Summary of Final Report, BD544-04
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STABILIZATION OF MARGINAL SOILS USING RECYCLED MATERIALS

PROBLEM STATEMENT

Marginal and weak soils, including soft clays, muck, organic deposits, and loose sand, are often unsuitable for construction due to their poor engineering properties. Site conditions can be enhanced through a number of in-situ ground improvement or replacement techniques, but these alternatives are sometimes costly. Recycled materials, such as plastics, construction debris and wood, are often processed, at the source, into products that can be adapted for a broad range of earth stabilization functions. Examples include recycled plastic lumber, shredded tires, and waste-to-energy ash, which can be used to improve soil conditions in-situ, stabilize weak or failing earth embankments, steepen existing slopes, or modify otherwise marginal soils for use as earth fill.

While extensive research has been conducted to investigate the use of recycled materials in engineering applications, the dissemination of the findings is often limited. The problem is compounded by the lack of a single resource containing relevant engineering and environmental characteristics of each material; the tendency of the researchers to publish their findings in technical reports rather than archived publications; and the wide discrepancies among local and state environmental regulations and acceptability. In addition, rapid implementation of recycled materials in highway construction is hindered by the lack of a rational procedure for selecting and approving the use of new recycled materials.

Among the problems encountered when a new material is proposed are (1) material availability in terms of quantity and price; (2) environmental impact of the proposed material; (3) consistent mixing and construction methods; (4) quality control in terms of spatial and temporal variability of the properties of the material; and (5) consistent design methods. Although this report does not constitute a standard, regulation, or specification, it provides a large body of valuable information and a rational procedure to be followed to assist FDOT personnel in selecting, approving, and implementing the use of recycled materials in roadway construction.

OBJECTIVES

The main objective of this project was to investigate the use of a broad range of recycled materials in geotechnical and transportation applications, and to classify these materials according to relevant factors such as availability, application, environmental impact, and cost. Specifically, the project was focused on the use of such recycled materials to improve the engineering properties of marginal soils, while maintaining conformance with regulations and practice in terms of the environmental, economical, and practical limitations of such use. Constraints associated with environmental regulations were also addressed.

FINDINGS AND CONCLUSIONS

A comprehensive literature review was conducted to gather available information, technical specifications, and parameter data for several recycled materials. The findings were summarized in a user-friendly relational database. Through feedback from FDOT personnel, and based on earlier nationwide research, a procedure was devised to categorize the types of marginal soils encountered and current solutions, and to classify them according to the appropriate stabilizing mechanism. A flow chart was developed to assist FDOT personnel in making recommendations regarding the implementation of any recycled material in the future. Factors of concern include availability, cost, earlier performance, environmental risks, and improvement in mechanical properties. A table provided in the final report summarizes the main characteristics of and concerns associated with each material.

Experiments were conducted on the stabilized soils that demonstrated potential for use in Florida or for which the data in the literature was inadequate. The data collected shows that the environmental properties of most recycled materials are within acceptable limits. However, researchers found that, in many instances, quality control issues prevent the use of a material. For instance, the environmental properties of certain batches may not be acceptable according to the current regulatory levels. In addition, the lack of adequate quantities of some of the materials creates a major obstacle to their continuous use over long periods of time, and thus raises a question of feasibility.

The wide range of engineering parameters, especially for unit weight, Limerock Bearing Ratio (LBR), internal friction angle, permeability, and compressive strength, emphasize the need to test materials at the local level, from a controlled source, and using specified sampling procedures. Once consistency can be assured at that level, the use of recycled materials for geotechnical applications will be more feasible. High up-front costs associated with quality control through testing should lead to lower costs in the future. The most viable option, to that end, is to place the burden of quality control primarily on suppliers, such as recycling firms and materials generators.

BENEFITS

This research has provided FDOT with state-of-the-art data that will facilitate the implementation of recycled materials in roadway construction. Substantial cost and time savings can be realized by following the proposed flow chart process, through which FDOT personnel can make decisions regarding approval and implementation of recycled materials in roadway construction. In addition, the database (as well as the tables and flow charts) can be used in the future to determine whether a particular recycled material warrants further study for use in roadway construction.

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