Florida Department of Transportation Research

Strength Envelopes for Florida Rock and Intermediate Geomaterials

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Current Situation

Florida's subsurface is unique in the sense that it is composed largely of geologically recent limestone, formed over the last 50-60 million years. In light of the formation process, the layering of limestone, sand, clay, and material weathered to various degrees can be complex. Near the surface (top 300 feet), layers of sand, clay, and limestone are common, with limestone and marl strata that occasionally classify as intermediate geomaterial "IGM" (unconfined compressive strength between 10 and 100 ksf). Currently, the relationship between shear strength and applied stress can be estimated through equations included in the AASHTO code (i.e., Hoek-Brown), and the competency of rock is assessed by engineering judgement or a combination of engineering judgement and RMR rating (AASHTO 10.6.3.2.1). Considering the differences between the type of materials that were used to develop the Hoek and Brown failure criterion and the RMR rating system, and local limestone and IGM , it became evident that the determination of a strength envelope for local materials was needed.

This bluff along the Apalachicola River shows the complex layers of typical Florida geology.

Research Objectives

University of Florida researchers were tasked with testing cores from locations across the state to characterize the material properties, develop a strength envelope, and provide bearing capacity equations for shallow foundation design.

Project Activities

State Materials Office (SMO) and consultants obtained rock cores at various sites across the state. The researchers and SMO personnel performed unconfined compression, splitting tension, and bulk dry unit weight on the collected samples. A percentage of the material was also tested for carbonate content and porosity. Ten Florida rock formations were identified, some of which would be categorized as IGMs. Correlations between rock strength and the various parameters examined were developed.

Triaxial testing was conducted to develop a relationship between shear strength and normal stress, and the results allowed the researchers to evaluate the ductility and brittleness of limestone samples. Florida limestones were found to be generally in the ductile range when subjected to confining stresses typical for shallow foundation loads. Finite element modeling (FEM) was used to analyze shallow foundations on both homogeneous rock and rock over sand. Each simulation was conducted for a full range of probable strength properties. These testing and FEM simulations resulted in the successful generation of strength envelopes and bearing capacity equations for various design conditions.

Project Benefits

The results of this project will allow geotechnical and structural designers to evaluate shallow foundations resting on IGM and limestone material for use as bridge support.

For more information, please see www.fdot.gov/research/.