

CIVIL ENGINEERING CONSTRUCTION

SBC2253

MARINE STRUCTURE

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ELEMENTS OF MARINE STRUCTURE

- a) Seawall *Benteng pantai dan laut*
- b) Docks and / *limbungan Pembinaan deck*
- c) Wharves / *Pembinaan pelabuhan/dermaga*
- d) Jetties, Dolphins and Fenders / *Jeti*
- e) Breakwater *Pemecah ombak*

SEAWALL

- The structure constructed parallel to shore line essentially to separate land area from water area.
- Located inside the sea and along the line landward of which further erosion, that is recession of shoreline, is to be stopped.
- Built as water retaining wall along the sea.

SEAWALLS

- Seawalls are constructed to resist encroachment by the sea
- It is often incorporated into the construction of a promenade
- Seawalls are constructed in various materials: masonry blocks, precast concrete, insitu concrete etc.

SEAWALL (CONT'D)

- The design of the wall should:
 - Minimise the effect of wave action
 - Prevent the under-scouring of the foundation
- Concrete blocks with projecting reinforcement may be used in conjunction with an insitu backing.

DOCKS

Docks may be divided into two types:

1. Dry Docks
2. Wet Docks

DRY DOCKS (CONT'D)

- A dry dock is a narrow basin or vessel that can be flooded to allow a load to be floated in, then drained to allow that load to come to rest on a dry platform.
- Dry docks are used for the construction, maintenance, and repair of ships, boats, and other watercraft.

DOCKS

- Enclosed areas for berthing ships, to keep them afloat at a uniform level, to facilitate loading and unloading cargo.
- Shut off by entrances or locks to maintain a fairly uniform level of water, and basin are partially enclosed areas of water, which are approached by open entrances and are subject to fluctuations of levels, due to tidal variations.

REPAIR DOCK

- Necessary for the execution of repairs, cleaning and painting of ships' bottoms.
- Expose the ship's exterior fully and keep it out of water during the progress of repairs or renovation.
- Four classes of repair docks:
 - i) Dry Dock
 - ii) Floating Dock
 - iii) Marine Railway
 - iv) Lift Docks

- Dry Dock
- - 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.
- - The docks is constructed of concrete or masonry and the altar courses and steps are of granite to withstand heavy wear. Suitable culverts are also walls for filling and emptying the dock.

- **Method of Dry Docking**

- The ship enters the dock on adjusting the water level inside the dock to that outside, when the entrance gate is closed.
- The water inside the dock is now pumped out by powerful pumps, the ship being kept vertical and central by the shores between the ship's sidiers and altar steps while slowly being lowered on to the keel and bilge blocks on which it comes to rest.

Floating dry Dock

- as a floating vessel which can lift a ship out of water and retain it above water by means of its own buoyancy
- It is a hollow structure of steel, or concrete consisting of 2 side walls and a floor, with the ends open.
- To receive a ship, the structure is sunk to required depth by ballasting its interior chambers with water, the ship is then floated into position and berthed.

- The dock is raised bodily with the berthed ship by unballasting the chambers by pumping out the water.
- Types of floating docks:
 - i) Rigid type or non-self docking
 - ii) Self docking type
 - iii) Self docking offshore type

DRY DOCKS

- Dry docks differ in design from wet docks in that they have to withstand hydrostatic pressure when the dock is emptied.
- The walls of the dock should be incorporated with the floor to form a rigid structure and so reduce uplift.

DRY DOCKS (CONT'D)

- If sufficient dead weight cannot be introduced into the construction to prevent buoyancy, a venting system must be provided to relieve the hydrostatic pressure.
- Alternatively, anchorage can be used.

DRY DOCKS (CONT'D)

