BLUFF STABILIZATION AND PROTECTION ON THE GREAT LAKES; A CASE STUDY

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OVERVIEW

The focus of this project was to design a shoreline remediation system that would stabilize and protect an eroding bluff on Lake Ontario. The significance of this project is the innovative techniques utilized to stabilize a 100-foot-high, almost 45º angle bluff from the erosive forces caused by waves, wind, groundwater, and rain. Geosynthetics, blown on compost material, and the installation of an irrigation system were all tools that were utilized for bluff stabilization, while an armor stone revetment was used to protect the toe of the bluff. This project may be used as an example for other shorelines experiencing similar bluff failure and erosional issues.

BACKGROUND AND OBJECTIVES

The Lake Bluff site consists of a drumlin located along the southern shore of Lake Ontario just east of Sodus Bay and west of the Chimney Bluffs State Park in New York State. The area served as a camping ground in the late 1800s and is currently the location of dozens of summer cottages. The shoreline's geomorphic progression is nearing early maturity, and as such, the topographic projection of the Lake Bluff drumlin has been decreasing in surface area by more than 60% over the last 100 years (more than 300 feet of shoreline). As the Lake Bluff size has decreased due to the erosive forces of the lake and weather, the cottage owners have been forced to continuously move their cottages back to the point where they are now limited by the lack of real estate. This has caused the property owners to take action to stabilize, and minimize the erosion of, the bluff.

APPROACH AND ACTIVITIES

The goals of the project were to control wave, surface water, and wind erosion, as well as the perched seasonal groundwater that contributed to the sloughing and destabilization. The system design included both onshore and offshore armor stone revetments, implementation of groundwater mitigation controls, and an upper bluff stabilization system along the 900-foot-long by 100-foot-high bluff. The revetment, constructed of a stone system, served as the first phase to stabilizing and protecting the bluff's toe. The revetment was designed to handle the lake's mean high water level with a 100-year wave run up. A typical section detail of the offshore revetment system is provided in Figure 1.

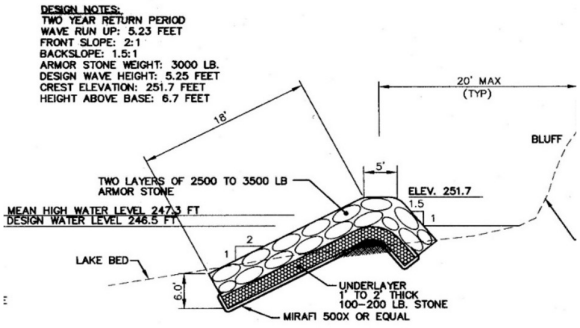

Figure 1 – Offshore Revetment Detail

More than 10,000 tons of armor stone were placed along the base of the bluff, with each stone weighing one to two tons. The crest height was designed to be about 4.5 feet above mean high water level of Lake Ontario. A photo of the installed armor stone is provided in Figure 2.

Figure 2 – Armor Stone Installed at the Toe of the Bluff

In addition to the revetment, the upper portion of the bluff was regraded and vegetated with a veneer cover system that was designed to resist erosion caused by wind and rain. The veneer cover system consisted of a seeded compost applied over a coconut fiber koir mat. Figure 3 illustrates the compost material being air applied over the koir mat.

Figure 3 – Installation of the Veneer Cover System

Localized slope failures occurred following the spring thaws in 2010, 2011, 2012, 2013, and 2014. These failures were primarily caused by groundwater seepage from a perched water table in the steep upper slope of the bluff. When saturated with water, the glacial till becomes a wet fluid mud with little or no structural integrity. Groundwater recharge mitigation was implemented to lessen the impacts. The mitigation efforts consisted of installing a French drain system along the top of the slope and diversion of roof drains and surface water flow away from the top of the slope. A photo of the localized failures can be seen on Figure 4.

Figure 4 – Localized sluffing caused by Perched Groundwater

Slope failure remediation was accomplished with additional riprap stone and fresh coverings of seeded compost. See figure 5 for an example of the slope repairs along the groundwater seepage line.

Figure 5 – Slope Repairs along the Groundwater seepage Line.

The main challenges on this project were perched water table control and site access for the equipment and materials.

RESULTS AND LESSONS LEARNED

The result of the constructed shoreline remediation system is that it has reduced the bluff recession rate from about 2 to 3 feet per year to less than 0.1 feet per year. The main lessons learned from this project are to control the ground water and/or springs that can destabilize the fine-grained bluff soils and account for extreme long term floods and water levels for wave run up elevations.

Figure 6 – (Counterclockwise from bottom left), Initial excavation, Coir mat installation, Final stabilized shoreline, Lake Ontario, New York