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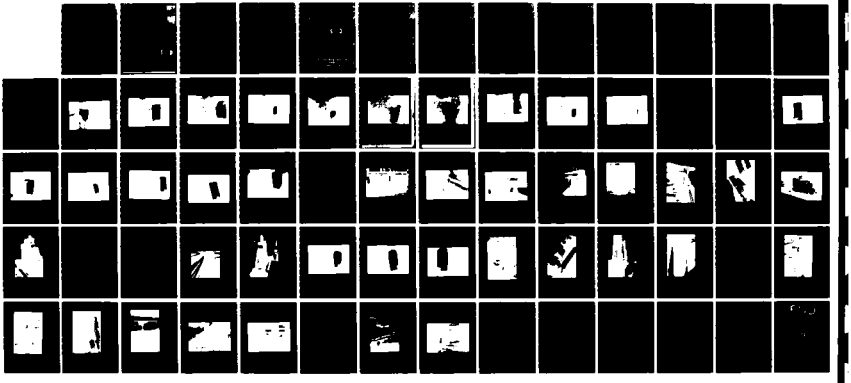

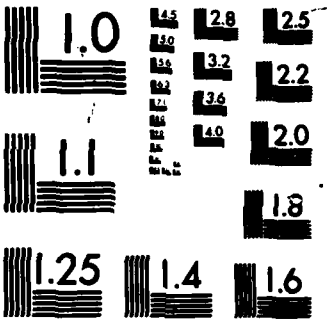

# PRELIMINARY INSPECTION OF WATERFRONT FACILITIES AT THE NAVAL STATION, GUANTANAMO BAY, CUBA

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PRELIMINARY INSPECTION OF

WATERFRONT FACILITIES AT THE

NAVAL STATION, GUANTANAMO BAY, CUBA



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FPO-1-79(10)
SEPTEMBER 1979

# Ocean Engineering and Construction

FPO-1-79(10)

# PRELIMINARY INSPECTION OF WATERFRONT FACILITIES AT THE Naval Station, Guantanamo Bay, Cuba

by

JACK E. BABER

September 1979

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## C. INTRODUCTION

This report describes the results of the underwater facilities inspection at Guantanamo Bay, Cuba, Naval Station. The underwater inspection was conducted by the Underwater Construction Team One based at Little Creek, Virginia. The preliminary inspection is utilized to determine the necessity for a more thorough underwater inspection and structural analysis. Specific recommendations for each inspected pier is provided along with general overall recommendations for all the facilities. The extent of damage, method of repair, and repair priority is not the subject of this report and the definition of these subjects requires a more detailed underwater inspection and the scheduling of priority funding by the facility.

D. BACKGROUND

The Chesapeake Division, Naval Facilities Engineering Command was requested by Underwater Construction Team One to provide assistance in developing an inspection plan, to participate in the underwater facilities inspection, and to write the final inspection report per references 1 and 2. The inspections began on the 19th of June 1979 and the inspection team departed the Naval Station, Guantanamo Bay, Cuba on the 28th of June 1979. Upon arrival, a meeting with the Public Works Center personnel established the following priorities for pier inspections:

1. Pier V
2. Pier L
3. Pier D
4. Pier Q
5. Mooring BB-1
6. Other waterfront facilities as schedule permits.

E. INSPECTION PROCEDURE

After reviewing available drawings and a previous inspection report, reference 3, and having a conference with on-site personnel, a final inspection plan was established. The inspection consisted of the following procedures:

1. Determine the general condition of the underwater portions of the piers and wharves.
2. Establish the prevalent mode of deterioration and inspect a representative number of piles or sections of wharves and quaywalls.
3. Inspect, in detail, readily apparent forms of extreme deterioration.
4. Obtain photographs of deterioration
5. Note condition of surface and above water structure

## F. INSPECTION RESULTS

A brief description of the inspection results for each of the piers and inspected structures is provided in the following sections. The numbering system that is utilized in this report designates the first bent away from shore as bent No. 1 and the piles in each bent are labeled a, b, c, ... from left to right while facing away from the shore. Some of the photographs for Pier L are mislabeled as Pier V but the figures are labeled correctly.

1. PIER V

Pier V is an open-type reinforced concrete pier that is approximately 1008 feet long and sixty feet wide. The concrete beam and deck structure is supported on precast reinforced concrete piles arranged in sixty-four bents with eleven bearing piles and one batter per bent. The underwater inspection revealed that the concrete was spalling from many piles and that rebar was exposed. Typical examples of the concrete deterioration underwater are shown in the following:

a. Figures 1, 2, and 3; Vertical crack on piles 21K - 12 feet, 41A - 15 feet, 64K - depth not noted.

b. Figures 4 and 5; Horizontal crack on piles 64A - 15 feet and 64B - 25 feet.

c. Figures 6, 7, and 8; General spalling on piles 10K - 25 feet, 37G - 5 feet, 43BP-B - 1 foot.

d. Figures 9 and 10; Complete exposure of rebar; 64H - depth not noted, 64K - depth not noted.

Various portionsof the Pier V fender system require repair because of the mechanical damage caused by ship impact. The practice of securing the fender system directly to the bearing piles, using two beams clamped to the pile,will cause early deterioration of the concrete pile. The future utilization of Pier V will depend on the rate of progressive deterioration of the pier structure. It is recommended:

a. That repairs to the concrete piles be initiated, as soon as possible;

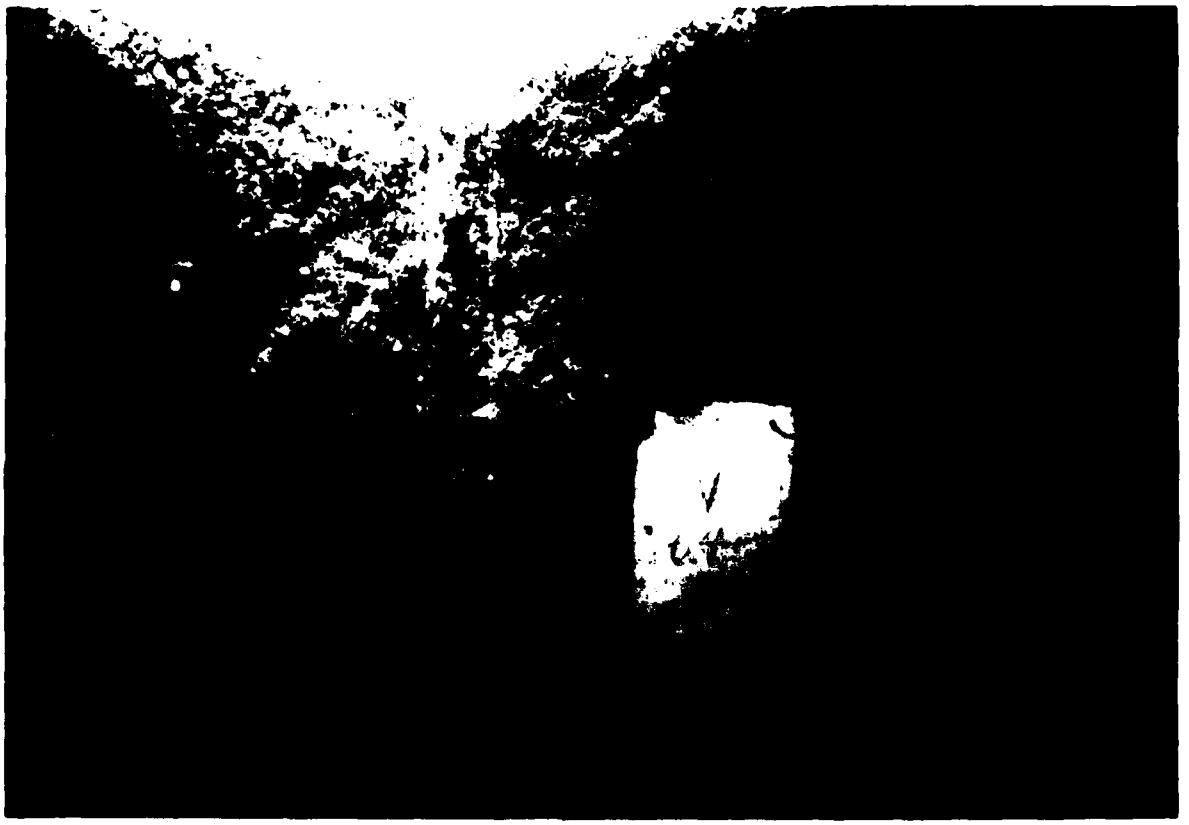
b. That an effective fender system be designed and maintained to protect the bearing and support piles.

1. Vertical Crack, Pier V; V - 21K - 12 feet

2. Vertical Crack, Pier V; V - 41A - 15 feet

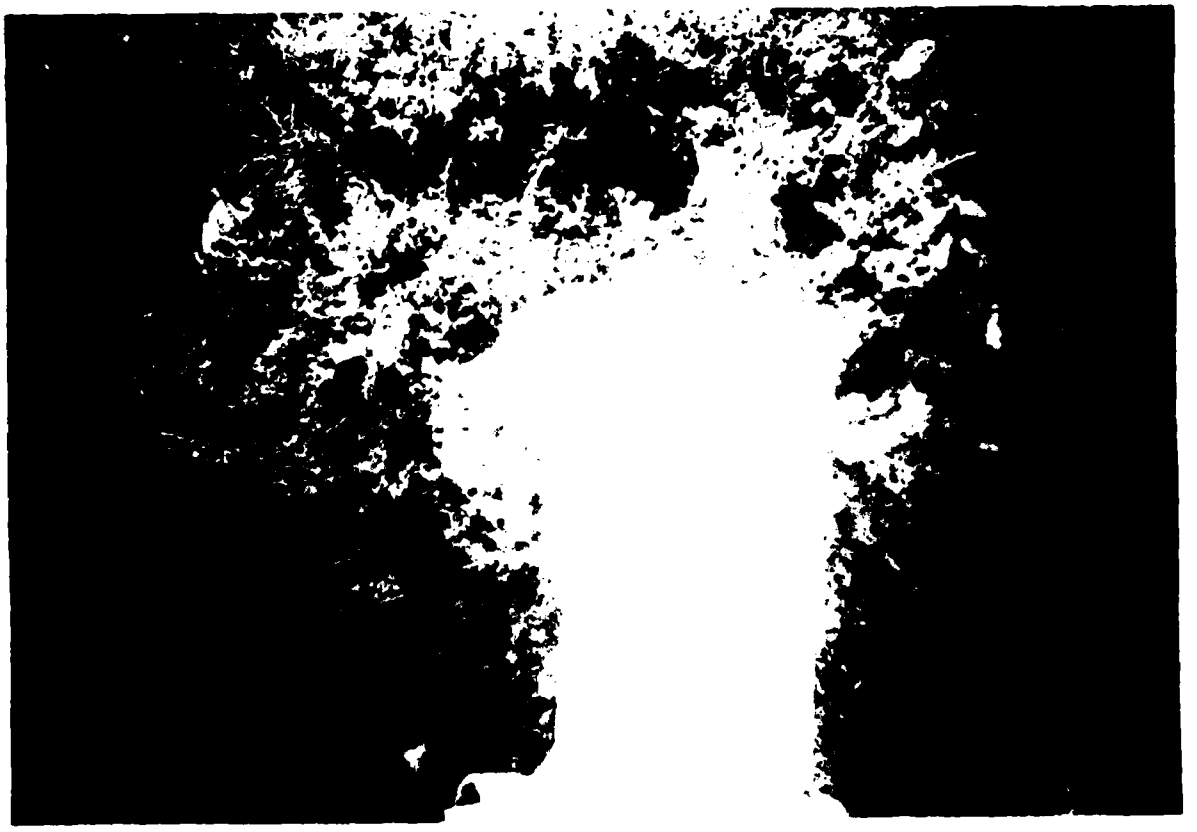
3. Vertical Crack, Pier V; V-64K - depth not noted


