CHAPTER 22

THE MAIN ORE UNLOADING DOCK FAILURES AND THEIR CORRECTION 1909 - 1925, GREAT LAKES REGION

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To start at the beginning of Chicago's lake structures (and first attempts to hold back wave action) we will go back about 120 years, to the year 1833. At that time an Illinois Congressman put through Congress an appropriation of \$25,000 to construct a harbor at the south end of Lake Michigan (Fig. 1). At that time the Chicago River was navigable only by cances. That Congressman, however, argued that the harbor should be located eleven miles south at the Calumet River. He was out-argued by a Captain of the Corps of Engineers, U.S. Army, who prevailed, and two 500 foot piers were built at the mouth of the Chicago River. The Congressman's name was Stephen A.Douglass and the Captain's name was Jefferson Davis, who evidently was a very persuasive fellow. These piers were either wooden oribs filled with stone, or stone-filled pile piers.

These two types of piers and breakwaters protected Chicago and the south end of Lake Michigan for over 80 years until the advent of Rubble Mound, Concrete Caissons and Interlooking Steel Cellular Breakwaters. These stone-filled wooden pile piers (Figs. 2 and 3) consisting of two rows of closely driven wood piles, filled with stone and tied together with a few rods and timbers, are a type peculiar to the south end of Lake Michigan, due to its geological formation. Sand from 5 to 20 feet in depth, overlaying a stiff clay, with stone and timber and piles at hand, enabled these structures to be built cheaply, quickly, and with a minimum of skilled labor. These piers or bulkheads now line practically all of Chicago and the south end of Lake Michigan for about 40 miles of shoreline. The stone-filled pile pier enabled the steel companies to expand into the Lake, to make additional land and provide easy economical dumping grounds right at their door. This process is still going on.

Gary Breakwater (built by the Great Lakes Dredge and Dock Co. in 1905-06) is a 24 foot wide stone-filled timber orib extending on a curve into Lake Michigan from Gary Harbor at the extreme south end of Lake Michigan. It is exposed to Northwest, Northeast, and North winds with a 300 mile fetch, with winds ranging from 20 to 60 miles per hour. This breakwater protects a 250 foot wide canal about 5000 feet long. The west, or ore-unloading side of the canal, parallel to a row of twelve blast furnaces, was lined by a dock or bulkhead (Fig. 2). This dock consisted of a 9 inch Wakefield line of sheet pile and 4 rows of wooden piles driven into the clay (which was found at about -28 feet) and the piles and sheet piles capped with a heavy mass of concrete, all anchored back by two inoh steel rods to anchor piles. A portion of this bulkhead moved out into the canal about three feet fifteen years ago, so the whole 5000 feet was further protected by a line of heavy steel Z piles and re-anchored.

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Six miles west of Gary lies Indiana Harbor and Canal which serves Inland Steel Company, Youngstown Sheet and Tube Company, Standard Oil Co. of Indiana and scores of other industries. In 1913, the Inland Steel Co., at the entrance to the harbor, had two blast furnaces, an ore dock and wooden bulkheads along the canal. The canal entrance and dock was protected by a stone-filled pier, its only protection from 300 miles of Lake Michigan (Fig. 5). The bulkhead or dock along the canal was a line of wood piles in front of a line of wooden sheet piles with three rows of wooden piles all capped with concrete and anchored back 80 feet to anchor piles. In midwinter of that year about 500 feet of the ore yard and dock slid out into the canal, raising the bottom of the canal about ten feet. (Fig. 6).

The Inland Steel Company requested bids and designs, and the one accepted was that of the Great Lakes Dridge and Dock Company. The principle feature of the design is the carrying of the ore load, 560 tons per lineal foot of dock, on wooden piling down to hard clay. The piles were from 45 to 115 feet long and capped with a mat of concrete, 21 inches thick, in the ore yard. Since that time, the ore yard and dock have been extended into Lake Michigan about 3500 feet, using the same design, protected by a class A breakwater. One section about 300 feet long settled 12 inches and moved out slightly, but the dock is still in use. Figure 7 shows final development of this design.

Later the Buffalo Union Furnace Company, the Donner Steel Company, and the Kelly Island Limestone Company docks, all of Buffalo, failed by sliding out and were corrected in the same manner as the Inland Steel Co. dock.

With the introduction of interlocking steel piling, steel foundation piling, concrete and reinforcing, practically all ore unloading docks followed the general desing of the 1913 Inland Steel design.

In my opinion, the most interesting of the ore dock failures and its correction was the failure of the Algoma Steel Company's dock and ore yard at Sault Ste. Marie, Ontario, in 1913. As the Great Lakes Dredge and Dock Company destroyed all of its files except those of the last 25 years, the sketch shown is drawn from my own notes and recollections. Just recently I received from Mr. K.J. Kenyon, Chief Engineer of the Algoma Steel Co., blue prints of the dock and ore yard section with borings which checks closely the sketch prepared from memory (Fig. 8). This ore yard and dock consisted of a platform dock on rows of wooden piles carrying the ore unloaders with the canal sloping up underneath from -25 feet to about \bullet 3.0 feet, and the ore carried on natural ground for about 250 feet back. The slide ran back about half the width of the ore piles (about 125 feet) destroying the platform dock. Soundings showed soft clay to -60 feet with gravel and sand to rock at -70 feet along the dock line. Competitive designs and figures were received by Julian Kennedy of Pittsburg (at that time considered the Father of Blast Furnace design), and the one submitted by the Great Lakes Dredge and Dock Co. was accepted and a contract was drawn up for about 500 lineal feet of dock. This was later extended for another 500 feet.



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Fig. 2.



Fig. 3. Wilmette, Illinois; Stone-filled pile breakwater (1,700 lineal feet), built in Lake Vichigan to protect lake end or intake of the Evanston Sanitary Canal. Other similar pile piers built at Calumet Harbor, Ill., for the Illinois Steel Works, 2,500 lineal ft. Calumet Harbor, Ill., for the Iriquois Iron Co., 3,700 lineal ft., Indiana Harbor, Ind., for the Inland Steel Company, 1,500 lineal ft.

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Fig. 6.



Fig. 7.

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As can be seen by the drawing, the design called for dredging with a dipper dredge down to -55 feet (an unusual depth in 1913) and consolidating the soft clay below that elevation by a pile of dumped blasted rook from -55 feet to -22 feet making a trapezoidal section 33 feet thick, 125 feet wide at -55 feet and about 40 feet wide at -23 feet. It was assumed that by the time the dumped rock had been built up from -55 feet to -22 feet, the soft clay would be stiffened or compacted sufficiently below to hold the stone-filled wooden crib. Moreover, it was assumed the mass of rock 33 feet thick and 125 feet wide, topped with a 36 foot wooden crib filled with rock and capped with six feet of concrete would act as a unit against the ore load which started about 40 feet back of the dock face. This was actually what occurred.

The design was considered ingenious as no anchorage was used, and for the first time the shear factor of soft clay was considered in heavy construction. This, we think, was soil mechanics in its earliest stage. The structures described in this paper are still in use after 40 years.