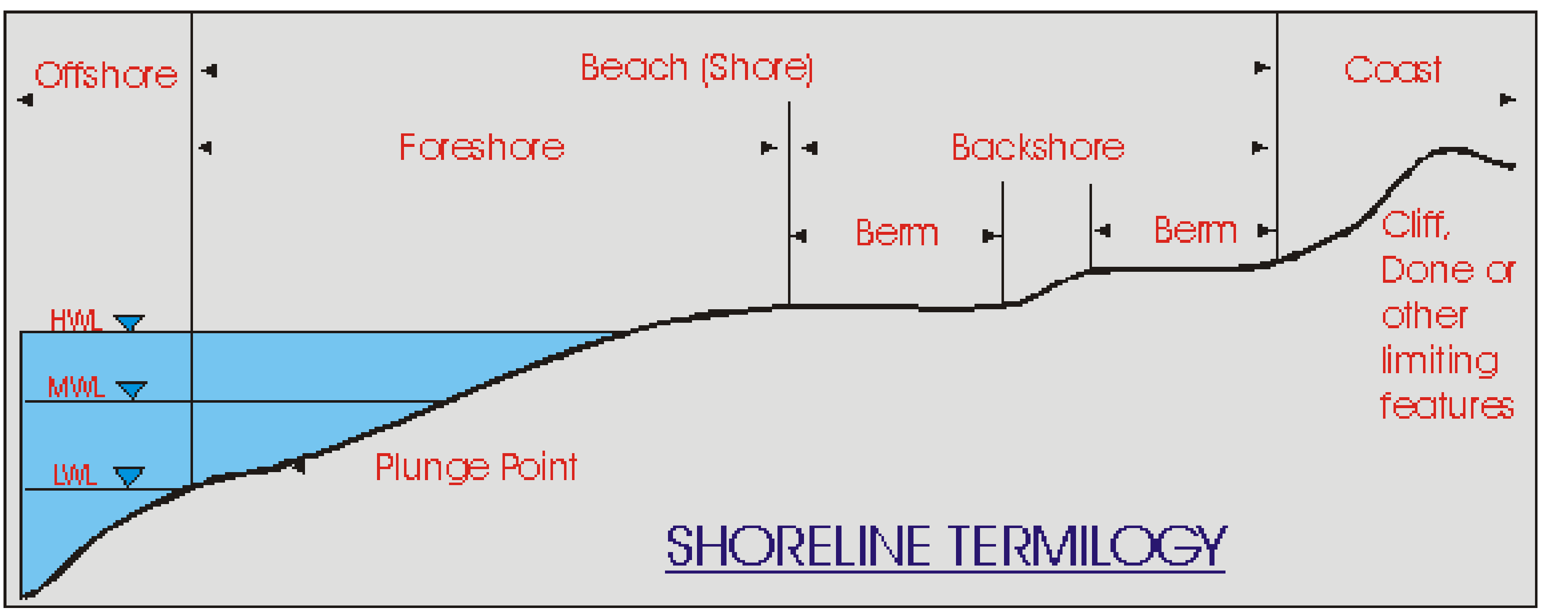
Shore Lines:

Shorelines are the areas between low tide and the highest level on land affected by storm waves. We are concerned mostly with ocean shorelines where processes such as waves, near shore currents and tides continually modify existing shoreline features. In contrast to other geologic agents shoreline processes are restricted to a narrow zone at any particular time. Shorelines migrate eastward or landward, however, depending on changes in the sea level and uplift or subsidence of the coastal region. Whatever there type, all shorelines involve a continual interplay between the energy level of shoreline processes and the shoreline materials. Areas where energy levels are particularly high, erosion predominates and the shorelines may retreat landward. Where sediment supply from the land is great deposition predominates.

In general, two leading types of shorelines may be recognized: THE SHORELINE OF EMERGENCE and the SHORELINE OF SUBMERGENCE. The first is the result of a gradual uplift of the seabed; the floor of the sea emerges to form a flat coastal plain consisting of unconsolidated deposits. Wave action then erodes the edge of the emergent landmass, carrying this away from the waterline. It is to form an offshore barrier beach that gradually works nearer to the original shoreline until the two will merge completely.

Shoreline are the result of a gradual depression a coastline, the original coastal area is submerged beneath the sea. The sea will thus stretch far inland and be in contact with an eroded land surface. The initial characteristic is extreme irregularity of outline. Figure 1 shows diagrammatic section of a developed shore.