4. Horizontal Crack, Pier V; V - 64A - 15 feet



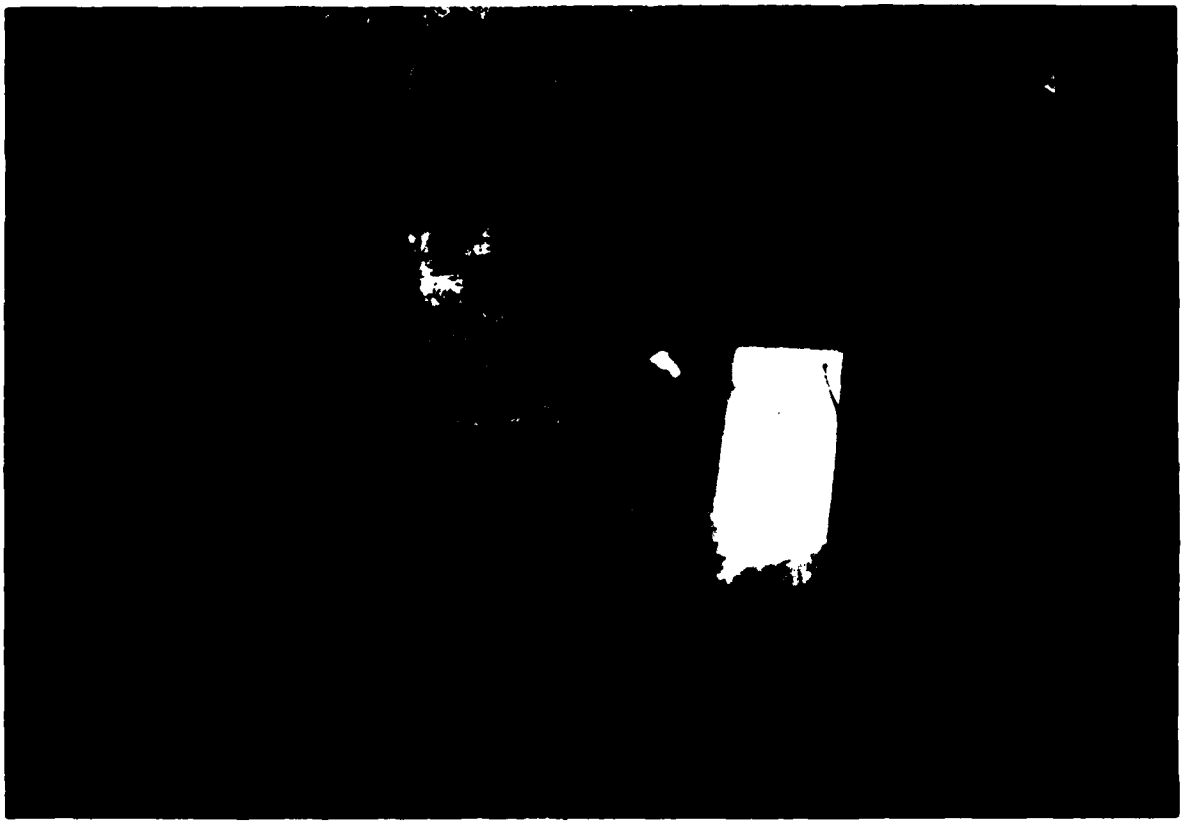
5. Horizontal Crack, Pier V; V-64B - 25 feet

6. General Spalling, Pier V; V- 10K - 25 feet



7. General Spalling, Pier V; V-37G - 5 feet


8. General Spalling, Pier V; V-34-BP-B - 1 foot



9. Rebar Exposure, Pier V; V-64H, Depth not noted

10. Rebar Exposure, Pier V; V-64K, Depth not noted

2. PIER L

Pier L is an open-type reinforced concrete pier approximately 60 feet wide and 644 feet long. The pier is supported by steel H-piles arranged in 81 bents with seven bearing piles and two batter piles per bent. The piles are presently partially protected by a wooden fender system that extends to the vicinity of the mean low water line, where intact, and by concrete collars that extend approximately 3-4 feet above and 1-2 feet below the mean low water line.

The general condition of Pier Lima can be described as follows:

a. The upper and lower portion of the reinforced concrete beam appears to be in good usable condition.

b. The fender systems have been systematically destroyed by combined actions of mechanical "mishaps," extensive Limnoria attack, wind and wave action, and floating debris.

c. The concrete jackets that have been placed on the H-piles to provide protection in the tidal/splash zone are either:

1) Cracked by the expanding forces of the corroding H-beam;

2) Accelerating the corrosion process of the H-beam;

3) Providing limited or no protection to the H-beam;

4) Missing entirely.

d. The steel H-beams that were inspected are severely deteriorated by a process which causes the steel to separate into laminations. The laminations appear to be a form of iron oxide that develops on the steel and progressively forms subsequent layers as pits form in the oxide coating and let moisture into the interface. These oxide coatings either

remain intact or are removed by the impact of debris, the wave action, or the excessive accumulation of corrosion products between oxide layers.

A representative sampling of the piles over the entire pier was examined to see if the condition prevailed throughout the structure. Batter piles or piles with readily apparent problems were, also, inspected. Ninety piles of the approximately 729 H-piles supporting Pier Lima, were inspected. Of the ninety piles inspected, seventy-eight were determined to be deteriorated to the extent that only minimal support can be provided by the H-pile. Typical examples of the H-pile deterioration are provided, as follows:

a. Figures 11, 12, and 13; Deterioration is in the final stages and only a final thinned piece of metal or a single oxide lamination remains.

b. Figure 14; Decreasing width and a horizontal crack in the flange.

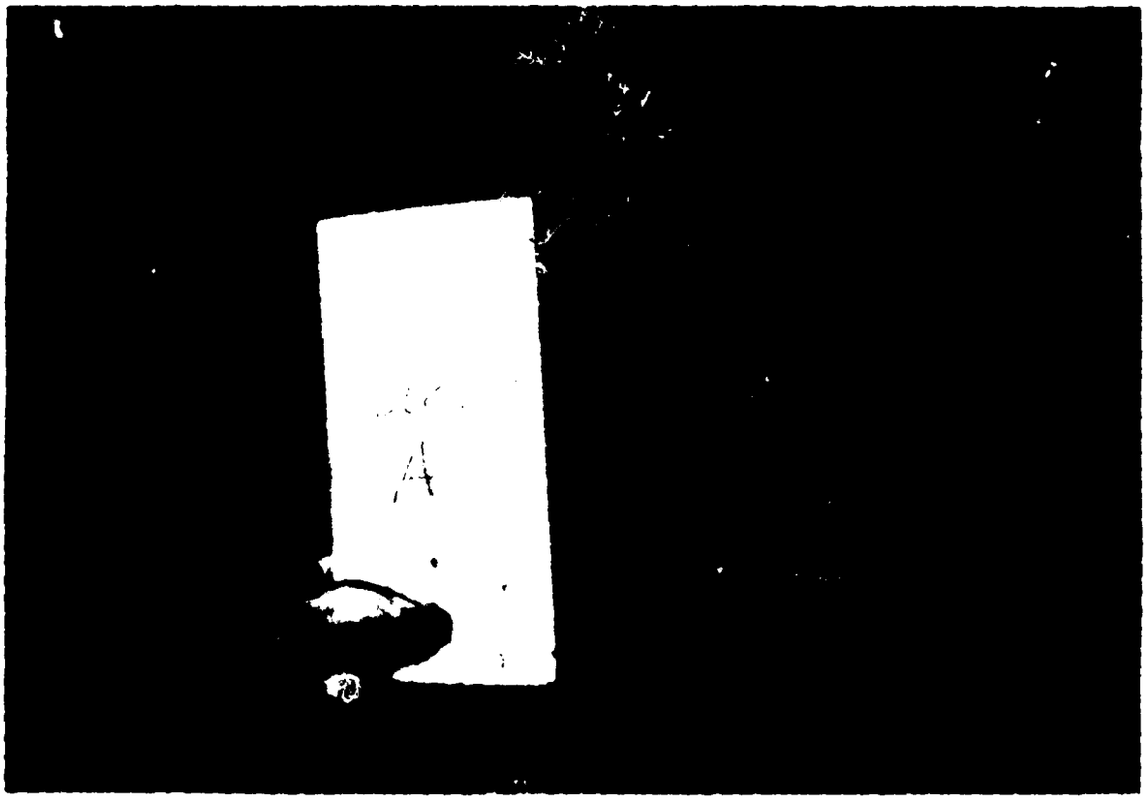
c. Figures 15 and 16; Separation of laminations as corrosion product expands.

The utilization of Pier L should be severely reduced or eliminated until a detailed diver inspection is performed to evaluate the extent and severity of deterioration. It is recommended:

a. That the concrete collars be removed from the H-piles and replaced with an effective system.

