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Figure 1: Steel Corrosion on Lake Superior .

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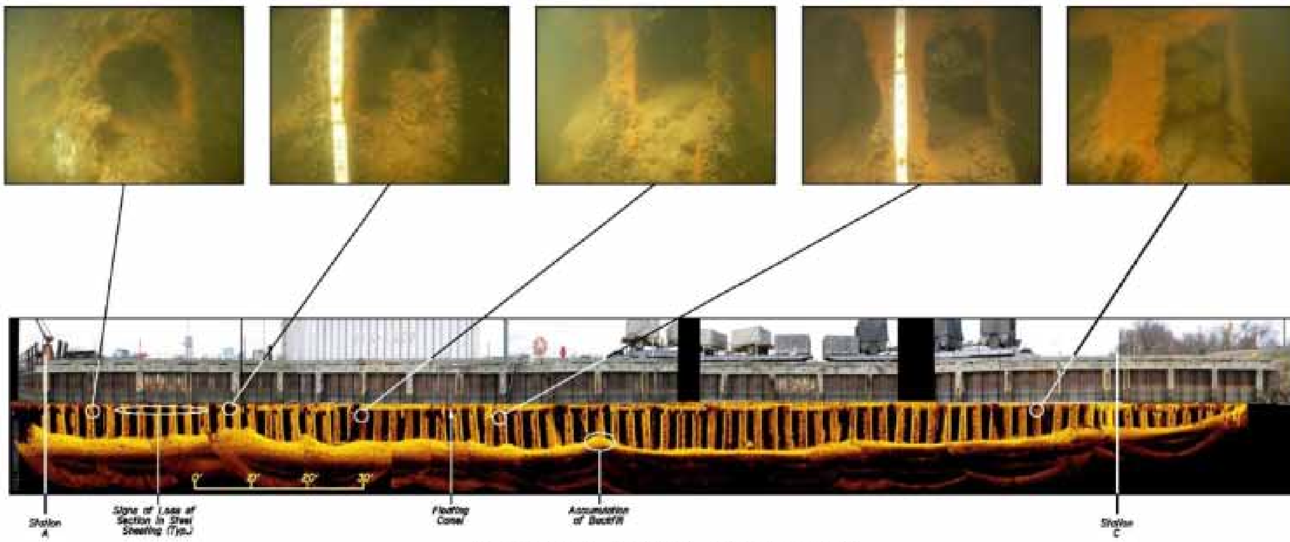
Figure 2: Concrete Structure Problems on Lake Michigan.

Best-Practice Inspection Guidelines for Great Lakes Port, Harbor and Marina Structures

Many of our Great Lakes ports, harbors and even marina infrastructure are aging and deteriorating. Some facilities date back to the turn of the century. With the lower than average Great Lake water levels, now may be an ideal time for facility owners and managers to inspect their infrastructure for problems that would need further expert review and possible repair. The sooner problems are identified, the greater the chances for less expense rehabilitation and repair versus the more costly complete-replacement.

While there are several specific types of infrastructure inspections for Great Lakes structures (refer to references listed below for details of the type classifications), this text will focus on the class of "routine" maintenance inspection that can be completed relatively easily and should be part of a port, harbor or marina facility regular maintenance program. Above-water inspections can be initially made by facility-managers and owners while all underwater inspections require trained engineer-diver teams with Great Lakes coastal infrastructure inspection experience. Routine maintenance inspections can often be performed as part of other tasks while present at the facility with a checklist or standardized form; however, more in-depth underwater engineering assessments require a variety of certifications in compliance with OSHA Commercial Diving Regulations and licensed to practice engineering for liability reasons in the state.

Routine structure inspections are inspections whose purposes are to assess the overall condition of the structures and observe any issues that may require further attention. When performed on a regular basis, they can indicate the initiation of problems before the associated damage becomes too severe. Recommended frequency ranges from 2-6 years between successive inspections and would increase as damage is starting to be seen. Inspection frequency would also be a function of structure type, importance, etc. Sequential inspections will show if changes are occurring and how fast they are changing. Documentation of each inspection is a must. Observations should be made by written summaries as well as photographs and videotaping if possible.

