SECTION D
GUIDE PILES

D1. General.

Marina guide piles must be provided at appropriate locations and in sufficient numbers to reliably retain a floating dock system in place under all design loadings, conditions and circumstances. It is important to determine in advance exactly what these factors are for a given site. Unusual and unanticipated events may occur that are beyond the design parameters. In such cases, failures may occur. However, to "over" design and build a marina beyond what is prudently called for at a given site may not be financially and economically feasible.

D1.1 Consideration must be given to pile loadings from forces applied to the floating berths, guide piles and the boats occupying the berths. These forces include wind, waves, currents, seiche, flood flows, impacts from boats underway, debris, partially sunk boats, and seismic events. Some of these forces may occur concurrently.

D1.2 Particular care must be given to seismic design in active earthquake regions. The type, weight and length of piles are very important in addressing seismic movements in a marina, as well as the soil characteristics of the bottom of a marina basin into which the piles are driven.

D2. Design Criteria.

D2.1 Marina guide piles should be placed at the ends of all fingerfloats adjacent to channels. The piles will help guard against accidental impact damage to docks and berthed boats from vessel traffic in the channels. Such impact incidents can be caused by severe wind conditions, currents, traffic problems and/or boat operator error.

Fingerfloat Piles Adjacent to Channel

D2.2 Mooring piles are sometimes provided in double berths over 36 feet long. Used to secure additional boat lines, they help to keep a moored boat away from the edge of the docks, thus reducing wear on both the boat and docks. They also provide protection to a boat berthed in one side of a double berth from another boat entering or exiting the other side.

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D2.2.1 Where funding is limited, double berths are sometimes provided with the intention of converting them into single berths at a future date when funds become available. As an interim measure, a mooring pile is sometimes provided in the center of a double berth, in lieu of a fingerfloat. This all depends on the relative costs of providing a fingerfloat versus a pile. Under such a plan, the required width of two single berths plus the width of the future fingerfloat must be provided for in the marina layout plan. Short-sighted planning may not include the width of the mooring pile or a future fingerfloat, meaning the two future single berths will be too narrow for their length. If a mooring pile is provided, and a future fingerfloat is installed, the mooring pile will either have to be removed, or utilized to secure the end of the future fingerfloat, depending on the fingerfloat length.

Mooring Pile in Double Berth

D2.3 Cut-off elevations for guide piles should be not less than 4 ft above the deck of a floating dock at design high water, not including the height of pile caps. This means that the top of a guide pile will be not less than 4 ft + the dock freeboard above the water line at design high water. Such cut-off elevations should be determined using maximum freeboard under DL only, and will typically be around 6.5 ft above design high water.

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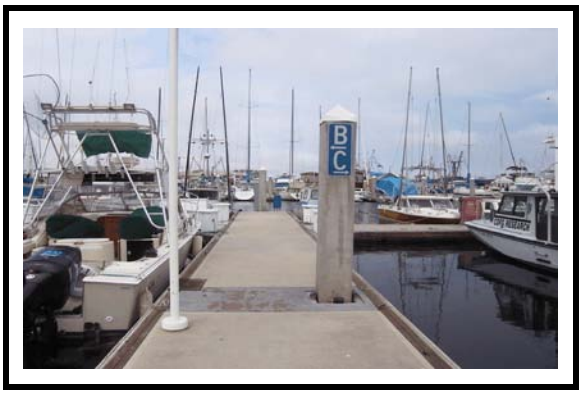
D2.4 Guide pile caps should be provided, typically made of fiberglass, polyethylene or other ultraviolet resistant plastic materials. Pile caps discourage the roosting of birds, can be color coded to identify particular fairways or channels, and are useful for mounting various marina operation devices such as signs, markers, antennas, video cameras, etc.



Pile Cap and Marker Signs

D3. Material Pile Types.

Marina guide and mooring piles are typically concrete, steel, composites or wood. Such piles are utilized primarily to resist lateral loads from docks and moored boats, and are available in square, round and/or octagonal cross sections, depending on the material and manufacturing process. Bearing piles for supporting buildings, fishing piers, etc. are not addressed in these guidelines.

D3.1 Concrete Piles. Prestressed concrete piles are probably the most common marina guide piles used in marinas. They are available in square, round and octagonal cross sections, in lengths up to 120 feet. The practical use of the longer concrete piles is typically limited by transportation of the piles to a project site, safe handling of the piles, and the size of the pile driving equipment available.

Square Concrete Guide Pile in River Marina

D3.1.1 Precast concrete piles are available in lengths up to 50 feet. They are steel reinforced but are not as strong and durable as prestressed concrete piles. Non-prestressed precast concrete piles are not recommended for use as marina guide piles. C

D3.1.2 Square concrete piles are usually less expensive, and work well with square pile yokes and roller systems. However, square piles tend to rotate during driving, often resulting in an unattractive appearance and problems with the pile yokes and rollers. Piles that have rotated even a few degrees during driving can cause expensive delays and modifications during construction, and long term maintenance problems. If square piles are used, great care must be taken to insure that the final orientation of the piles is square with the docks. C

D3.1.3 Round concrete piles are considered more attractive than square piles, and are the easiest to drive with regard to rotation and appearance. However, round concrete piles are not often used because (1) they are more expensive than square concrete piles, (2) their production is presently limited to a rather small number of casting yards, and (3) transportation costs prohibit long distance deliveries.