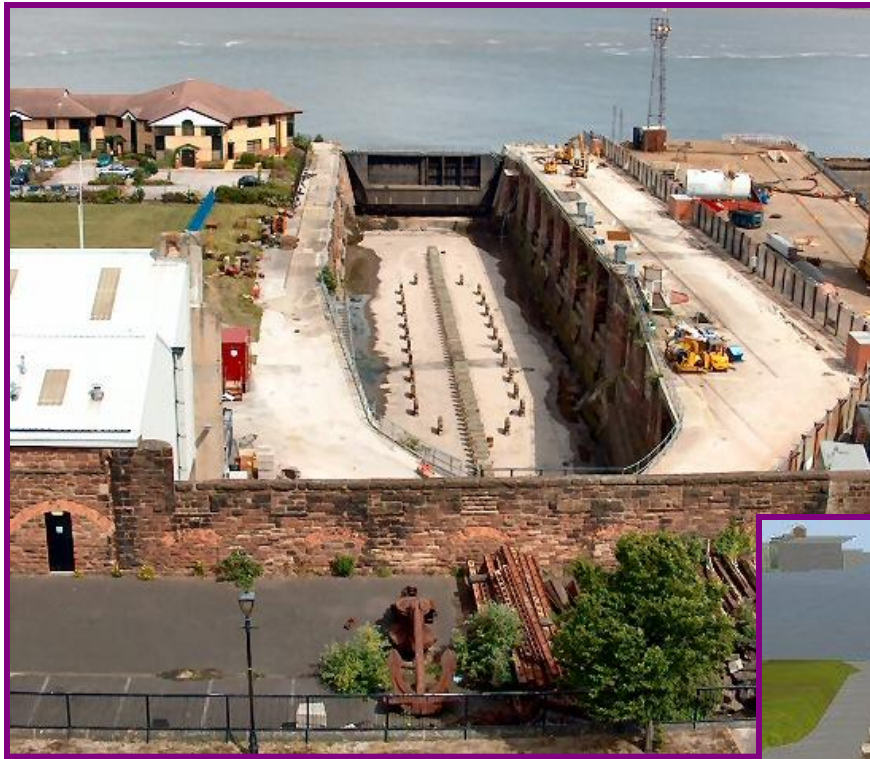
- The walls are normally massive insitu structures which are cast in large, deep trench excavations.
- The walls are cast in stages of up to 2 meters thick, with stepped construction joints.
- Longitudinal joints should be constructed at intervals of 15 meters.
- These joints are essentially construction joints with bars and should be filled with bitumen or other sealing compound.

DRY DOCKS (CONT'D)

- The floor of the dock must, in addition to resisting uplift, be strong enough to distribute a ship's load without settlement or undue deflection.
- If the load encountered are very high, a piling support may be adopted, both for supporting a ship's load and resisting uplift.

DRY DOCKS (CONT'D)

- Lock entrance gates, normally of steel construction, may be pivoted or sliding, or consist of floating caisson units.



DRY DOCKS

WET DOCKS

- A wet dock is a dock where the level of water in the dock is maintained despite the raising and lowering of the tide.
- This makes transfer of cargo easier. It works like a lock which controls the water level and allows passage of ships.
- Wet docks are large areas of water bounded by vertical solid walls against which vessels tie up.

WET DOCKS (CONT'D)

- The walls must be impermeable to retain the water at high tide level.
- Locks are provided if entry to the dock is desired at times other than high tide.

WET DOCKS (CONT'D)

- The walls may be formed by sinking monoliths to a suitable depth and joining them together with insitu concrete.
- A space of 2 to 3 meters is left between the monoliths to facilitate jointing and finishing.
- Alternatively, the walls may be constructed with deep diaphragms, decking being supported by cross-wall diaphragm.



WHARVES

- Wharves are berths for shipping which may retain the surrounding soil or simply provide mooring facilities.
- Those constructed to retain soil are usually mass concrete walls built by means of caisson or diaphragm walling.
- Open wharves, which provide mooring facilities at both sides, can be constructed of piles with concrete decking.

WHARVES (CONT'D)

- An alternative to insitu concrete and caisson construction is the use of precast concrete blocks, which may be dovetail-keyed and weigh anything from 10 tonnes to 30 tonnes each.



JETTIES

- Jetties jut out into the sea, usually at right angles to the shore line, although T-shaped and L-shaped jetties are not uncommon
- They are open structures, usually of steel tubular or hexagonal piling with a heavy concrete deck

JETTIES (CONT'D)

- They may be used for offloading heavy cargoes, in which case the deck may require extra bracing to the piles
- Alternatively, the jetty may carry pipelines and light lifting gear which do not require heavy bracing

JETTIES (CONT'D)

- The jetty structure must be designed to withstand impact loads and 'bollard pulls' from berthing ships
- This is usually accommodated by raking pile construction and fendering, the latter to avoid holing the ship

JETTIES (CONT'D)

- If the sea bed is a rock formation, the piling construction will not be economically produced by normal driving methods ;
 - holes up to 600 mm diameter may be bored into the sea bed and steel or concrete piles grouted in





