US Army Corps of Engineers®
Engineer Research and Development Center

National Erosion Control Development and Demonstration Program (Section 227)

Allegan County, MI, Bluff Study

Description

Slope failures in heterogeneous glacial soils are common within many sectors of North America affected by coastal erosion, groundwater processes, or river action. In the Great Lakes region, receding bluffs carved into glacial tills or lacustrine deposits occupy more than 60 percent of the shoreline. In coastal areas when mitigation strategies are chosen, much of the blame for slope movements is commonly placed on toe erosion although groundwater activity is sometimes a significant factor. Three sites along Lake Michigan where slope failures are frequent were selected for the demonstration project: the Miami Park South site (MPS), the Miami Park North site (MPN), and the 116th Avenue site (116th). These sites are roughly 152.4 m (500 ft) to 30.4 m (100 ft) in length and occur along the east coast of Lake Michigan, within 14.4 km (9 miles) of South Haven, MI. Western Michigan University (WMU) has monitored these sites continuously for slope movements since 1996 with a simple pole and cable survey system. To date, empirical and limit equilibrium models have demonstrated groundwater as a significant factor contributing to these observed failures. The objective of this demonstration project is to evaluate the effectiveness of dewatering strategies (active and passive) on slope stabilization through automated monitoring of the slopes.

Boreholes are drilled for installation of slope monitoring instruments using a 100-ft crane to support the drilling platform over a 50% slope

Issue

Bluff erosion along the shore of the Great Lakes creates significant property damage and land loss each year. Traditional means to combat erosion are expensive, non-aesthetically pleasing and deny access to the beach. There is a need to develop an innovative design for slowing or stopping bluff erosion, which is effective and less expensive than traditional methods.

Technology

Add active (groundwater pumps) or passive (gravity drains) dewatering systems to the bluffs for groundwater control. Dewater bluffs during winter and spring when erosion is typically occurring. Monitor bluff displacement continuously while dewatering, and while drains are dormant to measure effectiveness of the design. Monitoring is performed using state-of-the-practice electronic instruments; slope inclinometers, piezometers, thermistors and flow meters, such that movement of the slope can be correlated to ground temperature, groundwater level, groundwater removal, the presence or absence of frozen pore water,

and time. Each instrument is reading and recording every six hours. All monitoring is accomplished remotely and in real-time by the researchers, with data being transferred over the Web. Simultaneous control sites without dewatering measures in place, are being monitored for comparison to design performance. In addition, a numerical flow model is being developed to optimize dewatering effort/energy. The numerical model simulates saturated and unsaturated flow and will act as a design tool for other sites.

Supplemental instrumentation has been installed by ERDC Cold Regions Research Engineering Laboratory (CRREL) for the MPS site, consisting of five soil moisture probes at two sites (10 total), two soil resistivity probes, two thermistor strings with six thermistors per string, and two Web cams. The resistivity probes indicated liquid or frozen soil water and provide frozen soil depth with time. These supplemental instruments will assist in validation of the numerical flow model.

Status

Surface monitoring of slope movement by pole and cable survey system is ongoing. All drilling for subsurface monitoring instrumentation has been completed. All instruments have been installed at the Miami Park south site.

Additional instrumentation has been purchased by ERDC Cold Regions Research Engineering Laboratory (CRREL) for the MPS site, consisting of five soil moisture probes at two sites (10 total), two soil resistivity probes, two thermistor strings with six thermistors per string, and two Web cams. These supplemental instruments will assist in validation of the numerical flow model. The Web cams will allow 24-hr visual monitoring of the site on the Web. These instruments were installed during June 2004. The Web site is *https://webcam.crrel.usace.army.mil/allegan/*

Work on a numerical flow model is just beginning. Initial versions of the model will be run using FEMWATER; current plans include building a final model using ADH. A pump test at MPS was conducted in May 2004 to derive hydraulic properties of the strata in support of the numerical model.

Time Line

First year FY02, demonstration planning; Second year FY03, drilling and equipment purchasing; Third year FY04, installation of instruments, begin monitoring; Fourth year, FY05, start dewatering system. Include macrodeformation to ADH numerical flow model. Prepare mid-project publications; Fifth year, FY06, stop dewatering, continue monitoring, begin writing Operations Manual, and continue numerical model development; Sixth year, FY07, start dewatering, continue monitoring and test model dewatering optimization plan; Seventh year, FY08, stop dewatering, continue monitoring. Analyze long-term results from dewatering and prepare publications; Eighth year, FY09, start dewatering and complete Operations Manual for continued operation of project by WMU.

Points of Contact

Eileen Glynn, CEERD-GS-E, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; phone, (601) 634-3612; e-mail, Eileen.Glynn@erdc.usace.army.mil

Stacy E. Howington, CEERD-HC-HG, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; phone, (601) 634-2939; e-mail , Stacy.E.Howington@erdc.usace.army.mil

James P. Selegean, CELRE-HH-E, 477 Michigan 6th Floor, Detroit, MI 48226; phone, (313) 226-6791; e-mail, James.P.Selegean@lre02.usace.army.mil

Program Authorization

Water Resources and Development Act of 1996 (Public Law 104-303, 110 Stat. 3658) dated October 12, 1996.

Additional information can be found at *http://chl.erdc.usace.army.mil/section227*.