A

GUIDE TO MAINTENANCE AND OPERATIONS

OF

SMALL CRAFT HARBORS

Prepared by:

PERATROVICH, NOTTINGHAM & DRAGE, INC.

Engineering Consultants

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PREFACE

This report, prepared by Peratrovich, Nottingham & Drage, Inc. (PN&D), is the first of its kind in the state of Alaska, and was published to assist operators of small craft harbors in the maintenance and operation of their harbor facilities. Consequently, although there may be differences of opinion on some of the subject matter and the manner in which it is presented, it is believed that the information presented will be beneficial to the small craft harbor operator.

Maintaining small craft harbors in a condition to provide safe usage is the primary function of this report. Protection of the investment in the structure facility through well programmed repairs and preventive maintenance is second only to public safety and to the structure itself. To achieve the desired result requires constant alertness and thorough inspection procedures.

This report has been prepared to serve as a guide and to provide uniformity in the procedures and policies of determining the physical condition and maintenance needs of a small craft harbor. The procedures for correcting known deficiencies are outside the scope of this report and no attempt has been made to cover this field.

This report is a guide only and no legal responsibility for interpretation by others is inferred.

Preparation of the report was initially developed by PN&D for the Alaska Department of Transportation and Public Facilities (DOT/PF) Standards Division in Juneau, Alaska, for the intended use by Alaska operators. However, it was soon discovered that the information within would also be applicable to areas outside of Alaska. If the reader has any questions or suggestions or improvements, please contact Peratrovich, Nottingham & Drage, Inc., at any of their following addresses:

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Cover: 1988 photo of Valdez Small Boat Harbor in Valdez, Alaska

ABSTRACT

Guidelines and procedures are presented in this report for use in the development of Maintenance and Operations procedures for systematically monitoring and evaluating the condition of small craft harbor facilities. The report is published to assist local agencies and operators of small craft harbors in maximizing the efficient use and minimizing maintenance in small craft harbors.

Typical components of a small craft harbor are identified and described. General procedures for their efficient operation and maintenance are outlined.

The report is limited in scope to small vessel facilities. Accordingly, only timber and concrete floats with timber and steel piling are discussed.

The report emphasizes the importance of systematically maintaining continuing records that give an accurate historical account of performance and problems. In this way those persons responsible will have adequate background information for making decisions affecting maintenance and operations of their harbor facilities.

CHAPTER 1
INTRODUCTION

1.01 The Report

This report was originally developed for the State of Alaska and local government agencies responsible for maintenance and operations of most of the small craft harbor facilities in Alaska. A telephone survey of managers of small boat harbors in Alaska as well as different areas of the nation was taken in 1985 as a part of this effort.

1.02 Philosophy

The purpose of this report is to establish uniform guidelines for developing simple procedures which will provide a common approach for identifying, recording, and communicating harbor maintenance and operations problems and requirements.

Inspection of small craft harbors and the permanent inner harbor facilities should be performed on a regular, periodic basis (1-2 years as appropriate) and as need arises during or following severe events (storms, earthquakes, etc.). The purpose of these inspections is to verify that all components are performing as expected; to note needed maintenance; to bring needs to the attention of appropriate personnel; and to serve as an independent monitor to verify effect of standards of performance such as maintenance and design and construction procedures. As a structure becomes older some maintenance is to be expected, thus it is imperative that good continuing records are kept that give an accurate, historical account of performance and problems. In this way harbormasters will have adequate background information for making decisions.

With proper maintenance and inspection, harbor facilities can be periodically evaluated, allowing time for proper planning and review of options, and obtaining adequate funding.

Inspection of harbor components (includes the basin, adjoining uplands and all physical features which need to be maintained) is difficult for the untrained person because of the complexity and variety of elements that may require investigation and interpretation. Additionally, with everyday exposure even knowledgeable harbor personnel will tend to miss long-term condition changes. A systematic procedure will greatly aid the less experienced as well as the experienced inspector and limit critical oversights.

Because of the sometimes overwhelming number of elements that make up small craft harbors and the limitations of this report, we have selected a series of potential major high maintenance components for inspection and discussion. Other components may also be important and should be periodically inspected, but these selected major harbor components are what we have found to be the cause of most concern to harbormasters at this time. A brief description of the purpose and relative function of each component is provided in this report as well as a level of performance or expectations required for the component. To document results of the inspection, a recommended inspection report form has been developed with space provided for comments, cost estimates and recommendations. Appropriate distribution of the completed inspection reports will assure that problems are brought to the attention of the harbor owner and appropriate regulatory agencies.

Historical inspection records as well as applicable documents for each boat harbor, including updated photographs of key components, updated as-built plans, and specifications of all components, must be maintained in a central file. It may be necessary at some future date to refer to these when problems arise or details need verification or clarification.

1.03 Limitations

This report covers maintenance and operation procedures for facilities and construction materials which are common to many small craft harbors. Included are timber and concrete float systems which utilize polystyrene as the inner flotation material, timber and steel pipe piles for anchor piles,

utilities, upland facilities and other support facilities that are used for access to and repair of vessels utilizing the harbor.

1.04 High Maintenance Components

Personal experience with small boat harbors coupled with responses received from interviews as well as the questionnaires returned by harbormasters, led to identification of critical elements or components within harbors that are chronic high maintenance items. Some of these major items include electrical plug-ins and junction boxes, overhead wiring and lighting, float-to-float connections, anchor pile to float connections, float settlement (sinking), planking for ramps on boat launches, gangways, restroom/shower facilities, lack of mooring space and/or congestion within the harbor, and leaky water systems. The degree and time before a component becomes a major maintenance concern is a function of how well the component has been regularly maintained and how well the component was originally designed and constructed.

If the component is severely damaged during its design life, its life expectancy may be foreshortened accordingly. Similarly, if the original design or construction was not completed correctly or adequately, then normal wear and tear may increase maintenance requirements considerably and also reduce the useful life of the component and overall effectiveness of the harbor.

1.05 Standards of Performance

In a well-developed harbor, each component within the harbor should have been made from materials that were carefully selected for their expected use. Performance of these components, therefore, is highly dependent upon the condition of these materials.

For this reason, it is necessary to develop a level of expectation via the establishment of standards of performance for operations and maintenance.

In Chapters 3 through 10, a partial list with brief discussions of major harbor components that are chronic maintenance items has been provided. To assist the user when inspecting existing boat harbor components, we have provided general descriptions of these elements as well as the level of performance normally expected of them. These examples should only be used as a measure of potential problem areas. A suggested checklist of critical components for each chapter is summarized at the end of Chapter 2, which should be included in any inspection checkoff sheet. From this list, harbormasters can develop an inspection checkoff sheet specific to each harbor. The examples are not intended to cover all situations or areas of concern, but only to highlight those components that historically have been a problem to harbormasters.

CHAPTER 2
HOW TO PREPARE A MAINTENANCE FILE AND CHECKLIST

2.01 Recommended Procedures

This report has been developed to be used as a guide to each community for their use in the development of a maintenance file and checklist for monitoring the condition of facilities within their small boat harbor. Additionally, it can help to evaluate the relative performance of their existing facilities and to guide them in the proper selection of facilities for future development.

By following the recommended steps laid out in this report, preparation of a maintenance file will primarily consist of developing a checkoff list of critical components. Damaged, worn or other noteworthy items will be documented as detailed in the example inspection form.

STEP I — Locate (or develop) up-to-date as-builts for facilities to be inspected. An up-to-date complete file of all harbor items is an important component as a reference and historical or active comparison for all parties. As-builts should include copies of the contract drawings and specifications used for construction in the harbor including soils exploration data, pile driving logs, special material specifications and navigation control permit requirements as well as other related regulatory agency requirements, and names of former contractors and engineers. Reference specific facilities (items/components) on as-built. These should be tied to some simple location system so that exact references to components can be made simply without chance of error (for example: "Float A, Finger 5"). Most harbors already have such an identification system in place.

STEP II — Determine items to be inspected.

STEP III — Refer to appropriate chapters of this report and become familiar with those items and the checklist following each chapter.

STEP IV — Locate specific as-builts for those items and copy enough inspection forms.

STEP V — Systematically inspect the items listed for the component and read the text of the manual for corresponding descriptions and record conditions on the inspection form.

STEP VI — Items requiring attention should be photographed and described on form. Be sure to check appropriate box flagging when future action should be taken. Photographs in space provided on form.

STEP VII — Items which do not meet appropriate standards based upon this inspection may constitute a hazardous situation. If immediate corrections are not possible or planned, serious consideration should be given to posting warning signs. Such signs should be located in well-lit areas and where harbor users can see the sign before the hazard is encountered. Although such signs are no substitute for correction of the problem, they may help the operating agency in avoiding liability problems.

It is suggested that floats be inspected twice a year, preferably in the spring and fall, or after any potentially damaging extreme event. Other items should be inspected annually with the exception of underwater inspections, which should be performed less frequently. Floats having large vessels moored to them or considerable rafting on a regular basis, are often more susceptible to wear and tear; therefore, more attention should be given to these floats to evaluate their capacity to accommodate these larger vessels loads.

2.02 Inspection Form

ITEM CONDITION SHEET

INSPECTOR: _____ DATE: _____

PHONE NUMBER: _____ CITY: _____

TITLE OF PHOTO: _____ HARBOR: _____

LOCATION CODE ON AS-BUILTS: _____

- o New Damage
- o Old Damage
- o Repeat Damage
- o Normal Wear Item
- o Vessel Impact Damage
- o Storm Damage
- o Design or Construction Deficiency
- o Immediate Action
- o Annual Maintenance
- o Improvement
- o Recheck Next Year

DESCRIPTION:

_____

_____

_____

REMARKS:

_____

_____

_____

ESTIMATE OF COSTS

Operations and Maintenance Expense:	$_____
Construction Repair Expense:	$_____
Engineering and Contract Administration Expense:	$_____
TOTAL ESTIMATE	$_____

REPAIRS

- o In-House
- o Engineering Required
- o Outside Help

No. of Attachments:_____

2.03 Example Inspection Form

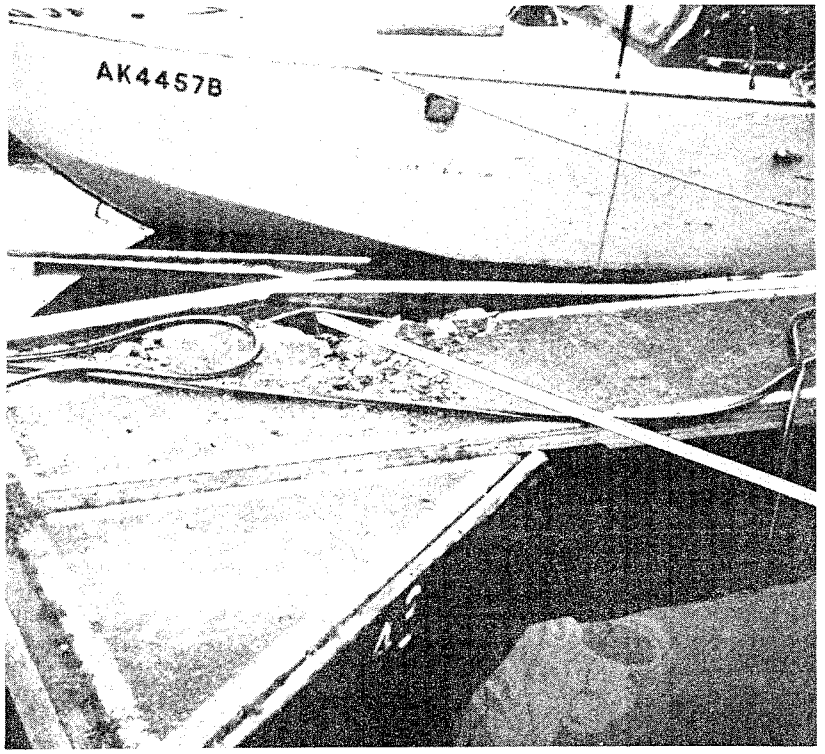
ITEM CONDITION SHEET

INSPECTOR: Bill Gunderson, Peratrovich, Nottingham & Drage DATE: 8/15/88

PHONE NUMBER: (907) 561-1011 CITY: Juneau

TITLE OF PHOTO: 24' Float Finger Damage HARBOR: Aurora

LOCATION CODE ON AS-BUILTS: 44



- o New Damage
- ● Old Damage
- o Repeat Damage
- o Normal Wear Item
- o Vessel Impact Damage
- ● Storm Damage
- o Design or Construction Deficiency
- ● Immediate Action
- o Annual Maintenance
- o Improvement
- o Recheck Next Year

DESCRIPTION: Float 3'- 2" x 10', 5-1/8" x 7-1/2" x 24' glulam and 3' x 4' knee brace, damaged during Thanksgiving Day storm 1984. See layout attached for location.

REMARKS:

ESTIMATE OF COSTS

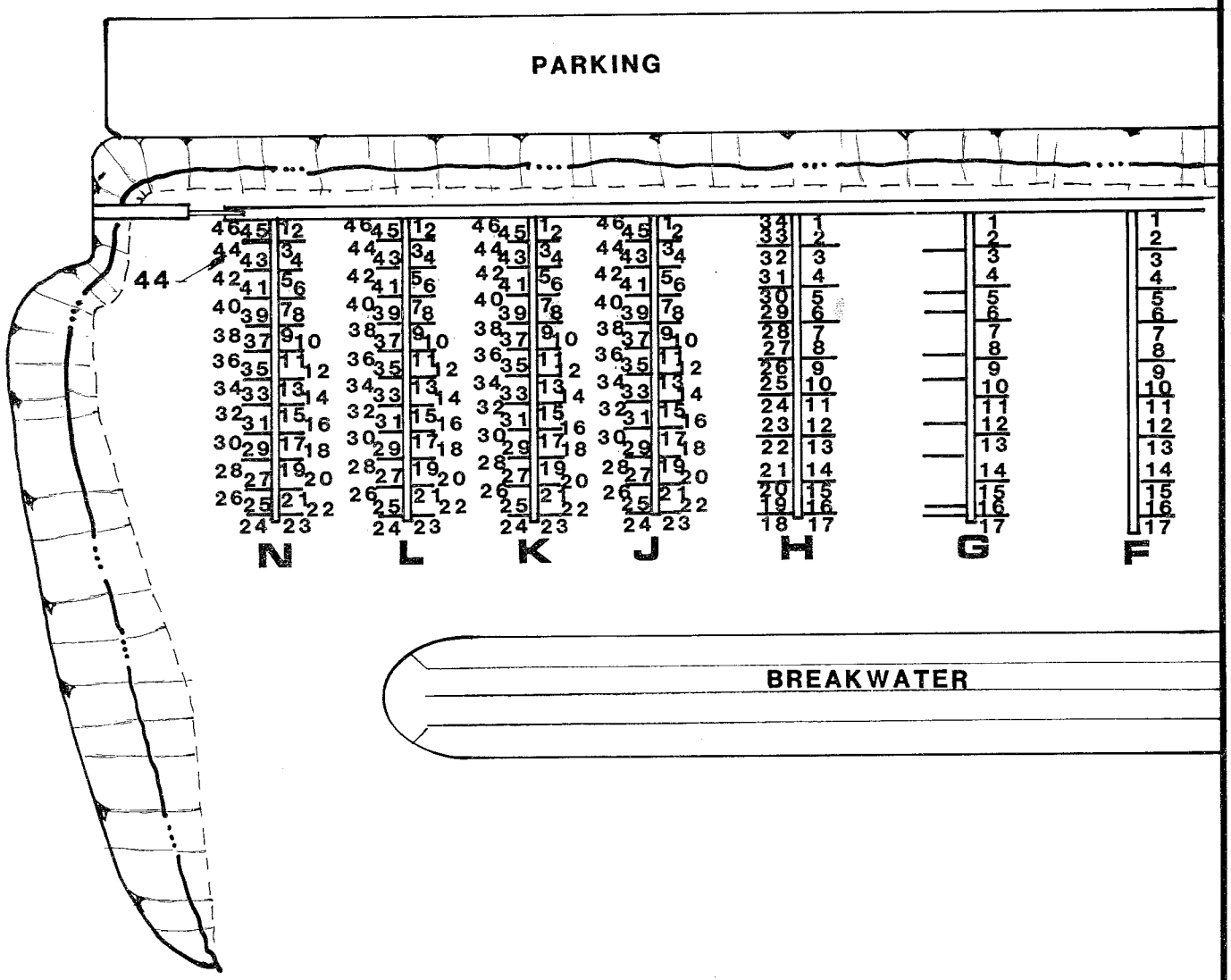
Operations and Maintenance Expense:	$ -0-
Construction Repair Expense:	$ 5,000
Engineering and Contract Administration Expense:	$ 500
TOTAL ESTIMATE	$ 5,500

No. of Attachments: 1

REPAIRS

- ● In-House
- o Engineering Required
- o Outside Help

EXAMPLE



NORTH END AURORA HARBOR
JUNEAU, ALASKA

LOCATION OF 24' FINGER FLOAT DAMAGE

Peratrovich, Nottingham & Drage, Inc.
Engineering Consultants

2.04 Checklist Items

Checklist Items for Chapter 3

FLOATS
- Bullrail and Cleats
- Decking
- Walers
- Flotation (Billets)
- Float-to-Float Connections
- Pile-to-Float Connections
- Utility Chase or Hangers

ANCHOR PILES
- Timber Piles
- Steel
- Connections

WATER SYSTEM
- Leaks
- Pressure
- Functioning Faucets/Valves
- Spacing

ELECTRICAL
- Meter Stands
- Condition
- Spacing
- Working Order
- Lighting System
- Overhead Lines
- Spacing
- Working Order

FLOAT SAFETY
- Freeboard
- Power Lines
- Gear on Floats
- Hazardous Materials or Floats
- No-Skid Decking
- Night Lighting Adequacy

Checklist Items for Chapter 4

GANGWAYS
- Top Chord
- Web Members
- Bottom Chord
- Races
- Hinge
- Sidesway
- Skid Resistant Surface
- Steepness
- Float Buoyancy

Signing
Lighting

APPROACH DOCKS
Railing
Bullrails
Decking
Stringers
Girders
Piles
Fill

Checklist Items for Chapter 5

BOAT HOUSES
Framing
Supports
Flotation (Freeboard)
Anchor Piles
Condition with Snow Load
Signing
Connections

SEAPLANE FLOATS
Bullrails
Deck Condition
Flotation (Freeboard)
Anchor Piles
Connections
Pile-to-Float Ramp Details

PLATFORMS
Flotation (Freeboard)
All Connections
Anchor Piles
Deck Condition

FISH CLEANING AREAS
Connections
Structure Condition
Adjoining Connections
Subsurface (Seafloor Debris)

Checklist Items for Chapter 6

DOCKS AND VESSEL HAULOUTS
Railing
Bullrail
Decking
Stringers
Girders
Piles
Cross Bracing
Fill
Cathodic Protection System

Fenders
Ladders
Signing
Lighting

BULKHEADS
Face Alignment
Corrosion
Loose Panels
Fill Loss

VESSEL GRIDS
Fill
Lighting
Access Dock or Catwalks
Vertical Piles
Batter Piles
Cap Beam
Piles
Rubstrips

BOAT RAMPS
Slope
Panel Condition
Panel Connections
Side Slope Condition
Grade Beam (if planks are settling)
Courtesy Float
Anchor Piles
Signing
Lighting

FUEL DOCKS
General Location
Flotation (Freeboard)
Fuel Leaks
Signing
Gangway Condition (etc.)
Office Condition
Float Condition (see Chapter 1)
Dock Condition (see 5.01)

MARINE RAILWAYS
Trolley
Sideracks
Rail Connections/Splices
Caps
Support Piles/Fill
Cables
Winches
Upland Area
Signing
Lighting

Checklist Items for Chapter 7

TRAFFIC PATTERNS/CONGESTION
- Points of Congestion

NAVIGATIONAL CONTROLS
- Lighting
- Speed Limits
- Signing

DERELICT VESSELS AND LONG-TERM STORAGE
- Water Storage Area
- Security
- Lighting
- Signing
- Hydrant Location
- Extinguisher
- Extinguisher Condition and Location

TRANSIENT USE
- Adequacy
- Location
- Float Condition
- Dock Condition
- Lighting
- Signing

Checklist Items for Chapter 8

PARKING
- Adequate Number
- Adequate Size
- Traffic Pattern
- Signing
- Lighting
- Pavement
- Striping

STORAGE
- Security
- Adequate Space
- Adequate Size
- Lighting
- Water Service
- Electrical Service
- Disposal Units

UTILITIES AND SERVICES
- Lighting
- Dump Stations
- Telephone Condition and Location
- Hydrants
- Garbage Facilities
- Washdown Areas

STRUCTURES
- Restrooms
- Harbormaster's Office
- Equipment and Maintenance Shop

DRAINAGE AND EMBANKMENT
- Slope Grades
- Catch Basins
- Riprap
- Filter Fabric

Checklist Items for Chapter 9

BATHYMETRY
- Map Bathymetry
- Adequate Depth
- Signing

RUBBLE-MOUND BREAKWATER
- Riprap Condition
- Signing
- Lighting

FLOATING BREAKWATERS
- Decking
- Walers
- Connections
- Flotation (Freeboard)
- Anchor System (Underwater)
- Stationing (Proper Location and Alignment)

Checklist Items for Chapter 10

SIGNS

Locations That May Require Signage:
- Dock Load Limitation and Access
- Boat Grids Limitations
- Boat Ramp Regulations
- Pedestrian Gangway Limitations
- Restrooms
- Parking Areas
- Disposal Sites
- Fire Facilities
- Telephones
- Basin Depths
- Speed Limits
- Traffic Direction
- Fuel Dock Safety
- Utilities
- Sea Plane Floats

Check Condition of Signing
Check for Compliance with Appropriate Standards

CHAPTER 3
FLOAT MOORAGE SYSTEM

3.01 Floats

3.01.01 Timber Floats

Timber floats are the most common and the least expensive type of modern float system currently in use. Life expectancy (or point in time when the maintenance costs override the usefulness (benefits) and/or the facilities are no longer safe to use) for timber floats is normally expected to be between 20 and 40 years, depending on the adequacy of design, construction, maintenance, actual usage, environment, etc. Portions of timber floats are subject to wood rot where timber is untreated, drilled after treatment, or damaged. A concerted effort should be made to locate and inspect these potential rot areas. Cracked or damaged timber should be noted and replacement recommended. The deck surface may also be unduly slippery when wet; a textured surfacing may be required in order to further reduce liability.

