FOI #15799

Torres Rojas, Genara

From: bslagle@jsengr.com
Sent: Wednesday, February 18, 2015 9:42 AM
To: Duffy, Daniel
Cc: Torres Rojas, Genara; Van Duyne, Sheree; Ng, Danny
Subject: Freedom of Information Online Request Form

Information:

First Name: Brian
Last Name: Slagle
Company: Janssen & Spaans Engineering
Mailing Address 1: 9120 Harrison Park Court
Mailing Address 2:
City: Indianapolis
State: IN
Zip Code: 46216
Email Address: bslagle@jsengr.com
Phone: 317-254-9686
Required copies of the records: No

List of specific record(s):
Engineering Department Manual Condition Survey Guidelines - Waterfront Structures, Appendix C

THE PORT AUTHORITY OF NY & NJ

FOI Administrator

March 9, 2015

Mr. Brian Slagle
Janssen & Spaans Engineering
9120 Harrison Park Court
Indianapolis, IN 46216

Re: Freedom of Information Reference No. 15799

Dear Mr. Slagle:

This is in response to your February 18, 2015 request, which has been processed under the Port Authority's Freedom of Information Code (the "Code", copy enclosed) for Engineering Department Manual Condition Survey Guidelines - Waterfront Structures, Appendix C

Material responsive to your request and available under the Code can be found on the Port Authority's website at http://www.panynj.gov/corporate-information/foi/15799-O.pdf. Paper copies of the available records are available upon request.

Please refer to the above FOI reference number in any future correspondence relating to your request.

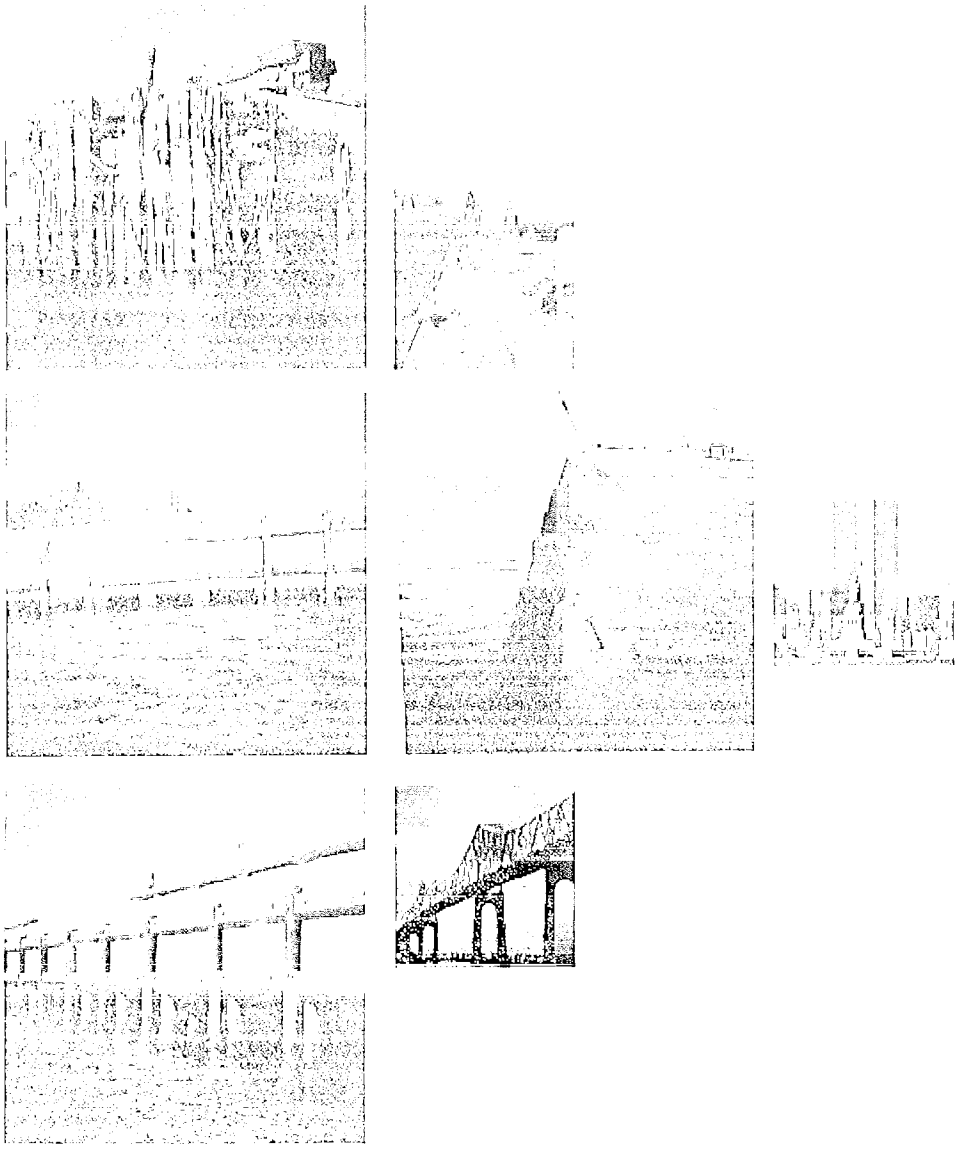
Very truly yours,

Daniel D. Duffy
FOI Administrator

Enclosure

4 World Trade Center, 18th Floor
150 Greenwich Street
New York, NY 10006
T: 212 435 3642 F: 212 435 7555

THE PORT AUTHORITY OF NY & NJ



GUIDELINES FOR CONDITION SURVEY OF WATERFRONT STRUCTURES

Engineering Department

September 1998

Scanned January 1999

Blue Hyper-Text symbolizes a link to an object, attachment or drawing contained in this document. Green Hyper-Text symbolizes missing objects, attachments or drawings. If you have access to these objects, attachments or drawings please forward them in digital format, if possible, to:

Engineering Management Department – 72 S
Attn. Mr. Peter Zipf

THE PORT AUTHORITY OF N. Y. & N. J.

ENGINEERING DEPARTMENT

GUIDELINES FOR

CONDITION SURVEY OF

WATERFRONT STRUCTURES

Date: SEPTEMBER 1998
Scanned: JANUARY 1999

PORT AUTHORITY OF N.Y. AND N.J.
GUIDELINES FOR CONDITION SURVEY
OF WATERFRONT STRUCTURES

TABLE OF CONTENTS — PAGE NO.

1. Introduction 1
2. General 1
3. Frequency of Condition Surveys 2
4. Personnel 2
5. Organizing a Condition Survey 3
6. Condition Survey Procedure 4
   - A. Rating System 4
     - 1) Rating Criteria for Waterfront Structures 4
     - 2) Inspection Terminology 7
   - B. Pier Components to be Inspected 10
     - 1) From the Deck 10
     - 2) From Floats 11
     - 3) By Divers 11
     - 4) By Test Pit Excavation 11
     - 5) Rip Rap Dikes and Shore Protection 11
     - 6) Crib Type Bulkheads 11
   - C. Inspection Methods 11
     - 1) Above Deck 12
     - 2) Below Deck 13
     - 3) Diver Inspections 16
     - 4) Inspection Requiring Excavation 16
     - 5) Rock Dikes and Rip Rap Slope Protection 17
     - 6) Crib Type Bulkheads 17
7. Report 18
8. Figures 20
9. Photographs 27
10. Attachment 1 31
11. Guidelines for Selecting Test Methods 33

1. INTRODUCTION

Waterfront structures (piers, wharves, bulkheads) and other marine facilities are exposed to the effects of waves, winds, currents, earthquake and the activity of destructive marine organisms, all of which lead to corrosion, erosion and decay. Heavy vertical loadings and ship impacts in addition to these natural environmental forces contribute to the rapid deterioration of marine structures and equipment if maintenance is neglected. As such, a marine facility should be inspected on a regular basis so that timely and effective repairs and preventive maintenance can be carried out. If inspections and prescribed repairs are performed regularly, the structural integrity of a marine facility could be maintained for periods in excess of 50 years.

The extent of deterioration of particular structural components within a marine facility may range from none to severe. The most severe condition necessitates immediate repair or replacement if a localized failure is to be averted. Deterioration could also be uniform throughout a facility, and a moderate reduction in permissible live load may be appropriate. On the other hand, deterioration of a marine facility could be so extensive as to require a major rehabilitation, or complete replacement.

The first step in determining the structural integrity of a marine facility is to perform a condition survey to determine the condition of all its principal structural components. The next step is to structurally, or operationally, evaluate the conditions revealed by the inspection, in relation to either the initial design intent, or the modified requirements due to a possible reduced structural capacity of the facility. Finally, a program is formulated to implement the necessary repairs. These guidelines address primarily a condition survey, the first step in developing the structural integrity of a marine facility.