D3.1.3.1 Where pile rollers are used with round piles, the rollers tend to wear thin in the middle as they progressively conform to the round shape of the pile. However, this arrangement can give long reliable service unless excessive lateral movement occurs between the pile and roller, a dynamic action that can quickly ruin the rollers.

Round Concrete Piles on a Barge

D3.1.3.2 Spun concrete piles are currently made in Australia and will probably soon show up in United States markets. Spun inside a long

spinning pipe mold, the piles have a hollow core, high strength, are very flexible, and weigh less than conventional concrete piles of the same diameter. The length of such piles is limited by the same factors as conventional piling: ease of handling, transportation, ease of access to the site, and availability of pile driving equipment.

Flex Testing Spun Concrete Pile

D3.1.4 Octagonal concrete piles offer a good compromise between square and round concrete piles. They appear to be round from short distances, keeping a good appearance even if they rotate during driving. The flat faces provide good bearing for pile rollers and help extend the service life of the rollers. If pile rotation occurs during driving, the pile yokes and rollers must be justified to the pile as with square piles. The faces of octagonal piles act as chamfered surfaces with chip resistant vertical edges that are reasonably user friendly to hands and equipment of boaters and maintenance staff. Octagonal concrete piles typically are more expensive than square piles of the same nominal dimensions.

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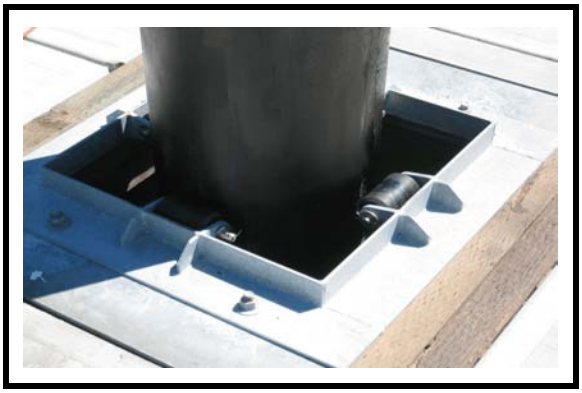
D3.2 Steel Piles. Steel piles are typically round in cross section, and are available in a variety of diameters, thicknesses, lengths and alloys. Structural steel tubing may sometimes be used as square piling in sizes up to 12 inches for special applications.

Steel Guide Piles in a River Marina

D3.3 Wood Piles. Wood piles have round cross sections by virtue of the natural shape of the trees from which they are made. Sizes range up to 100 feet in length with diameters from 10 to 36 inches. The larger sizes are very expensive, and shipping costs can be prohibitive. Wood piles in longer lengths will rarely be perfectly straight, so very specific tolerances must be specified in order for wood piles to work properly in pile yokes at various water levels. Also, the same roller problems will occur on round wood piles as with round concrete and steel piles.



Rollers on Round Steel Guide Pile

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D3.3.1 Pressure treatment is necessary to protect wood piles against rot, decay and various organisms in the water that eat and destroy untreated wood. This is particularly true in warm, clean, salt water environments in which marine organisms are vigorous and healthy. Wood piles must be pressure treated with a preservative approved for use in local waterways. Untreated wood piles should never be used for marina piles.

D3.3.2 Although the use of pressure treated wood piles in marinas has diminished over the years because of environmental water quality laws and regulations, there are still applications in which a wood pile is highly appropriate. Where larger boats use landings, fuel docks and sewage pumpout stations in waterways subject to surge, currents, floods, floating debris and other lateral loadings, flexible wood piles can be very beneficial in acting as shock absorbers, lessening possible damage to both the docks and the moored boats. However, if allowed to be over stressed, wood piles will crack or break. Under sever flood conditions in rivers, for example, a series of wood guide piles may snap consecutively if subjected to sudden and/or sustained lateral loads that they are not capable of withstanding. See Section C2.5 regarding environmental loadings.

D3.4 Plastic Piles. Plastic piles are manufactured of commercial grades of high density polyethylene plastic reinforced with steel rods, cables or pipes imbedded in their core for added strength and resistance against warping. Such piles are quiet compared to steel or concrete piles when boats, boat masts, rigging and/or other equipment bangs against them during windy weather and storms. They also are very smooth, enabling pile yokes to easily work against them with little friction.

D3.4.1 Plastic piles must be handled and driven with care to prevent cracking. They are flexible and must be protected from excessive bending when shipped, handled and driven. Cracks in plastic piles may not be evident at the time the cracks occur. Typically being black in color for ultraviolet protection and appearance, cracks may be hard to see until months after driving has been completed and the piles are in service. If cracked, the cracks will gradually widen from thermal expansion and contraction, and bending from applied loads. This will gradually allow water to enter the cracks and begin rusting the interior steel reinforcement, slowly breaking down the bond between the plastic and steel. This is particularly troublesome in salt water applications. Plastic piles have also been used for fender piles on large commercial ship piers.

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