Connections between floats and float-to-anchor piles are high stress areas and should be inspected thoroughly for wear, rust, cracks in welds, corrosion, or cracked coating which may indicate structural damage. Connections should be checked for missing bolts, plate slippage, or indications of excessive wear or movement of connected parts. Damaged cleats and bullrails used to tie up vessels should be repaired or replaced as needed.

Flotation billets, if uncoated, will eventually absorb water or deteriorate if exposed to fuel spills, and may become unevenly buoyant. Tilted or uneven floats should be identified, monitored and recommended for repair or replacement as required. Floats should be restabilized by adding additional (coated) billets under the affected area.

Snow and ice removal requirements are best developed by each local community based upon individual need and liability concerns. The use of carpeting or other non-skid type material could be added to each finger where individual stall users are typically responsible for snow and ice removal.

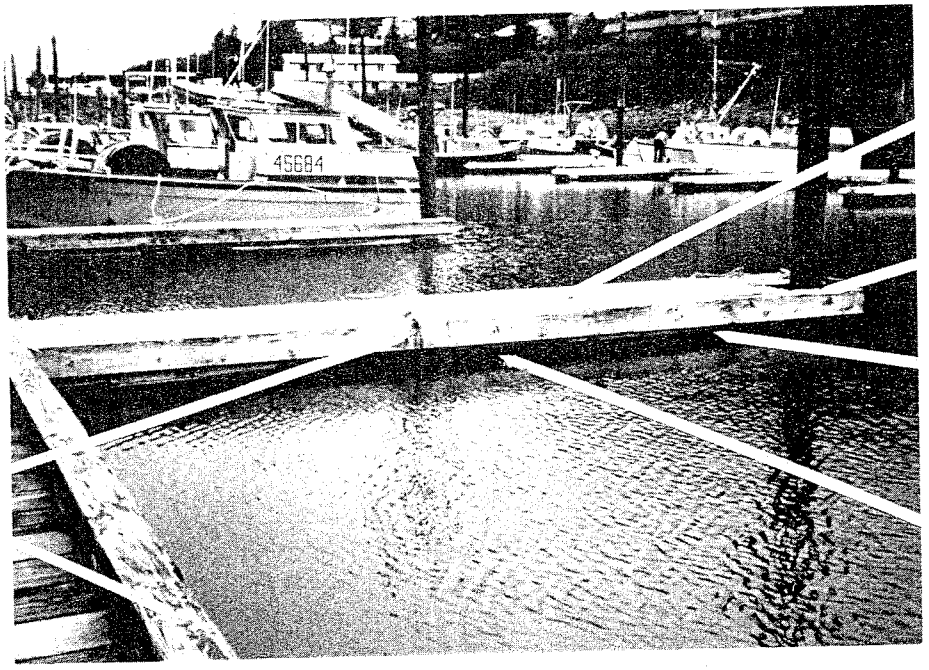
3.01.02 Concrete Floats

Concrete floats are normally expected to have a life expectancy of at least 30 years, if properly utilized and maintained. The major structural elements of a concrete float system are the walers. (Walers are horizontal structural members located near the top of the floats that are used to connect the floats together. They are usually wood, but could also be steel.) Damaged walers must be repaired as soon as possible to prevent further serious damage. Metal float-to-float and float-to-pile connections should also be thoroughly inspected for wear, corrosion, cracks in welds or cracks in the protective coating which could denote high stress deformation. All connections should be checked for missing bolts, plate slippage, or indications of wear or unanticipated movement of connecting parts. All through rods, nuts, and washers should be accounted for and should be tight. Dissimilar metal connections should be checked for corrosion and eliminated if possible.

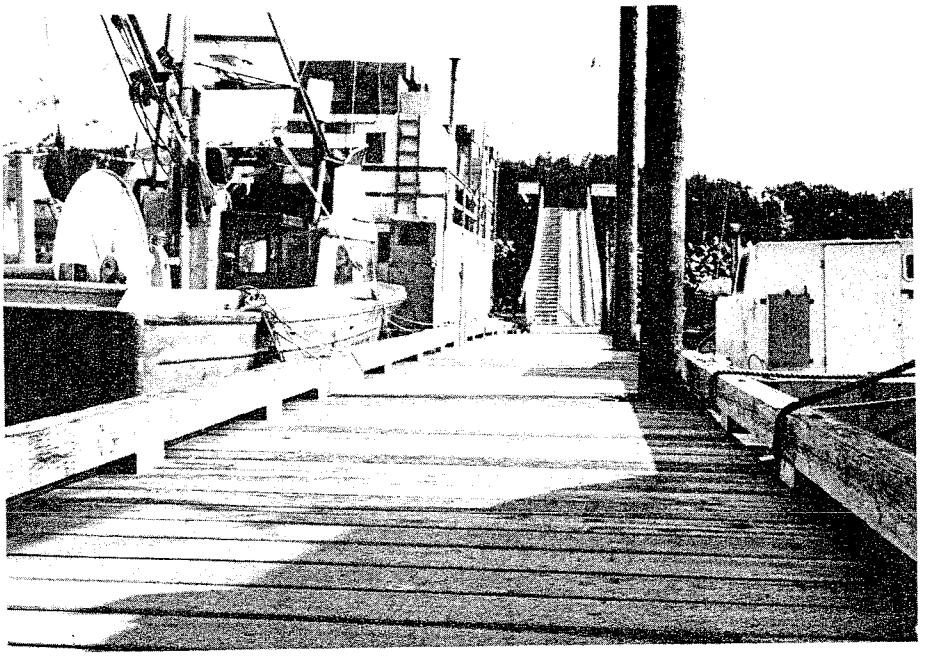
The concrete float unit itself should be relatively inert and highly wear-resistant. Any damaged or spalled concrete deck surfaces should be repaired to prevent exposure of the reinforcing steel within the concrete. Once exposed, corrosion of the reinforcing steel will often cause spalling of the concrete.

Indications are that the use of lightweight concrete may result in a lower life expectancy than when standard mineral aggregate is used. Additionally, good quality control is required during the fabrication of the floats to ensure maximum concrete resilence.

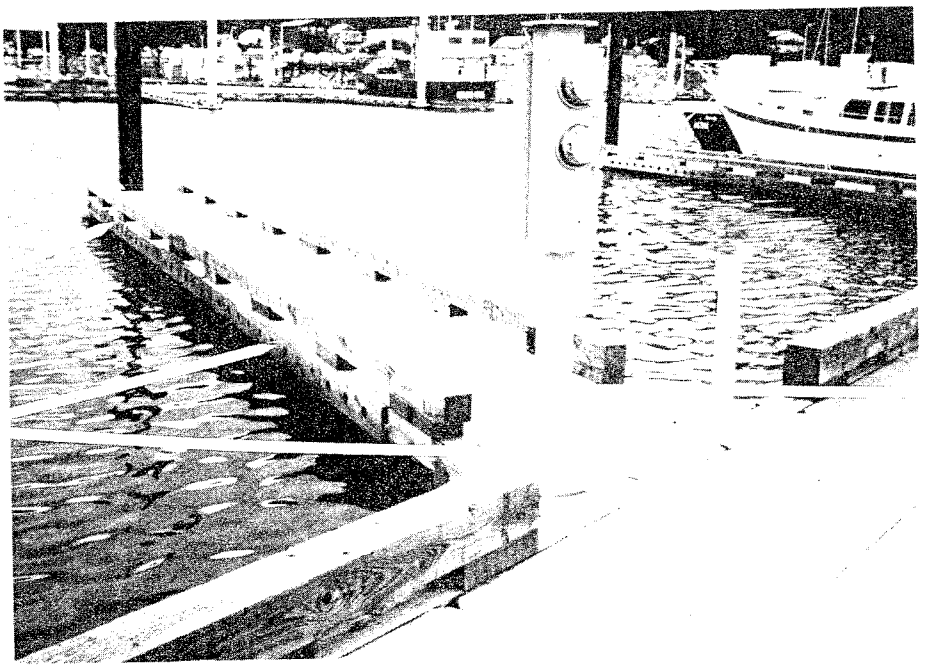
Inspectors who find spalled, worn or discolored concrete with the float system can be relatively certain that the problem is due to either lack of quality control in the factory or use of lightweight concrete. Concrete damage due to mechanical wear, such as at loose connections, can usually be



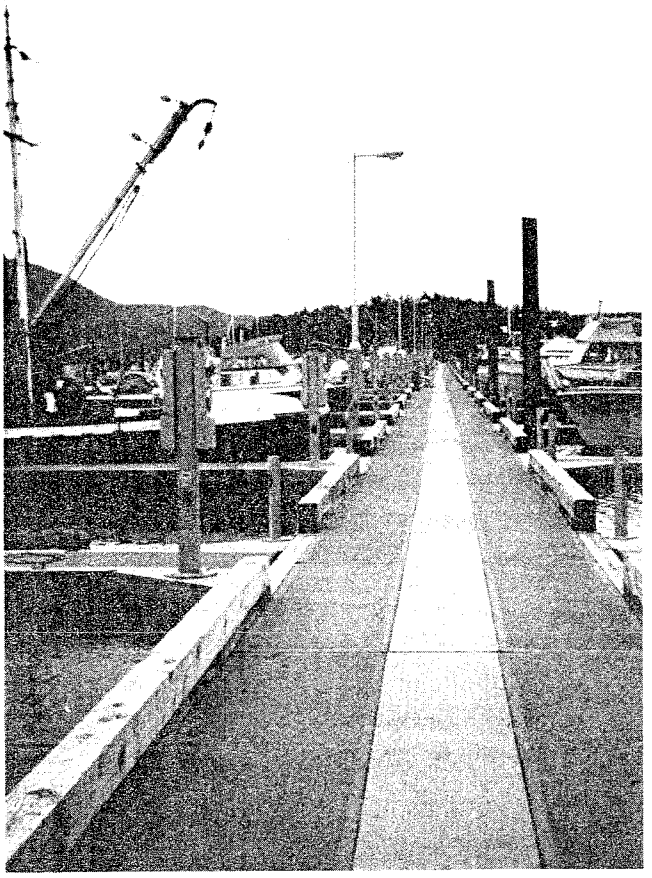
TIMBER FINGER FLOAT



TIMBER MAIN FLOAT



CONCRETE FINGER FLOAT



CONCRETE MAIN FLOAT

distinguished from the latter causes by close inspection. However, careful notation, good records, and a clean photograph will help determine the origin of the problem.

3.02 Anchor Piles

Anchor piles are either wood or steel piling that are used to secure the floats to the harbor bottom. Anchor piles should be checked for wear and decay (wood rot, marine borers or corrosion). Steel anchor piles should be periodically checked during the extreme lowest tides to determine the extent of wear or metal loss. Areas subject to contact at float-to-pile connections and at pile areas below Elevation 0.0' MLLW are the most susceptible to metal loss due to corrosion.

Timber piles damaged due to marine borers must be inspected underwater. Typically, however, timber piles that are pressure treated with proper preservatives will last for the intended design life of the facility unless mechanically damaged. Untreated wood should not be used as the life expectancy is minimal and could be less than three years in some environments.

At extreme high water the cutoff tops of the timber piles should be checked for wood rot. This type of pile damage may not be a serious problem unless the pile is used as a light pole support or if the pile is near the end of its useful life. Timber piles should be coated with a preservative treatment at the time of cutoff. The top of the timber piling should also be protected, such as with copper nails driven into the top followed by an aluminum cap plate or fiberglass cone-shaped cap.

3.03 Water and Electrical

Water and electrical systems have had some of the highest maintenance costs within small craft harbors.

Water lines and outlets must be checked for leaks and frozen sections with greater frequency than any other item. Much of the water distribution system within a floating moorage system in cold climates may be carried under water (to prevent freezing). The Uniform Fire Code requires that fire water distribution lines be kept dry if exposed to freezing temperatures. Periodic line pressure checks should be made to determine the degree of pressure loss due to submerged leaks. Good records must be maintained of each test describing location and results of testing.

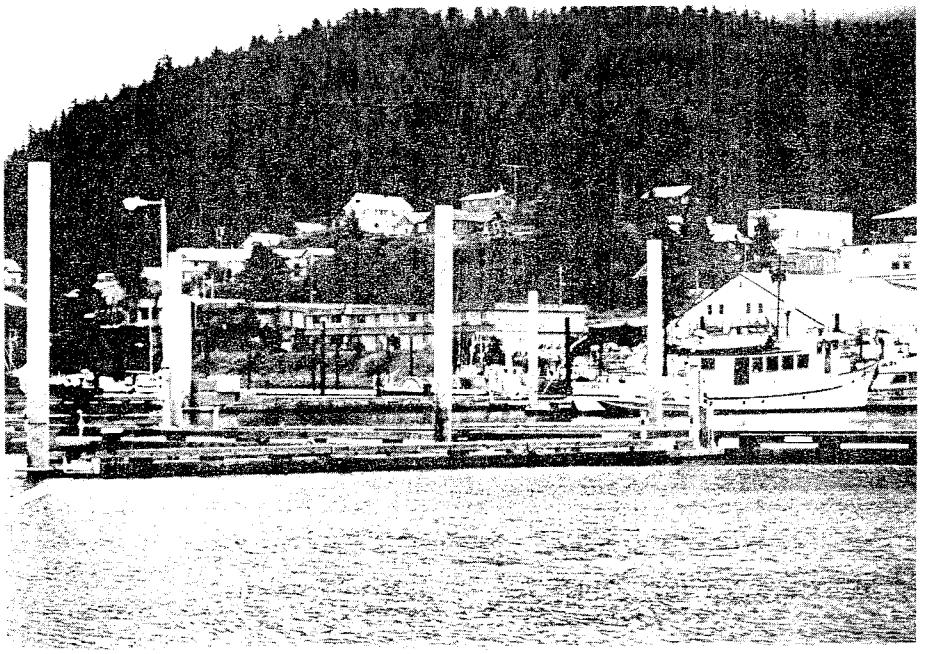
Electrical systems have been the highest maintenance item within most small craft harbors (though most electrical repair work is delayed until need for total replacement is warranted). Meter stands and plug-in outlets are continually being damaged by vessel contact, corrosion and improper usage. Overhead transmission lines damaged by vessel contact and adverse weather can also become dangerous to the harbor users. The use of overhead transmission lines for providing electricity, however, is common within small boat harbors, but this practice may not meet the National Electrical Code (NEC) requirements for clearance. For example, the code requires 18 feet minimum vertical clearance and 3 feet horizontal clearance for electrical transmission lines over areas used for recreational activity. However, very few harbors in areas with considerable tidal differences meet the requirement. If these clearances are not met, however, it is recommended that immediate measures be taken to bring this condition up to code.

An item of major concern is the indiscriminate use of dissimilar metal in the marine environment. Where copper/aluminum alloy components are used, localized battery action can take place that eventually will cause extensive maintenance. Attention to water tightness and material components are critical with marine electrical systems.

Annual inspections should include visual inspection of all meter bases, exposed wiring, light fixtures, etc. Wiring which is not exposed or readily observable may be inspected for damage by infra-red testing. Additionally, periodic questionnaires or meetings with vessel owners could help track electrolysis problems within small boat harbors. Electrolysis is one of the most complex and

STEEL PILES

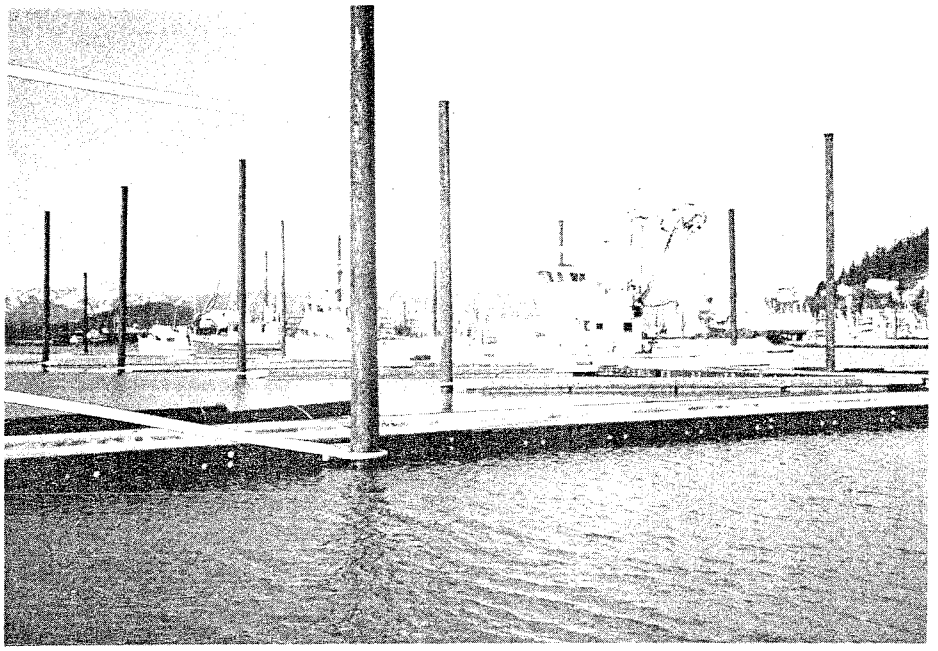
CONNECTIONS



STEEL PILE ANCHOR PILES

TIMBER
PILES

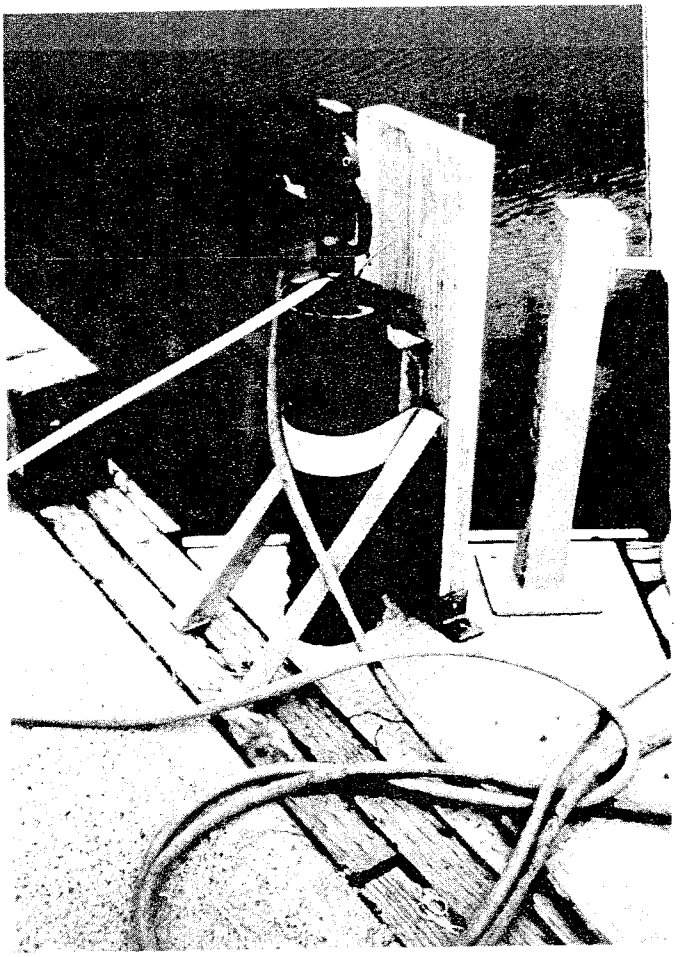
CONNECTIONS



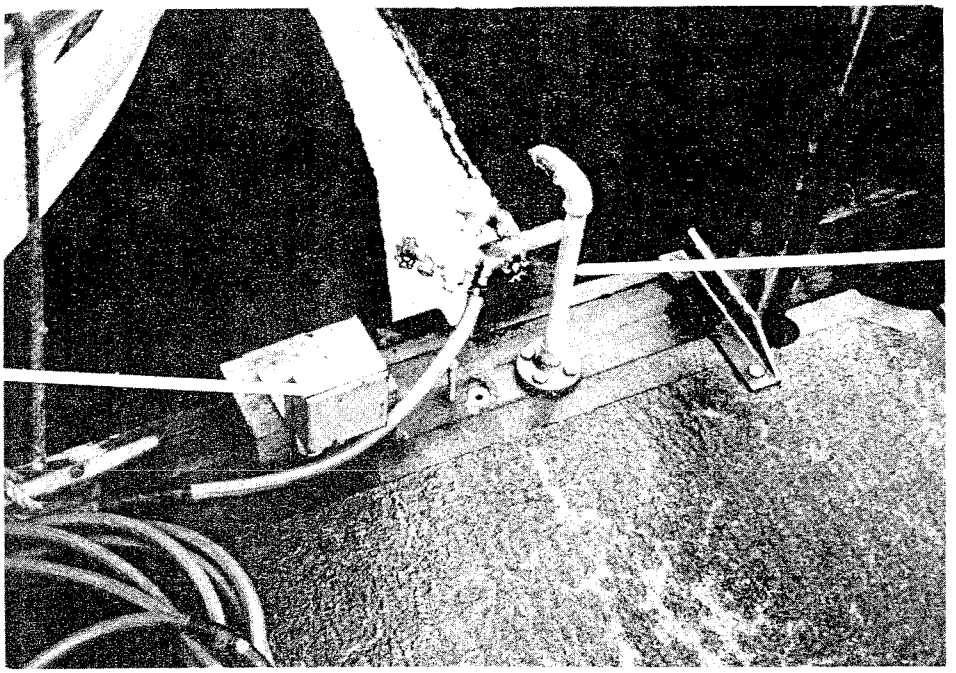
TIMBER ANCHOR PILES

WATER SYSTEM

ELECTRICAL (Power)