THE WAVES, CURRENTS AND TIDES:

The ocean dynamics i.e. the movement of the sea is more important in engineering geology than the specific properties of seawater. Never does one see the ocean at rest. The wind is the chief factor in the formation of waves and currents, but the regular movement of the tides is perhaps the greater determinant in the design and continuation of the marine works. These great forces of nature have to be tamed as they break upon and physically impact marine works founded on and supported by geologic formations. Local currents near harbor and in estuaries affect the silting and layout of marine works and must be accepted as basic conditions and integrated into design. Wave action, however, is of far more serious consequence. In general, waves are of two types: SWELL WAVES and STORM WAVES. Both are generated by the action of the wind on the surface of the sea. Storm waves are generated more directly than swell waves. Of major importance is the maximum force that is to be expected from wave action at the location of any proposed works.

It's difficult to imagine the force that the sea can exert. Even well authenticated figures tend to seem unrealistic. Approaching a coastline, wave size will naturally decrease, but the potential force of breaking wave is remarkable. Tall (but true) tales of the force of the sea make it obvious that the design and construction of marine works are supreme examples of the art of engineering geology and civil engineering of course.

Tidal movement is a natural phenomenon of an entirely different but equally majestic character, invading the simultaneous movement of all the water in the ocean. Under the combined attraction of the moon and the sun, but chiefly the moon, the ocean is pulled away from the earth in a dual cycle of about 12hrs and 50mins. The extra 50 mins make for a significant scheduling problem in marine construction operations. At full and new moon the tidal forces of the Sun are added to that of Moon, causing high spring tides; while at half Moons the forces are opposed, causing low neap tides.

DESTRUCTION OF SHORELINES:

1. **DESTRUCTION OF SHORE CLIFFS AND STEEP BANKS:**

Steep shore banks made of soil materials are susceptible to failures such as landslides and to gradual motion of large earth masses, plastic or otherwise. Clay banks are especially sensitive to wetting, either directly by waves or by spray. Wetting results in a decrease in cohesion and hence in the resistivity of the material to the shearing stress. This may thus cause flow or sliding when wetting alternates with drying, shrinkage cracks develop in the dry bank, and thus an easy path is provided for the penetration of water into the banks. A common cause for landslides in clayey banks is the erosion of the foot of the slope the -"removal of the lateral support" of the slope. When a clayey bank fails, one or more protective structures built along that bank are engulfed by the huge, semi liquid masses of material. So should be disturbed least and where practicable protected by coarse granular material or riprap.

The more sandy the clay-sand material, the more stable is the bank or cliff, because the drainage is rapid and thus the possibilities of high pore-pressure development are less.

2. SOFT-ROCK SHORE CLIFFS:

The softness of a rock is usually caused by the lack of firm cementing matrix or the alteration of its mineral constituents into soft compounds. In either case water sorption becomes rapid and erosion intense. Often erosion is temporary, halted by the erection of concrete walls immediately adjacent to the cliff. The height be such as to prevent water penetration into soft rocks. The destruction of soft rock shore cliff is not entirely without its beneficial effects. The eroded materials are the source of LITTORAL DRIFT ------- The sedimentary material transported by the waves and currents parallel to shorelines. This drift often comes to rest in beach areas where erosion has been making inroads in desirable land. Thus the erosion is temporarily halted and the beach is built in the process.

3. HARD-ROCK SHORE CLIFFS:

Normally cliffs that are composed of hard rocks such as granite, provide as good barrier to erosion as man can build. Even these cliffs are subjected to erosion over long periods of time. Usually there are few beaches in such areas, and thus every single beach is of great value. The only material to keep these beaches in existence is the littoral drift from erosion of the nearby hard rock cliff. Thus the erosion of the hard-rock cliff may be either beneficial or detrimental to the shore shaping according to circumstances.

PLANNING AND CONSTRUCTION OF LITTORAL BARRIERS:

1. PRINCIPLES OF PLANNING:

To prevent or to stop the destruction of a shoreline by waves and currents, PROTECTIVE WORKS (LITTORIAL BARRIERS) have to be planned and executed. Proper location and position of each barrier is very important. Each barrier should be provided with an adequate foundation capable of resisting vertical and especially lateral forces due to the impact of the destructive agents.

