GOVERNMENT OF INDIA
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
LOK SABHA
UNSTARRED QUESTION NO. 494
TO BE ANSWERED ON 22ND JULY, 2021

SAGARMALA SEAPLANE SERVICES

494. SHRI RAJESH VERMA:
SHRI KRIPANATH MALLAH:

Will the Minister of PORTS, SHIPPING AND WATERWAYS be pleased to state:

पत्तन, पोत परिवहन और जलमार्ग मंत्री

(a) whether the Government is planning to kick off ambitious project of Sagarmala Seaplane Services with potential airline operators within the country and if so, the details thereof along with the time frame fixed for the implementation of the project;

(b) the names of the States where the Government proposes to introduce sea-plane services under the Sagarmala project;

(c) the details of the airline operators who have expressed their interests in this project so far;

(d) whether the Government has issued any guidelines for the sea-plane operators to implement this project; and

(e) if so, the details thereof?

ANSWER

MINISTER OF STATE IN THE MINISTRY OF PORTS, SHIPPING AND WATERWAYS (SHRI SHRIPAD NAIK)

(a) Sagarmala Development Company Limited (SDCL), a CPSE under Ministry of Ports, Shipping and Waterways (MoPSW) had invited Expression of Interest (EoI) for Seaplane Services whereby airplane operators were invited to undertake development and operation in India. Further, MoPSW and M/o Civil Aviation have signed an Memorandum of Understanding (MoU) on 15th June, 2021 to jointly facilitate the development of Sea Plane Services in India under RCS-UDAN Scheme.

(b) Presently, it is proposed to introduce Seaplane Services in Gujarat, Assam, Lakshadweep Islands and Andaman & Nicobar Islands. Operations between Sabarmati River Front & Statue of Unity commenced on 31st October, 2020.

(c) In response to the EoI issued by SDCL, the following airline operators have shown interest:

(i) Pawan Hans Limited
(ii) SpiceJet Limited
(iii) Pinnacle Air Private Limited
(iv) Guardian Air Private Limited
(v) Mehair
(vi) Let's Fly Airways
(vii) Stuart Wheeler
(viii) Kairali Aviation Pvt Ltd

(d) & (e) MoPSW has issued guidelines for implementation of Floating Jetties/ Platforms for Marinas, Minor Harbors, Fishing Harbours / Fish landing centers, Waterdromes and such other similar facilities in coastal areas, estuaries, waterways, rivers and reservoirs on 3rd February, 2021. A copy of guidelines is attached as Annexure.

<u>**Annexure**</u>

Guidelines for Floating Jetties / Platforms for Marinas, Minor Harbors, Fishing Harbours, Fish landing centers, Waterdromes and such other similar facilities in coastal areas, estuaries, waterways, rivers and reservoirs.

Section 1 Scope and General

1.1 Scope

This guideline sets out various technical aspects for implementation of Floating Jetties / Platforms for Marinas, Minor Harbors, Fishing Harbours, Fish landing centers, Waterdromes and such other similar facilities in coastal areas, estuaries, waterways, rivers and reservoirs. The Floating Jetties may be made of pontoons or such floating units, thus the guidelines may also be suitably utilized for floating pontoons/ platformsin various waterborne systems and floating wave attenuators (or breakwaters) for Minor Harbors/Fish Landing facilities. The suitability of Floating Jetty/ platform and their broad Performance Criteria & Specifications and Loading and Stability.This document is intended for use as a guideline and should not be construed as design specification.

1.2 Referenced documents

IS 875 (Part-3) Design Loads for Buildings and Structures

IS 456: 2000 – Plain and Reinforced Concrete – Code of Practice

IS 800: 2007 – General Construction in Steel – Code of Practice

IS 4651 - Planning and Design of Ports and Harbours – Code of Practice (all Parts)

IS 226: 1975 - Structural steel (Standard Quality)

IS 2062: 2011 – Hot Rolled Low, Medium and High Tensile Structural Steel - Specification

However,there is no specific Indian Standards presently available covering the Floating Jetties / Platforms. In view of this gap, the following International standardsmay be referred to for detailing purposes till Indian Standards are published.

AS1170 Minimum design loads on structures

AS 1170.1 Part 1: Dead and live load and load combinations

AS 1170.2 Part 2: Wind loads

AS 1428 Design for access and mobility (all parts)

AS 1657 Fixed platforms, walkways, stairways and ladders—Design, construction and installation

AS 1851 Maintenance of fire protection equipment (all parts)

AS 3962-2020 Marina Design

AS 3004 Electrical installations—Floating Jetty and pleasure crafts at low voltage

AS 3600 Concrete structures and/or such other equivalent Indian Standards to the extent relevant.

AS 4100 Steel structures. AS 4586 Slip resistance classification of new pedestrian surface materials.

1.3 Definitions

Definition of major items /glossary of terms used in this report are attached as Annexure C

Section 2 Site Investigations

2.1 SURVEYS

2.1.1 General

2.1.1.1 Survey grid

A uniform survey grid shall be adopted for all terrestrial and hydrographic surveys. Consideration should be given to incorporating the survey grid for the project area into the regional coordinated survey grid, Indian Survey Grid.

Where a local survey grid is adopted, correlation to an established regional coordinated grid should be nominated on the drawings.

2.1.1.2 Survey datum

All survey data shall be reduced tochart datum (CD)as it provides direct correlation to navigable water depths. MSL/ISLW is normally used for terrestrial surveys, with definitive correlation to CD at any specific locations.

All survey and design levels within any project should be reduced to the same datum.Where any other local survey datum is adopted, the relationship of survey datum to CD should be established and reported on the drawings.

2.1.2 Hydrographic survey

The hydrographic survey should be undertaken to cover the proposed site of works, approach channel route and any adjacent nearshore waters where there is insufficient survey data to make an appropriate assessment of nearshore design waves, currents and clearances.

The survey data should also contain sufficient detail to enable an assessment to be made of the coastal processes affecting the proposed Floating Jetties for Marinas, Minor Harbors, Fishing Harbours / Fish landing centers, Waterdromes and similar facilities in waterways and riversand adjacent foreshores.

All height datum levels for hydrographic surveys should be to CD. As most terrestrial surveys are produced to MSL/ISLW, a diagram showing the relationship between MSL/ISLW and CD should be provided on relevant drawings.

2.1.3 Terrestrial surveys

Terrestrial surveys should be provided over any land areas that will be incorporated within the project site. Adjacent shoreline areas that could be affected by the proposed floating jetty/ platforms should also be surveyed. Where adjacent shorelines consist of beaches, beach profile data may be necessary.

