Wednesday, 3/15/2017

1:30–3 p.m.

Column Supported Embankments

Chairs: Victor Kaliakin, University of Delaware; Majid Khabbazian, Earth Engineering Inc.

Polymeric Shell-confined Aggregate Pier Ground Improvement Method to Support Bridge Embankments Over Soft Clay Soil

Tony Sangiuliano, Ontario Ministry of Transportation; Jason Brown, GeoSolv Design/Build Inc.; Brian Metcalfe and Kord J. Wissmann, Geopier Foundation Co. Inc.

Densified Aggregate Piers have been widely used for ground improvement since the mid 1990's. The piers are typically constructed by backfilling cylindrical cavities with densified stone using a vertical ramming apparatus. The strength and compressibility of densified aggregate piers systems are confining stress dependent and tend to have low capacities in highly compressible soil because of their tendency to bulge into weak soil. This paper describes the design and construction of a densified aggregate pier system with polymeric shells for confinement in soft soil for a highway embankment in Seeley's Bay, Ontario, Canada. The method allows for the insertion of High Density Polyethylene (HDPE) sleeves into the ground through the soft materials using a specially adapted mandrel. This paper is of particular significance because it presents significant insight into an effective ground improvement method in weak and sensitive soil subject to shear strength degradation by traditional aggregate pier methods.

A Geogrid-reinforced Timber Piled Embankment over Kettle-fill Deposits near Chicago, Illinois

Mickey L. Snider and Liviu M Iordache, Wang Engineering Inc.

A new grade separation for the Elgin O'Hare Expressway required a widening and grade increase for a 185-meter long embankment section carrying Illinois Route 53 across a series of peat bogs. The subsurface investigation showed a wetland developed over a kettle basin subsided into glacial diamicton and subsequently filled with lacustrine clay, silt and organic soils. The organic soil sequence included fibrous peat sandwiched between upper and lower layers of soft, organic-rich clay and silt. As an alternative to the costly dry-land bridge concept an alternative was proposed to place the new embankment over a 900 mm thick aggregate platform reinforced with two layers of biaxial geogrid and supported on 9- to 12-meter long timber piles. The timbers were driven 7-foot on-square center into competent glacial diamicton. The system was designed for 300 mm settlement at the top of pavement. Local excavation of the existing fill was required to achieve the critical height. High groundwater and soft ground resulted in challenging but manageable working platform conditions. Pile-driving analyzer tests confirmed capacity of timber piles and established site-specific driving criteria.

I-295 / I-76 / Route 42 Direct Connect–CSES Design Considerations and Measured Results

Kyle Shatzer, Frederic Masse, and Brandon Buschmeier, Menard USA; Mary Nodine, GEI Consultants

The I-295/I-76/Route 42 Direct Connection is a multi-phase, 9 year, $900+ million highway improvement project in Camden County, NJ. The New Jersey Department of Transportation (NJDOT) specified a design-build column supported embankment system (CSES) to control settlement and accelerate construction of several mechanically stabilized earth (MSE) wall embankments. This paper discusses methods for designing controlled modulus column rigid inclusion support across varied soil conditions and MSE wall embankment configurations. Additionally, results of initial CSES settlement predictions are

compared with measured values from the geotechnical monitoring program across Contract 1 CSES work areas.

Numerical Analysis of Rigid Inclusion Behavior under Lateral Loads
Alfonso Rivera, Guney Olgun, and Thomas Brandon, Virginia Tech; Frederic Masse, Menard USA
A numerical study using the finite element method was performed with the purpose of examining the lateral load response of rigid inclusion-supported footings. The lateral load behavior of rigid inclusion-supported footings is currently poorly understood. Uncertainty exists in regards to the performance of these systems under lateral loading. The results of the numerical study confirm earlier findings that show that the load transfer platform, a bridging granular mattress and one of the main components of a rigid inclusion-supported footing system, plays an important role in determining the capacity and response of such systems to lateral loading.

Numerical Modeling of Columnar-Reinforced Ground Behavior during Dynamic Centrifuge Testing
Soheil Kamalzare, Guney Olgun, and Mohammad Khosravi, Virginia Tech
Predicting the response of soil profiles during earthquakes is one of the major challenges in geotechnical earthquake engineering. The presence of reinforcing elements such as stiff columns adds further complexity to the problem due to the interaction of these stiff elements with the surrounding ground. This research presents the results of advanced numerical simulations of dynamic centrifuge tests performed on a columnar reinforced model with a loose sandy profile. The model was subjected to earthquake base motions of varying intensities to investigate the reinforcing mechanisms of soil-cement columns. Numerical simulations were performed using the finite element computational platform OpenSees with pressure dependent multi yield (PDMY02) constitutive model. Simulated and measured values were compared for seismic intensity, excess pore water pressure and ground settlement at different locations within soil profile. The calibrated numerical model was able to realistically predict the response of reinforced ground.

How Geosynthetic Reinforcement Supports the Piled Embankment: A Numerical Approach
Taehee Lee and Young-Hoon Jung, Kyung Hee University; Su-Hyung Lee and Il-Wha Lee, Korea Railroad Research Institute
The modern approach to the piled embankment includes the basal reinforcement of geosynthetic layers. Current design guidelines for piled embankment in the Netherlands, Germany, and UK have been updated to accurately estimate the practical tensile strains of employed geosynthetics, whereas the analytical approaches were usually underestimated against the experiment and in-situ results. In this study, a series of finite element simulations concerning different types of soil-geosynthetics interaction were conducted to reveal the difference of frictional modeling method. The geosynthetic strains along the diagonal and orthogonal direction from the pile center toward to the other pile were obtained according to the loading condition. The completely different responses were observed with respect to the type of the frictional model.