2. GENERAL

Assign a Professional Engineer, with extensive experience in waterfront structure design, construction, and inspection, to conduct a condition survey of each marine facility. This survey, which should be accomplished during favorable tide and weather conditions, shall be of a general nature covering the entire facility, but with emphasis on items that can become problematic before the next scheduled survey. Such items are usually prone to damage because accidents, abuse, or geotechnical shortcomings. Marine structure problems that can develop with little or no prior warning, include:

A. fender or facility damage due to vessel impacts;

B. damage to deck slabs caused by abuse, excessive loadings, or an unusually severe winter;

C. breakage of deck fittings, such as cleats, bollards, bits, and winches; and

D. lateral movement of a bulkhead that may be caused by an unusually heavy surcharge placed behind the bulkhead, or possible geotechnical shortcomings that were built into the structure.

The results of this condition survey are summarized in a letter report containing specific recommendations concerning the need for an immediate in-depth inspection, or the implementation of remedial repairs, if required.

3. FREQUENCY OF CONDITION SURVEYS

The frequency of a condition survey is determined by the Quality Assurance Division based on the following factors: previous condition survey reports and maintenance records, age of the facility, type of construction, exposure to environmental elements, and the abuses to which the facility is subjected by operations.

4. PERSONNEL

Assemble an inspection team with personnel qualified as follows:

A. Manager (Project Engineer). A registered Professional Engineer in the State of New York or New Jersey, specializing in structural engineering with at least ten (10) years experience in a responsible capacity in a combination of both design and construction of waterfront structures.

B. Team Leader. The Team Leader shall be a registered Professional Engineer in the State of New York or New Jersey, specializing in Structural Engineering with at least three (3) years of experience in a responsible capacity in marine structure inspection, or related work. He shall be at the site for the duration of the field inspection. He shall personally direct the inspection team to assure that each component is properly inspected and its condition is properly documented. When unusual structural problems or details are encountered, he shall personally observe and evaluate the situation.

C. Inspectors. Engineers, or technicians, with experience and a working knowledge of timber, steel, and concrete waterfront construction.

D. Divers. Preferably engineers, who can make determinations of the condition of materials, retrieve samples, perform nondestructive testing, and take underwater photographs. If the diver is not a registered Professional Engineer, he shall be supervised at all times by a Professional Engineer registered in the State of New York or New Jersey, specializing in structural engineering.

5. ORGANIZING A CONDITION SURVEY

A marine structure condition survey should be carried out in a systematic manner during favorable weather and tides so that all components to be examined are accessible for examination to the fullest extent practicable. The following guidelines are provided for use in organizing a condition survey.

A. Establish the objectives of the survey and planned usage of the facility. This includes assembling and reviewing available as-built drawings, previously prepared inspection and condition reports, and existing maintenance records.

B. Conduct a preliminary reconnaissance of the facility during low tide periods. This inspection should include "spot-checking" of all components that can be viewed above low water. Determine accessibility of items that have to be inspected including which components are accessible only to divers. Problem conditions should be recorded to make an early determination of items that will have to be covered in detail during the condition survey. For example, the preliminary examination may indicate that the deck of a marine structure appears to be in excellent state of preservation, whereas the piling, in the tidal zone, appears to have advanced deterioration. Such observations may be the basis for determining that a substantial effort must go into a detailed below deck inspection, whereas the deck requires little more than a general visual examination and perhaps, minimal nondestructive testing.

Since marine structures have known areas of concern regarding damage and deterioration, such areas shall be given special attention during the condition survey. Known problem areas include, but are not limited to:

1) fender systems;

2) fender system supporting structures such as concrete bulkheads that are vulnerable once the fenders are damaged;

3) timber and steel piles, including bracing, located in the tidal zone;

4) welds in steel;

5) bolt holes and saw cuts in timber, especially in the tidal zone; and,

6) the undersides of concrete deck slabs that extend along the docking face of a high level platform type structure.

C. Prepare a plan and identify all pile bent and pile row numbers, (see Sample Plan, Figure 1). Prepare a typical cross section of the structure, no longer than 11" x 17" sheet (for assembly on clip boards or loose-leaf binders) to identify all piles, brace members, deck, etc., (see Sample Cross Sections, Figure No's. 2,

3, 4, 5 and 6). The cross section(s) should be reproduced in sufficient quantity to provide a copy for each bent in the pier structure. These sheets are for use in recording the condition of each element inspected. All data shall also be tabulated for each type of structure. This inspection recording procedure will enable the survey team to compile a detailed inventory of the condition of the components for the entire facility.

D. Subdivide work into assignments that can be carried out independently, generally based on the means of access to the work area. Following are the basic subdivisions, most of which would apply to a typical marine structure inspection project:

1) Work that can be carried out by inspectors walking the pier deck;

2) Work that can be conducted, only during low tides, from floating stages or boats;

3) Diver work; and,

4) Work involving excavation in order to expose a critical structural component that would otherwise be inaccessible for examination.

6. CONDITION SURVEY PROCEDURE

Direct the condition survey procedure towards observing and recording sufficient information to permit development of a course of action; repair, rehabilitation, load limit posting, etc.

A. RATING SYSTEM

Since a substantial part of marine structure condition survey work is carried out below the deck, where the inspectors operate from unsteady floats, headroom is limited and tides restrict the time available for the work, a rating system for structural components should utilize symbols that are readily identified with the condition observed and are convenient to record.

1. RATING CRITERIA FOR WATERFRONT STRUCTURES

Terms used to describe the condition of a waterfront structural system, or element, are listed and defined below. When the term is applied to an overall system, this does not indicate that some elements of the system are not in a different condition.

a) OVERALL STRUCTURE

Excellent	"As New" Condition.
Good	System or element is sound and performing its function, although it shows signs of use and may require some minor repairs, mostly routine.
Fair	System or element is still performing adequately at this time, but needs "priority" and/or "routine" repair to prevent future deterioration and to restore it to good condition.
Poor	System or element cannot be relied upon to continue to perform its original function without "immediate" and/or "priority" repairs.

b) INDIVIDUAL COMPONENTS

1) Timber Piles

New	"As new" condition.
Minor	No significant deterioration noted except for light checking, light grooving, and delamination. Section loss is less than 10%.
Moderate	Moderate checking and some cracking; moderate gouging and delamination; areas of rot. Section loss is more than 10%, but less than 35%.
Severe	Splitting, extensive delamination; large and deep voids with areas of rot. Section loss is more than 35%. Broken piles or non-bearing piles are automatically rated severe.

2) Concrete Pile Extension

New	"As New" condition.
Minor	No significant deterioration noted, except for random hairline cracking and minor spalling at the bottom of the extension up to 6" deep. Less than 10%, bearing section loss at top of encasement.
Moderate	Cracks up to 3/16" wide and extensive spalling at the bottom of the extension up to 12" high. More than 10% but less than 50% bearing section loss at top.
Severe	Extension severed; no bearing on pile; cracks more than 3/16" wide; major spalling at the bottom of the extension more than 12" high, or less than 6" of timber pile remaining encased. More than 50% bearing section loss at top.

3) Steel Piles

New	"As New" condition.
Minor	No significant corrosion noted, except for light surface corrosion or pitting. Section loss is less than 10%.
Moderate	Moderate corrosion or pitting. Section loss is more than 10%, but less than 25%.
Severe	Severe corrosion or pitting. Section loss is more than 25%; bent or broken piles are automatically rated severe.

2. INSPECTION TERMINOLOGY

The following terms may be used during inspection to describe the condition of structural members.

a) Steel Members

1. Corrosion

Minor (or Light) - A light surface rust.

Moderate - Rust that is loose and flaking with some pitting. This scaling, or exfoliation, can be removed with some effort by use of a scraper or chipping hammer. Element exhibits measurable, but not significant, loss of section.

Severe - Heavy, stratified rust or rust scales with extensive pitting. Removal requires exerted effort and may require mechanical means. Significant loss of section.

2. Impacted Rust - Rust collected between two interfacing surfaces, usually two steel plates. Impacted rust can be minor, moderate, or severe as described above. Impacted rust can severely deform the steel members due to the expansive nature of rust.

3. Pitting - Formation of cavities due to corrosion. Minor, moderate, and severe pitting categories are used based upon depth and density of cavities.

Minor - Typically less than 1/4 inch diameter and 1/32 inch deep.

Moderate - 1/4 inch to 1/2 inch diameter and up to 1/8 inch deep.

Severe - Greater than 1/2 inch diameter and over 1/8 inch deep.

b) Concrete Members

1. Cracking – A separation into two or more parts with a space between the fractured concrete surfaces.

Hairline – Crack width less than 1/32 inch.

Fine – Crack width between 1/32 inch and 1/16 inch.

Medium – Crack width between 1/16 inch and 1/8 inch.

Wide – Crack width greater than 1/8 inch.

The above definitions for cracks can be modified, depending on the type of structural element. Other terminology, such as map cracking, pattern cracking, etc., may be used as appropriate.

2. Efflorescence – A white deposit caused by crystallization of soluble salts brought to the surface by moisture leaching through concrete.

3. Delamination – A layered separation of the concrete. When a delaminated area of concrete is struck (sounded) with a hammer, a hollow sound will be emittted.

4. Leaching – The dissolution and washing away of the calcium hydroxide in concrete. The moisture enters the concrete through exposed cracks in the surface.

5. Spall – A roughly circular, oval, or elongated depression in the surface of a concrete element caused by separation of a portion of the surface concrete.

