4.4 COASTAL STRUCTURES

The main and prime reason to construct coastal protection structures is to protect harbor and other infrastructures from sea wave effects such as erosion. Not only are they useful for changing current and sand movements but also to redirect rivers and streams.

Types of Coastal Protection Structures

There are various structures that considered or used as coastal protection structures for example groins, seawalls, bulkheads, breakwaters, and jetties.

1. Seawalls

This large coastal protection structures can be built using different types of construction materials such as rubble mound, granite masonry, or reinforced concrete. Seawalls are commonly built and run along shoreline to prevent coastal structures and areas from the detrimental influence of ocean wave actions and flooding which are driven by storms. There are various arrangements or configurations that might be employed includes curved face seawall, stepped face seawall, rubble mound seawall.

a. Curved face seawall

Curved face seawall is designed to withstand high wave action effects. Foundation materials loss, which might be caused by scouring waves and leaching from over topping water or storm drainage underneath the wall, is avoided by employing sheet pile cut off wall. Moreover, the toe of the curved face seawall is built from large stones to decrease scouring.

b. Stepped face seawall

Stepped face seawall is used to oppose or resist moderate wave actions. Reinforced concrete sheet piles with tongue and groove joints are employed to construction this type of seawall. The spaces which is created between piles is either filled with grout in order make sand proof cut off wall or install geotextile fiber at the back of the sheet pile to form sand tight barrier. Applying geotextile is beneficial because it allows seeping water through and consequently prevents accumulating hydrostatic pressure.

c. Rubble Mound Seawalls

Design and construction this type of seawall configuration might be easier and cheaper. It can resist substantially strong wave actions. Despite scouring of the front beach, quarry stone comprising the seawall could be readjusted and settled without causing structural failure.

2. Bulkheads

Bulkheads can be constructed by concrete, steel, or timber. There two major types which are gravity structures and anchored sheet pile walls. The bulkheads might not have exposed to sustainability strong wave actions and its main purpose is to retain earth but scouring at the base of the structure should be considered by the designer. Cellular sheet pile bulkheads are employed for situations where rock is close to the surface and enough penetration cannot be achieved for the anchored bulkhead type. Moreover, sheet pile should be sufficiently reinforced for bending moment, soil conditions, hydrostatic pressures and support points.

3. Groins

Groins are shore protection structures that decrease erosion effects to the shoreline by changing offshore current and wave patterns. Groins can be built by materials such as concrete, stone, steel, or timber and are categorized depend on length, height, and permeability. Furthermore, groins are commonly constructed vertically to the shoreline and it can either impermeable or permeable.

4. Jetties

Jetties are usually built of materials such as concrete, steel, stone, timber, and occasionally asphalt used as binder. This structure is constructed at river estuary or harbour entrance and extended into deeper water to oppose forming of sandbars and limit currents.

5. **Breakwaters**

There are three major types of breakwaters namely: offshore, shoreconnected, and rubble mound. Not only are they used to protect shore area, anchorage, harbor from wave actions but also to create secure environment for mooring, operating, and handling ships.

PIER

A **Pier** is a raised structure that rises above a body of water and usually juts out from its shore, typically supported by piles or pillars, and provides above-water access to offshore areas. Frequent pier uses include fishing, boat docking and access for both passengers and cargo, and oceanside recreation. Bridges, buildings, and walkways may all be supported by piers. Their open structure allows tides and currents to flow relatively unhindered, whereas the more solid foundations of a quay or the closely spaced piles of a wharf can act as a breakwater, and are consequently more liable to silting. Piers can range in size and complexity from a simple lightweight wooden structure to major structures extended over 1,600 m (5,200 ft). In American English, a pier may be synonymous with a dock.

Piers have been built for several purposes, and because these different purposes have distinct regional variances, the term *pier* tends to have different nuances of meaning in different parts of the world. Thus in North America and Australia, where many ports were, until recently, built on the multiple pier model, the term tends to imply a current or former cargo-handling facility. In contrast, in Europe, where ports more often use basins and river-side quays than piers, the term is principally associated with the image of a Victorian cast iron pleasure pier. However, the earliest piers predate the Victorian age.

TYPES OF PIER

Piers can be categorized into different groupings according to the principal purpose. However, there is considerable overlap between these categories. For example, pleasure piers often also allow for the docking of pleasure steamers and other similar craft, while working piers have often been converted to leisure use after being rendered obsolete by advanced developments in cargo-handling technology. Many piers are floating piers, to ensure that the piers raise and lower with the tide along with the boats tied to them. This prevents a situation where lines become overly taut or loose by rising or lowering tides. An overly taut or loose tie-line can damage boats by pulling them out of the water or allowing them so much leeway that they bang forcefully against the sides of the pier.

WORKING PIERS

Working piers were built for the handling of passengers and cargo onto and off ships or (as at Wigan Pier) canal boats. Working piers themselves fall into two different groups. Longer individual piers are often found at ports with large tidal ranges, with the pier stretching far enough off shore to reach deep water at low tide. Such piers provided an economical alternative to impounded docks where cargo volumes were low, or where specialist bulk cargo was handled, such as at coal piers. The other form of working pier, often called the finger pier, was built at ports with smaller tidal ranges. Here the principal advantage was to give a greater available quay length for ships to berth against compared to a linear littoral quayside, and such piers are usually much shorter. Typically each pier would carry a single transit shed the length of the pier, with ships berthing bow or stern in to the shore.

The advent of container shipping, with its need for large container handling spaces adjacent to the shipping berths, has made working piers obsolete for the handling of general cargo, although some still survive for the handling of passenger ships or bulk cargos. One example, is in use in Progreso, Yucatán, where a pier extends more than 4 miles into the Gulf of Mexico, making it the longest pier in the world. The Progreso Pier supplies much of the peninsula with transportation for the fishing and cargo industries and serves as a port for large cruise ships in the area. Many other working piers have been demolished, or remain derelict, but some have been recycled as pleasure piers. The best known example of this is Pier 39 in San Francisco.

At Southport and the Tweed River on the Gold Coast in Australia, there are piers that support equipment for a sand bypassing system that maintains the health of sandy beaches and navigation channels.

PLEASURE PIER

Pleasure piers were first built in Britain during the early 19th century. The earliest structures were Ryde Pier, built in 1813/4, Trinity Chain Pier near Leith, built in 1821, and Brighton Chain Pier, built in 1823. Only the oldest of these piers still remains. At that time the introduction of the railways for the first time permitted mass tourism to dedicated seaside resorts. The large tidal ranges at many such resorts meant that for much of the day, the sea was not visible from the shore. The pleasure pier was the resorts' answer, permitting holidaymakers to promenade over and alongside the sea at all times. The world's longest pleasure pier is at Southend-on-Sea, Essex, and extends 1.3 miles (2.1 km) into the Thames estuary. The longest pier on the West Coast of the US is the Santa Cruz Wharf, with a length of 2,745 feet (837 m).

