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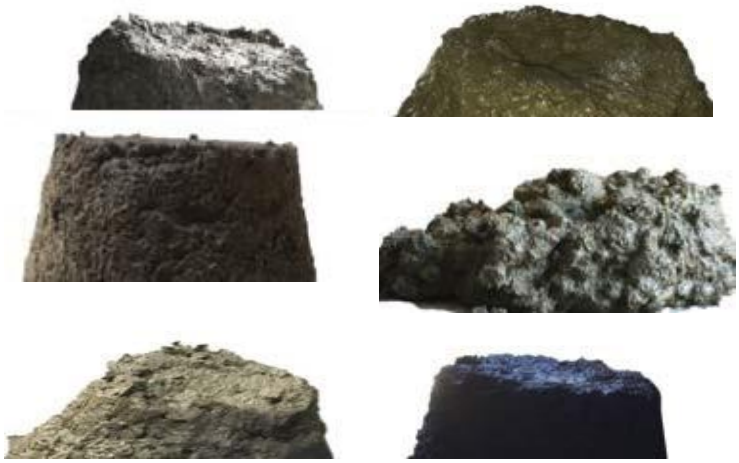
Characterization of Portland Cement Concrete Coefficient of Thermal Expansion in South Carolina

PROJECT SUMMARY

Report No: **FHWA-SC-17-03**
April 2017

With FHWA support, AASHTO recently officially adopted a new "mechanistic-empirical" process for designing pavements in which nationally calibrated models are used to simulate and predict pavement behavior that are best-fit approximations based on observations from across the US and Canada. Unfortunately, the predicted pavement outcomes using national models may not be accurate for specific locations. For this reason, virtually all states that use AASHTO pavement design methods are most strongly encouraged to perform a calibration of the new pavement models to local conditions. Because the new process is a complete break from the old procedure, the design inputs are totally different and frequently based on properties that the Department has not previously measured. While some inputs can be reasonably estimated, it is important to actually measure key properties that have been found to have the greatest impact on design predictions to ensure accurate pavement designs.



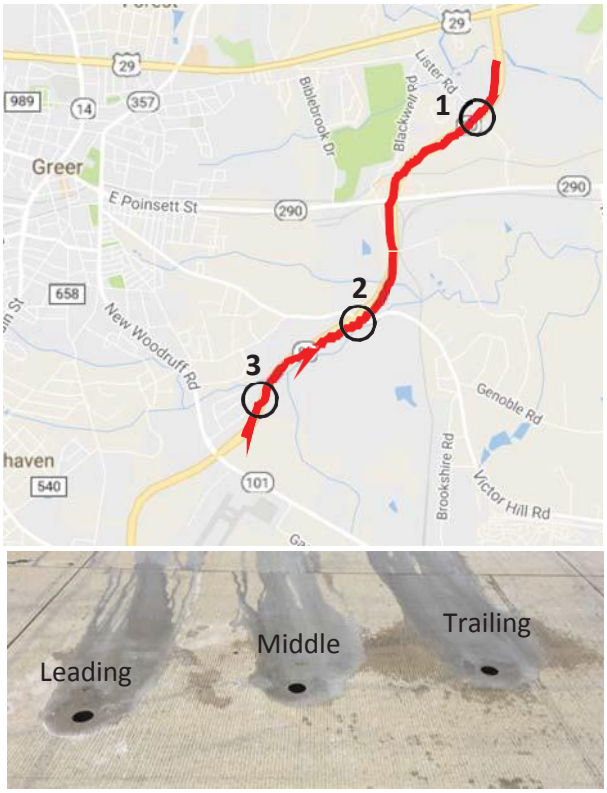
Images of slump measurements of laboratory mixtures

The South Carolina Department of Transportation (SCDOT) sought to regionally calibrate specific input parameter used by the Mechanistic Empirical Pavement Design (MEPDG) software. These properties include the coefficient of thermal expansion (CTE), compressive strength, and unit weight of typical SC concrete mixtures.

Additionally, splitting tensile strength was included in the experimental program.

This project determined the CTE of the most common pavement mixtures throughout the state of South Carolina using AASHTO T336-11 method. The data generated in this project provided a comprehensive overview of the CTE of concrete mixtures in South Carolina for direct implementation in designing PCC pavement and for the specification and testing of PCC materials. Laboratory produced mixtures were tested to identify the effective CTE value of the cement paste, sand, and coarse aggregate compotes typically used in SC concrete pavements. A 25 percent cement replacement of type F fly ash and a single source of natural sand was used in the mortar component of the concrete mixtures. A total three coarse aggregate sources were used in the form of no. 57 crushed stone product or a 75:25 blend of no. 57 and no. 789 crushed stone. The CTE values of the individual phases (i.e., cement paste, sand and coarse aggregates), and concrete mixtures were measured. The resulting CTE of paste and sand was 7.3 and 5.9x10^{-6} in./in./°F, respectively. The CTE of three coarse aggregates ranged from 2.96 to 3.83x10-6 in./in./°F. The range of average CTE values of the concrete was 4.82 to 5.32x10-6 in./in./°F. Results indicated that the CTE values were not directly related to the compressive strength on the concrete. The collected data were also used to calculate CTE values using the Tex-428-A method. Results from the Tex-428-A method in all but one data set, showed lower CTE values compared to the AASHTO T336-11 method. The maximum difference in CTE values between these test methods was 0.134x10-6 in./in./°F.

Field cored specimens were also taken from a section of SC - 80 in Spartanburg County, SC, and analyzed. Three pavement slabs were arbitrary selected along a 3.5-mile pavement section. The targeted slabs were of the outside travel lane, with cores taken between the wheel paths at the leading end, middle, and trailing ends of each slab. Results showed no significant differences between the average CTE values of pavement slabs. The effective CTE of SC - 80 concrete pavement was determined to be 5.05x10-6 in./in./°F. The compressive strength and unit weight properties of the SC - 80 specimens suggested that the laboratory produced concrete mixtures from the first part of this study were representative of the concrete pavements in South Carolina.



Map of sampling locations along SC 80 and Example of sampling locations within a slab

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