

LAYOUT, DESIGN AND CONSTRUCTION  
HANDBOOK  
FOR  
SMALL CRAFT  
BOAT LAUNCHING FACILITIES



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State of California - The Resources Agency  
DEPARTMENT OF BOATING AND WATERWAYS



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FOR  
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Introduction

This handbook is provided to assist in the layout, design and construction of small craft boat launching facilities. It addresses average conditions typically found at project sites and is not intended to be all inclusive or absolute. Unique or unusual conditions and circumstances may exist which require analysis and design considerations not covered by this handbook. Therefore, special care and attention should always be applied when designing and building a project to insure the best possible design, appropriate selection of materials, and a finished project that is safe, functional, attractive and durable over the design life of the project.

The primary purpose of this handbook is to provide technical assistance in the design and development of boat launching facility projects funded under the Local Assistance Launching Facility Grant Program of the Department of Boating and Waterways, State of California. In the presentation of design and construction criteria, the following convention is used:

- ☛ criteria printed in "standard type" are recommended general criteria;
- ☛ criteria printed in "*italics*" are mandatory minimum safety criteria.

It is recognized that in certain isolated instances, the application of mandatory minimum safety criteria may not be possible, feasible or desirable, but a better alternative exists that will not jeopardize the safety of persons using the boat launching facility, and the alternative is judged to be equal to or better than the mandatory criteria. Deviations from the mandatory minimum safety criteria will be considered on a case-by-case basis jointly by the project owner (usually the agency receiving the grant) and the Department of Boating and Waterways. The project owner will bear the responsibility to clearly document the rationale for the deviation.

It is not intended that deviations from either the recommended general criteria or the mandatory minimum safety criteria be used to justify wholesale departures from the advice, direction, experience and criteria presented in this handbook. To varying degrees, this handbook represents the collective wisdom and experience of boaters, harbor masters, concrete technicians, material suppliers, designers, engineers, consultants, government officials, and various other persons representing both public and private interests compiled over a period of approximately thirty years. The intent is that the handbook will be a reliable guide for the layout, design and construction of boat launching facilities.

Should you wish to submit comments, corrections or suggestions to be considered for future editions of this handbook, please send them to:

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## DEFINITIONS

### **ABUTMENT**

A fixed wedge shaped structure at the head of a launching ramp to which stationary boarding floats are attached, and which provides pedestrian access between shore and the boarding floats.

### **BOARDING FLOAT**

A platform-type structure, either floating or fixed, stationary or adjustable, located alongside of or near a launching ramp, designed for short term moorage of boats, and to facilitate pedestrian access to and from boats in the water.

### **CHANNEL**

A waterway which forms a navigable link between a launching ramp fairway and the main body of a lake, reservoir, river, bay or other waterbody upon which the primary boating activities occur.

### **DESIGN HIGH WATER**

A selected high water level based on hydrologic data and other appropriate records, which is used as a safe and practical upper limit for the design and construction of a launching ramp.

### **DESIGN LOW WATER**

A selected low water level based on hydrologic data and other appropriate records, which is used as a safe and practical lower limit for the design and construction of a launching ramp.

### **FAIRWAY**

A bay, lagoon, basin, watercourse or other waterway into which a launching ramp extends, and into which boats are launched and from which boats are retrieved.

### **FREEBOARD**

The vertical distance from the top of the deck of a boarding float to the water surface.

### **GANGPLANK**

A platform or bridge for pedestrian access affixed to the shoreward end of a self-adjusting boarding float which moves up and down a launching ramp on cables or rails in response to water level changes.

### **HEAD OF RAMP**

The upper end of a launching ramp.

<b>HIGH WATER</b>	The highest water level that can possibly occur at a launching ramp site.
<b>LOW WATER</b>	The lowest water level that can possibly occur at a launching ramp site.
<b>LAUNCHING LANE</b>	A clearly delineated section of a launching ramp, designed to accommodate the launching or retrieval of one boat at a time; a launching ramp will consist of one or more launching lanes.
<b>LAUNCHING RAMP</b>	An inclined paved surface consisting of one or more launching lanes, extending into a fairway, and upon which boats are launched into and retrieved from the water.
<b>LAUNCHING RAMP APRON</b>	The paved area immediately above a launching ramp which is used as a turn-around and maneuvering area for cars and trailers preparing to use the launching ramp. The launching ramp apron is also an important project transitional link between a launching ramp and entrance roads, parking areas and driveways.
<b>PILE YOKE</b>	A frame, ring or other structural device attached along the side of a boarding float, or a framed opening in a boarding float, through which a guide pile passes and keeps the boarding float in a specific location.
<b>SLOPE OF RAMP</b>	A measure of the steepness of a launching ramp, determined by dividing a launching ramp's vertical drop by its horizontal projection, multiplied by 100. The slope of ramp will always be expressed as a percentage.
<b>TOE OF RAMP</b>	The lower end of a launching ramp.

## DESIGN AND CONSTRUCTION

### Section 1. Water Areas

#### 101. Fairways

- A. Minimum water depth: 4' at design low water.
- B. Minimum bottom width: not less than the combined width of the launching ramp, boarding floats, and riprap shoulders or other shore protection immediately adjacent to the launching ramp.

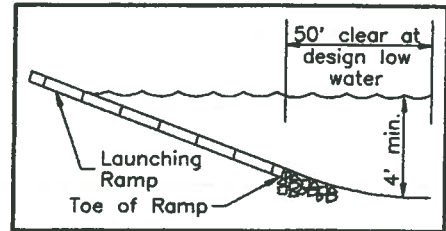


Figure 1. Fairways

- C. Minimum length: 50' beyond toe of ramp at design low water; *area shall be absolutely clear of navigational hazards and obstructions.*

#### 102. Channels

- A. Minimum water depth: 4' at design low water.
- B. Minimum bottom width: 75'.
- C. In cases where channels are constructed through lowlands or tidal areas which are periodically submerged, such submerged channels should be marked with appropriate navigational aids such as buoys, piles, lights or other devices in accordance with the California Waterway Marker System. See Appendix A.

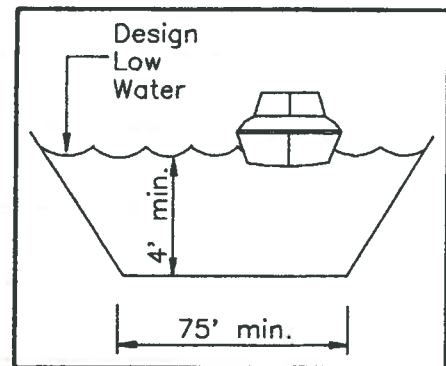


Figure 2. Channels

#### 103. Swimming Areas

- A. Where swimming areas are located adjacent to boat launching facilities, a barrier such as a fence or wall, or a warning device such as a log boom, buoys and/or signs should be installed between the two areas, and be designed to function effectively at all water levels.



## Section 2. Launching Ramps

### 201. General Requirements

#### A. Standard launching lane widths:

1. 15' on launching ramps of two (2) or more lanes.
2. 16' to 20' on single lane launching ramps. Generally, single lane launching ramps are not practical, particularly if they are over 100' in length. They can be difficult to use because of their narrowness, particularly for the inexperienced boater. However, in the case of low use remote sites, and extreme low water ramp extensions of multi-lane facilities, single lane launching ramps may be appropriate. The recommended width is 20', but shall be not less than 16'.

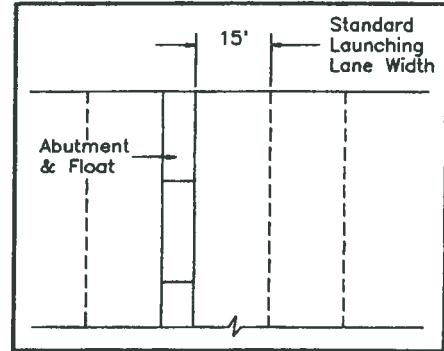


Figure 3. Standard Launching Lane Width

- B. The number of launching lanes will be dictated by demand and by the characteristics of the site. One launching lane will handle up to 50 launchings and 50 retrievals per day at a well designed and operated facility.
- C. On all launching ramps over 200' long and less than 60' wide (4 launching lanes), a 60' minimum diameter turn-around area should be provided every 200' to minimize car-trailer backing distances.
- D. The head of ramp should be constructed to an elevation not less than 1' above design high water.
- E. The toe of ramp should be constructed to an elevation not less than 3' below design low water.

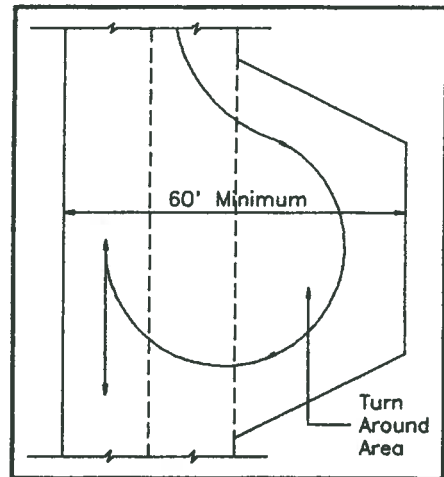


Figure 4. Turn-Around Area

- a. It is suggested that 25 year water level averages be used to establish design high water and design low water for launching ramps

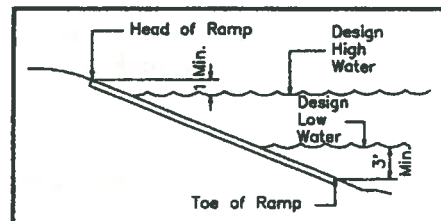


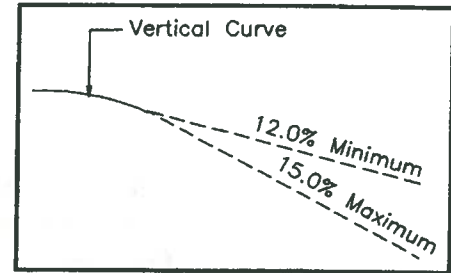
Figure 5. Ramp Head & Toe Details

constructed on lakes, rivers and other water bodies subject to periodic extreme water levels.

- b. If 25 year water data is not available, at least 10 year water level averages should be used.

**F. Slope of ramp:**

- a. 12.0% minimum
- b. 15.0% maximum
- c. The slope of ramp needs to be uniform throughout the length of the launching ramp wherever possible.



If it is necessary to alter the slope at some point, the change should be from a flatter to a steeper slope. Going the other way from steeper to flatter slopes forms a shallow valley and creates the possibility of boat props on long shaft outboard engines striking the launching ramp surface and causing damage to the prop, engine and/or boat. If necessary to go from a steeper to a flatter slope, it should be done gradually with a long smooth vertical curve at least 30' long.

- d. It is suggested that the boaters using a launching ramp be informed of the slope of the launching ramp, and of any changes in grade. This can be done with a sign at the head of the launching ramp, and with markings in the concrete at appropriate locations and elevations.

**G. A vertical curve must be constructed at the head of ramp, thus providing a smooth transition between the launching ramp and the launching ramp apron.**

1. A 15' to 20' vertical curve is usually adequate.
2. Generally, it is less expensive and easier to build a vertical curve into an asphalt concrete paved launching ramp apron rather than into the upper section of a concrete launching ramp.
3. A vertical curve at the head of ramp is a small but important design detail which must not be overlooked or neglected. The vertical curve:
  - a. eliminates the problem of trailer hitches striking and chipping the launching ramp surface at the point of change of grade;
  - b. enhances the driver's vision of the boat and trailer while backing; and
  - c. makes the launching ramp more comfortable and easy to use.



202. Construction Details and Materials

A. Launching ramps are to be constructed of reinforced concrete, using one or a combination of the following:

1. Cast-in-Place Concrete

a. Fresh Water Installations  
6" thick over aggregate base  
3" rebar cover at bottom

b. Salt Water Installations  
8" thick over aggregate base  
3" rebar cover, top & bottom

c. Full ramp slab thicknesses of 6" and 8" are to be constructed. Reduced slab thicknesses based on the nominal width of conventional form lumber should not be accepted.

d. Minimum steel reinforcement should be #4 rebars (1/2" diameter) at 12", both ways, or as required by the design engineer.

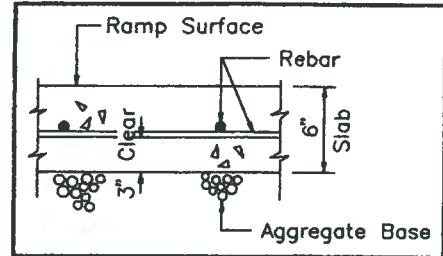


Figure 7. Fresh Water Launching Ramp Slabs

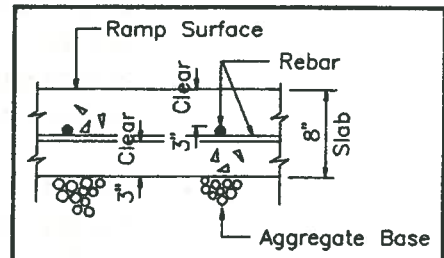


Figure 8. Salt Water Launching Ramp Slabs

2. Precast Concrete Panels and Planks

a. Precast concrete panels are typically 3' to 5' in width, up to 50' long, and are placed over aggregate base. Panels of this size are typically 8" thick, weigh up to 12 tons each, and must be specifically designed to withstand lifting stresses during manufacture, shipping and placement.

