Tuesday 3/14/2017

3–4:30 p.m.

Slope Stability and Stabilization 3

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

Slope Liquefaction Failure of a Riprap Slope During Springtime in a Northern Climate

Amaneh E. Kenarsari and Stanley J. Vitton, Michigan Technological University

A common problem in northern climates during the spring is slope failures occurring on slopes constructed the previous year. The main cause of the failure is a lack of vegetation coupled with ground freezing that prevents water drainage. Typical remediation of failed slopes is to reconstruct the slope back to its original configuration and place rip-rap over the failed section of the slope; a remediation technique that has been found to work well. This case study discusses the construction of a slope adjacent a state highway that utilized a geotextile separator and rip-rap in the construction of the slope. The following spring, however, the slope dramatically failed resulting in a large amount of soil flowing onto the state highway and a sinkhole forming on the back side of the slope. The primary cause of failure was found to be clogging of the geotextile thus allowing snowmelt and rain to generate pore water pressures behind the geotextile in excess of the rip-rap's ability to prevent failure.

Emergency Stabilization of the White Point Landslide

Travis Deane, Jason M. Buenker, and Daniel Pradel, Shannon & Wilson Inc.

The White Point Landslide destroyed a portion of a coastal roadway and threatened nearby residences in the Palos Verdes Peninsula of Southern California. The presence of a weak bentonite layer facilitated rapid mobilization of the landslide, which moved about 20 m (60 feet) towards the ocean in about 20 minutes. This article describes the design and implementation of an emergency program intended to stabilize the coastal bluff east of the landslide area and stop slope instability from propagating towards nearby residences. The stabilization program consisted of dewatering drains installed using horizontal directional drilling (HDD) combined with steeply inclined high capacity tieback anchors. This article also describes the conventional slope stability analyses and numerical modeling which were performed to better understand the mode of failure, nature of the failure, and impact of the proposed stabilization.

Ground Deformation at Lokanthali, Kathmandu due to Mw 7.8 2015 Gorkha Earthquake

Binod Tiwari, California State University, Fullerton; Daniel Pradel, Shannon & Wilson Inc.

The Mw 7.8 2015 Gorkha Earthquake left close to 9,000 people dead, 22,000 people injured and a loss of properties over $5B. One among the major disasters triggered by this earthquake was landslides. Moreover, many buildings, including several of modern construction, collapsed in Kathmandu due to the earthquake shaking. One of the widely covered damages was the ground failure at Lokanthali, along Araniko Highway in Kathmandu. This failure affected a 250 m long stretch of the highway with vertical movements of more than a meter and lateral displacements on the order of 0.5 m, and also seriously damaged dozens of buildings. To identify the causes of ground failure, the authors performed a site investigation including subsoil exploration with field Vane Shear Testing and Swedish Weight Sounding equipment, as well as topographical mapping. Additionally, numerical analyses were also performed to understand the seismic vulnerability of the site. Our study revealed that Lokanthali was affected by seismically induced landslide movement although the site has gentle slopes and the Gorkha earthquake produced relatively moderate ground accelerations at this location.

Optimizing Deflectors for Channelized Dry Granular Flows

George R. Goodwin, Clarence E. Choi, Charles W. W. Ng, and William W. Cheung, Hong Kong University of Science and Technology

One of the critical design scenarios for debris-resisting structures against geophysical flows is being able to predict the overflow velocity if the retention volume is compromised. Complex barrier geometries, especially vertical barriers equipped with deflectors on an inclined slope, can alter the overflow velocity. However, there are no scientific guidelines on how to select an ideal deflector geometry to minimize the overflow velocity. Flume tests were carried out to study the interaction between dry granular flow and rigid barrier deflectors of varying angles. The physical tests were then used to calibrate a Discrete Element Model (DEM). The DEM was then used to carry out a parametric study considering the influence of channel inclination and deflector orientation on overflow velocity. In this paper, the flume and discrete element modelling techniques are described and preliminary results are discussed.

Fragility Curves of Earthen Levees under Extreme Precipitations

Firas Jasim and Farshid Vahedifard, Mississippi State University

The current study presents a framework for assessment of levees' probability of failure under various water level and rain intensity conditions. Fragility functions are developed to demonstrate the probability of levees' failure under various stress conditions. Intensity-Duration-Frequency (IDF) curves of extreme precipitations are used in numerical simulation of an earthen levee in Sacramento, CA to develop fragility curves that consider a range of performance indicators. In order to examine the factors influencing the levee performance, a fully coupled 2D stress- variably saturated flow finite element model was built to simulate the levee behavior under combined effects of water level fluctuation and extreme precipitation. The results are then used to simulate the probability response of the collapse by creating fragility curves. The performance of the levee is expressed under extreme precipitations in terms of probability of failure against a prescribed rain intensity-duration for different return periods and water levels.

Probabilistic Slope Stability Analyses: Effects of Coefficient of Variation and Cross-Correlation of Shear Strength Parameters

Emir A. Oguz, Yagizer Yalcin, and Nejan Huvaj, METU

The assessment of the safety level of natural slopes, road cuts, embankments and levees require consideration of uncertainties and variability in material properties. In this study, for a number of slope geometries, including a real-life landslide case, probability of failure (PF) and the most critical failure surface are investigated with and without cross-correlation of shear strength properties. Slopes having different traditionally-defined factor of safety (FS) levels are studied. The uncertainty of soil properties are considered by different levels of coefficient of variation (COV). Limit equilibrium method is used for slope stability analyses and geotechnical material properties are considered to have normal statistical distribution. The results of this analyses show that the PF and the critical failure surface is significantly influenced by the COV level, the consideration of cross correlation of shear strength parameters, and by the traditional FS level of the slopes. The inverse relation between FS and PF is demonstrated to be nonlinear and the COV level has significant effect on this relationship. Results indicate that the deterministic slope stability analyses resulting in a single FS value is no longer sufficient to evaluate the safety of a slope in geotechnical engineering, and that the deterministic critical failure surface with minimum FS value is not always the most critical slip surface. The results presented in this study could be useful for further understanding of probabilistic slope stability and the effects of soil variability/uncertainty, with the aim of better geotechnical risk evaluation and communication.