

D-Cracking Field Performance of Portland Cement Concrete Pavements Containing Limestone in Kansas: Phase 1 Report

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Introduction

Premature deterioration of concrete pavement due to D-cracking has been a problem in Kansas since the 1930s. Limestone is the major source of coarse aggregate in eastern Kansas where the majority of the concrete pavements are constructed. It is generally recognized that freeze-thaw deterioration of non durable aggregates is the cause of D-cracking. The KDOT Standard Specification Section 1102 Aggregates for Concrete requires



D-Cracking in Kansas

the prequalification of limestone coarse aggregate materials by freeze-thaw testing with the intent of preventing D-cracking before 20 years.

Project Objective

This study investigates the D-cracking field performance of Portland cement concrete pavements (PCCP) containing limestone in Kansas built under the current specifications, with the ultimate goal of increasing concrete pavement life in Kansas. Phase 1 of this study focuses on evaluating the success of the current aggregate durability specifications (implemented between 1981 and 1987) and whether KDOT pavements constructed under the specifications are achieving the intended 20-year design life. This was completed by conducting field-performance evaluations, determining the rate of success, and comparing the results with materials, design, and environmental parameters.

Project Description

1. One hundred and thirty-three field performance evaluations were conducted on PCCP projects, representing 73% of the length of the current concrete state highway system in Kansas, determining the rate of success, and comparing the results with aggregate source parameters.

Results indicate that nearly one-third failure rate in preventing D-cracking before 20 years and that a limited number of quarries were linked with a high percentage of the failures. The required testing did not fully predict failure, but it did reduce the rate of failure.

2. KDOT policies and practices were reviewed, with several identified as increasing the risk of D-cracking.

Project Results

The results indicate that the failure rate from D-cracking has decreased, but not to an acceptable level. Limestone source material appears to be the dominant parameter affecting D-cracking, while other design parameters, such as base type, joint sealant type, joint spacing, and joint orientation do not appear to significantly affect the presence of D-cracking. Subsidiary aggregate-related reaction mechanisms were observed at locations with surface D-cracking likely due to the increased amount of water penetration. The subsidiary reactions generally do not appear to be present at locations away from the D-cracking.

KDOT policies (any actions, requirements, or decisions) that affect the risk of D-cracking were reviewed. Recommendations included implementation of field performance criteria for aggregate material sources, improvement and unification of quarry monitoring and sampling procedures, to perform life-cycle cost analyses for various aggregate materials in concrete and future monitoring of quarry field performance.

KDOT will strive, in cooperation with industry, to develop a feasible plan for preventing D-cracking susceptible aggregates from being included in KDOT PCCP. A complete plan will address reducing D-cracking in both the short term and long term.

Project Information

For information on this report, please contact Dr. Heather McLeod at the Kansas Department of Transportation Materials and Research Center; 785.291.3844; mcleod@ksdot.org.

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