Providing a walkway out to sea, pleasure piers often include amusements and theatres as part of their attractions. Such a pier may be unroofed, closed, or partly open and partly closed. Sometimes a pier has two decks. Galveston Island Historic Pleasure Pier in Galveston, Texas has a roller coaster, 15 rides, carnival games and souvenir shops.

Early pleasure piers were of wooden construction, with the first iron pleasure pier being Margate Jetty, opened in 1855. Margate pier was wrecked in storms in 1978 and never repaired. The longest iron pleasure pier still remaining is the one at Southend. First opened as a wooden pier in 1829, it was reconstructed in iron and completed in 1889. In a 2006 UK poll, the public voted the seaside pier onto the list of icons of England.

Fishing piers

Many piers are built for the purpose of providing boatless anglers access to fishing grounds that are otherwise inaccessible. Many "Free Piers" are available in larger harbors which differ from private piers. Free Piers are often primarily used for fishing.

BREAKWATERS

Breakwaters are structures constructed on coasts as part of coastal defense or to protect an anchorage from the effects of both weather and long shore drift.

- A structure protecting a shore area, harbor, anchorage or basin from wave disturbance.
- A barrier that breaks the force of waves, as before a harbor.

Breakwater types

There are several types of breakwaters, the different types can be divided into two categories. Rubble mound breakwaters which are made out of large heaps of loose elements, and monolithic breakwaters which have a cross section acting as one block, for instance a caisson.

The following breakwater types have been implemented: conventional rubble mound breakwater, caisson breakwater and the vertically composite breakwater. For each of these structures a class is defined with which a conceptual design can be made.

Conventional Rubble Mound

As mentioned in the introduction a rubble mound breakwater is made out of large heaps of loose elements, the armour layer of these types are made with either rock or concrete armour units such as Xbloc or XblocPlus. Both types of armour layer can be used to design a breakwater.

Design of breakwater with Rock as armour layer

Makes a conceptual design for a conventional rubble mound breakwater with rock as the armour layer, for one or several limit states. The following computations are performed:

- The armour layer is designed with the Van der Meer formulas for deep and shallow water (van der Meer, 1988; van Gent et al., 2003).
- The underlayer is designed by using the rules for the underlayer
- A filter layer is designed if one is needed, depends on **Dn50_core**
- The toe is designed with the toe stability formula of Van der Meer (1998).
- The crest freeboard is computed with the formula from EurOtop (2018)
- The required width of the scour protection with Sumer and Fredsoe (2000)
- If a **Soil** is specified, a slip circle analysis is performed

Composite (vertical)

The caisson type and vertical composite breakwater are included in one design class as they are basically the same structures. The main difference is the water depth immediately in front of the caisson. In this package the classification criteria from Eurotop (2018) is used, which classifies a vertical breakwater as vertical if dh>0.6dh>0.6, else the breakwater is classified as a vertically composite breakwater.

Design of (composite) vertical breakwater

Makes a conceptual design of a vertical or composite vertical breakwater, with a caisson on a rubble mound foundation. The following computations are performed:

- The necessary size of the armour layer of the foundation is designed with the modified Tanimoto formula (Takahashi, 2002).
- The required stone size for the core of the foundation
- The water depth in front of the caisson is computed based on the dimensions of the foundation and water depth
- The crest freeboard is computed with the formulae from EurOtop (2018), **vertical()** is used, which automatically classifies the breakwater so that the correct formula is used.
- The required width of the caisson is computed with the extended Goda formula (Takahasi, 2002).
- The required width of the scour protection with Sumer and Fredsoe (2000). Note that a scour protection is only added if the width of the foundation is not sufficient.
- If a Soil is specified the bearing capacity of the soil will also be checked with Brinch Hansen (1970).

Breakwaters

- Breakwaters are structures constructed on coasts as part of coastal defense or to protect an anchorage from the effects of both weather and long shore drift.
- A structure protecting a shore area, harbor, anchorage or basin from wave disturbance.
- A barrier that breaks the force of waves, as before a harbor.

- Breakwater are the structures constructed to enclose the harbours to protect them from the effect of wind generated waves by reflecting and dissipating their force or energy. Such a construction makes it possible 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.

Need of Breakwater

- Breakwaters are built to provide shelter from waves to manipulate the littoral/sand transport conditions and thereby to trap some sand entrance inside the Anchorage Area
- A breakwater is a large pile of rocks built parallel to the shore. It is designed to block the waves and the surf. Some breakwaters are below the water's surface (a submerged breakwater).
- Breakwaters are usually built to provide calm waters for harbors and artificial marinas.
- Submerged breakwaters are built to reduce beach erosion. These may also be referred to as artificial "reefs."
- A breakwater can be offshore, underwater or connected to the land. As with groins and jetties, when the long shore current is interrupted, a breakwater will dramatically change the profile of the beach. Over time, sand will accumulate towards a breakwater. Down drift sand will erode.
- A breakwater can cause millions of dollars in beach erosion in the decades after it is built.

Types of Breakwaters

- Detached breakwater (breakwaters can completely isolated from the shore)

    Head land breakwaters

    Near shore breakwaters

- Attached breakwater (Breakwaters can be connected to the shore line)

Low crested structure

High crested structure

- Rubble mound structure
- Composite structure
- Using mass (caissons)
- Using a revetment slope (e.g with rock or concrete armor units)
- Emerged breakwaters
- Submerged breakwaters
- Floating breakwaters

DETACHED Breakwater

Breakwaters without any constructed connection to the shore. This type of system detached breakwaters are constructed away from the shoreline, usually a slight distance offshore .they are designed to promote beach deposition on their lee side appropriate in areas of large sediment transport

Head land breakwaters(HB)

A series of breakwaters constructed in an "Attached" fashion to the shoreline & angled in the direction of predominant waves - the shoreline behind the structures evolves into a natural "crenulate" or log spiral embayment.

Nearshore Breakwaters

Nearshore breakwaters are detached, generally shore-parallel structures that reduce the amount of wave energy reaching a protected area. They are similar to natural bars, reefs or nearshore islands that dissipate wave energy. The reduction in wave energy slows the littoral drift, produces sediment deposition and a shoreline bulge or salient feature in the sheltered area behind the breakwater. Some longshore sediment transport may continue along the coast behind the nearshore breakwater

Rubble mound breakwater

- Rubble mounds are frequently used structures.