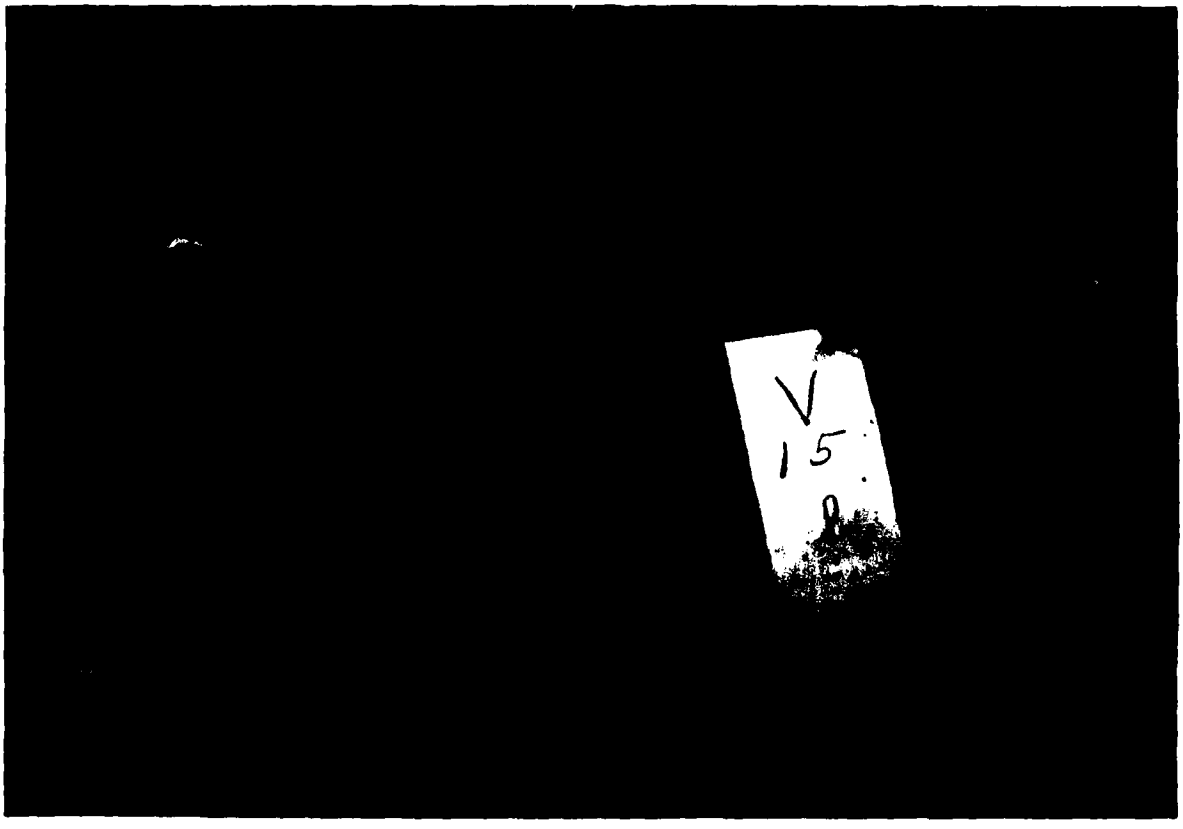
b. That an effective fender and batter pile system be designed and maintained to provide adequate protection to the pier structure.

c. That the connections between the concrete beam and girder support system be repaired to enable the H-piles to adequately support the pier.

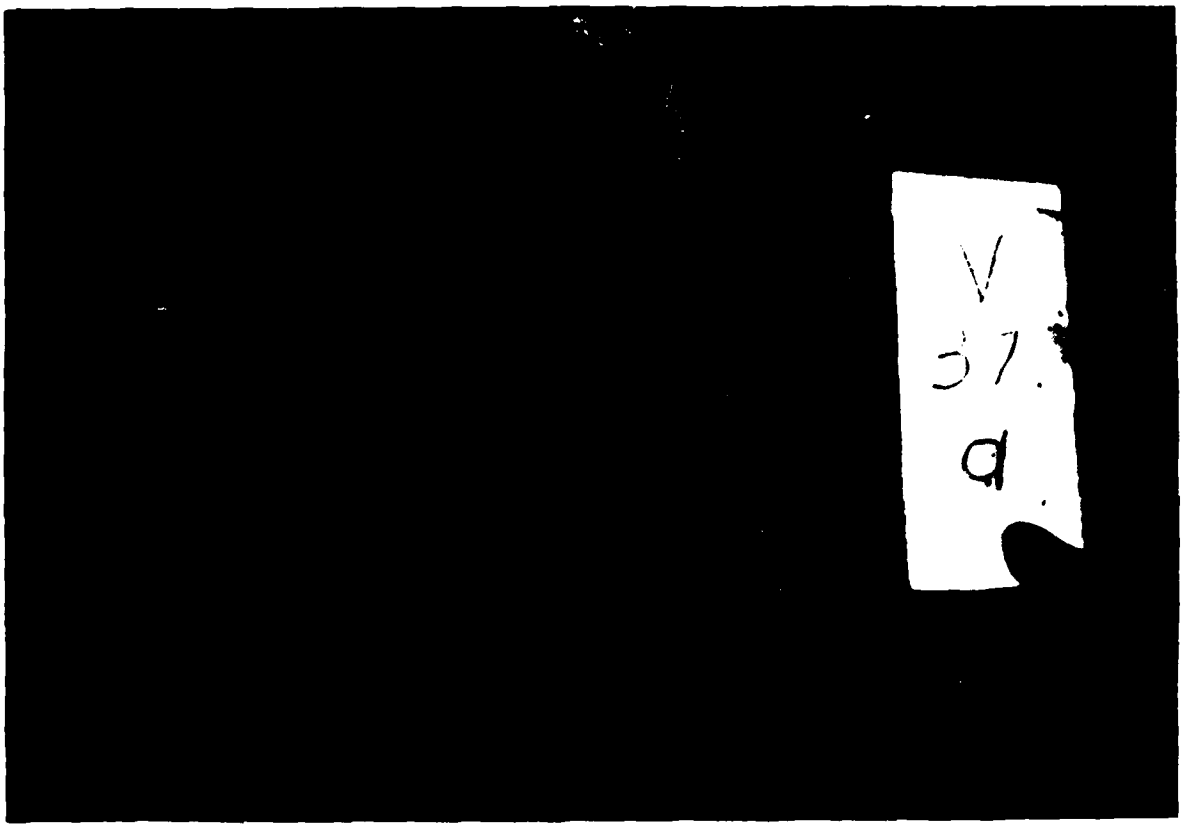


11. Single Sheet of Metal/Oxide, Pier L; V-20-A

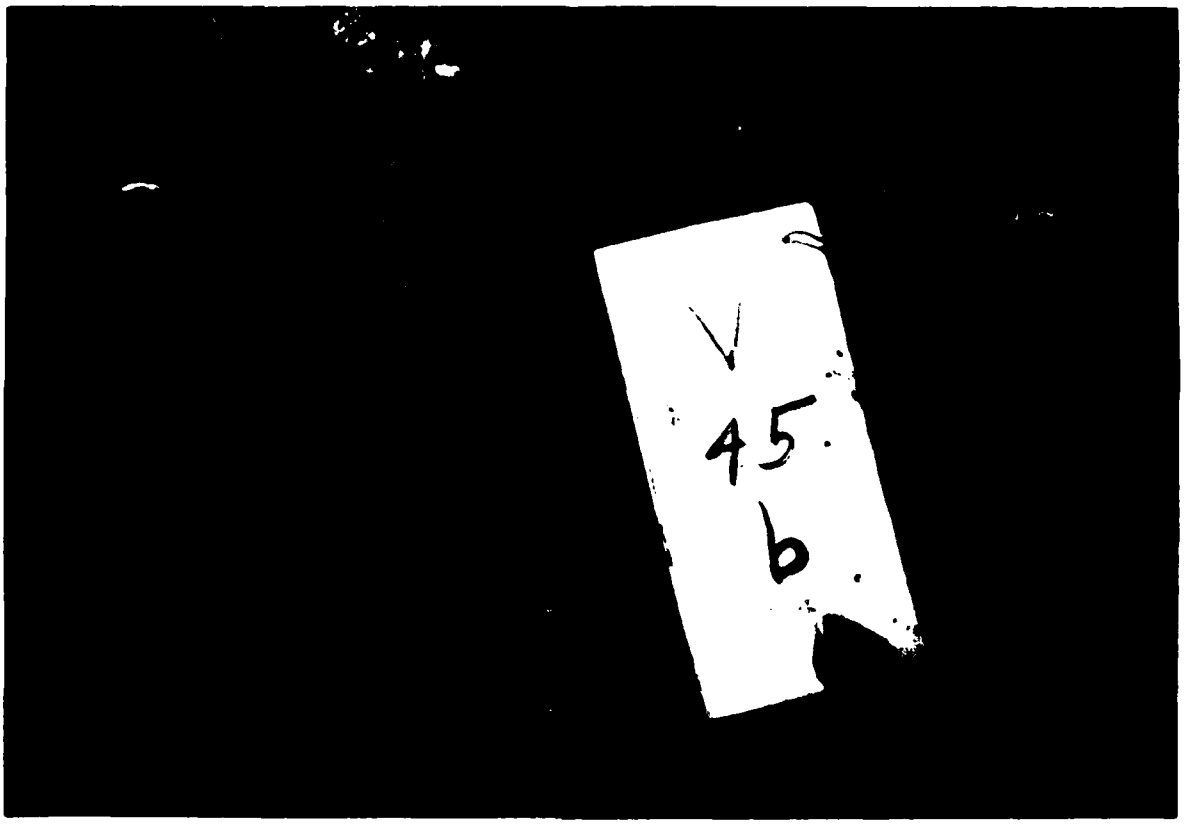
12. Single Sheet of Metal/Oxide, Pier L; L-68-B



