CHAPTER 9
WHARF HARDWARE, FENDERS, AND DOLPHINS

TYPES AND USES OF WHARF HARDWARE

Ships tie up to wharves with lines fastened to mooring fittings such as bollards, corner mooring posts, and cleats.

a. Bollards. Whether single- or double-bitt, bollards are steel or cast-iron posts (Figure 9-1) to which large ships tie up. To prevent ships' lines from riding up off the post, bollards may have waists smaller than their tops, or they may have caps or projecting, rounded horns. Double bitt bollards are also known as double steamship bitts or simply as double bitts. Bollard bodies may be hollow for falling with concrete after installation. Bollards were once designed to take line pull loads of about 35 tons. Modern container ports usually have bollards with 100-ton line pull capacities.

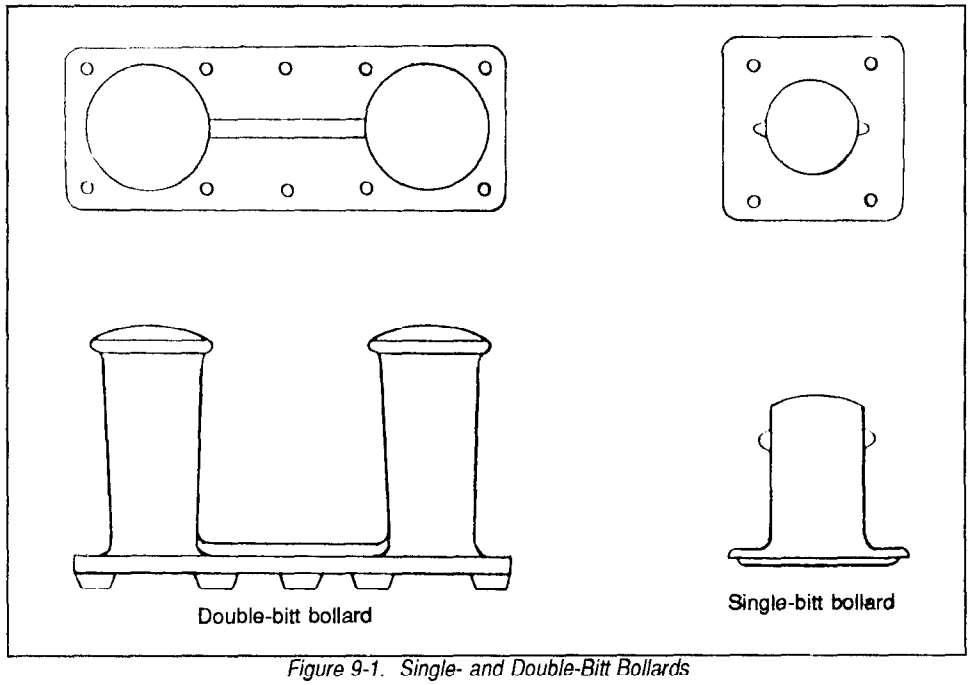

Figure 9-1. Single- and Double-Bitt Bollards

b. Corner mooring posts (Figure 9-2). Corner mooring posts are larger than bollards. They are fastened at the outshore corners of a pier, wharf, or quay. These posts are used to bring the ship into the pier or around a turning dolphin, as well as to secure lines. Once designed to take line pull loads of 50 tons, they are now designed for loads of up to 100 tons.

