

Australian Standard™

Guidelines for the design of maritime structures



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PREFACE

This Standard was prepared by Standards Australia Committee CE-030, *Maritime Structures*.

The objective of this Standard is to provide designers and regulatory authorities of structures located in the marine environment with a set of guidelines and recommendations for the design, preservation and practical applications of such structures. These structures can include fixed moorings for the berthing of vessels, piles and other parts of a substructure, wharf and jetty decks, building substructures over waters, etc.

This Standard has been prepared as a guideline only, to provide advice and recommendations for maritime structures. Clauses in this document are written using informative terminology and should not be interpreted otherwise. The requirements of a maritime structure and its associated facilities should be determined for the individual application. This Standard should be used in conjunction with the relevant materials and design Standards.

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STANDARDS AUSTRALIA

Australian Standard **Guidelines for the design of maritime structures**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out guidelines for the design of structures in a marine environment. It is to be used in conjunction with the relevant Standards and provides recommendations additional to the requirements of these Standards.

This Standard is intended to cover the design of near-shore coastal and estuarine structures, such as—

- (a) jetties;
- (b) wharves;
- (c) berthing dolphins;
- (d) floating berths;
- (e) seawalls;
- (f) breakwater structures, excluding rubble mound and floating types;
- (g) boat ramps;
- (h) laterally restrained floating structures; and
- (i) building substructures over water.

This Standard is not intended to cover the design of—

- (A) pipelines;
- (B) marinas (see AS 3962);
- (C) offshore oil and gas structures;
- (D) dredging and reclamation;
- (E) coastal engineering structures such as rock armoured walls, groynes, etc;
- (F) geometrical design of port and harbour infrastructure;
- (G) floating structures not permanently restrained, e.g., vessels, construction pontoons, barges.

For buildings constructed over water, these guidelines apply to the structure up to and including the main deck level. The superstructure above main deck level should be designed in accordance with the relevant Australian Standards and relevant building regulations.

1.2 REFERENCED AND RELATED DOCUMENTS

1.2.1 Referenced documents

The following documents are referenced in this Standard:

AS

1012	Methods of testing concrete
1012.13	Method 13: Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory.
1170	Minimum design loads on structures
1170.4	Part 4: Earthquake design loads on structures
1604	Timber—Preservative-treated—Sawn and round
1657	Fixed platforms, walkways, stairways and ladders—Design, construction and installation
3600	Concrete structures
3962	Guidelines for design of marinas
3972	Portland and blended cement
4100	Steel structures
5100	Bridge design
5100.2	Part 2: Design loads
5604	Timber—Natural durability ratings

AS/NZS

1170	Structural design actions
1170.0	General principles
1170.1	Part 1: Permanent, imposed and other actions
1170.2	Part 2: Wind actions
1554	Structural steel welding
1554.6	Part 6: Welding stainless steels for structural purposes
2312	Guide to the protection of iron and steel against exterior atmospheric corrosion
2832	Cathodic protection of metals (all parts)
4671	Steel reinforcing materials
4673	Cold formed stainless steel structures
4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

BS

6349	Maritime structures (all parts)
6744	Stainless steel bars for the reinforcement and use in concrete – Requirements and test methods

Disability Standards for Accessible Transport (Australian Government)

PIANC Design of fender systems—2002

1.2.2 Related documents

AS/NZS 1664	Aluminium structures
AS 5100	Bridge design (all parts)
SA HB 84	Guide to Concrete Repair and Protection

1.3 NOTATION

1.3.1 Abbreviations

The following abbreviations are used in this Standard.

AHD = Australian Height Datum

CD = Chart Datum, used for the preparation of navigation charts, and usually about the same level as LAT

CQC = Container Quay Crane (Portainer crane, ship-to-shore crane)

DWT = Dead Weight Tonnage (The total mass of cargo, stores, fuels, crew and reserves with which a vessel is laden when submerged to the summer loading line.)

NOTE: Although this represents the load carrying capacity of the vessel it is not the exact measure of cargo load.

GRT = Gross Registered Tonnage (The gross internal volumetric capacity of the vessel as defined by the rules of the registering authority and measured in units of 2.83 m^3 (100 ft^3)).