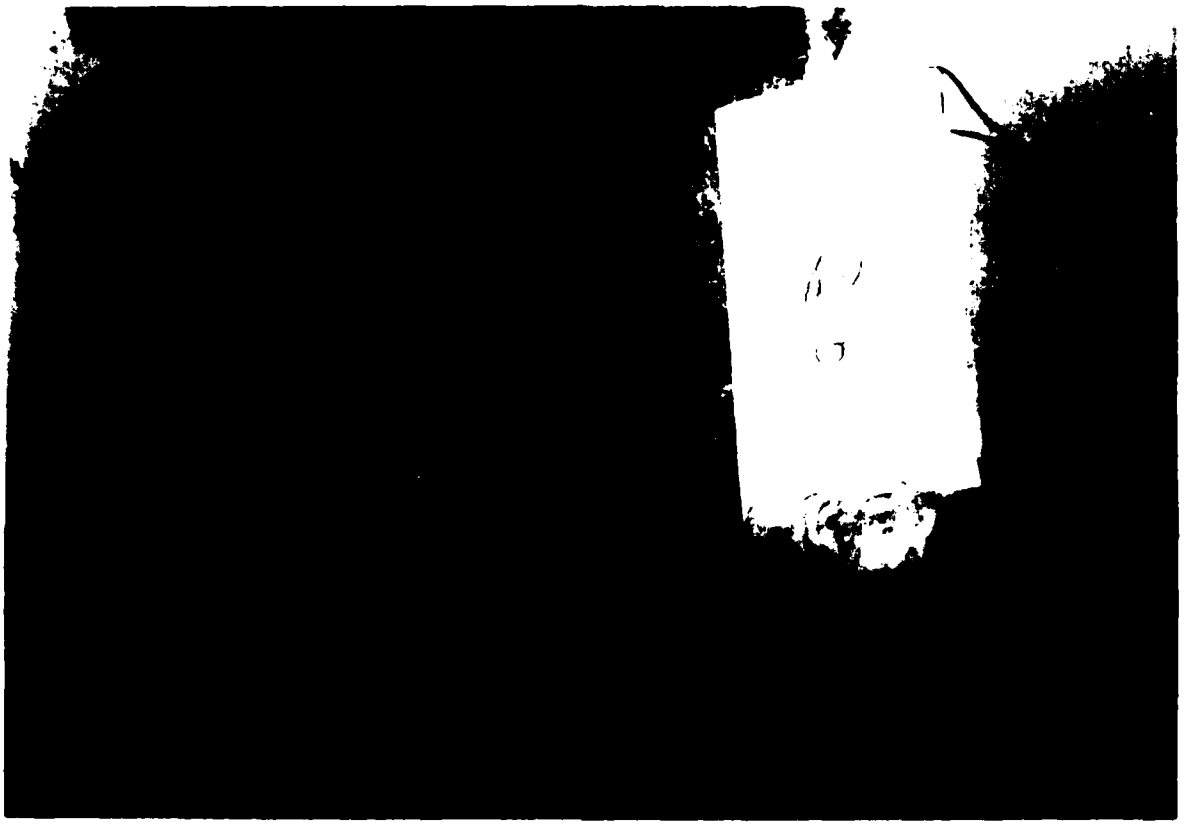

13. Single Sheet of Metal/Oxide, Pier L; V-15-L




14. Decreasing Width and Horizontal/Crack, Pier L; V-37-A




15. Separation of Laminations, Pier L; V-45-B



16. Separations of Laminations, Pier L; L-80-G

3. PIER D

Pier D is an open-type reinforced concrete pier that is approximately 295 feet long with a varying width from fourteen to thirty feet. The concrete beam and deck structure is supported on precast reinforced concrete piles arranged in thirty bents containing a varying number of piles with a maximum of four bearing piles and two batter piles per bent.

The underwater condition of the piles below the mean low water line appears good. The divers did not find any underwater deterioration which would be detrimental to the overall structure. The concrete pile caps, the deck support beams, and the fender system are deteriorated and should be repaired. Typical examples are shown in the following:

a. Figures 17, 18, and 19; Exposed rebar of pile caps and deck beams.

b. Figure 20; Destroyed fender system.

c. Figure 21; Fungus rot of fender pile top and anodic degradation of cleat.

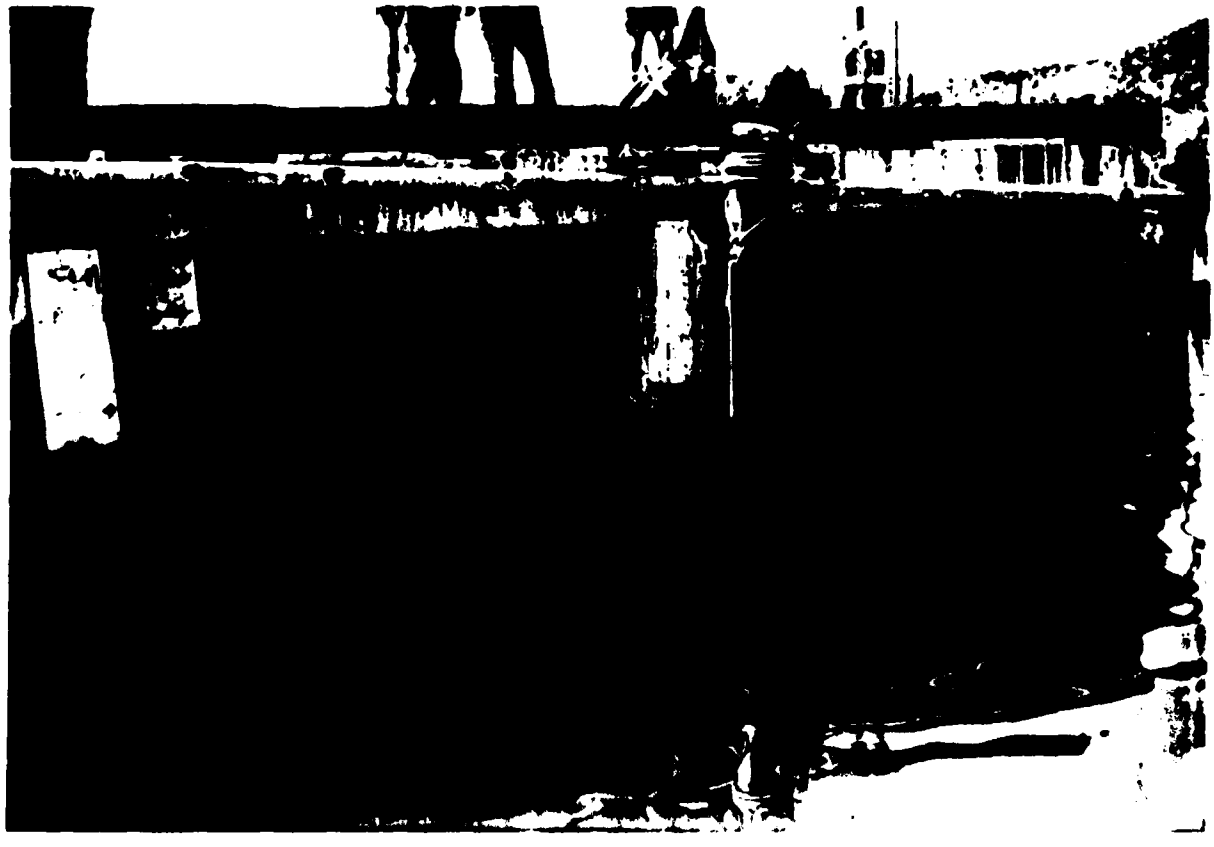
d. Figure 22; Destructive camel system.

e. Figures 23 and 24; Deteriorated repair of pile top and deck beam.

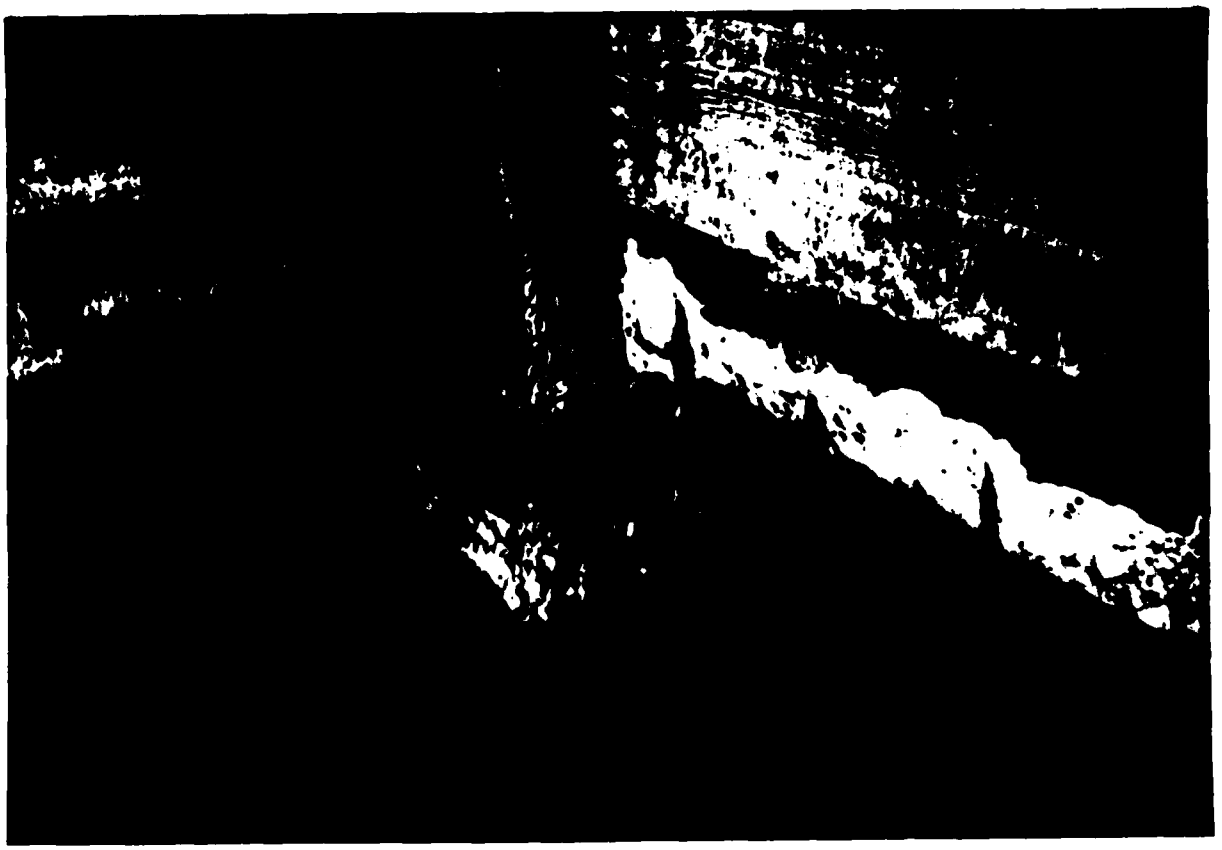
f. Figure 25; Limnoria attack and fungus rot of dolphin piles.