All existing features such as jetties, ramps, seawalls, stormwater outfalls, drains, rock outcrops and the like should be clearly identified.

2.2 GEOTECHNICAL

2.2.1 Geotechnical parameters

The geotechnical parameters of seabed materials within the area need to be ascertained, where the Floating Jetty/platform are installed for determination of the following:

a) Support systems for floating Jetties/ platform, e.g. piles, cables or chains with anchors.
b) Stability and settlement characteristics for revetments, breakwaters, and anyreclamation works.
c) Response to prevailing natural coastal and estuarine processes, currents and waves, aswell as susceptibility to artificial influences such as propeller wash and boat wake.
d) Material characteristics for ease of excavation, transportation and disposal. Chemicaltests may also be required.

2.3 WIND, HYDRODYNAMICS AND SEDIMENT MOVEMENT ASSESSMENTS

2.3.1 Sources of data

Wind, Wave, Tide, Flood, Storm surge and any other water level data may be available from the nearby ports. National Technology Centre for Ports Waterways and Coasts (NTCPWC) may be approached for suitable and timely data availability.

2.3.2 Data collection

2.3.2.1 Wind

Directional wind data is required for both the determination of wind loadings and for wave hindcasting.The primary source of wind design data is from IS 875. This may be supplemented by direct measurements at site.

2.3.2.2 Waves

The wave climate at the site may comprise of waves, ocean swells and vessel wash. The exposure of floating jetty/platformto ocean swells may be a direct exposure, but more probably would be ocean swells modified to some degree by diffraction (bending of waves around headlands or ends of breakwaters), refraction (bending of waves due to shoaling effects), or reflection (waves reflected from solid surfaces such as walls or breakwaters).Waves may be either measured or determined by hindcasting for various return period wind events using nomographs, and wave transformation procedures.

2.3.2.3 Tides

Tidal levels and predictions can be characterised by

(a) Tide tables.

(b) Installation of a tide recorder with continuous recording for 35 days, or use of a properly calibrated hydrodynamic model;

(b)Comparison of the recorded tide with that from a nearby permanent tide gauge with level tie-in between these two stations.

2.3.2.4 Storm surge

Storm surges are the result of cyclones or other extreme meteorological events and, as with extreme winds and waves, are unlikely to be observed during the data collection phase for a project.Storm surge levels are usually established by means of hydrodynamic numerical modelling that is calibrated using the available historical data.

2.3.2.5 Flood levels

If flood level data has not been recorded historically, levels can be established by the use of calibrated mathematical or physical river models.

2.3.2.6 Currents

The major currents at the location offloating jetty/ platformare usually due to either tidal effects or river flow. Tidal current data is required over both neap and spring tides for force calculations and for flushing estimates for the floating jetty/ platform. Currents during floods may provide design loads for floating jetties/ platformsites within rivers.Current measurements can be undertaken either by current meters or by the tracking of water movement by dye tracing or float drogues.

If the tidal flow information available in hydrographic charts is not sufficiently site specific and/ or not suitable for the design of floating jetties/ platformdetailed measurements or mathematical analyses are necessary whether the currents relate to tides, storm surge, or stream run-off.

Section 3 Dimensional Criteria

3.1 CHANNEL WIDTHS

Without prejudice to the provisions of IS 4651, the present provisions providedhereunder are more compatible, the same shall be preferred over IS4651.

3.1.1 Entrance channel

The width of the entrance channel is dependent on a number of factors, themajority of which are the following:

(a) Exposure to wind, wave and currents, which all reduce the manoeuvrability of boats.

(b) Number of boats in the harbour and usage levels.

(c) Type and size of boats.

(d) Extent of navigation aids provided.

For an entrance channel, the minimum width should be the greatest of—

(a) 20 m;

(b) (L + 2) m, where L is overall length of longest boat proposed to be handled in the floating jetty/ platform, in metres; or

(c) 5B m, where B is the beam of the broadest mono-hull boat in the floating jetty/ platform, in metres.

The preferred width of an entrance channel is 30 m or 6B m; whichever is the minimum.
Widening of the channel may be necessary where the channel changes direction.

In order to minimize the penetration of waves into a boat harbour, it is permissible to narrow the width of the entrance channel over a short length at protecting breakwaters. Theminimum width of this narrow section shall be the greater of 15 m and 3B m, where B is thebeam of the broadest mono-hull boat in the floating jetty/ platform, in metres

3.1.2 Interior channels and fairways

The channels leading tothe floating jetty/ platformare not as greatly influenced by the wind, waves, and currents at any site, as they are by the size, number and type of boats, and the frequency ofboat usage. Any non-motorized sailing vessel or multi-hull vessel using the harbour willneed to be considered when determining the interior channel and fairway widths. In somelocations, there may be climatic conditions, such as prevailing winds, which should beconsidered when interior channel and fairway widths are being determined.

The width of interior channels and fairways should be as follows:

(a) Interior channel:

(i) Minimum width 20 m or 1.5L m, whichever is the greater, where L isoverall length of the longest boat using the channel, in metres.

(ii) Preferred width 25 m or 1.75L m, whichever is the greater.

(b) Fairways:

(i) Minimum width 1.5L m, where L is the overall length of the longest boatusing that fairway, in metres.

(ii) Preferred width 1.75L m.

Where currents exceed 0.5 m/s, the width of interior channels and fairways should be increased to allow for the effect of the current on a boat as it moves along the channel and turns into its berth.

3.2 WATER DEPTHS

3.2.1 Entrance channel

The depth in the entrance channel should take into account the following factors:

(a) Draught of boats.

(b) Wave climate.

(c) Nature of the bed material.

(d) Likely rate of siltation in the entrance channel.

(e) Future extensions to the floating jetty/ platform.

(f) Construction considerations.

Where the area outside the floating jetty/ platformis not protected from open sea conditions, the entrance channel and main channel should be deep enough to allow the largest boat berthed in the floating jetty/ platformto enter the floating jetty/ platformat any stage of the tide.

Where the area outside the floating jetty/ platformis protected, the entrance channel should be deep enoughto allow all boats that usually berth in the floating jetty/ platformto enter at any stage of the tide. However,in areas of extreme tides the cost of excavating the channel may dictate that the larger boatscannot enter the floating jetty/ platformat very low tide.

The designer should determine the maximum draught of vessels to be accommodated at the floating jetty/ platform.

However, a minimum under keel clearance of

(i) 300 mm or 10 percent of the vesseldraught, whichever is the greater, where the base of the dredged channel consists of soft material; or

(ii) 500 mm, where the base of the dredged channel consists of hard material such as stiff clay, gravel, or rock.

