Wednesday, 3/15/2017

8–9:30 a.m.

Behavior of Compacted Clays

Chairs: Daniel VandenBerge, Tennessee Technological University; Corrie Walton-Macaulay, Bucknell University

Practical Considerations for Measuring the Shear Strength of Compacted Clay

Daniel VandenBerge, Tennessee Tech; James M. Duncan and Thomas L. Brandon, Virginia Tech

Over the past 60 years, numerous studies have been conducted on the shear strength behavior of compacted clays. Most important for practical purposes are the influence of moisture content during compaction, and strategies for developing laboratory testing programs to evaluate shear strength for design. This paper provides a summary of the state of knowledge regarding the strength of compacted clays to aid in selection of design parameters and the development of compaction specifications. The compaction process and the structure of compacted clays are reviewed as they affect shear strength and volume change behavior. The influence of compaction conditions on shear strength and volume change are illustrated using the results of triaxial tests and consolidation tests on compacted Oak Harbor clay, a lean clay of medium plasticity from Oak Harbor, Ohio.

Post-construction Deformation of Compacted Fills Caused by Wetting

Timothy D. Stark and Stephen Wilk, University of Illinois at Urbana–Champaign

This paper presents a modified constitutive model to predict post-construction movements of compacted fills due to wetting based on the results of Anisotropically-Consolidated Undrained (ACU) triaxial compression tests. The constitutive model is coded in the FISH language of the finite difference numerical software FLAC. The model allows deformation along the major and minor principal stress directions instead of the vertical and radial directions and user-defined wetting fronts to predict movement with time. The lateral and vertical progressive surface movement induced by top-down wetting is simulated and the results illustrate how the differential vertical and lateral movement at the ground surface can change during the course of top-down wetting.

Tensile Strength of Compacted Clay between Residual Saturation and Air-Entry

Idil Deniz Akin and William J. Likos, University of Wisconsin–Madison

Brazilian tensile strength (BTS) tests were conducted to measure evolution of tensile strength for compacted kaolinite disks at saturations (S) ranging from 0.02 to 0.73. Tensile strength and stiffness prior to failure followed non-monotonic trends marked by general increases as saturation increased from 0.02 to ~0.40, followed by general decreases as saturation further increased. Strain at failure increased monotonically with saturation. Evolution of the strength, strain, and stiffness response was interpreted to reflect corresponding evolution of interparticle stress components active in unsaturated soils, including capillary forces and double layer forces. Results provide experimental evidence for evolution of internal stress state in unsaturated soils over a wide range of saturation.

Shear Strength of Remolded and Compacted Beaumont Clay

Mark J. Thompson, CH2M; Daniel R. VandenBerge, Tennessee Technological University

A comprehensive investigation of the shear strength of Beaumont clay was undertaken to support the design of a new off-channel reservoir in Texas. Testing of intact, remolded, and compacted clay provided the basis for establishing soil shear strength parameters used in conducting slope stability analyses of the embankment dam. This paper focuses on characterization of the shear strength of remolded and compacted clay. Remolded clay was tested using direct shear, torsional ring shear, and consolidated-undrained triaxial methods. Compacted clay was tested using unconsolidated-undrained and consolidated-undrained triaxial methods. Specific topics of the paper include: (1) comparison of fully softened strength measurements from direct shear, torsional ring shear, and consolidated-undrained triaxial testing methods; (2) comparison of fully softened strength measurements with empirical correlations; (3) factors affecting the undrained strength of compacted clay from unconsolidated-undrained triaxial testing; and (4) summary of drained and undrained shear strength parameters of compacted clay for consolidated-undrained conditions. The laboratory testing addresses common misconceptions about the actual factors affecting shear strength characteristics of normally consolidated and compacted clay. Undrained strength of clay is primarily related to the void ratio during shearing (and degree of saturation for compacted clay), whereas drained strength parameters are not significantly affected by void ratio or compaction conditions.

The Use of Thermogravimetry in Quantifying the Hydration Products in Cement-Stabilized Kaolinite

Wassim Tabet, Geosyntec Consultants; Amy Cerato, University of Oklahoma; Rolf Jentoft, University of Massachusetts

The study presented in this paper was aimed at investigating the use of thermogravimetry (TG) to quantify the amounts of various hydration products, particularly calcium silicate hydrate (CSH) and calcium hydroxide (CH), in stabilized soils and establish correlations between them and strength gain over time. For that purpose, a pure kaolinite was chosen as the soil for this study and Portland cement was the selected stabilizer. Kaolinite samples and cement-stabilized samples were compacted at their optimum conditions and cured for different periods of time up to 90 days. The unconfined compression test, which is a relatively simple and commonly used test, was performed to measure the Unconfined Compressive Strength (UCS) for all the samples and record the macroscopic behavior. Then, a portion of soil from each set of samples was recovered and subsequently subjected to the TG test which was performed at a constant heating rate of 10 K/min until 1000 oC, while being connected to a Mass Spectrometer (MS) for simultaneous evolved gas analysis. The thermal decomposition was divided into four major regions i) desorption of adsorbed water below 105 oC, ii) dehydration of CSH phases between 105 and 440 oC, iii) dehydroxylation of kaolinite and CH between 440 and 580 oC, and iv) decarbonation of calcium carbonate at temperature between 580 and 1000 oC. The quantitative analysis revealed that strong linear correlations exist between the amounts of CSH and CH, and strength gain.