US Army Corps of Engineers ®

Great Lakes Coastal Infrastructure: Critical Protection at Risk

The United States Great Lakes navigation system includes over 600 miles of channels, 139 federal projects, 104 miles of structures, 20 dredged material disposal facilities, and the locks at Sault Sainte Marie, Michigan; Chicago, Illinois; and Buffalo, New York. This brochure provides an overview of the vital role that coastal infrastructure plays in protecting urban waterfronts from storm surges, waves, and ice. This paper is part of a larger effort to inform local officials and regional stakeholders of the benefits and risks associated with coastal infrastructure in light of current federal budgeting priorities. It also presents a strategy to prioritize limited federal funding and to begin a dialogue with local and state officials to investigate potential options for non-federal entities to assume fiscal responsibility for these structures in the long-term.

The Great Lakes coastal shoreline includes some of the most beautiful, valuable, and vulnerable property in the Midwest and Northeast. Cities and towns in eight States have flourished along the shores of the Great Lakes because of their natural beauty and the value they bring to commerce, navigation, and recreation. Most of these coastal cities were established as ports, taking advantage of the Great Lakes as their primary mode of transporting goods, material, and people.

A majority of Great Lakes coastal cities and towns have federal harbors that include channels for navigation and structures like breakwaters and piers. Although authorized to safeguard navigation activities in the federal harbors from waves and ice, these navigation structures also provide critical flood and storm protection for buildings, roads, and facilities that developed in their shadow along the urban waterfront. In some cases, this development includes critical infrastructure for power generation, water supply, and wastewater treatment.

Federal funding for the maintenance of federal harbors is prioritized based on the national economic benefits of the harbor related to commercial navigation. Harbors that lack significant commercial navigation are not currently a high funding priority. Consequently, maintenance of recreational harbors and harbors with limited commercial traffic has been deferred indefinitely. Ironically, federal investment in breakwater repair has gone down while the economic value of the critical city infrastructure protected by harbor structures has gone up. The failure of harbor infrastructure would put many public facilities at risk.

Great Lakes Navigation System

The Great Lakes navigation system is a network of harbors, channels, locks, and dams that provides for interstate and international transportation of goods and materials (five-year average 167 million tons of cargo).

Most of the federal harbors in the Great Lakes were constructed between 1860 and 1940. At some of these harbors, the level of commercial navigation has declined or been completely eliminated over the past 50 years. Recreation has become the major industry at many Great Lakes harbors, in some cases completely displacing industries that relied on commercial shipping. Currently, only 60 of the 139 federal projects on the Great Lakes support commercial navigation.

Coastal Forces

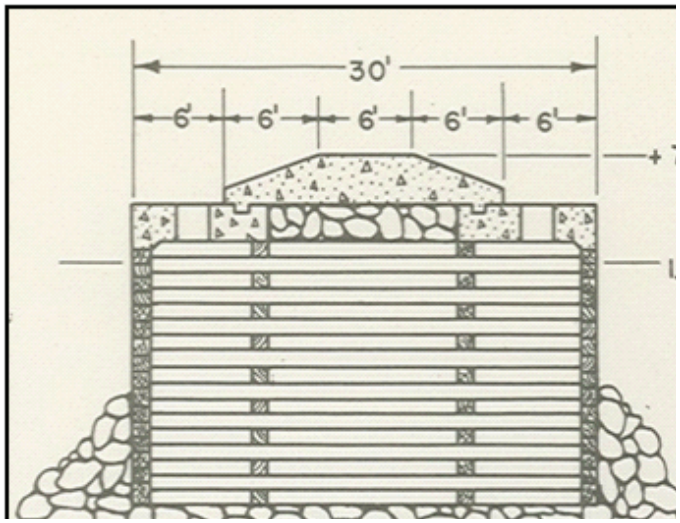
The Great Lakes are truly inland seas, with over 10,000 miles of coastline that is subjected to harsh, rapid changes in weather and wave conditions. Waves 10 to 24 feet in height, created by strong winds blowing over the lake surface, can deliver a powerful force capable of moving large stones weighing many tons each. Often, large waves combine with up to eight feet of storm surge, creating a substantial rise in water level.