WELL-PLANNED WATER STATION

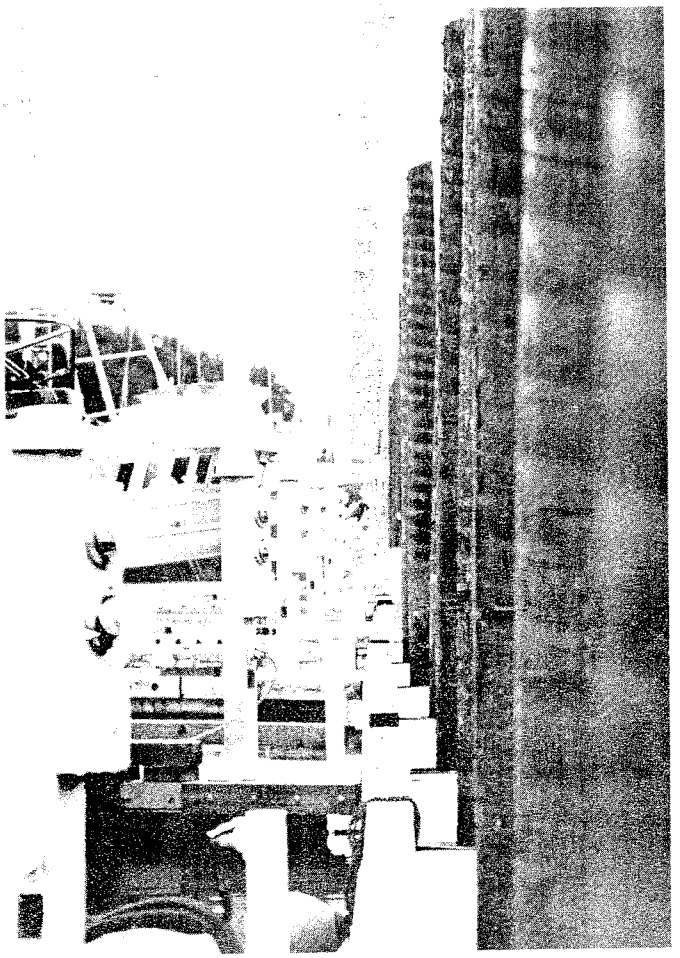


ELECTRICAL (Power)

WATER SYSTEM

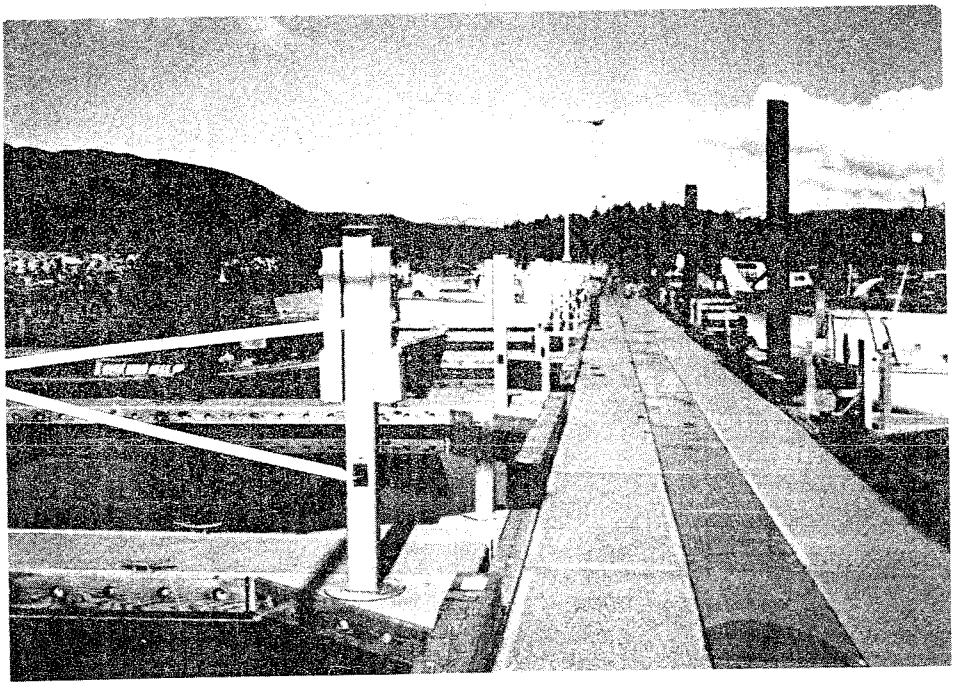
AFTER-THE-FACT WATER STATION

ELECTRICAL (Power)

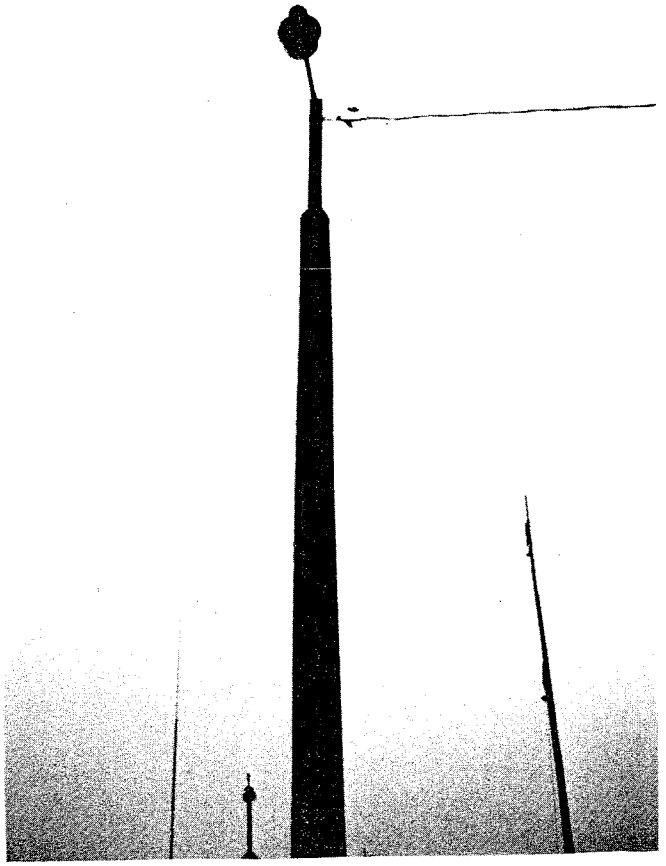


MARINA ELECTRICAL SYSTEM

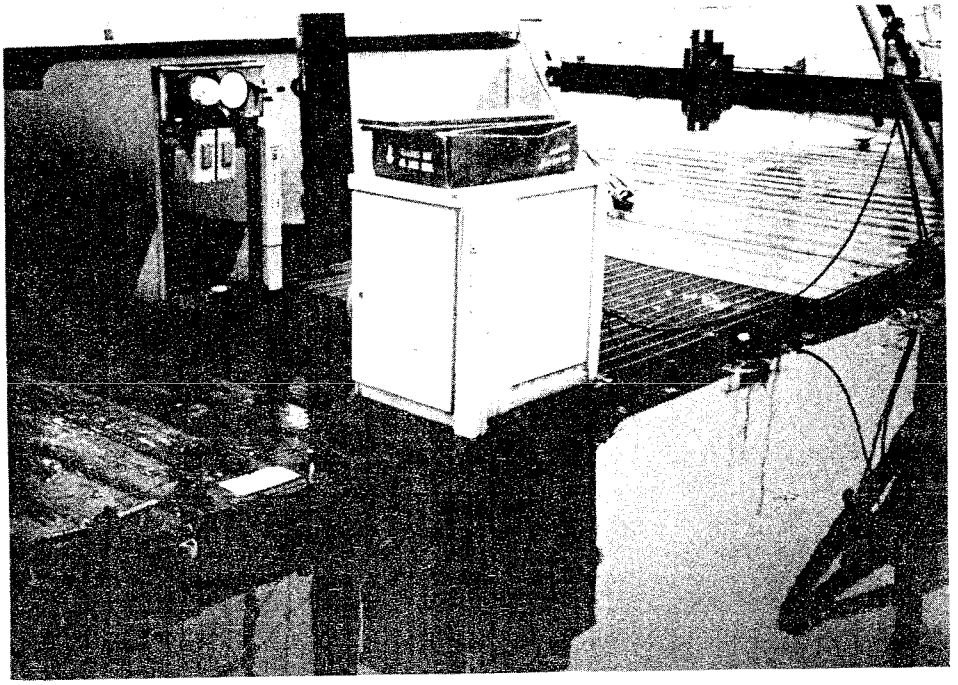
ELECTRICAL
(Power)



HEAVY-DUTY MARINE ELECTRICAL STATION



OVERHEAD POWER LINES



ELECTRICAL TRANSFORMER CAUSING FLOAT TO SINK

severe problems confronting harbor operators and solutions may require professional assistance. Electrolysis testing within small boat harbors requires cooperation between the harbor operators and vessel owners. Damage to vessels may be the result of ground deficiencies in the float electrical system or may be an internal problem of the vessel or neighboring vessel. Vessel owners, qualified inspectors, and harbor operators should work together to isolate the problem and develop solutions and undertake remedial action.

3.04 Discussion of Marina and Harbor Lighting

Several approaches to providing combination electrical service and lighting within marinas and harbors have been observed. Of these, the lighting portion can be divided into four general categories:

1. *Area Lighting*
2. *Float Anchor Pile-Supported Lighting*
3. *Float-Supported Lighting (Medium Level)*
4. *Float-Supported Lighting (Low Level)*

Each has definite limitations related to maintenance, safety, and function, as discussed below. Again, problem areas should be identified, monitored and recommended for replacement or repaired as required.

Area Lighting provides indirect lighting similar to highway interchange lighting by using a minimum number of high-level poles to support clusters of directed lights. The advantage with this system is the smaller number of units required and greatly increased safety provided by removing the possibility of contact with boat masts, etc. A major disadvantage is visual interference as a result of night water glare impacting approaching or entering marine traffic.

Float Anchor Pile-Supported Lighting is commonly used in harbor systems because of low initial cost. The National Electrical Code currently requires 18 feet vertical clearance from overhead transmission lines to the water level and at least 3 feet horizontal from structures. The horizontal requirement is difficult if not impossible to meet where trollers or boomed and masted vessels have harbor access. It is not uncommon for these extended members to periodically come in contact with overhead power lines. Vertical clearance can only be gained by use of very high piles or extensions on piles. For example, a high tide of Elevation +15' MLLW would require a pole connection elevation of 15' + 18' clear + 6' estimated line sag = Elevation 39' MLLW,while a high tide at Elevation 25' MLLW would require a connection at Elevation 49' MLLW or a pole with an overall length of 70 feet. There are many harbors that do not meet these requirements for safety.

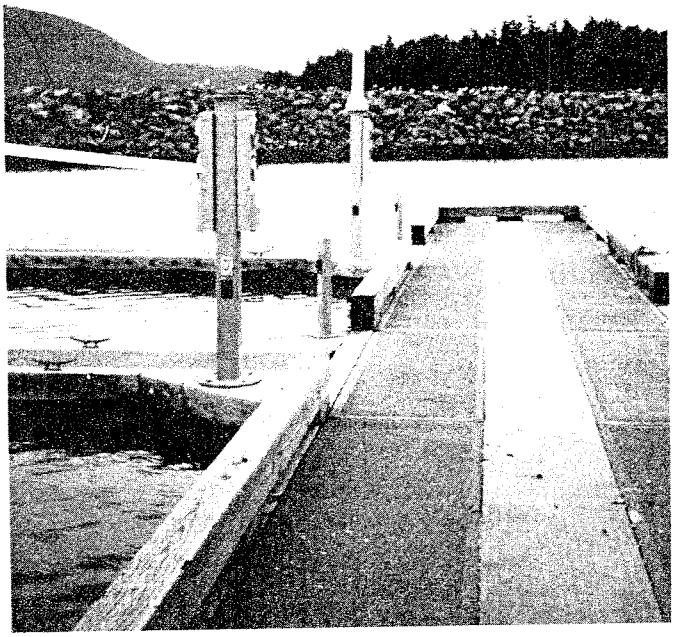
Float anchor piles are also structural members that undergo large deflections from wave action or when floats are impacted from vessels. It is possible to have relative pile movement of over 5 feet. When electrical lines are connected between two such piles, the possibility of line damage is increased.

Even if lights are placed to yield the proper vertical clearance, they will beat a fairly high level and could cause water glare problems similar to the area lighting technique.

Float-Supported Medium Level Lighting has been tried with some success. Power is sometimes supplied through conduits in the floats, affording protection from the elements and safety from impact. Many medium level facilities, however, may also use low level overhead lines which do not meet various codes for safety. These should be identified and safer solutions recommended.

Damage from boat impacts are the primary problems with this type of system, especially where conventional pole fixtures are mounted to the bullrails. Successful installations use strengthened base supports extending about 6 feet above deck level with poles mounted on top. These poles are

ELECTRICAL (Power)



WELL-PLANNED OVERHEAD AREA LIGHTING

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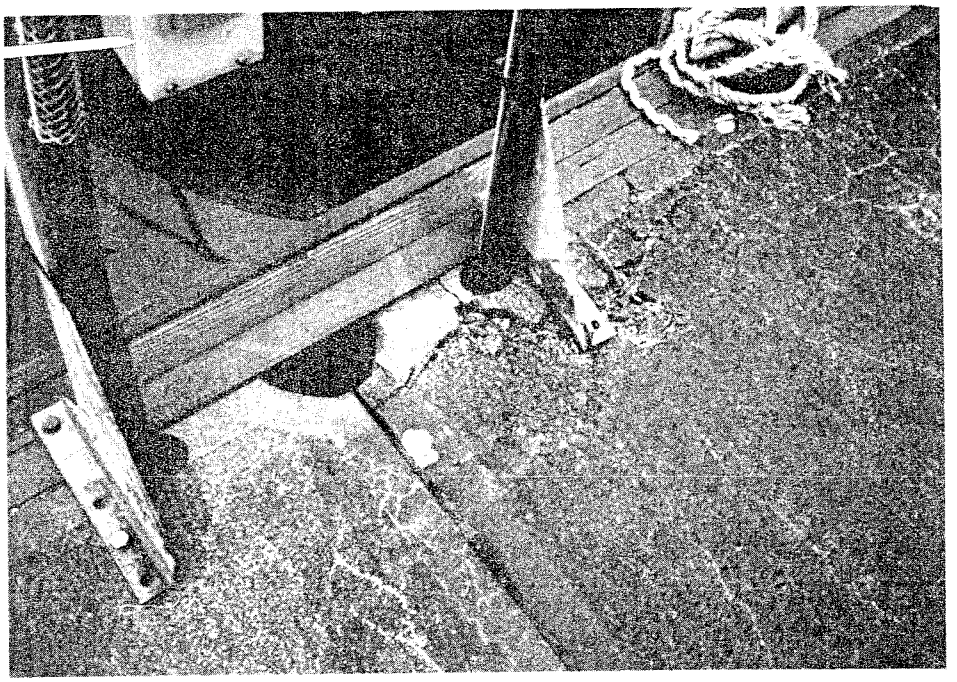
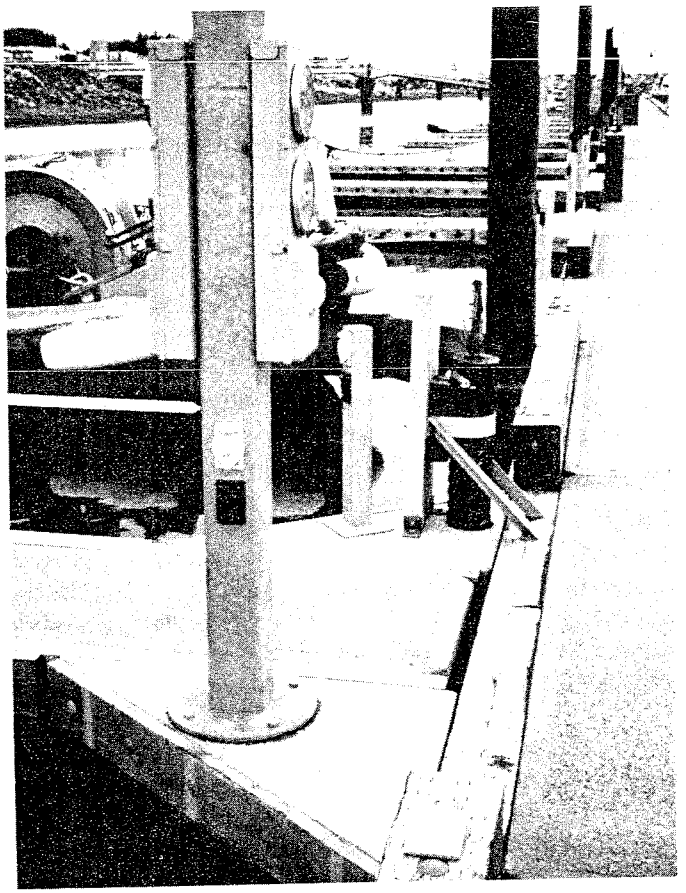
(Power)



FLOAT DAMAGE CAUSED BY ELECTRICAL SUPPORT
ATTACHED INTO CONCRETE

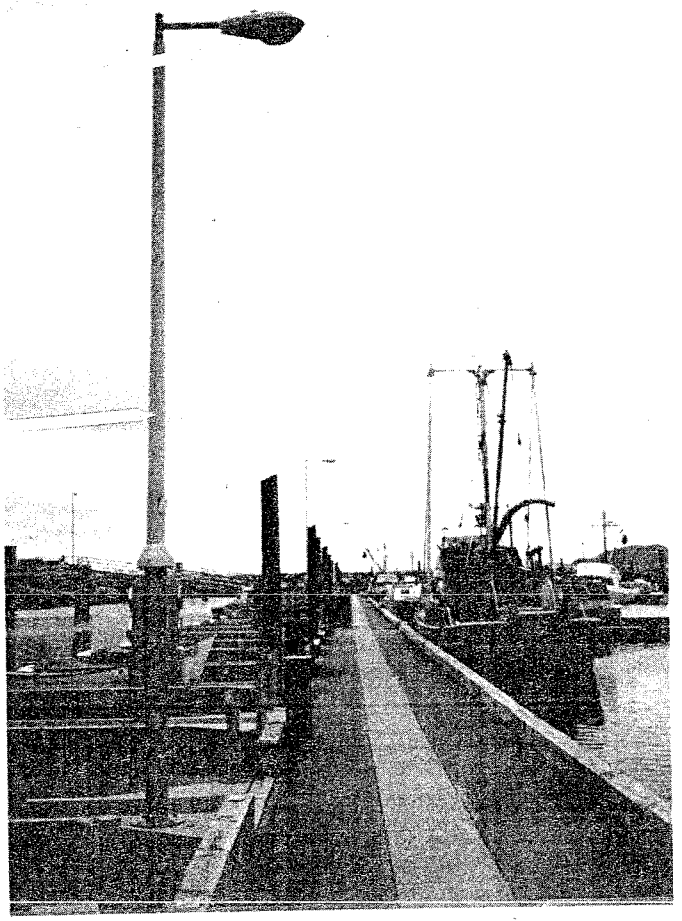
ELECTRICAL STANCHION



ELECTRICAL STATION STANCHION WITHOUT FIBERGLASS LIGHT POLE

LUMINAIRE

LIGHT POLE



STANCHION WITH LUMINAIRE

also positioned near main float/finger intersections or at protected locations in order to limit boat impact exposure.

