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EVALUATION OF EMBANKMENT DISTRESS AT SANDER'S CREEK – SR20

PROBLEM STATEMENT

Florida has a number of large organic deposits (e.g., the Everglades, Big Cypress National Preserve, Coastal Glades) dispersed throughout the state with a number of highways passing over them (e.g., Turnpike (417), SR-20). In the past, many roadway embankments constructed over organic deposits involved placement of embankments, which increased overburden stresses (e.g., bridge approaches, interchanges). Maintenance records for a number of these embankments have indicated significant settlements over time (creep) in the underlying organic deposits and a concomitant need for asphalt overlays every few years, as is the case with SR-20. Recently, surcharging to stress levels twice the final embankment loads has been proposed as a method to limit the long-term settlement (i.e. creep). Unfortunately, little, if any, laboratory and field information exists for such a solution, nor are there any applicable design guidelines. The lack of such guidelines is a major issue where construction over large, deep, and highly organic deposits in Florida is concerned.

OBJECTIVES

The purpose of this project was fourfold: (1) obtain undisturbed field samples at various organic contents and test in 1-D oedometer devices at various stress states (normal consolidation and over-consolidation) to quantify creep rates; (2) measure field creep settlements under normally consolidated and over-consolidated (i.e., surcharging) conditions; (3) develop a combined consolidation and creep theory to predict dissipation of excess pore pressure, and secondary and tertiary creep; and (4) compare measured and predicted creep under normally consolidated and over-consolidated (i.e., surcharging) conditions. To accomplish these objectives, the following work was carried out:

- Approximately twenty samples of fine grained soil at various organic contents were collected throughout Florida and tested in 1-D oedometer devices at various stress levels and durations at the State Materials Office, Gainesville.
- The consolidation and creep settlement of a new roadway (Toll 417) underlain by thick deposits of organic soils and surcharged to twice the final vertical stress was field monitored.
- Asphalt cores at SR-20 were obtained and used to determine long-term (20 years) settlements of an existing embankment overlying organic deposits which were not surcharged.
- A combined consolidation-creep model (Gibson-Lo) was developed and used to predict consolidation and secondary and tertiary creep at the SR-20 and Toll 417 sites.
- Laboratory 1-D testing guidelines and tentative ranges of material parameters (i.e. creep compression ratio, $C_{\alpha\varepsilon}$).

FINDINGS AND CONCLUSIONS

Laboratory and field investigations examined the settlement characteristic of insitu soils under embankments with various levels of organic content (OC). Based on twenty-five laboratory oedometer tests, researchers found that normally consolidated Florida soils with OC>25% exhibited significant secondary and tertiary creep response. All of the laboratory secondary and tertiary creep was predicted through Ladd's creep compression ratio, $C_{\alpha\varepsilon}$, normalized with respect to organic content and vertical effective stress. The laboratory tests also revealed that soils with organic contents varying from 25% to 50% did not exhibit downward creep upon unloading if surcharged to at least twice the current vertical effective stress. Soils with organic contents over 50%, however, did exhibit downward creep upon unloading, but at a greatly reduced rate (30% to 50%).

Field monitoring of a normally consolidated organic deposit under an existing embankment located on SR-20 exhibited significant settlement, i.e., secondary and tertiary creep—18" over the course of thirty years of monitoring. This phenomenon was successfully predicted using laboratory consolidation and creep data.

In the case of field surcharging, the Turnpike's Toll Road 417 was monitored both short-term and long-term for settlement. Sensors showed the field settlement due to surcharging to be approximately 50% consolidation and 50% creep. Upon surcharge removal, the field exhibited heave with small amounts of downward creep (2 years after load removal). The site had deep deposits of organic soils with organic content varying from 25% to 75%.

A prediction program based on Gibson-Lo's Theory and using conventional laboratory data (Compression Index, permeability, Creep Compression Ratio, etc.) was developed. It was used successfully to predict both the SR-20 and Toll Road 417 responses, and it may be used to examine different design alternatives (surcharge levels, time, etc.).

BENEFITS

This study revealed that organic soil deposits would undergo significant long-term creep (secondary and tertiary) settlement when the overburden stresses are increased, contributing to nearly one-half of the overall settlement. In new construction, the use of surcharging will significantly reduce the long-term creep response (30% to 50%). For existing embankments over organic deposits, the removal and replacement of embankment soils with lightweight fills (increase over consolidation ratio), instead of the placement of overlays, will significantly reduce long-term settlement. The research suggests that the expensive removal and replacement of thick and deep organic deposits with granular fills may not be needed if surcharging is undertaken—and thereby result in significant cost savings. The study also resulted in guidelines for laboratory 1-D oedometer testing to verify expected field settlement and in design methodologies to optimize a surcharge program that will reduce maintenance problems (i.e. long-term settlements) while minimizing the negative effects to construction, especially in terms of added construction time.

This research project was conducted by Michael C. McVay, Ph.D., at the Department of Civil and Coastal Engineering, University of Florida. For more information, contact David Horhota, Ph.D., P.E., Project Manager, at (352) 955-2924, email: David.Horhota@dot.state.fl.us .