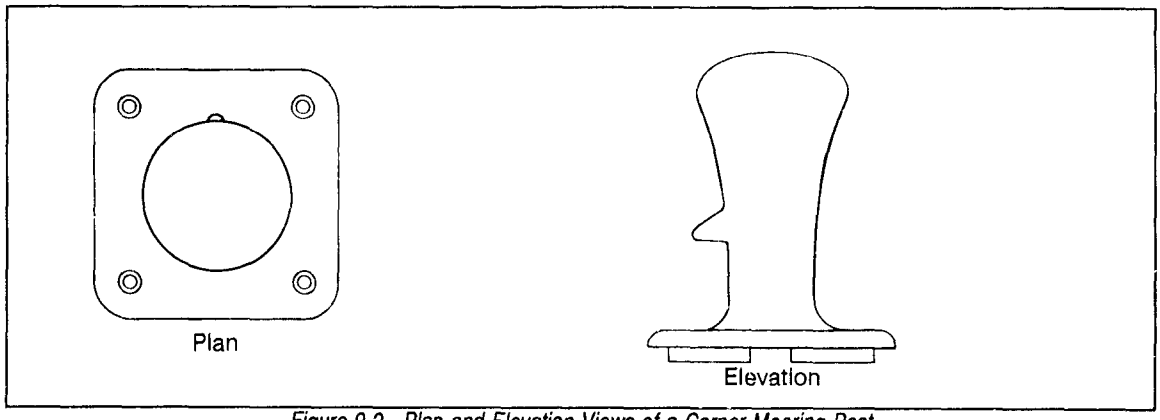

Figure 9-2. Plan and Elevation Views of a Corner Mooring Post

c. Cleats (Figure 9-3). Cleats are cast iron with arms extending from a low body. The base may be open or closed. They secure small ships, tugs, and work boats.

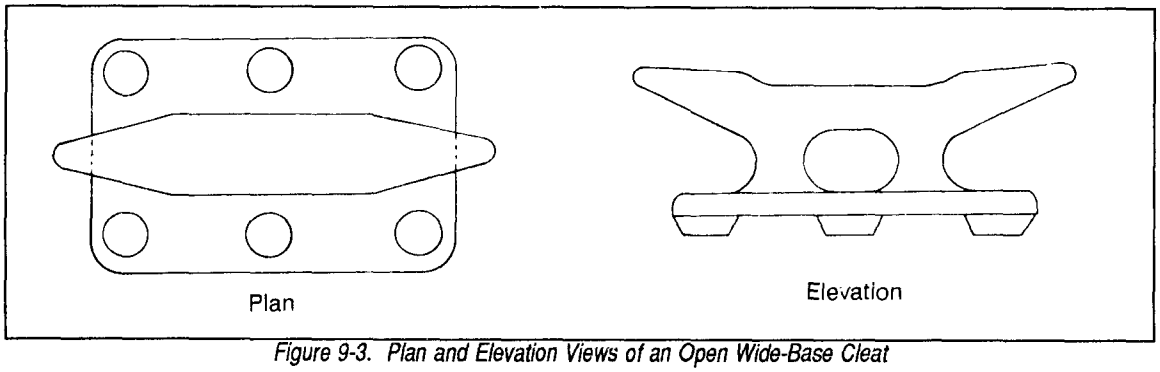

Figure 9-3. Plan and Elevation Views of an Open Wide-Base Cleat

d. Chocks (Figure 9-4). Chocks are usually timber braces. However, open or closed chocks are made of cast iron. They direct lines and snub lines when working a ship into or out of a berth. A closed chock may be used for a change in the vertical, as well as the horizontal, direction of the line.

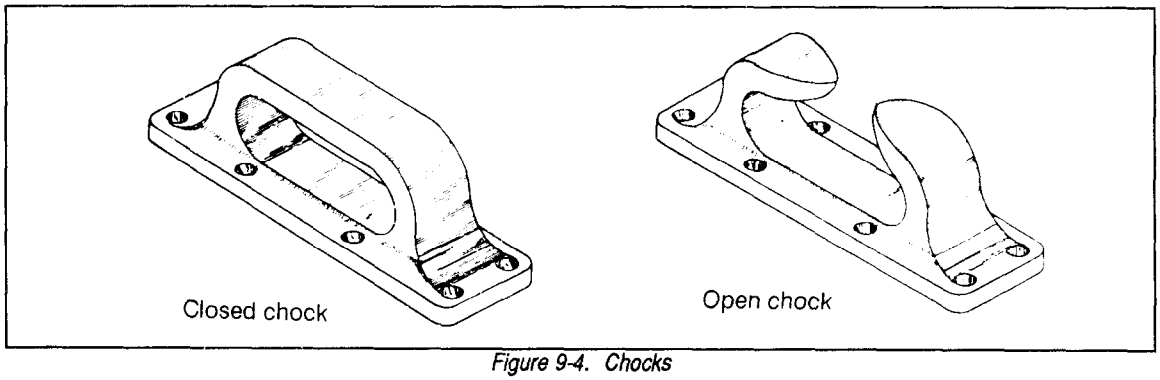

Figure 9-4. Chocks

e. Pad eyes (Figure 9-5). Pad eyes are metal rings mounted vertically on a plate to receive a ship's line. Spliced with thimble and shackle, they are used only for small craft.

f. Power capstan (Figure 9-6). Power capstans are vertical drums operating on spindles. They are used to pull long, large wire-rope lines, especially when the lines are attached to dolphins. Capstans operate electrically or by air.

