SCDOT

Research Summary

South Carolina Department of Transportation — Office of Materials and Research

Project Information

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Research Administration

Principal Investigator
Serji Amirkhanian
Director of Research for Construction Materials & Technology
Tri-County Technical College
7900 U.S. Hwy 76
Pendleton, SC 29670
Serji.amirkhanian@gmail.com
864-844-3145

Steering Committee Members:

Eric Carroll, Chairman
Luke Gibson
Kevin Harrington
Mike Lockman
Dahae Kim
Laura Kline
Jay Thompson
Carolyn Fisher, FHWA

Please contact us for additional Information:

Research Unit
803-737-1969 | HeapsMW@scdot.org

SCDOT Research Website:
http://www.scdot.scltap.org/

This final report is available online at:
http://www.scdot.scltap.org/projects/completed/

SPR 736, "Characterization of Bases and Subbases for AASHTO ME Pavement Design"

SYNOPSIS: The characteristics of base and subbase layers play a very important role in pavement performance under the complex conditions of traffic loading and environment. Unreasonable and inaccurate base design parameters can result in poor pavement performance as well as higher construction and maintenance costs. This study was conducted to develop material input databases for several common types of base and subbase layers in South Carolina including Graded Aggregate Base (GAB), Cement Stabilized Aggregate Base (CSAB), Cement Modified Recycled Base (CMRB), and Soil-Cement (S-C).

Problem

In recent years, many state DOTs, including SCDOT, have been investigating the utilization of AASHTO's Mechanistic-Empirical Pavement Design Guide (MEPDG) method of pavement design. For several years, SCDOT has been working on establishing a detailed and comprehensive library of MEPDG material input values. However, many of the input variables and values had not yet been determined. The main objective of this research project was to develop and determine some of these values for unbound pavement materials used in base and subbase course construction in South Carolina (SC).

Research

The MEPDG system adopted by AASHTO represents a fundamental change and increased sophistication compared to previous pavement design procedures. The MEPDG system using AASHTO's PavementME program is predicted to provide more cost-effective and better-performing pavement designs. However, since it would take an enormous amount of resources (e.g., time and money) to determine all required MEPDG material inputs exclusively through laboratory and field testing, there is a need for a secondary means to obtain those construction material property values. One method that many agencies use is correlation or predictive models based on data from routine or less expensive tests. This method was utilized in this project to establish PavementME material input values for many typical base and subbase materials used in SC. These input values for local SC base and subbase materials are a vital piece needed for SCDOT to successfully implement the MEPDG system of pavement design. This project involved the testing of multiple properties of local SC base and subbase materials, including compressive strength, resilient modulus, and elastic modulus, which can all help predict pavement durability and performance. In addition to laboratory testing, limited performance testing was also conducted using a test pit, which allowed testing in an environment more similar to actual field conditions in order to validate the laboratory testing methods (Figure 1). The types of SC base and subbase materials tested included graded aggregate base (GAB), cement stabilized aggregate base (CSAB), cement modified recycled base (CMRC), and soil-cement (S-C).

Figure 1: Photo of Test Pit Load Plate Assembly

Results

This project provided a comprehensive library of multiple types of material inputs for typical South Carolina base and subbase materials required for pavement design using the AASHTO PavementME program to help SCDOT design more cost-effective and durable pavements.

Both the compressive strength and resilient modulus of CMRB and S-C increased with increasing cement content and with increased curing duration regardless of recycled asphalt pavement (RAP) content and soil type (Figure 2). However, the effect of the cement content varied with curing duration. The compressive strength of CSAB also increased with increasing cement content; however, the rate of increase depended upon the aggregate (stone) source.

The compressive strength and resilient modulus values of sandy soil-based CMRB and S-C were higher than clayey soil-based samples, regardless of cement content, RAP content, and curing duration. Increasing cement content magnified this effect.

The measured elastic modulus values for all materials were relatively low, specifically when compared to the resilient modulus values; however, this could be due to the lack of an existing standardized procedure to measure elastic modulus of CSAB, CMRB, or S-C materials.

The test pit results indicated that the resilient modulus values measured using the AASHTO T-307 laboratory test method matched the "real-life" loading behavior of a 12" thick GAB layer. This appears to validate the AASHTO T-307 laboratory results for GAB materials. Since there is currently no standardized procedure to measure the elastic modulus of CSAB, CMRB, or S-C materials, the researchers recommended that SCDOT use resilient modulus value inputs for CSAB, CMRB, and S-C in pavement analysis and design, as indicated in the current version of the AASHTO PavementME program.

It is recommended that SCDOT conduct a study to investigate the combined effect of loading and moisture content on both destructive and non-destructive physical deformation. Also, SCDOT might consider developing a pavement performance deterioration database to contain vital parameters like resilient modulus at various important time points in a pavement's life, such as new construction, 1 year, 5 years, 10 years, and rehabilitation or reconstruction.

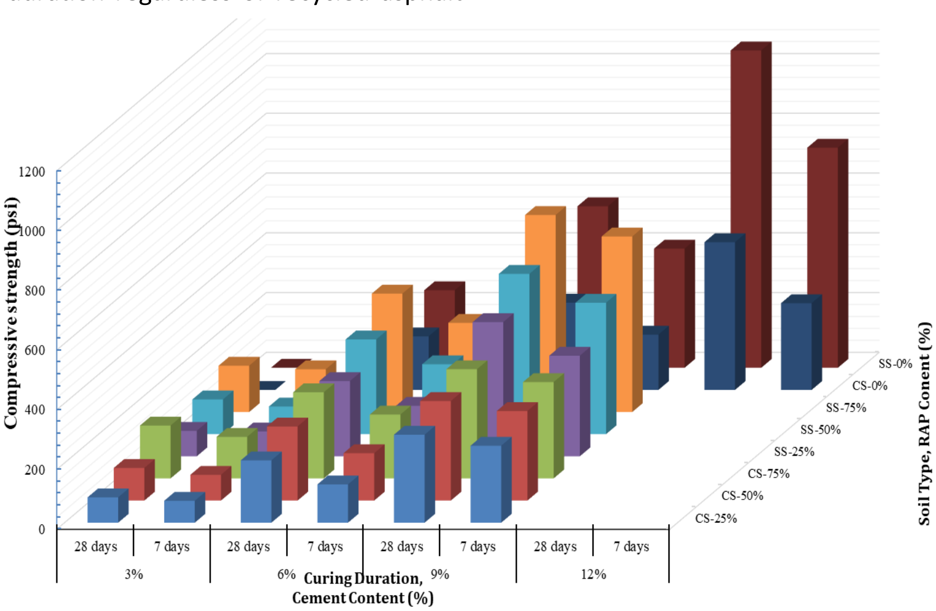

Figure 2: Influence of Curing Duration on Compressive Strength of CMRB and S-C at Various Cement Contents

Value & Benefit

When implemented, the findings of this research project will help the SCDOT engineers to have a more effective methodology for designing pavements in the future. This will enable the State to save both time and money by selecting the most cost-effective alternatives with the most optimized pavement life cycle. The people of SC can benefit by having a more reliable, durable, and cost-effective pavement system. Choosing the most cost-effective pavement option can save taxpayer dollars, selection of the most durable pavement materials for a project can reduce vehicle wear and tear for the traveling public, and optimizing the pavement life can reduce reconstruction-related traffic delays to the traveling public.

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