TECHNICAL SUMMARY

Kansas Department of Transportation

The Effects of Combined Supplementary Cementitious Materials on Physical Properties of Kansas Concrete Pavements

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Jennifer Distlehorst, P.E.
Kansas Department of Transportation

Bleed Water Rising to Surface After Tining

Project Description

The Kansas Department of Transportation (KDOT) has controlled harmful alkali-silica reactions (ASR) through testing and selective use of sand and gravel aggregates for more than 70 years. ASR can also be controlled through the addition of a non-reactive coarse aggregate "sweetener" and by the judicious use of selected supplementary cementitious materials. Current KDOT specifications allow the use of sands and gravels that may otherwise undergo ASR with the addition of a "sweetener" aggregate. Using one or more supplementary cementitious materials (SCMs) in a concrete may accelerate or hinder alkali-silica reactions, depending on the alkali and silica contents of the SCM and the aggregates used. Class C fly ash may aggravate ASR and until 2009 was not approved for use in Kansas pavements.

The purpose of this project is to evaluate the effect of combining portland cement with Class C fly ash and slag cement on the physical properties, alkali-silica reactivity (ASR), and durability of concrete containing reactive fine aggregate and limestone coarse aggregate.

Project Objective

This study evaluated the effects of combining varying proportions of slag cement and Class C fly ash with Type I/II cement in concrete pavement. Three different ternary cementitious material combinations containing slag cement and Class C fly ash (10% fly ash with 27% slag, 15% fly ash with 25% slag and

20% fly ash with 24% slag) were combined with limestone coarse aggregate and a moderately-reactive fine aggregate. Two concretes used only Portland cement. Specimens of each concrete from the project were tested in the laboratory to evaluate physical properties. On-going pavement condition surveys will track pavement performance.

Project Results

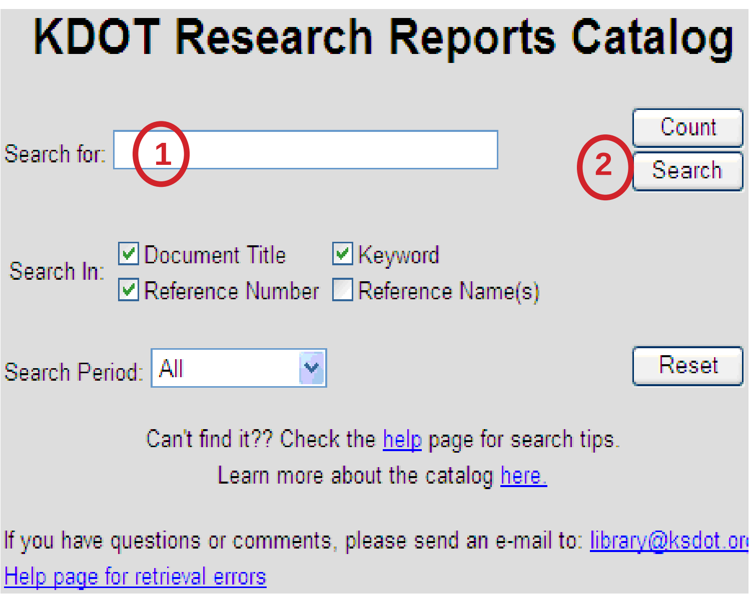
All three ternary-blend concretes met specification requirements for the tests of alkali-silica reactivity. The 10% fly ash-27% slag combination was the most effective in preventing expansion. The 10% fly ash-27% slag concrete also had the highest strength and lowest permeability of the five concretes tested.

The 10% fly ash-27% slag concrete performed the best of all five concretes in the other tests, with the exception of KT-MR-22 Freezing and Thawing Test. This is a test of the freeze thaw durability of saturated coarse aggregate, so these results depend on the durability of the coarse aggregate used and not on the composition of the cementitious materials. The 10% fly ash-27% slag concrete cylinders exceeded the strength of the cement-only optimized concrete cylinders by 30%. A strength difference that exceeds 14% is statistically significant. The strengths of the other concretes tested were not significantly different from the strength of the cement-only optimized concrete. The 10% fly ash-27% slag concrete was also the only concrete with significantly lower cylinder permeability than the cement-only optimized concrete as measured by the T-277 Rapid Chloride Permeability Test. The permeability of the 10% fly ash-27% slag concrete cylinders was 72% lower than the permeability of the cement-only optimized concrete cylinders. A permeability difference of 42% is statistically significant.

Pavement condition surveys will be performed on selected areas. Survey locations were selected to allow safe access to pavements during surveys and to interfere as little as possible with traffic in the interchange. Where possible, the concrete sampling locations were included in the survey sections. Pavements will be assessed for extent and types of cracking, extent of spalling along joints and surface condition. Signs of freeze-thaw distress, such as D-cracking or centerline spalling will be noted, as will signs of alkali-silica reactions. Complete surveys will be conducted when the pavements are five, ten, fifteen and twenty years of age. The pavements will be visited annually to visually assess the condition. If rapid deterioration is noted, more frequent surveys will be conducted.

Project Information

For information on this report, please contact Jennifer Distlehorst at the Kansas Department of Transportation by emailing her at jenniferd@ksdot.org.



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