SURFACE PAVEMENT SOLUTIONS FOR POOR SUBGRADE CONDITIONS

BACKGROUND

The western and northern parts of FDOT Districts 4 and 6 in southeast Florida contain problematic organic silts and peats at relatively shallow depths under existing roads. These conditions cause recurring pavement distresses in the form of cracking, rutting, and long-term secondary settlement. Traditional repair methods such as complete reconstruction, surcharging, or removal of unsuitable materials, often become impractical due to the high costs and prolonged construction time associated with these strategies. Although certain geosynthetic products have been used successfully in recent years as base and subgrade reinforcements, the design of such pavements requires placement of the geosynthetics either at the embankment/base or the base/subgrade interface, which requires a major reconstruction effort in terms of both time and budget. Therefore, research was needed to identify rehabilitation strategies that could be applied to the surface or near-surface layers only and to develop design methodology based on some site-specific conditions so that the identified techniques could be used elsewhere if similar soil conditions are encountered.

OBJECTIVES

Specific objectives of this study including the following tasks:

1. Conduct a comprehensive literature search and a state-of-the-practice survey to identify promising techniques and products.
2. Conduct field Piezocone Penetration Tests (CPTu) to evaluate the strength and compressibility of Florida organic soils, and concurrent laboratory consolidation tests (including secondary compression) to validate/calibrate the field test results.
3. Correlate site-specific soil conditions (thickness, moisture, and organic content) with pertinent soil properties, mechanistic pavement response parameters, and probable pavement performance.
4. Design the lengths, cross sections, and locations of experimental pavements, incorporating selected products and techniques.
5. Develop methodologies and a conceptual framework for implementing the design techniques in future pavement projects where similar organic soils may be encountered.

The research team identified as a pilot test site a 6-mile stretch along the alignment of SR 15 / US 98 in northwest Palm Beach County experiencing severe pavement distresses due to thick organic layers. This section of roadway was selected both because of the site conditions and the fact that the section was scheduled for reconstruction to begin in 2007.

FINDINGS AND CONCLUSIONS

As a result of the literature search and survey, researchers identified three promising asphalt reinforcement products for use in the pilot field test sections: (i) PaveTrac MT-1 steel reinforcing mesh manufactured by Bekaert Corporation; (ii) GlasGrid 8501 manufactured by Saint-Gobain Technical Fabrics; and (iii) PetroGrid 4582 manufactured by Propex Fabrics.

Researchers performed piezocone penetration tests (CPTu) with porewater dissipation experiments at nine field locations for rapid on-site evaluation of the strength and compressibility characteristics of

Florida organic soils and peats. They concurrently conducted a laboratory consolidation test program to validate the field test results. The site-specific soil conditions (moisture content, organic content, thickness and unit weight of the organic layer) were expressed by an Organic Factor (F_{org}), which was correlated with pertinent soil properties, mechanistic pavement response parameters, and probable pavement performance.

The team developed a conceptual design framework that links laboratory/field investigations, site-specific parameters, mechanistic analysis, and transfer functions for the prediction of pavement life, so that an appropriate strategy can be adopted in future reconstruction projects.

Three experimental pavement sections, each 500-feet long and incorporating one of the candidate reinforcing products, were designed at two different locations with different Organic Factors (F_{org}) in order to develop direct correlations between F_{org} and pavement performance, and also to facilitate relative comparisons of the candidate solutions. The sections were repeated in both Northbound and Southbound lanes to incorporate directional variations (if any) in traffic weight and volume. Each location also included four control sections containing no reinforcements, and two sections containing Asphalt Rubber Membrane Interlayer (ARMI).

As part of the laboratory experimental program, the time-stress-compressibility relationships were investigated over a stress range ($\sigma_v{}'/\sigma_p{}'$) of 0.3 to 1.15, encompassing both the recompression and compression zones. The research showed that the (C_α / C_c) ratio at any stress level has constant values ranging from 0.03 to 0.05, which are consistent with the values reported in the literature for similar soils. The in-situ coefficient of consolidation (C_v), and the compression index (C_c) were predicted from the CPTu data, both of which showed reasonable correlation with the laboratory derived values. These findings are significant because they imply that the C_c values predicted from CPTu data may be used to estimate C_α (since C_α / C_c is constant) and, hence, the long-term secondary settlement, thus avoiding lengthy and expensive laboratory testing protocols.

BENEFITS

This research resulted in several tools that will improve the processes for assessing and mitigating poor subgrade conditions. Frist, this research shows that piezocone penetration tests can be used as an efficient tool for relatively rapid in-situ characterization of subsoil strength, modulus, and compressibility, all of which may be used for forensic interpretations of pavement failures, mechanistic analysis, and validation of pavement performance models. Second, the researchers developed a site-specific parameter [Organic Factor (F_{org})] that can serve as an indicator of probable pavement performance whenever organic soils are encountered. Third, the team developed a method to determine the constant C_α / C_c ratio for Florida organic soils, which will enable quick estimation of C_α (and hence the Secondary Compression) without having to undertake long-term, difficult, and expensive laboratory testing protocols.

In addition, the research identified three promising "surface" reinforcing products, which were incorporated into the design of field test sections. Researchers expect the reinforced sections to perform better and last longer than the unreinforced control segments. The lessons learned through this research will enable informed decision making for future rehabilitation projects.

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