Kansas Department of Transportation

TECHNICAL SUMMARY

Evaluation of Low-Quality Recycled Concrete Pavement Aggregates for Portland Cement-Treated Base

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Introduction

Durability cracking or D-cracking is a progressive structural deterioration of concrete caused by freezing and thawing. D-cracking begins in coarse aggregate below the pavement surface at joints that permit moisture intrusion and then progress inward and upward. This distress has caused millions of dollars of damage to concrete pavements in Kansas to date. Because concrete pavements in Kansas use concrete mixtures made from limestone, they are highly susceptible to D-cracking when subjected to freeze-thaw conditions.

The Kansas Department of Transportation (KDOT) follows two procedures to assess the freeze-thaw performance or durability of coarse aggregates in concrete mixtures for pavements. The first method, KTMR-21 (1999), determines aggregate resistance to disintegration by freezing and thawing. The second method, KTMR-22 (2015), consists of a 90-day concrete curing period with a 21-day drying period after 67 days of curing in 100% humidity. This method is a modified version of ASTM C666 (2015). Dry curing removes moisture that would cause damage during freezing, and the low degree of saturation decreases deterioration during 660 cycles of freeze-thaw (which may take up to three months) required by KTMR-22. The combined durations of KTMR-22 curing and freeze-thaw testing may result in a 6-month aggregate qualification procedure.

Project Description

This research was divided into two studies. The first study focused on D-cracked recycled concrete aggregate (RCA) portland cement-treated base. RCA was obtained from D-cracked pavement sources in Topeka and Kansas City. These aggregates were used to batch three PCTB mixtures per RCA source. All mixes followed KDOT's 90-day curing outlined in KTMR-22, including 67 days in a wet room with 100% humidity and drying in a 73 °F room with 50% relative humidity for 21 days. After a day of curing, the samples were immersed in 70 °F water for 24 hours, followed by immersion in 40 °F water. Upon completion of curing, all samples were subjected to cycles of freezing in air and thawing in water per ASTM C666 Procedure B (KTMR-22, 2015). Multiple measurements of mass, relative dynamic modulus of elasticity (RDME), and length change for each sample were made.

The second part of the study compared samples of concrete mixture with RCA to control samples. The control concrete samples consisted of virgin aggregates that had not been previously used in any concrete mixing. The virgin aggregates and concrete mixtures were placed under the same conditions as the RCA to limit any variability.

Project Results

Mixtures with increased binder content resulted in higher freeze-thaw testing durability than those with lower binder contents. At lower binder contents, aggregate composition in RCA was shown to be a controlling factor in durability. Increased binder content decreased the influence of the coarse aggregate since the samples were less porous. None of the models reached the 660 cycles during freeze-thaw testing. Because the mixing was conducted at optimum moisture content, the result was a more porous material than used in concrete pavement.

Except for the Topeka 100% cement samples, other control samples demonstrated similar durability. However, testing on the 35% cement and 65% fly ash for both Topeka and KC control samples must be conducted to determine if the trend of comparable durability continues. The correlation between D-cracked RCA and control samples is promising since D-cracked RCA was expected not to perform as well as the control samples. Results showed that total binder percentage is the primary controlling factor in PCTB mixture performance in freeze-thaw conditions.

Project Information

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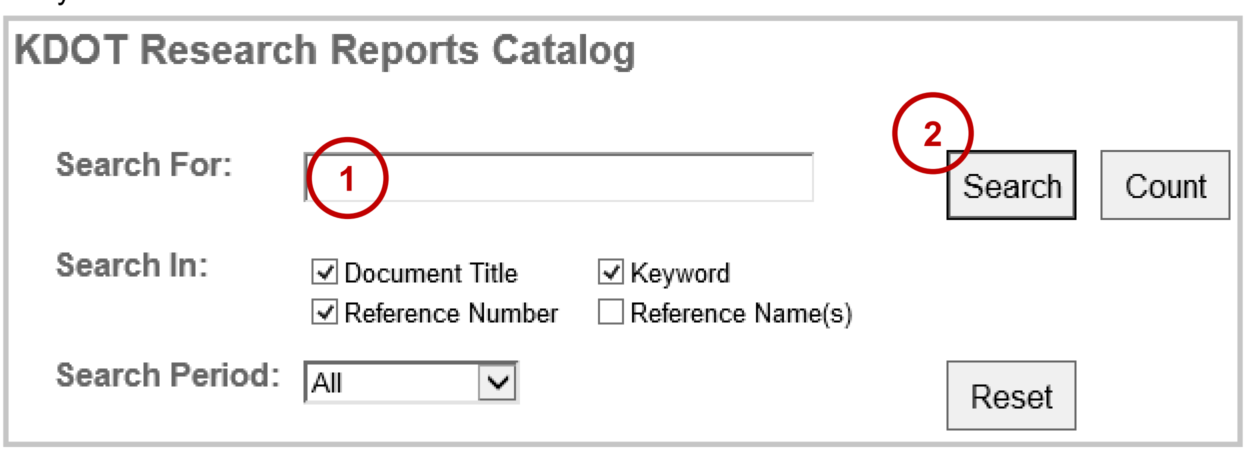

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