Future utilization of Pier D will depend on the rate of progressive deterioration of the pier structure. It is recommended:

a. That repairs to the deteriorated concrete be initiated, as soon as possible;

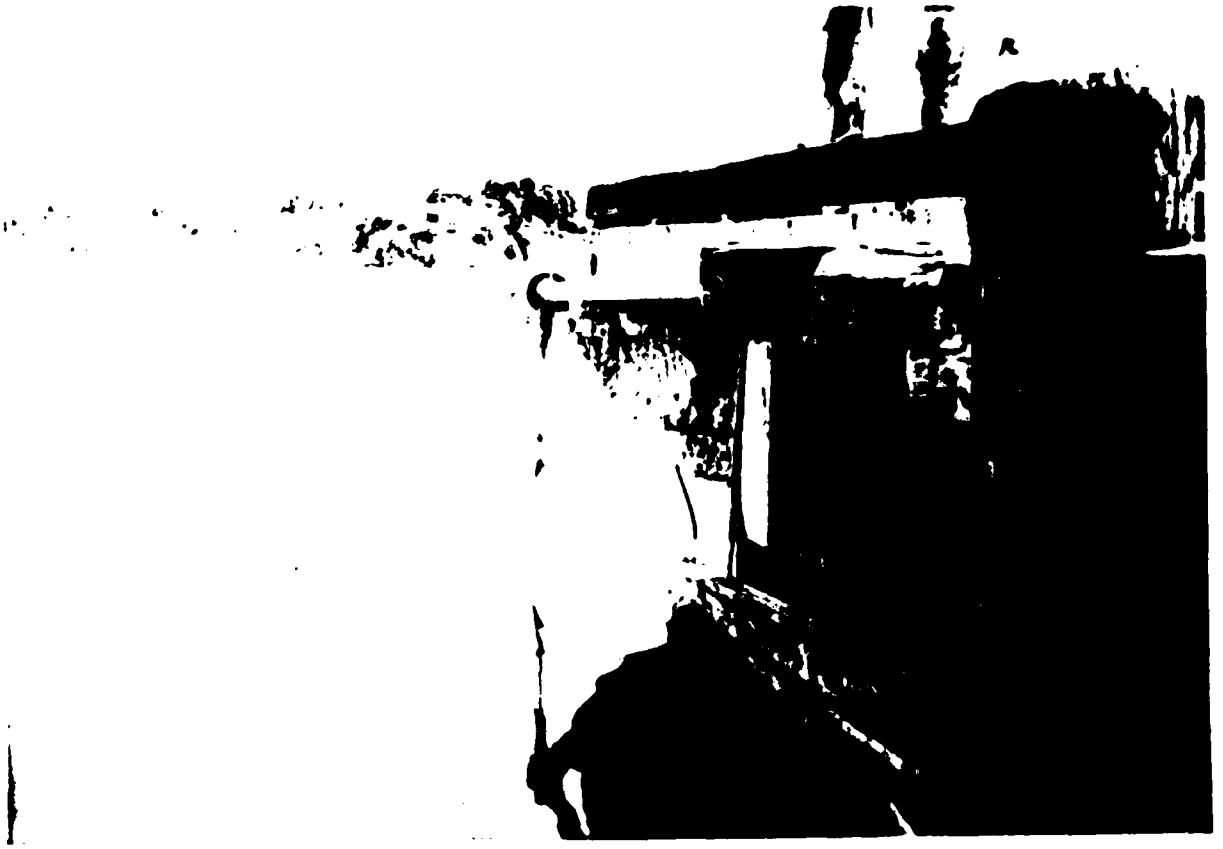


17. Exposed Rebar of Pile Caps and Deck Beams; Pier D

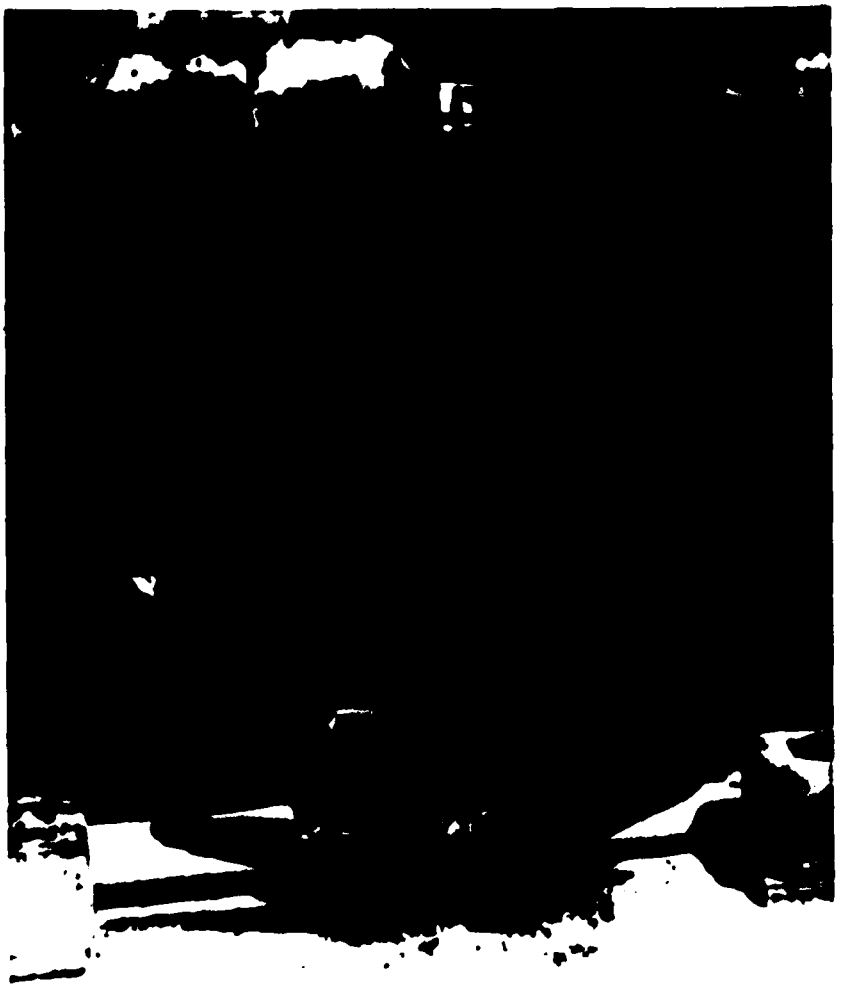


18. Exposed Rebar of Pile Caps and Deck Beams; Pier D

19. Exposed Rebar of Pile Caps and Deck Beams; Pier D



20. Destroyed Fender System; Pier D



21. Fungus Rot of Fender Pile Top and Anodic Degradation of Cleat; Pier D

22. Destructive Camel System, Pier D

23. Deteriorated Repair of Pile Top and Deck Beam; Pier D

24. Deteriorated Repair of Pile Top and Deck Beam; Pier D

25. Limnoria Attack and Fungus Rot of Dolphin Piles; Pier D

b. That the present system of floating wood camels be removed from contact with the pier and that a camel system be designed and installed in a manner that is not detrimental to the structure,

c. That the fender system be repaired and maintained to prevent destruction of the pier support structure,

d. That the pile tops be treated and capped to prevent fungus rot,

e. That dolphin piles be removed or repaired and protected to prevent degradation by Limnoria attack,

f. That deck hardware be protected by isolation or protective coatings to prevent accelerated degradation by concrete. Deck hardware degrades because it is anodic to the passivated steel within the adjacent concrete.

4. PIER Q

Pier Q is an open-type timber pile pier, approximately 180 feet in length and 30 feet wide, located on the leeward side of Guantanamo Bay. The timber deck is supported by timber piles arranged in 19 bents with four bearing piles and two to four batter piles per bent. The pier is protected by four timber and steel dolphins and a timber fender system. Overall views of Pier Q are provided in Figures 26 and 27. The creosoted timbers, utilized as bearing and batter piles, are beginning to show the effects of Limnoria attack. Piles in the protective dolphins have experienced "hour-glassing" and some of the piles have separated. The tops of the pier fender piles and the timber piles in the dolphins are being seriously degraded by fungus rot. Typical examples of the deterioration are shown in the following:

a. Figures 28, 29, and 30; Hour-glassing of piles Bent 11, Bent 12, Bent 16- Batter Pile.

b. Figures 31 and 32; Fungus rot of fender piles.

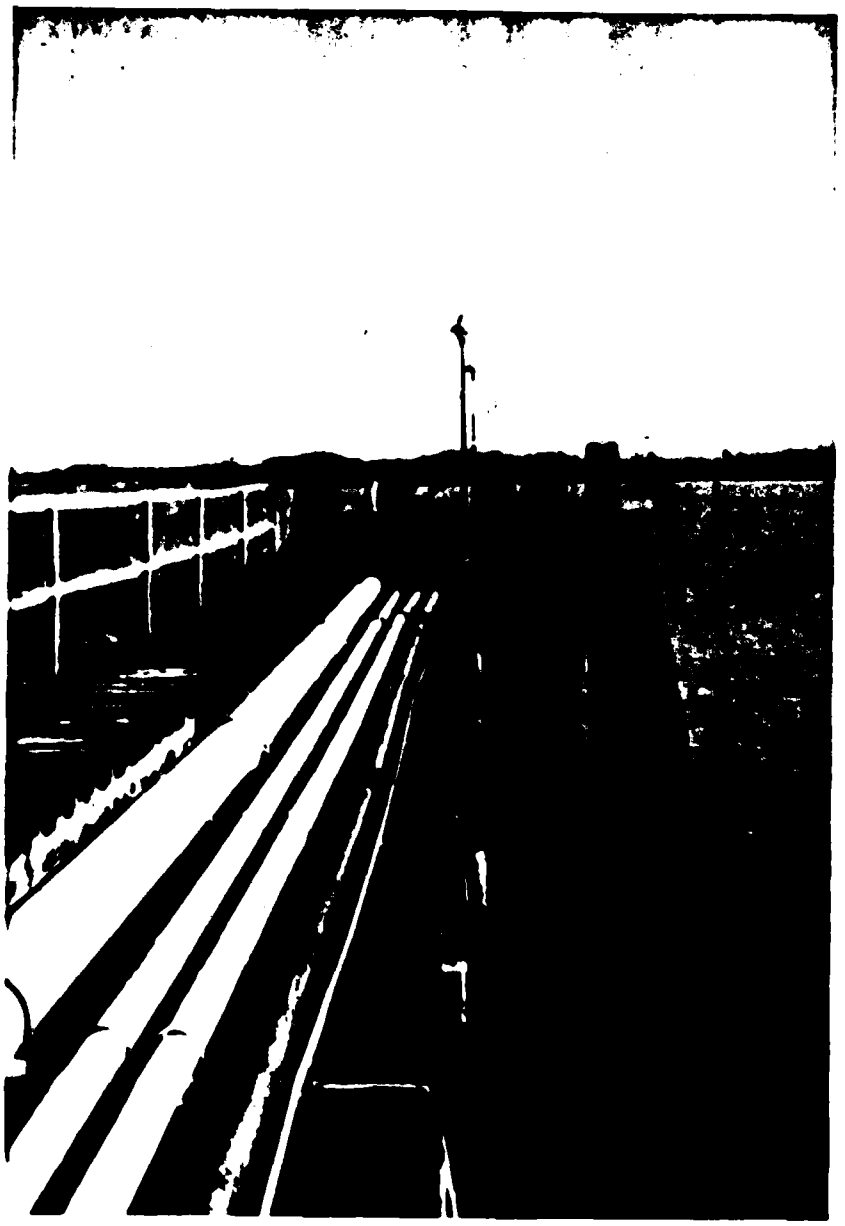
c. Figures 33 and 34; Degradation of dolphin piles by Limnoria attack showing hour-glassing and complete separation.