   Small (Pop-out) – Less than 6 inches in diameter and 1 inch deep.

   Medium – Between 6 inches and 12 inches in diameter and up to 2 inches deep.

   Large – Over 12 inches in diameter and any depth.

6. Scaling – The gradual loss of surface mortar and aggregates.

Light Scaling – Loss of surface mortar up to 1/4 inch deep.

Medium Scaling – Loss of surface mortar between 1/4 inch and 1/2 inch deep, including loss between large aggregate.

Heavy Scaling – Loss of mortar greater than 1/2 inch in depth significantly exposing large aggregate.

7. Hollow area – An area of concrete which emits a hollow sound when struck with a hammer, indicating the existence of a fracture plane beneath the surface.

8. Honeycomb – Typically small pocket voids formed by the entrapment of air during the placement of the concrete.

c) Timer Members

1. Marine Borer Attack

- Limnoria – Commonly referred to as wood gribbles, these crustaceans are tiny wood eaters that attack the timber from the outside, continually reducing the diameter of a timber pile. Severe attack will result in an hourglass shape to the pile.

- Teredo – Commonly referred to as shipworms, these mollusks burrow minute holes into the timber and attack from within. Severe attack will result in a hollowing of the pile, leaving just the outer shell, and may go undetected. Teredo leave a white calcified trail that may be exposed by exterior timber deterioration.

2. Fungal Rot – A breakdown of the cellular structure of the timber by fungi, evident by discoloration and softening of the wood. Advanced fungal attack will cause destruction of the wood cells and will cause the timber to easily break apart when struck with a hammer. Fungi require air to survive, thus fungal rot only occurs above water.

3. Checking – Vertical cracking of the timber surface due to drying and shrinking. Minor checking is generally acceptable in standard timber design. However, excessive checking may be problematic and should be closed. Checking also creates an opening for marine borers to access the untreated interior of a pile.

4. Overloading – Overstressing of the timber element by continuous or impact loads in excess of their ultimate capacity. Typically evident by severe vertical cracks in the timber that crosses the grain, breakage of the timber, or bulging of the timber with splitting of the wood fibers.

5. Peeling – Delamination of the outer surface of the timber with minor separation of the outer wood fibers. Depending on the severity, peeling may allow marine borers access to the interior of the timber.

6. Abrasion – Reduction of the timber surface due to continual rubbing by debris, ice, or suspended particulates in the water. When combined with Limnoria attack, abrasion may rapidly reduce the cross-sectional area of piles.

7. Connecting Hardware Corrosion – Pins and bolts connecting timber members are subject to corrosion and may provide the weak link in a structure if they fail. Additionally, holes left in the timber due to missing hardware provide openings for marine borers to access the untreated interior of the timber.

B. PIER COMPONENTS TO BE INSPECTED

The pier components to be inspected are listed below, grouped accordingly to the method used to make them accessible for inspection. Since marine structures vary by type of construction, not all components listed will be applicable to any particular facility.

1. <u>Items Inspected from the Deck:</u>

(a) Pavement,
(b) Deck Wearing Surface,
(c) Deck Slab,
(d) Expansion Joints,
(e) Deck Fittings – Cleats, Bollards, Winches, Bitts,
(f) Curbs, Rails, Utility Trenches, etc.

2. Items Inspected from Floats During Low Tide:

(a) Underside of Deck,
(b) Underside of Relieving Platform Slab (if accessible),
(c) Deck Framing Members,
(d) Column Pile Caps (Building Column Foundations),
(e) Pile Cap Beams,
(f) Pile Extensions,
(g) Pile Cross-Sectional Areas (above low water),
(h) Wall Foundations,
(i) Crane Support Systems,
(j) Sheet Pile Bulkheads (above low water),
(k) Concrete Bulkheads (above low water),
(l) Pile Brace Members and Connections,
(m)Fire Walls,
(n) Fire Protection Encasements,
(o) Ship or Barge Fender Systems.

3. Items that are Inspected by Divers:

(a) Piles,
(b) Sheet Piles,
(c) Bulkheads.

4. Items Inspected by Test Pit Excavation:

(a) Sheet Pile Bulkheads,
(b) Tie Rods,
(c) Deadmen,
(d) Footings and related pile supports.

5. Rip Rap Dikes and Shore Protection

6. Crib Type Bulkheads

C. INSPECTION METHODS

When inspecting a facility for structural integrity, the first indication of a problem condition, without exception, is its observed general condition. If there are visual signs of deterioration, decay, rusting, lateral movement, subsidence, concrete spalling, broken, rotted or missing timbers, examine the condition further to determine the extent of the problem.

Not every problem can be quantified in the field. Where measurements can be taken, such as loss of metal of a steel structural member, a relatively accurate reduction in strength can be calculated. Where timber members show varying signs of rotting, or where spalled concrete has exposed reinforcing steel, less precise evaluations must be made to determine structural strength. Use the following inspection methods:

1. Above Deck

(a) Pavement on fill can be observed only from the deck. Subsidence in pavement can be caused by leaching of the supporting fill material. If fill material is escaping, there may be a break in the relieving platform deck, or a break in the containment bulkheads. This condition should be investigated by a diver, or from excavations made below the pavement. All other paving conditions shall be observed, evaluated and rated by inspectors walking the deck. If the pavement appears to be spalled, cracked or worn, it probably warrants remedial treatment. Although minor defects in the pavement may not affect the structural integrity of a facility, they can hamper operations and eventually lead to more serious problems by allowing intrusion of water into the underlying material.

(b) With the exception of subsidence, the comments made for pavements on fill are applicable to structural deck wearing surfaces. Subsidence of a structural deck is always a serious problem.

(c) Deck slab defects can have a significant effect on the structural integrity of a facility and therefore require careful inspection, testing, and evaluation. Defective deck slab concrete should be observed, initially, by walking the deck. Nevertheless, from above, a concrete deck may appear to be completely sound but spalling and exposed reinforcing steel can be observed when viewed from the underside. Also, deck slab concrete that appears sound on the top and bottom surfaces may be weakened considerably by salt intrusion and freeze-thaw cycles. Determine the quality and condition of the concrete, where appropriate, by methods as described in "Guidelines for Selecting Test Methods" (page 33).

(d) Expansion Joints are generally fabricated of structural steel shapes, parts of which are not accessible for maintenance painting. After a period of time, corrosion commences and, if not checked, advances to the extent that the joint clogs with rust scale and thereby prevents contraction. Examine and

probe the joint to determine the degree of rust scale accumulation. Debris can also clog expansion joints and prevent expansion and should be noted. A defective expansion joint should be rehabilitated, or replaced.

(e) Deck Fittings, such as cleats, bollards and winches, become inoperative due to abuse and/or lack of maintenance. Broken or missing cleats and bollards are readily detected by visual examination. Anchor bolts for deck fittings are often exposed on the underside of the deck or edge beam, and should be inspected during the Below Deck Inspection.

2. Below Deck

Most structural deterioration of a pier facility occurs in the tidal or splash zone. Accordingly, this region of the structure should receive the greatest emphasis during an inspection. In addition to the underside of deck slabs and underside of relieving platform, referred to above, examine and rate all the structural components that can be seen and reached with probing tools and measuring instruments. A below deck inspection team should have readily available, a pointed boat hook, a probing pick or knife, hammer, calipers, lights and photographic equipment. In addition, a small tape recorder should be available to the inspection team for recording observations which would supplement the notes recorded on the inspection forms. All problem conditions shall be fully documented with color photographs insofar as possible. (See Sample Photographs, page 27.)

a) Concrete

Defective concrete is usually evident to an inspector. If moisture has reached the reinforcing steel, rust staining will appear on the surface of the concrete. Spalling is discernible by flaking, powdering, and surface irregularities. Occasionally, seemingly sound concrete has deterioration which is not yet visible. Several light hammer blows will indicate whether such concrete is actually sound. Sound concrete will not chip easily. Defective concrete will be sensitive to hammer tapping. Once spalling and other surface deterioration have penetrated to the reinforcing steel, the structural integrity of the concrete becomes suspect and it shall be carefully evaluated for continued service.

Be aware of a common source of distress in a high level platform type of marine structure having a reinforced concrete deck slab. Severe spalling frequently develops at the underside of the deck along the docking face(s) of the structure. The condition

is usually readily evident to an inspector. If the reinforcing steel becomes exposed, significant deck slab damage has occurred. Determine the quality and condition of the concrete, where appropriate, by methods as described in "Guidelines for Selecting Test Methods" (page 33).

b) Structural Steel

Structural steel left unprotected in a marine environment will deteriorate rapidly, particularly in the tidal zone. Welds and the adjacent base material tend to be vulnerable to corrosion. Sometimes deterioration of steel piling is caused by a combination of corrosion and erosion. Occasionally, rapid deterioration will be developed in a localized area by stray electrical currents, or by a local chemical effluent. Regardless of the cause for loss of metal, reduced steel section properties will result in reduced load carrying capacity. Determine the cause of the corrosion, as well as, the actual condition of the steel.

