a transit shed.

Workhouse: It is a shed for goods in transit from the vessel to the consignees or from consignors to the vessel. For export cargo, to facilitate the quick loading cargo is first brought to a workhouse and collected there. In case of import cargo, it is not possible to clear all the destinations by railway and trucks. In fact for general cargo, verification of marks, quantity and safe delivery makes it necessary to take this cargo to a permanent covered storage, thus for a permanent storage, a covered arrangement is called a workhouse. It means the goods can be stored for years as compared to transition sheds.

Layout of harbor :



Selection of site :

The guiding factors which play a great role in choice of site for a harbor are as follows :

→Availability of cheap land and construction materials Transport and communication facilities

→Natural protection from winds and waves Industrial development of the locality

→Sea-bed subsoil and foundation conditions Traffic potentiality of harbor

→Availability of electrical energy and fresh water Favorable marine conditions

→Defense and strategic aspects

Shape of the harbor: The following principles should be kept in mind:

In order to protect the harbor from the sea waves, one of the pier heads should project a little beyond the other.

Inside the pier heads, the width should widen very rapidly.

The general shape of the harbors should be obtained by a series of straight lengths and no re-entrant angle should be allowed

Harbor planning: The important facts to be studied and scrutinized can be enumerated as follows:

It is necessary to carry out a thorough survey of the neighborhood including the foreshore and the depths of water in the vicinity

The borings on land should also be made so as to know the probable subsurface conditions on land. It will be helpful in locating the harbor works correctly

Features of harbor:

- **Break water**
- **Docks**
- **Entrance channel**
- **Jetty**
- **Light house**
- **Berthing Basin**
- **Turning Basin**
- **Pier Head**
- **Wharves**

Breakwater :

→Breakwater are the structures constructed to enclose the harbors to protect them from the effect of wind generated waves by reflecting and dissipating their force or energy.

→Helps to use the area thus enclosed as a safe anchorage for ships and to facilitate loading and unloading of water by means of wave breakers.

→Height depends upon the its purpose, extent of enclosed water area and nature of existing shipping work.

→Generally the height of breakwater is kept as equivalent to 1.2 to 1.25 times the waves expected.

→It also helps to prevent beach erosion

→The most common breakwater used has a core of small rocks or rubble with a covering of large rocks to keep the core from being washed away

→It may be small structures, placed one to three hundred feet offshore in relatively shallow water

→Breakwater either fixed or floating- choice depend on normal water depth & tidal range Its construction is usually parallel or perpendicular to the coast

Alignment: A good alignment for a breakwater is to have straight converging arms so that the angle of inter section does not exceed 60 degrees. It is desirable to avoid straight parallel or diverging arms running out to sea.

Design of breakwaters: Following information should he collected before the design of a breakwater:

→Character of coastal currents

→Cost and availability of materials of construction

→Directions and force of prevailing winds

→Nature of the bottom or foundation

→Probable maximum height, force and intensity of waves.

The three important rules to be observed in the design of a breakwater are as under:

The design should be based on the extreme phenomena of the wind and waves, and not on the mean or the average.

The height of the wave should he determined by Using the equation

H = 034¥Fand the height of wall should be decided accordingly by making sufficient allowance for freeboard.

It should be seen that the material in the foundation is not subject to scour.

Detrimental forces acting on breakwaters:

Hydrostatic force: This force reduces the apparent weight and hence, the marine structures suffer these losses to a great extent unless the foundations are absolutely impervious.

External forces:
→The intensity of external forces, especially wind and wave action, is enormous.
→The power of wind produces vibrations in the masonry structure and weakens the different courses of masonry.
→In a similar way, the wave when it recedes induces 'suction action and it results in the erosion of the foundation unless it is made safe and secure.

Solvent action of sea water:
This quality of sea water causes damage to the materials of construction Sea insects.
The concentrated action of sea insects results in the undermining of the hardest and the soundest building material and it is for this reason that the marine structures are made specially bulky and strong.

Classification of breakwaters:
Heap or mound breakwater
Mound with superstructure
Upright wall breakwater.

Heap or mound breakwater :
It is a heterogeneous assemblage of natural rubble, undressed stone blocks, rip rap, supplemented in many cases by artificial blocks of huge bulk and weight, the whole being deposited without any regard to bond or bedding.
This is the simplest type and 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 and its side slopes regulated by the action of the waves.
The quantity of rubble depends upon the depth, rise of tides and waves and 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 he protected.
The disturbing action of the waves is the most between the high and low water levels. Consequently, all protective methods are adopted above the low water level.
Protection is also very necessary to the top of the mound and outer or exposed face.