3.2.2 Interior channels and fairways

The same consideration should be given to depths in internal channels as for entrance channels except that allowance for waves and the rate of siltation may be lower. As with the entrance channel it is preferable that all boats in the floating jetty/ platformcan access the channels at all states of the tide. However, where economics dictate, the water depth may be reduced; thisreduction can be greater in locations where the tidal range is higher.

3.2.3 At berths

While it may be acceptable in a floating jetty/ platformto restrict the larger boats to movement at higher tides, it is essential that the deepest draught boat likely to use any berth does not touch bottom at low tide.

Yachts have a deeper draught than the same length power boat. Hence, when there is insufficient water depth for yachts, it is recommendedthat a sign is placed at the berth restricting its use to shallow draught vessels.

3.3 BERTH SIZES

This berth sizes shall be followed for sizing of floating pontoons.

3.3.1 General

Where more specific requirements are not available for the floating jetty/ platform, the length, width anddepth of berths should be determined. These design characteristics should be recorded onthe floating jetty/ platformdrawings. Where no specific design criteria are established, guidelines forminimum design criteria are given in Clauses 3.3.2 and 3.3.3 and Table 3.2.

3.3.2 Berth widths

General expressions for berth width (b) are as follows:

(a) Double berth: 2 × design maximum vessel beam + 1 m up to 20 m and + 1.5 m above20 m.

(b) Single berth: design maximum vessel beam + 1 m up to 20 m and + 1.5 m above20 m.

(c) Multihull vessels can either occupy a double berth, or wider berths can beincluded,which specifically allow for single or double multihull vessels. The beam of amultihull may be up to 0.7L.

These dimensions may need to be increased to allow for larger fenders.The maximum length of boat for which each berth has been designed should be clearly marked on the floating jetty/ platformlayout drawing.For alongside berths, the minimum space between boats should be 0.2L up to 3.0 m.

TABLE 3.2
MINIMUM BERTH DIMENSIONS FOR MONO-HULL BOATS
(Extracted from AS3962)

Boat length (L), m	Boat beam (B), m	Width of berth (b), m	
		Single berth	Double berth
6	2.8	3.8	6.6
7	3.1	4.1	7.2
8	3.4	4.4	7.8
9	3.7	4.7	8.4
10	4.0	5.0	9.0
11	4.3	5.3	9.6
12	4.4	5.4	9.8
13	4.6	5.6	10.2
14	4.8	5.8	10.6
15	5.0	6.0	11.0
16	5.2	6.2	11.4
17	5.3	6.3	11.6
18	5.4	6.4	11.8
19	5.5	6.5	12.0
20	5.7	6.7	12.4
21	5.8	7.3	13.1
22	5.9	7.4	13.3
23	6.0	7.5	13.5
24	6.3	7.8	14.1
25	6.5	8.0	14.5
27.5	7.0	8.5	15.5
30	7.5	9.0	16.5
35	8.7	10.2	19.0
40	10.0	11.5	21.5
45	10.0	11.5	21.5
50	10.0	11.5	21.5

3.3.3 Mooring Bollards

Stainless steel / cast aluminium mooring bollards (5T Capacity for 3m wide Jetties and 10T capacity for 6m wide Jetties or any other size suitable for the moored vessels) shall be installed to cast-in anchor sockets, cast into the main structure of the jetty at locations at 4m spacing along both sides of the Jetty or the spacing suitable for the moored boats.

3.3.4 Mooring piles in double berths

Mooring piles between each boat in a double berth configuration may be required where
wind generated waves or boat wake exceed(s) 300 mm in height. The width of the double
berth should be increased by the width of the pile.

3.6 GANGWAY REQUIREMENTS

3.6.1 Width

The clear width of gangways should be in accordance with Table 3.3.

TABLE 3.3
CLEAR GANGWAY WIDTHS

Number of berths	Width (m)
Up to 2	0.7
Greater than 2, up to 10	0.9
Greater than 10, up to 60	1.2
Greater than 60, up to 120	1.5
Greater than 120	1.8

If 3 or 4wheeler vehicular access is required, the provisions of IS4651 may be used as guideline. However, for stability the provisions of this guideline must be satisfied.

3.6.2 Maximum slope

The maximum slope of a gangway and tread plateshould not exceed 1:3.5. Forprivate pontoons with no public access, the maximum slope should not exceed 1:3. Thegangway should be in accordance with AS 1657 or such other international standards.

Where access for disabled persons is required, the slope of gangways and tread platesshould not exceed 1:8.

The maximum slope is the slope that would occur at a water level of CD. The walkingsurface should be finished in accordance with AS 4586.

3.6.3 Handrails

At least one handrail should be provided on gangways for pontoons with up to 2 berths, i.e. for restricted access of floating jetty/ platform. For unrestricted access, gangways should haveHandrails on both sides. Handrails are not normally provided on floating jetties in working marinas or fishing harbours since the falling height (i.e. deck to water) is minimal and because handrails obstruct operations / functionality. However, handrails should be provided on floating jetties with unrestricted access and whose primary use is for the general public (e.g. ferry / tourist jetties). The design and location of such handrails is normally self-evident and common-sense can be applied.

Section 4 Loading and Stability

4.1 General

Fixed and floating structures should be designed for the following loads:

a) Dead load.
b) Live load.
c) Environmental loads.
d) Loads from vessel wash.
e) Berthing and mooring loads.

In designing Floating Jetties/ platform, the design should include assessment of the structural ability to resist all loads and the flotation and stability of floating systems.

Strength limit-state loads should be calculated for a 1 in 50 year return period for wind, wave, surge and flooding loads.

4.2 LOAD COMBINATIONS FOR LIMIT STATE DESIGN

4.2.1. Limit State Design should be used with the load combinations and load factors.Notwithstanding the loads and load combinations suggested below, all structures should comply with the requirements of AS 1170.1.

1. The structural, flotation and stability design of the floating jetties/ platform shall be carried out in compliance with Section 4 of AS 3962-2020."
2. Wind loading is based on the ultimate wind velocity. The ultimate wind loading from IS 875 part 3 can be used, adjusted with the appropriate factors allowed for therein.
3. Where the water depth in a particular section of varies, the piles should be checked for a water level at lowest astronomical tide (LAT). In this situation the piles in the shallower water will tend to carry a greater proportion of the total loads applied to this section of the Floating Jetty/ platform.

4.2.2. Due to the critical nature of the environmental loads on the design of a floating jetty/ platform, serviceability limit state is rarely critical. Stability is dealt with separately due to the special considerations for floating pontoons.