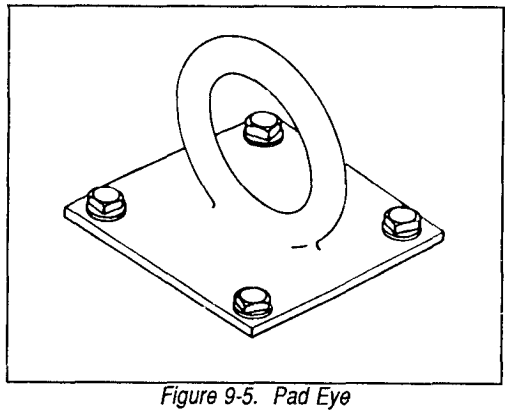

Figure 9-5. Pad Eye

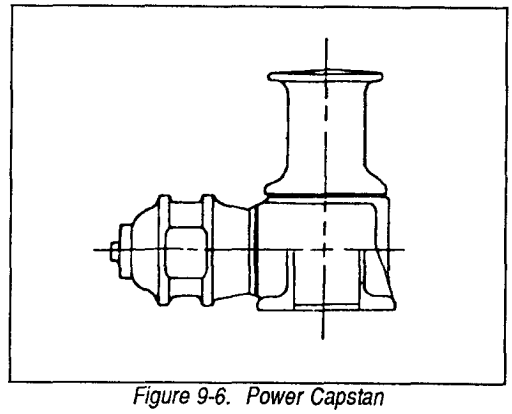

Figure 9-6. Power Capstan

Releasing hooks (Figure 9-7). Releasing hooks on the ends of mooring lines are attached to buoys, or to dolphins reachable only by service boats. Releasing hooks allow the lines to be detached from the anchors by tripping the hooks with small rope lines running from the releasing hook to the ship.

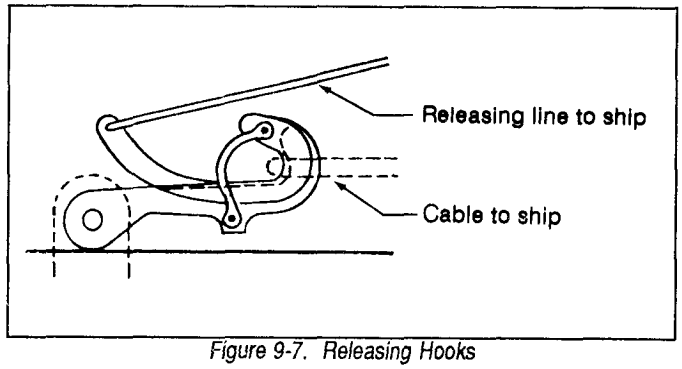

Figure 9-7. Releasing Hooks

INSTALLATION OF WHARF HARDWARE

a. Currently approved AFCS wharf or pier designs apply mostly to timber wharf or pier construction.

b. Concrete decks. Wharf or pier hardware for commercial concrete decks is positioned from 30 to 80 feet apart, depending on the type of hardware and ships to be accommodated. Fittings are fastened to the deck curb with galvanized bolts that pass through pipe sleeves set in the concrete. This technique allows removal of the bolts and accessories if necessary.

c. Steel decks. The decks of DeLong and Marathon-LeTourneau (M-L) self-elevating, spud-type barge piers are provided with mooring hardware, usually single- or double-bitt bollards. Bollards for spud-type barge pier decks are now designed for a 100-ton line pull and weigh 4.3 tons per assembly. Twelve such bollards, six per side, are usually specified for each of the large 300-foot units. The small 150-foot units carry from four to six bollards. Designs for these mooring units are available only upon request from the two manufacturing corporations: DeLong and Marathon-LeTourneau.

FENDER PILES AND CHOCKS

a. Use of timber. Timber is suitable for use as permanent or semipermanent wharf fenders in the TO. Fenders serve the following purposes:

(1) They cushion a wharf from the impact of ships and protect the outer row of bearing piles.

(2) They protect the hulls of ships from abrasion.