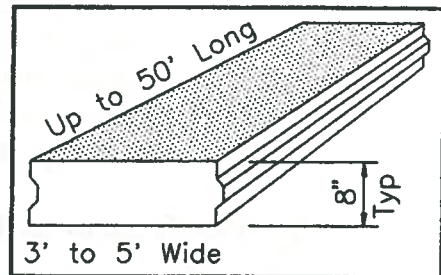


Figure 9. Typical Concrete Precast Panels

b. Precast concrete planks are considerably smaller than precast concrete panels, typically being 12" to 24" wide, and up to 15' long. They should be not less than 6" thick, and be designed to bolt, cable, clip, key, or otherwise fasten together during installation. In quiet

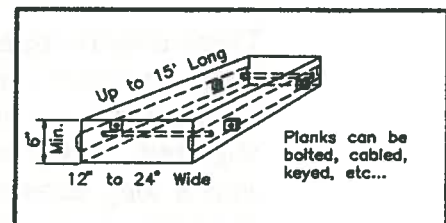


Figure 10. Typical Precast Concrete Planks

water locations not subject to severe waves, currents and surge, and where soil conditions will permit, the planks can be made and placed without keys or other fasteners.

c. The concrete cover requirements for protection of the reinforcing steel in precast panels and planks are the same as cited above for both fresh and salt water cast-in-place concrete installations.

d. Precast concrete panels and planks are subject to undermining when placed in water bodies that experience currents, wind and storm waves, or other high energy water movements. Therefore, they must be protected for a width of 3' to 5' around the perimeter of the launching ramp with riprap, gunite, geotextile fabrics, and/or other means of protection.

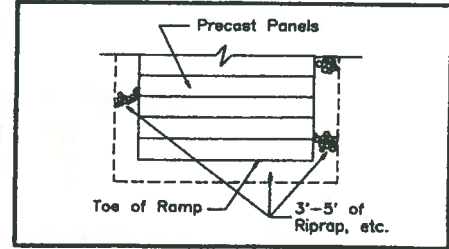


Figure 11. Riprap Protection

e. Precast concrete planks are often installed with 3" to 4" gaps between planks to provide space to mechanically fasten planks together. When this is the case, the planks must be placed over geotextile fabric to prevent base rock and soil from being washed away through the gaps. After placement of the planks, the gaps should be filled with rock.

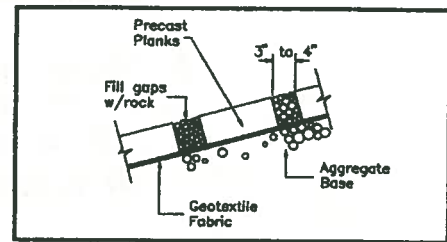


Figure 12. Precast Plank Gap Detail

B. Specifications for launching ramp concrete should include the following:

6 sack concrete  
4,000 psi compressive strength  
Type II cement

3/4" maximum aggregate  
5% air entrainment  
3" to 4" slump

These specifications have been developed over a period of 20 years and are based on actual construction experience on dozens of launching ramp projects. They provide a concrete mix that is easy to work, will readily take and hold a V-groove finish, and will result in a strong, durable, functional launching ramp with a long service life. Therefore, any deviation from these specifications should be done carefully and thoughtfully.



C. Concrete Quantities can be estimated from the following monograph:

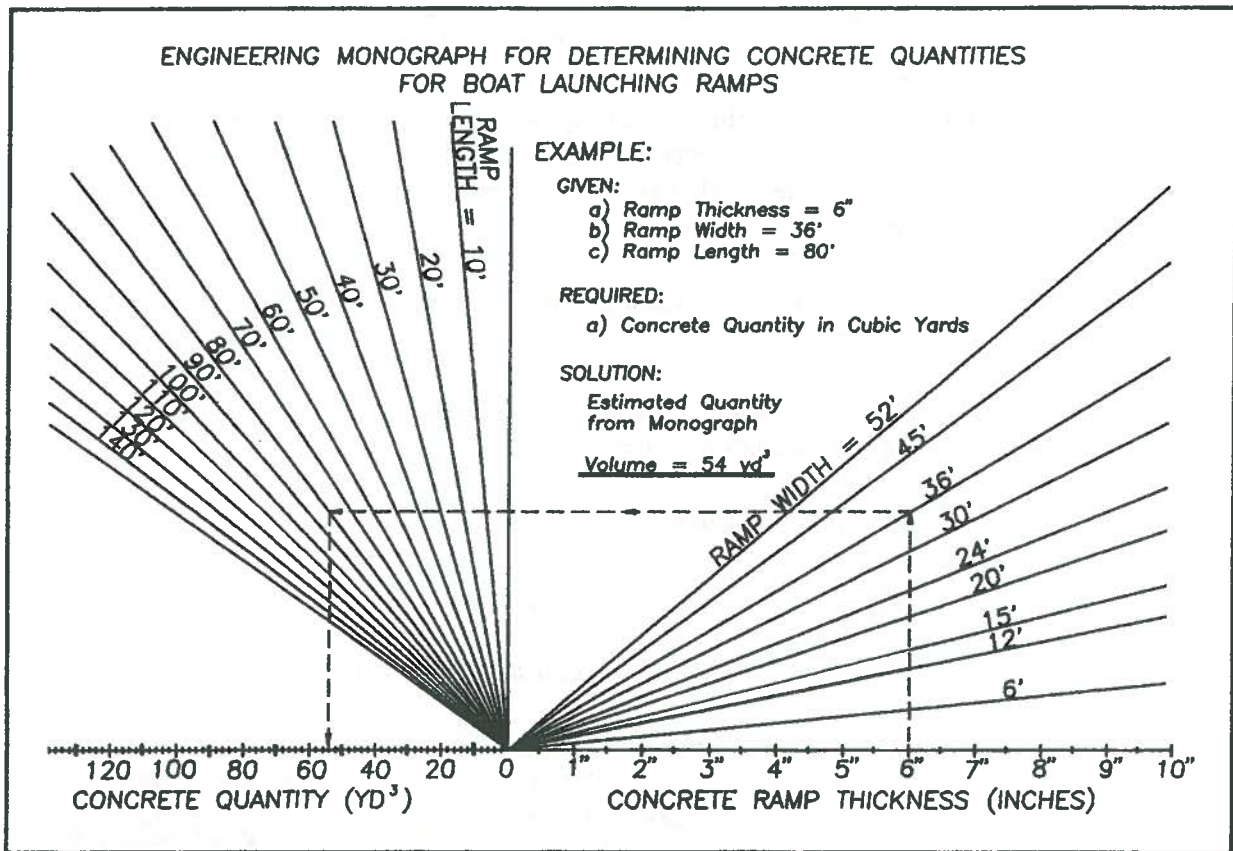


Figure 13. Concrete Quantities Monograph

D. V-Groove Launching Ramp Finish

1. V-groove finishes should be provided on all concrete launching ramps to ensure maximum traction for vehicles launching and retrieving boats and trailers. Particular attention is required in salt water where slick marine growth will frequently be present. Spinning vehicle tires will quickly wear away the growth on the peaks of the V-grooves and grip the launching ramp surface.
2. V-grooves are to be 1" x 1", and aligned at 60° to the longitudinal axis of the launching ramp. Larger grooves are sometimes used but are more difficult to walk on. Under no circumstances shall the grooves exceed 1-1/2".

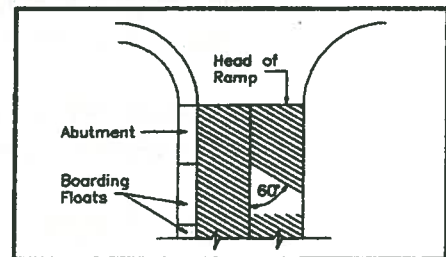


Figure 14. V-Groove Alignment

3. A V-groove finish will not only provide good traction, but will also assist in "cleaning" the launching ramp surface in response to boat wakes, wind and storm waves, and rainwater running down the ramp. Sand, soil and other debris will tend to be carried down and off the sides of the launching lanes and launching ramp. Therefore, the direction of the V-grooves should be determined in consideration of the following:

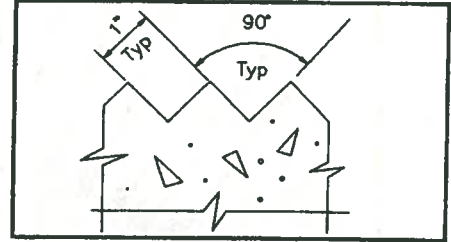


Figure 15. V-Groove Detail

- a. direction of prevailing wind, waves and currents;
- b. source of sand, silt and other debris on the launching ramp;
- c. number of launching lanes;
- d. topography of the site; and/or
- e. presence of abutments and boarding floats on the launching ramp.

4. On wide, multiple lane launching ramps, it is advantageous to alternate the direction of the V-grooves from lane to lane, thus forming a "herringbone" pattern. This provides a distinct permanent delineation of the launching lanes. Changes in the direction of the V-grooves should never be made except at launching lane lines.

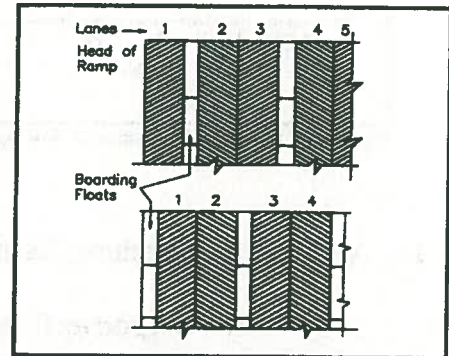


Figure 16. "Herringbone" V-Grooves

- E. V-groove tool design varies in size, shape, weight, and material used for fabrication. Steel, aluminum and wood tools have been used successfully. However, it appears that aluminum is perhaps the best choice in consideration of the tool's size, weight, and the ease and speed with which a finisher can produce crisp, straight V-grooves in wet concrete.

1. V-Groove Tool Design (for a tool to be used to finish large areas of cast-in-place concrete; smaller modified tools should be used for precast panels)
  - a. Weight: 22# to 25#
  - b. Length: 24" to 30"

- c. Width: 20" to 24"
- d. Material: 1" x 1" x 3/16" aluminum angle
- e. Fabrication: Cut, shape, weld and grind smooth one end (see commentary below) of 14 to 17 pieces of aluminum angle to resemble the bow of a boat. Assemble the pieces to form a tool 20" to 24" wide. Fit them snugly together, slightly staggering each piece so as to form a 60° angle on both the leading and following edges so that the tool will fit snugly against the forms on each side of the launching lane. Weld the angles to cross pieces of larger angle or channel to hold the tool together. Provide an appropriate means of attaching a handle. The handle assembly for a "Fresno" float works well. If a "herringbone" finish is required on a multiple lane launching ramp, a second "mirror image" tool must be made in order to form V-grooves in alternating directions.
- f. Commentary: Contractors have suggested cutting the trailing edge of the tool square rather than bow shaped. They claim that the wet concrete breaks free of the trailing edge much sharper and cleaner than it does from the gradual release from a bow shape. Also, some

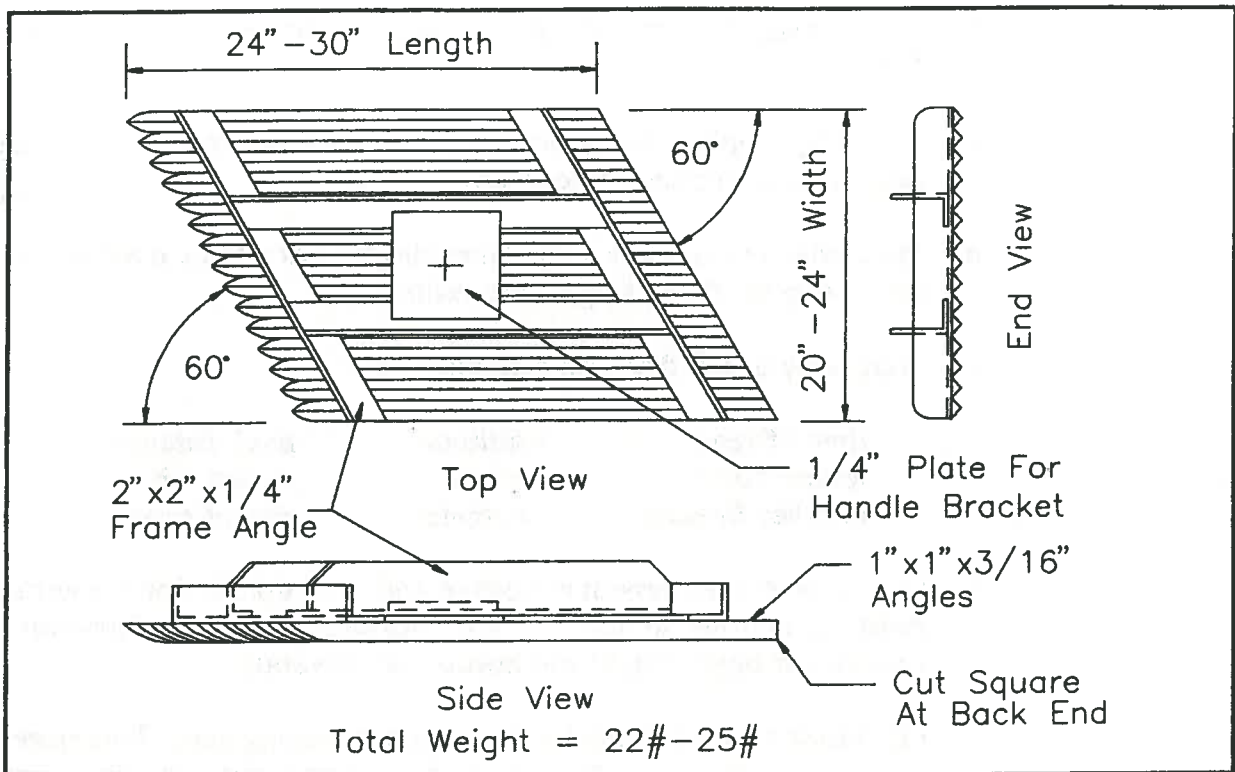


Figure 17. V-Groove Finish Tool

contractors prefer to build lighter tools and add field weights as required to get the best results and production.