4.2.3. For Strength Limit States, the designer should be satisfied of the appropriate load combinations and load factors for the particular circumstances.

4.2.4. However, where more accurate data is not available, the following load combinations are suggested:

a) For pontoon piling:
   (i) Wind load (See Note 1) + 1.5 × current load + 1.5 × wave load.
   (ii) The piles are to be designed for water level at highest astronomical tide (HAT) (See Note 2).
   (iii) Where flooding or surges can occur: 0.8 × wind load (see Note 1) + 1.25 × current load + 1.25 × wave load taken at the maximum water level.
b) For the Floating Jetty/ platform, Wind load (see Note 1) + 1.5 × current load + 1.5 × wave load + 1.5 × the vertical effect of wave action.
c) For boat impact:

(i) 1.5 × the loading created by boat impact.

(ii) Taken on its own without environmental loads.

4.3 Dead Loads

The dead load should include the self-weight of the structure and the load due to services such as electrical cables and water pipes and fittings (full of water).

4.4 Fixed Structure Live Load

4.4.1 Structures for unrestricted access

Fixed walkways and fingers with unrestricted access should be designed for either of the following live loads, whichever produces the most adverse effect:

(a) A uniformly distributed load over the deck plan of 5 kPa.

(b) A concentrated load of 4.5 kN.

4.4.2 Structures for Restricted access

Fixed walkways and fingers with restricted access should be designed for either of the following live loads, whichever produces the most adverse effect:

(a) A uniformly distributed load over the deck plan of 3 kPa.

(b) A concentrated load of 4.5 kN.

4.5 Floating Structure Live Load

Floating structures should be designed for the following live loads:

(a) Structural load—applied to the full length and width of the structure or to any part thereof so as to produce the most adverse structural effect on the structure.

(b) Flotation load—the floating structure should have 50 mm reserve buoyancy when the flotation load is applied to the full length and width of the structure. If full flotation is not provided to the top of the deck, the minimum freeboard to the top of the deck should be sufficient to maintain 50 mm reserve buoyancy. If the width of the flotation unit varies with the degree of immersion, the minimum freeboard under stability loading should be increased so that the reserve buoyancy is equal to the maximum width of the flotation unit multiplied by the 50 mm freeboard.

(c) Stability load—the floating structure should comply with Clause 4.12 when subjected to the stability load.

If the freeboard is greater than 500mm and the draft is less than 150mm, the response time of the floating jetty/ platform to cyclic vertical loading should be checked.

4.5.1 Floatation and stability loads

Floating structures should be designed for flotation and stability loads. These loads should be applied over the whole of the deck area and gangways, where applicable. Design loads should be applied at a location to cause the most adverse action effect. For example, for a finger, the load may be applied across half the width of a floating pontoon.

4.6 Environmental Loads

The principal environmental loads likely to be encountered in Floating Jetty/ platform are as follows:

(a) Wave loads, both short-period local wind waves and long-period swells resulting from storm or wind activities offshore.
(b) Wind loads on the Floating Jetty/ platform structures and on vessels moored at the Floating Jetty/ platform.
(c) Current loads due to tidal currents, river and stream flows, and storm water outlets.

4.6.1 Negative Lift

For floating pontoons, a phenomenon known as negative lift should be considered during flooding. This phenomenon occurs as a result of current velocities passing under the pontoon and causing suction downward on the leading edge of the structure. The negative lift is proportional to the velocity squared, and can result in submersion of the leading edge of pontoon at moderate velocities. However, depending upon the draft of the fishing boats, the suitable decision need to be taken on case to case basis.

4.7 Berthing and Mooring Loads

The berthing impact force should be derived from the energy impacted to the structure and restraining system from the design vessel striking the structure at a perpendicular velocity not less than 0.3 m/s. For recreational vessels greater than 25 m in length, a berthing velocity of 0.2 m/s may be used and for floating ferry terminals a perpendicular velocity greater than 0.3 m/s may be appropriate.

The effect of berthing impact loads should be considered at both high and low tide. At low tide the pile loading is likely to be the dominant effect. At high tide, the effect of the pile deflection on the structure is likely to be dominant. The mass of the attached water should be taken into account and berthing energy shall be determined for mid-point berthing. However, berthing velocity need to be cross checked based on the location of the berths (sheltered exposed, etc.) and applicable codes such as BS.

4.8 Anchor Loads

Floating structures should be designed to include the effect of the elasticity in the anchorage system. The loads transferred into the structure will depend upon the method and number of attachment points. The attachment points should be designed as cleap / bitt attachment points. The jetties and attachment points must be capable to withhold the (inner) stresses resulting from attached ships under wave impact.

4.9 Provision for future requirement

While planning for the floating jetties/ platform, suitable provision should be made to add additional units either longitudinally or laterally to increase the size of the floating jetty/ platform. Interconnecting arrangements shall be made as an inherent part of the floating jetty/ platform to cater to the future requirement.

4.10 Stability

A principal factor in safe pedestrian or vehicular access on floating structures is stability, i.e., the ability to withstand overturning forces or moments and return to a normal attitude after removal of these unbalanced forces or moments.

A floating structure is stable if under all conditions of loading the metacentre is located an adequate distance above the centre of gravity. Alternatively, adequate stability is provided if under all loading conditions, the whole of the top of the flotation structure is clear of the water surface and the opposite chine remains submerged.

Section 5 Design Consideration

Part-I

5.1 Conventional Jetties Vis-à-vis Floating Jetties/ platform

The conventional way of increasing the berthing capacity in small harbours particularly in Fishing Harbours is to develop Fixed Concrete Jetties. However, development of a fixed concrete jettymay often have delayed because:

- Fixed jetties and quays are expensive.
- Fixed jetties and quays are relatively slow to build.

The traditional quay only provides berthing along its front edge particularly when the fish-handling sheds need to be built on the quay itself.

A few harbours have fixed "finger" jetties that allows berthing along both sides, which is a more desirable solution than quay walls, yet it will still suffer from the time-consuming consents process and, in locations with a large tidal range tantamount to freeboard problem

As an alternative, the Concrete **floating jetties/ platform**can be suggested if any of the above narrated restrictions are faced.

5.2 Floating Jetties/ Platform

Floating jetties/ platform are recommended especially in locations having a large tidal range where a conventional quay would mean the fishing boat floating many metres below the top of the quay during low tide periods.

In such locations, the deployment of floating jetties/ platform results in a constant freeboard between jetty and boat which eases the disembarkation of the catch and the embarkation of ships' stores, with a consequent increase in productivity and safety.

