I. RESEARCH PROJECT TITLE

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

II. RESEARCH PROBLEM STATEMENT

The Commitment of the Kansas Department of Transportation (KDOT) to reduce construction interruptions of the traveling public requires that any concrete pavement that will be built will last longer than the previous generations of concrete pavements, especially in the metropolitan areas. For a durable concrete pavement in Kansas, the aggregates must be resistant to freeze-thaw damage. Coarse aggregates produced from different ledges often show different freeze-thaw behavior, even when they are of similar mineralogy. Currently KDOT uses a series of rapid test methods to approve aggregates for use in concrete. The first screening test is KT-MR-21, Soundness and Modified Soundness of Aggregates by Freezing and Thawing Test Method. Under this test method, water-saturated aggregates are subjected to 25 cycles of rapid freezing and thawing. The aggregate gradations are determined before and after freeze-thaw cycles. In order for an aggregate to pass the KT-MR-21 test, the total coarse aggregates retained on the No. 8 sieve after the freeze-thaw cycles must be above 85%. An alternative unconfined aggregate freeze thaw test method was developed by the Ministry of Transportation Ontario (MTO) to be more representative of field conditions with de-icing salt exposure and has been standardized as CSA A23.2-24A. This test method requires soaking aggregates in a 3% sodium chloride solution for 24 hours, draining the solution, and subjecting the sample to 5 cycles of 16 hours of freezing at -20°C and 8 hours of thawing under ambient condition. To pass this test method, the average aggregate mass loss before and after the freeze-thaw cycles as measured on each sieve size must be less than 10%. This test has been shown to better correlate with the field performance of the coarse aggregates, partly due to the fact that D-cracking aggregates are sensitive to salt content and type (Wyers et al. 2005).

III. RESEARCH PROPOSED OR RESEARCH OBJECTIVES

The primary objective of this research is to determine if the Canadian unconfined aggregate freezing and thawing method can be used as a screening test for the Kansas coarse aggregates. The secondary objective of this research is to determine how the test method can be modified to make it faster and more accurate. These two objectives will be accomplished by completing the following tasks:

Task 1: Evaluate the potential for the proposed test method (CSA A23.2-24A) for assessing unconfined coarse aggregate resistance to freeze and thaw for use in Kansas concrete pavements. At least 15 different aggregates will be tested following CSA A23.2-24A and the results will be compared to the cumulative mass loss in KT-MR-21. Kansas Class 0, Class 1, and Class 2 aggregates will be selected for testing. A variety of limestone and sand-gravel aggregates will be tested.

Task 2: Evaluate ways to improve CSA A23.2-24A test method using calcium chloride or magnesium chloride, instead of sodium chloride since limestone aggregates may be more sensitive to other salts. Also, the length of the freeze and thaw period in CSA A23.2-24A test method will be re-evaluated to determine if the test duration can be shortened.

Task 3: Evaluate CSA A23.2-24A and KT-MR-21 by comparing the results to those from the ASTM C 666 test method B (as modified by KDOT) and the Micro-Deval test method.

Task 4: Statistically analyze the results.

Task 5: Write the final report which would include recommendations for a modified CSA A23.2-24A test method for Kansas aggregates. This data and the recommendations from this project will serve as a preliminary evaluation of the proposed test to differentiate between durable and non-durable aggregates.

IV. ESTIMATE OF FUNDING AND RESEARCH PERIOD

Budget: Total Budget $12,250.00
Project duration: 18 months

V. URGENCY AND PAYOFF POTENTIAL

This research should have a high priority. Freeze-thaw damage is one of the most common and costly problems with concrete pavements in Kansas. A more accurate and rapid coarse aggregate screening method for preventing D-cracking on Kansas pavements would be very beneficial to the state of Kansas. The small investment in this research project could help reduce material testing costs, concrete pavement repair costs, and construction traffic delays for the traveling public.

VI. IMPLEMENTATION STRATEGY

Implementation of this study is expected to be carried out by the Bureau of Materials & Research.

VII. PROJECT PERSONNEL

This project will be performed under the direction of Kyle Riding, Principal Investigator, and Mustaque Hossain, Co-Principal Investigator (Co-P.I.), in close cooperation with the Bureau of Materials & Research. One undergraduate student in civil engineering will also work on this project.

Kyle Riding is an assistant professor of Civil Engineering at Kansas State University. His areas of expertise include construction materials, pavement performance, and structural concrete design. **Mustaque Hossain** is a professor of Civil Engineering at Kansas State University. His areas of expertise are pavement materials, pavement design, performance management and non-destructive evaluation using Falling Weight Deflectometer (FWD).

VIII. SUBMISSION INFORMATION

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