Preliminary investigations of the site should be regarding the properties of local rock and soil materials, particularly their durability --- their resistance to abrasion. The stability of the local deposits, i.e. their resistance to translation, should be investigated.

A detailed map of the shoreline should be available and if necessary additional surveys should be made. It is necessary to know the geological history of the site i.e. the geological processes that are acting on the shore at the time of investigations and those that have acted on it previously. The nature of shoreline whether submergent, emergent or neutral, should be established and the factors, which have been primarily responsible for the actual shaping of the shoreline. It is important for engineering purposes to know not only the qualitative picture of the processes but also the rates at which these processes may operate or are operating. Some analogies can be drawn from the various studies made previously. It should be noted that each shoreline is an individual engineering project requiring individual analysis.

SUMMARY OF INFORMATION FOR PLANNING LITTORAL BARRIERS:

For rational planning the following information may be needed:

1. The geological history of the site, its stratigraphy and lithology.
2. Classification of the grain sizes in the given beach or beaches.

3. Petrographic identification of rocks along the shoreline.

4. Influence of climatic factors such as rainfall and surface runoff on the cliffs and banks along the shoreline.

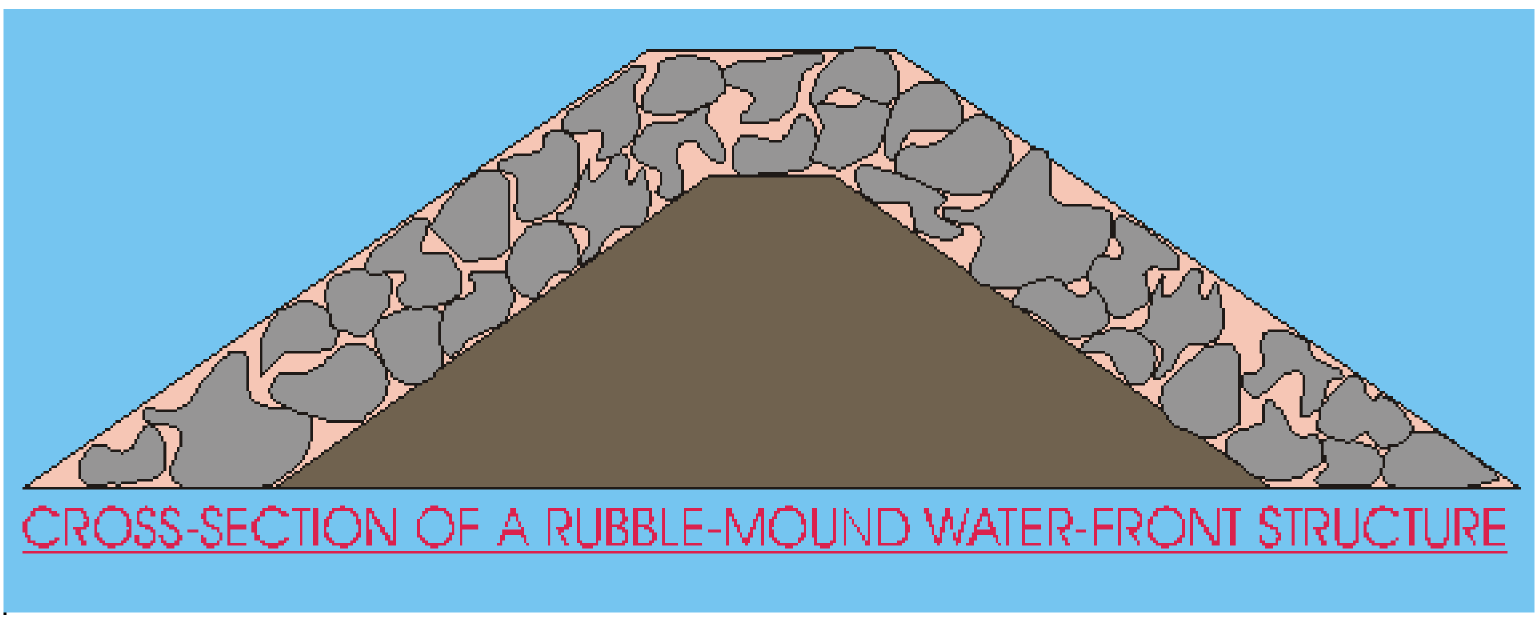
5. The natural / artificial sources of future supply.