- Rubble mound breakwater consists of armour layer, a filter layer & core.

- It is a structure, built up of core of quarry run rock overlain by one or two layers of large rocks. Armour stone or precast elements are used for outer armour layer to protect the structure against wave attack. Crown wall is constructed on top of mound to prevent or to reduce wave

- A breakwater constructed by a heterogeneous assemblage of natural rubble or undressed stone.

- When water depths are large RBW may be uneconomical in view of huge volume of rocks required.

- Built upto water depth of 50m.

- Not suitable when space is a problem. If the harbor side may have to be used for berthing of ships, the RBW with its sloping faces is no suitable for berthing.

- These type of breakwaters dissipate the incident wave energy by forcing them to break on a slope and thus do not produce appreciable reflection.

ADVANTAGES OF RMBW

- Use of natural material

- Reduces material cost

- Use of small construction equipment

- Less environmental impact

- Easy to construct
- Failure is mainly due to poor interlocking capacity between individual blocks

- Unavailability of large size natural rocks leads to artificial armour blocks.

Disadvantages of RMBW

- Needs a considerable amount of construction materials.

- Continuous maintenance is required.
- Sometimes there are difficulties in erection, as the rock weight increases with the increase of wave heights.
- Can't be used for ship berthing

VERTICAL BREAKWATER

- A breakwater formed by the construction in a regular and systematic manner of a vertical wall of masonry concrete blocks or mass concrete, with vertical and seaward face.
- Reflect the incident waves without dissipating much wave energy.
- Wave protection in port/channel
- Protection from siltation, currents
- Tsunami protection
- Berthing facilities
- Access/transport facility
- Normally it is constructed in locations where the depth of the sea is greater than twice the design wave height.

Vertical Wall Breakwaters - Types

Conventional type

The caisson is placed on a relatively thin stone bedding. Advantage of this type is the minimum use of natural rock (in case scarce) Wave walls are generally placed on shore connected caissons (reduce overtopping)

Vertical composite type

The caisson is placed on a high rubble foundation This type is economic in deep waters, but requires substantial volumes of (small size) rock fill for foundation

Horizontal composite type

The front slope of the caisson is covered by armour units This type is used in shallow water. The mound reduces wave reflection, wave impact and wave overtopping Repair of displaced vertical breakwaters Used when a (deep) quay is required at the inside of rubble mound breakwater

Block type

This type of breakwater needs to be placed on rock sea beds or on very strong soils due to very high foundation loads and sensitivity to differential settlements

Piled breakwater with concrete wall

Piled breakwaters consist of an inclined or vertical curtain wall mounted on pile work. The type is applicable in less severe wave climates on site with weak and soft subsoils with very thick layers. Manfredonia New Port (Italy)

Sloping top

The upper part of the front slope above still water level is given a slope to reduce wave forces and improve the direction of the wave forces on the sloping front.
Overtopping is larger than for a vertical wall with equal level.

Perforated front wall

The front wall is perforated by holes or slots with a wave chamber behind. Due to the dissipation of energy both the wave forces on the caisson and the wave reflection are reduced

Semi-circular caisson

Well suited for shallow water situations with intensive wave breaking Due to the dissipation of energy both the wave forces on the caisson and the wave reflection are reduced

Dual cylindrical caisson

Outer permeable and inner impermeable cylinder. Low reflection and low permeable Centre chamber and lower ring chamber fills with sand Combi-caisson

Disadvantages of vertical wall breakwaters

- Sea bottom has to be leveled and prepared for placements of large blocks or caissons.
- Foundations made of fine sand may cause erosion and settlement.
- Erosion may cause tilting or displacement of large monoliths.
- Difficult and expensive to repair.
- Building of caissons and launching or towing them into position require special land and water areas beside involvement of heavy construction equipments.
- Require form work, quality concrete, skilled labour, batching plants and floating crafts.

PARAMETERS FOR THE CONSTRUCTION OF A BREAKWATER

When a breakwater is to be built at a certain location, and the environmental impact of such a structure has already been evaluated and deemed environmentally feasible, the following parameters are required before construction can commence:

- a detailed hydrographic survey of the site;
- a geotechnical investigation of the sea bed;
- a wave height investigation or hindcasting;

• a material needs assessment; and

• the cross-sectional design of the structure.

Geotechnical investigation

A geotechnical investigation of the sea bed is required to determine the type of founding material and its extent. The results of this investigation will have a direct bearing on the type of cross-section of the breakwater. In addition, it is essential to determine what the coastline consists of, for example:

- soft or hard rock (like coral reefs or granite);
- sand (as found on beaches);
- clay (as in some mangrove areas); and
- soft to very soft clay, silt or mud (as found along some river banks, mangroves and other tidal areas).

Basic geotechnical investigations

Basic geotechnical investigations normally suffice for small or artisanal projects, especially when the project site is remote and access poor. A basic geotechnical investigation should be carried out or supervised by an experienced engineer or geologist familiar with the local soil conditions. The following activities may be carried out in a basic investigation using only portable equipment:

• retrieval of bottom sediments for laboratory analysis;

• measurement of bottom layer (loose sediment) thickness;

• approximate estimation of bearing capacity of the sea bed

The equipment required to carry out the above mentioned activities consists of :

A stable floating platform (a single canoe is not stable enough, but two canoes tied together to form a catamaran are excellent)

Diving equipment

A Van Veen bottom sampler (may be rented from a national or university laboratory)

A 20 mm diameter steel pricking rod and a water lance (a 20 mm diameter steel pipe connected to a gasoline-powered water pump).

Simply picking up samples from the sea bed with a scoop or bucket disturbs the sediment layers with the eventual loss of the finer material and is not a recommended method. The sediments thus collected should then be carefully placed in wide-necked glass jars and taken to a national or university laboratory for analysis. At least 10 kilograms of sediment are normally required by the laboratory for a proper analysis

Sometimes, a good hard bottom is overlain by a layer of loose or silty sand or mud. In most cases this layer has to be removed by dredging to expose the harder material underneath. To determine the thickness of this harder layer, a water lance is required. This consists of a length of steel tubing (the poker), sealed at the bottom end with a conical fitting and connected to a length of water hose at the top end. The water hose is connected to a small gasoline-powered water pump drawing seawater from over the side of the platform. The conical end has four 3 mm diameter holes drilled into it.

The diver simply pokes the steel tube into the sediment while water is pumped into it from above until the poker stops penetrating. The diver then measures the penetration. This method, also known as pricking, works very well in silty and muddy deposits up to 2 to 3 metres thick. It is not very effective in very coarse sand with large pebbles.