Float-Supported Low Level Lighting is rapidly becoming common practice, particularly for private marinas. Low height units containing stall electrical service as well as low-power direct deck lighting are closely spaced along main floats. The resulting lighting is low level and does not produce much, if any, water glare.

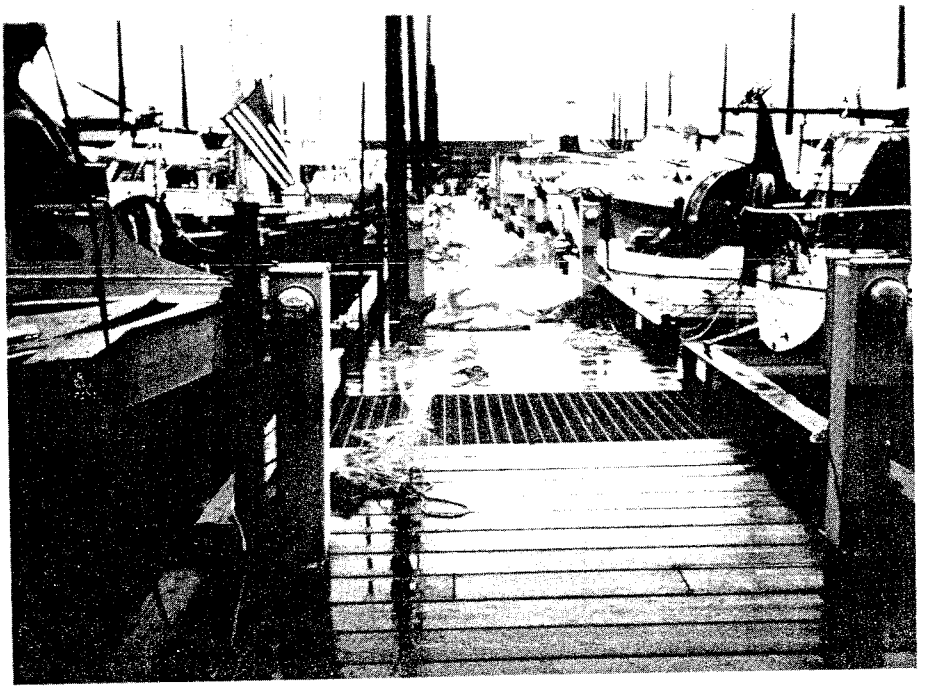
Refinement of this lighting type offers almost every advantage now missing in many marinas

3.05 Float Safety

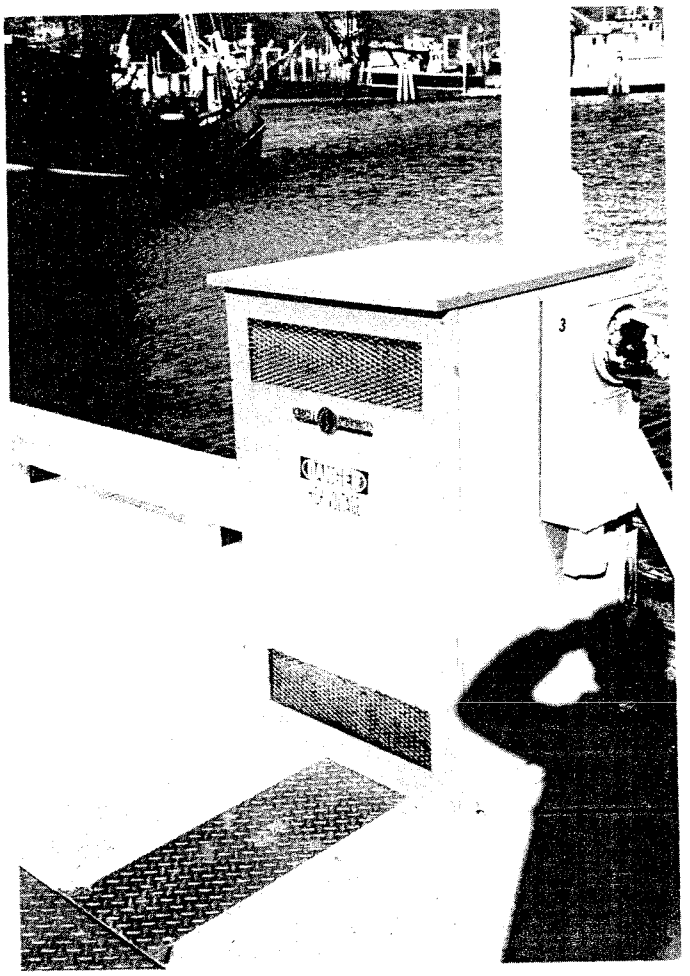
In order to minimize exposure to the harbor owners and operators from liability claims, harbor users should be prevented from storing or leaving gear, nets, or other potentially hazardous objects on floats. Nonconforming electric lines, damaged components and other dangerous situations should be clearly posted. Warning signs prohibiting storing of hazardous material on the floats should be posted and the policy enforced. Similarly, signs warning parents not to leave unattended children on floats are recommended. Unleashed dogs or other animals should not be permitted on floats.

Some type of non-skid surfacing may be desirable on older timber floats.

Floats should have between 12 to 15 inches of freeboard. In excess of this amount makes it difficult for a person who has fallen overboard to climb back out. Safety life rings should be provided at critical locations.



FISHERMAN'S GEAR STORED ON FLOATS



WELL-MARKED HAZARD

CHAPTER 4
APPROACH STRUCTURES

4.01 Gangways

The majority of gangways in small craft harbors are either steel or aluminum. In some cases, short or older gangways are made of timber. Timber gangways are generally less desirable because they may rot, and because they generally weigh more and increase the flotation requirements of the support dock. Gangways may require more critical structural inspection than most items in a harbor because they carry greater concentrated loads; and failure, should it occur, could be sudden and catastrophic.

All members of a metal gangway should be carefully examined for mechanical damage or corrosion. Even more importantly, the connections should be carefully scrutinized. If connections are welded, they should be systematically checked for corrosion or cracking. If bolted, the condition of the bolts should be checked as well as holes examined for evidence of wear or enlargement. Pin wear may be difficult to detect, but an extra effort should be made during this inspection to ensure that no major changes are occurring.

Members of a timber gangway should be inspected for rot. Similarly, bolts and other connectors should be examined for corrosion and connections for hoe elongation or rot in the vicinity of bolt holes. Where timber members be directly upon one another, check for crushing of the wood. Such crushing can be an indication that the member is rotting or has been subjected to loads greater than those for which it was designed. Checking or severe splitting of the wood, particularly near points of support or connections, should be reported. This condition can indicate distress and may require inspection by a structural engineer.

Particular attention should be paid to the hinge connection between the gangway and the abutment or approach dock. This hinge must support half the weight of the gangway, yet still allow relative motion between the gangway and abutment. Bolts or pins should be carefully examined for any signs of distress, metal loss, deformity, or hole elongation.

All gangways, regardless of type of construction, should meet safety standards such as rails spaced with no more than 6-inch gaps; top handrails at least 3-1/2 feet above the walkway surface; etc. Walkway surfaces should also have cleats or other type of non-skid treatment. If grating is present, this should be carefully inspected for corrosion or wear, particularly at weld points.

The bottom support point where the gangway rests upon the support float must allow motion between the ramp and float as the tide varies. This is generally arranged through a roller-type assembly or gangway low friction raceway. All these points must be examined for signs of binding, corrosion, debris, or anything which might prevent their ability to move freely. If this connection becomes frozen or fixed it can result in submergence of the support float.

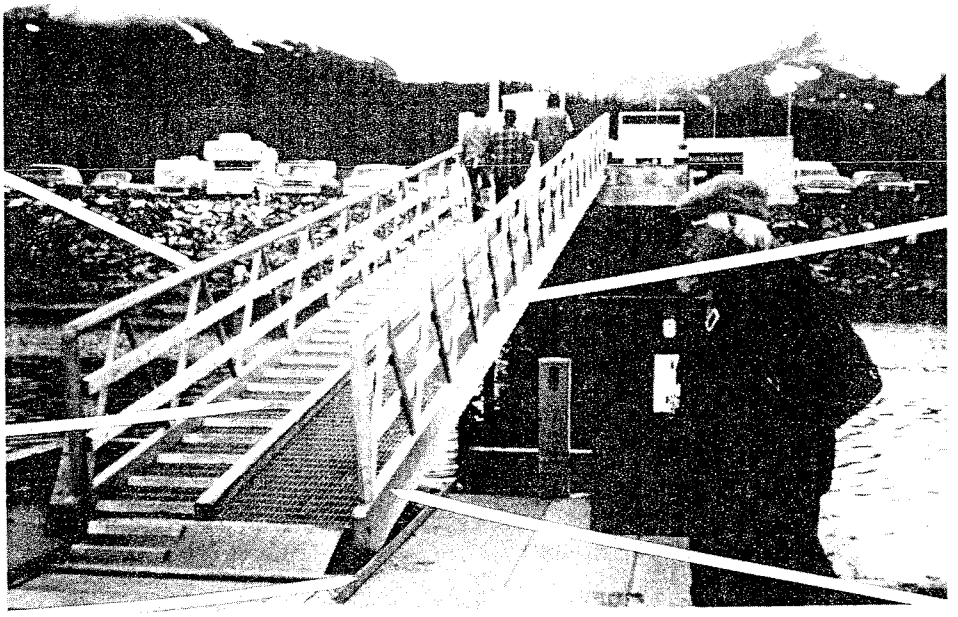
Approach structures are usually of timber, steel, or earth fill. Earth abutments should be examined for loss of fill around the edges of the wingwalls or subsidence near the head or point of gangway attachment. Toe of fill slopes should also be checked for sluffing or erosion due to boat wave action.

Approach docks are discussed in more detail under 6.01. Support floats should be given the same critical examination as other floats per 3.01. Particular attention should be given to whether or not the float lists severely or has buoyancy problems. This should be checked at both high and low tides. Listing or buoyancy problems in a support float can indicate flotation deterioration or an original design or construction inadequacy, either of which may require correction.

Gangways designed for large tidal variations can become very steep at low tide. Coupled with wetness or ice, this can create a very hazardous situation. Appropriate lighting and cautionary signing should be installed. Excessively steep gangways may warrant replacement.

TOP CHORD

WEB MEMBERS



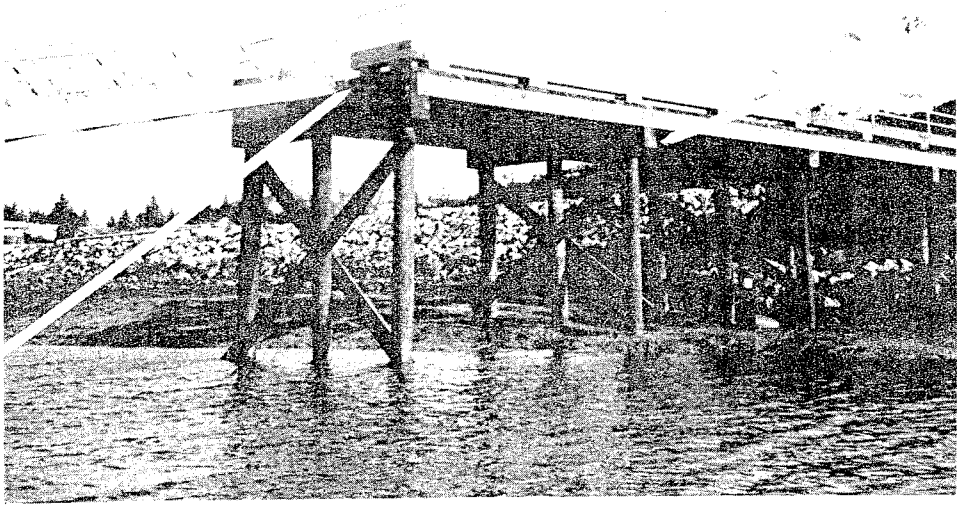
GANGWAY

GANGWAY RACES

BOTTOM CHORD

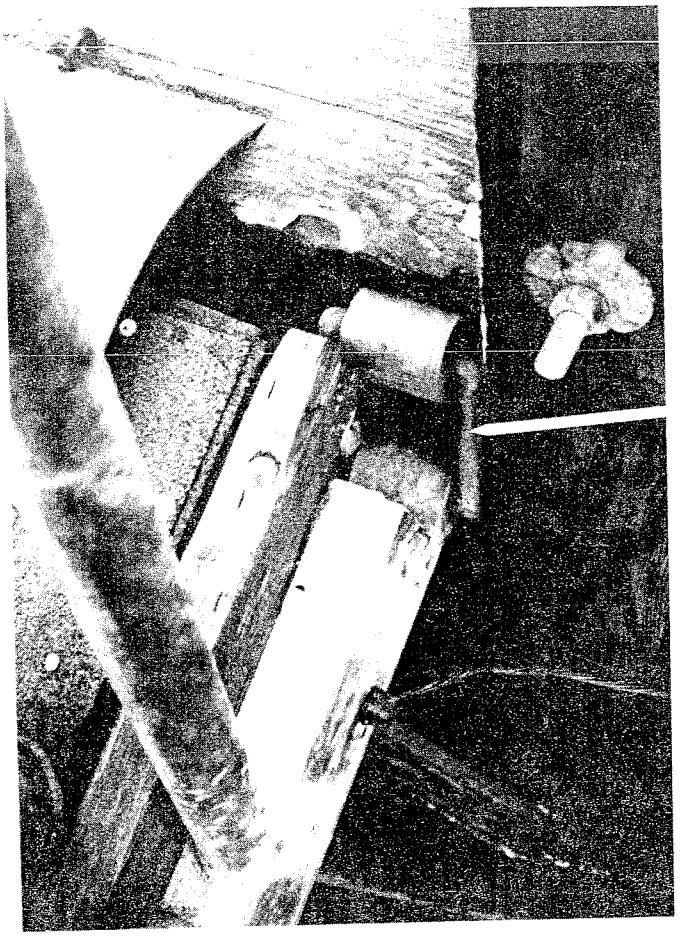
GANGWAY

APPROACH DOCK



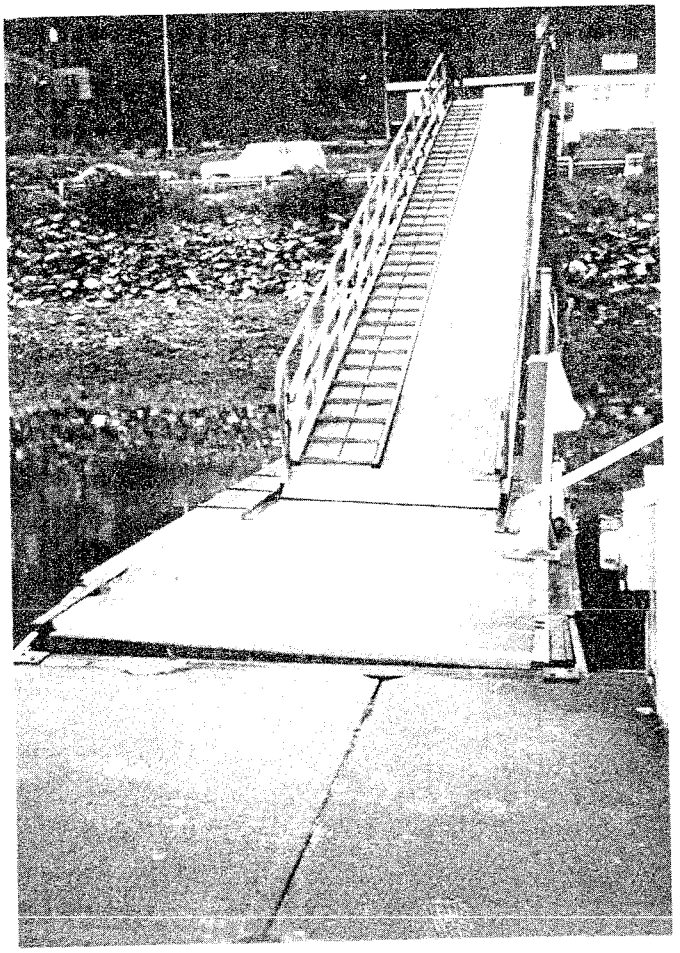
GANGWAY HINGE

APPROACH DOCK



GANGWAY HINGE

GANGWAY HINGE



GANGWAY RACES

CHAPTER 5
FLOATING STRUCTURES

5.01 Boathouses

Boathouses or boat shelters are floating structures used for the covered storage of vessels. The buildings generally consist of timber or light steel framing on timber or concrete floats, and are usually restrained by timber or steel pilings.

Superstructure inspection should be performed similar to that for any enclosed structure. If framing is made of timber, inspect for rot or extreme checking or splitting in the main members. If steel, look for corrosion or unusual deformations. Concrete superstructures should be inspected for spalling or cracking. In all cases, connections should be carefully examined for any signs of corrosion, looseness, or distress.

Float and piling inspection are the same as previously outlined. In some cases, adjoining floats may not have been designed to accommodate concentrated loads from a poorly tethered boathouse. Consequently, the condition of the connections between structure and float should be particularly noted and monitored. Floats should be checked for subsidence and for listing or uneven flotation. Superstructure framing members should be examined near the bottom for evidence of improper wetting or submergence under winter snow or other short-term loadings.

Vertical clearances for entrance to boathouses should be clearly posted so as to be visible to approaching vessels.

5.02 Seaplane Floats

Seaplane floats are usually constructed of timber or concrete. Inspection should proceed similar to that for other floats of the same material. If the floats are made of concrete, check concrete for spalling, particularly at points of hardware attachment. If floats are timber, check for rot and at metal connections for corrosion or distress. In both cases, check for settlement or degradation of flotation.

Inspection of piling also proceeds in the same manner as previously outlined. Piling should be checked for mechanical damage and corrosion of steel. If timber, check for rot, mechanical damage, or marine borer attack.Contact between dissimilar metals should be noted, monitored for corrosion,and recommended for replacement where necessary.

5.03 Platforms

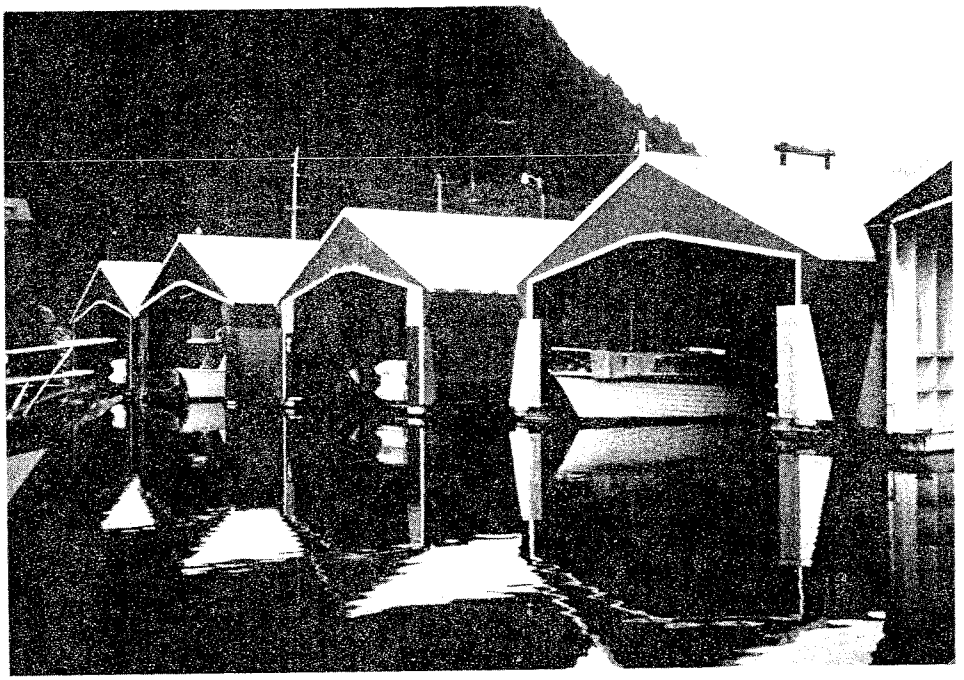
Floating platforms are used in harbors for a variety of reasons. Their construction and methods of restraint are similar to float systems although their shape may vary considerably.

They should be checked for settlement or listing and their flotation units examined for leakage or deterioration.

Timber framed platform members should be examined for rot or mechanical damage. Connections should be checked for corrosion and tightened if loose. Concrete platforms should be checked for spalling and signs of corrosion. Connections through concrete should also be thoroughly examined for corrosion,spalling and looseness.

