

File No. M- 25021/20/2020-SM  
Government of India  
Ministry of Ports, Shipping and Waterways  
(Sagarmala Cell)

3<sup>rd</sup> Floor, PTI building,  
4, Parliament Street,  
New Delhi - 110001,

Dated: February 03 , 2021

To,

1. The Chairman, Major Ports [ as per list enclosed]
2. Principal Secretaries, Ports Department, [Govt. of Gujarat, Govt. of Karnataka, Govt. of Odisha, Government of Maharashtra, Govt. of Kerala, Govt. of Tamil Nadu, Govt. of Andhra Pradesh, Govt. of West Bengal]
3. Principal Secretaries, Fisheries Department, [Govt. of Gujarat, Govt. of Karnataka, Govt. of Odisha, Government of Maharashtra, Govt. of Kerala, Govt. of Tamil Nadu, Govt. of Andhra Pradesh, Govt. of West Bengal]
4. CEO of State Maritime Boards [Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Kerala, Tamil Nadu, West Bengal]
5. Principal Secretary (Commerce and Transport), Govt. of Odisha
6. Secretary (Ports), Govt. of Goa
7. Secretary (Ports), Govt. of Puducherry
8. Secretary (Shipping), A&N islands Administration / UT of Daman and Diu and Dadra and Nagar Haveli/ Lakshadweep
9. Directorate General of Shipping, Mumbai
10. Chairperson, IWAI

**Subject: Guidelines for Floating Jetties/platforms-reg**

Sir,

I am directed to say that Ministry of Ports, Shipping and Waterways has been working on the guidelines for the 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/platforms have several advantages including less project cost, fast implementation, etc.

2. The draft guidelines for floating jetties were issued for the comments/suggestions of various stakeholders and general public. The comments, received in this regard, were examined and the guidelines for Floating Jetties/platforms have been finalized with the approval of the Hon'ble Minister of States for Ports, Shipping and Waterways (I/C).

3. The 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' are forwarded herewith for information and necessary action. All Maritime States & UTs / State Maritime Boards / Major Ports/ IWAI / Fisheries Department of State Government may explore using the floating jetties/platforms in their all upcoming projects as per the provisions contained in the guidelines.

**4. This issues in supersession of Ministry's letter of even number dated 02.02.2021**

Yours faithfully,

  
03/02/2021  
(Sanjay Kumar)

Under Secretary to the Govt. of India  
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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 / platforms in 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 standards may be referred to for detailing purposes till Indian Standards are published.

AS 1170 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 to chart 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 rivers and 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, storm water 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 any reclamation works.
- c) Response to prevailing natural coastal and estuarine processes, currents and waves, as well as susceptibility to artificial influences such as propeller wash and boat wake.
- d) Material characteristics for ease of excavation, transportation and disposal. Chemical tests 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/platform to 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 of floating jetty/ platform are 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/ platform sites 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/ platform detailed 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 provided hereunder 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, the majority 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. The minimum width of this narrow section shall be the greater of 15 m and  $3B$  m, where B is the beam of the broadest mono-hull boat in the floating jetty/ platform, in metres

#### 3.1.2 Interior channels and fairways

The channels leading to the floating jetty/ platform are 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 of boat usage. Any non-motorized sailing vessel or multi-hull vessel using the harbour will need to be considered when determining the interior channel and fairway widths. In some locations, there may be climatic conditions, such as prevailing winds, which should be considered 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 is overall 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 boat using 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/ platform is 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/ platform to enter the floating jetty/ platform at any stage of the tide.

Where the area outside the floating jetty/ platform is protected, the entrance channel should be deep enough to allow all boats that usually berth in the floating jetty/ platform to enter at any stage of the tide. However, in areas of extreme tides the cost of excavating the channel may dictate that the larger boats cannot enter the floating jetty/ platform at 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 vessel draught, 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/ platform can access the channels at all states of the tide. However, where economics dictate, the water depth may be reduced; this reduction 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/ platform to 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 recommended that 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 and depth of berths should be determined. These design characteristics should be recorded on the floating jetty/ platform drawings. Where no specific design criteria are established, guidelines for minimum 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:  $2 \times$  design maximum vessel beam + 1 m up to 20 m and + 1.5 m above 20 m.
- (b) Single berth: design maximum vessel beam + 1 m up to 20 m and + 1.5 m above 20 m.
- (c) Multihull vessels can either occupy a double berth, or wider berths can be included, which specifically allow for single or double multihull vessels. The beam of a multihull 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/ platform layout 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 ( <i>L</i> ), m	Boat beam ( <i>B</i> ), m	Width of berth ( <i>b</i> ), 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 4 wheeler 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 plate should not exceed 1:3.5. For private pontoons with no public access, the maximum slope should not exceed 1:3. The gangway 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 plates should not exceed 1:8.