Since the preservation of steel in marine environments is usually dependent upon protective coatings and cathodic protection, these corrosion prevention systems shall be examined and their condition reported during a facility inspection. Determine whether the cathodic protection system is currently in operation. If it is not, determine why and how long it has been inoperable.

Electronic and ultrasonic testing procedures are available to make thickness measurements of sound steel submerged in water. However, when possible, it is preferred that experienced divers make actual measurements with gauges, calipers, and other instruments since such measurements are often more accurate. Measurements shall be taken after chipping away all rust and marine growth, to bare metal. If measurements are to be taken on a steel pipe pile, the procedure may involve either the removal of a small steel coupon, or drilling a hole which will permit measurement of the steel thickness.

Steel piles that support a marine structure, unlike timber piles, sometimes exhibit varying degrees of deterioration at different parts of the structure. For this reason, together with the fact that steel piles are usually of high capacity and, accordingly, of increased importance to the structure, each pile should be inspected. Do not resort to spot checking or partial inspection of steel piles.

c) Timber

Timber, widely used in the past for pier foundations, is vulnerable to deterioration in the tidal zone. A preservative treatment of creosote oils, or impregnation with a compound consisting of copper, chromate and arsenic, will retard deterioration. Some installations are provided with concrete encased piles which ward off the deterioration in the tidal zone. Nevertheless, deterioration will eventually occur. Apart from deterioration that may occur inside a protective encasement, deterioration of timber above low water is generally easily visible. Its extent should be probed by thrusting a sharp pointed tool, such as a pick hammer, knife, or ice pick, into the timber. Sound timber will permit very little penetration, approximately 1/4 inch to 1/2 inch. Rotted timber will allow the tool to enter several inches. Sometimes the rotting is so extensive that a portion of the timber disintegrates under probing.

At any one facility supported on timber piles, pile deterioration, whether caused by rotting in the tidal zone or by marine borer attack, generally follows a fixed pattern.

Rotting in timber is most prevalent at bolt holes and at saw cuts. Probe these areas thoroughly to locate the extent of any deterioration.

Check fastenings (bolts and hardware) for necking of the bolt shank. This condition is exposed adjacent to washers and/or between adjacent timbers. Other conditions include loss of bolt heads and/or washers that have corroded away, and enlargement or distortion of washers. Apply several hammer blows to determine soundness of fastenings.

d) Fender Systems

Fender Systems are provided along docking surfaces of all marine structures. Their function is to protect both the vessel and the waterfront structure from damage that can be caused by vessel movements during docking and undocking maneuvers, and while a ship is in berth. Damaged fender systems may not directly affect the structural integrity of a marine facility, but when they are rendered ineffective, the ship and/or structure become vulnerable to damage. Examine fender systems to ensure their capability of furnishing the protection required. Consider that split and frayed timbers do not necessarily warrant immediate replacement, since

the non-resilient fenders provided on marine structures utilize split and crushed timbers to absorb impact energy.

Inspect ship fenders both from floats, during low tide, and from the deck. Examine the timbers, hardware, and connections, as well as, the structural supports of the fenders.

3. Diver Inspections

With the exception of deterioration that can be caused by marine borer attack of timber piles (even those having received a protective treatment), submerged sections of piles and bulkheads, if properly constructed, generally remain well preserved for extended periods of time. Nevertheless, they should be inspected periodically. This work should be done by divers.

Marine growth makes direct observations of pile defects extremely difficult. A diver shall remove this growth before making the examination. Underwater inspections of steel and concrete piles are carried out using the same procedures prescribed for inspecting the pile sections above low water with recognition of the fact that visibility may be limited and working conditions are less efficient.

Timber piles, especially those that were not chemically treated, may be infested with marine borers. Ordinarily, their presence can be detected by observing small holes on the surface of the pile. If so detected, the diver should remove slender nondestructive cores from the pile, using special equipment available for such sampling. If several cores are concentrated in an area, a determination can be made regarding the degree of marine borer infestation.

Piles that were pressure treated with creosote oils before installation, should have been certified accordingly by the pile supplier. Since many of the piles to be inspected are very old and their records are no longer available, determine the penetration of the creosote treatment by examining the aforementioned cores.

4. Inspection Requiring Excavation

Steel components that are completely embedded, such as bulkheads, tie-rods, and deadmen, should have remained relatively well preserved if they were properly protected against corrosion when installed. Deterioration may have, nevertheless, set in despite all preventive measures. Embedded timber and concrete components are also subject to deterioration. Therefore, these components, which can be made accessible to the inspector only by excavating the backfill material, shall be inspected

as recommended by the consultant and approved by the Engineer. Generally, such inspections may be required no more frequently than once every ten (10) years.

If the inspection indicates that the structural materials uncovered are free of deterioration, only one or two such excavation pits should suffice. On the other hand, if significant deterioration is uncovered in the initial test pits, additional pits should be excavated and inspections made.

5. Rock Dikes and Rip Rap Slope Protection

When provided in the form of a dike to contain backfill, or when used to prevent slope erosion, the volume and configuration of the rock dike, or rip rap placed at a marine facility, should remain relatively unchanged if the structural integrity of the structure is to be preserved. Occasionally, due to dredging, an overload on fill behind a dike or a geotechnical shortcoming, a change in slope or a shifting of the rip rap may occur. The change could have taken place in the past and is now stabilized, or it can be in the form of continuing "creep". Verify the condition by:

a) Taking alignment measurements of the structure and comparing them with the alignment shown on "as-built" drawings;

b) Sounding the rock or rip rap at 10 or more cross-sections to determine the slope. Compare the present slope with the slope shown on the "as-built" drawings; and,

c) Sounding the rock or rip rap with a fixed baseline and stations at 50 feet on centers along the bulkhead. Compare the present profile with the "as-built" drawings.

6. Crib Type Bulkheads

Crib type bulkheads are structures built of interlocked timber members that work in conjunction with backfill to form a gravity type retaining structure. Distress, in the form of lateral movement and/or pavement subsidence, can be caused by deterioration of the timbers, by excessive lateral loads that result when the fill behind the bulkhead is overloaded, or by dredging in front of the structure.

Check the condition of the exposed timbers and the alignment of the bulkhead. Determine whether there is backfill subsidence. If the exposed timbers are not deteriorated or damaged, but there is misalignment and/or backfill subsidence, there may be a creep-type movement of the foundation soil. This shall be verified by a sounding survey and a geotechnical assessment of the structure's stability for the over-dredged condition.

7. REPORT

Prepare a report summarizing the results of the condition survey following the outline and order shown below. The reports shall provide the detailed information needed to substantiate requests for funding to maintain and repair the waterfront facility.

- EXECUTIVE SUMMARY (Maximum 2-3 pages)
  - Significant Findings
  - Immediate Repairs Implemented
  - Disclaimer*
- TABLE OF CONTENTS
- LOCATION PLAN
- LIST OF FIGURES AND DRAWINGS
- LIST OF PHOTOGRAPHS
- LIST OF TABLES/DATA

1. SCOPE OF WORK AND INSPECTION PROCEDURE
   - Scope of Work
   - Inspection Procedure
   - Condition Rating System and Definitions
   - Repair Categories**
2. DETAILED INSPECTION FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS
   - Facility Description
   - Inspection Findings
   - Conclusions
   - Status of Previous "Priority Repair" Recommendation
   - Recommendation (Tabulate "Priority", "Routine" repair recommendation, and "Safety" items)
3. APPENDICES AND REFERENCES
4. FIELD NOTES, TRANSCRIPTS, ETC. (In separate binding)