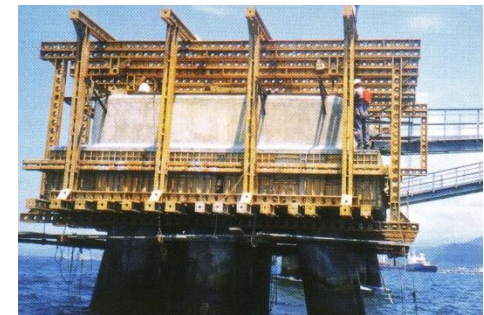
JETTIES

DOLPHINS

- Dolphins are individual mooring points to which vessels may be tied while waiting to enter a wharf or dock.
- They are also used as a guide to ships entering narrow harbours.
- Their construction is similar to that of jetties.

DOLPHINS

- Marine structure for mooring vessel.
- Used for tying up ships and for transferring cargo from one ship to another when moored along both sides.
- Types of dolphins :
 - * breasting dolphins
 - * mooring dolphins



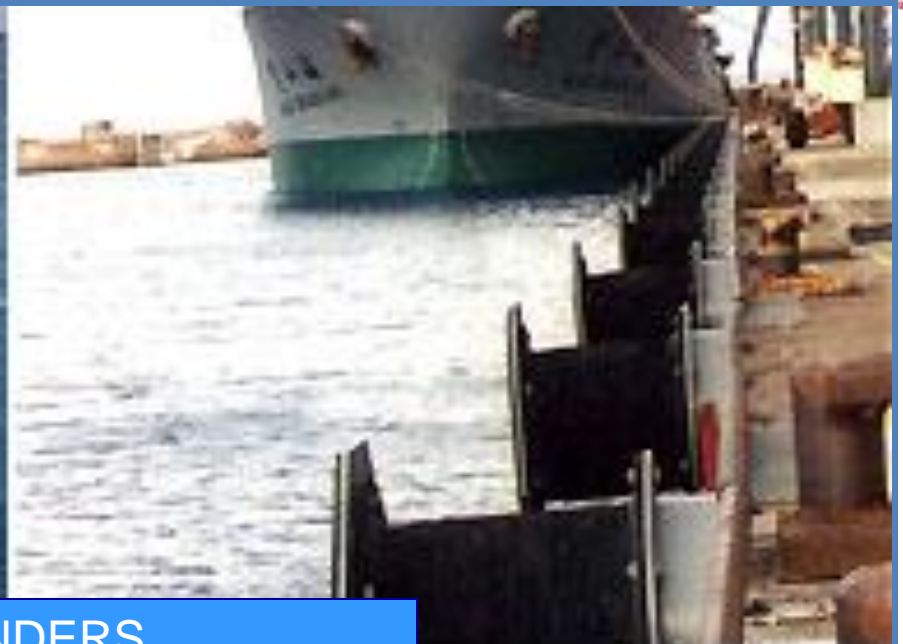
FENDERS

- Fenders are used in conjunction with all the marine constructions / structures mentioned
- They are used to absorb the kinetic energies produced by berthing vessels
- To achieve the necessary absorption, they have to be flexible and may take the form of tubes or springs of metal, rope and plastic

FENDERS (CONT'D)

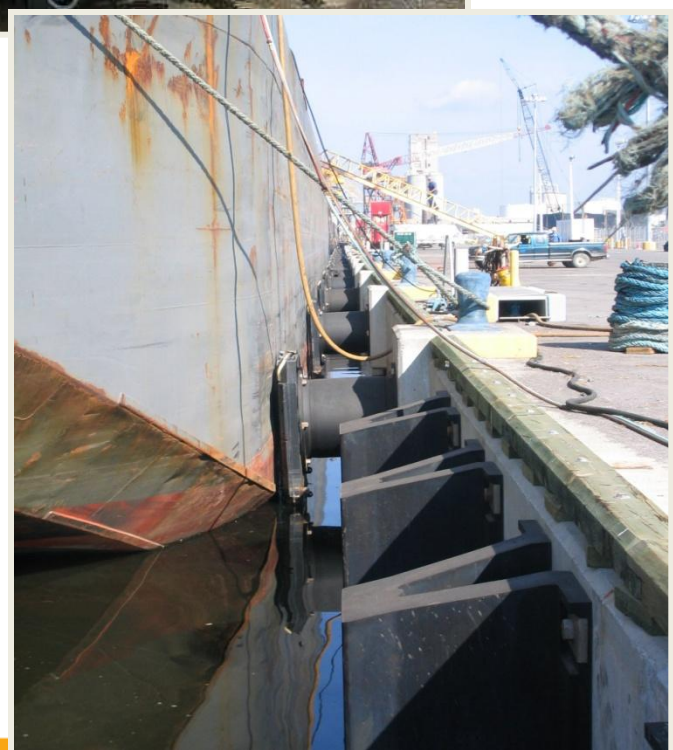
- Floating fenders, of rubber and timber, are used to distribute loads over many vertical fenders at the wharf side
- If floating fenders are not used, the load will normally be applied at deck level and the deck must be suitably braced and protected