The combination of storm surge and large waves, especially when accompanied by ice, generates powerful forces on harbor structures. Structures can be exposed to these forces many times each year, which can weaken a deteriorated structure with every event.

The photo above (*Duluth-Superior Harbor*) depicts large waves engulfing a harbor entrance. In addition, massive ice floes can literally engulf breakwaters (*below – Petoskey Harbor, MI*). The top of the breakwater is barely visible in the ice. Coastal structures constantly exposed to these forces year after year gradually weaken, which can eventually lead to partial or total failure of the structure if adequate maintenance is not performed.

Harbor Structures

Great Lakes harbor construction began in the 1800s when demand for commerce prompted the nation to deepen coastal rivers and bays and to construct jetties or piers perpendicular to the shore. Jetties and piers help keep channels open for navigation. Later, offshore breakwaters were constructed to provide safe entry into the harbors, especially during storms.



Several types of breakwaters have been constructed in the Great Lakes. The oldest and largest group (31% of total) used timber crib core sections. Timber cribs are wooden frames that were constructed on shore, floated into position, and filled with rocks to sink them into place. Most timber cribs had a concrete or stone superstructure added later, and some have added steel sheetpile reinforcement.

Other structures are constructed with laid-up stone (13% of total), tightly placed cut stone blocks stacked into a pile around a core section that was often a timber crib. Newer breakwater structures are typically steel sheetpile (25% of total) or stone rubble mound (28% of total). The latter structure type consists of large irregular boulders placed tightly together.

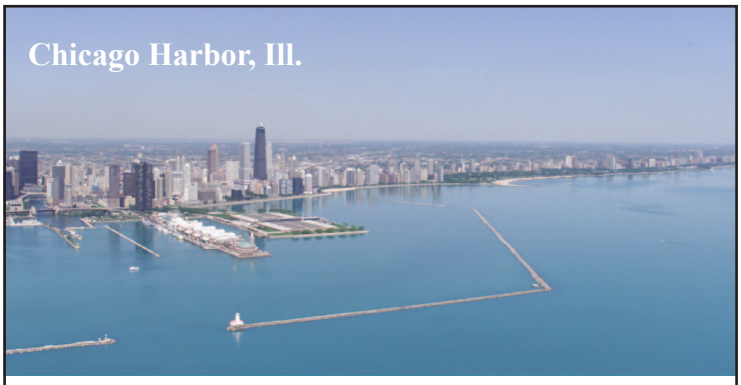
Over half of the coastal structures on the Great Lakes were built before World War I and over 80% are older than the typical 50-year design life. Deterioration is most extreme in breakwaters built with timber cribs, since wood decays rapidly when exposed to the air during low lake levels. Lake levels have been relatively low over the last several years, especially in Lake Michigan and Lake Huron, which has accelerated deterioration

Grand Marais Harbor is located on the south shore of Lake Superior, 93 miles west of Sault Ste. Marie, Michigan. This project serves as an important Harbor of Refuge and supports charter fishing and recreational navigation interests. The local community has established a significant infrastructure around the harbor facilities that generates income from harbor users and visitors to the area.

Harbor infrastructure consists of approximately 4,000 feet of timber crib and cellar steel sheet piling piers, and a 5,770 feet long pile dike, currently in ruins. The piers primarily protect the entrance channel to the harbor, MDNRE Burt Township Marina, the city beach and Lake Superior shoreline to the east and west of the harbor structures.

Cleveland Harbor is located on Lake Erie. The port supports the transport of more than 15 million tons of commercial cargo for the steel, auto, and construction industries. Estimated annual business revenues of approximately $280 million dollars support nearly 4,000 jobs.