HAT = Highest Astronomical Tide (see Clause 3.2)

ISLW = Indian Spring Low Water (Obsolete estimate of Lowest Astronomical Tide (LAT) formerly used as chart datum)

LAT = Lowest Astronomical Tide (Now adopted as chart datum for all Australian Hydrographic Charts (see Clause 3.2))

LOA = Length Overall of a vessel, measured to the extremities of fittings.

MSL = Mean Sea Level, usually about the same level as AHD

1.3.2 Symbols

The following symbols are used in this Standard.

d_b = reinforcing bar diameter

E_d = design action effect

$E_{d,dsb}$ = design action effects destabilizing structure

$E_{d,stb}$ = design action effects stabilizing structure

E_s = serviceability earthquake action

E_u = ultimate earthquake action

f = co-efficient of wave height (see Clause 5.9.1)

f'_c = characteristic compressive strength of concrete, in Megapascals (MPa)

f_s = steel reinforcing stress, in Megapascals

F_b = berthing impact loads

$F_{b,u}$ = berthing impact actions under abnormal conditions

F_D = action in the direction of wind, in kilonewtons (kN)

F_e = earth pressure loads

F_{env} = combined environmental loads

F_{gw}	=	ground water loads
F_{lat}	=	minimum lateral load (see Clause 5.3.1)
F_{lp}	=	liquid pressure load
F_{m}	=	mooring loads
F_{s}	=	stream flow loads, including debris loads
$F_{\text{wave.S}}$	=	wave loads under serviceability conditions (1 in 1 year)
$F_{\text{wave.U}}$	=	wave load under ultimate strength conditions
g	=	acceleration due to gravity
G	=	permanent action (dead load)
H_1	=	wave height used for design of structures (see Clause 1.4.3)
H_s	=	significant wave height (see Clause 1.4.5)
P	=	pressure, in kilopascals (kPa)
Q	=	imposed action (live load)
S_{u}	=	loading combination (see Clause 5.12.4)
T_s	=	period of significant waves
W_{s}	=	wind load for serviceability limit state
W_{u}	=	wind load for strength limit state
V	=	design wind speed, in metres per second
v	=	current velocity, in metres per second

1.4 DEFINITIONS

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

1.4.1 Action

Set of concentrated or distributed forces acting on a structure (direct action), or deformation imposed on a structure or constrained within it (indirect action).

NOTE: The term load is often used to describe direct actions.

1.4.2 Design life

The period for which a structure or a structural element remains fit for use for its intended purpose with appropriate maintenance (see Clause 6.2).

1.4.3 Design wave (H_1)

The highest 1% of waves in any given time interval. Used, for example, in the analysis of structures.

1.4.4 Load

The value of a force appropriate to an action.

1.4.5 Significant wave height (H_s)

The average height of the highest one-third of waves in any given time interval. It approximates the wave height for this train of waves as estimated by an expert observer.

1.4.6 Sponson

Rubbing strip, generally at main deck level, to strengthen and protect vessel from berthing impacts.

1.4.7 Swell waves

Waves generated some distance from the site; no longer under the influence of generating wind.

1.4.8 Vessel displacement

The total mass of a vessel and its contents.

NOTE: This is equal to the volume of water displaced by the vessel multiplied by the density of the water.

1.4.9 Vessel wash

Waves formed by the passage of a vessel.

1.4.10 Wind wave

Waves formed under the influence of local generating winds, usually called seas.

SECTION 2 SITE INVESTIGATION AND PLANNING

2.1 GENERAL

In maritime structures, the effect of the local environment and geographical configurations (including the new configuration after completion of the proposed maritime facility) has significant bearing on the performance of the structures. Detailed site investigations are an essential part of the planning and design of maritime facilities. Thus, for any site on which it is proposed to install a maritime structure, a detailed site investigation should be undertaken to provide sufficient information for the design and construction of the structure. Maritime structures that have the potential to obstruct currents and waves are likely to affect the littoral processes and the effect of such structures on the adjacent natural features must be investigated.

Hydrographic and terrestrial surveys should be undertaken. Such surveys and subsequent investigations (e.g., geotechnical) should adopt a uniform survey grid.

The wind, wave, current, berthing and other actions that may be applicable to the structure should be considered in the site investigation.