6. The dependability of such sources for littoral drift.

7. The rates of erosion of all shoreline materials in the area or those located at some distance from the area but still serving as a source of littoral drift.

ARTIFICIAL LITTORAL BARRIERS:

The man made littoral barriers termed also as PROTECTIVE STRUCTURE / CORRECTIVE STRUCTURES / WATER FRONT STRUCTURES are jetties, groins and break waters. These structures are of trapezoidal or a similar cross section and of limited transverse dimensions in comparison with their length. The following X-section of a groin (Figure 2) may be considered typical for all structures mentioned.

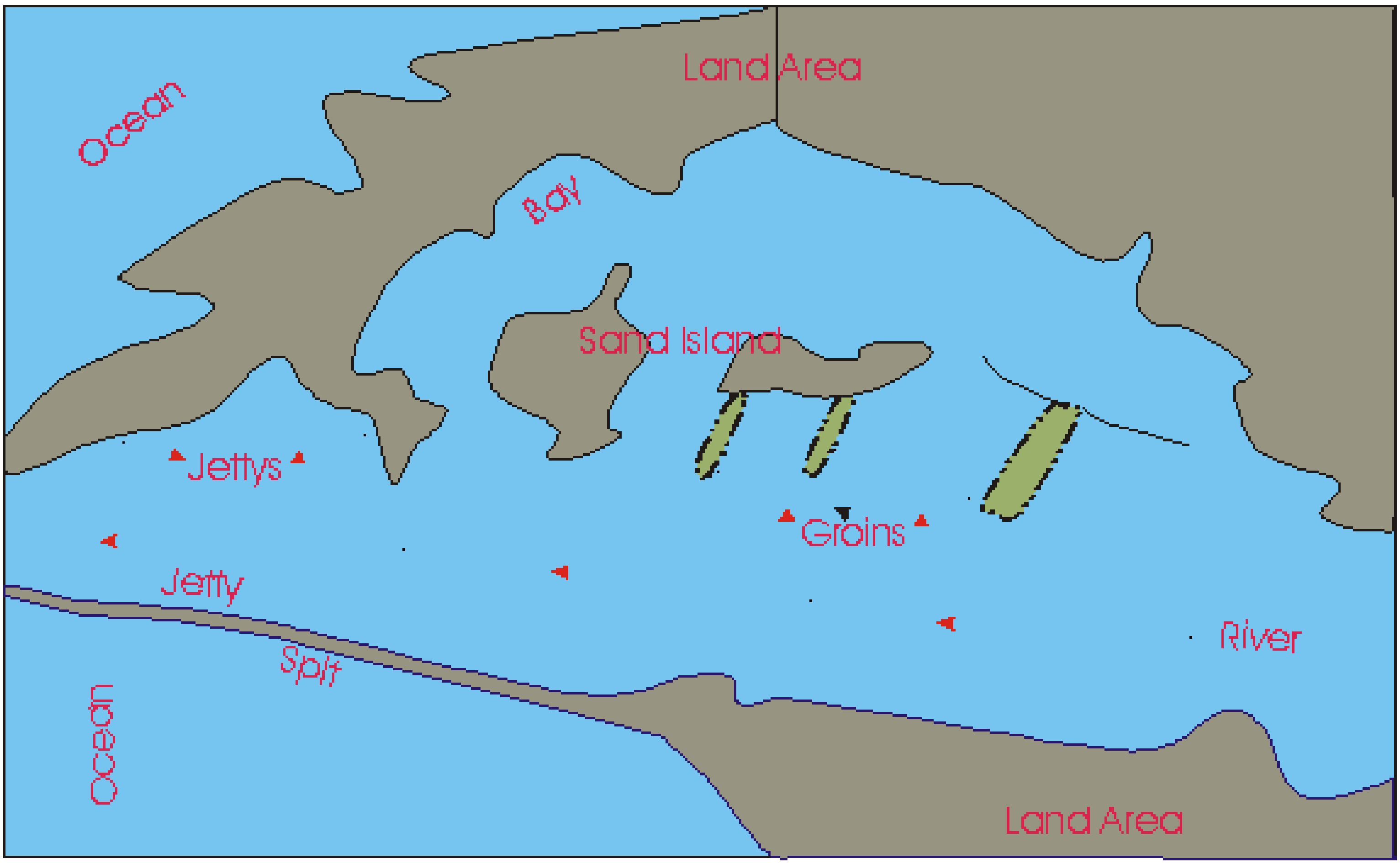


1) Jettys: The purpose of construction is to protect inlets (entrances) to rivers and bays. Also used for protection of harbor areas. Often two approximately parallel jetties start at each shore of the river and extent some distance out to the ocean or sea into which the river flows. The velocity of flow between the jetties is increased because of its confinement and thus deposition is prevented.