(3) The 3- or 4-foot extension of a fender pile above the deck of a wharf supplements wharf mooring hardware. They are not, however, used for warping a ship into or out of the berth.

b. Ease of replacement. Since fender piles are not part of the structural support of the wharf, they are easier to replace than bearing piles.

c. Common methods of protecting fender piles.

(1) A heavy replaceable timber wearing-ribbon is installed along a line of fender piles at the elevation which receives the heaviest abrasion.

(2) Floating logs or camels.

(3) Rope wrappings, particularly on corner fenders.

(4) Wales behind piling to absorb part of berthing forces during mooring (Figure 9-8).

(5) Wales in front of and behind the piling. Rear wales are connected to the wharf deck with short sections of cylindrical rubber fender. The placement of short sections makes a timber pile fender system more flexible. It can accommodate the larger berthing forces of container ships and is the most widely used type.

d. Fender piles for quays. Completely rigid structures include solid-fill quays. Sometimes these quays have their fender piles backed up with heavy springs to combine yielding and resistance.

e. Installation. Fender piles are driven at a slight batter, usually about 1:24. They stand beside each outside structural pile except on the extreme inshore wharf sections. In timber fendering with bolted sections of wales and chocks, the bolt holes should be drilled the same diameter as the bolt. All holes on the face of the fender should be countersunk. All fender hardware should be galvanized. Every third fender pile may extend 3 to 4 feet above the curb. The others are cut off flush with the top of the curb.

f. Chocks and wales.

(1) Chocks are timber braces placed between fender piles to hold the piles in position. The ends of the chocks should be firm against the piles.

(2) Wales may be used near the mean low water line where tidal currents are swift or tidal variations are great. Timber chocks are usually placed between fender piles and are bolted to the wales. They add rigidity to the line of fender piles. They serve as a continuous line backing at the top of some fender systems.