2.2 SURVEY

2.2.1 Survey grid

A uniform survey grid should be adopted for the project area. All terrestrial and hydrographic surveys should use this survey grid.

Consideration should be given to incorporating the survey grid for the project area into the regional coordinated survey grid, e.g., International Survey Grid or Map Grid of Australia 1994 (MGA94), for projects in Australia.

Where a local survey grid is adopted, this should be clearly noted on the drawings and the correlation to GRS80 or WGS84 grid should be nominated on the drawings.

2.2.2 Survey datum

All survey data should be reduced to a recognized datum, which may be Chart Datum (CD) or Australian Height Datum (AHD). Chart Datum is the preferred datum for surveys and mapping of maritime works and offshore topography, as it provides direct correlation to navigable water depths.

The correlation between CD and AHD for the specific location should be clearly shown on all the drawings, e.g., by a note or a diagram.

2.2.3 Hydrographic survey

The hydrographic survey should be undertaken to cover the proposed site of works and any adjacent near-shore water up to mean high water level, including adjacent navigable waterways where there is insufficient existing survey data to make an appropriate assessment of design waves, currents and other pertinent analysis and design parameters. The survey data should also contain sufficient detail to enable an assessment of the hydraulic and seabed processes affecting the proposed structure and adjacent foreshores.

Height datum levels for hydrographic surveys should be to the relevant Chart Datum.

2.2.4 Terrestrial surveys

Terrestrial surveys should be provided over any land areas that will be incorporated or impacted upon by the project site and should overlap with the hydrographic survey

2.3 GEOTECHNICAL

The geotechnical properties and design parameters of seabed materials in the vicinity of a maritime structure should be assessed. These parameters should be used to evaluate foundation capacity, stability and settlement characteristics of the structures and associated works and to determine the response to, and effect on the prevailing natural coastal and estuarine processes. Such processes include tides, current and wave actions and effects of propeller and boat wash.

2.4 ASSESSMENT OF LOADS

Maritime structures should be designed to resist the loads applicable to the service performance requirements of the completed facility, the ultimate (survival) loads that the facility may be expected to withstand, as well as loads applicable at the various stages of construction.

Wind, wave, tide, current and storm surge and other such natural loads and conditions (including sediment movement, flood debris) should be considered during any investigation of loads applied to, or affecting, the performance of a maritime structure.

Wind data should be determined from AS/NZS 1170.2 and/or site-specific anemometer records, where records of adequate duration, to determine an appropriate long-term record, are available.

The determination of wave parameters used to derive the design wave height, wave period and wave direction should be assessed using site-specific wave records where records of adequate duration, to determine an appropriate long-term record, are available. If such records are not available, wave heights and periods may be determined from available wind data.

Tidal information, including tidal currents, for the site of the works should be determined and appropriate design maximum and minimum tidal planes established.

Changes in water levels due to global warming should be considered (see Clause 4.6).

SECTION 3 DIMENSIONAL CRITERIA

3.1 STRUCTURE HEIGHTS

Deck levels should generally be kept as low as practicable, in keeping with their function to provide access to the waterway and to floating vessels.

The minimum height of deck of a wharf or jetty in tidal conditions should be determined as the 1/100 annual exceedance of probability elevated water level, plus a suitable freeboard depending on exposure to waves, wave heights, wind set-up, formation of bars at river entrances and seiche.

For wharves and jetties in locations subject to local river flooding or storm surge situations, the design may allow for periodic inundation during such events. Such structures should be able to withstand lateral loads and uplift from elevated water levels including flood effects from the design flood event.

Where overtopping of deck structures by waves would result in disproportionate level of damage to the superstructure above main deck level, means to prevent water damage to the property should be incorporated in the design.

3.2 FENDER HEIGHTS

Fender structures in tidal waters should extend to at least the height of the sponson or rubbing strake of the highest vessel likely to use the facility, during the design elevated water level, which should be no lower than the highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions (HAT) plus an allowance for storm surge. The fender system should also extend down to a level no lower than the sponson of the smallest craft likely to use the facility, at the lowest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions (LAT). Vessel load conditions and motion in response to waves and any other influencing effects should also be considered.

