CHAPTER 7

LIVE-LOAD REQUIREMENTS

7-1. Vertical loads.

a. Uniform loads. Uniform live loads of 600 and 1,000 pounds per square foot respectively should be used for the design of general berthing piers and container wharves.

b. Truck loads. American Association of State Highway and Transportation Officials (AASHTO) HS20-44 loadings will be used for all piers. (see app A.)

c. Loads on railroad tracks. American Railway Engineering Association (AREA) E-72 loadings will be used when the railroad is constructed on the pier. (see app A.)

d. Crane loads. Concentrated wheel loads due to crane reactions can be obtained from its manufacture. To compensate for infrequency of loading and other factors, only 75 percent of the wheel load values may be used in designing deck components (slabs and beams). When designing substructure components (piles and pile caps), 100 percent of wheel load values will be used. An impact factor of 20 percent should be added to the wheel load concentrations in the normal design of deck and stringers and 10 percent where two or more cranes act together; and 10 percent, in the design of pile caps and secondary framing members.

e. Impact. Impact factors should apply only to concentrated liveload conditions. Apply impact loadings to decks, stringers, girders, and pile caps; but not to piling or similar members supporting pile caps or girders.

7-2. Lateral loads.

a. Docking impact. The impact energy may be calculated according to the following equation:

$$E = K \frac{WV^2}{2g} \qquad (7\text{-}1)$$

where

- E= impact energy to be absorbed by the dock, foot-pounds
- K= coefficient of restitutions
  - = .3 for light pile supported structures
  - = 0.5 for large, heavy pile supported structures
  - = 1.0 for solid fill structures
- W= loaded displacement of vessel, pounds
- V= component of velocity approaching vessel normal to the face of mooring, feet per second
- g= 32.2 feet per second per second

The velocity and angle of approach used for design should be as follows:

(1) *Velocity of approach*. For destroyers and small craft, use 1.7 feet per second for normal berthing conditions. For a vessel with 50,000-ton loaded displacement or over, use 0.5 foot per second for normal berthing conditions, and for other vessels, allow 0.8 foot per second.

(2) *Angle of approach with respect to face of berth*. For destroyers and smaller craft, the angle of approach should be 20 degrees, and for larger vessels, 10 degrees.

b. Forces from moored ships. Forces due to winds and currents on moored ships may be estimated in accordance with the following: (1) Forces due to winds. The maximum wind force shall be calculated as follows:

$$W = A \times C \times P \qquad (7\text{-}2)$$

where

- W= wind force, pounds
- A= exposed area of the broad side of the ship in a light condition, square feet
- C= shape factor
  - = 1.3
- P= wind pressure, pounds per square foot
  - = 0.00 256 vs
- v= wind velocity, mile per hour

When ships are berthed on both sides of a pier, the total wind force acting on the pier, as a result of wind on the ships, should be increased by 50 percent to allow for wind against the second ship.

(2) *Forces due to current*. For salt water, the current pressure in pounds per square foot equals 15 V', where V is the velocity of the current in feet per second. This pressure will be applied to the area of the ship below the waterline when fully loaded. Since the ship is generally berthed parallel to the current, this force is seldom a controlling factor.

c. Winds on piers and pier sheds. The wind pressure on piers and pier sheds should be calculated for the maximum wind velocity in the area, and the proper shape factor applied for the type of structure on the pier.

d. Earth pressure. Earth pressure shall be considered in the design.

e. Tidal lag. Allow for pressures resulting from differences between tide levels. Unbalanced waterheads

due to tidal lags are usually assumed to be one-half of the mean-tide ranges.

f. Earthquake forces. Earthquake forces should be considered if in an area of seismographic disturbance.

g. Ice. The structure will be designed to resist all static and impact forces from ice. In some locations, ice may accumulate on the structure. Allowance should be made for the effect of this accumulation upon the stability of and upon the stresses in the structure.

7-3. Longitudinal loads.

a. In truck loading, provide for longitudinal forces due to traction and breaking equal to 5 percent of the total truck live loading in any one truck lane.

b. For railroad and crane loading, provide for longitudinal forces equal to the larger of the following: (1) Due to braking-15 percent of live loading on any track without impact.

(2) Due to traction-25 percent weight on the driving wheels on any one track, without impact.

7-4. Loading combinations.

Piers and wharves should be designed for a combination of dead plus full live loading at normal allowable stresses; or a combination of dead plus full live loading, plus lateral loading on moored ships, plus wind loading on pier and pier shed at one-third increase in normal allowable stresses.