

JOINT TRANSPORTATION RESEARCH PROGRAM

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Field Trials of Rapid-Setting Repair Materials

Introduction

Repairs performed under high traffic volumes and aggressive environmental conditions require materials that will cure rapidly while providing adequate strength and durability. The ability to rapidly repair and rehabilitate deteriorated bridge decks and highway pavements minimizes interference with traffic in heavily traveled areas, travel delays, and construction costs. As a result, rapid-setting repair materials are being routinely used in such applications.

The main factors which cause premature failure of repairs include exposure to freezing and thawing cycles, aggressive chemical exposure, mechanical abrasion, loss of bond between existing concrete and repair material, and dimensional stability of the repair material (elastic modulus, shrinkage, expansion, etc.). While some of the problems associated with premature deterioration of repairs are due to structural failures, most of the problems are durability and construction related.

The primary objective of the present study was to identify the critical properties of the rapid-setting repair materials (based on the laboratory tests) that could be correlated to their field performance.

Findings

The first phase of the project involved laboratory evaluation of six commercial rapid-setting repair materials (RMs). When tested in the laboratory, all but two exhibited acceptable rates of strength gain and three RMs displayed relatively poor freeze-thaw resistance. All the RMs exhibited acceptable values of free-shrinkage, high resistance to cracking, and good bond to substrate concrete. The resistance to chloride ion penetration of one of the RMs was very poor.

The second phase of the project involved field installation and performance evaluation of the RMs. It was seen that while, in most cases, the controlled laboratory conditions yielded consistent mixes and acceptable performance, the properties of mixes produced on site were more variable. This variability was the result of somewhat uncontrolled changes in the amount of aggregate extension used, varying moisture content of the aggregates, amount of water added, and ambient temperature conditions. Follow-up inspection of the repair patches indicated that all the patches except one underwent premature failures (primarily cracking and edge de-bonding). The ambient temperature during the repairs was around 10°C. This led to an extended set-time for all the materials. The 12-hour compressive strengths values of the specimens from the field-mixes were, in some cases, lower than the 4-hour compressive strength values of laboratory mixes. Since the repairs were open to traffic approximately 4 hours after placement, the low early age strengths could be a potential reason for premature failures of some of the patches.

In general, several materials were found to be very sensitive to excess water added during mixing, a practice which resulted in lowering their freeze-thaw resistance. For most of the materials installed in the field the consistency of the mixes varied from batch to batch—this can be attributed to the variations in the aggregate extension adopted, mix-water added and also the moisture content of the aggregates used. Construction related issues (consolidation and finishing) also played an important role in determining the field performance of the repair patches.

Implementation

Based upon laboratory and field results, modifications to the current INDOT performance specifications for rapid-setting repair materials have been suggested. In particular,

several recommendations for improvements in quality control measures of field-mixes and construction related issues have been proposed. Future research directions involving the evaluation of the robustness of the repair materials with respect to the uncertainties present on site have also been highlighted.

The implementation process should be coordinated by the maintenance personnel to ensure smooth adoption of the proposed changes in the existing specifications and to eliminate poorly performing materials from the list of INDOT approved materials. In addition, INDOT should consider conducting a short training course for the personnel responsible for the patching operations to highlight the importance of the proper quality control and field patch installation practices described, respectively, in sections 8.6.1 and 8.6.2 of this report.

The benefits of this research include the following:

- Generation of the laboratory and field performance data for the range of rapid patching materials formulations.
- Development of the proposed performance criteria as potential basis for modification of specifications and the QC/QA procedures.
- Demonstration of differences between lab and field

mixtures and identification of underlying causes for these differences.

- Development of recommendations for improvements to field patch installation procedures.

The implementation of findings from this study will help INDOT to reduce the cost of pavement and bridge deck repairs by eliminating materials identified as poor performers and by increasing the overall quality of the installed patches.

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