Pilings should be examined as outlined in 3.02.

Platforms that are used for storage should have loading limits clearly posted.



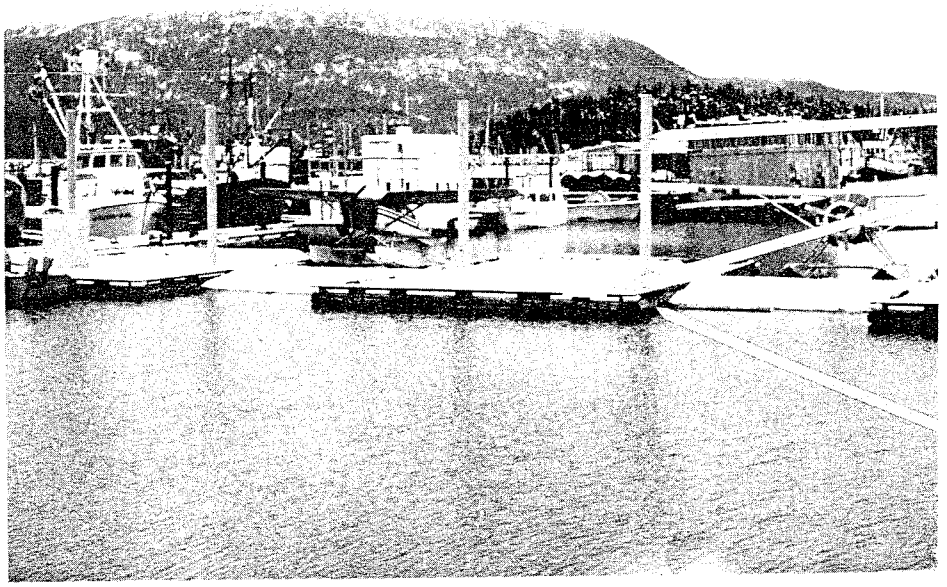
TIMBER BOATHOUSE CONSTRUCTION

ANCHOR PILES

FRAMING

FLOTATION

STEEL AND CONCRETE BOATHOUSE CONTRUCTION

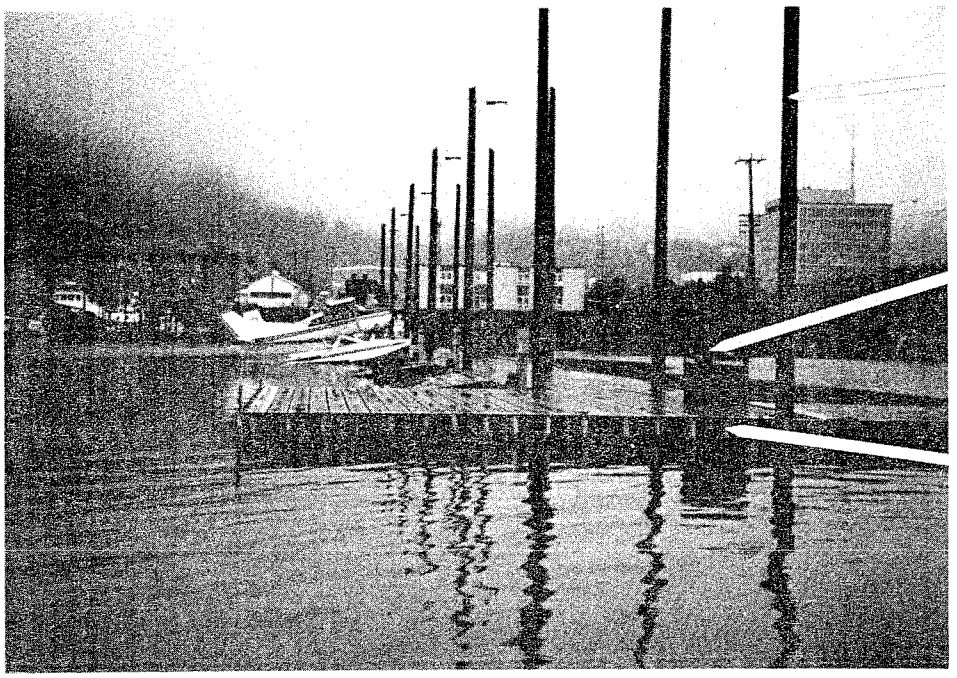


ANCHOR PILES

FLOATS AND FLOTATION

FRAMING

CONCRETE SEAPLANE FLOAT



ANCHOR PILES

FLOATS AND FLOTATION

FRAMING

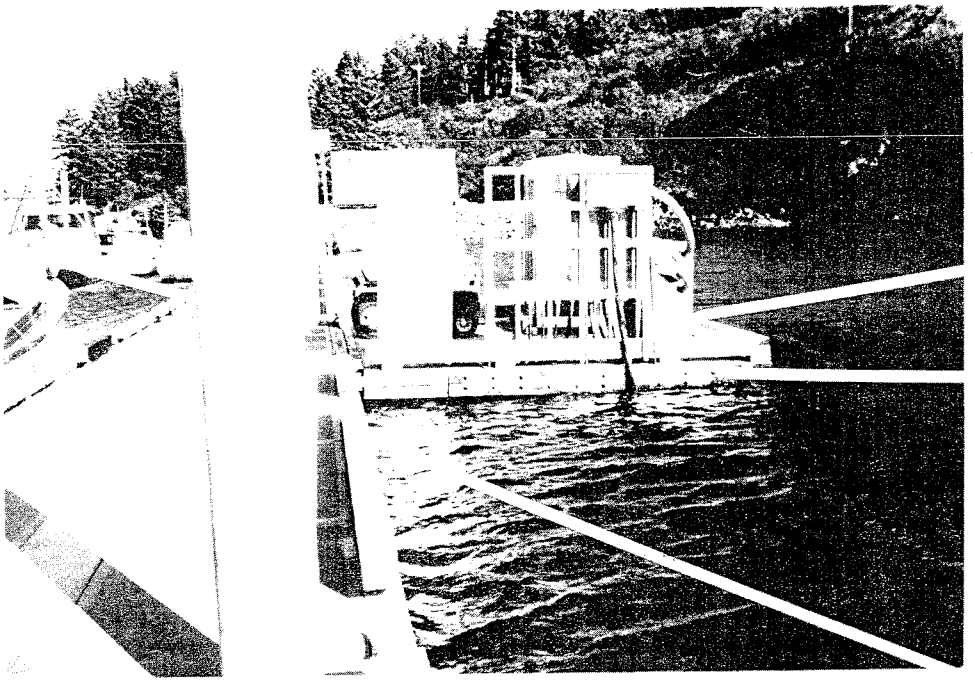
TIMBER SEAPLANE FLOAT

5.04 Fish Cleaning Areas

Fish cleaning areas provide harbor personnel with a specific area where they can monitor fish waste disposal, decrease the maintenance required to clean up floats throughout the harbor, and thereby minimize potential liability claims. Fish cleaning facilities should have adequate fresh water, fresh air, and lighting, and should be located near gangways but not in environmentally sensitive areas. Daily maintenance of the walkway area, including wash down, is required as well as inspection of adjoining float or dock connection systems that are exposed to the corrosive action from the fish waste.

CHAPTER 6
OTHER MARINE FACILITIES

ANCHOR PILES

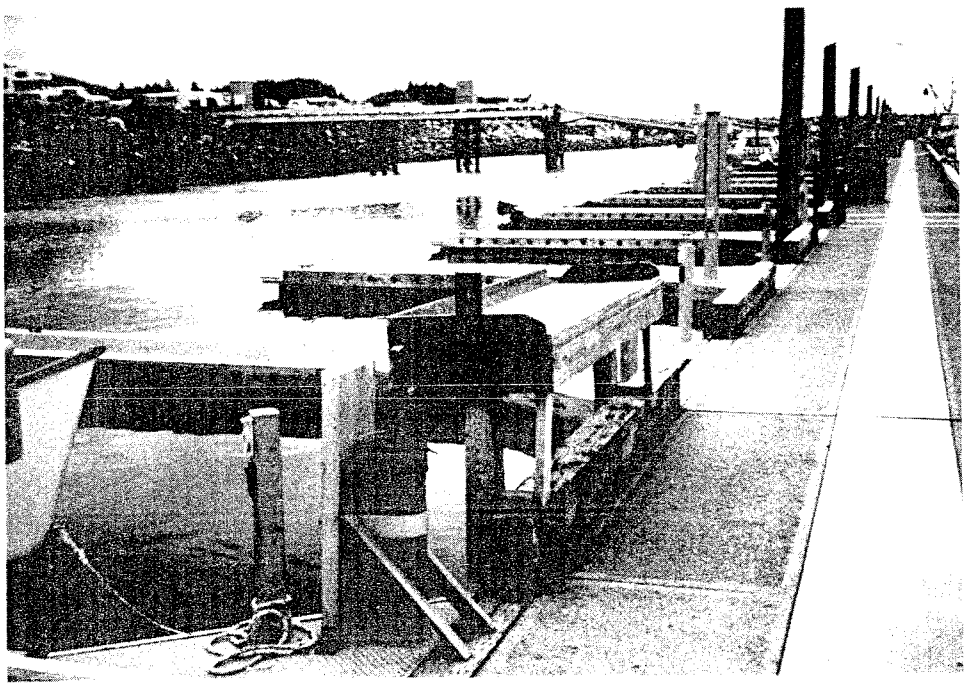


CONCRETE SURFACE

FLOTATION

CONNECTIONS

STORAGE PLATFORM



FISH CLEANING TABLE

6.01 Docks and Vessel Haulouts

In general, docks should be systematically inspected from the top down. The main supporting members of dock superstructures are usually composed of timber or steel, while the decking is timber or concrete. These items are treated separately.

Docks accessible to the public should have railings that are designed to meet local safety codes. For example, rails should be spaced so that no gaps are larger than 6 inches and should be sound and free from rot. A check of all bolted and fastened connections should be made. Connections should be sound, free from rot, corrosion, or undue "slop".

Timber decks should be examined for rot or signs of distress. Any loosening of deck spikes should be noted. Concrete decks should be checked for cracking for spalling. Particular note should be taken of cracks running parallel to and above framing members from the top, and cracks running parallel to framing members approximately at mid-span from below. Any exposed reinforcing steel should be noted.

Docks with steel framing members should be checked for corrosion. Any deformities or mechanical damage should be noted. Each connection should be examined for corrosion, wear, and looseness. Notes should be made of any elongation of holes or "mushrooming" around their edges. Any visible wear or loss of protective coating should be noted.

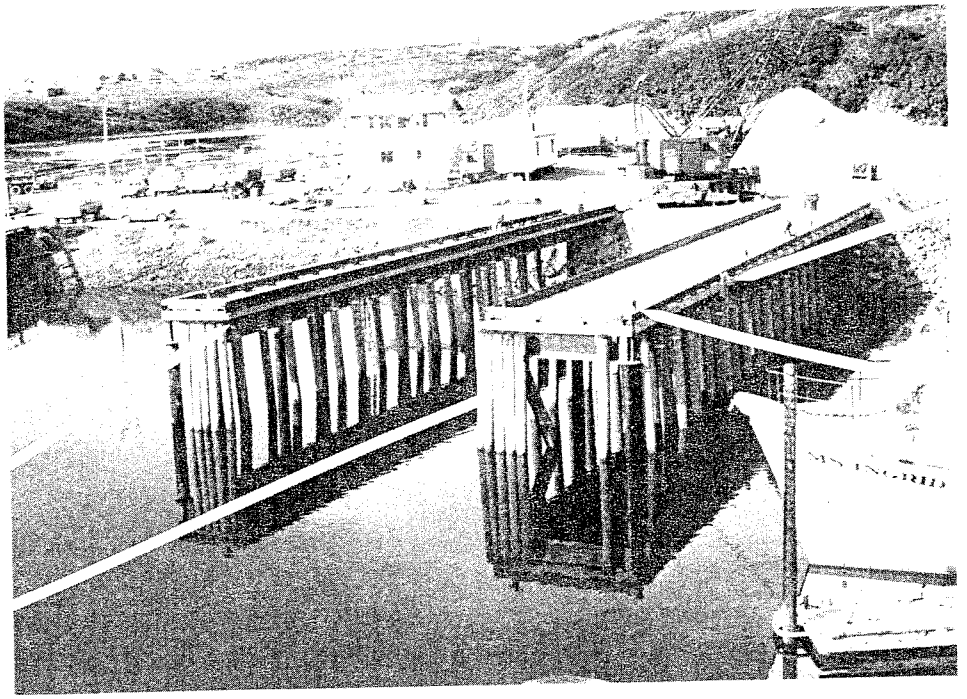
Timber framing members should be examined for rot, mechanical damage, and severe or unusual checking or splitting. Timber connections should be inspected for wear, corrosion, or crushing. Integrity of cross bracing should be reviewed; in some cases this may involve underwater inspection. Field drilled bolted connections for cross bracing are common areas for rot and should be routinely checked. Crushing may occur where one member rests upon another, particularly where stringers bear on pile caps or where pile caps rest on piling. Such crushing can be an indication that portions of the structure are rotting or being subjected to loadings greater than for which it was designed.

Many dock structures are supported on steel or timber piles. Steel piles should be examined for mechanical damage and corrosion. Pipe piles are preferred in the marine environment as they offer less surface area than a comparable H-pile. H-piles, in particular, must be examined very closely for metal loss due to corrosion. Timber piles should be examined for mechanical damage, rot, or marine borer attack. A thorough evaluation of such piling would normally include an underwater inspection.

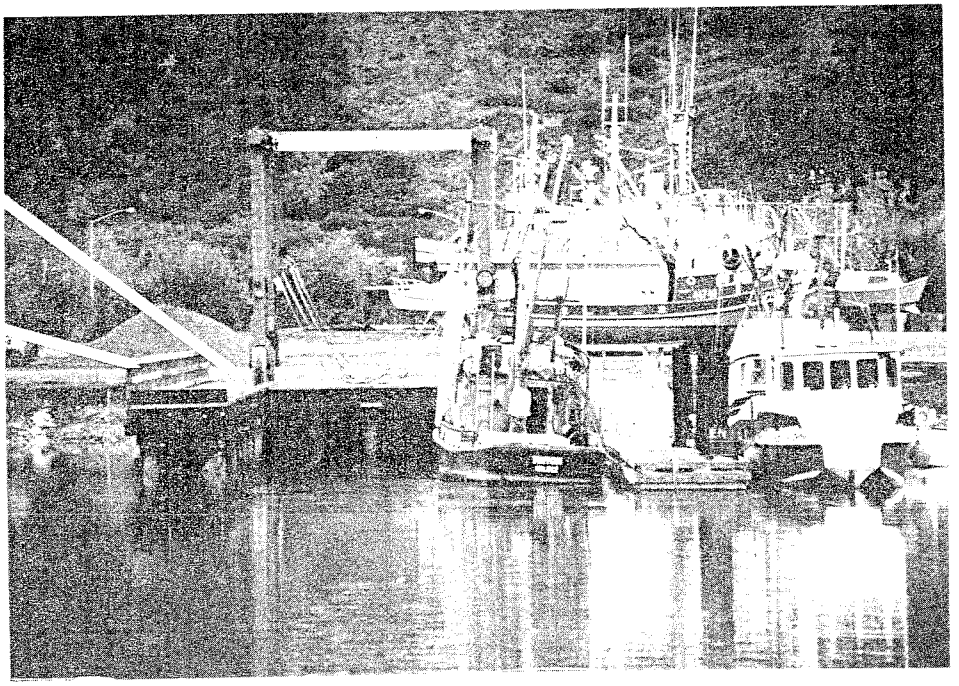
Docks should be equipped with ladders at regular intervals. While such ladders should not be the primary method of disembarking from a ship, their presence is desirable for emergency use or other unanticipated purposes. Ladders should conform to U.S. Coast Guard Standards such as the inclusion of 42-inch handrails above the deck top surface where possible. Conflicts may occur with ship mooring lines and other boating operations; handrails and ladders should be designed to minimize these conflicts, as well as heavy impacts from vessels and other floating objects. Ladders should be kept free from barnacles or other growth and should have their rungs and attachments to the dock inspected for rot, metal loss, or weld failures.

6.02 Bulkheads

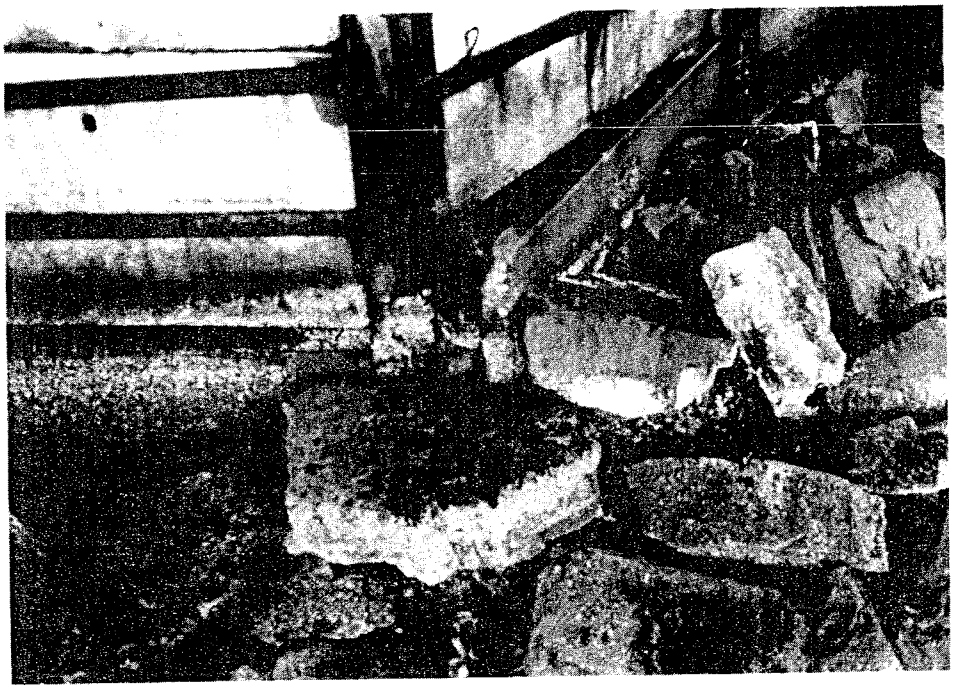
Typically, bulkheads located within small craft harbors are designed for light loading and are basically soil retainment structures. These walls have usually been made of either concrete or timber planking placed horizontally behind steel or timber piling that were either driven or placed into the native soils. Cables or steel rods are used as tiebacks between the wall face and deadman anchors located within the fill.



CONCRETE AND STEEL BOAT HAULOUT DOCK



TIMBER BOAT HAULOUT DOCK



CONCRETE PANEL/SOLDIER PILE BULKHEAD PROBLEMS

The steel connections between the wall face and the tieback rods/cable are highly susceptible to corrosion that ultimately leads to bulkhead failure.

This weakening condition is characterized by bulging of the exposed face of the wall, separation of the soldier piles and the panels, and/or loss of wall panels.

If a bulkhead appears to be distressed, this condition should be brought to the attention of a qualified engineer. In any case, proper signage warning the user of the vehicular load limitations should be posted.

6.03 Vessel Grids

Vessel grids are a convenient and relatively low cost way of exposing vessel hulls for repairs in areas of significant tidal variation. Grids should be designed to accommodate the heaviest vessel anticipated and should be clearly posted with weight limitations. Load limits should be stated as tons per bent maximum.

Inspection of grid facilities should proceed much the same as for other structures. Members and connections should be examined for corrosion, rot, or distress. The pile caps should be examined for crushing, which might indicate that the facility has been overloaded or is rotting.

All piling should be inspected for mechanical damage and corrosion (if steel)or rot and marine borer attack (if timber). Rub strips should be inspected and replaced periodically when necessary.

6.04 Boat Ramps

Boat launching ramps should be constructed at a slope steep enough to provide easy launching (while not swamping the boat during the launch), but gradual enough so that vehicles do not experience difficulty climbing the ramp with boat and trailer. Twelve percent is considered to be an optimum slope. A vertical crest curve should be provided at the top of the ramp rather than a break in grade. This provides better visibility for the vehicle operator during backing and prevents the undercarriage of low-clearance vehicles from abrasion.

Boat ramps are considered high maintenance items. Common problems include spalling of surface concrete, and subsequent exposure of reinforcing steel and shear failure of planks. Often, metal hook-and-eye type connectors between planks will corrode and fail. These problems can be avoided by proper initial design and construction; but once they occur, not much can be done to repair them short of replacing the planks.

