Kansas Department of Transportation

TECHNICAL SUMMARY

Evaluation of Canadian Unconfined Aggregate Freeze-Thaw Tests for Identifying Nondurable Aggregates

Report Number: KSU-10-9 ▪ Publication Date: June 2012

Santosh K. Mummaneni
Kyle A. Riding, Ph.D., P.E.
Kansas State University Transportation Center

Introduction

D-Cracks (Low Intensity) Observed near Joint on College Avenue

The Kansas Department of Transportation (KDOT) wants to construct durable concrete pavements with minimal maintenance needs. This goal can only be achieved by using durable aggregates that are resistant to freezing and thawing damage when used in concrete. There is a critical need for a quick and field representative test method that classifies durable aggregates from the nondurable ones. The current battery of tests used by KDOT to qualify an aggregate for use in on-grade concrete can take up to six months to complete. The Canadian freeze-thaw method CSA A23.2-24A, developed by the Ministry of Transportation Ontario (MTO) (CSA A23.2-24A 2004), was developed to quickly screen aggregates for freezing and thawing durability. The method was developed to use salt solutions instead of water to saturate the aggregates before freezing to be more representative of field conditions.

Freeze-thaw deterioration of aggregates in concrete is the biggest durability problem faced by Kansas concrete pavements (Clowers 1999). The main objective of this study is to determine any correlations between the CSA A23.2-24A method and the currently used KDOT aggregate qualification methods to allow for use of the simpler and more rapid CSA test method.

Project Objective

The main objectives of this study were:

1. To determine the ability of the Canadian test method CSA A23.2-24A to assess the freeze-thaw resistance of unconfined coarse aggregates to freeze-thaw damage by comparison to the currently used KDOT aggregate qualification tests.

2. To determine if the use of magnesium chloride or calcium chloride salt solutions in the CSA A23.2-24A test method correlate better to the currently used KDOT aggregate qualification tests than sodium chloride salt solutions.

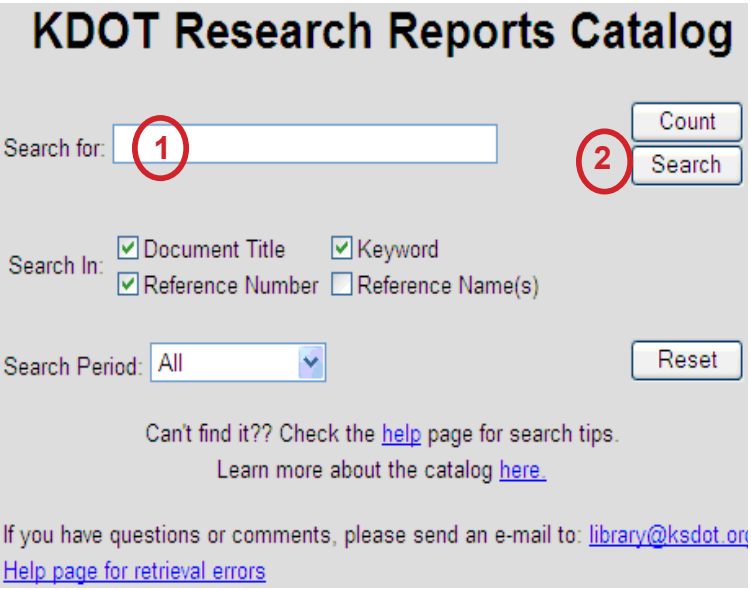
Project Results

The objective of this project was to determine if non-durable Kansas limestone aggregates could be identified using the CSA A23.2-24A test. In this method, aggregates were exposed to 3% NaCl solution and subjected to five unconfined freezing and thawing cycles. After this process, the aggregates were re-sieved with the mass loss on each aggregate size measured. With the aid of Canadian reference aggregates, a new locally available limestone control aggregate was developed for testing alongside the aggregates. For the Canadian standard control aggregate, three minutes of sieving with KSU sieving equipment yielded similar results as that obtained by MTO, giving confidence in the KSU methodology.

A version of CSA A23.2-24A modified to allow for smaller aggregate sizes was used for Kansas aggregates with size fractions between 1/4 and 3/4 inch which are typically used in Kansas. Thirty-nine aggregate samples were tested using this modified test. Twelve aggregates from the same quarries as used in the modified test method were tested in the CSA A23.2-23A test method using the 1/4 to 1 1/2 inches size fractions. A comparison of the freeze-thaw loss of the aggregates from 1/4 to 1 1/2 inches to the mass loss for the modified version of the CSA A23.2-24A test method showed that the exclusion of the large size fractions from the testing did not significantly alter the aggregate mass loss. To confirm if the Kansas limestone aggregates are sensitive to alternative salt solutions, the CSA A23.2-24A method was modified using 3% of CaCl2 and 3% of MgCl2 salt solutions and used on a subset of the aggregates. The MgCl2 gave results similar to when the NaCl was used. The use of CaCl2 consistently resulted in a decrease in freeze-thaw loss (%). No relationship between the CSA A23.2-24A test method results and the currently used KDOT performance tests was seen in the test results. The only relationship that could be determined from comparing the results of the currently used test methods to each other was that all of the aggregates that performed poorly in the KTMR-22 concrete beam freezing and thawing test had a PVF greater than 40. Nitrogen adsorption testing done on selected aggregates concluded that there was no correlation between aggregate surface area and freeze-thaw performance.

Project Information

For information on this report, please contact Dr. Kyle A. Riding at Kansas State University Transportation Center, 2123 Fielder Hall, Manhattan, Kansas 68506; 785.532.1578; riding@ksu.edu.



Directions for Downloading the Full Report

To download the full report, visit http://www.ksdot.org/burmatrres/kdotlib2.asp and do the following:

1. Enter KSU-10-9 in the search box.
2. Click the Search button to the right of the search box.
3. You may have to scroll to find the specific report.
4. To download the report, click on the title of the report to open the PDF file and save it to your hard drive.

If you have any questions, please email us at library@ksdot.org.