FENDERS





FENDERS

BOLLARD

- Mooring fittings
- Located along the face of the dock
- Used to bring the ship into the dock

Beacon



BREAKWATER

Breakwaters are structures are normally constructed at the offshore region, parallel to the shoreline. The main functions of breakwaters are to provide harbour protection, act as a littoral barrier, provide shore protection, or provide a combination of the above features.

The most widely used type of breakwater is of rubble-mound construction.

BREAKWATERS / MOLES

- Breakwaters or moles are constructed in the outer harbour area to dampen heavy waves and swell so as to provide easier entrance and exit of vessels.
- They may be constructed with concrete blocks, rock fill, or a combination of both.

Breakwater

Types:

vertical wall breakwater

rubble sloping mound breakwater



BREAKWATERS / MOLES (CONT'D)

- The choice of material will depend upon the conditions of the site, i.e. :
 - depth of water, foundation conditions, range of tides, availability of materials and the anticipated extent of fine weather during construction.
- Vertical-sided breakwaters are suitable for shallow waters up to 15 meters deep; working in depths above this proves difficult for divers who position the block.

BREAKWATERS / MOLES (CONT'D)

- Where blockwork is used a foundation is prepared by dredging the marine bed and laying a concrete base.
- Blocks are lowered by cranes operated from pontoons, and are positioned by divers.
- The location of the blocks is made easier by a dovetailed jointing system.

BREAKWATERS / MOLES (CONT'D)

- As with other large marine structures, caissons are also commonly used for this type of work and are particularly suited to construction of breakwaters in deep waters.
- The caisson fill may be rock, sand or concrete
- Rubble or rock-fill breakwaters are suitable for both shallow and deep waters.

BREAKWATERS / MOLES (CONT'D)

- The rock fill should contain heavy stones, ranging from 1 to 5 tonnes each in weight, to prevent movement by wave action.
- The material is transported and placed by bottom-opening barges, some of which have a capacity of 600m³.
- Rubble breakwaters require protection against pounding of the deck area by heavy seas and this can be achieved by casting a concrete slab, or by grouting the top layer of rock or laying a precast interlocking deck.

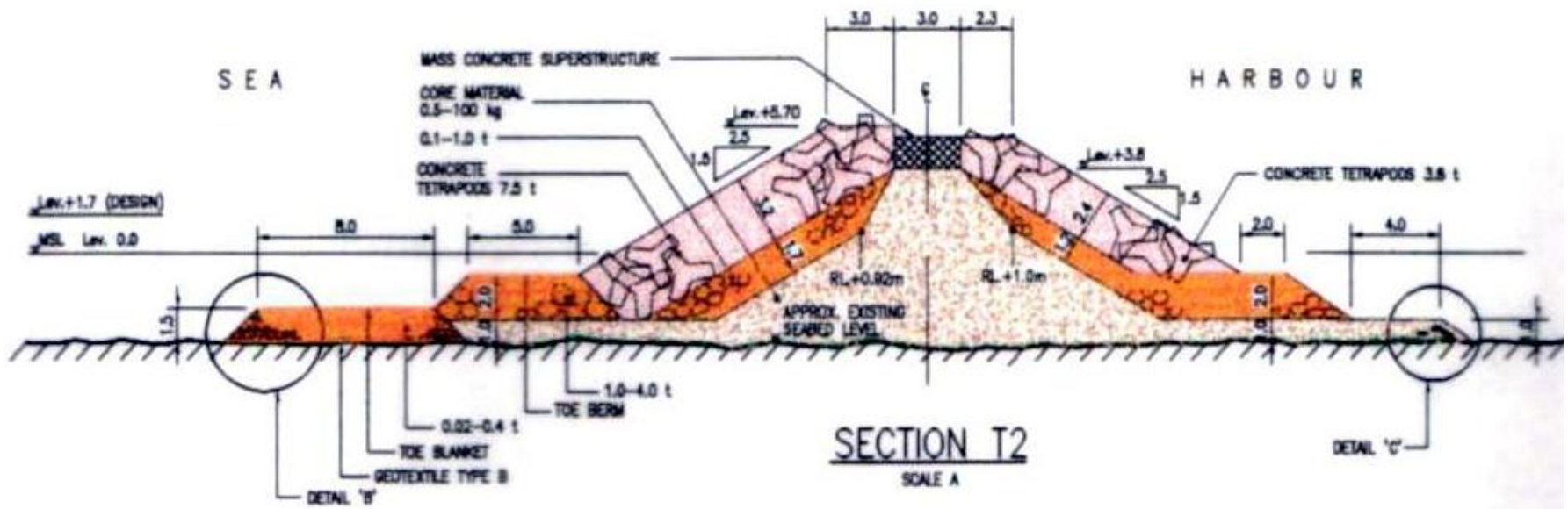
BREAKWATERS / MOLES (CONT'D)