#### F. V-Groove Construction Procedure

1. The consistent experience of the engineering staff of the Department of Boating and Waterways is that the successful accomplishment of satisfactory V-grooves by contractors is a continuing problem. It is not a difficult task, but contractors are consistently overconfident of their skills, abilities, and past experience of finishing concrete on level ground. However, finishing V-grooves on a 12%-15% slope is another matter. Consequently, it is strongly advised that contractors involved in V-groove finish work on launching ramps pay close attention to the following recommendations:

- a. Prior to beginning concrete work on the actual launching ramp, the contractor should be required to make 4'x8'x4" V-groove concrete test panels on flat ground at the construction site. Upon approval of a test panel by the engineer or inspector, the panel will demonstrate the contractor's ability to form satisfactory V-grooves and will serve as an objective standard on the site for judging the acceptability of the V-grooves formed on the actual launching ramp.
- b. Use a concrete crew of not less than 5 workers including at least 2 finishers.
- c. All tools, supplies, equipment and materials are to be on site before beginning placement of concrete.
- d. Place concrete and finish one launching lane at a time, maximum width of 15' (up to 20' on single lane ramps).
- e. Start early in the day with attention to:

time of year	altitude	haul distance
temperature	winds	design mix
weather forecast	climate	size of crew

f. Start concrete placement at bottom and work uphill. Some contractors insist on starting at the top and working downhill. However, the reasons for beginning at the bottom are several:

- (1) Truck access is often limited to the launching lane. Therefore, the contractor can use the lane to deliver materials, and construct the launching ramp as he moves uphill. Starting at the top will require



the contractor to drive heavy construction vehicles over new concrete, possibly breaking the peaks off the V-groove finish and/or cracking the slab.

- (2) Launching ramps are often built during the fall and early winter months when water levels are lowest, but also when rain and snow are probable. Starting at the top of the ramp may waste valuable time and access if the water level begins to rise. Starting at the bottom will help insure that the full design length of ramp can be constructed.
  - (3) Even though the concrete is relatively stiff at a slump of 3"-4", the wet concrete tends to creep downhill when it is being screeded and worked. Starting at the bottom lets gravity work for instead of against you. Gravity will hold the wet concrete in the forms, and downhill creep will not occur.
  - (4) Perhaps the best reason for starting at the bottom is that the contractor will typically learn and develop some technique as he goes along in the process of finishing the ramp. The ramp finish typically gets better with experience. Therefore, it is appropriate for the contractor to do his worst work at the bottom of the ramp, and his best work at the top where both the visibility and use are the greatest.
- g. Limit placement of concrete to the following maximum rates per hour:

8-10 yd<sup>3</sup>/hour for 6" thick sections  
11-13 yd<sup>3</sup>/hour for 8" thick sections

This will result in a production rate of about 30-35 linear feet of 15' wide launching lane per hour, or an area of about 450-525 square feet.

- h. Adequately vibrate the concrete every 12" on centers with internal vibrators to eliminate air pockets, and to insure full contact with the rebar and construction forms. Do not over-vibrate as the aggregate will settle to the bottom and weaken the launching ramp slab.
- i. Screed the wet concrete to the top of the forms using a vibratory power screed, working uphill via hand or gasoline powered winches. Do not attempt to manually drag the screed uphill!
- j. Wood float the concrete as necessary to touch up and repair the screeded surface.

- k. Beginning at the appropriate lower corner, begin forming V-grooves at 60° from the longitudinal axis of the ramp. Initially, there will be a triangular area at the very bottom of the ramp within which it will be awkward to use the V-groove tool. However, after progressing up the ramp to the point where the V-

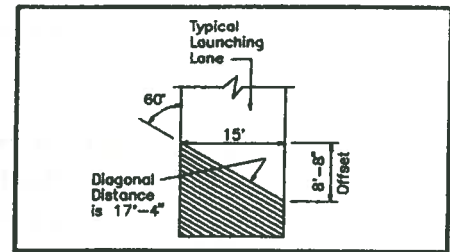


Figure 18. V-Groove Offset

groove tool can be used over the full width of the launching lane, the grooving operation will be much easier. Care must be taken to insure that the 60° angles on the front and rear of the V-groove tool fit snugly against the forms on each pass of the tool across the wet concrete. It is often helpful to fabricate a couple of smaller V-groove hand tools to use in the tight corners at the top and bottom of the ramp. The offset from side to side of a 15' wide lane will be about 8'-8". The use of a straight 20' length of 2"x6" lumber will be of great assistance in maintaining the correct alignment and provides a guide for running the V-groove tool across the wet concrete. The diagonal distance across the launching lane will be about 17'-4". When done properly, crisp V-grooves can be formed with only one or two passes of the tool.

1. Vibrate, screed and V-groove one hourly placement of concrete before allowing the next placement. If unexpected delays occur between hourly placements due to equipment problems, traffic, etc., leave the rough edge along the upper side of the last placement generally along the same 60° alignment of the V-grooves. This will eliminate most of the problems of trying to finish both "old" and "new" concrete on the same pass of the finish tool.
  2. To assist contractors and others in the construction of V-groove surfaced boat launching ramps, the Department of Boating and Waterways has produced an eight minute video which illustrates the information presented above. The video can be ordered by contacting the Department as per the information at the end of the Introduction to this handbook.
- G. Erosion control features are necessary for all launching ramps to prevent undercutting by waves, surge, currents and runoff drainage.
1. On all cast-in-place launching ramps, reinforced cutoff walls not less than 6" thick and 16" deep should be constructed on all edges. Deeper cutoff walls will be necessary when launching ramps are constructed on highly erodible soils.

2. On precast launching ramps, it is impractical to install precast panels or planks with cutoff walls. Therefore, it is important to stabilize and protect the soil areas adjacent to the launching ramp to prevent erosion and undercutting. A commonly used method which works well is to place geotechnical fabric under both the launching ramp and the base rock, extending the fabric beyond the foot print of the launching ramp for a distance of at least 5'. Place riprap 12" to 16" deep in a 5' wide strip down each side and across the bottom. Key the riprap into a shallow trench, compacting the rock neatly into a uniform appearing layer, approximately flush with the surface of the ramp. This will enhance the effectiveness of the rock, and will discourage removal by vandals, rock throwing children, and boaters looking for wheel chocks.

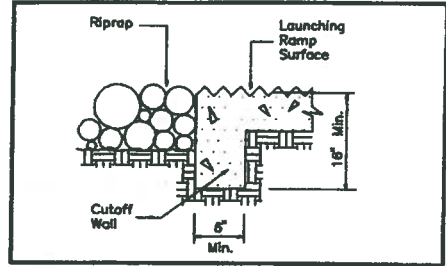


Figure 19. Cutoff Wall Details

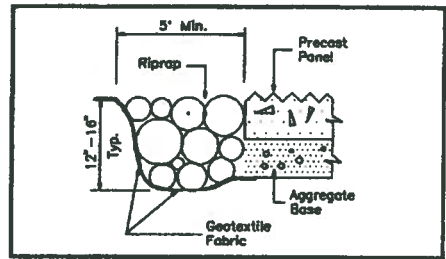


Figure 20. Riprap Details

3. Below is a recommended riprap specification from the California Department of Transportation Standard Specifications, Section 72-2. It is suitable for sites with low exposure to wind, waves and currents.

Facing Class -- Method B Placement

0 -	5%	of rock larger than 200 lbs			
50 -	100%	" " " " " "	75	"	
90 -	100%	" " " " " "	25	"	

A higher class rock specification may have to be used at sites with greater exposure. The final decision must be determined by the project design engineer. See Appendix B for Standard Specification 72-2.

4. Sometimes launching ramps subject to strong river currents will still be undercut along the upstream edge even with the installation of fabric and riprap. In severe cases, the placement of larger riprap may solve the problem. However, it may be necessary to inject grout into the base rock below the ramp through holes drilled through the launching ramp slab. The number and location of the

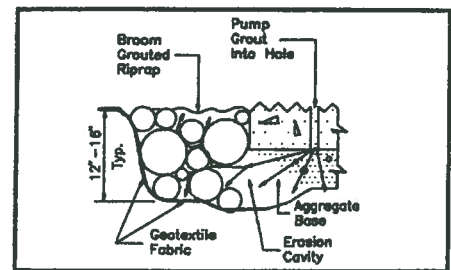


Figure 21. Grouted Riprap

holes will depend upon the nature and severity of the problem. Pump the grout until it can be seen flowing from under the concrete ramp slab out into and up through the perimeter riprap. Additional grout should be spread or blown into the surface of the perimeter riprap to the extent possible above the existing water line, and finished with a coarse straw broom. "Brooming" of the grouted riprap will help fill the voids and when done skillfully results in a textured surface which is attractive, durable and safe to walk on.

- H. Weep holes to eliminate or reduce hydrostatic pressure are generally not necessary on a concrete launching ramp unless it is subject to rapid and sustained drawdown of the water body. Weep holes should only be considered if the water level is known to drop at a rate of 1' per hour or more over a sustained period of five or six hours. If required, weep holes are typically provided on 10' centers with due consideration to the location of construction joints and the porosity of the aggregate base rock and the native soil.

Either of the following methods can be used to provide weep holes.

1. After the concrete cures for a few days, drill 3"-4" diameter holes through the launching ramp slab on 10' centers. Clean out the holes and fill with 3/4" drain rock.
2. During placement of the launching ramp concrete, secure short lengths of 3"-4" diameter Schedule 40 PVC pipe at each weep hole location, making sure that the pipes are pushed down into the base rock, and are filled with wads of newsprint or rags. The pipes must be long enough to reach slightly into the rock to prevent wet concrete from entering the pipes, and short enough to allow finish work to occur. The following day the weep holes must be located, opened up and cleaned out. Fill the weep holes with 3/4" drain rock.



### Section 3. Boarding Float Systems

#### 301. Boarding Floats

##### A. General Requirements

##### 1. Width Requirements

a. *Minimum overall width shall be not less than 6' (72").* Floats less than 6' wide tend to be unstable and "log roll" in the water.

b. Minimum clear travel width should be not less than 5'0" (60") between cleats, bull rails, rings or other mooring hardware mounted along the edges of the boarding float, nor should any part of the hardware be mounted more than 6" in from the edge of the boarding float.

c. In cases where guide piles are located inside the frame of the boarding float, but to one side, the minimum clear distance between the face of the pile and the opposite edge of the float should be 4'0" (48").

d. In cases where guide piles are located along the centerline of the boarding float, the minimum overall width should be 8'0" (96"), and the minimum clear distance between the face of the pile and the edge of the float should be 3'2" (38").

e. The placement of trash receptacles, fire hose cabinets, signs or other obstacles on boarding floats is not recommended as they diminish the clear travel width, obscure vision, and obstruct boat lines.

##### 2. Length Requirements

a. Boarding floats should provide not less than 50' of float in the water measured from the waterline on the launching ramp at design low water.