Floating Jetties/ platform will require the following considerations:

i. Floatation stability: Ensure under all conditions the Floating Jetty / Pontoon will float and possess a positive righting level.
ii. Mooring stability: Ensure the mooring design considers worst load combinations with a factor of 1.5 minimum.

Floating Jetties/ platform may be suitable in benign wave conditions typically of about 1m from an operational point of view. In any case, the relative motion between a pontoon and vessel/boat shall not be more than 0.5m.

The **floating jetties/ platform** may be implemented initially in India's over-crowded fishing harbours since they are cost effective and also.

- They do not require any form of permanent construction on the seabed.
- They can be easily moved or removed in case of a need to re-configure the port.
- The environmental impact is negligible.
- Safety is much improved.

If floating jetties/ platform are considered they shall be unsinkable, fully reinforced concrete jetty, as was recently developed in Maharashtra, Goa, Kerala and Gujarat.

Considering the heavy use of our fishing harbours, it is clear that the structure of any floating jetty/ platform must be built of fully reinforced concrete. The use of lighter forms of construction such as steel or aluminium will not provide the strength or durability required. However, a steel structure in saltwater locations would need frequent slipping, chipping and painting, thus imposing on the harbour authority an onerous, ongoing and expensive maintenance regime.

A similar comment applies to the deck of the floating jetty/ platform. A deck made from anything other than reinforced concrete will never survive the loads (especially impact loads), the frequent spillages of caustic chemicals and petroleum products, and the degradation caused by sunlight and high humidity.

Whenever floating jetties/ platform are designed,the following major factors to be given proper attention:

- There should not beany"one size fits all" approach. For example, for the small boats of the coastal fleet, a 3m wide floating jetty/ platform with a freeboard of 0.5m would be adequate, while for the larger vessels of the offshore fleet, a jetty width of 6m may be required.
- The width of the jetty should be kept as low as possible, say upto 3 - 6m, eventhough, a 3m jetty width is inadequate for road vehicles it is fine for hand-trollies and electric trollies and the 6m width is adequate for 3-wheelers and light trucks. It may also be noted that for much wider floating jetties/ platform, the cost increases very substantially due to the increased volumes of materials required and hence, an optimization in width is required.
- Considering the floatation safety, the jetties must be unsinkable no matter how much they may suffer from vessel impact or lack of maintenance. It is therefore advised to use special foam (EPS, Expanded Polysterene) core which is encapsulated by concrete on all but the bottom side (in order to reduce weight and ensure floatation).The foam material should be chosen according to environmental guidelines. The EPS should have a moulded density of 15kg/m, water absorption for 96 hours of 3-3.5 % by volume and Compressive strength of 65-110 Psi at 10% deflection. It should be secured that the foam is able to withstand saltwater, acid, and biologic impacts. A typical cross-section of the floating jetty/ platform is depicted hereunder:

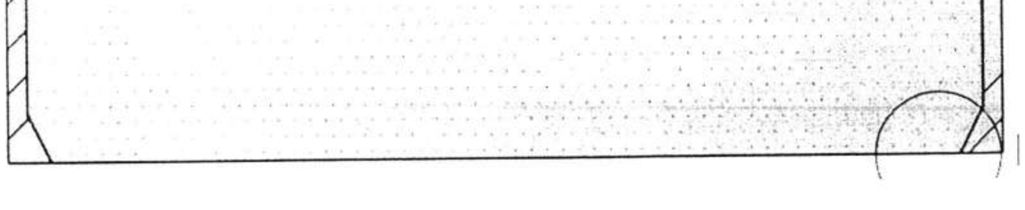

Fig 5.1 Typical cross section of concrete pontoon with foam core. For reference only, the open recess / utility duct location depends on the design and need not be at the centre.

An open recess along the top of the unit has to be provided to carry utilities. Alternatively, considering the intensity of use in fishing harbours, instead carry the utilities within under-deck, cast-in ducts to ensure that the utility pipes and cables are not damaged by the fishermen or their vehicles. Open ducts also hinder passengers with trolley luggage and / or buggy carts at sea plane stations. Utility ducts should be concealed by covering with reinforced concrete covers of the same strength as that of the pontoon. This provides an unobstructed and aesthetic surface which requires minimal or no maintenance.

5.3 Material Consideration

5.3.1 Concrete

The jetty may be constructed of reinforced concrete of grade M45 or greater.Concretemixdesigntoincludeasuitablepercentageof GGBStoensurechlorid eprotectionof concrete. Rate penetration, water absorption, initial surface absorption tests to be performedto establish suitable concrete mix design and ensuredurability.

5.3.2 Steel/Stainless Steel

The concrete shall be reinforced with hot-dipped galvanised steel or corrosion-resistant steel. The concrete cover shall at no location be less than 45mm.

All cast-in components shall be of stainless-steel Grade 316 / 316-L / A4. The pontoons wall be connected using multiple flexible connectors on both sides. Connecting parts to be suitably protected and easily accessible.

5.3.3 Aluminium

Aluminium is a common material typically used in mooring bollards,

5.3.4 UPVC

Cast-in industry grade UPVC utility ducts can be considered along each side and along centre line of the jetty.

5.3.5 Piles

Wherever Steel and Concrete piles are used, maintenance required is simple touching up of the protective epoxy paint / coating in the inter-tidal zone.

In case of driving of the mooring piles, it must be done from a work-barge equipped with spuds to ensure accurate positioning.

5.3.6General

It shall be ensured that the materials used in the construction of Floating Jetty/ platform should comply with the relevant materials Standard.

5.4Mooring of the Floating Jetty/ Platform

The mooring system should be selected accordingly to local soil properties. Floating jetty/ platform systems shall be moored in position either with piles or with chains even though, each mooring method has its pros and cons as detailed hereunder;

5.4.1 Chain moorings

Chain moorings are preferred when the floating jetty/ platform is located in an area with waves because the chain catenary absorbs the mooring forces without causing any snatching.The laying of chain moorings and their concrete gravity anchors or *Danforth* high-holding power anchors (as appropriate for the site conditions) can be undertaken with locally available boats, with load-out by Hydra crane.

5.4.2 Pile moorings

Pile Moorings are generally preferable compared to chain moorings particularly in the location where there is wave action is not severe, subject to cost economic.Once installed, the piles can be "forgotten" for many years; no adjustment is required. The only maintenance required is simple touching up of the protective epoxy paint in the inter-tidal zone.

The piles hold the floating jetty/ platform system precisely in place and the seabed is completely unobstructed. There are other anchoring systems like seaflex, helical anchors etc. or anchoring to a strong quay wall if available which can be adopted when a certain site / project demands the same.