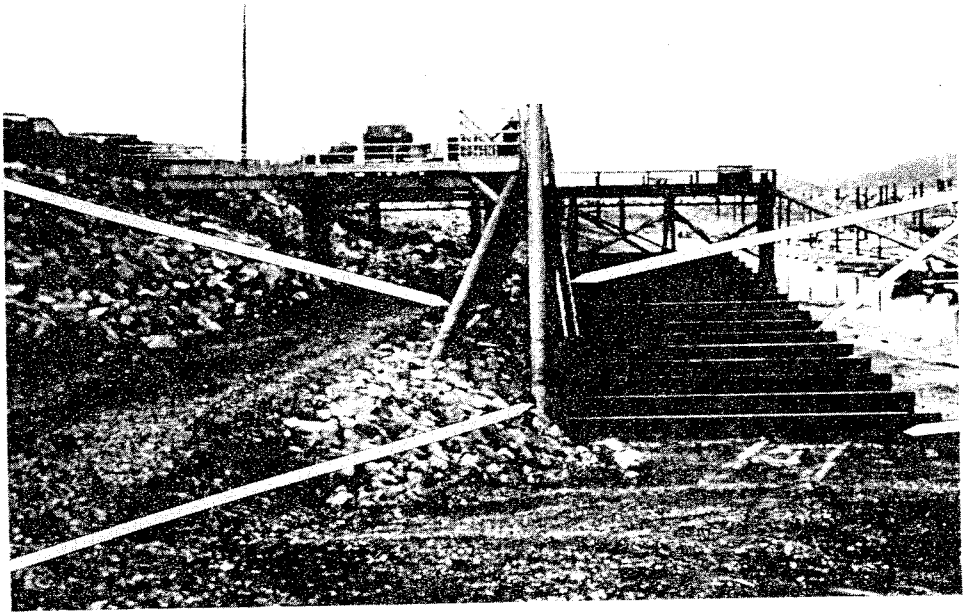
Ramp embankments are often protected by riprap which must be repositioned if it is moved out of place. Gaps in riprap which expose filter fabric or embankment fill should be promptly covered with more riprap.

6.05 Fuel Docks

Fuel docks should be given the same inspection accorded other docks. Special attention should be given to float settlement and integrity of flotation media, which often may be susceptible to deterioration caused by contact with gas or oil. Tanks and pumps should be inspected for leakage or signs of damage or wear. Fire control systems should be inspected and relevant equipment checked. An operating telephone should be available at the fuel dock site with emergency numbers clearly posted. Fuel docks should be clearly labelled as such. Appropriate safety messages (e.g., No Smoking) should be clearly visible.

Whenever possible, fueling docks should be located near the harbor entrance in an area protected from waves, but in any case, far enough removed from the entrance channel to minimize

BATTER PILES

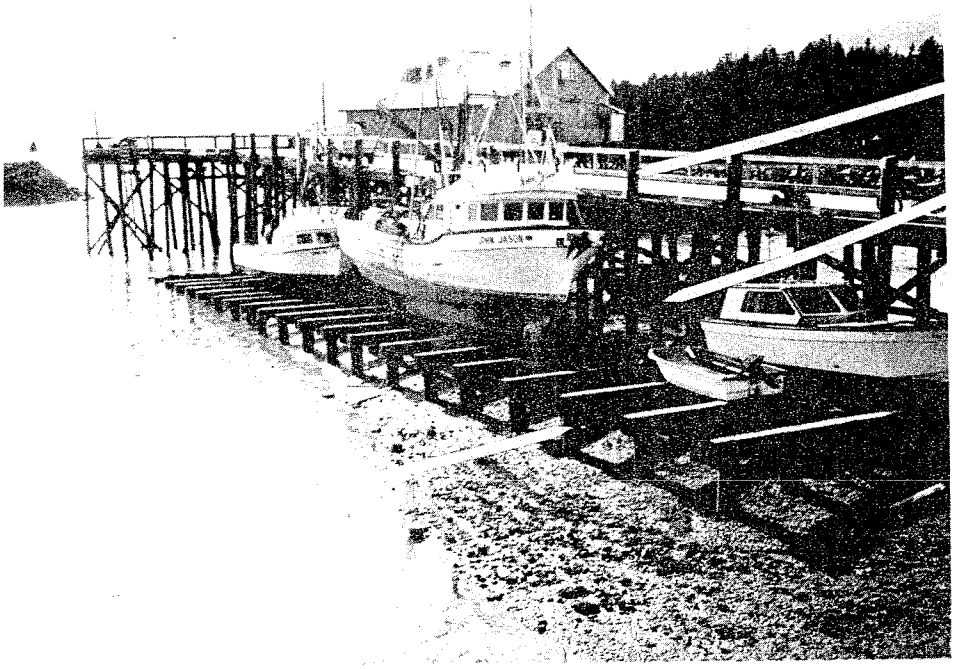


RUB STRIPS

PILE CAP

VERTICAL PILES

HIGH-CAPACITY STEEL GRID

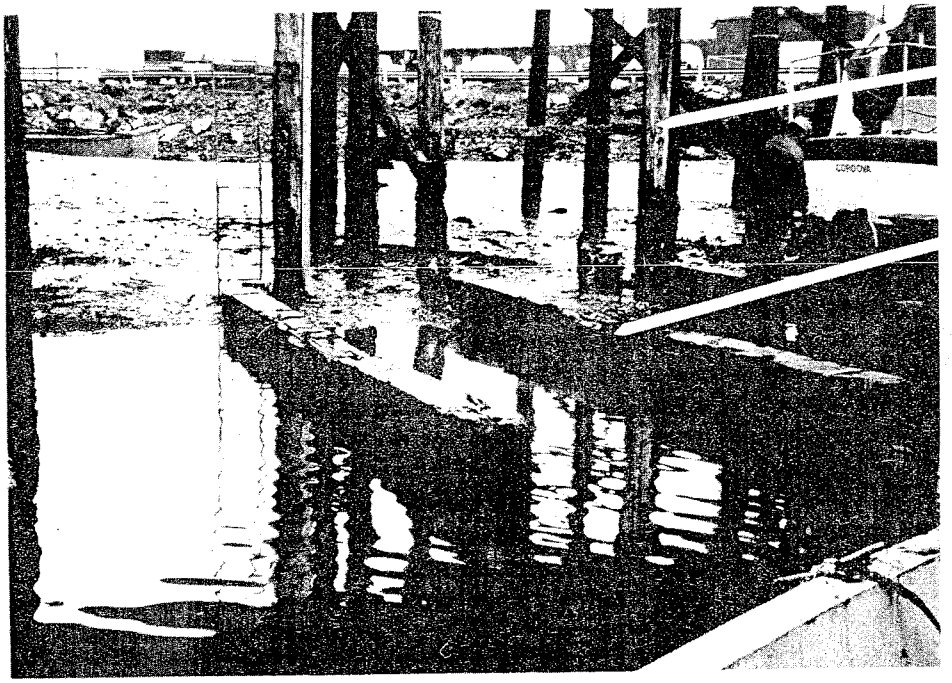


VERTICAL PILES

BATTER PILES

PILE CAP

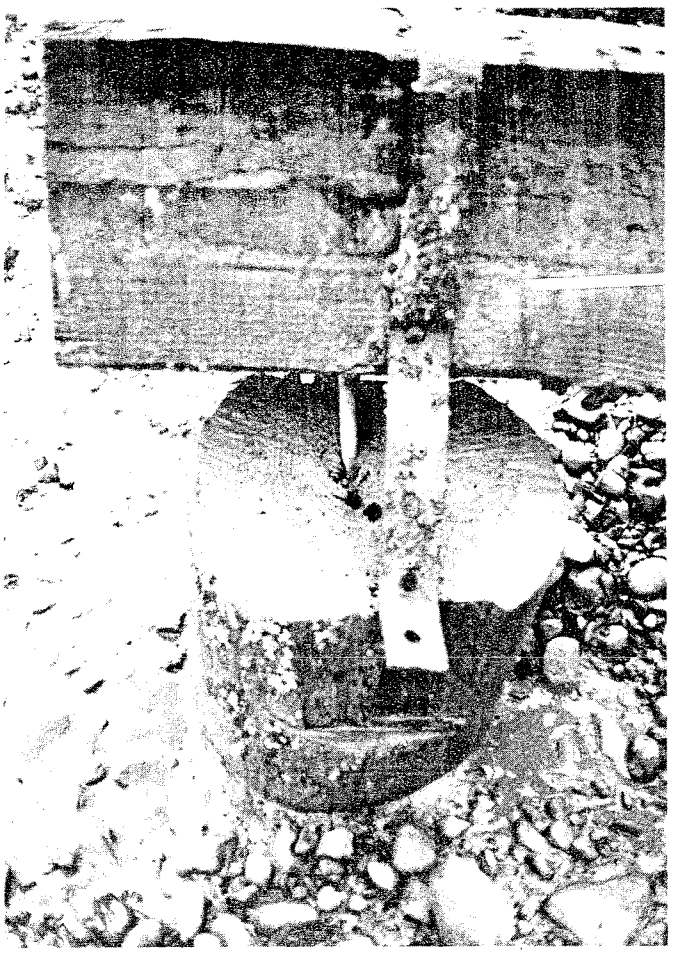
TYPICAL TIMBER GRID



VERTICAL PILES

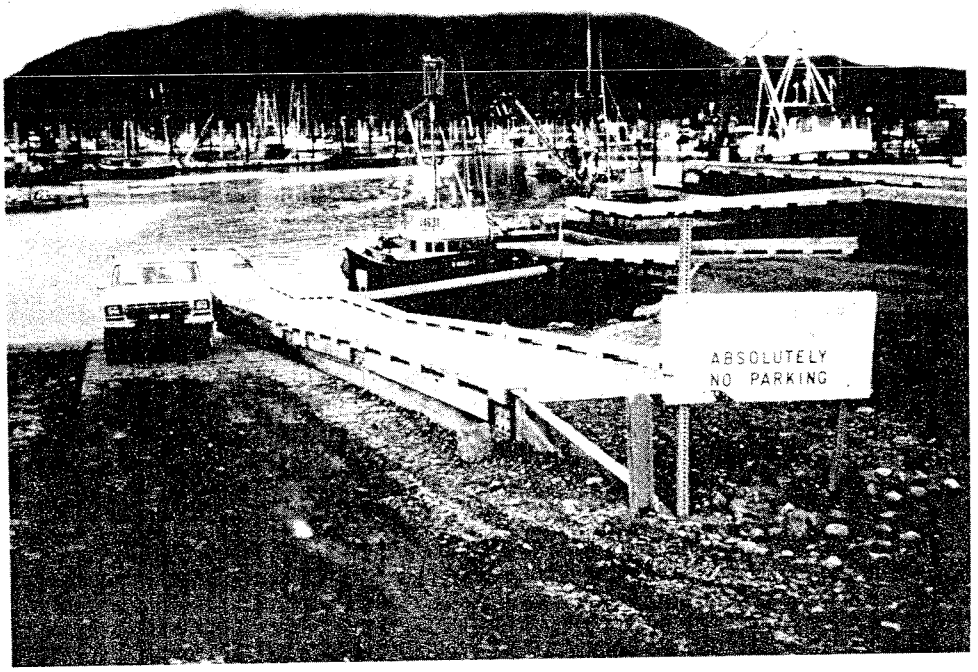
PILE CAP

WORN CAPS ON TIMBER GRID

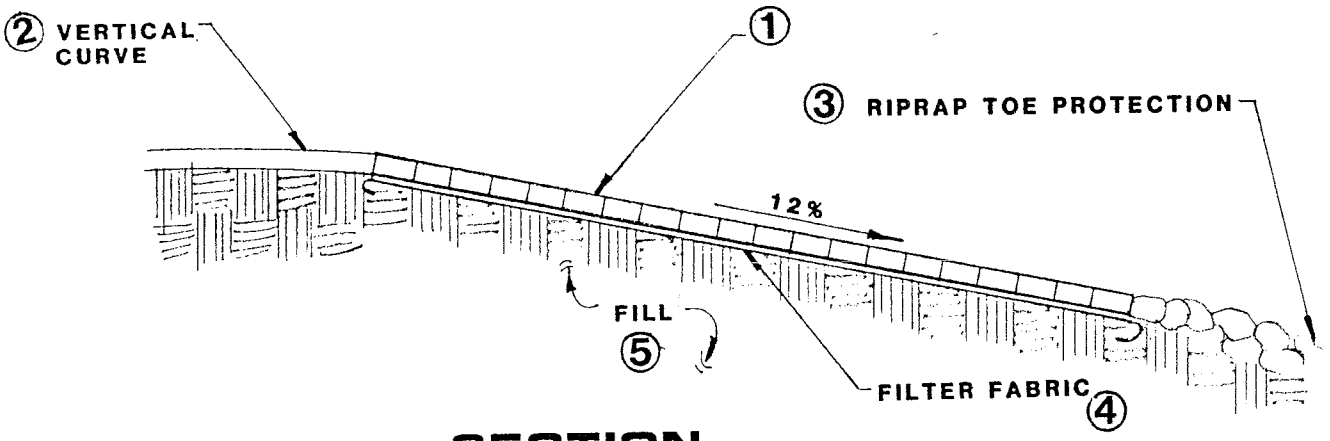


PILE CAP

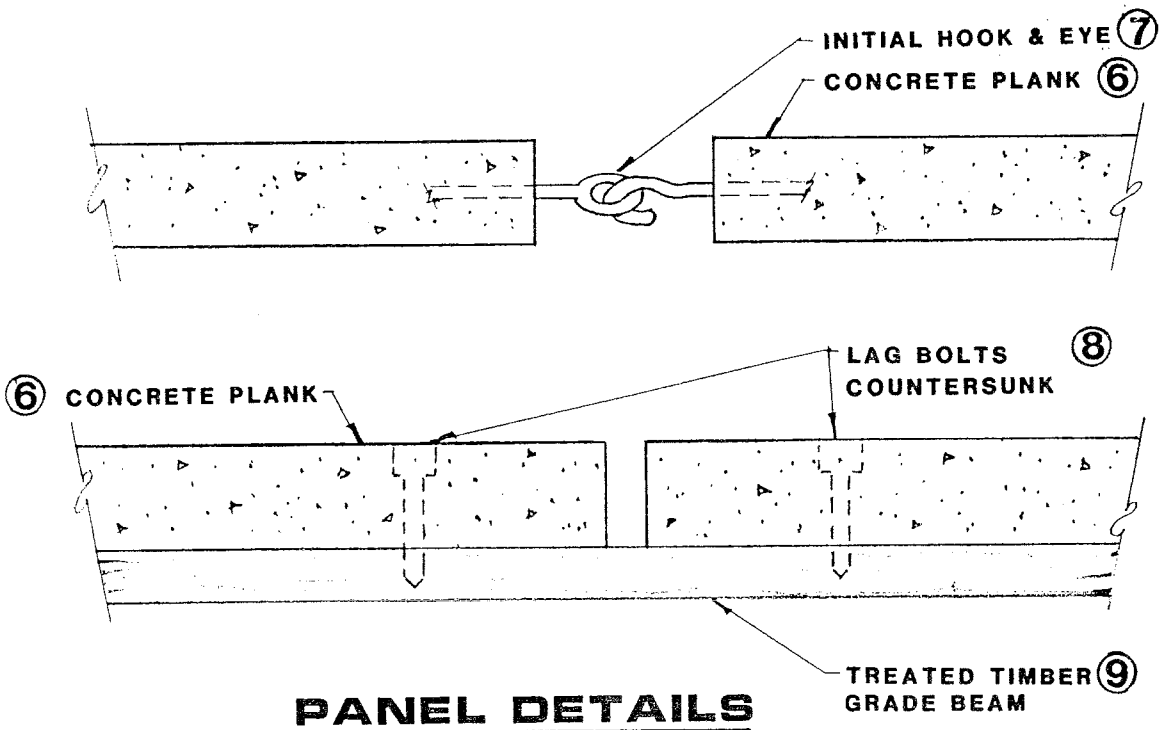
DAMAGED CAP



BOAT RAMP

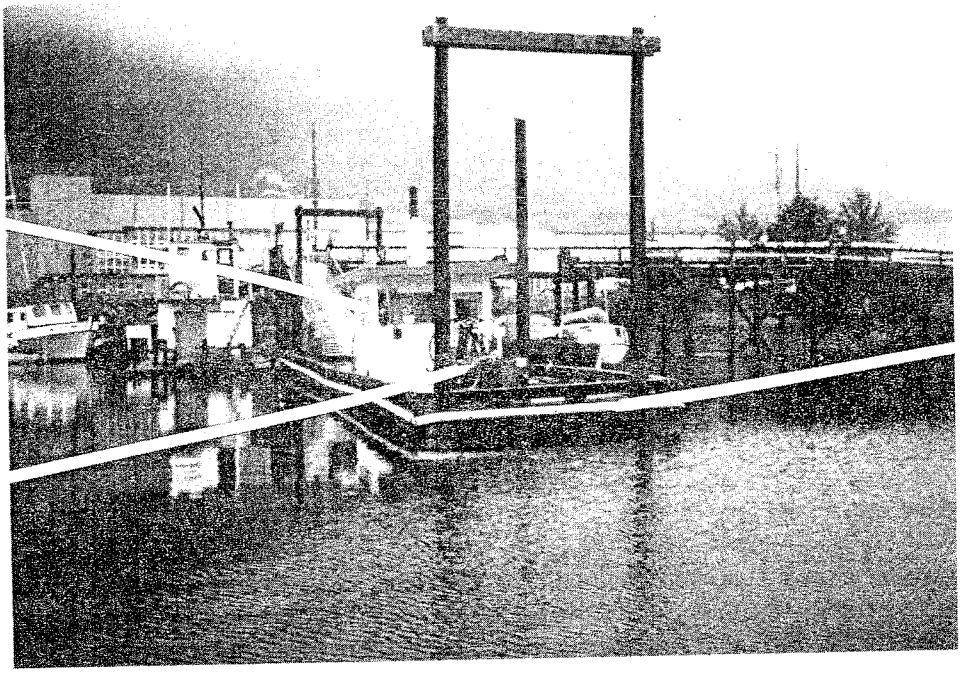


SECTION
BOAT RAMP



PANEL DETAILS

OFFICE

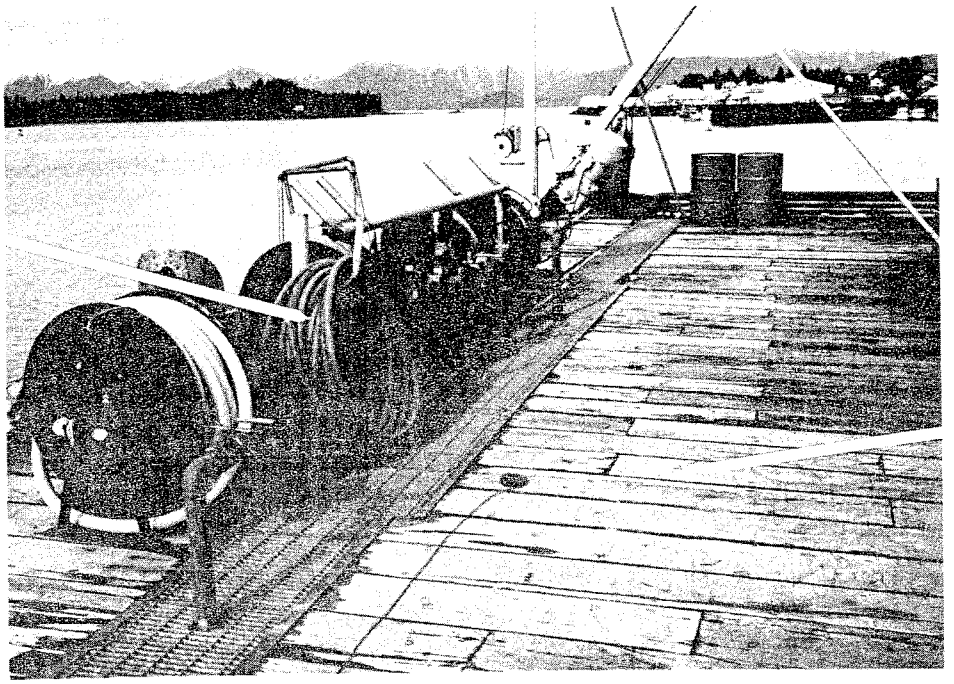


FUEL DOCK

PUMPS

FLOATING FUEL DOCK

PUMPS



FUEL DOCK

FUEL DISPENSING STATIONS

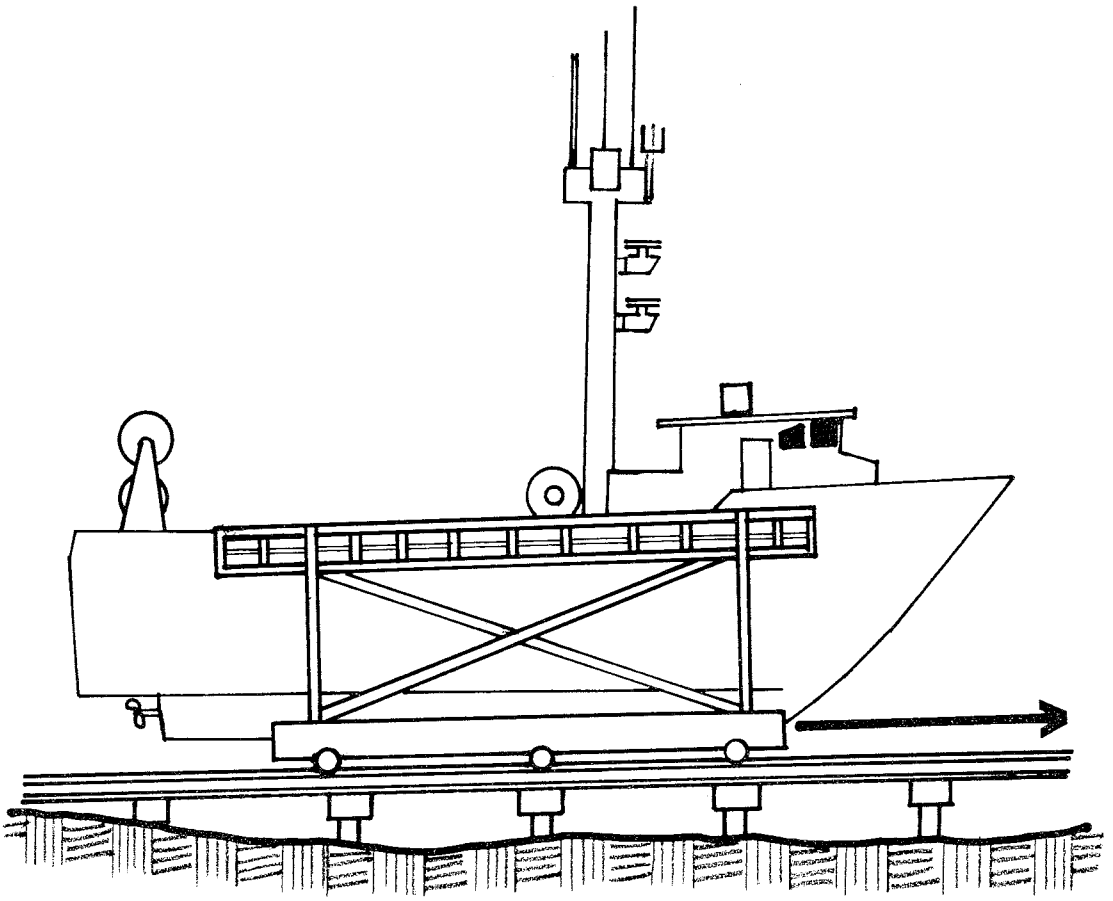
interference with traffic. The adjacent land area should be suitable for buried fuel storage tanks and easily accessible for fuel distribution vehicles. The pump out station normally should be located in the same area and is often on or along the fueling dock so that its operation can be supervised by the station manager. However, it should not be so close to the fuel pumps that a user has to wait for a pump out operation before he can dock for fueling. Boats should not have to go too far for fueling. Also, the station should not be in a location where it interferes with traffic flow or constitutes a fire hazard because of its proximity to other harbor facilities or berthed craft.