- Composite breakwaters for very deep water consist of rock-fill and precast concrete block walls, the walls being taken to a depth of 5 to 10 meters below low water.
- The concrete blocks for breakwaters of this magnitude should be very heavy, averaging between 20 and 50 tonnes each.



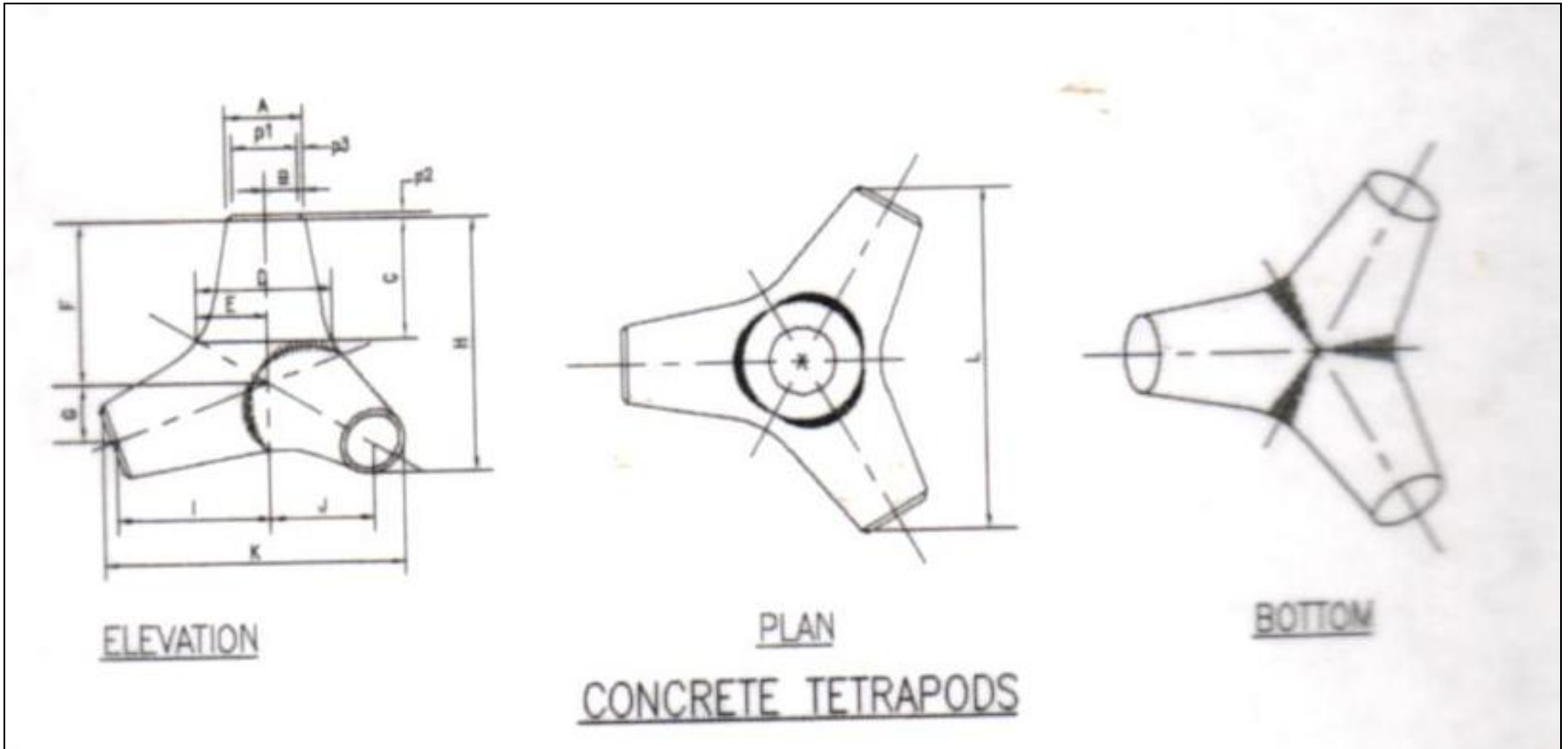
BREAKWATERS

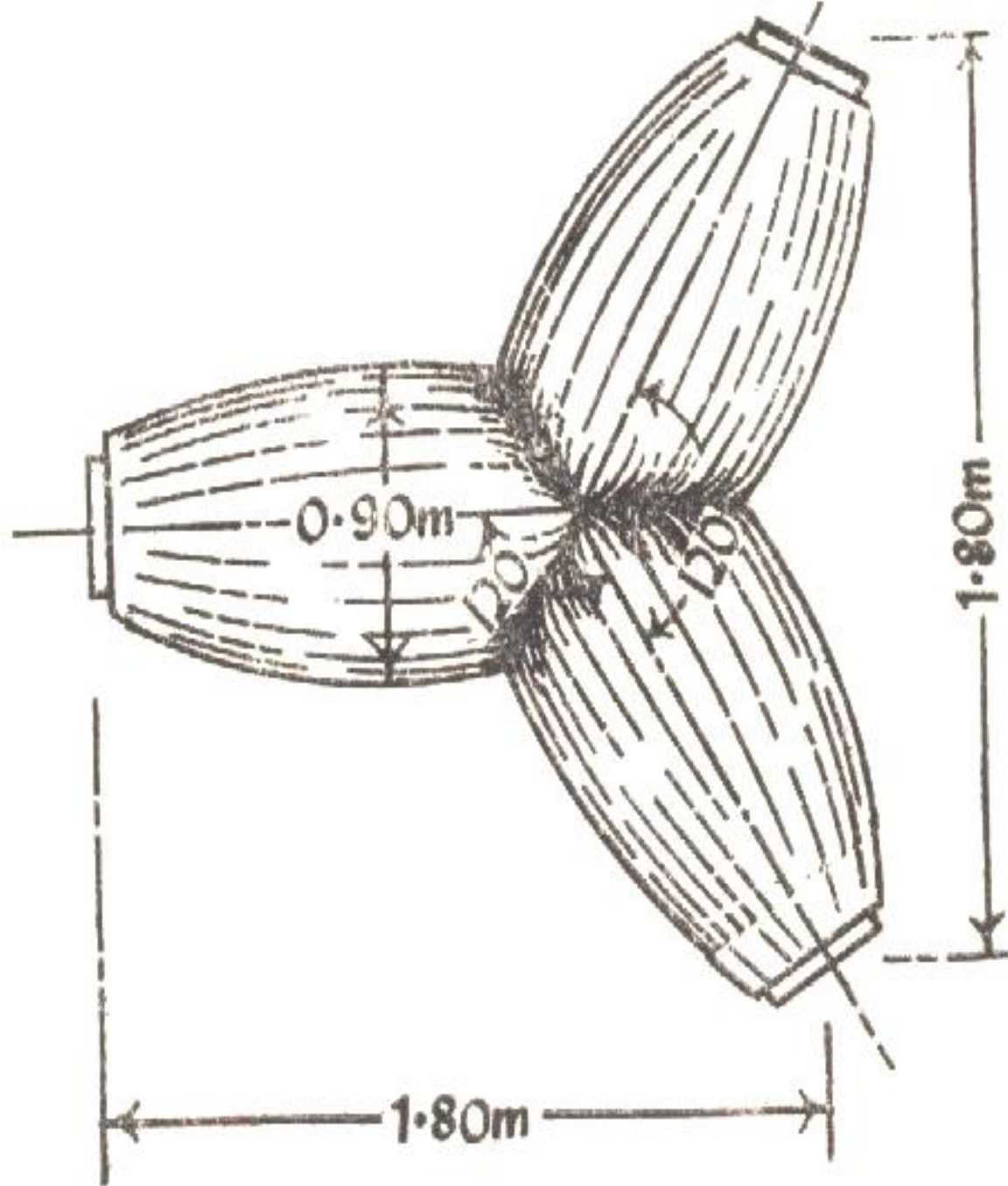
Tetrapod



Tetrapod

- A four pronged pre-cast concrete block, the prongs radiating at 120 degree to each other from a common centre.
- Each prong is cylindrical in shape and slightly truncated
- Blocks of required weight depending on the height of waves are simply heaped on the exposed face of the breakwater wall at a slope of 1.5 to 1.