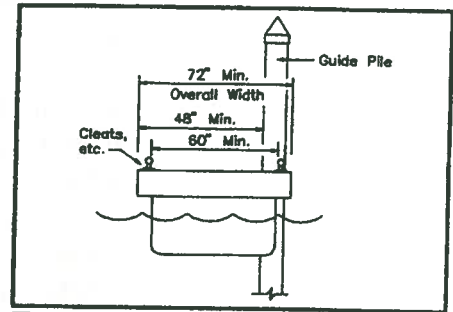


Figure 22. Float Width Requirements

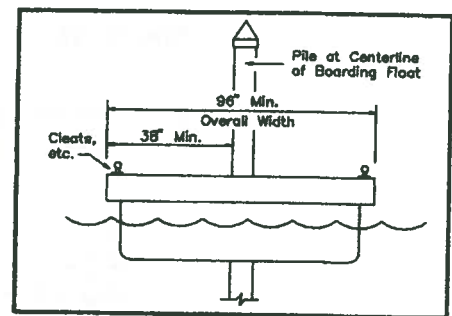


Figure 23. Width Requirements-Center Pile

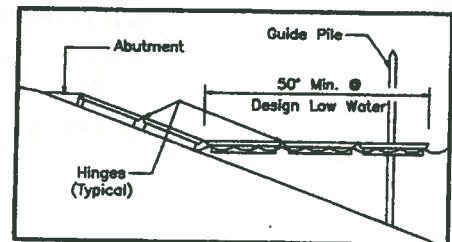


Figure 24. Float Length Requirements

- b. Where articulated (hinged) boarding floats are installed, the individual float sections should be not more than 20' nor less than 16' in length with 20' being the recommended standard.

- c. Individual boarding float sections which will always be floating at low water should not be articulated, but be continuous. This provides a more stable float, spreads the live loads more uniformly, and helps prevent the end of the float from drooping.

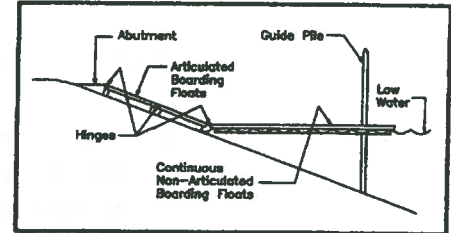


Figure 25. Continuous Non-Articulated Float

### 3. Height Requirements

- a. *Maximum overall height of boarding floats shall not exceed 30" where float sections will come to rest on the upper reaches of a launching ramp surface during periods of low water, and where the "resting" float sections are used for pedestrian access to float sections which are in the water.*

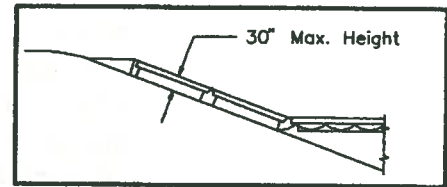


Figure 26. Maximum Float Height

- b. *If it is necessary to exceed a 30" maximum height, safety hand rails shall be provided.* However, handrails make launching and retrieving boats more difficult and usually interfere with the efficient movement of people, boats and boat lines. Therefore, every effort should be made to keep the overall height of the boarding floats to 30" or less.
- c. The 30" maximum does not apply to self-adjusting boarding float systems which operate on raised rails and walkways. During low water periods, these floats hit rail stop blocks and come to rest on raised walkways until higher water levels return. During these low water periods the floats are "high and dry", are out of active service and do not provide any pedestrian access. Therefore, the height is not critical from a safety standpoint and handrails should not be required. For further comments, see Self-Adjusting Dual-Rail Guided Boarding Floats on page 28.

## B. Design Criteria

1. **Dead Load Only (DL):** Boarding floats are to float level in the water within the following limits:

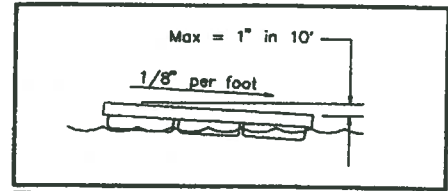


Figure 27. DL Level Limits - Length

- a. **Length:** 1/8" per foot over the length of an individual boarding float section, not to exceed 1" in 10'.
- b. **Width:** 1" maximum over the width of the boarding float.

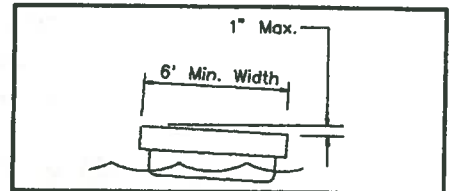


Figure 28. DL Level Limits - Width

2. **Uniform Live Load (ULL)**

- a. 20#/ft<sup>2</sup> is a statewide and nationally recognized standard uniform live load for launching ramp boarding floats, in service, in the water. It is equivalent to a live loading of 15 people on a 6'x20' boarding float, each weighing an average of 160#.
- b. Live loads of less than 20#/ft<sup>2</sup> may be appropriate for some light weight boarding float systems in certain applications. For additional comments, see Stationary Glulamated Boarding Floats on page 26.
- c. In locations where boarding floats will be used by large numbers of people from buses, ferry boats, boat shows, or other short term-high intensity sources, a live load of 40#/ft<sup>2</sup> is to be used.

3. **Live Point Load (LPL):** 650#

- a. A live point load may be applied at any point on the boarding float deck not closer than 12" from the edge of the float.
- b. The live point load is an assumed load based on a 250# person, in a 250# heavy duty electric wheelchair, assisted by a second person weighing 150#, for a total live point load of 650#.

4. **Freeboard**

- a. **Dead Load Only (DL)** - see Fig. 29

(1) 14" minimum / 20" maximum to top of deck.

(2) 4" minimum to bottom of fenderboard.

b. DL + ULL: 10" minimum to top of deck.

c. DL + LPL: 13" minimum to top of deck.

(1) A reduction of freeboard will occur, but will probably be limited to the general area around the point of live load.

(2) Reduced freeboard is to be further limited by a maximum localized deck slope of 1/4" per foot in any direction resulting from the live point load.

d. DL + ULL + LPL: 8" minimum to top of deck.

5. Boarding floats are to be designed to withstand wind, wave, current and impact loadings, applied to both floats and tied up boats, that may reasonably occur during the life of the structure as the result of its location and exposure.

a. Minimum boarding float wind loading is to be 25# per linear foot of float. This is predicated on a uniform wind load of 15#/ft<sup>2</sup> applied to a maximum allowable freeboard exposure of 20".

b. Minimum boat wind loading is to be 45# per linear foot of float. This is predicated on a uniform wind load of 15#/ft<sup>2</sup> applied to an estimated in-the-water average profile height of trailerable boats of 3'.

c. The float and boat wind loading is to be applied concurrently, resulting in a combined loading of 70# per

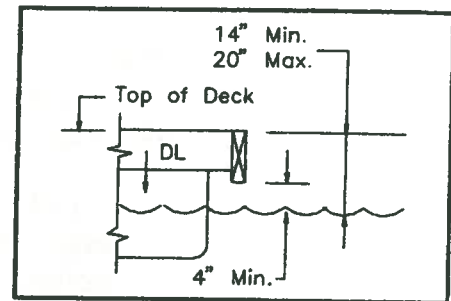


Figure 29. Freeboard: DL Only

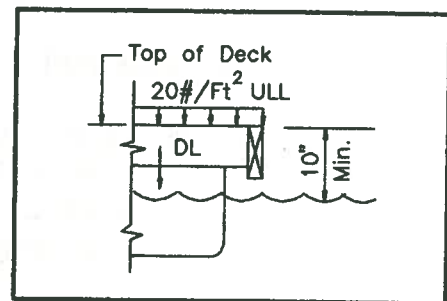


Figure 30. Freeboard: DL + ULL

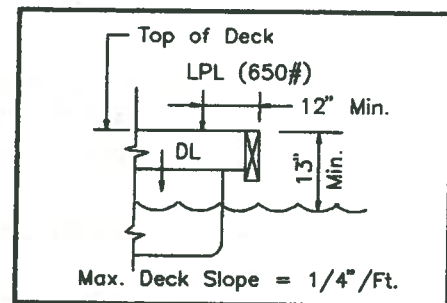


Figure 31. Freeboard: DL + LPL

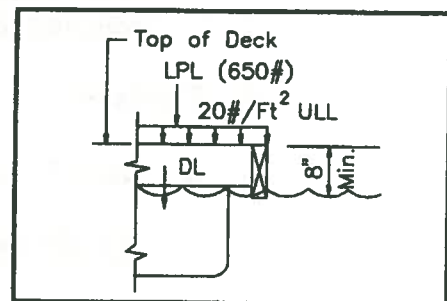


Figure 32. Freeboard: DL + ULL + LPL

linear foot of boarding float, without regard for any "shadowing" effect that may occur from boats shielding floats from the wind, or vice versa.

- d. Wave, current and impact loadings must be determined on the basis of the particular site, the type of boats to be used at the facility, and the boating activities that are likely to occur.
6. Where boarding floats must support a gangplank, special attention must be given to insure that adequate flotation is provided to support the dead and live loads on both the boarding float and the gangplank. In some situations, it may be necessary to provide flotation under the outboard end of the gangplank to help carry the gangplank loads.

### C. Design Details

1. Framing bolts should be not less than 3/8" diameter, and be either hot dipped galvanized or stainless steel.
2. When designing for wood decking, 2x6 lumber is recommended. 2x4 decking is not strong enough for the typical deck spans, and 2x8 and larger decking is subject to excessive warping and curling.
3. Experience has shown that it is better to attach wood decking to the boarding float frame in the transverse direction rather than the longitudinal direction.
  - a. Longitudinal decking goes on faster and offers some increased strength from the continuity of the decking over the full length of the boarding float frame. However, it also resists torsional twisting. Consequently, nails, screws and/or other fasteners at opposite corners on the ends of the decking planks frequently pull loose, and/or the decking splits. This allows the decking to curl and spring up directly into the path of oncoming foot traffic, creating dangerous tripping hazards and increased maintenance work.
  - b. Transverse decking, on the other hand, is essentially neutral to torsional twisting, the fasteners tend to hold better, and less splitting occurs. Also, transverse decking provides slightly better traction for foot traffic due to the spaces between the planks, and is more easily removed and replaced for maintenance purposes.
4. Wood decking and framing members are to be pressure treated as per the latest requirements of the American Wood Preservers Association (AWPA)



and the American Wood Preservers Bureau (AWPB). See Appendix C for more information.

- a. Wood species typically used for West Coast wood boarding float construction are Coastal Douglas Fir, Western Hemlock and HemFir.
  - b. Although cedar and redwood are commonly available on the West Coast, have natural resistance to rot and decay, and can be pressure treated, they are not recommended for construction of boarding floats. These species lack the structural strength and hardness necessary for a reasonable service life.
  - c. Creosote and creosote coal-tar solution preservatives are not recommended for boarding float construction, particularly for decking. They will soil the clothing, shoes and equipment of boaters using the boarding floats.
5. All ferrous metals used are to be hot-dip galvanized after fabrication.
6. All metal plates used to fabricate clips, brackets and other structural parts for boarding floats are to be made from material not less than 1/4" in thickness.
7. Cleats for boat lines should be provided along the edge(s) of boarding floats on 10' centers.

- a. Although bull rails and rings are sometimes used for this purpose, cleats are more acceptable to California boaters in general. Regional differences may alter this general preference.

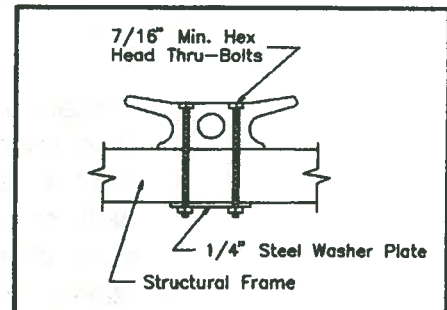


Figure 33. Typical Cleat

- b. Cleats should be cast ductile iron, 8" or 10" in length, have a base not less than 2 1/4"x4", and be designed to receive two (2) hex head galvanized machine bolts not less than 7/16" in diameter. The bolt heads should fit flush into recesses in the top of the cleat.
- c. Cleats should be hot-dip galvanized after they have been thoroughly cleaned with a wire wheel and had all burrs and rough spots ground smooth to prevent chafing of boat lines.

- d. Cleats should always be bolted through the main frame of the boarding float. Do not use lag screws. If larger cleats are required for larger boats, it is recommended that  $\frac{1}{4}$ " backup washer-plates large enough to receive both bolts be used on the lower face of the float frame.
8. Legs or other protective devices should be installed to protect the flotation pontoons on all boarding floats that periodically come to rest on the launching ramp surface. Plastic pads of  $\frac{1}{2}$ " or thicker ultra high molecular weight polyethylene (UHMW) should be attached to the bottom of the legs to prevent damage to the launching ramp surface. The thickness of the pads must be considered in the overall height of the boarding floats in order to avoid exceeding 30".