6.06 Marine Railways

The responsibility for operation and maintenance of marine railways for launching or dry-docking vessels might be somewhat of a rarity for most harbormasters, since most marine railways are privately owned.

However, in the instance where inspection is necessary and the responsibility of the harbor maintenance crew, this type of facility should be checked in the same procedure as would a dock, boat ramp and boat grid. Special attention should be given to the support members (pile or fill), pile caps or sleeper beams and rail connections (to caps and for rail splices).

The trolley and side racks should be inspected for wear and all fasteners tightened or replaced if damaged. Load capacities of the facility should be clearly posted.



MARINE RAILWAYS

CHAPTER 7
BOAT TRAFFIC

7.01 Traffic Patterns/Congestion

The establishment of efficient vessel movement patterns is a topic that should receive extensive consideration at the time when facilities are being designed. Aside from remedial dredging when required, little can be done to improve vessel movement patterns in existing facilities without great expense. Harbors experiencing difficulties with congestion or traffic problems should be monitored more closely and reported on a regular basis. The following are some general guidelines that should be observed if inner harbor floats are rearranged.

For most efficient operations, small craft ship channels should be checked at critical locations to ensure that they haven't been silted in or obstructed, and they should be maintained as straight as possible; where bends occur, they should be gradual. The width of the entrance channel depends principally on the number and size of vessels using the channel. In most cases, two-way traffic must be accommodated. For small boat traffic, a minimum navigable width of approximately 50 feet, or roughly five times the beam of the largest class of craft planned to be berthed in the harbor, should be maintained. Entrance channels for typical Corps of Engineers small craft projects range in width from 50 to 1,000 feet. If sailboats are to use the channel, extra width may be provided if tacking is allowed. It is also desirable, where possible, to maintain separate channels when small craft are combined with a commercial fleet.

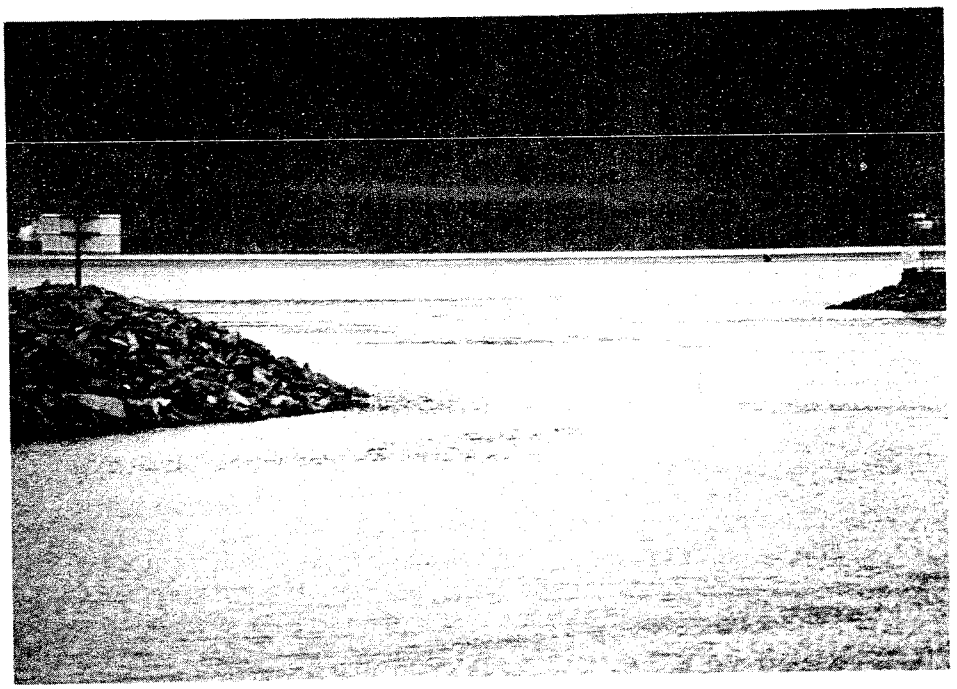
For several reasons, larger craft should generally be berthed near the entrance as they are less influenced by residual wave action entering the harbor and they require greater maneuvering space. Also, more physical space is needed for the larger craft than for the smaller ones, and if the larger craft are berthed so they need not traverse the inner fairways of the harbor, those fairways will have less influence from heavy boat wakes and may be made proportionately narrower. The deeper drafts of the larger craft require a deeper channel and basin; hence, the inner parts of the harbor can be made shallower if they are not used by the larger craft.

Commercial craft usually fall in the same category as large private recreational craft with regard to their water area requirements. The berthing areas of commercial and recreational craft should generally be separated because of different adjacent land use requirements. If possible, commercial boats should be located near the entrance in a separate basin or across a fairway from recreational craft. A commercial fishing fleet will require special hoists and other equipment for moving fish out of the holds onto perimeter docks and for sorting and preparing catch for market. In some instances, canneries or freezing plants are located adjacent to the fleet berthing areas. For safety reasons, the general public should be excluded from these working areas.

Sailboats without auxiliary power should be berthed in slips that open to the leeward side of the prevailing winds, and also in a location that can be reached via wide fairways and channels or routes that allow for sailboat tacking with least interferences to powered craft.

The use of seaplanes in or adjoining small craft harbors is common and can be the source of many conflicts with other vessels. Here again, seaplane floats and related facilities should also be located near the harbor entrances and near the fueling docks in order to minimize these conflicts.

Ramps or hoists for launching trailered craft should be separated as far as possible from the berthing areas so that vehicular traffic to berthing areas and trailer traffic to the launching area do not merge. Boating habits of the owners of these craft are different from those of the berthed craft; conflicts will result if the same fairways are used. If possible, the trailered craft should have a separate entrance or be launched directly into the ocean or lake without using the inner harbor. If trailered craft must use the same protected waters, the launching area should be at the inner end of the harbor complex where more parking space is available. The launched craft may then have to share the main channel with the berthed craft, and the channel made wide enough to accommodate traffic from both sources without overcrowding.



HARBOR ENTRANCE

7.02 Navigation Controls

Navigation controls are an important aid in establishing an orderly flow of vessel traffic and are monitored by the U.S. Coast Guard. Harbors should have their entrance channels clearly marked. Illumination levels should be adequate to be seen for approximately two miles under clear conditions. Since white light tends to blend in with background lights, some component of red or green could be included in the illumination source. Such lighting should be given the same electrical inspection as other lighting. All illumination and lamp replacements for navigational controls should be carefully selected to ensure that they are in conformance with regulations, Coast Guard permits, etc.

Harbor speed limits should be clearly posted at appropriate locations. Speed limits should be low enough to avoid damage from wakes within the confined harbor area.

7.03 Derelict Vessels and Long-Term Storage

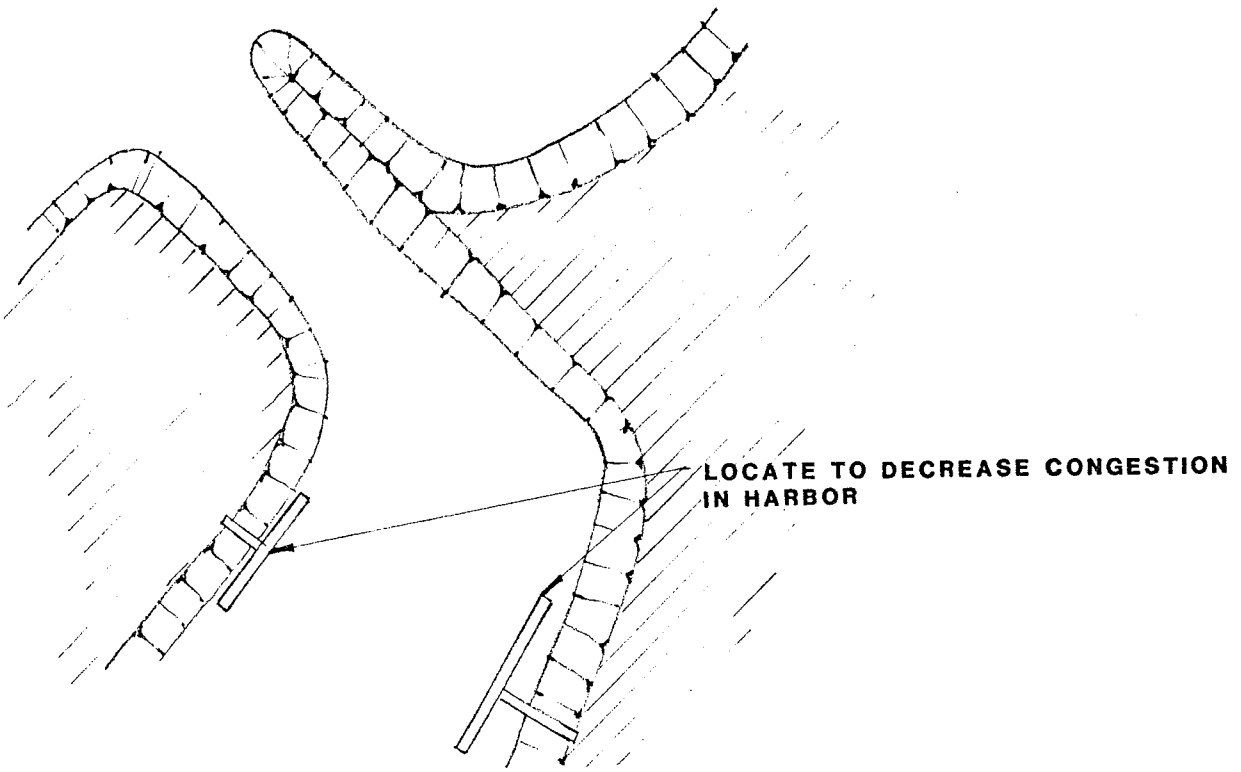
Providing adequate long-term storage space for disabled or derelict vessels is a major problem for many boat harbors. While space must be provided for such vessels, such space should meet certain minimal requirements. The long-term storage area should have a fire station nearby with adequate hydrants, extinguishers, etc. Pumping facilities should be readily available.

The location in the basin where long-term storage takes place should be located away from the fuel dock and harbor entrance at a site where vessel traffic will be minimally affected. The area should be well lit, and, if possible, secured.

7.04 Transient Use

Moorage space for transient vessels is a major problem in many small boat harbors. Where moorage space is limited, vessels are often tied several abreast ("hot berthed"). These procedures, besides causing inconvenience, can restrict vessel channels and cause safety hazards.

Although transient vessel space is best accommodated at the time of initial harbor layout and design, some changes or rearrangements could be made to minimize operational problems. Factors that should be considered include locating transient moorage near the harbor entrance to minimize traffic within the harbor, and providing a relatively long, uninterrupted space for transient moorage. In this way, a variety of vessel sizes and shapes can be accommodated. Transient floats should also be provided the same utilities as permanent moorages. Inspection of the float and utilities would therefore proceed similarly.



TRANSIENT VESSEL MOORAGE

CHAPTER 8
UPLAND FACILITIES

8.01 Parking

The parking space and layout for any harbor facility is critical; to a large degree, it has a major influence on public sentiment toward the overall harbor facility. An inefficient layout can severely hamper effective use of launch ramps, storage facilities, and many other features of a small boat harbor. Normally in an existing harbor it is difficult, and sometimes impossible, to economically improve the upland areas without major investments. However, to the extent that some improvements can be made to improve the upland operations, the following recommendations apply.

As a general guideline, at least one vehicle space per permanent boat stall should be provided. This, however, is a local concern and each community will have their own requirements. While it is highly unlikely that all boats will be used simultaneously, each boat in use will normally require more than one parking space. Another general rule-of-thumb is that approximately 35 to 50 car/trailer spaces should be provided per launch ramp in use. Here again, this is a local concern, and these rule-of-thumb guidelines are presented in order to assist the harbor inspectors in quantifying some of their parking problems.

In addition to local regulations, vehicle parking spaces should conform to minimum dimensions such as those illustrated on the typical parking standards. Nonconforming situations should be monitored, reported, and improved when possible.

A minimum of one parking space located near the launching ramp and restroom facilities should be provided and identified for use by individuals with physical disabilities, and the facilities provided in accordance with handicap regulations. This parking space is normally 12 feet wide, and located so that persons using wheelchairs, braces, or crutches are not required to wheel or walk behind parked cars. Wheelchair ramps should be located wherever necessary to cross curbs and other obstructions. Handicap parking should be identified with appropriate signs and markings. Consequently, +-2 percent of the total parking spaces are usually designated as parking spaces for handicap use.

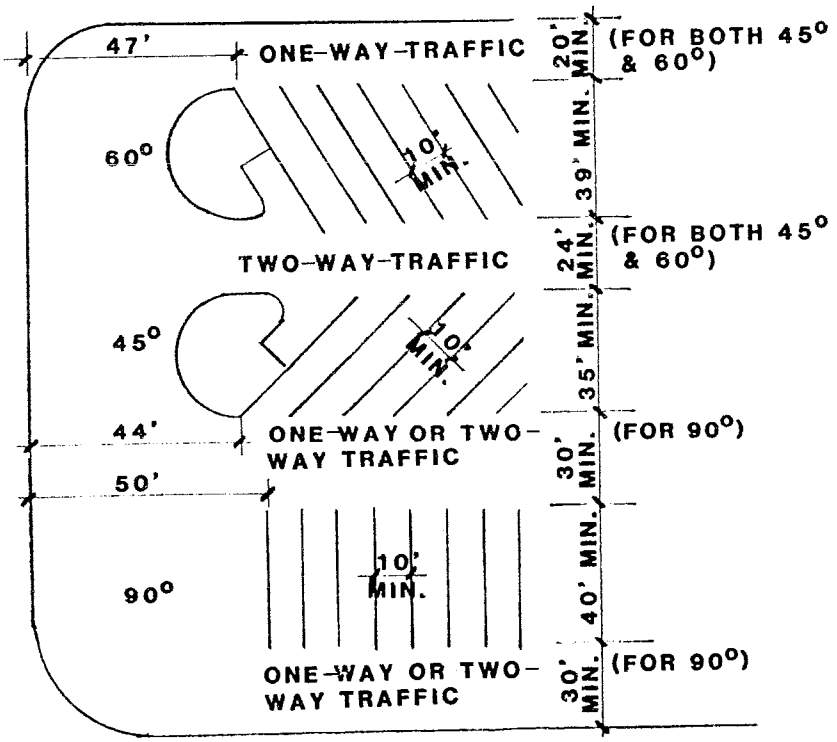
It is important to provide an efficient scheme for normal vehicle movements as well as emergency vehicles. Local and state standards for parking areas and egress and ingress safety standards and signage should be followed. The distance over which boat trailers need to be backed up should be minimized, and trailer movement should be isolated from the movement of other vehicles as much as possible. The readability and clarity of striping and signing should be checked. Turns with radii of less than 45 feet for boat trailers should be avoided. Loading zones and no parking areas should be clearly signed. It is also suggested that signs be provided to advise owners to lock their vehicles when unattended, and that responsibility for theft, damage, etc., be clearly stated on a sign.

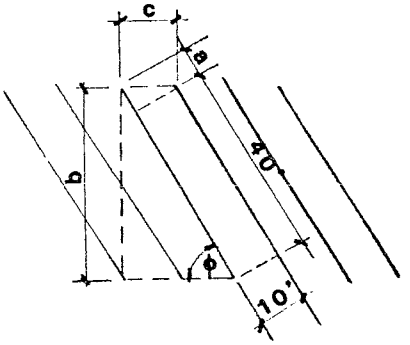
The condition of the surfacing in the parking areas should be regularly examined. If paved, are any cracks or notable subsidences occurring? If unpaved, are potholes developing or worsening? Any such occurrences should be noted for future repair. A properly designed and maintained parking area should perform satisfactorily for a 20-year period.

It is critical that adjacent residents and property owners be considered when making any major changes that could affect the operations of the harbor facilities.

8.02 Storage

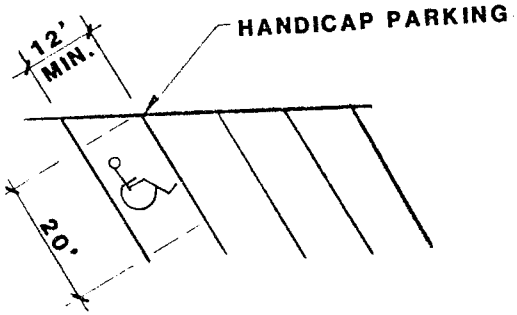
Long- and short-term vessel storage should be secured and should be laid out to economically use available space and not interfere with other operations.

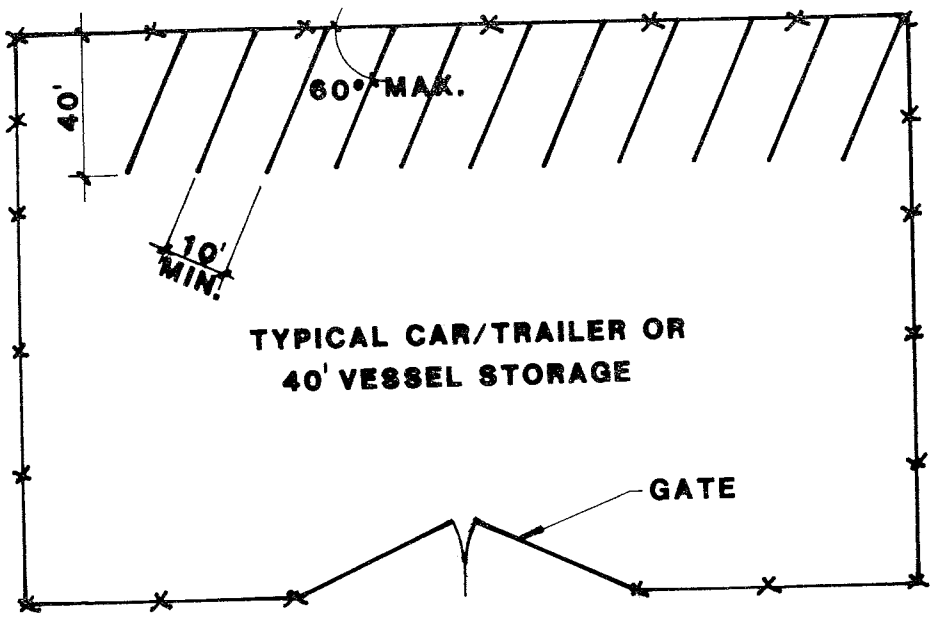




ϕ	a	b	c
45°	10'	35.4'	14.1'
60°	5.8'	39.6'	11.5'
90°	0	40'	10'

TYPICAL PARKING STANDARDS





SECURED STORAGE AREA

Fences and gates should be undamaged, without holes or gaps. Locks should be in operable condition. Gates should be wide enough to accommodate the type and size of vessels using the facilities.