Quay walls: Wharves along and parallel to the' shore, are generally called quays and their protection walls are called quay walls
design of quay walls:
They are built to retain and protect the embankment or filling:
Factors affecting the design are as follows

→Character of foundation
→Pressure due to water that finds its way to the real of the wall
→Effect of buoyancy for the portion of the wall submerged
→Earth pressure at rear
→Weight of the wall itself
→live load of vehicles passing on the platform at the rear
→dead load of the goods stored on the platform
→force of impact of vessels
→Quay wails are designed similar to retaining walls

WHARVES Platforms or landing places are necessary for ships to come, close enough to the shore, for purposes of embarkation, disembarkation, etc. at the same time.

→These platform locations should give sufficient depth of water for the ship to float. Such platforms are, called wharves. They are built out into or on to. the water Thus, a wharf affords a working platform alongside the ship in continuity of the shore.
→A wharf is quay but the term wharf is generally used for an open structure of piles or posts with bracings, jutting from the shore towards the sea.
→A wharf may be a sheet pile wall or it may consist of a piled projection with or without artificial retention of soil some distance behind or it may be a gravity wall.
→Wharves may either be parallel to the shore and abutting against it or they may project into the water either at right angles or oblique to the shore.
→The former type is adopted at places where depth of water is sufficient for the ships to berth, say 10 m to 12 m
→ The latter type is adopted at places where depth of water near the shore is not enough for the ships to enter safely.
→The level of wharf should be above the high water level. But at the same time, it should be economical to load the vessels when the water level is low.
→Wharf should act as a unit when there is an impact from any vessel.
→Hence, it should be properly braced and bolted. It is desirable to provide rounded corners for
→wharves which art likely to be used by large vessels.
→Such a construction will result in a smooth entry of vessels into the slips

JETTIES:

- These are the structures in the form of piled projections and they are built out from the shore to deep water and they may be constructed either for a navigable river or in the sea.
- In rivers, the jetties divert the current away from the river bank and thus, the scouring action is prevented.
- As the current is diverted to deep waters, the navigation is also controlled.
- In the sea, the jetties are pr at places where harbor entrance is affected by littoral drift or the sea is shallow for a long distance.
- Thus, they extend from the shore to the deep sea to receive the ships.

- In a limiting sense, a jetty is defined as a narrow structure projecting from the shore into water with berths on one or both sides and sometimes at the end also.
  Jetties are exposed to severe wave action and their structural design is similar to that of breakwater.
- However, the designed standards may be released to a certain extent due to the fact that the jetties are usually built normal to the most dangerous wave front.
- The impact caused by the berthing ships will depend on the skill of the berthing officer, local condition of currents, wind, etc.
- The berthing velocity depends upon the condition of approach, wind, etc. and it decreases with the increase in the size of the ships

TIDES AND WAVES: Tides are caused by gravitational pull of the moon and the sun. The rise and fall of the tides play an important role in the natural world and can have a marked effect on maritime-related activities. ... The difference in height between the high tide and the low tide is called the tidal range.
They are as follows:
Coastal currents and evidences of sitting, including littoral drift or coast erosion. Tides and tidal range.
Wind, wave and their combined effect on harbor structures.
Tides:
Tides on the coast-line are caused by the sun and moon.
The effect of tides is to artificially raise and lower the mean sea level during certain stated periods.
This apparent variation of mean sea level is known as the tidal range.
Spring tides and Neap tides:
At new and full moon or rather a day or two after (or twice in each lunar month), the tides rise higher and fall lower than at other times and these are called Spring tides.
Also one or two days after the moon is in her quarter i.e. about seven days from new and full moons (twice in a lunar month), the tides rise and fall less than at other times and are then called neap tides.
Waves and wind:
The 'sea wave' is by far the most powerful force acting on harbor barriers and against which the engineer has to contend.
The wave has the impulse of a huge battering ram and equipped with the point of a pick axe and chisel edge".
It is the most in compressible natural phenomena.
The formation of storm waves takes place in the open sea due to the action of wind.
Water waves are of two kinds:
- Waves of oscillation and
- Waves of translation;

The former are stationary, while the latter possess forward motion. But all translator waves originally start as waves of oscillation

TASK (Tidal Analysis Software Kit) is a complete software solution for the harmonic analysis of data from tide gauges right through to the prediction of tides into the future and the production of fully formatted tide tables.
Designed for the professional hydrographic, GeoTide handles each step of tidal analysis and prediction in an intuitive and user-friendly way.
Tidal prediction uses the values of the harmonic constants to predict the tide.
Once the harmonic constants have been determined the tide can be accurately predicted for many decades into the future.
These windows-based programs use the industry standard technique of harmonic analysis to produce accurate tidal predictions from observed tidal height or stream data.