Future utilization of Pier Q will depend on the rate of progressive deterioration of the pier structure. It is recommended:

a. That repairs to dolphin piles be initiated, as soon as possible, to prevent damage to the pier structure.

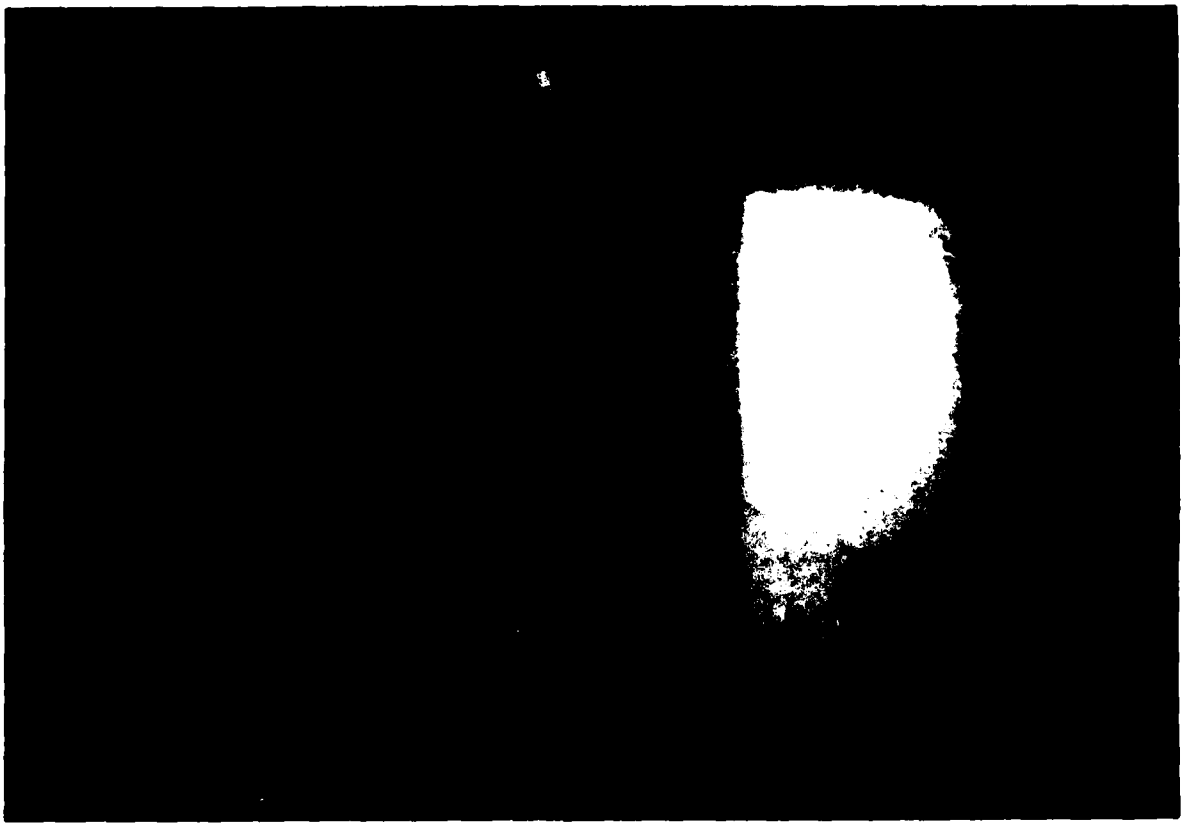
b. That repairs to the underwater portion be initiated to prevent further deterioration of sound piles.

c. That pile tops be coated and capped to prevent fungus rot.

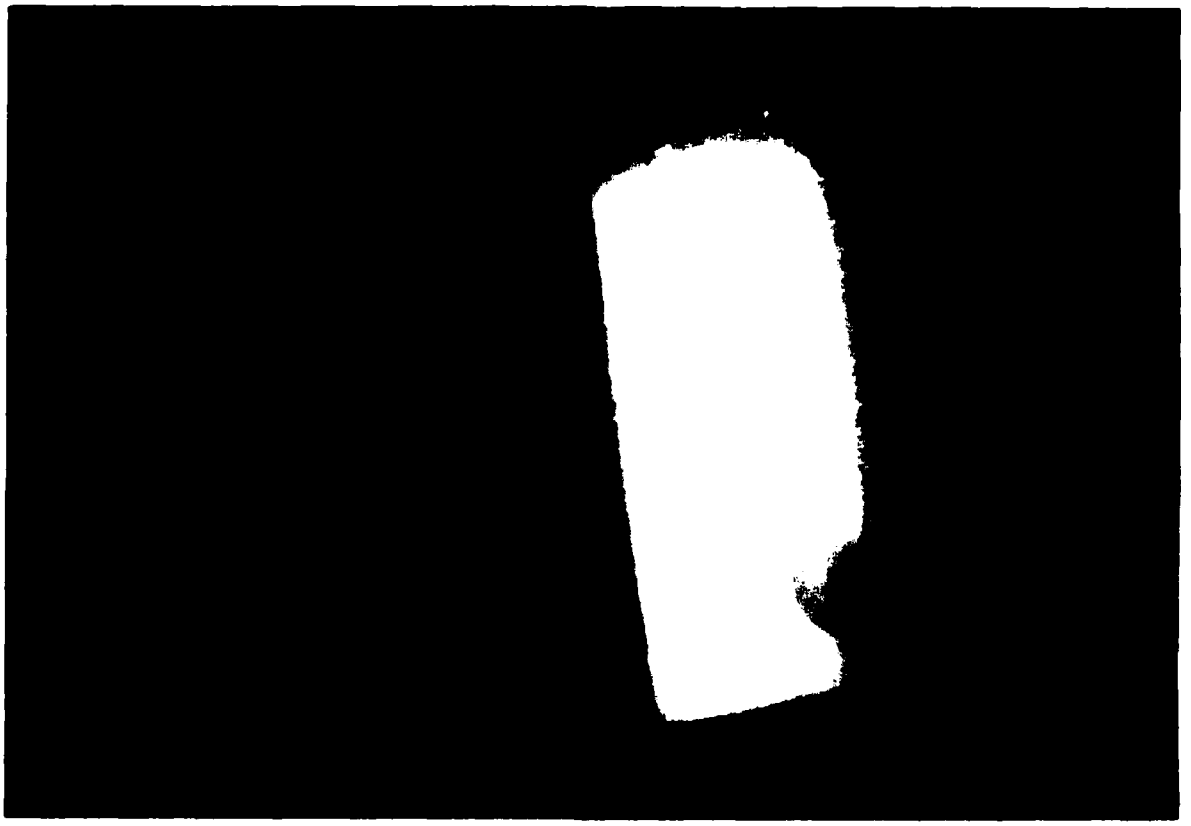


26. Overall View of Pier Q, Mahomilla Bay, looking North

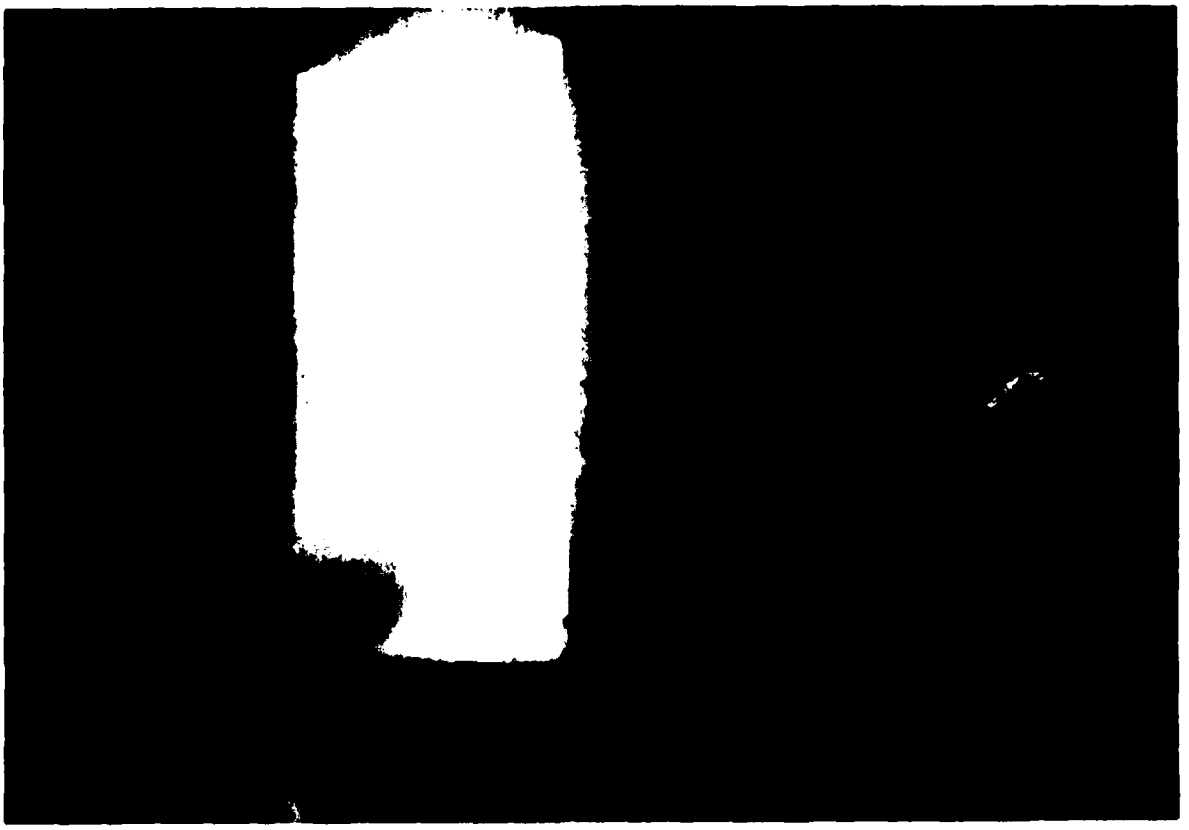
27. Overall View of Pier Q, Mahomilla Bay, looking South