3.3 LAYOUT OF BERTH STRUCTURES

The layout of the structures for a berth should be designed to take account of—

- (a) restraining the vessel against environmental loads (winds, waves and currents) and interaction effects between passing vessels;
- (b) providing safe berthing and unberthing in extreme events (storms, floods);
- (c) allowing safe navigation access to the berth to and from the waterway;
- (d) minimum intrusion into the navigable waterway;
- (e) ease of cargo handling;
- (f) safe personnel and vehicle access;
- (g) disabled access (where applicable); and
- (h) minimum impact on the hydrodynamic regime.

NOTE: The operation of some facilities may require that some vessels be removed in the event of a major storm.

3.4 ACCESS AND SAFETY

3.4.1 Application

For maritime structures that may fall outside the provisions of relevant building codes or other regulations, the guidelines in Clause 3.4.2, 3.4.3, 3.4.4 and 3.4.5 should be followed.

3.4.2 Access for operational, inspection, maintenance and servicing personnel

Where access to structures is required for operational, inspection and maintenance personnel, the structures should comply with the requirements of AS 1657.

Ramps or sloping surfaces should not be located in the tidal zone (where marine growth can make them slippery). Where slopes are required below high water mark, access should be provided by way of a series of horizontally surfaced steps let into the slope, proud of the slope, or cleats fixed to the surface at maximum 300 mm centres. Appropriate non-slip surfacing should be provided.

3.4.3 Access to public transport facilities

Where access is required to public transport facilities, structures should comply with the requirements of the *Disability Standards for Accessible Public Transport*.

Gradients of gangways (hinged ramps attached to floating structures, whose gradients varies with the tide) should not exceed 1 in 8 when the tide is at LAT, or steeper than 1 in 12 for more than 20% of the time.

3.4.4 Safety fencing

In general, wharf faces and the like are not provided with safety or other fencing to prevent persons or vehicles from falling off the edge of a public access structure. Such fencing would hinder the normal operation of the wharf or maritime facility. Edge kerbs may be considered in areas generally used by wheeled vehicles.

Where access to the water or vessels is not required and where a person falling from the structure is likely to fall more than 1.5 m to strike a hard surface or the seabed, a guardrail (handrail) in accordance with AS 1657 should be provided.

3.4.5 Safety ladders

Where persons who fall from a wharf or maritime facility would not be able to easily regain the shore, safety ladders should be provided. Such ladders should be of durable material and extend from deck level down to below low water level—bottom rung should be 300 mm below LAT. Such ladders should be located at maximum 60 m intervals.

Where safety ladders are used to provide access to craft, suitable buffer rails, at least 250 mm proud of the ladder, should be provided each side to prevent vessels crushing persons on the ladder.

SECTION 4 DESIGN REQUIREMENTS

4.1 AIM

The aim of the design of maritime structures covered by this Standard is to provide structures that are stable, have adequate strength against ultimate conditions and remain serviceable while being used for their intended function, and which also satisfy requirements for robustness, economy and ease of construction, and are durable (low maintenance and low repair costs).

4.2 DESIGN REQUIREMENTS

4.2.1 General

The design of the structure and its components should take into account, as appropriate, stability, strength, serviceability and durability. The design should be in accordance with the relevant Australian Standards together with any additional recommendations in these guidelines.

4.2.2 Stability

The structure and its component members should be designed for static stability under overturning, uplift and sliding and dynamic stability in design conditions as given in Clause 5.12, such that stability loads and other actions exceed the destabilizing loads and other actions. The loads and other actions will need to be combined as given in Clause 5.12.

4.2.3 Strength

The structure and its component members should be designed for strength as follows:

- (a) Determine the appropriate loads and other actions in accordance with Section 5.
- (b) Combine and factor the loads in accordance with Clause 5.12 to determine the design loads for strength.
- (c) Determine the design action effects for the structure and its components for each load case.
- (d) Determine the design strength in accordance with the requirements of the appropriate Australian Standard(s).

The effects of fatigue from wind, wave, current and other actions under both normal and storm conditions should be considered.

4.2.4 Serviceability

The structure and its component members should be designed for serviceability by controlling or limiting settlement, horizontal displacement and cracking.

Under the load combinations for serviceability design detailed in Clause 5.12.4, vertical deflection should be limited in accordance with the requirements of the appropriate materials Standards.