5.5 Manufacturing the Floating Jetties/ platform

The floating jetties/ platforms can be manufactured either within the premises where such facilities are to be installed or in a common place and transported to the site of work. In calm weather, a string of floating jetty/ platform units can be towed at sea from one harbour to another.The heavy-duty floating jetty / platformunits will have to be manufactured at, or near to the harbour in question, since towing at sea for long distances is unlikely to be very practical, certainly on a year-round basis.

Accordingly, optimization of the jetty size should be based on an efficient ratio between jetty size, transportation, loads and construction cost and the stability of the whole jetty-system.

5.6Qualification criteria for selection of the contractor and Project Execution

Being a relatively new concept, while prequalifying the willing Contractors, the experience of the Indian companies along with the experience of their partners/consortium members for having executed 'Similar works' in any other country shall be considered, subject to meeting the prevailing extant guidelines/rules of GoI.

During execution, it may be explored, as to whether setting up a pre-cast concrete manufacturing facility at the harbour and probably also a plant to produce the flotation foamis necessary for any technical limitations of the site/project where manufacturing elsewhere and transporting to site is infeasible technically.

5.7 Testing and Acceptance

Based on the project requirement, suitable provision should be added while planning the floating jetties/ platforms, to conduct various tests both onshore and offshore as per the relevant standards to ensure the quality of the floating jetty/ platform and their versatility and its robustness.

Section 6 Services

6.1 GENERAL

The design of a floating jetties/ platform may include the following services on need basis:

a) Water supply.
b) Lighting.
c) On-land stormwater control and disposal.
d) Electricity.
e) Telephones.
f) Any other services required to suit the user requirements.

Permanent and temporary services should be installed in such a manner as to minimize thehazard of users tripping over them.

6.2 WATER SUPPLY

Water services, if provided from public mains, should be in accordance with the requirements of the relevant authority. Flexible, non-corrodible, ultraviolet-stabilizedpiping should be used. A water reticulation system that is also used for firefighting isappropriate. If fire hydrants are installed on a floating jetty/ platform, a separate reticulation system may benecessary. Non-return valves may be required by water authorities.

6.3 LIGHTING

Adequate lighting should be provided for safe pedestrian access to the berths, security of vessels and shore facilities, and safe navigation within the floating jetty/ platformarea.

All lighting should be designed and located to minimize glare for vessels navigating in the vicinity.

6.4 STORMWATER CONTROL AND DISPOSAL

Contaminated run-off from hard-stand including boat maintenance areas should be capable of being isolated so that run-off can be collected, treated and disposed of, in accordancewith the requirements of the relevant authority.

6.5 ELECTRICITY

Adequate outlets shall be provided per internationally recognised custom and practice. In fishing harbours, careful consideration shall be given to the provision of electrical outlets (if any) due to the likely issues of control and damage.The use of earth leakage circuit breaker devices on all electrical circuits including floating jetties/ platform, is necessary. One device should be included for each outlet.Adequate power should be provided for all berths so that on-board generators do not have to be used.

APPENDIX A
METACENTRIC HEIGHT METHOD OF STABILITY CALCULATION

A1 SCOPE

This Appendix sets out the metacentric height method for calculating the stability of the Floating Jetties/ platform. The method only applies to an angle of tilt up to 15°.

A2 DEFINITIONS

For the purposes of this Appendix, the definitions below apply

A2.1 Chine

The lower external line of any flotation component.

A2.2 Centre of gravity (G)

The centre of mass of components under the circumstances being considered, i.e., dead load centre of gravity refers to the centre of mass of all components comprising the flotation unit. Live load centre gravity for stability purposes refers to all temporarily applied loads.

A2.3 Displacement (Δ)

The mass of the volume of fluid displaced by the flotation unit.

A2.4 Centre of buoyancy (B)

The centre of gravity of the volume of fluid displaced by the flotation unit.

> NOTE: The centre of buoyancy for rectilinear flotation units may be approximated as
> 0.5 × mean draught.

A2.5 Mean draught (D)

The average draught of the flotation unit.

$$D = \frac{total\ mass}{density\ of\ fluid\ x\ plan\ area\ of\ flotation\ units}$$

A2.6 Metacentre (M)

The point at which a vertical line through the centre of buoyancy (B), passes through the vertical axis of symmetry of the flotation unit.

A2.7 Displacement volume (V) The volume of the fluid displaced. A2.8 Metacentric height (GM)

The vertical distance between the centre of gravity (G) and the metacentre (M).

A2.9 Second moment of area (I)

The second moment of area of the plan of the flotation area at the water line, taken about the axis of symmetry.

> NOTE: The second moment of area of the flotation area for rectilinear flotation units can be taken as:

$$D = \frac{plan\ length\ of\ pontoon\ unit\ x\ (plan\ width\ of\ pontoon\ unit)^3}{density\ of\ fluid\ x\ plan\ area\ of\ flotation\ units}$$

A2.10 Heeling moment (H)
The product of the eccentric load about the centroid of the water plane area and the perpendicular distance from that point to its line of action.

A2.11 Stability angle (")
Angle of tilt.

A3 CALCULATIONS
The stability for marina pontoons should be calculated as follows.

a) Calculate the height of the vertical centre of gravity of the marina pontoon above the
keel, under dead load (hg) , as follows:
   i. Divide the marina pontoon into elements and calculate the height of the centre
of gravity of each element above the keel.
   ii. Calculate the weight of each element.
   iii. Multiply the weight of each element by the height of its centre of gravity above
the keel, to obtain its moment.
   iv. Calculate the total weight of the marina pontoon by summing the weights of the
individual elements.
   v. Using the theory of moments, calculate the height of the centre of gravity of the
marina pontoon above the keel (hg), by dividing the sum of the moments in Item (iii) by the total weight in Item (iv).

b) Calculate the displacement volume of the marina pontoon under dead load, as
follows:

$V_u = \frac{W_d}{\rho}$. . . A3(1)

Where
V_u= displacement volume (in sea water), in cubic metres
W_d = total dead weight of marina pontoon, in kilograms
ρ= density of water
= 1026 kg/m3 for sea water
= 1000 kg/m3 for fresh water

c) Calculate the draught of the marina pontoon under dead load, as follows:

$$h_d = \frac{V_d}{A}$$ A3 (2)

Where
h_d = draught, in metres
V_d = displacement volume under dead load, obtained from Equation A3(1), in cubic Metres
A = plan area of the pontoon at the water surface, in square metres

d) For the worst combination of loads, obtained from Section 4, calculate the new centre of gravity of the pontoon. This is done by considering the combination of loads as a weight located at the centroid of the water surface area and an applied moment which causes the pontoon unit to tilt through an angle φ (see Figure A1(b)).