Placing *ready mix* concrete to the mould













GROYNES

- Groynes are small section walls of concrete or other suitable material which are built to protect or retain beach material.
- Steel sheet piling may be used suitably capped and backed with concrete.
- Adequate penetration of the piles prevents under-scouring of the structure by wave action.

Scour is an erosion process which is carried out by the tidal movement of water



GROYNES

MARINAS

Structure constructed to provide facilities for boat owners either for berthing or getting supplies such as food, freshwater and accommodation. It sometimes provide the owner for ship repairs and maintenance.







MARINE STRUCTURE

PHYSICAL PLANNING OF CONSTRUCTION

PHYSICAL PLANNING

- Physical Planning covers the collection, processing and use of relevant data with regard to natural conditions for site selection, choice of location and orientation of major ports components such as access channels, breakwaters, basin, quays and specialized berths.
- The natural conditions in sequence are :
 - Climatic conditions, i.e. winds, temperature, rainfall & humidity
 - oceanographic conditions I.e waves, tides, currents, sediment transport and ice conditions
 - Topographic and hydrographic conditions
 - Soil Conditions

CLIMATIC CONDITIONS

WINDS

- The wind climate in terms of speed and direction patterns varies tremendously from region to region.
- Directions are strongly predominant, and in such cases these directions will ,to a large extent, determined ship maneuvers at berthing and parting.
- Where possible, berths should be oriented parallel to the predominant wind direction.
- Winds forces are relatively ,more important for loaded ships with most of the hull below the water surface.

WINDS (cont'd)

- Operation of the certain cargo-handling installations such as container crane is sensitive to high wind speeds, which will reduce handling because it will be discontinued.
- Wind statistics are useful for evaluation of local wind climates and it is normally possible to find such wind data based on actual measurements rather than usual observations.

TEMPERATURE, RAINFALL AND HUMIDITY

- Adversely affect port operations and may be may be major reasons for low-cargo handling rates and interruptions of cargo handling.

OCEANOGRAPHIC CONDITIONS

WAVES

- Water exert forces directly on breakwaters and exposed terminal structures, and determine major features of harbor layout through indirect action by generating movements, or moored ships.
- A natural wave train may be described as series of individual waves of different heights, wave lengths, and limited crest lengths.
- The limited length of a wave crest is a reflection of the fact that the waves are not unidirectional.
- Waves can be characterized by recording the time history of the water surface elevation in one point.

OCEANOGRAPHIC CONDITIONS

TIDES, STORMS, SURGES AND SEICHES

Tides movements will be recorded at the site to get the sufficient analyze the astronomically related tidal effects to show evaluate extremes for developing design water levels.

Lower water results from higher barometric pressure and higher levels from lower pressure. This effect may add several decimeters to water level variations caused by astronomical tides and storm surges.

Seich effects involves a resonance between natural period of oscillation and some external agitating effect.

OCEANOGRAPHIC CONDITIONS

CURRENTS

The currents are important through their effects on ships, whether moving or moored and through their sediment transporting capability , resulting in erosion and/or accumulation.

Tidal currents vary regularly similar to tidal water levels, and may therefore be studied sufficiently by measurements covering a fairly short period of time.

The current related to wind set up and barometric effects are only on special cases of major importance normally when the astronomical tides are small.

OCEANOGRAPHIC CONDITIONS

SEDIMENT TRANSPORT

The simplest form of sediment transport is that caused by the current alone, such as in rivers and by tidal currents, where the influence of waves is significant.

Sediment transport in the form of grains rolling along the bed is called bedload, and grains carried in suspension by the turbulence generated in the current is called suspended load.

