Durability of Cementitiously Stabilized Aggregate Bases for Pavement Application

(Abstract)

by

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Variations in environmental conditions have been recognized by pavements engineers as a major factor affecting pavement performance. These variations resulting from freeze-thaw (F-T) or wet-dry (W-D) actions can significantly affect the engineering properties of pavement material. In this study, the effect of W-D and F-T cycles, on the resilient modulus ($M_r$) of stabilized aggregate bases is examined. A total of four aggregates is utilized. Cylindrical specimens are stabilized with CKD, CFA, and FBA, and then cured for 28 days. After curing, specimens are subjected to W-D or F-T cycles prior to testing for $M_r$. Results show that the changes in $M_r$ values due to F-T or W-D cycles depend on the stabilizing agent properties and physical properties represented by maximum dry density and optimum moisture content.

In addition, the effect of F-T cycles on the flexural behavior of CFA-stabilized aggregate beams is investigated. This study is motivated by the fact that stabilized aggregate bases are subjected to flexural stresses under wheel loading. Beam specimens are prepared by compacting aggregates mixed with CFA and water, and then cured for 1 h, 3 days, and 28 days. After curing, specimens are subjected to F-T cycles and then tested for resilient modulus in flexure ($M_{rf}$) and modulus of rupture (MOR). It is found that both $M_{rf}$ and MOR exhibit a decrease as F-T cycles increase. Among other benefits, this study helps enrich the database on the durability of stabilized aggregate bases. Also, the test procedures employed in this study are expected to benefit future studies in this area.

Cementitious stabilization has been extensively used to improve the performance of pavement material. In the past, emphasis has been placed to observe the macro-manifestation of stabilized pavement materials, but very little efforts have been directed toward the micro-manifestation. In this study, X-ray diffraction, scanning electron microscopy, and energy dispersive spectrometry are used to assess the micro-structural development of cementing compounds in stabilized specimens. Specifically, the reference intensity ratio (RIR) method is employed to semi-quantify the mass percent of minerals and cementitious compounds in the mixtures. Results reveal the formation of ettringite, C-S-H, C-A-H, and C-A-S-H, which are responsible for the increase in strength. Findings shed a light on the use of semi-quantification technique in cementitious stabilization, which would provide a better understanding of cementitious reactions to their short- and long-term role.

The design of a pavement structure has evolved from empirical, namely, AASHTO 1993 design guide, to mechanistic-empirical approach (AASHTO 2002 Design Guide). In the mechanistic-empirical method, the most commonly used approaches are: (1) multilayer elastic; and (2) finite element. These methods relate the performance of a pavement structure to stresses and strains induced by vehicular loads. The distribution of these stresses and strains changes when an unbound base layer (conventional pavement structure) is replaced by a stabilized layer. As a result, the stabilized layer exhibits some flexural stresses; when these stresses exceed the limiting strength cracks are formed and propagate to the surface causing damages to the overall pavement structure. To this end, the flexural behavior of stabilized aggregate beams is investigated in this study using finite element model based on a smeared crack approach. A commercial finite element software, ABAQUS is used for that purpose. The load-deflection curves of CFA-stabilized specimens under a flexure loading are compared with the predicted values obtained from the finite element simulations. Overall, the numerical predictions correlate well with the laboratory results. Thus, the smeared crack model can be useful in predicting the flexural performance of a stabilized beam or a stabilized base, and used in the mechanistic design of pavements.