2) Groin: A littoral barrier starting at and perpendicular or at an angle to the shoreline. Sand that is being carried by a long shore current is stopped on the up current / up drift side of the groin and thus aids in widening the existing beaches. The more accurate the angle made by the groin with the shoreline, the less is its capacity to form an adequate beach. There are solid groins and permeable groins, the latter

modify the littoral processes as desired but do not obstruct them. The length of groin should be approximately 50% longer than the width of the beach it serves; figure 3 depicts the disposition of jetties and groins.

3) Breakwaters: These are barriers constructed to break up and disperse the waves of heavy seas, to provide shelter for ships, and generally to contribute to the increase of shipping facilities in a harbor. An offshore breakwater may or may not be connected with the shore by a bridge. Many start directly from the shore itself.



GROINS AND JETTYS AT THE MOUTH OF A RIVER

4) Dredged channel: This is constructed across the shoreline just updrift from the site subject to erosion. It's dredged periodically and the dredged material deposited on the down drift side of the channel.

5) Sea wall and Bulkhead: They are protective water front structure. They protect the shore from wave and serve for docking of vessels.

· Sea wall range from a simple riprap deposit along a stretch of the shore to a regular masonry retaining wall.

· Bulkheads are vertical walls, either of timber boards or of steel sheet piling driven into the ground vertically to the natural ground behind the wall.

HARBO(U)RS

PRINCIPLES OF HARBOR LOCATION:

Harbors may be natural or artificial, i.e. manmade. Artificial Harbors may be either offshore or inside the shore by dredging interior basins and building entrance jetties. An offshore harbor should be protected by a breakwater system; hence their planning should take advantage of natural headlands. A harbor of refuse is a temporary haven without elaborate artificial protection where vessels may seek shelter in heavy weather or obtain emergency supplies and repairs.

Shoreline considerations: The structure of the shoreline and particularly the number of river mouth that may be used for development of harbors is of importance for harbor locations.

Use of the wind Rose: Wind studies for a proposed location are made, and percentage of time when the wind blows from a given compass direction are determined from the wind rose. Thus direction of prevailing gale can be determined. In order to minimize the detrimental effect of gale on navigation, the breakwaters should be located practically normal to the direction of prevailing wind. Examples of harbor plans are shown in figures 4, 5 & 6.