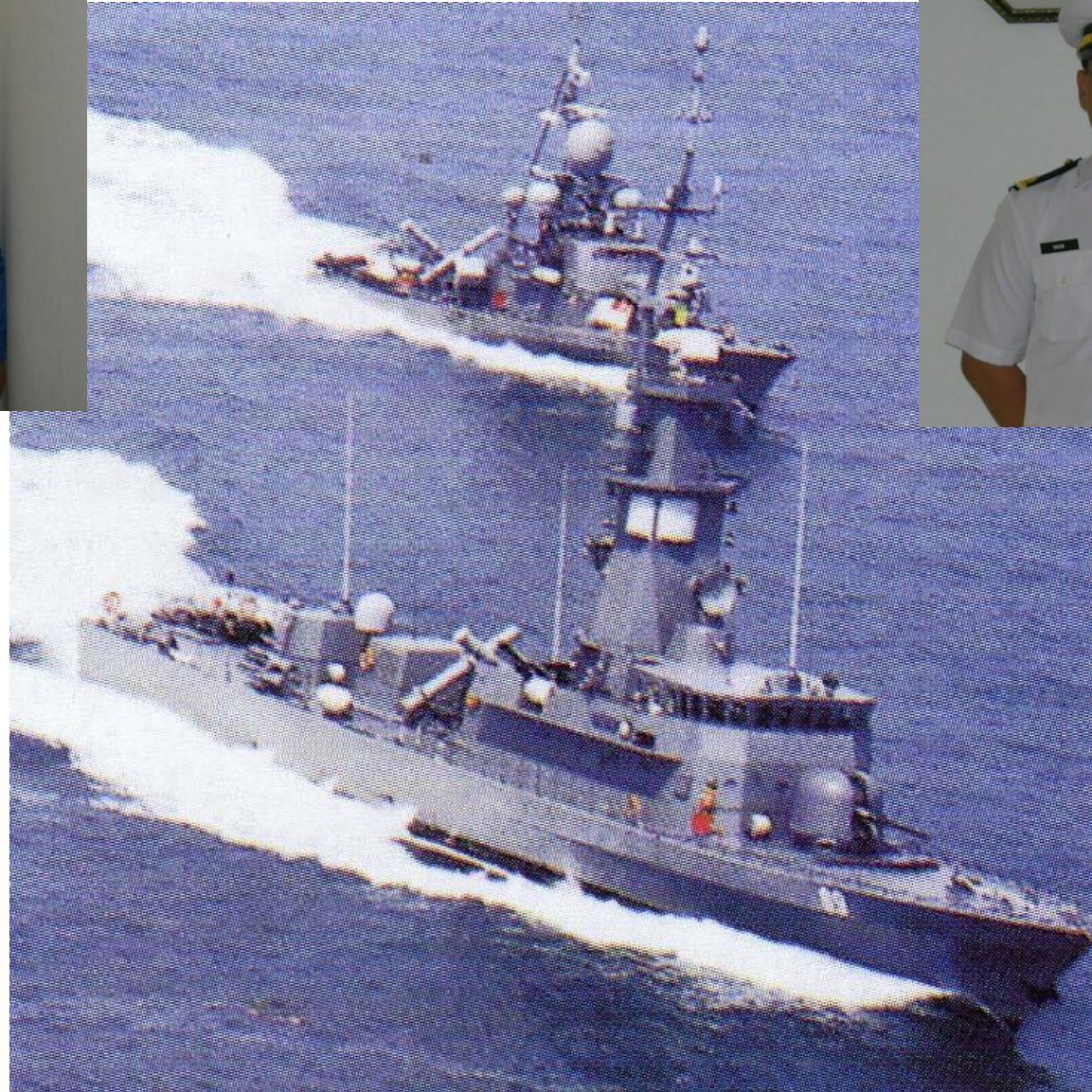
OCEANOGRAPHIC CONDITIONS

ICE CONDITIONS

Ice forces are exerted on structures either from drifting ice sheets which have gained velocity as a result of shear forces transmitted from winds or currents, or from ice sheets resting against structures and acted upon by winds or currents.

Ice occasionally piles up on sloping breakwaters and may even overtop the structure with danger or damage to its superstructure.

A harbor without protecting breakwaters and piers on open coast will be subjected to the full loads of drifting ice.



TOPOGRAPHIC AND HYDROGRAPHIC CONDITIONS

To be efficient, ports often require large areas of level land immediately adjacent to large areas of waters with considerable water depths.

Normally selection of new ports will start with examinations of existing information regarding land topography and nearshore hydrography to identify sites with suitable combinations of desirable features.

Normally existing maps and hydrography charts are useful and sufficiently reliable guides for the first identification of suitable sites.

THE END

THANK YOU