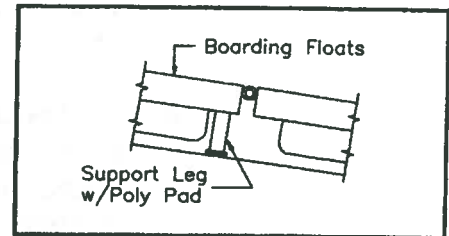


Figure 34. Protective Legs on Boarding Floats

9. Pontoons for flotation should consist of a rigid vessel filled with marine grade flotation foam. The rigid vessels are typically rectangular tubs or circular culvert pipes made of polyethylene.
- a. Tubs for flotation pontoons should be black in color, have a minimum wall thickness of 0.20", and be manufactured of cross linked rotationally molded polyethylene (CL-200). The tops of the tubs must be sealed to prevent water from entering the pontoons and filling any gaps that may exist between the tub walls and the interior foam. Even small amounts of water inside the pontoons can seriously alter the freeboard and balance of the boarding float. The tops of the tubs can be sealed with a thin sheet (10 mil) of polyethylene and then capped with  $\frac{1}{2}$ " pressure treated fir plywood. The pontoon assembly can then be securely fastened on all four sides to the bottom side of the float frame. Care must be taken to provide drainage for water that collects on top of the pontoon covers and within the float frame. The bottom corners of the frame blocking can be clipped, or  $\frac{3}{4}$ " diameter holes can be drilled in the frame at appropriate points. Fiberglass tubs may also be used but are not readily available, and must be evaluated as to wall thickness, ultraviolet damage resistance, and other factors as required.
- b. Circular pipes used for pontoons should be of dual wall construction, black in color, and manufactured of high density polyethylene. Dual wall pipe consists of a smooth bore pipe fitted snugly inside a corrugated pipe. Although dual wall polyethylene pipe is readily available in a variety of diameters, it should be kept in mind that the

overall height, including pontoons, of certain types of boarding floats which will periodically rest on the launching ramp surface during periods of low water shall not exceed 30". The nominal sizes most commonly used for boarding float pontoons are 12", 15" and 18". The actual gross outside dimensions will be 2½"-3½" greater than the nominal dimensions because of the pipe corrugations. Aluminum pipe has also been used for pontoons, but is expensive and difficult to obtain. The use of galvanized pipe is not recommended because of its relatively short service life even in fresh water installations.

- c. In choosing a pontoon, it should be kept in mind that tubs and circular pipes have different flotation characteristics. Tubs are uniform in shape, and the relationship between live loading and flotation capacity is linear, a highly desirable characteristic. Circular pipes are not uniform in shape, and the live load to flotation capacity relationship is nonlinear. Additionally, tubs are more efficient than circular pipe from the standpoint of providing more buoyancy per square foot of boarding float deck surface.
10. *Flotation foam shall be placed inside all pontoons, even those that are considered to be watertight.* The foam will increase the rigidity and stability of the pontoon walls, and is a relatively inexpensive insurance in the event the pontoons are broken or punctured.
- a. The flotation foam placed inside the pontoons is to be new expanded polystyrene (EPS) with a density of 1 - 2#/ft<sup>3</sup>, a compressive strength of 15-20 psi, and a maximum water absorption of 2% by volume. The foam material, commonly called "bead board" is an open-cell foam made by steaming small pellets of polystyrene inside a mold or form. It is relatively inexpensive and works well inside a closed vessel such as a polyethylene pontoon. However, it is easily damaged and will dissolve upon contact with gasoline, oil, paint thinner and solvents that are often used around boats and docks. Therefore, it must not be used exposed, but shall be inside a protective vessel.
  - b. Although the Department of Boating and Waterways does not recommend the use of exposed foam for public projects, there may be other applications where the use of exposed foam flotation billets is appropriate. If so, the foam should be a closed-cell extruded polystyrene with a density of 1.2 - 2.0#/ft<sup>3</sup>, an average compressive strength of 18 psi, and a maximum water absorption of 0.5% by volume. This type of foam is much more resistant to mechanical damage than bead board, but will also "melt" in contact with gasoline and solvents. It is also more expensive than bead board.



- c. A third type of flotation foam is polyurethane. It is a closed cell foam typically made by mixing the necessary components, pouring the mixture into a mold, vessel or shell of some type, and allowing it to expand in place. It is more dense than polystyrene foam, and is also more resistant to gasoline and solvent melting. However, the quality control of mixing, pouring and foaming the pontoons is highly critical, being greatly influenced by temperature, mixing time and other variables. Also, as the components expand and the foam is created, polyurethane will often fold over upon itself and create sizeable voids which cannot be detected. These voids will sometimes fill with water over an extended period of time and cause serious flotation problems. The use of polyurethane foam for flotation is not recommended.
11. Bumper material used for boarding floats includes vinyl, rubber, tires, fire hose, conveyor belting, plastics, and various other innovative materials. However, the standard has been and remains marine grade vinyl, either non-yellowing white or gray in color.
  - a. The vinyl mix should include an anti-fungus additive, and be free of all fillers such as chalk and talc.
  - b. The vinyl must be extruded straight and square. Otherwise, it will pucker and bow when it is fastened to the boarding float.
  - c. The vinyl should be fastened to the boarding float in lengths not less than 8', and all ends must be cut square to insure joints that are smooth, tight and inconspicuous.
  - d. Either aluminum or stainless steel large head nails (7/16") should be used on 4" centers to fasten the vinyl bumper along both its top and bottom flanges. The nails should be set slightly below the surface of the vinyl to prevent injury or damage to boaters and/or boats. However, care must be taken with the aluminum nails. If set too deeply into the vinyl, the nail heads sometimes pop off. Stainless steel nails cost about twice as much as aluminum, but usually are worth it since the total quantity of nails will be small. Do not use galvanized roofing nails. They will rust, have a short service life, and will soon stain the vinyl. Stainless steel staples are used by some boarding float manufacturers, and work well. However, maintenance workers usually cannot replace the staples because they usually do not have access to large staple guns, and may not be able to obtain the staples. Large head nails hold well, are easy to obtain, and are the fastener of choice.

- e. Minimum thickness of the vinyl bumper body and flanges should be 1/8".

#### D. Types of Boarding Float Systems

1. **Non-Floating Boarding Platforms.** These are movable wedge-shaped structures that rest on the launching ramp surface and stay in place because of their 4-5 ton weight. Typically constructed of steel, they have retractable wheels, are fitted with trailer hitches, and must be repositioned up and down the ramp as water levels change. They can easily be removed from the water for winter storage. Non-floating platforms are practical at locations where water levels do not change rapidly, where the seasonal water level fluctuation is not more than 3'-5', where soil conditions prohibit driving piles, and/or where winter ice would damage other types of non-removable boarding float systems.
2. **Suspended Non-Floating Boarding Platforms.** These are structural steel or aluminum frames with decking that are suspended from pairs of piles. The platforms are usually articulated with hinges, and constructed in 16'-20' sections. The entire structure is "yo-yo'ed" up and down with hoists and cables as water levels dictate. Access from shore is typically via a gangplank or other bridge structure. This system is only suitable for sites with water level fluctuations of less than 10'. The primary advantage is that the platform is not subject to the constant movement and wear from floating in the water, and can be raised several feet clear of the water for winter storage to avoid damage from storm waves in open water locations.
3. **Articulated Boarding Floats.** This type of float system consists of a series of individual float sections hinged together end-to-end, attached to a hinged abutment on shore, and held in position by a row of guide piles. The series of floats rises and falls with changing water levels. At design high water, all float sections will be floating. However, at lower water levels, the upper float sections will rest on the ramp surface and the lower sections will be floating. Thus, the articulated boarding float system has the advantage of being permanently located, and is self-adjusting in response to changing water levels. This type of boarding float is the most common in California waters, and is practical in coastal applications and in rivers and lakes with annual water level fluctuations up to 20'. Beyond this level, the cost of the floats and the excessive length of the piles becomes cost prohibitive.
4. **Stationary Glulamined Boarding Floats.** This type of float system consists of thin, glulamined wood planks and beams bolted together to serve as both the deck surface and the structural frame. The wide, thin planks provide both the strength and the flexibility of the system. The

planks are typically 3"-4" thick, 24"-36" wide, and up to 60' in length. Combinations of planks and cross beams allow for construction of boarding floats of almost any width and length. The float system is typically hinged to an abutment on shore, and functions much the same as articulated boarding floats except that the whole float structure flexes as required in response to changing water levels. This type of boarding float is particularly useful in applications where rough water will be experienced because of wind and storm waves, or large ship wakes. It has been used successfully at sites where 3'-4' waves occur over extended periods of time. However, the flexibility of the system means that it is a rather light system in terms of dead weight, and it tends to ride high in the water. This means that the freeboard may be excessive, and the float may be "tender", or overly responsive to live loads. Also, the application of a 20#/ft<sup>2</sup> live load will typically require enough flotation pontoons to overly stiffen the system and defeat some of the advantages of the flexible glulamated planks. Stationary glulamated boarding floats should not be considered at sites where the water level fluctuation annually exceeds 20'.

5. **Self-Adjusting Cable Guided Boarding Floats.** This system consists of a 50'-60' long boarding float which moves up and down a launching ramp on a steel cable with changes in the water level. The float is usually constructed in two pieces which are hinged together. The shoreside section should be about twice the length of the waterside section. This will place the hinge at about the two-thirds point out from shore. A two-piece hinged float works better than a single float of the same overall length. This is primarily because of the behavior of the float during low water periods when it will of necessity come to rest on the lower part of the launching ramp. If not hinged, it is subjected to rather severe bending as it stops and progressively comes to rest on the ramp as the water recedes. The cable, stainless or galvanized steel, is typically 7/8"-1" diameter, and must be tightly stretched between cable anchors at the top and bottom of the launching ramp. This system is practical for installation on straight launching ramps in waterbodies with annual water level fluctuations of more than 20'. It cannot effectively be used on launching ramps with large curves. This would necessitate the cable either crossing over adjacent launching lanes, or going off the side of the launching ramp at its mid-point, depending on which way the ramp curved and the location of the float. The primary advantage of this system is that it can be economically used on long straight launching ramps several hundred feet long in waterbodies with large annual drawdowns.
6. **Self-Adjusting Single-Rail Guided Boarding Floats.** This system is similar to the cable guided system described above, with the exception that a steel rail is used in lieu of a cable. The rail is constructed of light steel beams

or steel pipe, and is mounted on brackets which adequately elevate the rail and also attach it to the launching ramp. The boarding float is attached to the rail with trolleys which freely run up and down the rail in response to water level changes. This system is useful on long launching ramps in waterbodies with large annual drawdowns, and is particularly suited for ramps with curves. The single-rail system has been used successfully on curves with radii as small as 85'.

7. **Self-Adjusting Dual-Rail Guided Boarding Floats.** This system is similar to the single-rail system except the rail and guidance hardware are more sophisticated. The two rails are steel channels built into a raised concrete walkway, and the boarding float is fitted with trolleys and guide rollers on each side of the float at two locations. The dual-rail system will function well on both straight and moderately curved launching ramps, but will not reliably negotiate curves of less than 300' radius. For large drawdown situations, the dual-rail system is the most stable and reliable self-adjusting system available to date. Its major drawback is that it is also the most expensive. It should also be noted that this float system will exceed 30" in height when resting on the launching ramp during periods of low water. The rail will be about 11" high and the float will be an additional 28", making the overall height from the top of the float deck to the launching ramp surface approximately 39". However, this does not suggest that handrails are necessary. This type of float will be out of service and not used by boaters when it is resting on the launching ramp. It will not provide pedestrian access at such times.

## 302. Abutments

### A. General Requirements

1. The width of an abutment is to be the same as the overall width of the boarding floats.
2. The upper or shoreside end of an abutment must be "feathered" into the pavement, walkway or other pedestrian access route so as to provide a smooth transition to and from the abutment.
3. *The maximum height of an abutment shall not exceed 30". Under unusual circumstances where the height must exceed 30", handrails shall be provided along the sides of the abutment for safety.*

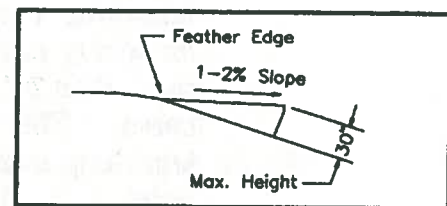


Figure 35. Abutment Details



4. The lower, or waterside end of an abutment is to be constructed perpendicular to the slope of the launching ramp. This provides slightly more clearance between the "vertical" face of the abutment and the upper end of the first boarding float section.

5. *Where abutments are located on the edge of a launching ramp, and riprap or other revetment materials are over 30" below the top of the abutment, handrails shall be provided for safety. If required, handrails shall be 42"-45" high, have no openings through which a 6" sphere will pass, and designed to withstand a minimum lateral live loading of 20# per linear foot of railing.*

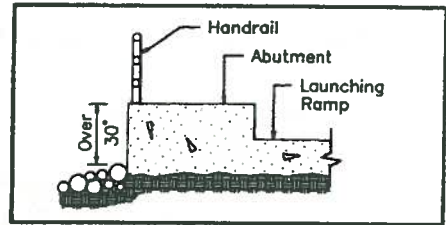


Figure 36. Abutment Handrails

6. Abutments are typically constructed of reinforced concrete. The concrete surface should receive a rough broom finish perpendicular to the direction of traffic to provide appropriate traction. If other construction materials are used, the surface traction must be not less than that provided by a rough broom finished concrete abutment.
7. The horizontal and vertical edges of an abutment should be rolled over or chamfered approximately 1".
8. Abutments should slope toward the boarding float at a slope of 1%-2% for drainage. This will diminish the "hump" effect at the abutment hinge when the boarding floats are resting on the launching ramp surface during periods of low water. If particular site problems dictate the need for a side slope on the abutment surface, it should not exceed 1/4" per foot.