- GeoTide Analyzer converts tide gauge data into the harmonic constants for that place
- GeoTide Predictor converts the harmonic constants into tidal predictions

Dredging: it is the operation of removing material from one part of the water environment and relocating it to another. In all but a few situations the excavation is undertaken by specialist floating plant, known as a dredger. Dredging is carried out in many different locations and for many different purposes, but the main objectives are usually to recover material that has some value or use, or to create a greater depth of water.

Purposes of dredging:

- Maintenance: dredging to deepen or maintain navigable waterways or channels which are threatened to become silted with the passage of time, due to sediment sand and mud, possibly making them too shallow for navigation. This is often carried out with a trailing suction hopper dredge. Most dredging is for this purpose, and it may also be done to maintain the holding capacity of reservoirs or lakes.
- Land reclamation: dredging to mine sand, clay or rock from the seabed and using it to construct new land elsewhere. This is typically performed by a cutter-suction dredge or trailing suction hopper dredge. The material may also be used for flood or erosion control.
- Capital dredging: dredging carried out to create a new harbor, berth or waterway, or to deepen existing facilities in order to allow larger ships access. Because capital works usually involve hard material or high-volume works, the work is usually done using a cutter suction dredge or large trailing suction hopper dredge; but for rock works, drilling and blasting along with mechanical excavation may be used.
- Preparatory: dredging work and excavation for future bridges, piers or docks or wharves, This is often to build the foundations.
- Winning construction materials: dredging sand and gravels from offshore licensed areas for use in construction industry, principally for use in concrete. This very specialist industry is focused in NW Europe, it uses specialized trailing suction hopper dredgers self discharging the dry cargo ashore.
- Contaminant remediation: to reclaim areas affected by chemical spills, storm water surges (with urban runoff), and other soil contaminations, including silt from sewage sludge and from decayed matter, like wilted plants. Disposal becomes a proportionally large factor in these operations.

- Flood prevention: dredging increases the channel depth and therefore increase a channel's capacity for carrying water.
- Fishing dredging is a technique for catching certain species of edible clams and crabs. In Louisiana and other American states, with salt water estuaries that can sustain bottom oyster beds, oysters are raised and harvested. A heavy rectangular metal scoop is towed astern of a moving boat with a chain bridle attached to a cable. This drags along the bottom scooping up oysters. It is periodically winched aboard and the catch is sorted and bagged for shipment

NAVIGATIONAL AIDS

Necessity for signals:

The mariner and his ship have to be guided by proper signals during navigation, especially,
to avoid dangerous zones like hidden rocky outcrop and sand bars,
to follow proper approaches and
to locate ports

Fixed and floating light stations:

The light stations when they are built on land are called fixed as in the case of permanent lighthouse structures.

Such structures are located either in the hinterland close to the shore or in the sea on submerged outcrops and exposed to the fury of the waves.

Alternately, where there are difficulties in establishing proper foundations; floating light rations in the form of a light vessel may be adopted.

Buoys of standard shapes also belong to the 'floating type and are generally used to demarcate boundaries of approach channels in harbor basins.

Lighthouse:

It is a lofty structure popularly built of masonry or reinforced concrete in the shape of a tall tower on a high pedestal.

The tower is divided into convenient number of floors, the topmost floor containing powerful lighting equipment and its operating machinery.

The lower floors are used, as stores and living rooms necessary for the maintenance and working of the light station.

The main parts of a typical lighthouse tower are illustrated in fig.

Lighthouses may be located on shore or on islands away from the mainland as in the case of warning light stations.

Maintenance of ports and harbor:

Ports and harbor facilities should remain in service in good condition for a long time, so as to perform their method functions. Towards this objectives, a high level of precautions is to be taken to maintain the structural performance of the port .

1. Visual inspection of deteriorated structures and deterioration grading , major , minor , and local
2. Measurement and prevention of chloride ion concentration in concrete

3. Diagnosis of structural member surfaces with appropriate NDT tests such as chloride test , half-cell potential survey , carbonation test , sounding hammer test and cover-meter test .
4. Grouting motor/injection of epoxy resin into cracks and restoration of spelled concrete
5. Surface coating of rust stains and their extensions
6. RC deck protective coating
7. Installation of cathodic protection to fender piles
8. Replacement of corrodes steel pipe piles/steel beams
9. Dredging where sediment found under water
10. Re-casing of piles/pile caps
11. Improvements of load bearing capacity under structures which are subjected to wave action
12. Structural steel and concrete repairs
13. Restoration of navigational aids
14. Structural steel and concrete repair