An efficient storage scheme should be compact enough to maximize available storage, but still allow easy movement of boats and trailers in and out of the area.

Untrailered boats should be stored in a safe and stable way and not precariously perched on blocks or in any other potentially hazardous manner. In general, and in order to minimize any liability claims, the area should be kept neat and not have blocks, garbage, or other clutter in vicinity.

The area should have proper surface drainage and be well lighted, with readily available fire protection. Electrical and fresh water service should also be available in the storage area for those wishing to do maintenance on their vessels or gear.

In areas where floats must be pulled out during the winter, consideration must be given when laying out storage options. It is possible that much of the space used for vehicle parking during the summer could be converted to winter snow or float storage.

8.03 Utilities and Services

To a large extent, the safety and practicality of a harbor facility depends upon the adequacy of its support facilities such as the adjoining upland utilities and services. The following are recommendations for items to inspect or improvements that could be made that would improve operations and reduce maintenance.

Accordingly, water hydrants should be checked to ensure that they meet local standards for pressure and flow.

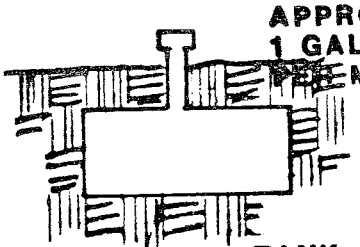
Surface lighting should be adequate to clearly illuminate all parking, abutments, storage areas, and any other facilities which will be in use at night. Particular attention should be paid to lighting at the top of gangways, ladders, and approach ramps. (In general, upland lighting should be on the order of four candela per square foot.)

Dump sites should be clearly identified and their locations checked for efficiency and consideration of fire safety, as well as for the presence of leaks or other malfunctions. Waste oil dump sites should be provided to accommodate approximately one gallon per boat stall per month. Dump sites should clearly be labelled as such and posted with appropriate safety messages (e.g., No Smoking).

A working telephone should be readily available. This is not merely a convenience for those using the harbor; it is an essential safety feature. Telephones should have emergency numbers clearly posted. Their location should be conspicuously posted so that they may be easily located when needed.

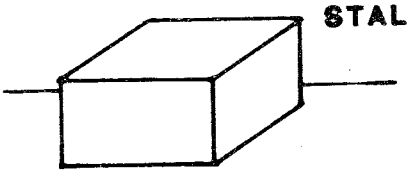
Garbage facilities should be readily available near the head of every gangway or approach ramp. (A reasonable guideline for providing adequate garbage disposal is 1 cubic foot per boat stall per week.) These facilities should be as close to launch ramps and gangways as practicable and should also be provided near restrooms. Dumpsters should be clearly posted as available for harbor users only.

Washdown areas should be provided near areas accessible to the top of boat launching ramps. The location should be carefully chosen so as not to interfere with traffic or reduce the ramp use efficiency, but still convenient to the intended user. These facilities should be inspected to ensure that they are functioning adequately. If non potable water is used for washdowns, appropriate warning signs should be present.



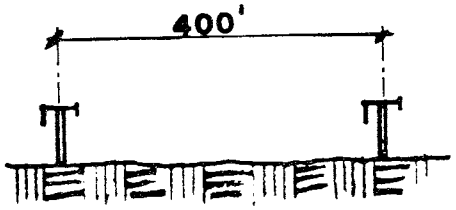
APPROXIMATE CAPACITY
1 GALLON PER STALL
PER MONTH

WASTE OIL TANK

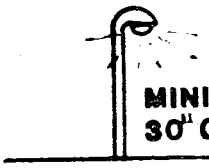


1 CUBIC FOOT PER
STALL PER WEEK

GARBAGE DUMPSTER

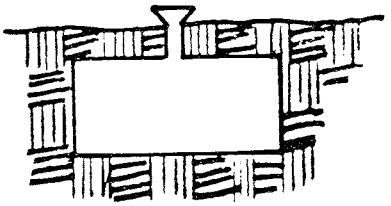


POTABLE WATER & HYDRANT
SPACING



MINIMUM 5 CANDLE/FOOT^2
30" OFF DECK

AREA LIGHTING



WASTE DISPOSAL TANK

SERVICE CAPACITIES

Sewage disposal dump stations should be provided to prevent the disposal of waste material into the harbor. A reasonable guideline for providing adequate disposal storage capacity is two gallons per stall per week. This capacity may prove to be inadequate during peak use areas, and, therefore, additional pumpouts may be required.

8.04 Structures

Structures commonly found upland of small boat harbors include a harbormaster's office, a maintenance equipment shed, and restrooms with shower facilities.

Routine checks of plumbing, electrical, mechanical, and structural systems should be made of all buildings. Any evidence of moisture in prolonged contact with structural elements should be noted and reported.

Buildings should be inspected for compliance with applicable fire codes. Maintenance equipment sheds should be checked for unsafe storage or improper use of inflammable chemicals. Evaluation of types of space usage in such facilities should be periodically undertaken.

Restrooms should meet all local and state requirements for access to and use by handicapped persons and should comply with public health requirements of local, state, and federal agencies within whose jurisdiction they are built. They should be clearly signed, preferably with international symbols. Restroom facilities should be made as convenient to launch ramps and gangways as practicable. (Normally, at least one toilet fixture for each sex should be available for each 30 parking spaces or fraction thereof.)

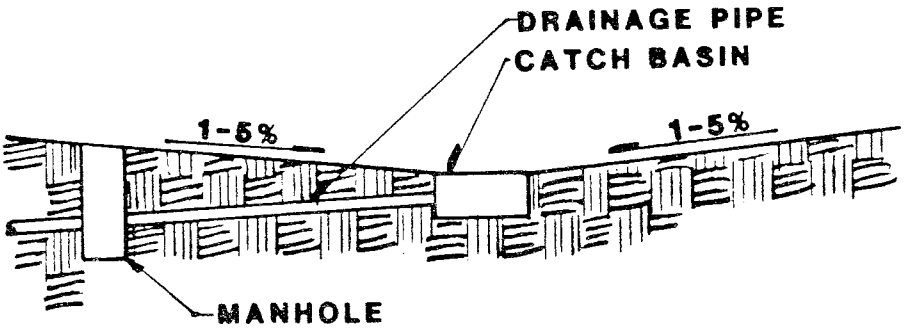
8.05 Drainage and Embankment

Upland areas should have good surface drainage. (Paved slopes should be maintained at 1-1/2 percent minimum with 5 percent maximum grades. Gravel Slopes should also be maintained at 2 percent minimum grades.) Catch basins, manholes and drain pipes should be kept free of debris, unblocked, and in good general condition.

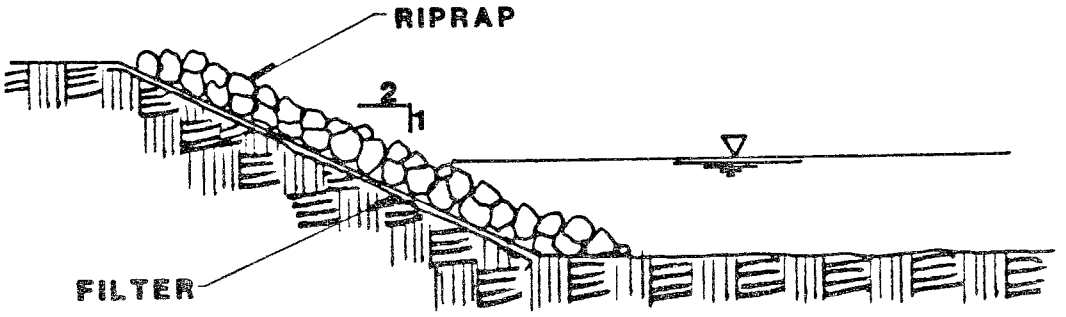
Embankment slopes of the inner harbor basin should be protected against erosion by providing gentle slopes, riprap, stabilizing fabric, or a combination of these--depending on level of exposure.

Riprap should be checked for loss or sluffing. Fabric material should be kept covered and should not be visibly tattered or unraveled at its edges. Embankment should be stable and not allowed to creep. Depending upon riprap, exposure, and composition of embankment, slopes at the edges of embankments should generally be maintained between 1-1/2:1 and 3:1.

CHAPTER 9
BASIC CHARACTERISTICS



UPLAND DRAINAGE



SECTION
HARBOR SIDE

9.01 Bathymetry

The term "bathymetry" refers to the depth or profile of the bottom surface. It is important that harbor bathymetry be known and be consistent, so boat skippers know exactly where in the harbor they may safely take their vessel and under what tidal conditions. Terraced bottoms may be developed to allow shallow draft vessels to moor further in, while those requiring more water depth may remain closer to the harbor entrance.

While harbor bathymetry normally remains fairly constant, there can be situations where it will change--usually for the worse. Potential sources of siltation at locations near culverts or adjoining streams, or near unstable embankments susceptible to sluffing, are areas warranting close observation.

In general, the minimum water depth that should be provided would include a 4-foot minimum vertical clearance at the lowest water expected for the deepest draft vessel anticipated. If such depths are not present, dredging or restriction on certain types of vessels is warranted. Any shallows should be clearly marked, preferably with water depths called out at lowest tides.

9.02 Wave Barriers: Rubble-Mound Breakwaters

The rubble-mound breakwater is one of the most common types of breakwater used. The earth and rock structure is designed to help block or reduce the wave energy entering a harbor. Components include a core usually consisting of shot rock or other types of fill, filter cloth, and heavy rock riprap protection. The core provides most of the bulk or weight of the structure, while a filter material or cloth (if present) prevents the core from washing out through the gaps in the larger riprap.

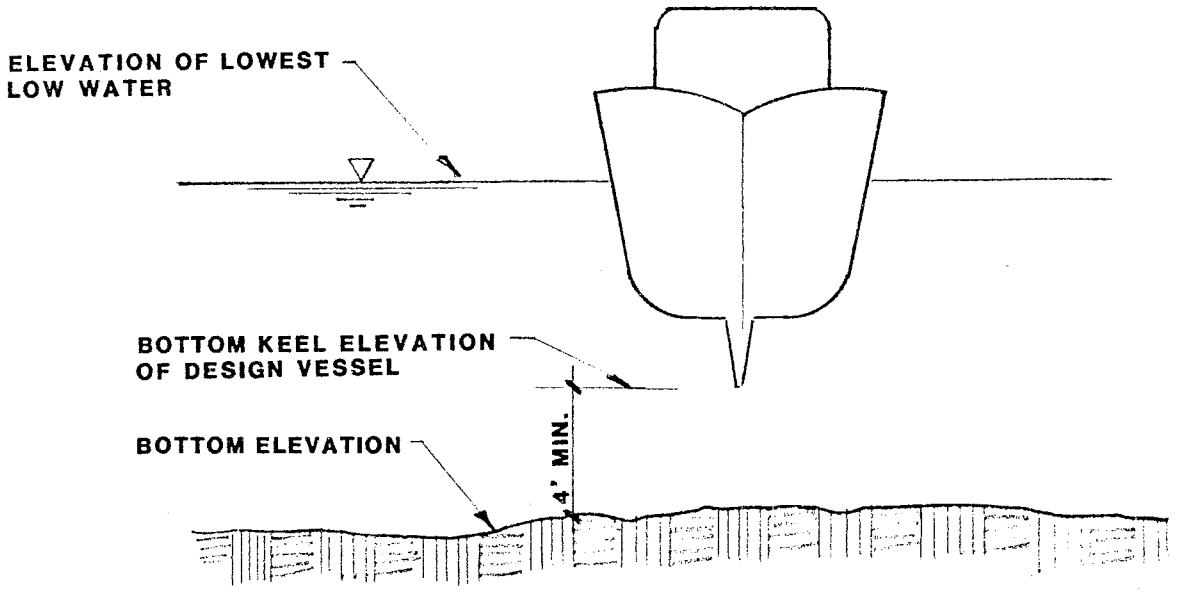
The function of the riprap is to protect the core of the structure from washing away or seriously deforming during wave attack. In general, the larger the anticipated waves and the steeper the embankment slope, the larger the riprap units should be. Slopes may range from 1.5:1 to 3:1; steeper than 1.5:1 is not advised. A properly designed rubble-mound breakwater should last 20 to 50 years with minimal maintenance requirements, depending on exposure.

Thorough examination of the riprap protection for excessive gaps, movement, or sluffing is required. Units should be replaced as soon as possible where necessary. An examination should be made once or twice yearly, or after extreme events. A thorough inspection would include underwater inspection along the toe of the riprap at critical locations to check for erosion.

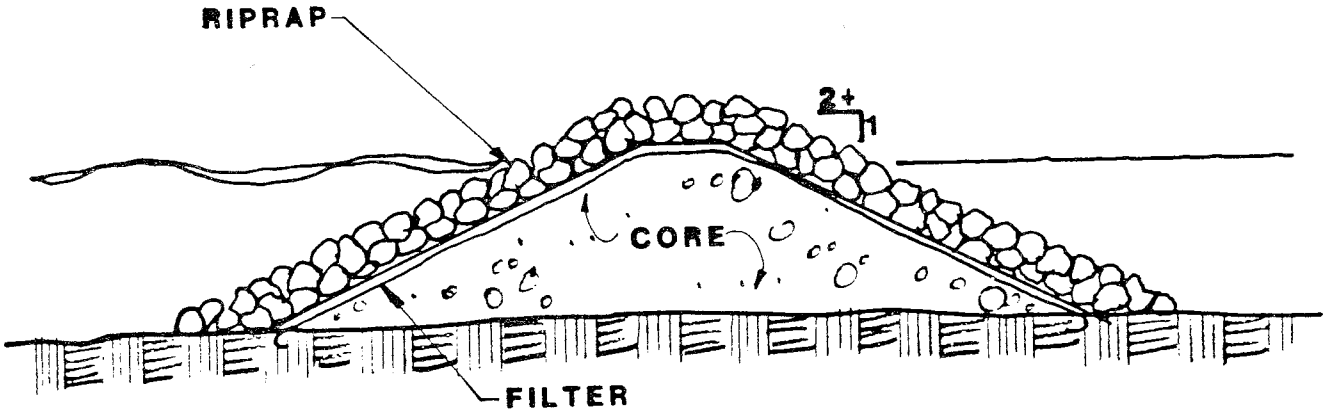
9.03 Wave Barriers: Floating Breakwaters

Floating breakwaters consist of a float system whose primary purpose is to help attenuate near-surface wave energy. They generally require heavier construction and much deeper flotation systems and connections than floats used primarily for mooring because of their more exposed location. While not as effective in reducing wave heights or blocking winds as rubble-mound breakwaters, they can be cost-effective in areas requiring secondary breakwaters or where water depths are too great for economical construction of a rubble mound.

A typical floating breakwater consists of a concrete foam-filled float, tied together with timber walers. These floats are often held in place by an anchor system, rather than piling, because of the greater depths where they are typically found. Maintenance requirements for floating breakwaters may be more stringent due to their exposure, even though the elements warranting inspection are generally similar to concrete mooring floats. Particular attention should be paid to float-to-float connections and to float-to-anchor line connections, since a floating breakwater will generally undergo greater levels of motion than a mooring float, and therefore have greater potential for wear. Mechanical wear between connections may cause excessive wearing of the galvanizing layer or



HARBOR BATHYMETRY LIMITS



RUBBLE-MOUND BREAKWATER

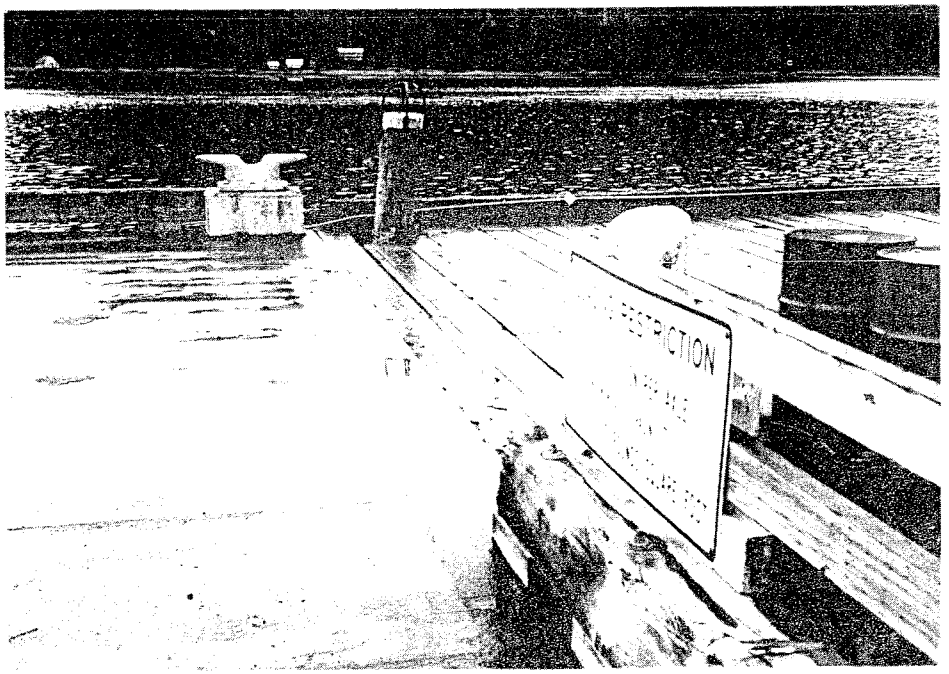
protective coating, thereby greatly shortening the life of the connectors. Any such wear or corrosion should be carefully monitored and reported.

Floating breakwaters should be checked regularly to ensure that their location remains constant. Since they are anchored, there is always the potential for them to drag anchor in extreme conditions. As with other floats, their vertical settlement should also be monitored. Divers should be used periodically to inspect the anchoring system. Fouling of the anchor line, excessive corrosion of chains or cables, and cable-to-anchor conditions are of particular interest. Any evidence of anchor shifting or moving should also be noted.

CHAPTER 10
SIGNING

10.01 Signing

The placement and requirements of signs has been mentioned throughout the text of this report. The purpose of signing is to protect the harbor owner by warning facility users of imposed load limits and potential risks involved in using the facilities. At a minimum, signing should follow local ordinances and/or OSHA requirements. Areas restricting the general public should be signed accordingly.



DOCK LOAD LIMITS SIGN

FIRE CALL BOX

CHAPTER 11
SAFETY AND LIABILITY

11.01 Safety and Liability

Harbors are places of great importance to a vast assortment of people as they attract people of varied interest and ability. Harbors are also inherently dangerous, often without seeming so to the uninitiated.

There are numerous codes, the Uniform Building Code and the Occupational Safety and Health Association as examples, that establish certain safety or use procedures which often cannot be economically met in some harbors. As a result, litigation is becoming more prevalent, using almost any code as a basis. The harbor owner is without defense in most cases of accident or claimed accident, because no single code addresses harbors, ports, and marinas.

The question regarding this situation is, "How do I protect myself from such litigation?"

Obviously, insurance is one way of providing some assurance of protection, but this can become costly with repeated claims and possibly even cancelled.

Another approach is to attack the problem "head on," by inspecting and identifying all potential problems or code variations that could exist within your area. This can be done by using skilled professionals familiar with various aspects of water-related development.

Once potential hazards have been identified, there are a number of avenues which can be taken, including:

1) Bring the condition up to an applicable code.
2) Isolate the condition.
3) Provide warning signs.
4) Establish use regulations.
5) Acquire specific variations from codes through OSHA, the U.S. Coast Guard, UBC, etc.

To point out some areas of concern, here are a few litigation cases in point:

1) Man falls down access ramp at low tide and breaks a bone.
2) Ship line breaks rib of man leaning on bollard.
3) Drunk man falls off ladder.
4) Man has heart attack on ladder.
5) Man gets crushed between boat and fender pile.
6) Woman slips and falls on sloping ramp.
7) Man slips on spilled fuel.
8) A man was injured when his foot slipped on an exposed bolt.
9) A man slipped and fell on a wet deck while wearing street shoes.

A list of potentially unsafe conditions common to marine facilities would include:

- Slippery Ramps and Surfaces due to Ice, Water, Spilled Fuel, Etc.
- Out-of-Code Railing
- No Rails on Some Floats
- Deck Clutter Including Lines and Cords
- Low or Unsafe Electrical Lines, Fixtures and Grounding
- Uneven Surfaces
- No Handicapped Provisions
- Lack of Fire Fighting Facilities
- Poor Lighting
- Cranes
- Ladders
- Lack of Life Saving Devices
- Many Others

The most important recommendation that can be offered at this time is to first identify all possible problems by performing a thorough inspection, after which a plan of action should be established.