## B. Design Details

1. Abutment concrete should be reinforced and have a minimum compressive strength of 4,000 psi.
2. Hinges used to connect boarding floats to an abutment should be hot dipped galvanized steel pipe. The hinges should be continuous, without any gaps, and cut flush with or slightly inside the alignment of the sides of the abutment and the boarding floats. The top surface of the barrel of the hinge should be flush with the top of both the abutment and the deck of the boarding floats.
3. If new construction, abutments should be cast monolithically with the launching ramp slab. If an abutment is being added to an existing

launching ramp, it must be securely anchored with dowels epoxied into the existing slab and tied to a rebar cage in the new abutment. The surface of the existing slab must be cleaned and prepared as required to provide bonding of the new concrete to the old.

### 303. Guide Piles and Pile Yokes

#### A. Guide Piles

1. Piles are typically used on articulated boarding floats at locations where the annual water level fluctuation is 20' or less.

2. Piles are available in three cross sectional shapes:

a. Round - in steel, concrete or wood.

b. Octagon - in concrete only.

c. Square - in concrete only.

3. After piles have been driven and cut off to the proper elevation, they should be capped with fiberglass or polyethylene cone-shaped white pile caps with a wall thickness of not less than 1/8". The pile caps dress up the appearance of the facility, protect the end of the piling, prevent trash and other objects from being tossed into open-ended steel piles, and discourage the nesting and roosting of birds on the piles. Bird droppings are unsightly, cause slippery deck surfaces, and are highly corrosive to metal parts on both boats and boarding floats. Pile caps can be fastened to wood piles with galvanized nails or screws, and to steel and concrete piles with epoxy adhesives.

4. It is recommended that the pile cutoff elevation be design high water plus 4'. For very stable, sheltered waterbodies, this may be excessive. However, the cutoff elevation should never be less than design high water plus 3'. In certain rivers and other waterbodies subject to flood stage water levels that exceed design high water, the boarding floats must be removed during flood periods and reinstalled on the piles after water levels return to normal.

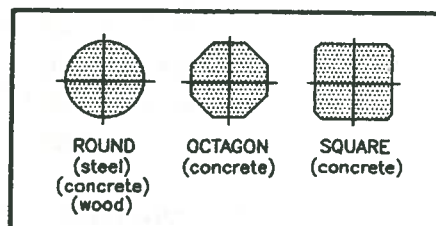


Figure 37. Types of Piles

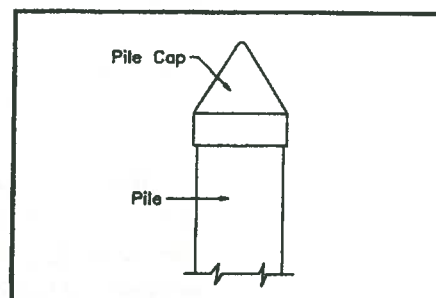


Figure 38. Typical Pile Cap

5. If it is necessary to use steel piles in salt water, the engineer should use great care to select the proper alloy and pile coating to insure a minimum 20 year pile service life.
6. Square concrete piles must be steel trowel finished on all four faces. This is for general appearance as well as to provide a smooth non-abrasive surface upon which pile yoke rub strips, rollers and other materials will rub.
7. Wood piles must be pressure treated in accordance with the latest requirements and recommendations of the American Wood Preservers Association (AWPA), the Western Wood Preservers Institute (WWPI), and in accordance with the quality standards established by the American Wood Preservers Bureau (AWPB). The species of wood and the type of treatment must be selected by the engineer for the particular application.
8. Care must be taken when driving octagonal and square piles to keep them square with the alignment of the boarding floats and prevent them from rotating as they are driven. Otherwise the piles and pile yokes will not function together properly.
9. In applications where steel piles and steel pile yokes are used together, it will be necessary to attach rub strips to either the piles or to the yokes to prevent abrasive wear, and to minimize the banging noise that will occur because of wind and waves. Pile ringing can be heard over great distances and is annoying to boaters, campers, nearby residents and others within earshot, particularly at night.
10. Piles are to be driven straight and plumb within a tolerance of 1" in 10'.

#### B. Pile Yokes

1. In cases where boarding floats are stationary and do not move laterally, a clear distance of 1" on all sides should be provided between a pile and the pile yoke. This criteria should be used on both exterior and interior pile yokes. Exterior yokes are attached to the boarding floats and are outside the basic dimensions of the floats. Interior yokes are openings within the framework of the boarding float.

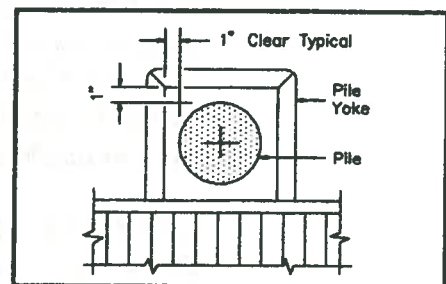


Figure 39. External Pile Yoke - Square

- Exterior yokes should only be used where they will not interfere with the safe and convenient passage of boats and trailers. The yokes must be designed to eliminate all sharp corners and edges which could cause personal injury, or puncture the hull of a boat on impact.

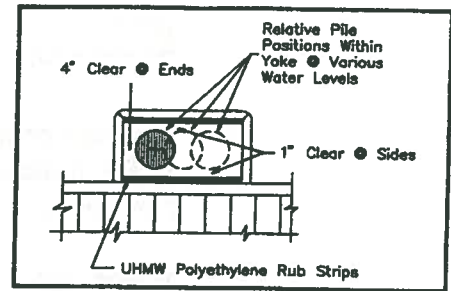


Figure 40. External Pile Yoke - Stretched

- Internal yokes should only be used where they will not interfere with the safe and convenient passage of pedestrians on the boarding float.
- Rollers are not recommended for boarding float pile yokes unless the floats are stationary and only move vertically on the pile with water level changes.

- It is recommended that ultra high molecular weight (UHMW) polyethylene be used on pile yokes as wear strips. Strips 1" or thicker and up to 6" wide are readily available and provide a superb wearing surface which will usually last for many years.

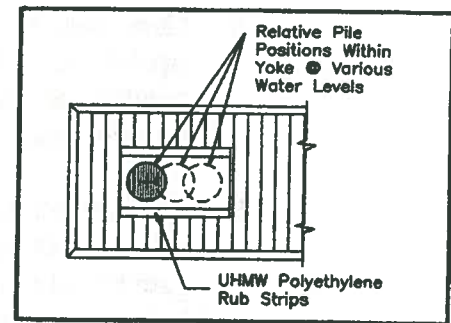


Figure 41. Internal Pile Yoke - Stretched

- In cases where articulated boarding floats are hinged to fixed concrete abutments, the boarding floats will not only move vertically with the rise and fall of the water, but will move laterally as well as the floats rotate on the abutment hinge. Therefore, adequate capacity must be provided inside the yoke for the relative movement between the pile and yoke. Recommended clearances between the pile and yoke are 1" along the sides and 4" at each end. The end clearances are particularly critical. Extra space is needed here to insure that the pile never binds against either end of the yoke. The following example problem and tables can be used to accurately determine the critical inside dimensions of a pile yoke.

**EXAMPLE PROBLEM:** Determine the inside dimensions of a pile yoke for a 12" diameter pile located 96' from an abutment on a 14.5% launching ramp.

$$W = \text{inside yoke width} = \text{pile diameter} + \text{end clearances} \\ = 12" + 1" + 1" = 14"$$

$$L = \text{inside yoke length} = \text{pile diameter} + \text{displacement} + \text{end clearances} \\ = 12" + 12.0" + 4" + 4" = 32"$$



H = Horizontal Boarding Float Displacement							
% Slope	12.0	12.5	13.0	13.5	14.0	14.5	15.0
∅	6° 50'34"	7° 07'30"	7° 24'25"	7° 41'18"	7° 58'11"	8° 15'01"	8° 31'51"
Cos ∅	0.99288	0.99228	0.99166	0.99101	0.99034	0.98965	0.98894
L (Feet)	H = [(L/Cos ∅) - L] X 12 (Inches)						
36	3.1	3.4	3.6	3.9	4.2	4.5	4.8
40	3.4	3.7	4.0	4.4	4.7	5.0	5.4
44	3.8	4.1	4.4	4.8	5.2	5.5	5.9
48	4.1	4.5	4.8	5.2	5.6	6.0	6.4
52	4.5	4.9	5.2	5.7	6.1	6.5	7.0
56	4.8	5.2	5.7	6.1	6.6	7.0	7.5
60	5.2	5.6	6.1	6.5	7.0	7.5	8.1
64	5.5	6.0	6.5	7.0	7.5	8.0	8.6
68	5.9	6.3	6.9	7.4	8.0	8.5	9.1
72	6.2	6.7	7.3	7.8	8.4	9.0	9.7
76	6.5	7.1	7.7	8.3	8.9	9.5	10.2
80	6.9	7.5	8.1	8.7	9.4	10.0	10.7
84	7.2	7.8	8.5	9.1	9.8	10.5	11.3
88	7.6	8.2	8.9	9.6	10.3	11.0	11.8
92	7.9	8.6	9.3	10.0	10.8	11.5	12.3
96	8.3	9.0	9.7	10.5	11.2	12.0	12.9
100	8.6	9.3	10.1	10.9	11.7	12.5	13.4
104	8.9	9.7	10.5	11.3	12.2	13.1	14.0
108	9.3	10.1	10.9	11.8	12.6	13.6	14.5
112	9.6	10.5	11.3	12.2	13.1	14.1	15.0
116	10.0	10.8	11.7	12.6	13.6	14.6	15.6
120	10.3	11.2	12.1	13.1	14.0	15.1	16.1
124	10.7	11.6	12.5	13.5	14.5	15.6	16.6
128	11.0	12.0	12.9	13.9	15.0	16.1	17.2

Figure 42. Boarding Float Rotational Displacement Table.

### 304. Gangplanks

#### A. General Requirements

1. Minimum width: 48".
2. Maximum slope: 1:12 (8.33%).
3. The maximum slope of gangplanks at 1:12 is flat enough that cleats are not usually necessary. They often

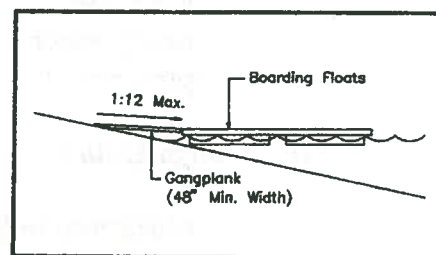


Figure 43. Gangplank Details

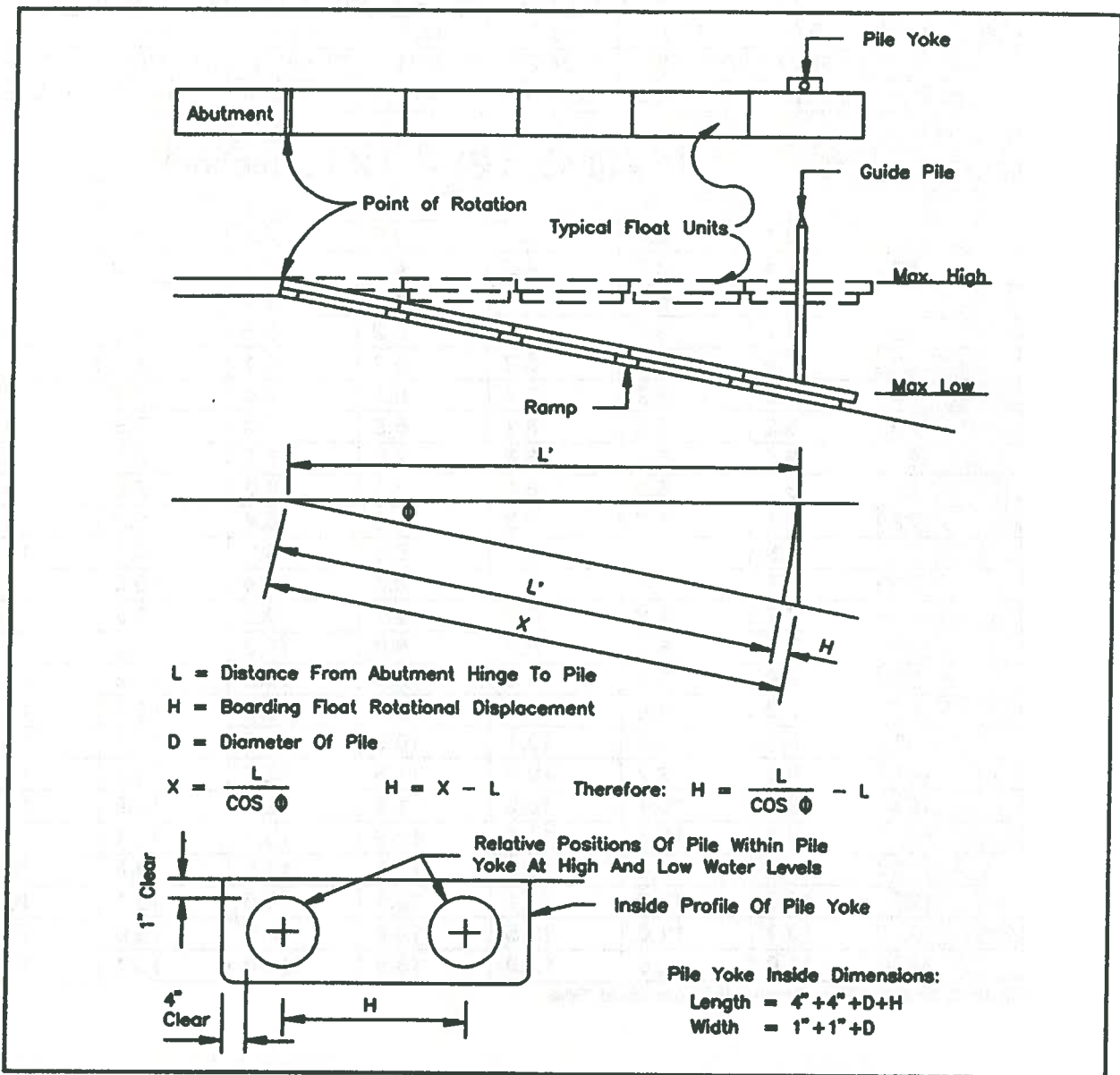


Figure 44. Boarding Float Rotational Displacement Diagram - Basis For Figure 42. Displacement Table

constitute a barrier for handicapped persons using walkers, canes, and heavy electric wheelchairs. At higher elevations where ice may be a problem, 1/4"x 3/4" cleats on 12" centers may be appropriate.