28. Hourglassing of Piles, Pier Q, Bent 11



29. Hourglassing of Piles, Pier Q, Bent 12



30. Hourglassing of Piles, Pier Q, Bent 16- Batter Pile

31. Fungus Rot of Fender Piles, Pier Q

32. Fungus Rot of Fender Piles, Pier Q

33. Degradation of Dolphin Piles, Limnoria Attack, Pier Q

34. Degradation of Dolphin Piles; Limnoria Attack, Pier Q

5. PIER C

Pier C is an open-type Pier, 370 feet long and 34 feet wide. The concrete beam and deck structure is supported by twenty-five bents with four bearing piles and two batter piles per bent. The piles are pre-cast, reinforced concrete piles approximately sixteen inches square. Where the piles or portions of the support beams have been repaired, the concrete sections have an increased cross-section. The underwater inspection revealed that there was some bleeding from seawater penetration to interior reinforcing steel in bents one, seven, and nine. Between bents seventeen and eighteen the deck girder is cracked and some spalling is evident throughout the structure. The concrete over the steel fender piles is removed by the combined action of corrosion and the flexing of the fender pile. The sheet piling that surrounds the area adjacent to the end of Pier C is severely deteriorated at the top and bottom, and portions of the underwater sections are missing. Sufficient fill behind the sheet piling has been removed to cause visible sinking at the fill surface. Typical examples of the deterioration are shown as follows:

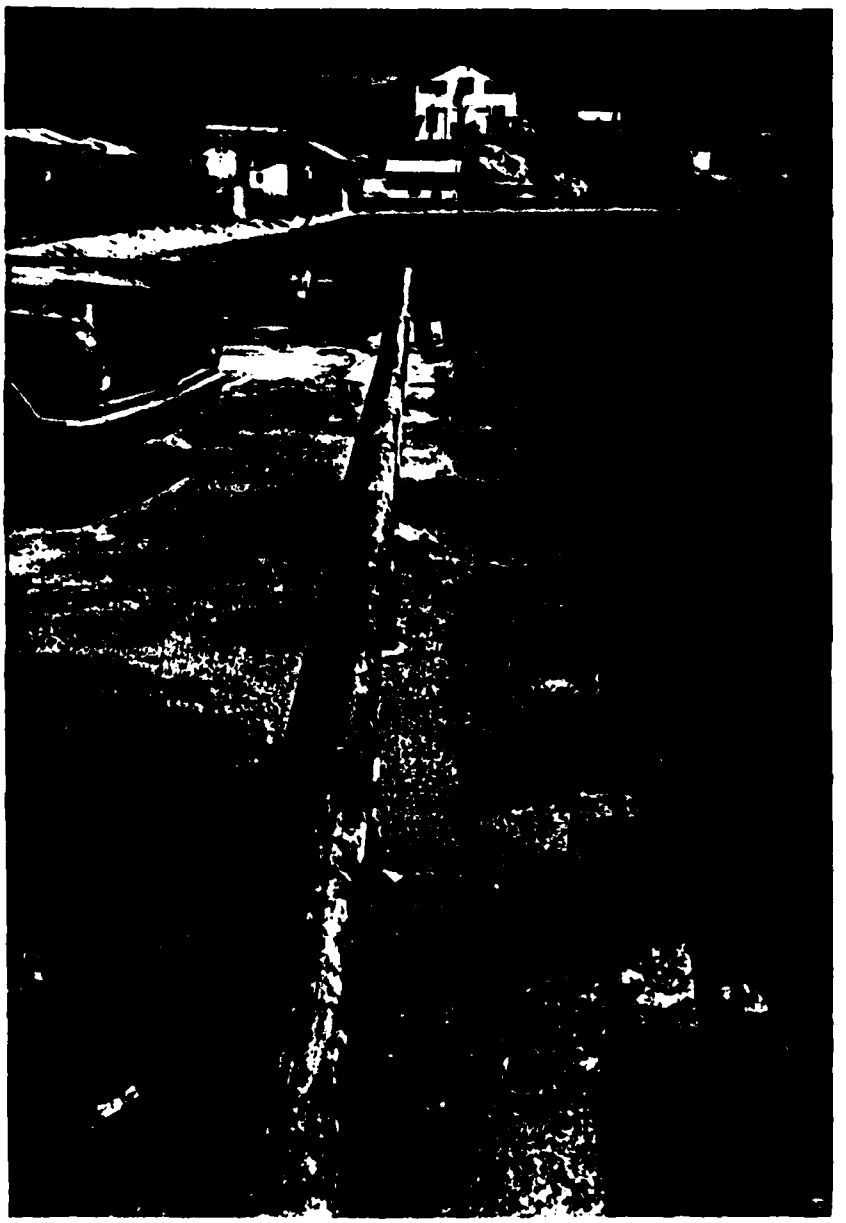
a. Figures 35, 36 and 37; Deterioration of top portions of sheet piling and surface subsidence.

b. Figure 38; Spalling of concrete at fender tie-rod connection.

c. Figures 39 and 40; Spalling concrete cover of fender piles.

Future utilization of Pier C will depend on the effective repair of the deteriorated portions of the structural portions of the pier. It is recommended:

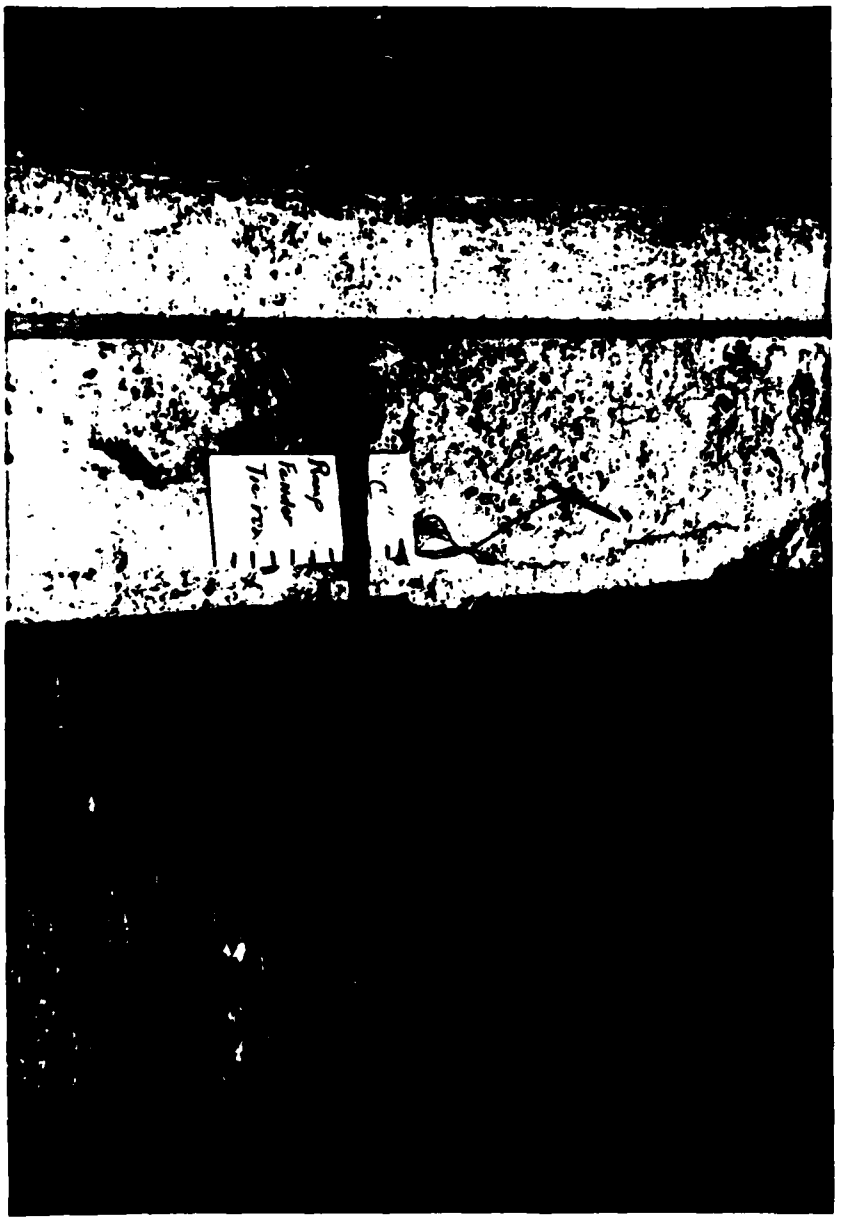
a. That the sheet piling be repaired to prevent further soil subsidence.



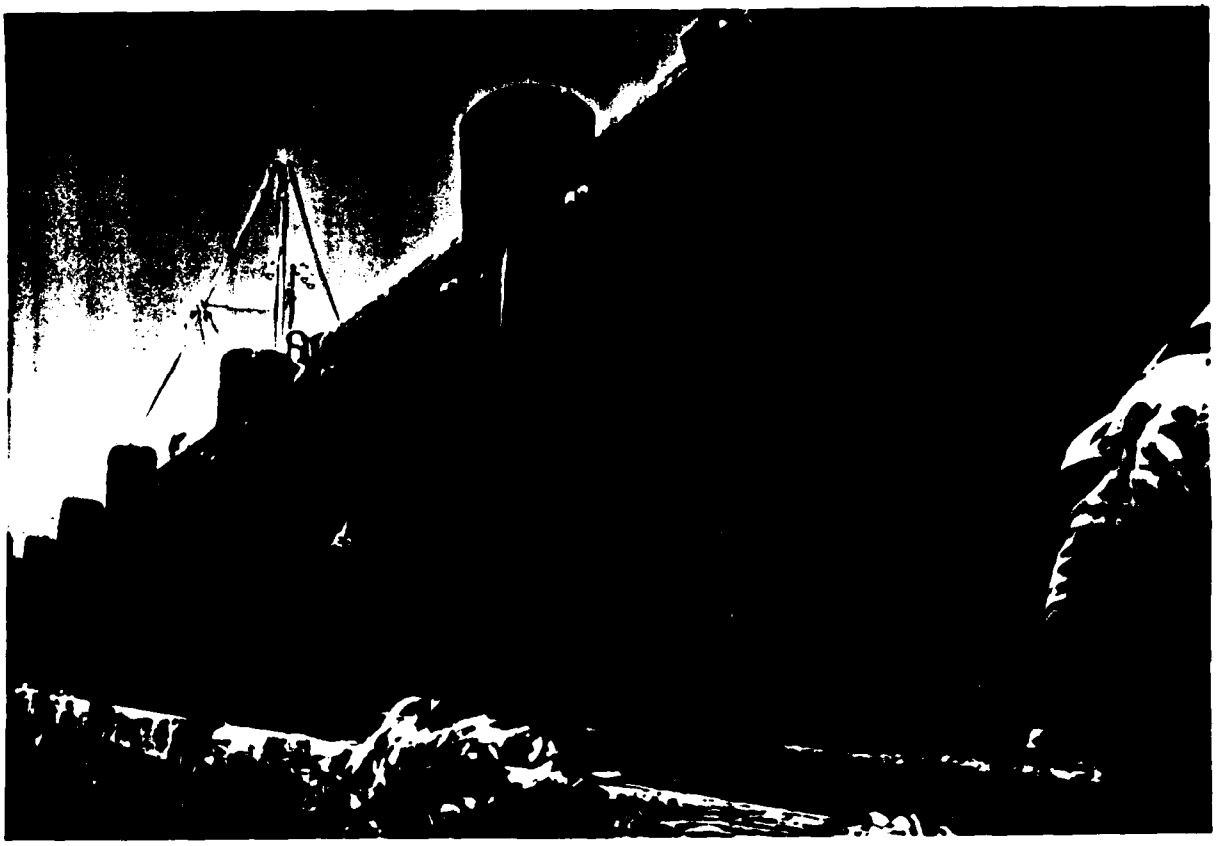
35. Deterioration of Sheet Piling and Soil Subsidence, Pier C