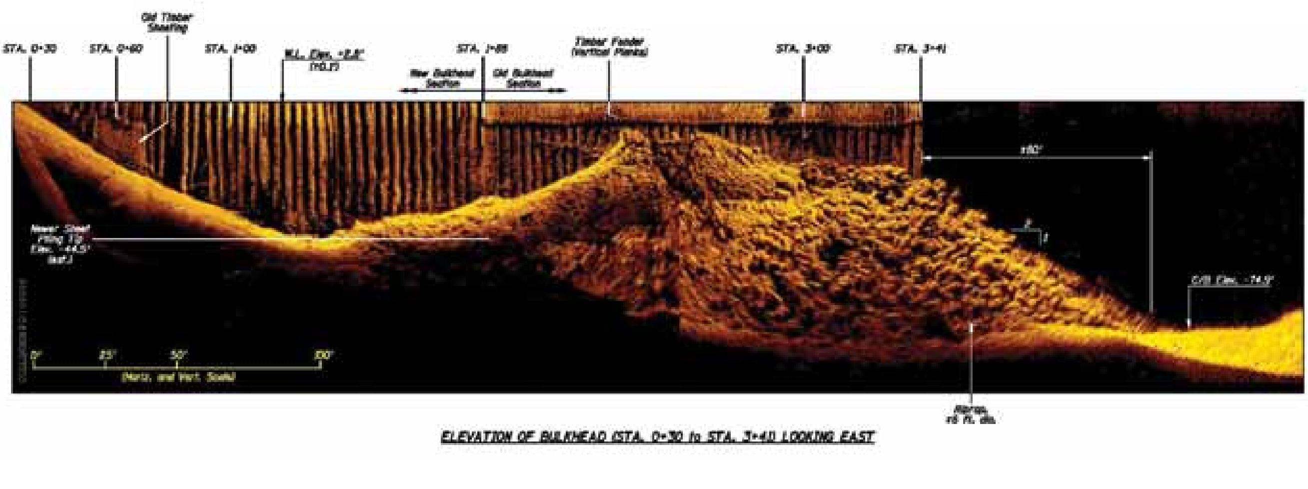


ELEVATION OF BULKHEAD (SECTION A-C) LOOKING NORTH

Typical Wall Section STA. 0+30 to STA. 1+88.

View of Sinkholes Looking North from STA. 2+00.

Typical Wall Section STA. 1+88 to STA. 3+41.



ELEVATION OF BULKHEAD (STA. 0+30 to STA. 3+41) LOOKING EAST

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Figure 3: Timber Bulkhead Wall Failure on Lake Superior.

Waterfront owners also have the ability to see high-definition images of their submerged assets with acoustic imaging, which can document existing conditions across large areas of an underwater structure. Refer to the photos on the facing page (top) for an example of a steel bulkhead with corrosion holes and sinkholes.

It is useful for personnel to obtain water-depth measurements along waterfront facilities. In addition to the structure, it is useful for personnel to obtain water-depth measurements along waterfront facilities. In addition to having information on the channel bottom elevation along a waterfront facility for navigational limitation knowledge, it is also useful for structure interaction evaluation. Loss of channel bottom material from currents, wave actions or vessel prop wash can cause the failure of a structure.

Refer to Figures on the facing page (bottom) for an example of a dockwall with scour undermining the bottom of the sheeting that resulted in large dangerous sink holes and structure instability. The three smaller pictures show the bulkhead from above the waterline while the longer image below shows details of the entire bulkhead underwater using scanning sonar. The above left picture details the new bulkhead section while the above right picture details the older wall section. The above center picture shows a large sinkhole that has formed by the loss of fill from behind the bulkhead due to underwater scour. The scanning sonar image clearly shows both the location and extent of the large amount of material lost from behind the bulkhead wall.

Above-water routine inspections can be made from the edge of the slip, dock or pier but are more effective from a boat if available. Typical features to observe depend upon the type of material and construction of the structure.

For steel or other metallic structures, personnel should look for loose connections, corrosion and/or flaking, impact

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Figure 4: Typical Diver Inspection of Steel Bulkhead Wall.

damage and pitting of the metal. See Figure 1 for an example above-water steel observation.

For concrete structures, personnel should look for cracking, efflorescence/exudation and leaching (white deposit caused by moisture leaching through the concrete), scaling, delamination, spalling and/or signs of exposed rebar. See Figure 2 for an example of above-water concrete observation.

For timber structures, personnel should look for evidence of insect damage, rot/ fungus, checking, cracking or splitting, impact damage, connecting hardware problems, or broken pieces. Refer to Figure 3 for an example of damaged timber structure.

For underwater inspections, it is best practice to use ADCI certified commercial engineer-diver teams experienced in Great Lakes underwater inspections. Typically, the underwater inspections can be divided into three levels of inspection (Levels I, II, and III). Divers often photograph and videotape observed defects for further analysis and comparisons to earlier inspections. See Figure 4 for a picture on an inspection diver complete with attached camera to his helmet.

Level I underwater inspection involves the detection of damaged areas without removing biofouling organisms, which are generally aquatic growth and mussels. Level II inspections require a cleaning removal of the biofouling to inspect the structure underneath the growth. Level III inspections would include non-destructive testing of the structure to determine hidden or interior damage.

Currently, the American Society of Civil Engineers is finalizing a new Waterfront Facility Inspection Manual, which will likely be published in late 2012. This ASCE Waterfront Facility Inspection publication will supplement, but not replace the 2001 Underwater Investigations Standard Practice Manual No. 101. Both the ASCE Waterfront Facility Inspection Manual and ASCE Underwater Investigations Manual provide useful information for the planning, construction, inspection and rehabilitation of waterfront facilities.

For Additional Information:

ASCE Underwater Investigations Standard Practice Manual No. 101, 2001

United Facilities Criteria (UFC) #4-150-07 Maintenance and Operation: Maintenance of Waterfront Facilities New York City Economic Development Corporation Waterfront Facilities Maintenance Management System Inspection Guidelines Manual, 1999

The Repair, Evaluation, Maintenance and Rehabilitation (REMR) Notebook, U.S. Army Corps of Engineers, 1991

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