## B. Design Details

1. Maximum height of the lip from the top leading edge of the gangplank to the surface of the launching ramp or other paved surface is to be 1". The 1" maximum gap is to be bridged the full width of the gangplank with a

thin bridging material securely fastened to and flush with the deck of the gangplank. Aluminum plate or 3/8" black conveyor belt material with a rough textured surface works well for this purpose.

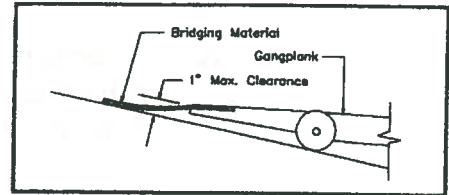


Figure 45. Gangplank Lip Bridge

2. The surface of the gangplank should be "rough" to the extent that safe passage is provided for all persons under wet or dry conditions. Adequate traction can usually be provided through proper choice of materials, coatings, and periodic maintenance.
3. Handrails will not be necessary on gangplanks unless required by special circumstances at a particular site. Handrails typically are obstructions to boat lines, vehicles and persons launching and retrieving boats.

#### Section 4. Shoreside Facilities

##### 401. Parking

###### A. General Requirements

1. Where physically possible, parking areas are to be located immediately adjacent to the launching ramp with all parking spaces within 600' of the head of ramp.
2. There should be sufficient parking spaces to meet the expected demand on a normal peak day during the boating season. The typical minimum parking requirement per launching lane is 20-30 car/trailer spaces. This will vary with the type of waterbody, boating activities allowed, and whether the project is in an urban or rural area.
3. Where land area is severely limited or unusual in shape, individual car or trailer spaces, or a designated trailer-only parking area may be useful in meeting part of the demand for parking.
4. Pull-through car/trailer parking spaces are strongly recommended and should be utilized to the maximum extent possible.
5. A nominal number of car-only parking spaces should also be provided. These can be provided at the ends of rows of car/trailer parking spaces, and/or in small irregular shaped areas not large enough for car/trailer spaces.

6. At certain sites there may be a demonstrated demand for 10'x60' recreational vehicle/boat trailer parking spaces. The number and location of these spaces will be determined by site factors and the actual demand.
7. Additional car-only parking spaces must be provided for picnic, day-use, and other non-boating activities that occur within the project area.
8. Large visual expanses of asphalt paving are to be avoided through the use of appropriately placed planter islands and planter strips. These planter areas should also be used as a primary means of directing and controlling traffic flow and drainage.
9. **Handicap Parking**
  - a. For each type of parking space provided (single space or car/trailer space), a minimum of one (1) parking space near the launching ramp and restroom must be set aside and identified for handicap use.
  - b. In larger parking lots, one handicap parking space must be provided for every 50 car/trailer spaces, and one for every 40 single car spaces.
  - c. Where possible, handicap parking is to be located so that handicapped persons moving to and from their parked vehicles will not be required to travel behind parked cars.
  - d. Handicap ramps or depressed curbs must be provided wherever necessary to cross curbs and other obstructions.
  - e. Handicap parking spaces must be identified with standard symbols and markings on the pavement using reflective white paint. Signs on vertical poles will not be required on pull-through parking spaces.
  - f. For information on handicap accessible curbs and ramps, refer to Section 7103 of the California State Accessibility Standards - Interpretive Manual (Catalog No. 7540-930-1901-0) available from the Department of General Services, Office of Procurement; Documents Section; P.O. Box 1015; North Highlands, California 95660.

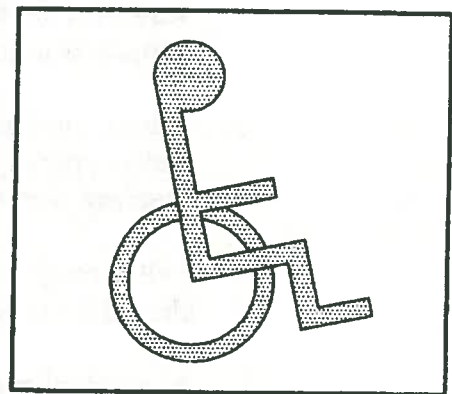


Figure 46. Handicap Symbol



## B. Design Details

### 1. Finish parking lot grades are to be:

- a minimum of 1%
- a recommended maximum of 5%
- an absolute maximum of 10%

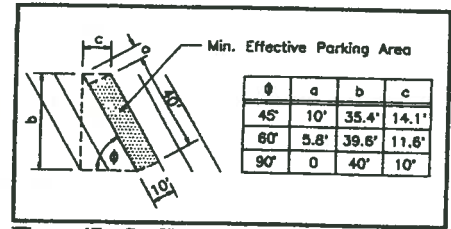


Figure 47. Car/Trailer Parking Spaces

### 2. Parking space minimum dimensions are to be as follows:

- Car/trailer spaces - 10'x40'
- Regular single car spaces - 9'x20'
- Compact single car spaces may be reduced to 8'x18', and are to be identified with a large painted "C" on the paving in the middle of the space.

- Car/trailer handicap spaces are to be 15' wide and 40' long. The parking spaces must be outlined and striped to provide a 10' wide parking area and a 5' wide loading and unloading area.

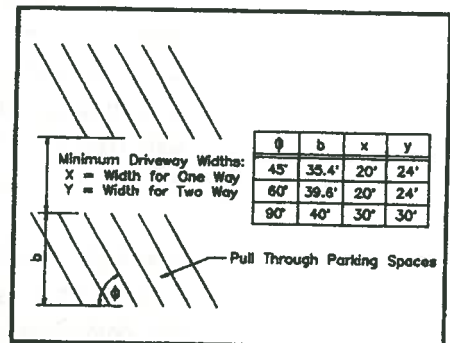


Figure 48. Minimum Driveway Widths

- Single car handicap spaces are to be 14' wide and 20' long. The spaces must be outlined and striped to provide a 9' wide parking area and a 5' wide loading and unloading area.

- When necessary to provide two adjacent handicap parking spaces, two car/trailer spaces can be provided within a 25' wide area lined and striped to provide two 10' wide parking spaces with a common 5' wide loading and unloading area in the center. Similarly, two single-car spaces can be provided within a 23' wide area.

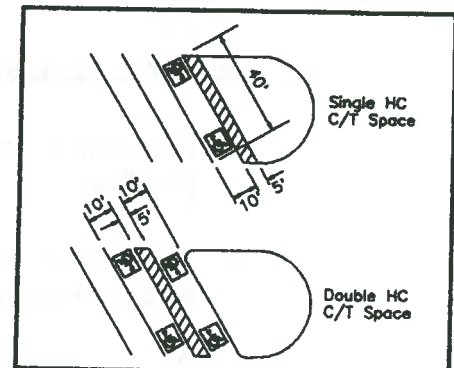


Figure 49. Handicap Car/Trailer Parking Spaces



3. Minimum driveway widths between rows of car/trailer parking spaces:
  - a. 20' for one-way traffic for both 45° and 60° parking
  - b. 24' for two-way traffic for both 45° and 60° parking
  - c. 30' for both one and two-way traffic for 90° parking
4. Unless unusual soil conditions are encountered at a site, 2" AC (asphaltic concrete) laid over 6" AB (aggregate base rock) will usually be satisfactory.
5. Special specifications may be necessary for paving parking areas in unusually hot or cold climates in desert and mountain regions. Specific information can be obtained from district offices of the California Department of Transportation.
6. It is not recommended that a fog seal be applied to the paving until it is approximately one year old. New paving is still somewhat pliable and will continue to compress under traffic loads the first few months following construction. A fog seal applied too soon will quickly break down, will be ineffective and waste construction dollars.
7. Asphalt curbing is economical and serves well for drainage control. However, it is to be avoided where vehicle wheels will impact and/or come to rest against the curb. Wheels will impact and break the curb, particularly during warm summer months when prolonged heat softens the asphalt. Where wheel loads occur, concrete curbs are to be constructed.

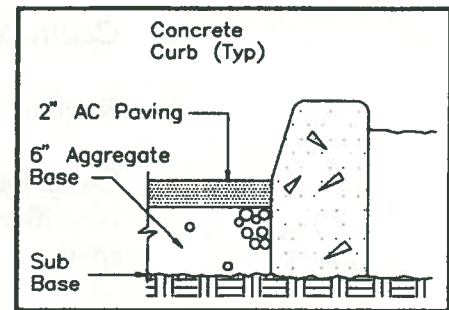


Figure 50. Paving/Concrete Curb Detail.

## 402. Restrooms

### A. General Requirements

1. Restrooms are to be located as convenient to the launching ramp as possible.
2. The restroom architectural design should be compatible with the surrounding area and existing structures.
3. Restrooms must meet all local, state and federal public health requirements.

4. One toilet fixture per sex for each 30 parking spaces (based on the total of all car/trailer and single-car spaces) or fraction thereof should be provided.
5. Trash receptacles should be provided near the launching ramp and restrooms, and elsewhere as required.
6. If shower facilities are necessary, they are to be "cold water showers" only, consisting of a shower head on the outside of the restroom building and a small concrete slab and drainage features.
7. To the extent possible, restroom buildings are to be constructed of vandal resistant, low maintenance materials. Consideration should be given to the following:
  - a. Chrome plated mirrors in lieu of glass mirrors
  - b. Steel doors and steel door frames
  - c. Solid polyethylene toilet partitions
  - d. Reinforced concrete foundation slabs
  - e. Good ventilation
  - f. Urine resistant wall coatings (tile, epoxy, etc.)
  - g. Fire resistant roofing
  - h. Stainless steel or aluminum toilet fixtures
- B. Handicapped access for restrooms must be designed to meet all local, state and federal requirements. For state standards, see the California State Accessibility Standards - An Interpretive Manual (Catalog No. 7540-930-1901-0), available from the Department of General Services, Office of Procurement; Documents Section; P.O. Box 1050; North Highlands, California 95660.

**403. Utilities**

- A. Drinking water fountains should be provided if there is potable water readily available. Fountains must be handicap accessible.
- B. A fresh water boat and engine washdown area should be provided at projects constructed in salt water areas.
  1. A washdown area may have to be monitored, coin operated or otherwise controlled for water conservation. If not, the public will sometimes use it as a free car wash during periods of drought when water use may be restricted elsewhere.
  2. Rubber or vinyl hoses should not be provided. The boaters will learn to bring their own hoses and engine fittings.

3. The washdown area should be located on a concrete slab that is drained and sewered to prevent runoff water from returning to the waterbody.

C. Area lighting is recommended if use conditions warrant.

1. Light standards and fixtures should be selected that will effectively light the launching ramp, parking and restroom areas, but will not be intrusive into adjacent properties.
2. Light fixtures should be directed and/or shielded in such a way that they do not blind boat operators returning to the launching ramp.

3. A light standard and "white-light" fixture approximately 20'-25' high in the vicinity of the head of ramp should be considered for projects where night launching and retrieving occurs. A white light on a standard pole on shore does not violate navigation codes, and serves as a guide to incoming boats for locating the launching ramp at night.

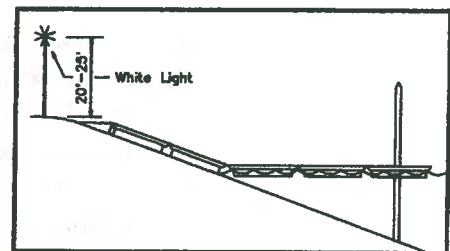


Figure 51. "White Light" at Head of Ramp

- D. **NO OVERHEAD POWERLINES WILL BE PERMITTED** over parking areas, launching ramp areas, driveways, approach areas, and/or any other areas where a vehicle can drive while towing a boat trailer within the project area. This provision is included in this handbook as a safety measure in consideration of the growing number of trailerable sailboats that are equipped with metal masts and rigging hardware that will conduct electrical current.