WHARF

A **wharf**, **quay** or **staith(e)** is a structure on the shore of a harbour or on the bank of a river or canal where ships may dock to load and unload cargo or passengers.[2][3] Such a structure includes one or more berths (mooring locations), and may also include piers, warehouses, or other facilities necessary for handling the ships. Wharves are often considered to be a series of docks at which boats are stationed.

A wharf commonly comprises a fixed platform, often on pilings. Commercial ports may have warehouses that serve as interim storage: where it is sufficient a single wharf with a single berth constructed along the land adjacent to the water is normally used; where there is a need for more capacity multiple wharves, or perhaps a single large wharf with multiple berths, will instead be constructed, sometimes projecting over the water. A pier, raised over the water rather than within it, is commonly used for cases where the weight or volume of cargos will be low.

Smaller and more modern wharves are sometimes built on flotation devices (pontoons) to keep them at the same level as the ship, even during changing tides.

In everyday parlance the term *quay* is common in the United Kingdom, Canada, Australia, and many other Commonwealth countries, and the Republic of Ireland, whereas the term *wharf* is more common in the United States. In some contexts *wharf* and *quay* may be used to mean pier, berth, or jetty.

In old ports such as London (which once had around 1700 wharves) many old wharves have been converted to residential or office use.

Certain early railways in England referred to goods loading points as "wharves". The term was carried over from marine usage. The person who was resident in charge of the wharf was referred to as a "wharfinger".

JETTIES

Jetties protect the shoreline of a body of water by acting as a barrier against erosion from currents, tides, and waves. **Jetties** can also be used to connect the land with deep water farther away from shore for the purposes of docking ships and unloading cargo. This type of **jetty** is called a pier.

For regulating rivers

Another form of jetties, wing dams are extended out, opposite one another, *from each bank of a river*, at intervals, to contract a wide channel, and by concentration of the current to produce a deepening.

For berthing at docks

Where docks are given sloping sides, openwork timber jetties are generally carried across the slope, at the ends of which vessels can lie in deep water or more solid structures are erected over the slope for supporting coal-tips. Pilework jetties are also constructed in the water outside the entrances to docks on each side, so as to form an enlarging trumpet-shaped channel between the entrance, lock or tidal basin and the approach channel, in order to guide vessels in entering or leaving the docks. Solid jetties, moreover, lined with quay walls, are sometimes carried out into a wide dock, at right angles to the line of quays at the side, to enlarge the accommodation; and they also serve, when extended on a large scale from the coast of a tideless sea under shelter of an outlying breakwater, to form the basins in which vessels lie when discharging and taking in cargoes in such a port as Marseille.

At entrances to jetty harbor

The approach channel to some ports situated on sandy coasts is guided and protected across the beach by parallel jetties. In some cases, these are made solid up to a little above low water of neap tides, on which open timber-work is erected, provided with a planked platform at the top raised above the highest tides. In other cases, they consist entirely of solid material without timber-work. The channel between the jetties was originally maintained by tidal scour from low-lying areas close to the coast, and subsequently by the current from sluicing basins; but it is now often considerably deepened by sand-pump dredging. It is protected to some extent by the solid portion of the jetties from the inroad of sand from the adjacent beach, and from the levelling action of the waves; while the upper open portion serves to indicate the channel and to guide the vessels. The bottom part of the older jetties, in such long-established jetty ports as Calais, Dunkirk and Ostend, was composed of clay or rubble stone, covered on the top by fascine-work or pitching, but the deepening of the jetty channel by dredging and the need that arose for its enlargement led to the reconstruction of the jetties at these ports. The nes jetties at Dunkirk were founded in the sandy beach, by the aid of compressed air, at a depth of 22.75 feet (6.93 m). below low water of spring tides; and their solid masonry portion, on a concrete foundation was raised 50 feet (15 m). above low water of neap tides.

At lagoon outlets

A small tidal rise spreading tidal water over a large expanse of lagoon or inland backwater causes the influx and efflux of the tide to maintain a deep channel through a narrows no longer confined by a bank on each side, becomes dispersed, and owing to the reduction of its scouring force, is no longer able at a moderate distance from the shore effectually to resist the action of tending to form a continuous beach in front of the outlet. Hence a bar is produced that diminishes the available depth in the approach channel. By carrying out a solid jetty over the bar, however on each side of the outlet, the tidal currents are concentrated in the channel across the bar, and lower it by scour.

Thus the available depth of the approach channels to Venice through the Malamocco and Lido outlets from the Venetian Lagoon have been deepened several feet (metres) over their bars by jetties of rubble, carried out across the foreshore into deep water on both sides of the channel. Other examples are provided by the long jetties extended into the sea in front of the entrance to Charleston harbour, formerly constructed of fascines weighed down with stone and logs, but subsequently of rubble stone, and by the two converging rubble jetties carried out from each shore of Dublin Bay for deepening the approach to Dublin harbour. Jetties have the adverse effect of endangering Surf Culture as a whole with their ability to destroy surf breaks.

At the outlet of tideless rivers

Jetties have been constructed on each side of the outlet river of some of the rivers flowing into the Baltic, with the objective of prolonging the scour of the river and protecting the channel from being shoaled by the littoral drift along the shore. The most interesting application of parallel jetties is in lowering the bar in front of one of the mouths of a deltaic river flowing into a tide — a virtual prolongation of its less sea, by extending the scour of the river out to the bar by banks. Jetties prolonging the Sulina branch of the Danube into the Black Sea, and the south pass of the Mississippi River into the Gulf of Mexico, formed of rubble stone and concrete blocks, and respectively, have enabled the discharge of these rivers to scour away the bars obstructing the access to them; and they have also carried the sediment-bearing waters sufficiently far out to come under the influence of littoral currents, which, by conveying away some of the sediment, postpone the eventual formation of a fresh bar farther out

At the mouth of tidal rivers

Where a river is narrow near its mouth, has a generally feeble discharge and a small tidal range, the sea is liable on an exposed coast to block up its outlet during severe storms. The river is thus forced to seek another exit at a weak spot of the beach, which along a low coast may be at some distance off; and this new outlet in its turn may be blocked up, so that the river from time to time shifts the position of its mouth. This inconvenient cycle of changes may be stopped by fixing the outlet of the river at a suitable site, by carrying a jetty on each side of this outlet across the beach, thereby concentrating its discharge in a definite channel and protecting the mouth from being blocked up by littoral drift. This system was long ago applied to the shifting outlet of the river Yare to the south of Yarmouth, and has also been successfully employed for fixing the wandering mouth of the Adur near Shoreham, and of the Adour flowing into the Bay of Biscay below Bayonne. When a new channel was cut across the Hook of Holland to provide a straighter and deeper outlet channel for the river Meuse, forming the approach channel to Rotterdam, low, broad, parallel jetties, composed of fascine mattresses weighted with stone, were carried across the foreshore into the sea on either side of the new mouth of the river, to protect the jetty channel from littoral drift, and cause the discharge of the river to maintain it out to deep water. The channel, also, beyond the outlet of the river Nervion into the Bay of Biscay has been regulated by jetties; and by extending the south-west jetty out for nearly 0.5 miles (0.80 km) with a curve concave towards the channel the outlet has not only been protected to some extent from the easterly drift, but the bar in front has been lowered by the scour produced by the discharge of the river following the concave bend of the southwest jetty. As the outer portion of this jetty was exposed to westerly storms from the Bay of Biscay before the outer harbour was constructed, it has been given the form and strength of a breakwater situated in shallow water.

