Wednesday, 3/15/2017

9:45–11:15 a.m.

Slope Stability and Stabilization 5

Chairs: Binod Tiwari, California State University, Fullerton; Beena Ajmera, California State University, Fullerton

Numerical Simulation of Pier Scouring Applying Eulerian Multi-phase Model

Aneseh Alborzi and Abdolreza Osouli, SIUE

Soil scouring occurs frequently due to water flowing around bridges piers and abutments. This investigation aims to simulate pier scouring process applying numerical approach. The CFD software package FLUENT is applied to model pier scouring. The Eulerian multi-phase model in FLUENT is used to simulate soil-water interaction. The numerical modeling results are compared with measured scours at the sites and common scour prediction methods including SRICOS, old and modified Hydraulic Engineering Circular No. 18 (HEC – 18). Measured scour depths occurred at two bridge sites are also available to provide a comparison. Numerical scour predictions are in a reasonable agreement with old HEC -18 method which is compatible for non-cohesive soil. The effects of various pier width and nose shape on scour were also investigated.

A Prediction Model for Overtopped Levee-Floodwall Erosion Rate Based on Plasticity Index and Compaction Level

Seyed Sina Nassiri, Parham Safarian, David Molohon, and Abdolreza Osouli, SIUE; Julian Chastain, Southern Illinois University

Prediction of levee erosion rate during floodwall overtopping for materials with various plasticity indices is critical. Levee soil properties, and intensity or duration of flood are the contributing factors in erosion rate and scour depth predictions. In this study, over 15 laboratory scaled levee-floodwalls constructed of soils with plasticity indices of 0%, 6%, 9%, 30%, and 40% were overtopped. The floodwall scale of 1:20 is utilized assuming that a typical full-sized floodwall is 2.1m high. The erosion rates at the levee crest are measured and used to propose an erosion rate prediction model which considers the plasticity index (PI) and compaction level (CL) of soils.

Probabilistic Slope Stability Analyses–A Case Study

Rabindra Chaulagai and Abdolreza Osouli, SIUE; Jose Clemente, Bechtel

In this paper, the stability of a 40 m high cut slope was analyzed using both deterministic and probabilistic approach. According to the subsurface investigation, sand and clay layers existed at the site, however, the thickness of the layers varied across 1.2 km of the slope. The most critical thickness and order of layers were identified to develop representative cross section. The groundwater effect along with variations in soil shear strength properties were considered in the analysis. The results of in-situ tests and laboratory tests were used to extract soil properties. Consequently, from deterministic analysis, the safety factor at different ground water conditions in the representative cross section was adequate. However, the probability of failure was high and drainage trenches along each of the slope benches were installed to bring the ground water level down permanently. The probabilistic analysis provides an insight to slope design and ground water level adjustments to mitigate the associated risk when there are uncertainties in subsurface investigation.

Use of Recycled Drill Pipe for Soldier Pile and Anchored Walls for Roadway Embankment Reconstruction

Chris Sneddon and Steven Manuel, Santa Barbara County Public Works

Recycled materials are often selected for transportation construction for their environmental or sustainability benefits. But they can also be used to create projects that are low cost, simple, and efficient to build. This paper describes development of standard details for creating retaining walls from recycled high-strength drilling pipe and used metal beam guard rail. Construction of these walls is inexpensive and efficient because they use only readily available material, require no specialized equipment or labor, and can often be done without requiring road closures. During el-Niño fueled rainy seasons Santa Barbara County is often inundated with drenching rainstorms that cause landslides, debris flows, and embankment failures. These failures close miles of roads and isolate people from lifeline services. The County needed a way to quickly and safely stabilize and reopen roads with a supply of contractors, equipment, and materials that are limited during large storm events. Out of these emergency response efforts Santa Barbara developed standard details for several slope stability repair options using low-cost, readily available equipment, material and labor. An emphasis was placed on designs that would get roads open quickly. Using recycled high-strength drill pipe for piles and used metal beam guard rail elements for lagging, the county created standard design details for soldier pile walls up to 4 feet tall, and anchored walls up to 8 feet tall. These walls can be built in days, not weeks or months. And they only require these materials and a few other readily-available components. As a result, roads can be opened and back in service within days of an embankment failure, restoring access for emergency services and residents.

Application of Terrestrial Lidar and Photogrammetry to As-built Verification and Displacement Monitoring of a Segmental Retaining Wall

Michael P. McGuire, Lafayette College; Michael B.S. Yust, University of Texas at Austin; Bart Shippee, Shippee Engineering Inc.

Terrestrial lidar and photogrammetry have significant potential for as-built verification and displacement monitoring of earth retaining structures. This paper focuses on application of a method for measuring the position of the wall facing to a tall Segmental Retaining Wall (SRW) constructed in Conshohocken, Pennsylvania. The 3D point cloud data obtained using lidar or photogrammetry is processed by software developed in the Python programming language to produce vertical profiles of the wall alignment at user-specified locations. Profiles developed using point cloud data obtained at a single time are compared to the specified alignment and to measurements of alignment performed using a plumb line and total station. Profiles developed using point cloud data obtained at different times are compared to observe the displacement of the facing. Settlement of the wall is measured by comparing the position of horizontal block joints at different times.

Total Failure Probability of a Slope at a Given Site in a Seismic Prone Zone in a Specified Exposure Time

Wenping Gong, C. Hsein Juang, James R. Martin II, Wenxin Liu, and Sara Khoshnevisan, Clemson University

This paper presents a study on the probabilistic seismic hazard analysis of a slope at a given site in a specified exposure time. This study is part of the long-term performance assessment of a slope. For the

long-term performance assessment, the factors that may lead to failure of the slope over time, such as the seismic ground motion, spatial variability of soil strength, and fluctuation of groundwater level, should be considered. Here, the earthquake-induced ground motion at a given site in a specified exposure time is simulated by a random variable based on the USGS National Seismic Hazard Maps, the spatial variability of the shear strength of the soil is modelled by a random field, and the fluctuation of the groundwater level is modelled by a random variable. To estimate the total failure probability of the slope at a given site in a given exposure time, a recently developed sampling technique is adopted for the propagation of uncertainties, and a 2D finite difference program is used as the deterministic model for the slope stability analysis. To demonstrate the proposed approach, an illustrative example of a two-layer earth slope is studied; and, a parametric study is undertaken to investigate how the long-term performance of the slope is affected by the influencing factors. With the results presented, the versatility and effectiveness of the proposed probabilistic framework are illustrated.