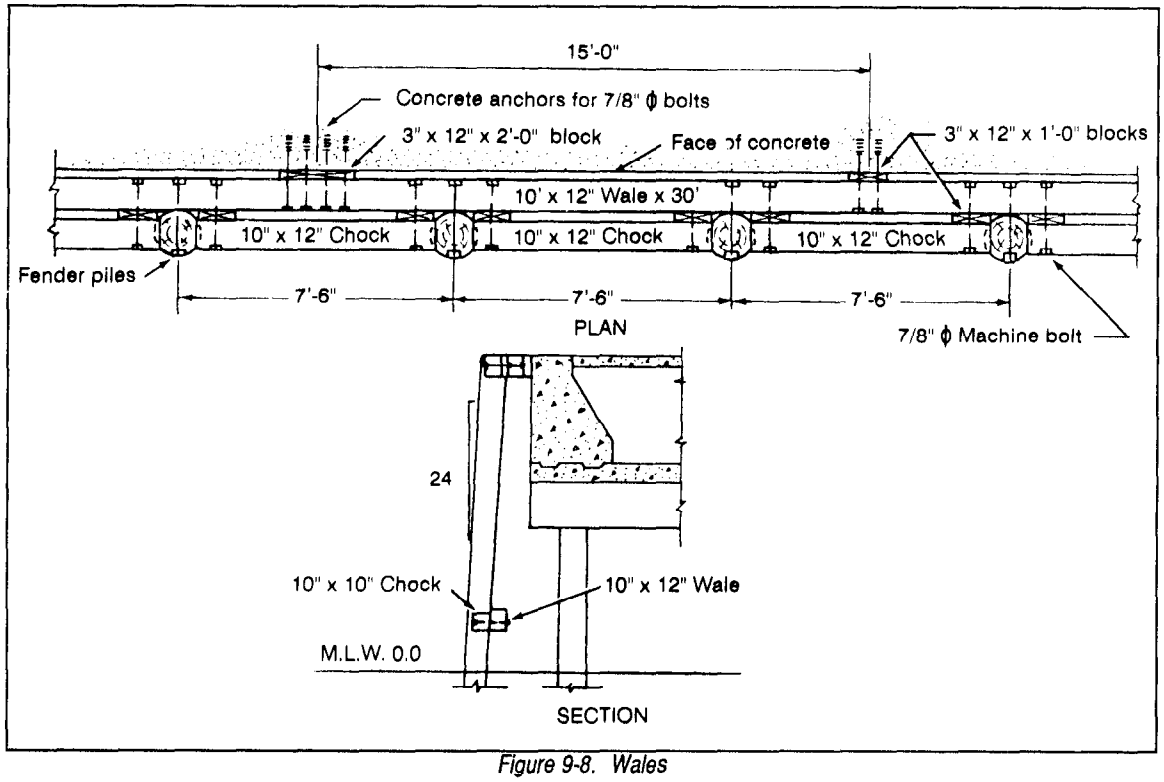

Figure 9-8. Wales

PILE CLUSTERS AND CORNER FENDERS

Pile clusters stand at the faces or corners of wharves or act as isolated dolphins. They must combine beam strength and rigidity with stability against the horizontal stresses of the piles. Therefore, individual piles making up the clusters must be joined so the cluster acts as a unit.

a. Corner fenders. Corner fenders are piles driven in clusters at the exposed corners. Bolted and lashed together, corner fenders allow ships to pivot in the corner while warping in and out of a berth. The corners of a timber wharf structure are strongly reinforced with layers of digital planking, laid one across the other. Diagonal batter piles reinforce this backing. The standard corner-fender cluster is made up of 10 piles battered to allow adequate spacing at the points. Timber connectors may be used with the bolts to tie the piles more firmly into a single rigid member. To avoid abraiding the hulls of ships and outside pile surfaces, heavy rope mats may be lashed to the clusters at the level of contact. Corner piles extend three to four feet above deck level to supplement mooring hardware.

b. Mooring piles.

* Mooring piles are clusters of three or more piles used to supplement or replace wharf mooring hardware. The top of the cluster is lashed.

* They are placed at intervals along the face of a wharf without bollards or other items of mooring hardware. A maximum of 3 piles of each cluster may extend 3 feet or more above the wharf deck (Figure 9-9).