QUAYS

The construction of quays falls broadly into two classifications: quays with a closed or solid construction, and quays with an open construction, where the deck is supported on piles. A key element inside a typical fishing harbour, however, is the draft, ranging from 1.5 metres to 6 metres may be required, depending on the type, size and number of resident fishing vessels. An artisanal fishing port hosting small fishing vessels having a loaded draft of no more than 1 metre would not normally require a draft of more than 1.5 metres at low tide unless large vessels visit the port during the peak fishing season.

Solid quays – minimum draft 1.5 metres

The earth-retaining structure, as the quay wall is known, consists of a number of layers of concrete-filled jute bags placed on a rubble foundation in a brickwall fashion. This structure does not require any major cranage and may be built with the sole assistance of one or two divers. The major advantage of this type of construction is that an uneven sea bed or large boulders can be included in the foundation. The jute bags should be filled with just enough concrete to form a pillow of uniform thickness. Overstuffed bags, item B, should not be incorporated into the wall. Prior to commencing such work, a temporary guide frame should be built as shown in the construction method for solid breakwaters. The frame can be in scaffold pipes, bamboo or other timber sections.

Granular material only (no silt, mud or clay) should be used as backfill and the top surface should be blinded or sealed with graded aggregate. The blinding should be compacted properly using a vibrating plate compactor. The front or toe of the quay should also be protected against scour by both propellers and tidal streams. This protection can consist of concrete-filled jute bags laid side by side over the screeded rubble. The concrete capping block should be cast in situ after the granular backfill has been placed. Each capping block should not be more than 5 metres long and should contain some reinforcement.

Solid quays – minimum draft 3 metres

Concrete blockwork quay built from concrete blocks placed by a crane on a screeded bed of stone rubble. This kind of earth-retaining structure is very common but requires the use of a suitable crane. The crane can either be the floating type or terrestrial. The concrete blocks are first cast in a yard and after 28 days have elapsed, they are lifted and placed on the sea bed. The blocks are placed to form pillars on the screeded rubble. The block pillars should be kept about 50 mm apart in such a way that each pillar may settle without rubbing against adjacent pillars. To achieve this, it is common to nail wooden spacers, 50 mm thick, to one side of the blocks prior to placing. Slings may either pass underneath the block or lift the block via hooks. The slings may be in wire rope or chain and the factor of safety in the lifting apparatus for safe working loads is 8. Some countries require a higher value to take the wear-and-tear of the slings into consideration.

Solid quays – minimum draft 6 metres and beyond

The cross-section may be adapted for a quay with a draft of 6 metres by increasing the size and width of the concrete blocks; however, the required size of the blocks would be so large as to require very large and heavy lifting equipment. A more economical solution in terms of the equipment required. The earth-retaining structure in this case is a special corrugated sheet of steel, known as a sheet pile, which interlocks with adjacent units to form a continuous wall. This wall is driven into the sea bed, sheet pile by sheet pile, and the top tied back to an anchor wall, which may consist of a slab of reinforced concrete or a length of the same bulkhead. A temporary timber or steel guide frame is generally erected to help drive the sheet piles vertical and in a straight line. The crane used to drive sheet piles must have a long jib to enable it to pick entire lengths of sheet pile for driving.

The crane may either be mounted on a barge, in which case the sheet piles are driven from the sea side of the bulkhead, or driven over a temporary reclamation and driven from the rear of the bulkhead. The temporary reclamation may then be used as backfill. Sheet piles are suitable for driving into clay, sand and silt deposits, as well as some types of coral. Sheet piles cannot be driven in most types of rock and in the presence of large boulders. Hammers for driving sheet piles may be of two types: impact hammers or high-frequency hammers. Impact hammers, as their name suggests, are hammers which impart an impact to the sheet pile. In the presence of soft deposits or clay, impact hammers do not pose any problem. In the presence of difficult ground, however, such as when sand contains large boulders, the impact from the hammer may damage or bend the sheet pile.

Open quays – minimum draft 1.5 metres

The deck of an open quay is supported on piles and the whole structure is open to full view. In view of this, an open structure is considered to be more delicate than a solid one and special fendering measures have to be incorporated in the design to prevent damage to the structure. Open quays may be constructed entirely in timber, concrete or steel, or a mixture of the three. Timber, however, may be attacked by insects. It illustrates how an artisanal open quay may be built using mainly locally available materials, such as timber or steel pipes. Given the small dimensions of the structure, a crane may not be needed if a light lattice tower or tripod and a piling winch are available to drive the piles. The figure also demonstrates the manner in which the pile heads should be prepared to receive the cross-beams. The timber used in such a structure should be the right kind of timber and treated against decay and attack by insects.

Open quays – minimum draft 3 metres and beyond

Conventional, deeper water open quays of the type traditionally found in larger fishing ports. The structures are typically subdivided into two categories: with and without tidal variation. Cross-section without tidal variation, where the impact load from a vessel is transmitted directly to the deck of the quay via a simple rubber fender. The open quay, in this case, is fronted by another structure, the rubbing fender pile, which has to absorb the impact from a vessel mooring at low tide without damaging the main quay piles immediately behind it. If the quay wall is solid (sheet piles), then timber or rubber strips are applied to the sheet pile for the vessels to rub against. Piled quays are particularly effective at absorbing wave energy due to the presence of the rubble slope underneath the deck. The rubble is normally similar to a breakwater grading, requiring core material (1–100 kilograms), armouring (200–1 000 kilograms) and toe berm (1 000–2 000 kilograms) to prevent scour damage. If the reclamation behind the piled structure is not sealed properly with a geotextile membrane, fines tend to leach out of the rubble, leading to uneven settlement of the apron.

