Tuesday 3/14/2017

9:45–11:15 a.m.

MSE Retaining Walls 2

Chairs: Christopher Meehan, University of Delaware; Mike Adams, Federal Highway Administration

Time-dependent Load Redistribution in Geosynthetic Reinforced Soil Walls Considering Strain Softening of Backfill Soils

Huabei Liu, Huazhong University of Science and Technology

Considering that the backfill soils of most geosynthetic-reinforced soil structures (GRS) are well-compacted granular soils exhibiting evident strain softening, it is expected that the strain softening behavior beyond the peak strength will affect the long-term response of GRS structures if the structures are subjected to large in-service load. Since granular soils generally exhibits small time-dependent behavior, it has been demonstrated by many that under small service loading, geosynthetic reinforcements generally experience load relaxation, and the service loading is redistributed to the backfill soil. However, if the service load is large, and strain softening is mobilized in some part of the backfill soil, the situation could be different. In this study, a calibrated Finite Element procedure for the long-term behavior of GRS structures was employed to analyze the long-term response of wrapped-face GRS walls. It was shown that in contrast to load redistribution to the backfill soil, after strain softening, the reinforcement load increased with time in the high wall with large reinforcement spacing. This issue should raise attention in the limit state design of GRS structures. Adequate margin of soil strength should be preserved in order to maintain the long-term safety of GRS structures.

Column Supported Embankment and MSE Walls in Grapevine, Texas

Hosam Salman, Ravi Vedantham, and John Jenkins, WSP–Parsons Brinckerhoff

Due to the presence of soft soils and high ground water levels underneath a proposed Mechanically Stabilized Earth (MSE) wall to be constructed adjacent to Denton Creek in Grapevine, Texas, the minimum required global stability factors of safety could not be achieved. In order to make the overall MSE wall system work, ground improvements under the MSE walls were essential. Various alternatives were evaluated to come up with the most effective alternative to mitigate the site conditions and meet the project requirements. The selected ground improvement system consisted of a combination of aggregate base rock layer with geogrid reinforcement and multiple rows of cast-in-place pile (drilled shaft) foundations under the wall. The MSE wall survived the severe flood event the DFW area experienced in spring and summer of 2015 that overflowed Denton Creek. This paper summarizes the overall design approach, analysis and techniques used for the pile supported MSE wall with ground improvements.

Thermal Interaction of a Geosynthetic Reinforced Soil Integrated Bridge System in St. Lawrence County, N.Y.

Michael T. Adams and Jennifer E. Nicks, Federal Highway Administration; Thomas Stabile, Engineering & Software Consultant Inc.; Andrew E. Willard, St. Lawrence County Department of Highways

The Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS) can be used to support a variety of superstructures for single span bridges. The technology appears to demonstrate compatibility between the substructure and the superstructure, requiring no special design details to maintain serviceability of the approach due to lateral movement induced by thermal expansion and contraction of the bridge.

This paper presents the behavior of the lateral abutment face movement in combination with the corresponding back wall pressures at the interface between the bridge and the approach of a GRS-IBS built along CR47 in St. Lawrence County, NY in 2013. The 32 m long, single span GRS-IBS, with a 3.7% superelevation and 30 degree skew, was instrumented to monitor the thermally induced movement of the abutment wall face in combination with lateral backwall pressures to evaluate the response of this particular superstructure geometry for the IBS. During the initial eight month monitoring period, the data shows both the GRS abutment and superstructure moved in unison with the seasonal change in temperature. In addition, the passive pressures induced from the thermal expansion of the superstructure are minor, and similar to those seen in an IBS with no skew.

Development of a Risk Assessment for MSE Wall Projects
Michael T. Adams, Federal Highway Administration; Jennifer E. Nicks, Federal Highway Administration
This paper presents a conceptual framework for prospective owners of mechanically stabilized earth (MSE) walls to assess and manage the risk of their project. The proposed framework is based on information about the causes of failure for MSE walls. The format of this assessment is centered on the principles of risk management necessary to meet the objectives of an owner or agency. The intent of the assessment is to manage the effects of uncertainty and poor practice centered on the main factors associated with MSE wall failures: soil type, design, communication, water, and construction. The assessment first establishes a relative consequence, or impact of failure, valued against the project requirements, cost, and significance, followed by determining the likelihood of an event based on the level of practice leading to uncertainty that could cause poor serviceability or failure. The assessment attempts to guide the owner towards best practices while also providing them with fundamental information to identify, analyze, and prioritize risk necessary to make informed decisions on the course of a wall project with respect to economics (cost), requirements, and performance.

16-year Performance Update: Geosynthetic Reinforced Soil Walls as Integral Bridge Abutment Walls
Michael R. Simac, Earth Improvement Technologies; David J. Elton, Auburn University
The first use of geosynthetic reinforced soil walls for integral bridge abutment construction in North America occurred on the Greenville Southern Connector (I-185) toll road in 1999. A second bridge with a longer span and higher loads was constructed in 2000 for the same project. Each of these four bridge abutment walls were constructed over 20 ft. (6 m) high using modular concrete block wall (MCBW) facing units and geosynthetic reinforcement with a silty fine to medium sand backfill around vertically driven steel H-pile foundation elements. While the piles were designed to carry all the vertical live and dead bridge loads, the lateral loads due to momentum, braking, and thermal movement would be transferred through the integrally cast-in-place concrete abutment to the piles laterally loading the wall facing elements, located just 3 ft. (1 m) behind the MCBW facing being restrained by the geosynthetic reinforcement within the abutment wall. This paper is a 16-year update on the service life performance of these MSE integral abutment walls based on visual observations and deformed shape measurement of the wall facing blocks. Results of survey monitoring of the wall facing deformations are presented and discussed. The wall face performance indirectly evaluates the distribution of stresses into the wall system structural components. This evaluation is done within the context of the prevailing 1998 FHWA (ASD) engineering analysis and design procedures for MSE walls utilized in 1999, including distribution of the pile induced lateral loads. A brief description of the geosynthetic installation details around the piles is presented to understand the applied analytical methods.

Effect of Reinforcement Spacing on the Behavior of Geosynthetic-reinforced Soil

Amr M. Morsy and Jorge G. Zornberg, University of Texas at Austin; Dov Leshchinsky, ADAMA Engineering Inc.

While significant emphasis has been placed in the technical literature on the interaction between soil backfill and geosynthetic reinforcement, companion phenomena that may develop in a reinforced soil mass due to reinforcement vertical spacing may have been overlooked. This paper integrates the results of experimental and field evaluations aimed at identifying such phenomena. Both evaluations were in turn complemented with numerical simulations. The experimental program, conducted on geosynthetic-reinforced soil (GRS) cells, indicated that the soil confined between subsequent reinforcement layers acts as a monolithic block. The field evaluation, which included assessment of the behavior of two GRS walls, showed responses consistent with those in the experimental component. Numerical simulation of these walls indicated that the effect of closely-spaced reinforcement increases with increasing backfill shear strength. Overall, the effect of reinforcement vertical spacing may have a relevant impact on the behavior of GRS that is often not accounted for in design.