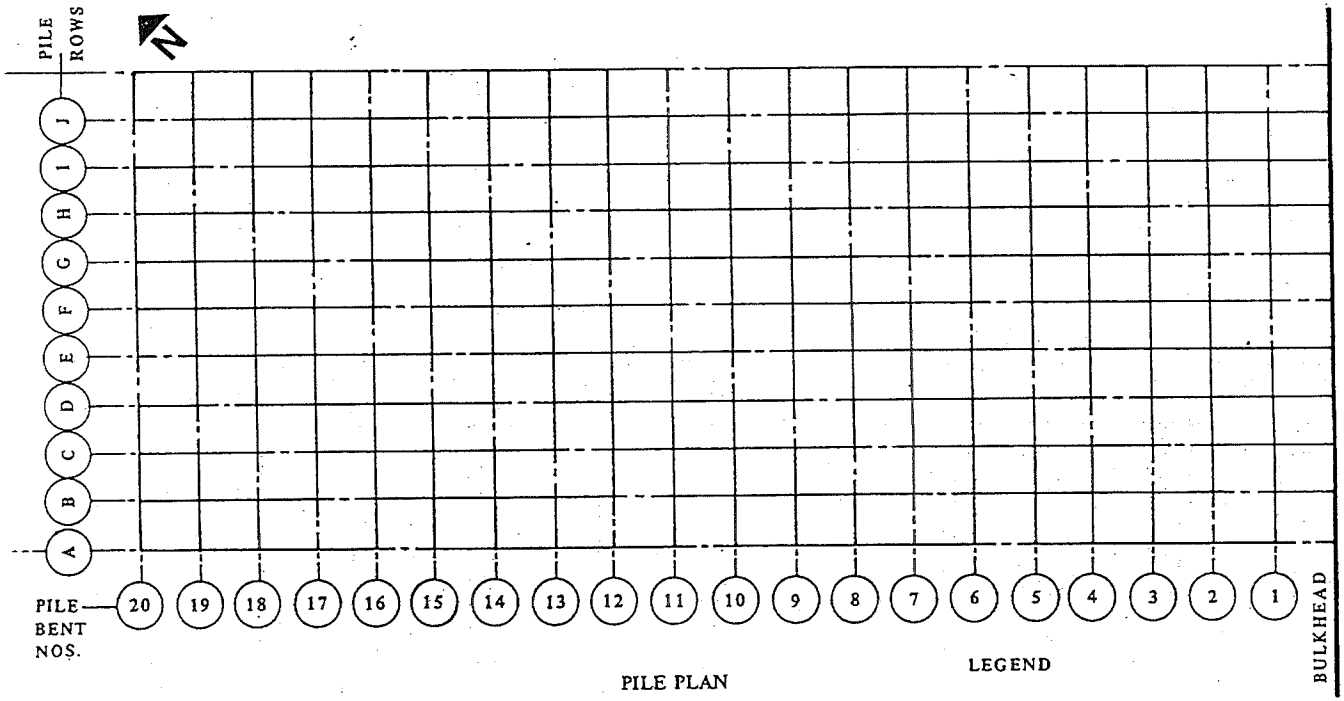
* Add "This Report contains conclusions concerning the causes of the noted deterioration and recommendations for the rehabilitation of the structures. The repair procedures contained in the recommendation section of the Report outline the general extent of the required rehabilitation work. The presentation of these conceptual repairs does not preclude the necessity of performing further

investigation and preliminary design work for the purpose of establishing the complete scope and final design of the rehabilitation work".

**The following are the repair definitions:

Terminology	Definition
Immediate	Requires "immediate" action including possible closing of the structure, or areas affected, for safety reasons until interim remedial measures, such as shoring or removal of potentially unsafe structures (or elements), can be implemented. These closings, if any, always require immediate action upon discovery.
Priority	Conditions for which no immediate action may be required, or for which immediate action has been completed, but for which further investigations, design and implementation of interim or long-term repairs should be undertaken on a priority basis, i.e., taking precedence over all other scheduled work.
Routine	Conditions requiring further investigation or remedial work which can be undertaken as part of a scheduled maintenance program, other scheduled project, or routine facility maintenance depending on the action required.
Recommended	Recommend a course of action through the engineering assessment of the structure or element based on the provided operational loads and conditions observed (See Attachment 1: "Guideline for Analyzing Existing Timber Pile Vertical Load Capacity"). The recommendations shall be in accordance with the definitions of prioritized recommendations. The priority, routine repair and safety items shall be shown red, blue and green in color respectively, on plans. The recommended repair works shall be in generic type only.

8. FIGURES



PILE PLAN

LEGEND

INSPECTOR'S COMMENTS:

PIER NO:

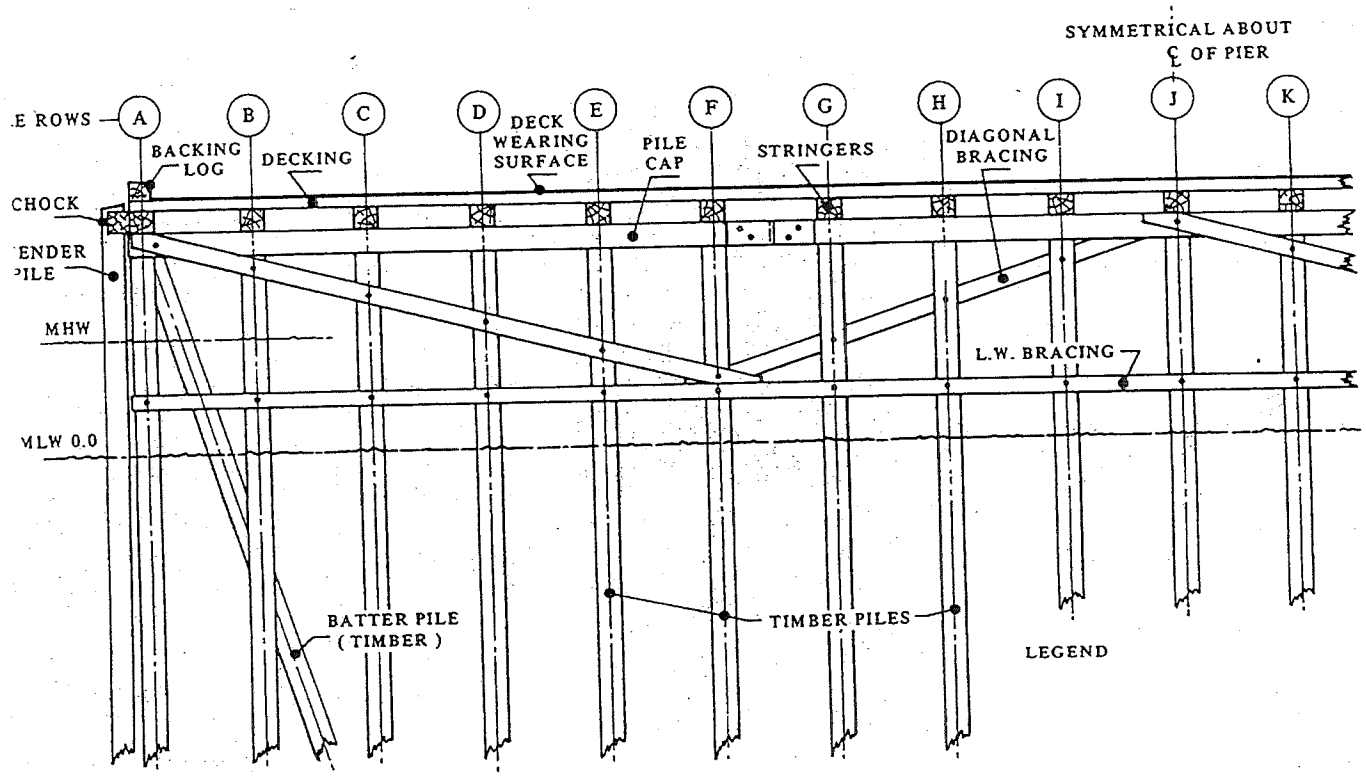
LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG. 1



SECTION THRU PIER

INSPECTOR'S COMMENTS:

BENT NO.

PIER NO:

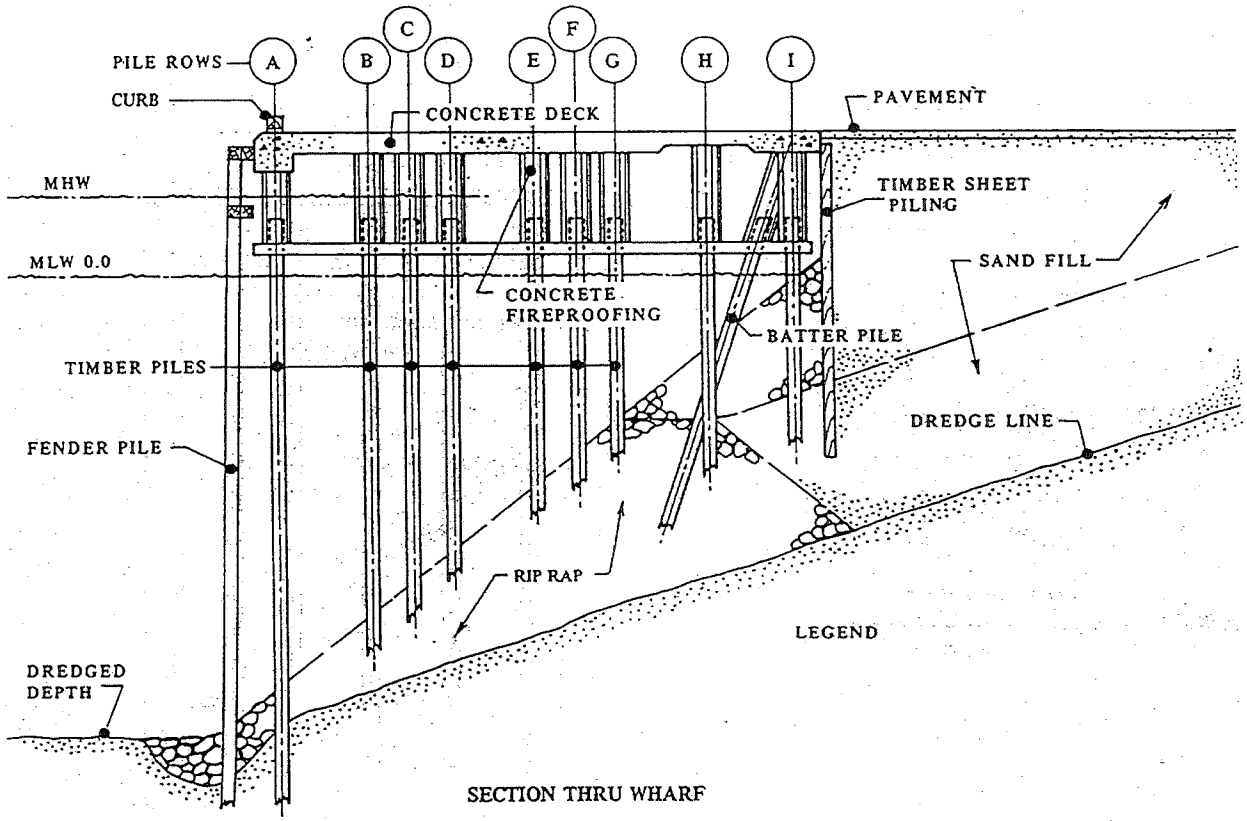
LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG. 2



SECTION THRU WHARF

INSPECTOR'S COMMENTS:

BENT NO.