Horizontal deflection and acceleration limits for trafficable structures should be limited to a maximum deflection of $l/150$, where l is the distance between underside of the deck structure to the level of the support in the seabed, and a maximum acceleration of 0.1g.

Designers should exercise care at the interface between flexible maritime structures and rigid shoreline structures. Horizontal deflection limits in commercial structures subject to heavy vehicle loadings need to consider dynamic effects of the horizontal vehicle loads (e.g., braking) on the structure.

For maritime structures, serviceability conditions are those that may be experienced under normal conditions, and may include for example wave action, which has dynamic effects as well as fatigue effects on those elements constructed from fatigue-prone materials.

Typically service conditions would include effects from waves with significant wave heights that occur once or more each year.

4.2.5 Durability

The structure and its component members should be designed for durability in accordance with Section 6.

4.2.6 Other relevant design requirements

The design should take into account the effects of vessel berthing, scour, flood, cyclic loading, fatigue, temperature effects and any other special performance requirements.

4.3 FLOATING STRUCTURES

Floating structures dealt with in this Standard include pontoons used for floating berths (ferry wharves and similar) that are stationary, restrained by piles or permanent moorings and generally in enclosed waters.

Floating structures should be designed to maintain a safe freeboard under the most adverse combination of live load and environmental loads including consideration of dynamic effects. The design of floating structures for full live load as well as full environmental loads (storm conditions) is not usually necessary. However live load under serviceability environmental conditions (e.g., once in one-year storm or wave) should be considered in analysis for stability and freeboard.

When assessing stability of floating structures under live load, the load cases of full load intensity on the whole deck as well as the case of the full load intensity on part of the deck (e.g., one side of the structure centre-line) should be investigated.

The minimum freeboard, ignoring other operation constraints, under the most adverse design loading is 5% of the moulded depth (minimum 50 mm), measured from the top of the flotation unit for rectilinear flotation systems. For horizontal cylindrical flotation systems, freeboard should be at least 25% of the diameter of the cylindrical float, measured from the top of the flotation system.

Floating structures should be designed to have watertight sealed compartments to prevent sinking or overturning in the event of a leak in the outer skin. The structure should be capable of maintaining adequate freeboard (under dead load only) in the event of the external skin of any compartment being punctured and filling with water up to the external water level.

For large flotation structures (e.g., ferry landings) consideration should be given to allowing access from hatches in the deck.

4.4 BREAKWATERS

The function of a breakwater is to reduce wave action either by attenuating the wave as it is transmitted or by reflecting part of the wave energy. Design considerations for breakwaters are that the structure should attenuate wave action without creating adverse conditions and be fit for purpose over their design life.

NOTE: This Standard does not cover the design of rubble mound and floating breakwaters (see Clause 1.1).

4.5 EFFECTS OF SCOUR AND SILTATION

Maritime structures and their component members should be designed to remain stable and of sufficient strength and not be overloaded in the event of temporary or permanent changes in the level of the seabed due to scour or silting.

Wharves and jetties in river estuaries should be analysed with appropriate allowance for velocity-induced scour, which may be exacerbated at the peak of a flood event.

Structures in coastal areas subject to littoral drift should be analysed with allowances for erosion of the seabed in down-drift areas, and build-up of sediment in up-drift areas.

Wharves used by vessels should be designed to allow for this additional scour effect to the materials beneath the wharf from propeller wash or bow or stern thrusters.

4.6 SEA LEVEL RISE (global warming)

Maritime facilities should be designed to cater for increase in water level due to promulgated sea level rises caused by global warming.

The amount of sea level rise to be considered depends on the design life of the structure.

The allowance for sea level rise does not necessarily include the construction of the deck of the facility at a higher level, although in some cases this may be prudent. Allowance for sea level rise may include options to raise the heights of restraining piles on floating structures at a later time, or installing substructure of adequate strength to permit future topping slabs etc.

The allowance for future sea level rise is provided in Table 4.1.

TABLE 4.1
ALLOWANCE FOR SEA LEVEL RISE

Design life	Sea level rise m
25 years	0.1
50 years	0.2
100 years	0.4

NOTE: Based on the mid-scenario from the International Panel on Climate Control (2001). These values are updated by IPCC from time to time.