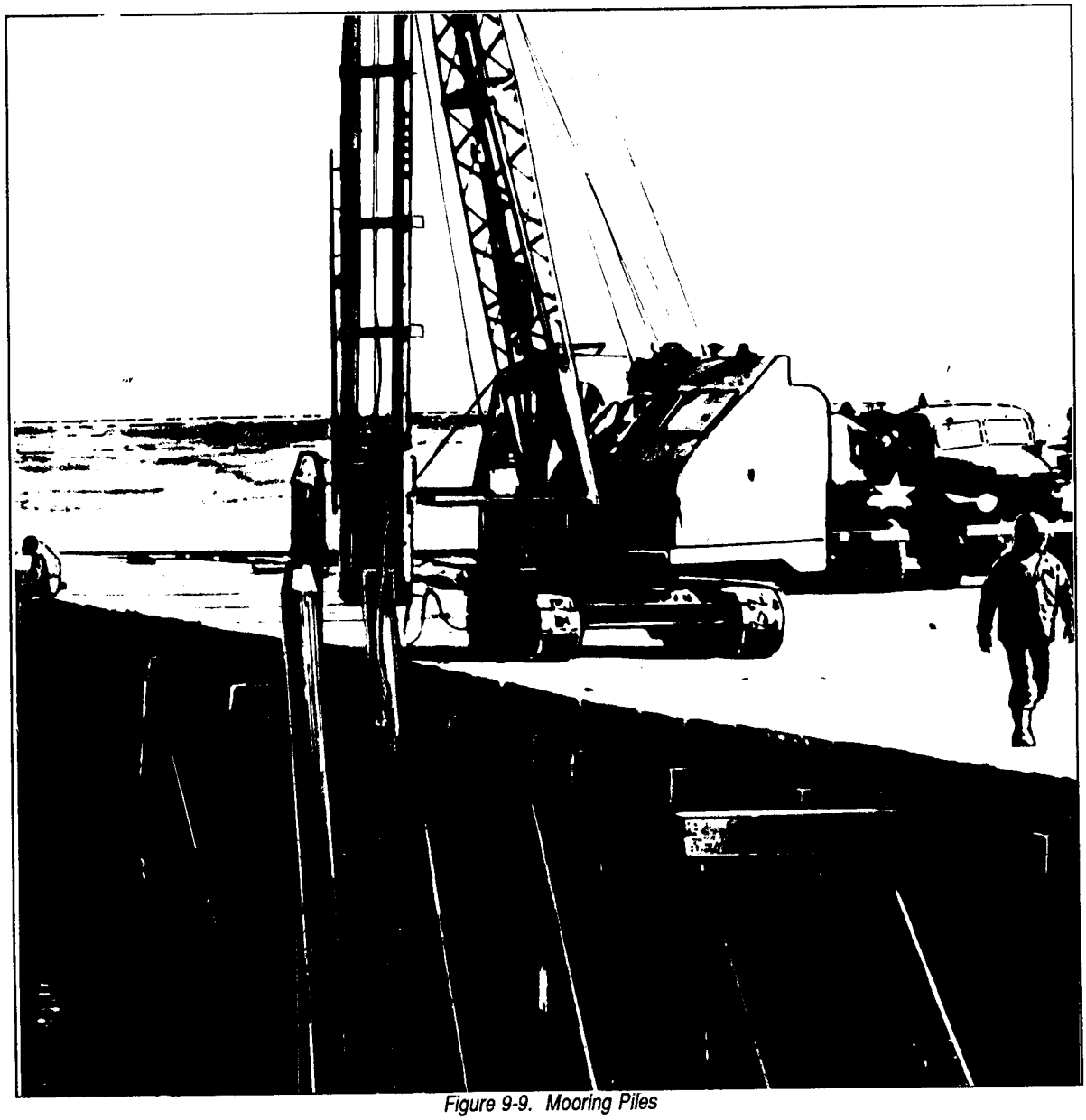

Figure 9-9. Mooring Piles

FLOATING LOG FENDERS (CAMELS)

a. Floating logs absorb part of the impact when a ship is berthed. They protect the surface of fender piles while the ship is tied up. The simplest type of fender is a single line of floating logs. Each log is secured by two or more lengths of 1/2-inch galvanized chain fastened to 3/4-inch eyebolts in the fender log and wharf pile. Some arrangements, such as loose steel collars around the wharf piles, permit the floating logs to rise and fall with the tide.

b. Floating clusters of logs or strongly constructed rafts are called camels. They absorb impact shock and protect fender piles from the sliding friction of a ship moving in the berth. Camels may breast a ship off the face of the wharf into water deeper than that at the face.

PILE MOORING DOLPHINS

a. General. Dolphins are independent marine structures for mooring ships. They consist of a group of timber piles bound at the top with cable or wire. The term dolphin also refers to any other structure that serves the same purpose. Successful designs include sheet pile cells, single large-diameter steel piles like those employed with the DeLong Barge, and clusters of small-diameter steel pipe.

b. Construction of timber pile cluster dolphins.

(1) Basic considerations. Normally driven small end downward, there are times when timber piles should be driven butt down. Factors influencing this decision are: length of pile, depth of water, and type of soil. Short piles driven into shallow water with a hard bottom may be driven with the butt end down. This allows a larger portion of the pile to absorb the bending moment stress. Another consideration is the displacement of soil when 19- and 30-pile dolphins are installed. Impervious, cohesive soils allow excess pore water pressures to rise very high. Pore water pressure affects the shear strength of the soil and may reduce the load capacity of a dolphin until the pressure has dissipated. Some soils take three months or longer to dissipate excess pore pressure.

(2) Construction techniques.

(a) The center of the cluster, called a king pile (Figure 9-10, page 9-8), may be a single pile or a cluster driven vertically and wrapped to act as a unit. The other piles are driven in one or more concentric rings around the king pile, each battered towards the center. The king pile is longer than the others for use as a mooring post.

(b) When the king pile is made of a cluster, it is wrapped with at least six turns of 1-inch galvanized wire rope stapled to each pile at each turn.

(c) Two wrappings of l-inch galvanized wire rope are used for the pile cluster. One wrapping is located near the top of the cluster and another about two-thirds the distance above mean low water.

(d) The piles are chocked and bolted together 2 feet above mean low water to further ensure the cluster will act as a unit.