WHARF NO:

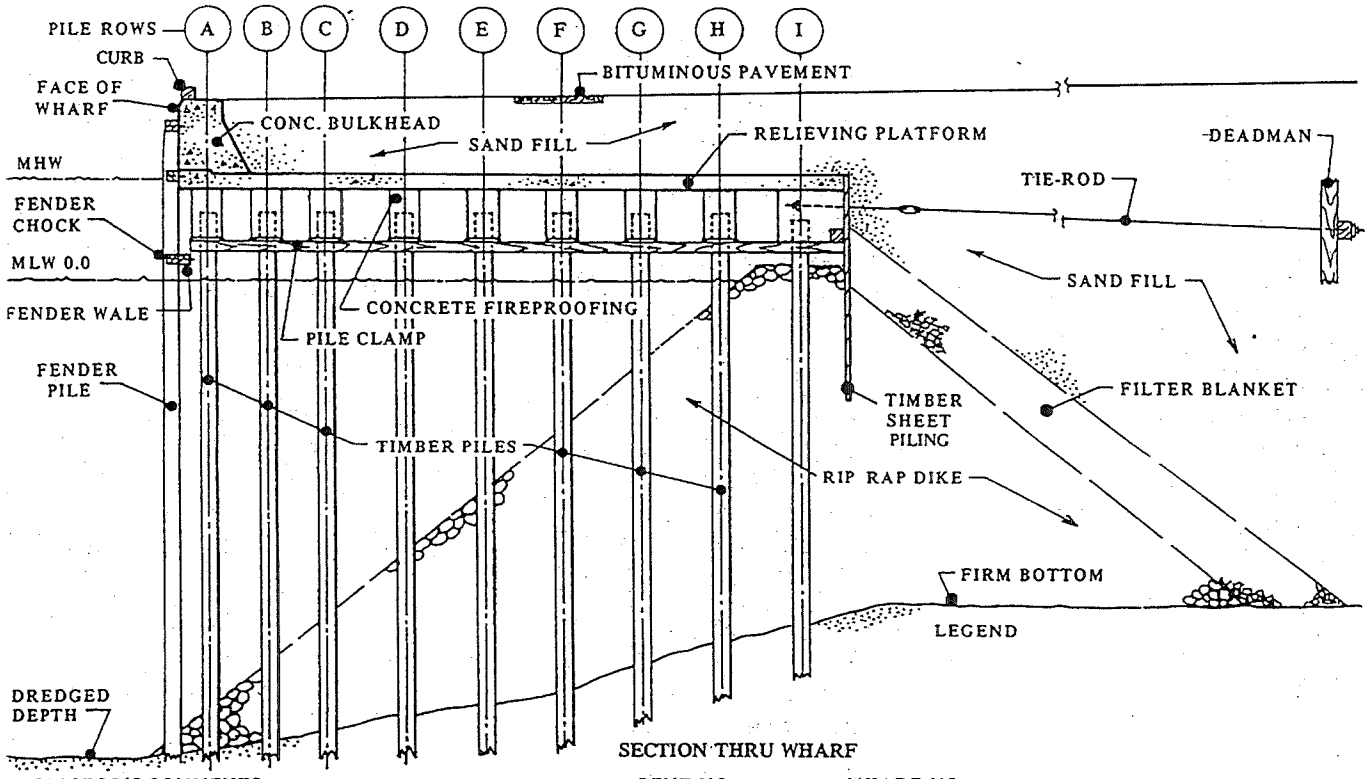
LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG. 3



SECTION THRU WHARF

INSPECTOR'S COMMENTS:

BENT NO.

WHARF NO:

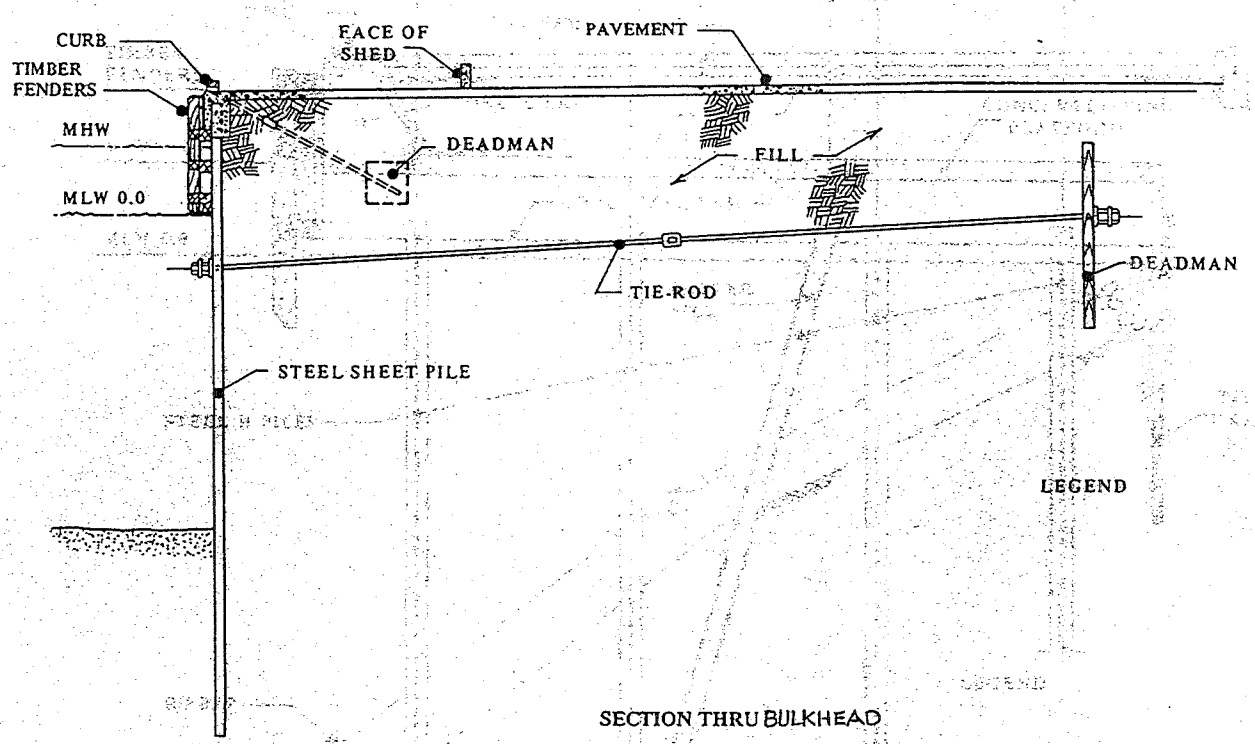
LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG. 4



LEGEND

SECTION THRU BULKHEAD

INSPECTOR'S COMMENTS:

STA. NO.

BULKHEAD NO.:

