

DESIGN, ENGINEERING AND CONSTRUCTION OF A WAVE WALL FOR NORTHWESTERN UNIVERSITY

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INTRODUCTION

Northwestern University sits on prime Lake Michigan real estate in Evanston, Illinois, north of Chicago. Needing to make the most of their landlocked urban campus, the university planned to build a new athletics center on coastal land extending onto a sandy beach. Because the design process occurred after a number of years of low water, architects designed the state-of-the-art building extremely close to the lake's ordinary high water mark without understanding the historic dynamics of the lake. With the architectural design already completed, SmithGroupJJR's coastal engineers were asked to perform a rigorous review of the site and potential wave conditions. They determined that the building would be subject to large wave forces and foundation erosion if left unprotected, and designed a reflecting wave wall integrated into and wrapped around the lakeside of the building.

DESIGN AND ENGINEERING

A full site analysis was performed to determine the lake conditions at various water levels using offshore and nearshore numerical models. Wave climate, longshore currents, and cross-shore stability were modeled to gain an understanding of the dynamic nature of the beach, recognizing that sand is a highly erodible subsurface. Based on the information collected, the engineers looked at beach run-up and residual forces against the walls of the planned building and determined the structure could not withstand these forces without protection. A wave wall was planned along the edge of the property boundary, helping to maximize the footprint of the already-designed athletic center. Based on a review of previous designs and studies, a 90-degree return was incorporated into the wall's design to limit water overtopping as well as aerated spray against the building. In addition, the wall's return arc redirects wave energy back toward the lake and safely protects the building behind it.

PHYSICAL MODEL TESTING

Scaled physical model tests were performed in Texas A&M's Haynes Coastal Engineering Laboratory. Three channels were constructed in a parallel series to mimic a wave flume layout so that multiple designs could be tested concurrently. This allowed the engineering team to expedite testing and evaluate a myriad of layouts, elevations, and return angles. Using the test case of a 100-yr. storm wave event coupled with historic high water levels as the worst-case scenario, the engineers were able to optimize the wall's dimensions and ensure that overtopping and wave forces remained within limitations.

CONSTRUCTION

To complement the aesthetics of the building, the engineers designed a curvilinear wall that blends into its surroundings while expressing itself as an architectural feature. Each wall section was individually precast to create a smooth, curving design that mimics the shape of a crashing wave.

Shortly following the installation of the wave wall in spring of 2017, it was immediately put to the test with higher summer water levels and average storm events. The waves crashing against the wall validated its need and performance. The university is extremely pleased with the look and functionality of this innovative design, and the protection it provides for its new multimillion-dollar lakeshore athletics center.



Figure 1 - Precast Individual Wall Sections

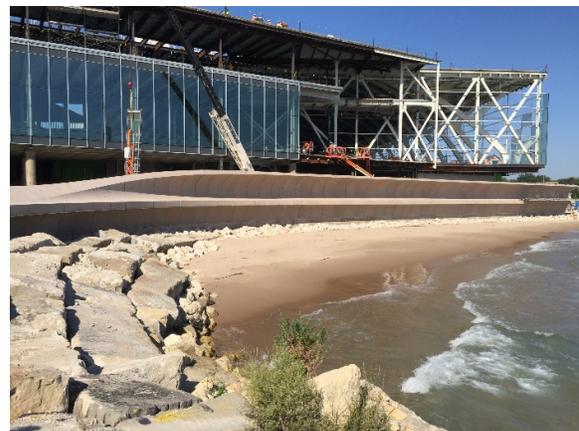


Figure 2 - Installed Wave Wall