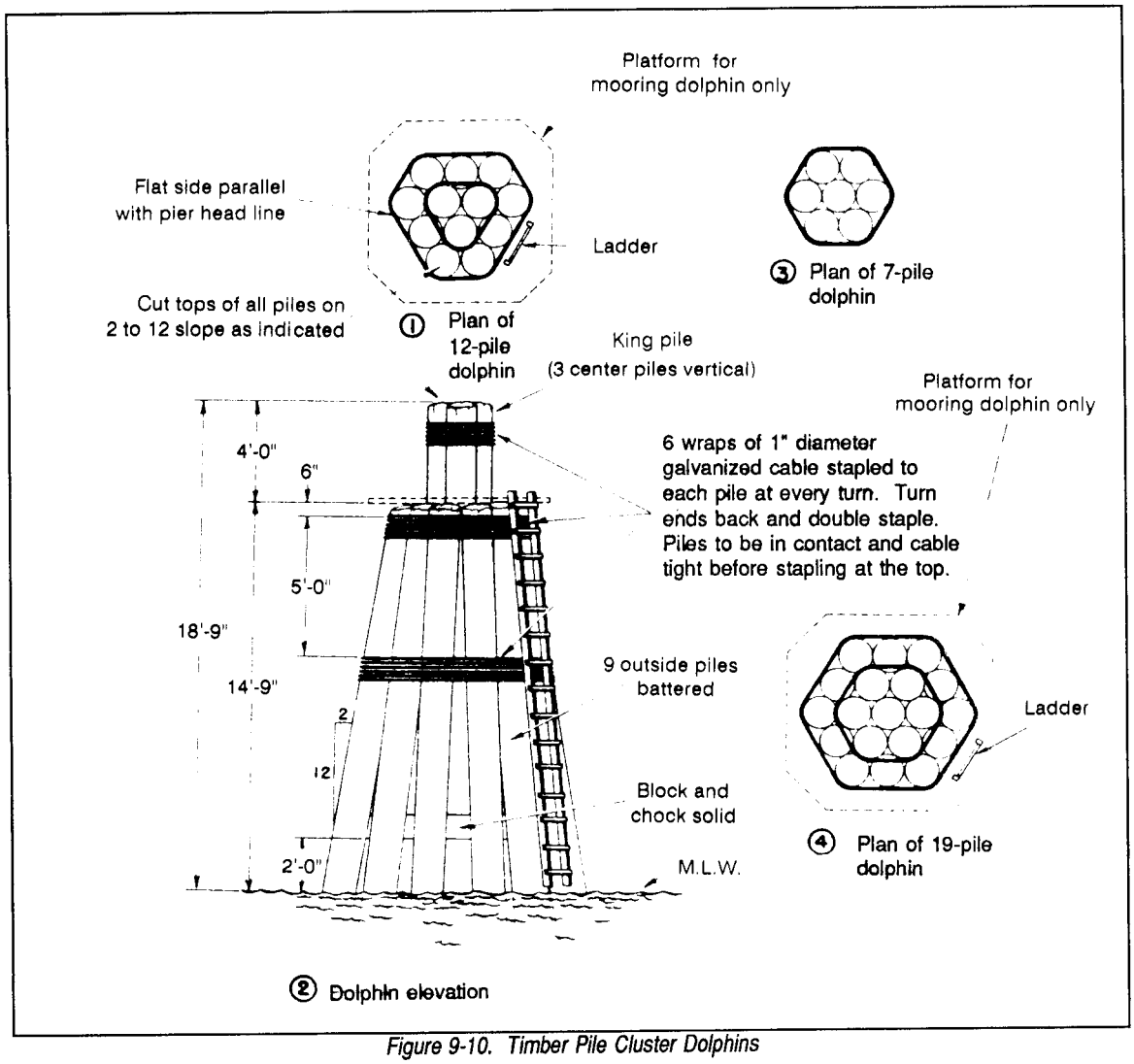

Figure 9-10. Timber Pile Cluster Dolphins

c. Uses.

(1) Dolphins sometimes extend the effective face of a wharf or jetty for mooring. A large cargo ship or tanker can discharge from a small wharf or jetty equipped with dolphins. However, the distance between extreme mooring dolphins must be at least as great as the length of the vessels.

(2) Dolphins may provide offshore moorings for ships worked by lighters. In such cases, they are installed well out of the harbor fairway.

(3) Turning dolphins warp or turn a ship around at the end of a pier.

(4) Dolphins serve as guide walls at ferry slips and at lock entrances.

(5) Dolphins can be used to keep vessels off structures not designed to accommodate their loads.

(6) Dolphins protect bridge piers from waterborne vessels, flood damage, and ice.