The piles may either be in normally reinforced concrete, prestressed concrete, or steel. Whereas most concrete piles are solid, steel piles are usually hollow pipes. In most cases, if only small lengths of pile can be handled by the crane, piles can be jointed in situ to form longer lengths as required. Concrete piles are generally glued with special epoxy glues, whereas steel piles are commonly welded together via simple butt-joints. If hollow pipes are used, these may either be filled up with concrete and reinforcing steel (to prevent corrosion on the inside and add strength to the pile) or, if the pipe thickness is enough, left as open-ended piles.

FENDERS

These are the marine equipment's specially designed for the purpose of imparting safety to the port and vessels against collision with other vessels. These are special equipment designed to provide the cushion effect to ship, boats or other naval vessels when they experience collision against other vessels, wharves, piers and ports or berths. These are also referred as marine bumpers.

Marine fenders are a type of marine equipment that are used to prevent boats, ships and other naval vessels from colliding against each other or against docks, wharves and piers. In other words, marine fenders can be simply termed as a marine bumper.

Marine fenders are important marine equipment as they prevent loss to the body of a boat or a ship. The fender systems that are used in naval vessels have evolved continuously throughout the times and now are devised in such a way that the prevention process is almost faultless and foolproof.

Marine fenders, in today's times are employed in such a way that they are kept on the hull or the head of a boat or a ship in order to prevent casualty to the hull or the head of the naval vessel if there is any collision happening between boats. However, at the same time, marine fenders are also employed in piers, docks, wharves and other regular boat entrance and exit points on a permanent basis.

This permanent fixing of marine fenders help because, in case there is a heavy traffic of boats passing through from a particular dockyard, and there is an accident or a collision then the casualty to the boat and the dockyard will be both minimised to a great extent.

Fender systems have been devised in order to protect all vehicles from damage caused due to accidents. When it comes to marine fenders, the marine equipment is one of the best technological advancements to have occurred in contemporary times.

Even in the earlier centuries, fender systems were used to prevent loss to a naval vessel's torso but the concept and idea has evolved more in the modern times than in the past. Through successful innovations and initiations, there are a wide variety of marine fender systems available which act as excellent marine equipment.

There are various types of marine fenders which have emerged over the years and which provide excellent utility in the area of water transportation. The wide variety of marine fenders ensures that sufficient options are provided so as to enable a person or an authority to choose the best possible fender system or marine fender.

During its voyage, a vessel has to approach port for loading and unloading of crew and commodities and to other vessel for supplying and accepting certain commodities; in these cases there are definite chances of collision and during collision huge amount of energy is transferred which causes fatality to its crew and damage to vessel itself, port and commodities. Marine fenders prevent either the head or hull of a vessel to collide with any other water body. The certain features for which a port authority has to look after before buying the marine fenders are briefed as follows:

i) These marine bumpers should be made up of high performance materials which require no or little maintenance. **ii)** ii) These are to be designed in such a way that they can serve all the working demands for which these are deployed. **iii)** iii) These marine fenders should be capable of serving to all their commitments in all prevailing environmental conditions. **iv)** iv) The marine fenders should be durable i.e. they are so designed and developed so as to serve a longer period of time.

Categorizations Of Marine Fenders

Marine Fenders can be categorized in different types on the basis of location where these are fitted and material they are made up of.

On The Basis Of Material

The different sorts of marine bumpers available in the market as per the material they are made up of are as follows:

1. Rubber Fenders
2. Foam Fenders **3.** Composite Fenders

1.Rubber Fenders:

Rubber fenders are developed in wide range of variations to serve different applications. These fenders are developed complying with PIANC guiding principles. Rubber Fenders decrease the input reaction force and provide requisite angular guidance to the hull pressure. These are the fenders which have highest market demand. These fenders also have a positive impact on rubber industries round the globe. There noticed a great advancement and growth of rubber industry due to marine application of rubber in last ten years. There are many types of rubber fenders, manufactured by different shipping accessory companies, which are detailed as follows:

a) Super Cone Fenders: These are the latest sort of rubber fenders and generally referred as “Cone Fenders”. The conical body of the cone fenders keep them stabilised at even higher values of compression angles. They are highly efficient and provide optimum performance. They have better resistance to shear and overcompression. Their geometry plays a significant role in their stability. Today, rubber compounds find their widespread application in marine industry and extensively used for manufacturing of Cone Fenders.

b) **SCK Cell Fenders:** These fenders have simpler design which is the main reason for their popularity. These high performing fenders have great strength. These cell fenders are available in vast size range and capable of supporting large panels. These cell fenders are preferably found appropriate for systems which deal with hull at low level.

c) **Arch Fenders:** This type of marine equipment is used in order to provide aid and assistance to a type of marine fender known as the cylindrical fender. Since the maintenance aspect in arch fenders is absolutely zero, it is one of the best marine equipment and the best fender system. Arch fenders can be used for small and midranged ships and boats and provide excellent quality service to the same. These fenders are favoured when there is a need of rough marine fender system. These are most reliable fenders which serve their purpose victoriously even in severe most conditions. These allow easy installation. These are excellent in wear resistance and shear resistance. If these fenders are to be provided on corners of harbor these are called as Corner Arch Fenders.

d) **Leg Fenders:** These are the fenders which can be easily installed due to their modular design. A main advantage of these fenders is that they require less or no maintenance. Leg fenders are majorly opted at locations where the area on which fenders are to be mounted is limited.

e) **Parallel motion Fenders:** These can reduce the overall reaction to about 60% more as compared to conventional cone fenders. These are somewhat similar to leg fenders with difference that parallel motion fenders are vertical non tilting type fenders, but still capable of catering berth or vessel at 20° without energy dissipation.

f) **Slide in Slide Out Fenders (or SISO Fenders):** These fenders have frontal frame to which wear pads are fastened with the help of bolts. For maintenance purpose and in case of failure the complete assembly of fenders is not needed to be changed but the replacement made is conforming to only wear pads with sliding panel, which are to be replaced with newer ones. Sliding panels can be easily removed from guide rails and replaced with spare panels. So their maintenance is quite easier and can be quickly availed for services when go out of order.

g) Cylindrical Fenders: They are the most basic and common fender systems used in today's times. They can be used for all types of marine boats and ships and they are quite economical too when the aspect of fitting them up is taken into account. These are easy to install, widely used fenders with simpler design. They can serve to both large as well as small vessels. As per the requirement of cylindrical fenders, these are available in three size categories: Small Cylindrical Fenders, Intermediate Cylindrical Fenders and Large Cylindrical Fenders. These fenders are economical and have thick walls which can efficiently resist wear, abrasion and higher loads.

h) Extruded Fenders: These are the rubber fenders with simpler design and are directly fastened using bolt fasteners to the structure. These fenders are highly flexible and can fit any length and even curves.