i. Calculate the height of the centre of gravity of the pontoon unit above the keel (hg), by dividing the sum of the moments determined from Paragraph A3(a)(iii), by the total dead weight of the pontoon plus the weight of the loads obtained from Section 4.

ii. Calculate the displacement volume of the marina pontoon when loaded as follows:

$$V_1 = \frac{W_1}{\gamma} \qquad \text{...... A3 (3)}$$

Where

V_1 = displacement volume under dead and live load, in cubic metres
W_1 = total dead and live weight, in kilograms\
γ = density of water

iii. Calculate the draught of the marina when loaded as follows:

$$h_1 = \frac{V_1}{A} \qquad \text{........... A3 (4)}$$

Where

h_1 = draught, in metres
V_1 = displacement volume under dead and live load, obtained from Equation A3(3), in cubic metres
A = plan area of the pontoon at the water surface, in square metres

e) Calculate the centre of buoyancy (see Paragraph A2.4).

f) Calculate the height of the metacentre above the centre of buoyancy, as follows:

$$h_{mb} = \frac{I}{V_1}$$

Where

h_{mb} = height of the metacentre above the centre of buoyancy, in metres
I= second moment of area of pontoon area about the axis of symmetry under consideration, in metres to the fourth power
V_1 = displacement volume under dead and live load, in cubic metres

For rectilinear pontoons

$$I = \frac{lb^3}{12}$$

Where

l = plan length of pontoon unit, in metres

b = plan width of pontoon unit, in metres

g) Calculate the height of the metacentre as follows:

$$h_{mc} = h_{mb} + \frac{h_1}{2} - h_{g_1}$$
$$h_{mc} > 0$$

Where
h_{mc} = metacentric height, in metres
h_{mb}= height of metacentre above centre of buoyancy, in metres
H_1 = height from keel to loaded waterline
H_g = height from keel to centre of gravity, in metres

h) Calculate the angle of tilt as follows:

$$\tan \emptyset = \frac{M}{W_1 h_{mc}}$$

Where
$\emptyset$= angle of tilt, in radians
M = applied moment, determined from Paragraph A3(d), in kilogram metres
h_{mc}= metacentric height, in metres.

i) Calculate the minimum freeboard, as follows:

$$h_f = h - (h_1 + 0.5\, b \tan \emptyset)$$

Where
h_f = freeboard, in metres
h =depth of pontoon, in metres
h_1= draught, in metres
B = width of pontoon, in metres.
$\emptyset$= angle of tilt, in degrees

j) Check the freeboard and chine calculated, in accordance with Clause 4.9.2.

APPENDIX B

Specification / Schedule of Technical Requirements (SOTR) for Floating Jetties

Schedule of Technical Requirements (SOTR) for Floating Jetty Systems.

To achieve the best combination of utilisation, durability, sea-worthiness, safety, and low maintenance, plus the ability to be moved/re-located (if ever required), floating jetties/ platform should meet the following specifications.

Ser.	Specification	Rationale
1	The jetty shall be constructed of reinforced concrete of grade M45 or greater. **NOTE:** Cement and GGBS(Ground Granulated Blast-furnace Slag) can be used in the concrete mix to ensure the chloride protection of the concrete of less than 2000 COULOMBS (AASHTO T 277 93/ASTM C 1202,2005) Water penetration <30mm (BS EN 12390 Part 8:2000) and water absorption <2.3% (BS1881 Part 122, 1983, Initial Surface absorption <0.25ML/M2 S (BE 1881 Part 208:1996 C1.8 1.3.1)	To ensure stability and seaworthiness, zero corrosion, low maintenance, and safety.
1a	The use of additives should be considered for increasing the lifetime of the jetties.	To ensure sustainability, seaworthiness, low carbon foot print and potential to address different forces such as compressive, shear, torsional and flexural forces coming from the ocean/ water body.
2	The concrete shall be reinforced with hot-dipped galvanised steel or corrosion-resistant steel. The concrete cover shall at no location be less than 45mm.	To have a long design life and also to ensure that the reinforcement does not corrode and affect jetty usability during its economic life.
3	The deck of the jetty shall be plain concrete with an additional suitable protective non-slip coating to resist oil and fuel spills and other contaminations to the concrete deck should be considered at locations prone to such contaminations.	To ensure safe environment, even during wet conditions.
4	Cast-in plastic utility ducts to be provided along each side and/ or along centreline of the jetty. Manholes, pull pits in the pontoons shall be an integral part of the pontoon structure and be in waterproof reinforced concrete. Manholes and pull	To accommodate water and electricity services.

Ser.	Specification	Rationale
	pits shall be provided with reinforced concrete covers complying with the structural deck load. Each Manhole / pull pit shall be provided with a drain hole. Cast-in industry grade UPVC utility ducts can be considered along each side and along centre line of the jetty.	 Use of industry grade UPVC will ensure longevity to the floating structure
5	All cast-in components shall be of stainless steel Grade 316 / 316-L / A4. The pontoons wall be connected using multiple flexible connectors on both sides. Connecting parts to be suitably protected and easy accessible.	For strength and non-corrosion. Multiple flexible connectors ensure ease of maintenance, safety and flexibility of the pontoon Connections.
6	Stainless steel / cast aluminium mooring bollards (5T Capacity for 3m wide Jetties and 10T capacity for 6m wide Jetties or any other size suitable for the moored vessels)shall be installed to cast-in anchor sockets, cast into the main structure of the jetty at locations at 4m spacing along both sides of the Jetty or the spacing suitable for the moored boats	For mooring the fishing boats.
7	Fenders to be designed to suit the vessel sizes. Suitable size anchor sockets to be cast into the pontoon structure to all for installation fenders. Option to cast-in a stainless-steel or aluminium fender plate along the berthing faces.	To provide additional resistance to vessel impact and abrasion from the vessels' tyre fenders.
8	Cast-in stainless-steel 316/ A4 equivalent anchor-sockets along top edge at 1m spacing.	To allow future fitting of hanging fenders (if required).
9	In locations where the tidal range is very large, a gangway for the final movement from floating jetty/ platform to landside may be required accordingly the design of the floating jetty/ platform shall take into consideration this factor also. Access gangways fabricated from grade 6031-T6 or 6036-TS aluminium. Internal clear width to be designed as per project requirement, minimum width 1.20m, maximum width 4.0m. Gangways decked with WPC or FRP non-slip grating. Gangways to be designed for project	To provide To provide safe passage to and from pontoons.