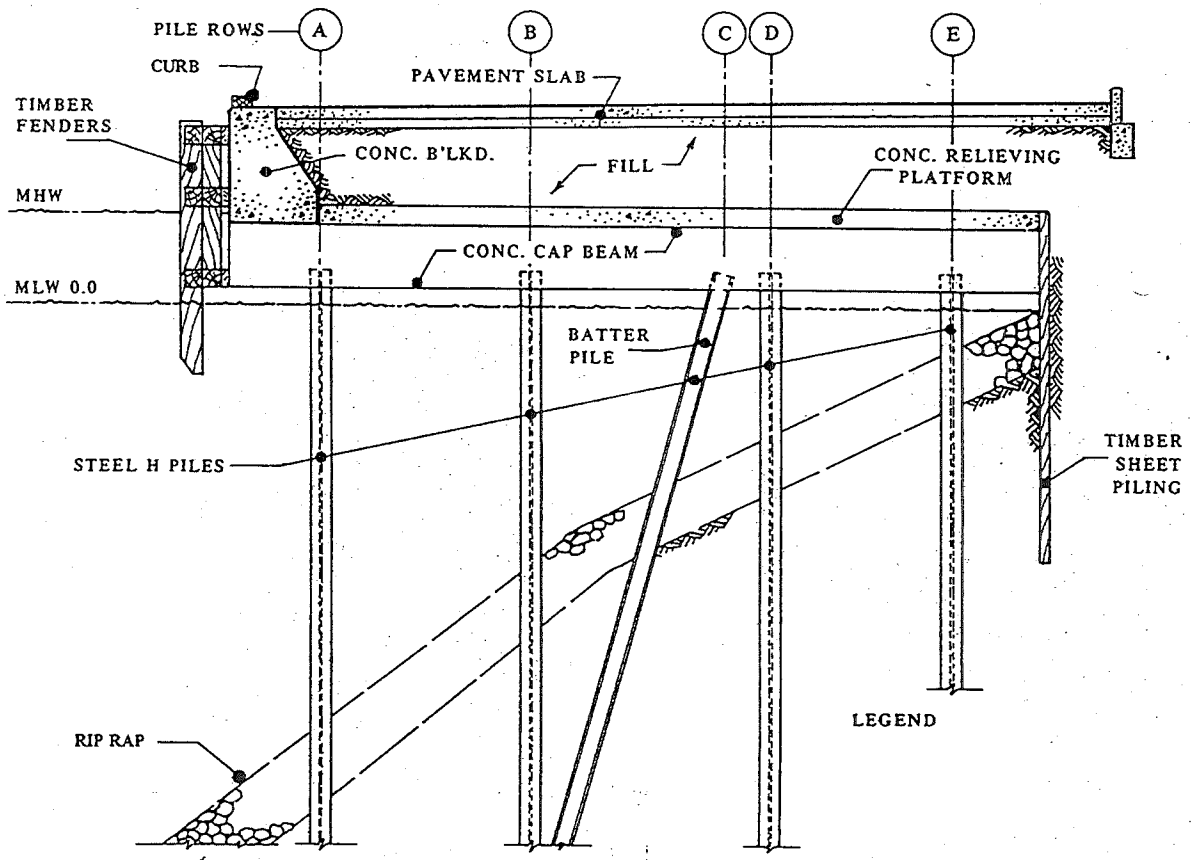
LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG. 5



LEGEND

INSPECTOR'S COMMENTS:

SECTION THRU WHARF

BENT NO.

WHARF NO:

LOCATION:

INSPECTED BY:

DATE: TIDE: TEMP:

INSPECTION NOTES

FIG 6

9. PHOTOGRAPHS

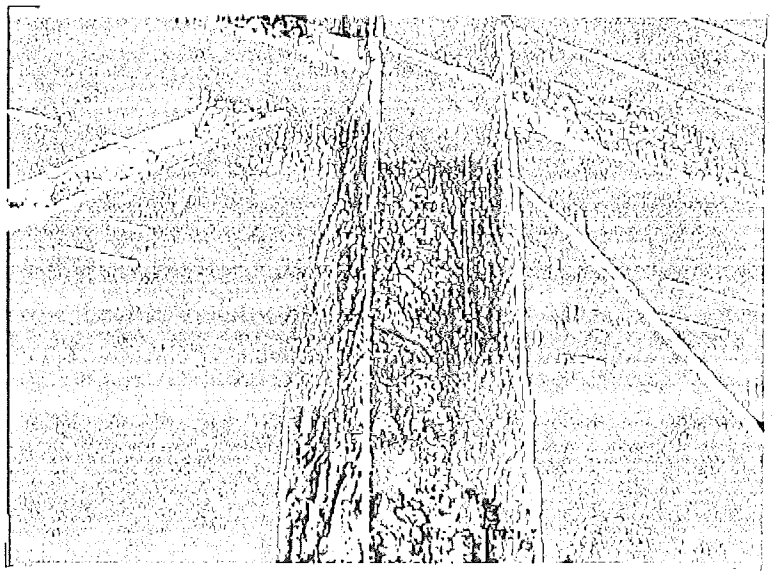


Photo No. 1

Pile No. F-14, Corroded in the Tidal Zone.

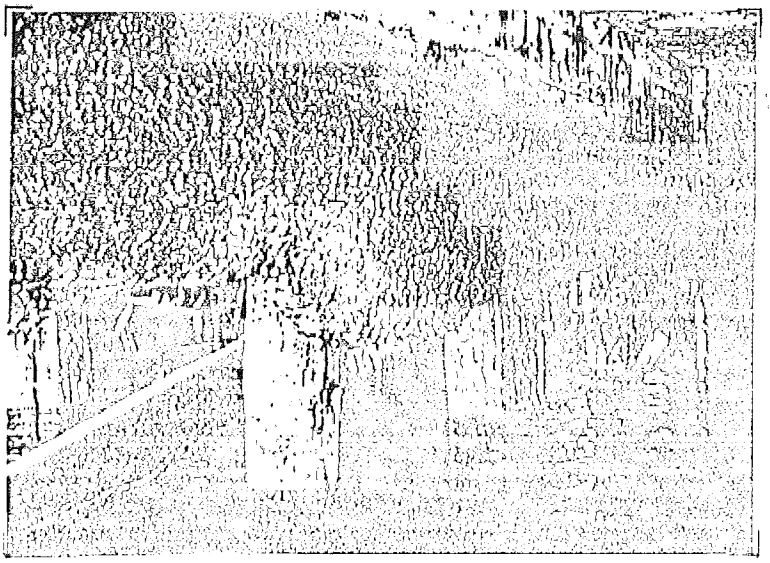


Photo No. 2

Section of Firewall Missing at Bent No. 47
Between Pile Rows E to J.

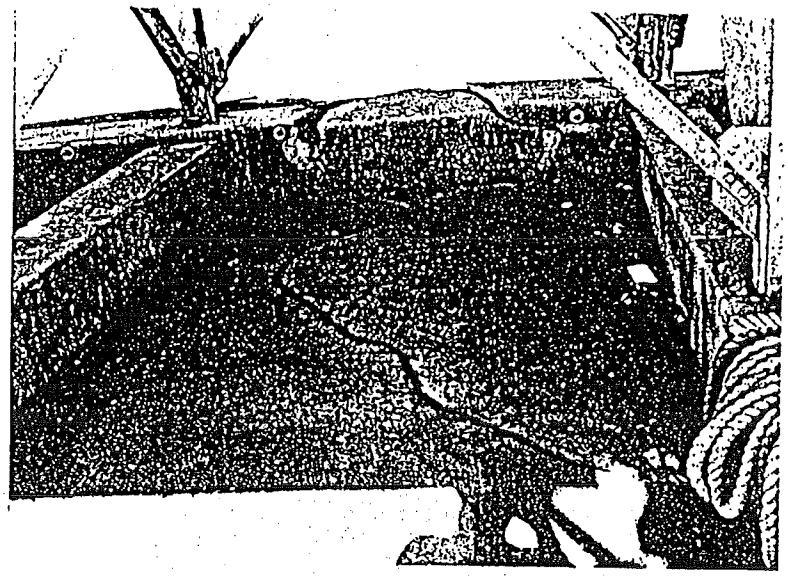


Photo No. 3

Crack in Deck, North Side of Pier Between Bent Nos. 14 and 15.

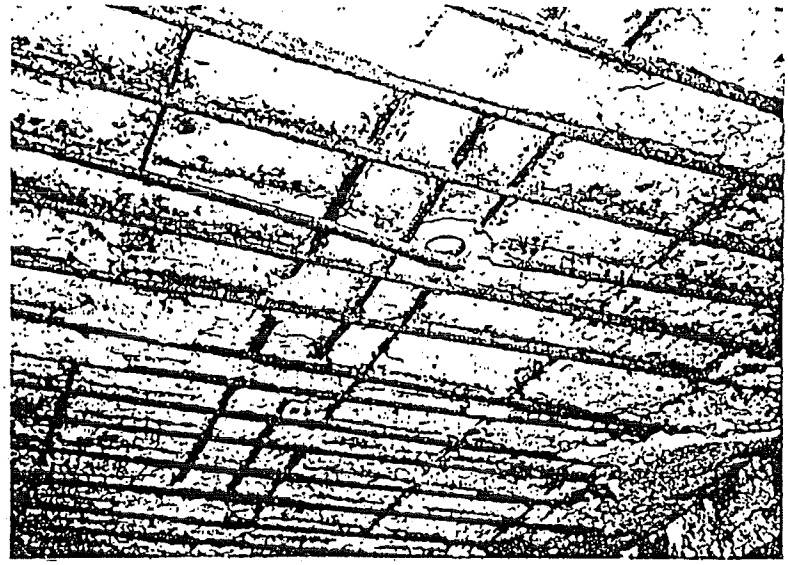


Photo No. 4

Spalled Concrete; Exposed and Corroded Reinforcing Steel, Underside of Deck, South Side of Pier Between Bent Nos. 7 and 8.