i) Composite Fenders (Rubbylene): These are the fenders which are made up of composite rubber compounds and provide maximum resilience to the vessel. These fenders are made up with tough materials having lower coefficient of friction and maximum resistance to wear.

j) Marine Fender Bars: These fenders are made up of high performance tough bars which have highest impact resistance. These bars have wider flexibility of application. They can be installed at all sorts of locations.

k) Pneumatic Fenders: These are the ideal choice for inter ship dealings and port accessories. Their deployment is quick and robust. At the time of docking the pneumatic fenders minimize the risk of damage and safeguards both people and cargo. These fenders should comply with quality assurance guidelines of ISO issued in 2014. These are of five types namely: chain-tire net (CTN) pneumatic fenders;

Sling type fenders; low pressure pneumatic fenders; hydo-pneumatic fenders and. The CTN pneumatic fender has a network of tyres connected with chains in horizontal as well as vertical direction to protect the fender body. As the chains remains in water all the time so must be made up of corrosion resistant galvanized materials. These are simplest and cheaper type of marine fenders which increases the clearance between structure and the hull to a larger extent. Sling type pneumatic fenders are similar to chain type fenders with the only difference that fenders can be slung with even ropes made up of meshed wire strands than chains. Low pressure pneumatic fenders are the type of pneumatic fenders which deliver minimum pressure to the hull by absorbing kinetic energy to a maximum extent by providing maximum contact surface. Hydro-pneumatic Fenders: These are the pneumatic fenders which are made in compliance to the need of fender.

2)Form Fenders

The structure of these fenders is a dual-layered closed cell structure. The inner core of foam fenders is made up of polyethylene foam and reinforced polyurethane elastomer is used as covering to the core. The water penetration in these type of fenders is approximately nil. These can serve continuously throughout their life and even when damaged. There are different sorts of foam fenders:

a) Sea-Guard fenders: These can serve equally well in floated as well as suspended conditions. These fenders are available for both ship as well as harbor and have easy maintenance works. These fenders are mostly employed in ship-to-ship operation and cannot be destroyed or destructed. These fenders are unsinkable and deflation-free. Most of the foam fenders are manufactured on the guidelines of US navy stipulations.

b) Sea-cushion fenders: These are rough and tough fenders. These are floating fenders to be employed in roughest situation and the core used in their manufacturing is of superior grade then in sea-guard fenders. It has a network of chain tire with hard core which serves as a unsinkable and sea-cushion. These are most reliable and efficient sort of foam fenders used for LNG vessels which require least maintenance. They find their application in LNG ships because they cannot burst.

c) Donut Fenders: These are a special sort of marine fenders and moreover a type of berth fenders which are used as a guide or a turn structure. For the alignment of ships these fenders have tubular pile which can be rotated. These are made up of nylon filament reinforced in polyurethane skin. These are available in bright colours for improved visible access. As it is a sort of form fenders so require less maintenance.

3) Composite Fenders

These are the fenders which can be made up of any sort of composite materials. All sorts of Tug Fenders are considered in this category

Tug Fenders: These are only vessel fenders and installed on a tug vessel. These fenders are exposed to maximum wear and abrasion so these are made up of toughest materials which are capable of bearing greater degree of wear and abrasion, to which a ship is exposed due to water currents and other ship. So that the fenders can serve longer life with maximum efficiency. These can be cylindrical, tapered, key hole, M- and W-tug fenders on the basis of geometrical features. These all are ship fenders and somehow similar to one another with only difference in geometric design. All of these tug boat fenders are made up of extremely tough materials so as to resist wearing and shearing offered to the ship by other ship and the water current. All these fenders are heavy duty fenders and different design enable efficient working in different condition.

On The Basis Of Location They Are Fitted: On The Basis Of Location Of Fenders These Are Of Two Types Namely:

1.) Ship Fenders: These are the fenders which are installed to the ship so as to have increased clearance while having ship-to-ship dealing. Tug boat fenders fall in this category. These fenders should be made up of material stronger than that used in dock fenders because the ship fenders are exposed to more severe conditions than the dock fenders.

2.) Dock Fenders: Dock fenders are the sort of fenders which are installed at harbor and provide protection to ship and dock at the time of docking. Leg fenders and parallel flow fenders are the examples of such sorts of fenders.

All these fenders serve the primary purpose of absorbing high kinetic energy so that the shock experienced by the dock or the ship is minimized so as to cause no harm to the cargo and the crew.

W Fenders:

These type of marine fenders are used mainly to aid the larger ships and boats because they offer a high rate of resistance and thus better protection to the water-crafts in case of any accident occurring.

Other types of marine fenders are the I fender, Cell Fender, Cone Fender and the Pneumatic Fender which along with the other three marine fenders, help in providing a very viable and feasible solution to the problem of accidents and collisions of naval vessels.

Precautions While Working With Marine Fenders

- A certain degree of softness in fender is necessary for efficiently absorbing the kinetic energy and thrust, but it should be hard enough to bear the impact.
- Fenders should not burst while in operation.
- Proper repair works and maintenance should be carried out to ensure maximum safety.

DOLPHINS AND FLOATING LANDING STAGE

A kind of floating dolphin landing stage includes main hull, and the main hull bottom is provided with multiple drinking water bodies being parallel to each other, and drinking water is provided with ballast tank in vivo. It is connected in main hull front at least provided with the anchor chain that a pair are symmetrical arranged in anchor capstan, anchor capstan connection through the hawse-pipe on main hull with being located at the anchor of main hull bottom. The utility model has the advantages that, improve the utility of coastline of port and pier, particularly original old harbour is renovated, the solution for anchor of exempting to cast anchor can be provided for substantial amounts of harbour anchorage by using the arrangement form of multiple rows of row combination, bank electricity is inputted into this floating dolphin landing stage using very simple technique to realize come port berthing ship lay day " oil changes electricity ", positive booster action is played to build green harbour.

Floating dolphin landing stage

Technical field

This project is related to a kind of floating dolphin landing stage, and its structure type is simple, cheap, deep with enough drinking water The drinking water of degree and anchor chain exit point is more than the extreme draft for mooring waters ship.