Harbor infrastructure includes more than five miles of breakwater and pier, built between 1875 and 1915. In addition to providing safe navigation for lake freighters, the system protects extensive waterfront development, including the Rock-n-Roll Hall of Fame, Cleveland Browns Stadium, the Great Lakes Science Center, eight cargo docks, two tour boat operations, three marinas, berthing for a maritime museum, and a U.S. Coast Guard station. The typical storm wave in this harbor is 11.5 feet, while the maximum recorded wave height was 13.8 feet in 1982.



Chicago Harbor is located on Lake Michigan in the city of Chicago, IL. This harbor is a part of the Port of Chicago, and is the secondary link of the Great Lakes and Inland Waterway System. In 2008 approximately 149K tons were directly received through this harbor. The South Branch of the Chicago River connects to Chicago Sanitary & Ship Canal and Illinois River.

The Chicago Harbor has 20,357 linear feet of timber crib, laid-up stone, and concrete caisson breakwater structures. The 5,321 foot northwestern breakwater is the harbor's primary shield to strong waves and storm surges from Lake Michigan.

Milwaukee Harbor supports commercial shipping that transported 3.8 million tons of cargo in 2005. The harbor is home to a new terminal for cruise ships and a high-speed ferry. The port generates revenues of $80 million annually and directly supports over 1,000 jobs.

The Lake Michigan waterfront is the focal point of the City of Milwaukee, Wisconsin. The 3.7-mile-long harbor breakwater was built in the 1890s. It protects a major commercial navigation port, municipal and private marinas, the regional wastewater treatment facility, the art museum, and recreational facilities.

High Lake Michigan water levels in the mid 1980s combined with storm surge from an intense storm caused significant flooding of the Jones Island wastewater treatment plant. The typical storm wave at this location is 16.4 feet and the maximum recorded wave height was 21.3 feet in 1960.

Summary

Federal harbor infrastructure that protects waterfronts in many Great Lakes coastal cities and towns requires regular maintenance and repair. However, harbor infrastructure maintenance is no longer a federal budget priority, which has produced a serious situation of continuing deterioration. In addition, recent low water levels have accelerated deterioration in many harbor structures.

Approximately 80 percent of the Great Lakes harbor structures are older than their 50-year design life and many are more than 100 years old. With the current federal funding situation, the majority of harbor structures are not likely to be repaired in the foreseeable future. Many federal harbors are no longer considered a budget priority because of the lack of commercial use; further, the repair of navigation structures even at commercial harbors has a low budget priority.

With the lack of adequate maintenance, harbor structures will continue to deteriorate and put critical city infrastructure at risk. Reduced maintenance could increase shipping costs and also reduce protection of coastal assets and infrastructure that are currently sheltered by the harbor structures. Substantial damage to urban areas could result, with damages and replacement costs of harbor infrastructure being far greater than the investment required to maintain harbor infrastructure.

The Way Ahead

The Corps of Engineers and state and local officials are faced with the challenging task of developing a sound strategy to ensure the continued protection of critical coastal infrastructure. The Corps is implementing a two-tiered approach to address this need. The first approach will focus on prioritizing limited funding to critical commercial harbor infrastructure using risk-based methodology. The second approach will be to initiate a dialogue with state and local officials to determine the best strategy for protecting vital harbor infrastructure that is no longer a budget priority.

The Corps of Engineers has established a technical team to develop consistent methods to assess harbor infrastructure condition and determine the risks associated with the potential failure of structures. This information will be use to prioritize limited federal funding in a manner that reduces risk to the Great Lakes navigation system.

For federal structures that are no longer a budget priority, the Corps will initiate a dialogue with state and local officials to inform them of the current condition of the infrastructure and the projected risks posed by deferred maintenance. Together we can investigate options that would allow non-federal entities to assume maintenance responsibility for these structures if state or local officials want to preserve the navigation, recreation, and flood damage reduction benefits they provide.

Although the challenges posed by limited funding for harbor structure maintenance are very serious, our best opportunity for protecting our valuable Great Lakes coastal resources lies in working collaboratively on a local, state, and federal level to prioritize limited resources and develop innovative, effective solutions to these serious challenges.

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