Ser.	Specification	Rationale
	specific loading. Max Gradient not to exceed 1:4.	
10	The jetty shall be designed for mooring in position either with chains or with steel or concrete piles.	To ensure safe positioning of the jetty against all normal environmental and operational forces.
11	The jetty shall be designed to withstand a constant, everyday wave height of 0.3m from any direction, and an occasional (i.e. storm) wave height of 0.6m from any direction.	To ensure a long design life.
12	The jetty shall have a demonstrable service life under normal operating conditions of at least 20 years with minimum maintenance.	To ensure a cost efficient solution.
13	The unloaded freeboard of the jetty shall be nominal 0.5m for 3m width and nominal 0.8m for the 6m width. Considering the commercial application of the pontoons. This entails a rougher handling of the boats compared to yachts in a marina. The pontoon width and freeboard shall be considered individually and specifically for each project, to comply to the site's requirement.	To ensure suitable work conditions for the pontoon users. In addition, Pontoon width and freeboard shall further suit the project's expected live loads on the pontoons.
14	The jetty system shall hold accreditations from Indian national classification authorities. The system must have a track record of at least 10 years in harsh environmental conditions.	To demonstrate that the jetty system meets recognised quality and safety standards.
15	Mooring fingers to be considered in harbour arrangements where such fingers may be suitable. Fingers below 8.0m length and 1.0m width or narrower, may due to the light weight of these boats, be provided in marine grade aluminium with WPC decking or FRP non-slip grating and Fiber reinforced concrete floats. Concrete Fingers above 8.0m length to be provided in concrete, with specification similar to the concrete pontoons.	The use of short aluminium fingers in combination with the concrete walkway pontoons is recommended in some applications. Concrete fingers to be provided with similar specifications as the concrete pontoons.
16	Based on the installation conditions the choice of anti-corrosive materials will play a major role. Accordingly, while preparing the DPR this aspect should be given due consideration.	For sustainability of the floating jetty/ platform

Details of all designs and specifications of the pontoons and all their component parts shall be submitted approval.

APPENDIX C

For the purpose of this Standard, the definitions furnished below shall apply.

C.1 Attenuator

A floating barrier to reduce wave height.

C.2 Berth

Boats at Floating Jetty/ platform can either occupy single or double berths.An area of water allocated for the wet storage of boats attached to a fixed or floating jetty/ platformand allowing for walk-on access to boats.

C.3 Berth, double

A berth for two boats between finger floats or piles

C.4 Berths, fixed

Berths consisting of piled walkways (jetties) and mooring piles

C.5 Berths, floating

Berths consisting of walkways that are buoyant and not supported by any other structure.These floating walkways may be located by means of guide piles, anchor chains or cables, allowing free vertical movement. The boats are moored in either single or double berths, with finger pontoons or along-side berth configuration.

C.6 Berth, single
A berth for one boat between finger floats or piles.

C.7 Boat beam
Greatest width of vessel including all permanent attachments.

C.8 Boat length
The length measured between extremes, including bowsprits and stern davits/marlin boards.

C.9 Channel
An unobstructed waterway that allows the movement of boat traffic.

C.10 Channel, entrance
A channel that allows boat movement between the marina/floating jetty/ platform and the mainwaterway (e.g.river, bay).

C.11 Channel, interior
A channel within the floating jetty/ platform that allows boat movement between the entrance channel andthe fairways.

C.12 Channel depth

The depth of water in the channel measured below chart datum.

C.13 Channel width

The width available for navigation at a nominated channel depth.

C.14 Chart datum (CD)

The datum, normally corresponds to the level of LAT, used in hydrographic charts and other hydrographic surveys for the specific region.

C.15 Chine

The lower external line of any flotation component.

C.16 Fair chart (collector sheet)

A compilation of all available hydrographic data.

C.17 Fairway

An unobstructed waterway between rows of berths which allows boat movement betweeninterior channels and individual berths.

C.18 Fetch

The distance over open water across which wind waves can be generated.

C.19 Finger

A fixed or floating structure connected to the walkways, which provides pedestrian accessto and from a berthed boat.

C.20 Floating structures, stabilized

Structures for which adequate stability can be demonstrated by virtue of connected fingersor which are of L-shape or T-shape or similar stable configuration. Any connections shouldbe capable of transmitting the stabilizing forces.

C.21 Floating structures, non-stabilized

Floating structures without the stabilizing elements, e.g. arectangular plan pontoon.

C.22 Freeboard

Distance from the still water level and deck level.

C.23 Gangway

A structure that provides pedestrian access between a fixed jetty or shore and a floatingStructure.

C.24 Highest astronomical tide (HAT)

The level of the highest predicted astronomical tide for the year at the specific locality

C.25 Lowest astronomical tide (LAT)

The level of the lowest predicted astronomical tide for the year at the specific location.This may coincide with the level of the CD for the specific locality.There is a possibility of negative tides.

C.26 Marina

A group of pontoons, jetties, piers, or similar structures designed or adapted to provideberthing for craft used primarily for pleasure or recreation and may include ancillary workssuch as slipways, facilities for the repair and maintenance of boats and the provision offuel, provisions and accessories.

C.27 Mooring

A detached or freestanding structure to which a boat is moored.

C.28 Pontoon/ Floating Jetty

A floating platform.

C.29 Sea, beam

Sea condition with waves approaching from within 22.5°from abeam.

C.30 Sea, head

Sea condition with waves approaching up to 22.5°from the centre-line.

C.31 Sea, oblique

Sea conditions that are not head sea or beam sea.

C.32 Seawall

A structure separating sea and land.

C.33 Shortage of Berth Capacity

- Loading of stores and equipment, unloading of the fishermen's catch is difficult, time-consuming and in some cases hazardous.
- Maintenance of boats (e.g. servicing of engines, replacing fishing tackle) is also difficult when not berthed alongside a jetty.
- Fuelling of boats is often accomplished with jerrycans carried across the decks, or with long hoses, both of which often lead to spillages and pollution.
- The situation is exacerbated in harbours having a large tidal range; during the low tide period the distance from the deck of the boat up to the jetty-top can be considerable.

C.34 Slope

The vertical change over the horizontal change in dimension.

C.35 Walkway

C.35.1 Primarywalkway

A structure that provides for pedestrian access between secondary walkways and the shore.

C.35.2 Secondary walkway

A structure that provides pedestrian access between berths and primary walkways or shore.Usually lies parallel to a fairway.

C.36 Wave height

C.36.1 Design maximum wave height (H1)

The average height (crest to trough) of the highest one percent of waves measured over aperiod of time.

C.36.2 Significant wave height (Hs)

The average height (crest to trough) of the highest one third of all waves measured over aperiod of time.