

SCOPE

- I 1.1 This practice covers the design of steel and reinforced concrete marine piers and related marine facilities.
- I 1.2 **An asterisk (*)** indicates that additional information is required. If a job is contracted, this additional information is furnished in the Job Specification.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I ↕ 2.1 **Table 1** lists the International Practice, Standard and Specification which shall be used with this practice.

TABLE 1

PRACTICE	
IP 4-1-3	Design Loads for Structures
STANDARD AND SPECIFICATION	
ACI Standard 318 Building Code Requirements for Reinforced Concrete	AISC Specification Specification for Structural Steel Buildings - Allowable Stress Design or Load and Resistance Factor Design

DEFINITIONS

- I 3.1 **Dead load** (in addition to that defined by ACI and AISC) includes:
 - a. The total weight (mass) of the structure and all materials permanently fastened thereto or supported thereby, including fireproofing, piping, insulation, empty equipment and attached piping.
 - b. Hydrostatic forces caused by liquids permanently contained within the structure to give stability (permanent ballast) and by the water surrounding the structure.
- I 3.2 **Fluid loads** are the gravity loads of liquid or solid materials in equipment and piping, during operation or hydrotest.

DESIGN

- S,O 4.1 **Load conditions for marine piers and related marine facilities** which are designed to accommodate only **one ship at a time** are given in **Table 2**.
- S,O 4.2 Load conditions for marine piers and related marine facilities which are designed to accommodate more than one ship at a time shall reflect which loads act simultaneously and to what degree they will act together, including **Table 2** Loading Conditions as a minimum. Piers with multiple berths shall be designed to comply with the following:
 - a. A combination of berthing impact at one berth with mooring line and breasting loads on the other berth(s) based on expected operating loads for concurrent berthing operations.
 - * b. A combination of mooring line and breasting loads for multiple vessels simultaneously. Wind shielding from vessels (if any) must be approved by Owner's Engineer.
- I 4.3 **Structures shall be designed for the loads and load conditions** given in **Table 2** and shall be per **ACI 318** and **AISC Specification** (for allowable stress design) as appropriate taking into account the following:
 - a. Loads and forces resulting from the most critical combination of wind, waves, current, and ice acting directly on the structure and attached equipment shall be treated as wind loads.
 - b. All other loads except earthquake loads shall be treated as live loads.
 - c. Unless otherwise specified, basic loads shall be per **IP 4-1-3**.
- S,O *4.4 **Design loads and forces** shall take into account the **effect of the specified range of tides**, including changes in buoyancy and current forces.
- I *4.5 **Calculation procedures for piles subjected to lateral loads** shall be submitted to the Owner's Engineer for approval.

IP 4-4-1	Marine Piers and Mooring Facilities	
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- S 4.6 **Minimum live loads** to be used for **design of decks, beams, and piles** shall consist of the fluid loads in equipment and piping and the following:
- a. Uniform load of 100 psf (488 kg/m²) on all open pier deck areas, dolphin decks, and roadways.
 - * b. When specified, loads from vehicular traffic or storage areas, or both, shall be considered to act simultaneously with a uniform load of 100 psf on all remaining open areas.
 - c. Uniform load of 50 psf (244 kg/m²) on areas beneath major piping.
 - d. Applicable live loads from operating platforms, walkways, access gangways, stairways, and ladders.
 - e. Unbalanced forces from vibrating equipment.
 - f. Snow and ice gravity loads according to local conditions.
- Where more critical, e.g., in designing anchor bolts or checking stability against wind or ship impact, live loads shall not be included.
- S,O * 4.7 **Environmental loads** shall be considered for two situations: a maximum operating environment, and an extreme environment. The operating environment shall be the worst combination of wind, waves, current, and ice that will occur with the vessel moored at the berth. The extreme environment shall be the worst combination of wind, waves, current, and ice that will act at the terminal. Extreme wind and wave conditions shall, at least, be based on a 50 year recurrence interval storm.
- S,O * 4.8 **Berthing impact loads** shall be based on the specified vessel impact energies, and the stiffness of the structure/fender system. Horizontal berthing loads parallel to the breasting face, caused by friction between the vessel hull and fender face, shall be assumed to act simultaneously with normal berthing loads.
- Design impact energies shall be absorbed within 67% of the ultimate capacity of the energy absorption system, defined as the yield stress for flexible pile dolphins and the "bottom-out" energy capacity for buffers.
- Support structures shall be designed to resist berthing impact loads resulting from the design impact energies, treating the berthing loads as live loads. In addition, such structures shall have an ultimate capacity capable of resisting the berthing impact loads resulting from impact energies 50% greater than the design impact energies. This ultimate capacity will be in the elastic range without permanent deformation or set.
- S,O ♦ * 4.9 **Breasting loads**, caused by operating environment wind, waves, and current forcing a vessel against the berth, shall be considered for the following conditions:
- a. The maximum broadside wind, wave, and current loads.
 - b. The maximum quartering wind, wave, and current loads.
- In addition, the fender system shall be designed to resist the vertical friction loads from vessel motion due to tides and vessel draft changes.
- R ♦ 4.10 **Breasting supports** shall be positioned as follows:
- a. Center-to-center spacing between outer breasting supports shall be at least 25% LOA of the largest vessel, and
 - b. Distance between outer breasting support and bow and stern of vessel shall not exceed 50 % of the LOA.
- S,O * 4.11 **Mooring Line loads** shall be based on the worst case of operating environment wind, waves, and current. Additionally, surge forces from passing ships, tide and vessel draft changes, and the use of mooring lines to maneuver vessels during berthings shall be considered. Mooring points and supporting structures shall be designed to satisfy the following requirements:
- a. A working load equal to the breaking strength of the strongest single mooring line which shall be connected to the mooring point.
 - b. A working load equal to the maximum combined load developed in all mooring lines run to the mooring point due to the worst case of operating environment wind, waves, and current acting on the moored vessel, considering the vessel's draft condition and mooring equipment.
 - c. An ultimate load equal to the breaking strength of one line plus 50 percent of the breaking strength of all other lines to be run to the mooring point.
 - d. All bollards hooks, and individual mooring fittings shall have working and ultimate loads as specified in 4.9 a, b, and c with mooring fitting substituted for mooring point.