36. Deterioration of Sheet Piling and Soil Subsidence, Pier C

37. Deterioration of Sheet Piling, Soil Subsidence, Pier C



38. Spalling of Concrete at Fender Tie-Rod Connection, Pier C



39. Spalling Concrete Cover of Fender Piles, Pier C

40. Spalling Concrete Cover of Fender Piles, Pier C

b. That repairs of spalling concrete, cracked girder, and areas of "bleeding" concrete be repaired to halt further deterioration of the structure.

6. Mooring BB-1

Mooring BB-1 consists of two sheet pile caissons located approximately 300 feet apart. Between the two caissons, a concrete deck, 32 feet wide, is supported by approximately 20 bents with four bearing piles and two batter piles per bent. The batter and bearing piles consist of steel H-beams that are protected by a wooden fender piles, wales, and chocks. Deterioration of the H-piles and sheet piles is minimal and Limnoria attack is beginning to show on the wooden sections of the mooring.

7. Pier A, Wharf B, Wharf T

The underwater portions of Pier A, Wharf B, and Wharf T showed no significant deterioration. These waterfront structures appear to have been recently repaired and are in good condition.

8. Quaywall Deterioration

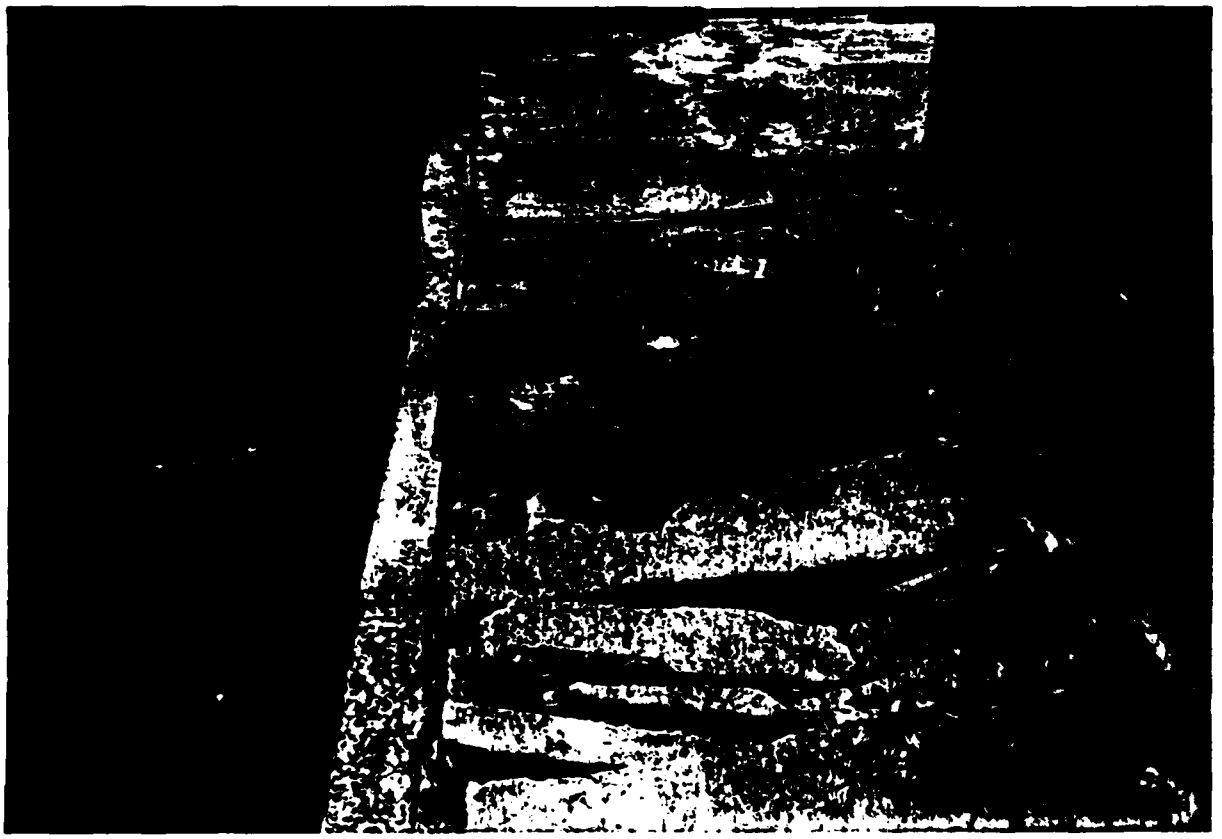
At several locations between Carinso Point and Radio Point, the "quaywalls" have been completely undermined because the supporting fill has been washed away. Extreme examples are shown, as follows:

a. Figure 41; Quaywall between Pier V and L

b. Figure 42; Cement slabs behind quaywall between Piers C and D.

These quaywalls cannot protect the fill that supports the cement slabs, asphalt surface, etc., and should be repaired if the area behind these walls is to be utilized.

41. Quaywall Between Pier V and L



42. Cement Slabs Behind Quaywall Between Pier D and C

G. WATERFRONT FACILITY RECORDS

In order to enable inspections of waterfront facilities to be utilized effectively, precise records of each structures past, present, and anticipated condition should be maintained. All photographs, slides, etc. should have a small sign designating pier or wharf; location along pier or wharf; and depth or vertical position along pier or wharf. For example; an underwater photograph six feet from the bottom on pile b of bent 11 for Pier L should be designated L-11 b-6. Other designations which accurately describe the place other waterfront structures should be established by the facility and maintained in all records. As a minimum, the following data should be assembled:

a. Up-to-date simple schematics that disclose the location of each pile, quaywall section, surface condition, etc.

b. The location, type, and severity of any deterioration that is located in all inspections.

c. Photographs which document the type of deterioration, the progression of the deterioration, the repair of each pile, quaywall section, fender system, etc.

d. Official as-built drawings including drawings utilized for repair and new construction.

e. Specifications for repair of waterfront facilities.

The availability of this data will enable the facility to schedule maintenance, repairs, and inspections in a manner which will assure maximum utilization of a waterfront facility and which will minimize cost and effort to make the facility available.

## H. CONCLUSIONS

On the basis of the underwater inspection of the waterfront structures at Guantanamo Bay, Cuba, the following conclusions are reached:

a. Underwater inspections should be performed by divers on a regularly scheduled basis in order to verify or locate structural deterioration and to identify maintenance requirements in a timely and cost-effective manner;

b. Repairs to underwater structures should be designed for the environment and installed under effective quality control to verify compliance with specified application procedures.

## I. RECOMMENDATIONS

Specific recommendations have previously been provided for each structure inspected. The following general recommendations apply to all of the utilized waterfront facilities:

a. Detailed underwater inspections should be scheduled for all facilities in order to establish the extent of underwater damage and deterioration, the requirements for repairs and/or the need to de-rate the facilities for damage control and safety reasons.

b. Repairs to the waterfront facilities should be scheduled, as needed, to prevent further degradation of facilities and to avoid safety problems.

c. Procedures or warnings concerning constraints on the docking at the piers and wharves should be provided to all vessels utilizing the facilities in order to prevent much of the inadvertent mechanical damage.

d. A simplified record keeping system should be established for each facility such that "up-to-date" and "present-condition" drawings and maintenance records are available.

e. Utilization of piers or fenders which have been damaged should be minimized until repairs have been completed. No docking impacts directly onto the piling should be allowed; and temporary fendering or camels should be provided where permanent fenders have been destroyed and are awaiting repairs

f. A minimum of 3½ inches of the appropriately mixed and applied concrete or grout should be utilized to cover any reinforcing bar or

mesh in any repairs of pier deck beams, pile caps, or pile protective covers.

g. With respect to Pier L, its utilization should be reduced. An engineering inspection and repairability assessment should be undertaken immediately to establish repair requirements and interim de-rating criteria. (These recommendations have been accomplished per reference 5).

## J. SUMMARY

The Underwater Construction Team One and the Ocean Facilities Engineering and Construction Project Office; Chesapeake Division, Naval Facilities Engineering Command jointly participated in an inspection of the underwater and adjacent portions of the waterfront facilities at the Naval Station, Guantanamo Bay, Cuba.

The inspection revealed that the underwater and below deck portions of the Pier L were deteriorated to the extent that pier usage should be limited until a more thorough underwater inspection and analysis could be performed, references 4 and 5. The inspection of Piers V, C, D, and Q reveal that portions of the structure were in various stages of deterioration but limitations on pier utilization are not required. However, repairs and pier utilization procedures should be initiated to prevent or curtail further deterioration which will result in limitation of pier capacity in the near future.

Pier A, Wharf T, Wharf B, and Mooring BB-1 did not reveal significant deterioration requiring replacement or repair, however, procedures for utilization and maintenance of the structures should be instituted to minimize the causes of deterioration affecting the other waterfront structures. In general, damage to minor waterfront structures have already been noted by resident inspectors and their condition was not included in this inspection.

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