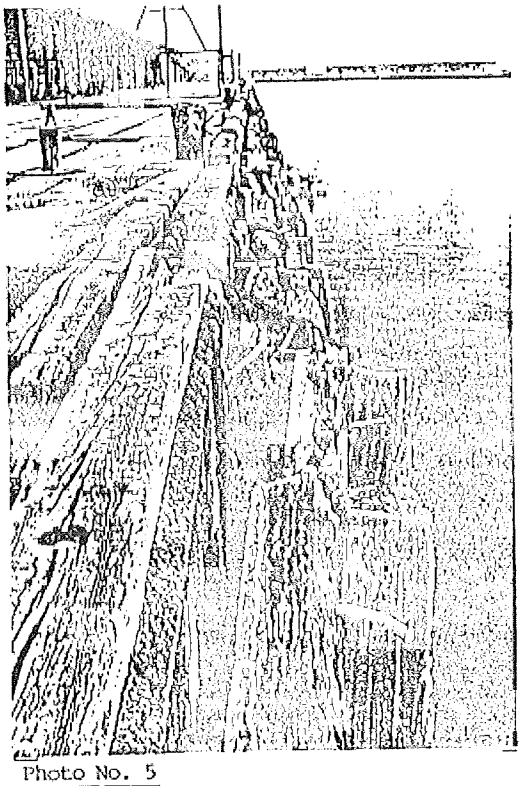


Photo No. 5

Broken and Deteriorated Curb and Fender Timbers Between Bent Nos. 95 and 102.

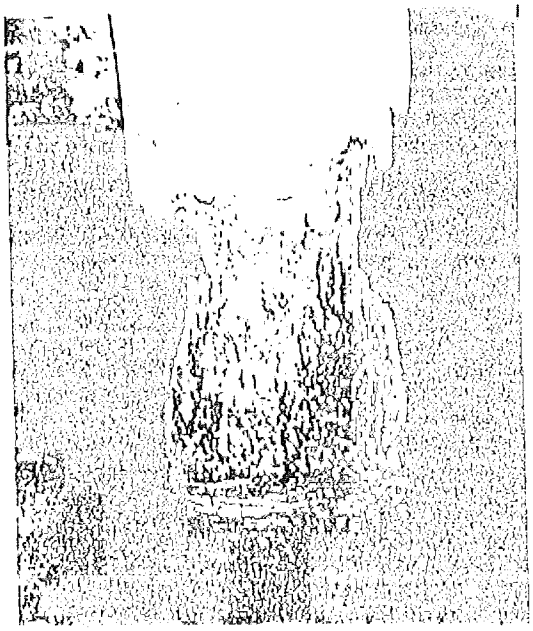
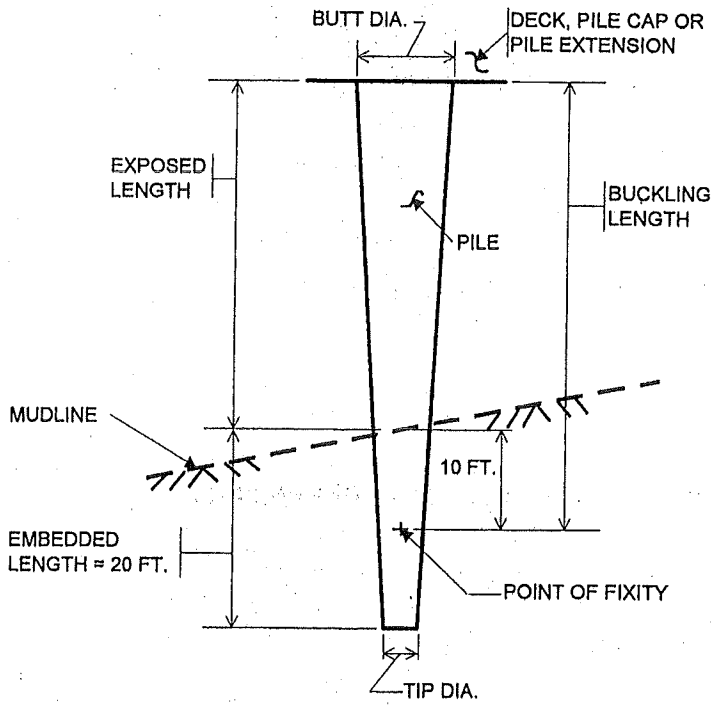


Photo No. 6

Pile No. L-36, Deteriorated in Tidal Zone.

10. ATTACHMENT 1

GUIDELINE FOR
ANALYZING EXISTING TIMBER PILE VERTICAL LOAD CAPACITY



BASES OF ANALYSIS

1. ALLOWABLE PILE COMP. PARALLEL TO GRAIN Fa = 1200 PSI
2. MODULUS OF ELASTICITY OF TIMBER PILE E = 1800 KSI
3. PILE TAPERNESS CONFORM TO ASTM D25.
4. SIDESWAY IS PREVENTED.
5. TIP OF FIXITY = 10 FT. BELOW MUDLINE.
6. EMBEDDED LENGTH = 20 FT. BELOW MUDLINE.
7. AXIAL LOAD CAPACITY BASED ON PILE SECTION AT POINT OF FIXITY.
8. CRITICAL BUCKLING LOAD USING GERE-CARTER FORMULA
   a. BUCKLING LENGTH MEASURED BETWEEN POINT OF FIXITY AND CONNECTION TO SUPERSTRUCTURE.
   b. SAFETY FACTOR = 3

ATTACHMENT 1

11. GUIDELINES FOR SELECTING TEST METHODS

GUIDELINES FOR SELECTING TEST METHODS

The consultant, after examining all available drawings, maintenance records, previous test reports, and an initial inspection, shall determine which of the tests described in Section I are applicable to the evaluation of the structure. The number and frequency of tests shall be determined by the intended use of this data. The consultant shall select the appropriate test methods outlined in Section I, and include any additional testing that he deems so necessary. In addition, tests shall be performed by a qualified testing laboratory in accordance with the guidelines set forth in Section II.

Section I – Test Method

1. Concrete Delamination Detection (Chain Drag Method and Impact Echo)

   A delamination survey provides information on the subsurface condition of concrete decks. Chain drag method can be used where the concrete is overlayed by asphalt or other coatings infrared thermography. Impact echo is used for deep delaminations.

2. Half-Cell Test (ASTM C-870)

   The purpose of half-cell testing is to determine the areas in the deck in which active corrosion is present. Corrosion of the reinforcing bars in concrete decks is detected by electronic current flowing from the rebar at one point (the anode) to another point (the cathode). During active corrosion, an electrical potential difference exists between the anode and the cathode which can be measured by silver-silver chloride half-cells.

3. Chloride Analysis

   Chloride analysis provides a quantitative measure of the chloride ion contamination of concrete at selected levels in the deck.

4. Pachometer Surveys

   A pachometer is a device for measuring thickness. In the context of concrete structures, a pachometer is used for measuring the clear concrete over embedded reinforcing steel.

5. Electrical Resistance Testing (ASTM D-3633)

   The resistivity test is used to measure the permeability of a waterproofing membrane, or sealcoat, on concrete surfaces. (The method assumes that where a dielectric material is used as a deck seal, its electrical resistance is a measure of its waterproofing ability.)

6. Core Drilling and Testing (ASTM-C42)

The following laboratory testing can be performed on the core sample:

A. Visual appraisal – provides information on concrete deterioration, delamination, location and corrosion of rebars.

B. Compression test determines the compressive strength of the in-place concrete.

C. Microscopic determination of air-void content (linear traverse) (ASTM C-A457) – determines air-void content, specific surface, spacing factor, and air-paste ratio of the air-void system in hardened concrete.

Section II – Sampling

Except for Delamination, Half-cell, and Electrical Resistivity, all other test methods described below, the sample location shall be selected randomly in accordance with ASTM D-3665 using statistical methods. Plot the locations on a plan view of the deck. For planning, the deck area will be divided into lots consisting of 10,000 Sq. Ft.

The following guidelines shall be used in the section of procedures and frequency of tests. In addition to the guidelines specified below, the consultant shall perform any additional testing that he deems necessary.

1. Delamination

- Apply to 100% of the deck area in question.
- Plot results of test on plane view of deck.
- Cores should be taken to validate the location and depth of delamination.

2. Half Cell

- One test/lot (16 sampling points/test).
- Each lot shall be divided into sublots of 625 sq. ft.
- One sublot shall be randomly selected and shall be proportioned into a 8' grid pattern, thus providing 16 sampling points/sublot.
- The data is plotted on a grid and equipotential lines drawn from the grid.

3. Chloride and PH Sampling

- One test/lot.
- Sample powder at 1", 2" and 3" levels.
- Perform chemical analysis on samples at each level and report chloride ion in #/cu. yd., and PH.

4. Pathometer Survey

- Use same locations selected for chloride sampling.
- Locate two rebars on either side of chloride location.
- Take pachometer readings for depth of concrete cover at one-foot intervals for five feet on each bar, and record depth of cover.

5. Electrical Resistivity

- Use this test procedure to 100% of the area when membrane waterproofing is questionable.

6. Core Drilling

- One core/2 lots.
- Randomly select half of the total number of lots for core sampling.
- 80% of the cores selected shall be random samples within the selected lot, and 20% shall be selectively chosen to evaluate suspect concrete locations as determined from above tests.

7. Core Testing

- Perform a visual appraisal of all cores taken, and prepare a report showing all physical characteristics and properties of each core.
- 90% of the core samples shall be tested for compressive strength; the remaining 10% shall be tested for air void content and petrographic examination.