Background technology

Existing port and pier have jetty type wharf, quay by horizontal layout form, dig into formula harbour, island-type pier With formula harbour in dike；This kind of

Wharf Construction investment is huge, and the construction period is long, and the big-and-middle-sized harbour in generally harbour and inland is adopted With；Most of inland rivers and the port and pier in reservoir waters are influenceed typically to use special landing stage by the seasonal water level swell that disappears Form, water level phase of rising that disappears wants frequent shifting berth, causes to be unable to the actual conditions of operation during its shifting berth, to normal production and operation order Impact, and the old anchoring in landing stage and the formation of mooring form can only moor a boat by waters center side, utility of coastline It is extremely low, and being exposed to the anchor chain and mooring cable of the water surface and being had the wet season more wound by a large amount of floating refuses, but can not be with very Convenient method cleaning, has uglified harbour water area environment, has a ship waters wide, there is large number of different types of anchor Ground, but be all the form of single secure anchoring up to now, and this anchoring approach wastes a large amount of water surface areas. Before setting sail Necessarily unmoor, build fixed anchorage and carry out the mode of anchorage ship and also there is no precedent. Due to being independent anchoring, ship is in anchoring Harbor generator is at least also used in period, substantial amounts of ship is generated electricity using subsidiary engine in anchorage causes substantial amounts of waste gas row again Put, severe contamination harbour environment.

With the fast development of economic society, China faces resource environment constraint, communications and transportation development and faces soil, water front The rigid constraint of resource scarcity will be further exacerbated by, and more urgent requirement is proposed to communications and transportation Green Development. Therefore, build If green harbour is the important measures for promoting transportation Green Development. Now, limited harbour coastline resource is non-renewable, Old terminal facilities, equipment and very low utilization rate hinders the fast development of port construction.

The content of the invention

The technical problems to be solved in the utility model is to provide a kind of floating dolphin landing stage to improve the bank of port and pier Line use ratio, particularly renovates to original old harbour, uses the arrangement form of multiple rows of multiple row chain of rings combination can be with The solution for anchor of exempting to cast anchor is provided for substantial amounts of harbour anchorage, bank electricity is inputted by ship by this floating using very simple technique Pier landing stage, which is realized, carrys out port berthing ship lay day " oil changes electricity ", and positive booster action is played to build green harbour.

In order to solve the above technical problems, the technical solution adopted in the utility model, which is a kind of floating dolphin landing stage, includes master Hull, the main hull bottom is provided with ballast tank in vivo provided with drinking water body, drinking water；

In main hull front main ship is passed through at least provided with the anchor chain that a pair are symmetrical arranged in anchor capstan, anchor capstan connection Hawse-pipe on body is connected with being located at the anchor of main hull bottom.

Further, the hawse-pipe is penetrated from main hull front and passed from drinking water body bottom, the master in hawse-pipe exit Hull base plate is set and hawse-pipe central axis.

Further, four drinking water bodies set up separately at four angles of main hull bottom.

Further, main hull bottom is provided with a drinking water body, and drinking water body forms a Back Word along main hull bottom margin Type closed shape.

Further, main hull bottom symmetrical absorbs water provided with two and is not connected between bodies, two described drinking water bodies.

Further, the ballast tank of each drinking water body carries out ballast or off-load using portable pump.

Further, the drinking water of the drinking water body, which is more than, moors most gobbling for waters berthing this floating dolphin landing stage ship Water.

Further, bank electricity can be inputted this floating dolphin by the floating dolphin landing stage using very simple technique Landing stage, realizes and carrys out port berthing ship lay day " oil changes electricity ".

Advantages：

1. The floating dolphin landing stage after anchorage is appropriate, because of its anchor chain exit point（Hawse-pipe is exported）With enough depth, Using when the water-area navigation or berthing operation ship are heavily loaded

extreme draft deeply plus rich d -trans- allethrin as its draft. When carrying out ship berthing Without producing anchor chain touching carry out ship and hindered because its anchor chain exit point is relatively deep, forming peripheral direction all around can moor The floating dolphin of ship, economic and practical, operation technique is simple, construction cost is cheap, is efficiently to utilize non-renewable harbour bank Line resource provides a solution.

2. Floating dolphin landing stage only set anchor and anchor chain it is supporting come anchorage landing stage, exempt to set to bank base mooring hawser be set, it is excellent In conventional landing stage as fine as a spider's web cable lead around defect, can create whole in the waters collar of its berthing inward ship operation Clean, safe water environment.
3. With two this landing stages and any pierhead pontoon as dried food and nuts pierhead pontoon, wharf for bulk cargo landing stage, container The a chain of landing stage of pierhead pontoon, roll-on berth is combined, and applicability is extensive.
4. Can also constitute jointly pontoon bridge type harbour using a plurality of floating dolphin landing stage, this combining form be suitable for from The shallower water environment of bank and reach deeper water, deeper water is arranged in using this landing stage of supporting relatively deep drinking water, it is supporting compared with This light-draft landing stage, which to be arranged in, gone directly compared with shallow water area on the bank, supporting between this landing stage of pontoon bridge type harbour scope two of which Using landing stage connection is jumped, anchor arrangement need not be configured by jumping landing stage, and such combination can be utilized extends compared with shallow water area to profundal zone Carry out wharf.
5. This landing stage can as floating dock dolphin, the sinking at floating dock and lift what the special process of ship operation needed Maximum is heavy deep larger, general river ship dock >=3m, the drinking water of seagoing vessel floating dock is bigger, if made using itself mooring system Industry, cumbersome, labor

intensity are big, add and are frequently adjusted using highpower windlass, energy consumption is big；It is fixed using pile foundation

Harbour configuration guide pillar can solve above-mentioned problem, but pile foundation fixed quay is built by harbour addressing, all many conditions of fluctuation in stage Limitation and it is difficult, and invest huge, unsuitable popularity. This project only needs to configure two floating dolphin landing stages, A side of a ship shipboard only on this landing stage, which is set, to sink with floating dock and the attachment means of lift ship floating linkage can just solve to float The above-mentioned problem of dock, and economic, applicable, safety, energy-conservation.

6. Common pierhead pontoon general at this stage be using anchoring and mooring two ways is come fixed quay landing stage, its Middle anchoring form is because anchor chain exit point surfaces mostly and causes berthing ship from the initial and tail sections close to landing stage, wherein mooring Form be to guide mooring rope on the bank earth anchor facility from landing stage bollard, be substantially all exposed to landing stage and pull in shore the water of side On face, it is also as fine as a spider's web that What is more, and such landing stage offshore side is just unable to berthing ship completely. Form dock barge only Can be by the middle of the river（Or waters center）A side of a ship berthing carry out ship. Harbour utility of coastline is extremely low, the protrusion on floating dolphin landing stage Advantage can be achieved on four direction all around and harbour utility of coastline can be substantially increased with berthing ship, be precious The rational exploitation and utilization of expensive coastline resource, there is provided a solution for beautification harbour environment. Further use this practicality New any combination form, can easily be realized using the technique being simply connected with bank base very much the harbour itself and come Port berthing operation ship uses bank electricity, reaches the purpose of " oil changes electricity ", and a kind of solution is provided to create the green harbour of energy-saving and emissionreduction Certainly scheme.