The maximum slope is the slope that would occur at a water level of CD. The walking surface 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 have Handrails 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) +  $1.5 \times$  current load +  $1.5 \times$  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:  $0.8 \times$  wind load (see Note 1) +  $1.25 \times$  current load +  $1.25 \times$  wave load taken at the maximum water level.
- b) For the Floating Jetty/ platform, Wind load (see Note 1) +  $1.5 \times$  current load +  $1.5 \times$  wave load +  $1.5 \times$  the vertical effect of wave action.
- c) For boat impact:
  - (i)  $1.5 \times$  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 Flotation 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 jetty may 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 be any "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-trolleys and electric trolleys 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:

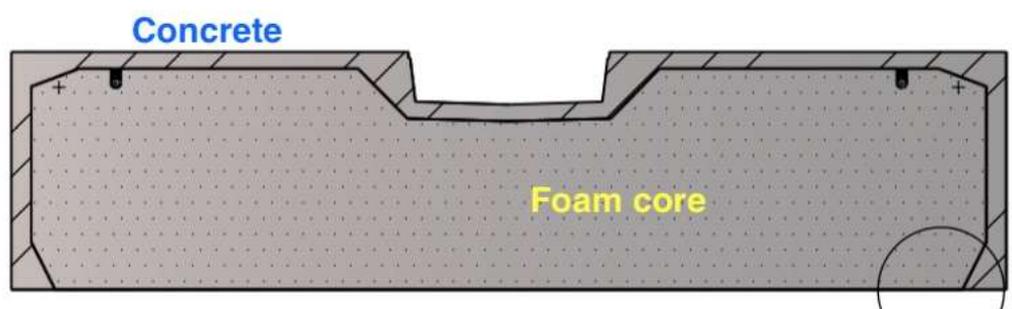


Fig 5.1 Typical cross section of concrete pontoon with foam core. For reference only, the open recess / utility duct location depends on the design and need not be at the centre.

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. Concrete mix design to include a suitable percentage of GGBS to ensure chloride protection of concrete. Rate penetration, water absorption, initial surface absorption tests to be performed to establish suitable concrete mix design and ensure durability.

#### **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.

#### **5.3.6 General**

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

### **5.4 Mooring 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 / platform units 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.

#### **5.6 Qualification 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 foam is 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 storm water 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 the hazard 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-stabilized piping should be used. A water reticulation system that is also used for firefighting is appropriate. If fire hydrants are installed on a floating jetty/ platform, a separate reticulation system may be necessary. 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/ platform area.

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 accordance with 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 ( $\Delta$ )

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  $0.5 \times$  mean draught.

#### A2.5 Mean draught (D)

The average draught of the flotation unit.

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

#### 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:

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

#### 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:

$$V_u = \frac{W_d}{\rho} \quad \dots \text{A3(1)}$$

Where

$V_u$  = displacement volume (in sea water), in cubic metres

$W_d$  = total dead weight of marina pontoon, in kilograms

$\rho$  = density of water

= 1026 kg/m<sup>3</sup> for sea water

= 1000 kg/m<sup>3</sup> for fresh water

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

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

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  $\phi$  (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:

$$V_1 = \frac{W_1}{\gamma}$$

..... A3 (3)

Where

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

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

$$h_1 = \frac{V_1}{A}$$

..... 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
- $H_l$  = 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:

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

Where

$\phi$  = 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:

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

Where

$h_f$  = freeboard, in metres

$h$  = depth of pontoon, in metres

$h_1$  = draught, in metres

$B$  = width of pontoon, in metres.

$\phi$  = 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.  <b>NOTE:</b> 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 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.	To accommodate water and electricity services.

Ser.	Specification	Rationale
	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 specific loading. Max Gradient not to exceed 1:4.	To provide safe passage to and from pontoons.
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.

<b>Ser.</b>	<b>Specification</b>	<b>Rationale</b>
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 / platform and 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 main waterway (e.g. river, bay).

### **C.11 Channel, interior**

A channel within the floating jetty/ platform that allows boat movement between the entrance channel and the 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 between interior 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 access to and from a berthed boat.

**C.20 Floating structures, stabilized**

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

**C.21 Floating structures, non-stabilized**

Floating structures without the stabilizing elements, e.g. a rectangular 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 floating Structure.

**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 provide berthing for craft used primarily for pleasure or recreation and may include ancillary works such as slipways, facilities for the repair and maintenance of boats and the provision of fuel, 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 Primary walkway**

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 ( $H_1$ )**

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

#### **C.36.2 Significant wave height ( $H_s$ )**

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