SECTION 72  
SLOPE PROTECTION

72-1 GENERAL

**72-1.01 Description.**—Slope protection consists of rock, sacked concrete, concrete, concreted-rock or slope paving. The type of slope protection to be used will be designated in the Engineer's Estimate, the special provisions or shown on the plans. The slope protection shall be placed in conformance with these specifications, the special provisions, and the details and dimensions shown on the plans or directed by the Engineer.

72-2 ROCK SLOPE PROTECTION

**72-2.01 Description.**—This work shall consist of placing revetment type rock courses on the slopes.

The size of the individual pieces of rock shall be as indicated in the table in Section 72-2.02, "Materials," or as specified in the special provisions. The classes of rock slope protection are indicated by the average size of the individual piece to be used and will be designated in the Engineer's Estimate as 8-ton, 4-ton, 2-ton, 1-ton, 1/2-ton, 1/4-ton, Light, Facing, and No. 1, No. 2 or No. 3 Backing.

**72-2.02 Materials.**—The individual classes of rocks used in rock slope protection shall conform to the following, unless otherwise specified in the special provisions, or as shown on the plans.

PERCENTAGE LARGER THAN \*

Rock Sizes	Method A Placement					Method B Placement					Backing		
	Classes					Classes					Classes		
	8 Ton	4 Ton	2 Ton	1 Ton	1/2 Ton	1 Ton	1/2 Ton	1/4 Ton	Light	Facing	No. 1	No. 2	No. 3
16-Ton.....	0-5												
8-Ton.....	50-100	0-5											
4-Ton.....	95-100	50-100	0-5										
2-Ton.....		95-100	50-100	0-5									
1-Ton.....			95-100	50-100	0-5	50-100	0-5						
1/2-Ton.....				95-100	50-100	—	50-100	0-5					
1/4-Ton.....					95-100	95-100	—	50-100	0-5				
300-Lb.....							95-100	—	30-100	0-5	0-5		
75-Lb.....								95-100	—	30-100	80-100	0-5	
25-Lb.....									95-100	90-100	90-100	25-75	0-5
5-Lb.....												90-100	25-75
1-Lb.....													90-100

\* The amount of material smaller than the smallest size listed in the table for any class of rock slope protection shall not exceed the percentage limit listed in the table determined on a weight basis. Compliance with the percentage limit shown in the table for all other sizes of the individual pieces of any class of rock slope protection shall be determined by the ratio of the number of individual pieces larger than the specified size compared to the total number of individual pieces larger than the smallest size listed in the table for that class.

The material shall also conform to the following quality requirements:

Tests	California Test	Requirements
Apparent Specific Gravity.....	206	2.5 Min.
Absorption.....	206	4.2% Max.*
Durability Index.....	229	52 Min.*

(72-1)

$$\frac{\text{Coarse Durability Index}}{\% \text{ Absorption} + 1} = \text{Durability Absorption Ratio (DAR)}$$

\* Based on the formula contained herein, absorption may exceed 4.2 percent if DAR is greater than 10. Durability Index may be less than 52 if DAR is greater than 24.

Rocks, when conforming to the provisions in this Section 72-2.02, may be obtained from rock excavation of the roadway prism or other excavation being performed under the provisions of the contract, in accordance with the provisions in Section 4-1.05, "Use of Materials Found on the Work."

Rocks shall be of such shape as to form a stable protection structure of the required section. Rounded boulders or cobbles shall not be used on prepared ground surfaces having slopes steeper than 2 to one. Angular shapes may be used on any planned slope. Flat or needle shapes will not be accepted unless the thickness of the individual pieces is greater than  $\frac{1}{2}$  the length.

**72-2.03 Placing.**—Rock slope protection shall be placed in accordance with one of the following methods as designated in the Engineer's Estimate.

#### Method A Placement

A footing trench shall be excavated along the toe of slope as shown on the plans.

The larger rocks shall be placed in the footing trench.

Rocks shall be placed with their longitudinal axis normal to the embankment face and arranged so that each rock above the foundation course has a 3-point bearing on the underlying rocks. Foundation course is the course placed on the slope in contact with the ground surface. Bearing on smaller rocks which may be used for chinking voids will not be acceptable. Placing of rocks by dumping will not be permitted.

Local surface irregularities of the slope protection shall not vary from the planned slope by more than one foot measured at right angles to the slope.

#### Method B Placement

A footing trench shall be excavated along the toe of the slope as shown on the plans.

Rocks shall be so placed as to provide a minimum of voids and the larger rocks shall be placed in the toe course and on the outside surface of the slope protection. The rock may be placed by dumping and may be spread in layers by bulldozers or other suitable equipment.

Local surface irregularities of the slope protection shall not vary from the planned slopes by more than one foot measured at right angles to the slope.

At the completion of slope protection work, the footing trench shall be filled with excavated material and compaction will not be required.

**72-2.04 Measurement.**—Rock slope protection will be measured by the ton or cubic yard as designated in the Engineer's Estimate.

Quantities of rock slope protection to be paid for by the cubic yard will be determined from the dimensions shown on the plans or the dimensions directed by the Engineer and rock slope protection placed in excess of these dimensions will not be paid for.

Quantities of rock slope protection to be paid for by the ton will be weighed in accordance with the provisions in Section 9-1.01, "Measurement of Quantities."

Quantities of earthwork required in connection with placing rock slope protection will be measured for the type of earthwork involved, all in accordance with the provisions in Section 19, "Earthwork." Full compensation for backfilling footing trenches will be considered as included in the contract price paid for excavating the trench and no separate payment will be made therefor.

**72-2.05 Payment.**—The contract price paid per cubic yard or per ton for rock slope protection (the class of rock and method of placement to be designated in the Engineer's Estimate) shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the rock slope protection, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer, except excavation.

Excavation will be paid for as provided in Section 19, "Earthwork."

**AMERICAN WOOD-PRESERVERS' ASSOCIATION  
STANDARD**

(This Standard is under the jurisdiction of AWWA Committees T-2, T-3 and T-8)

**C18-90**

**STANDARD FOR PRESSURE TREATED MATERIAL  
IN MARINE CONSTRUCTION**

**1. SPECIFIC REQUIREMENTS**

1.1 Piles and timbers in marine construction shall be treated in accordance with the requirements of American Wood-Preservers' Association Standard C1, "Standard for Preservative Treatment by Pressure Processes—All Timber Products," except as supplemented herein.

1.5 Framing.—Pile cutoffs, bolt holes, and field cuts shall be protected in accordance with AWWA Standard M4.

1.51 The lower bracing timbers shall be attached to the piles at a minimum height of 3.5 feet above mean low water for marine structures at sites where the tide range is 6 feet or less, and at middle elevation for tidal ranges exceeding 6 feet.

1.6 Incising.—Required of all species sawn four sides as listed in AWWA Standard C2. See Note D.

1.8 Marking.—All products shall be marked or branded in accordance with AWWA Standard M1.

1.82 Piles.—Each pile shall be branded at points 5 feet and 10 feet from the butt end of the pile unless other measurements are specified by the customer. The standard brand shall be used except that only the length shall be shown on the bottom line of the brand.

where pholad attack is not prevalent, either dual treatment or high retentions of ACA, ACZA or CCA treatment will provide adequate protection.

Section 2.13—In those areas where *Sphaeroma terebrans* or where *Limnoria tripunctata* and pholad attack are expected or known, the dual treatment provides the maximum protection known at present.

**Marine Piling—Specific Requirements of Use for Treated Wood Subject to Exposure of Marine Borers**

Marine Boring Organism	Type of Treatment		
	Creosote and Creosote Solution	Waterborne Preservatives (ACA, ACZA, CCA)	Dual <sup>a</sup>
<i>Teredo</i>	<sup>b</sup> S	S	S
Pholads	S	<sup>c</sup> X	S
<i>Limnoria tripunctata</i>	X	S	S
<i>Sphaeroma terebrans</i>	X	X	S

<sup>a</sup> Method as defined in paragraph 2.13 of C1.

<sup>b</sup> (S) Satisfactory for use where the particular boring organism is present.

<sup>c</sup> (X) Maximum service life will not be obtained when waterborne preservatives are used where *Sphaeroma terebrans* or pholads are known to attack and when creosote and creosote solutions are used where *Sphaeroma terebrans* or *Limnoria tripunctata* are known to attack.

**Round Timber Piles Exposed to Moderate or Severe Marine Borer Hazard**

	Southern Pine, Red Pine	Coastal Douglas-fir	Oak	AWPA Standard
<b>Moderate Borer Hazard</b>				
Creosote <sup>a</sup> -----	20.0	20.0	10.0	C <sup>1</sup>
Creosote solution <sup>a</sup> -----	20.0	NR	10.0	C <sup>3</sup>
<b>Severe Borer Hazard</b>				
<i>Limnoria tripunctata</i> only				
ACA <sup>a</sup> -----	2.50 and 1.50	2.50	NR <sup>2</sup>	C <sup>3</sup>
ACZA -----	2.50 and 1.50	2.50	NR <sup>1</sup>	C <sup>3</sup>
CCA <sup>a</sup> -----	2.50 and 1.50	NR	NR	C <sup>3</sup>
<i>Sphaeroma terebrans</i> , or <i>Limnoria tripunctata</i> and <i>Pholads</i>				
(Dual treatment)				
<b>First treatment</b>				
ACA -----	1.00	1.00	NR	C <sup>3</sup>
ACZA -----	1.00	1.00	NR	C <sup>3</sup>
CCA -----	1.00	1.00	NR	C <sup>3</sup>
<b>Second treatment</b>				
Creosote <sup>a</sup> -----	20.0	20.0	NR	C <sup>3</sup>
Creosote solution <sup>a</sup> -----	20.0	NR	NR	C <sup>3</sup>

See footnotes page 2.

**3. Results of Treatment**

3.1 Retention—pcf. The minimum retentions are listed in the table below. Preservative retention shall be determined by assay method.

Section 1.11—In those areas where *Teredo* and pholad attack are expected or known and where *Limnoria tripunctata* are not prevalent, creosote or creosote solution treatment will provide adequate protection.

Section 1.12—In those areas where *Teredo* and *Limnoria tripunctata* are expected or known and

## Other Members Used in Marine Construction

Material and Usage	Cresosol <sup>1</sup>	Cresosol Solution <sup>1</sup>	Cresosol-Petroleum	Pentachlorophenol	ACC	ACA	ACZA	CCA	AWPA Standards
<b>Timber and Plywood in Salt Water Use:</b>									
Southern Pine -----	25.0	25.0	NR <sup>3</sup>	NR	NR	2.50	2.50	2.50	C2, C3
Coastal Douglas-fir and Western Hemlock -----	25.0	NR	NR	NR	NR	2.50	2.50	2.50(E)	C2, C3
Plywood -----	25.0	25.0	NR	NR	NR	2.50	2.50	2.50	C2, C3
<b>Members Out of Water But Subject to Salt Water Splash and / or Ground Contact:</b>									
<b>Timber, Lumber and Plywood:</b>									
Southern Pine, Coastal Douglas-fir, Western Hemlock -----	12.0	12.0	12.0	0.60	NR	0.60	0.60	0.60(E)	C2, C3
<b>Members Out of Water and Not Subject to Salt Water Splash and Not in Soil Use:</b>									
<b>Timber, Lumber and Plywood:</b>									
All Softwood Species listed in AWPA Standard C2 -----	10.0	10.0	10.0	0.50	0.50(E)	0.40	0.40	0.40(E)	C2, C3
<b>Structural Lumber in Salt Water Use:</b>									
Southern Pine -----	25.0	25.0	NR	NR	NR	2.50	2.50	2.50	C2
Coastal Douglas-fir, Hemlock -----	25.0	NR	NR	NR	NR	2.50	2.50	2.50(E)	C2
<b>Structural Lumber in Salt Water—Dual Treatment</b>									
<b>Southern Pine:</b>									
First treatment -----	NR	NR	NR	NR	NR	1.50	1.50	1.50	C2
Second treatment -----	20.0	20.0	NR	NR	NR	NR	NR	NR	C2
<b>Coastal Douglas-fir, Western Hemlock</b>									
First treatment -----	NR	NR	NR	NR	NR	1.50	1.50	1.50(E)	C2
Second treatment -----	20.0	20.0	NR	NR	NR	NR	NR	NR	C2

<sup>1</sup> When these preservatives are specified for material to be used in salt water, the creosote solution shall conform to AWPA Standard P2, and the creosote shall conform to AWPA Standard P1.

The assay retentions for southern pine and red pine are based on two assay zones—0 to 0.50 inch and 0.50 to 2.0 inches.

NR—Not Recommended.

<sup>3</sup> Creosote solution will conform to AWPA Standard C2. Creosote shall conform to AWPA Standard P1.

<sup>4</sup> All footnotes, including (E), refer to those of Standard C2. Footnote (E) refers to Note E of C2 and is applicable to individual species, sawn four sides.