1. Here breakwater should be convergent to protect the entering ship.

2. A natural curvature of the shoreline may replace a breakwater.

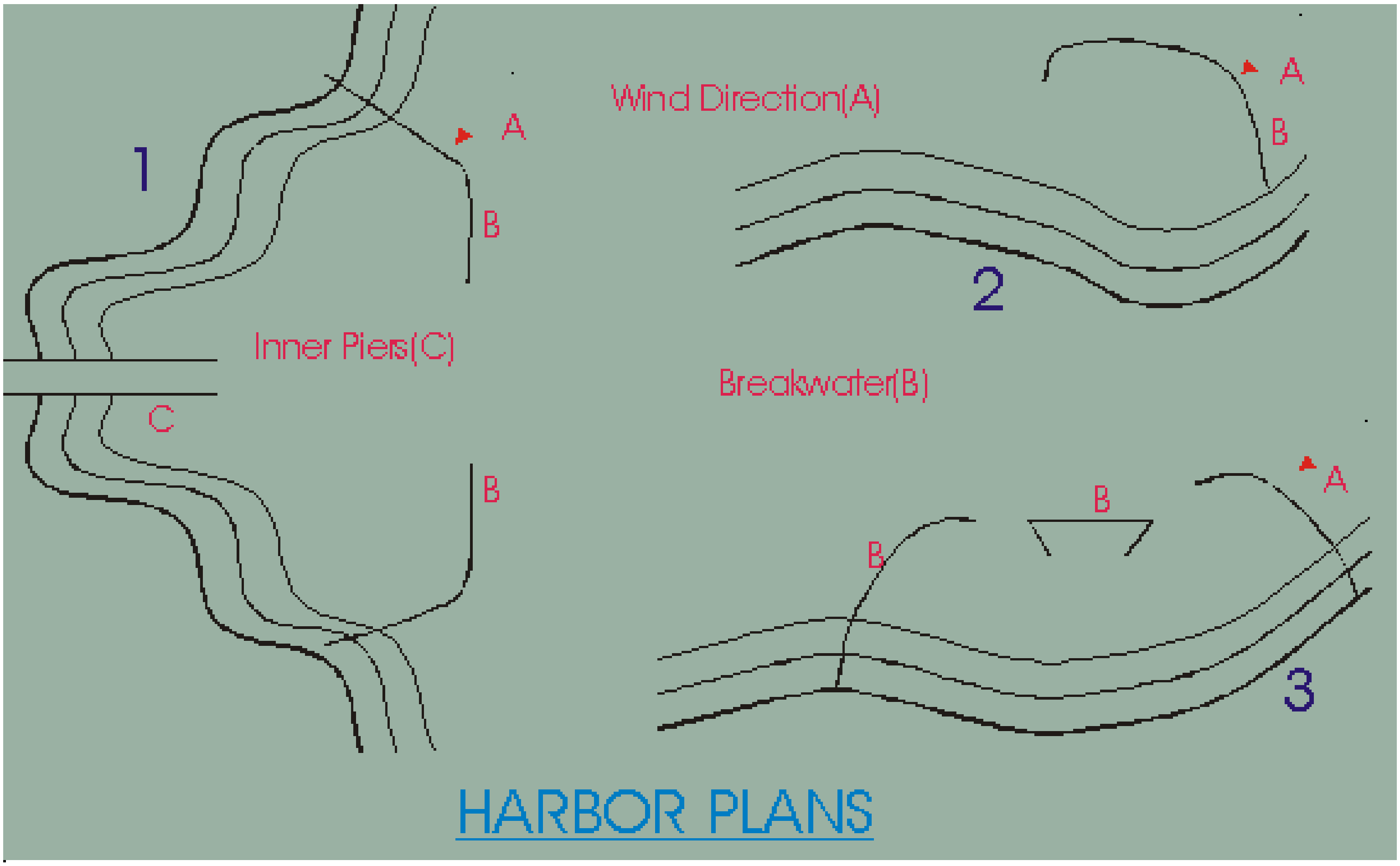
3. If the arms of breakwaters happens to be far apart, a third is required to close the system.

Harbor Waves:

Generally two kinds of waves should be considered when planning a harbor: (1) Those tend to prevent vessels from entering the harbor and (2) those that may develop in the harbor itself. Common ocean waves are having short periods and are progressive. Tidal waves are progressive except that at a certain time it changes its direction. Surge is the wave motion having period between ocean wave and tidal wave. Its height is small but horizontal motion may be large. If surge is by progressive wave train, all area experience same horizontal motion, where as if surge is of standing-wave type, there will be distinct area of active and quiet water. Seiching is an oscillation of water in harbors. Once started the motion persists unless brought to rest by frictional forces.

In the design and location of harbor structures composed of or founded on piles, the ability of the piling to withstand deterioration should be known, two major causes being corrosion and abrasion.

Duddly Beach



SEDIMENTATION IN HARBORS AND ITS CONTROL:

One of the most important problems of harbor engineering is to continuously maintain the minimum depth of water required for the convenient movement, anchoring and berthing of ships. Since depth of water in a harbor is decreased by the deposition of silt, the currents bringing the silt to the harbor should be stopped or diverted and the silt be given an opportunity to settle down at a [lace where the silt deposits are not detrimental to navigation. If silt deposits are being formed within the harbor area, they should be removed. Generally, this is done by dredging and some times by eroding and flushing the shoals i.e. shallow places.

Before measures against harbor silting are taken, the following information should be obtained:

1) The direction along which sediment may reach the harbor, whether from the uplands by streams, from sea by waves or along the coasts by littoral currents.

2) The predominant character of sediment, whether coarse or fine or both and,

3) A rough estimate of expected quantities of sediments.

Hereafter measures should be taken against harbor silting for different particular cases of sediments like coarse sediments, fine sediments, and/or harbor locations like off channel harbors, shoreline harbors.