



# Improving Concrete Patching on Iowa Roadways

## Tech Transfer Summary

The outcome of this applied research will aid Iowa DOT to improve full- and partial-depth repairs on Iowa roadways.

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### **Sponsor**

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## Objective

The main objective of this study was to evaluate the performance of current and alternative patching materials and placement procedures for full- and partial-depth repairs of jointed plain concrete pavements (JPCP) in Iowa. Best practices for Portland Cement Concrete (PCC) pavement patching practices were identified based on a literature search and a survey of states department of transportation (DOTs) representatives in the upper Midwest states with climates similar to that of Iowa. Performance of standard and alternative patching materials and placement procedures were evaluated, and guidelines and repair procedures were developed to facilitate future full- and partial-depth repairs of PCC pavements in Iowa. Finally, a web-based application was developed to communicate the guidelines and repair procedures to designers, inspectors, and repair contractors throughout the state.

## Research Description

This applied research project included a literature review, survey of state DOTs in the upper Midwest, development of repair guidelines, field evaluation of trial repairs, and development of a web-based application.

A comprehensive literature review was performed to compare current patching materials and installation procedures specified by the Iowa DOT for full- and partial-depth repairs of PCC pavements to those specified by other state DOTs in the upper Midwest. Previous research by others was also reviewed to support the identification of “best practices” for PCC pavement patching.

A survey of Midwest state DOTs and road/highway agencies was performed to gather information regarding currently used materials and procedures for full- and partial-depth repairs for concrete roadways. The survey was distributed to state and selected county/district engineers in the following states: Iowa, Illinois, Indiana, Wisconsin, Minnesota, Michigan, Ohio, Nebraska, Missouri, North Dakota, South Dakota, and Kansas.

Utilizing the literature review and state DOT surveys, recommended repair procedures and drawings were developed, and a field trial project was identified for the recommended procedures and drawings. The trial field project included trial batching of recommended repair materials alongside Iowa DOT standard mixes. Trial pavement patches were then performed with the proposed mixes and the recommended repair procedures, and the condition of the pavement patches were documented and monitored for a period of two years.

A user-friendly, web-based application was developed to communicate the recommended materials, repair drawings, repair procedures, and QA/QC procedures to personnel designing, inspecting, and performing repairs on Iowa DOT pavements. The goal of the application is to provide guidance regarding the selection of patching materials, the definition and preparation of the patch area, the details of the repairs, the installation of the repair, and the associated QA/QC procedures and reporting.

## Key Findings

Full-Depth Repairs - Based on this applied research project, the following practices were recommended as priorities (additional recommendations are included in the Final Report) by the authors to supplement Iowa DOT standard practices in full-depth concrete pavement repairs.

1. It is recommended that Iowa DOT use non-chloride accelerators as opposed to calcium chloride (or other chloride containing accelerators) for enhanced early strength gain of full-depth repairs.
2. It is recommended that the non-chloride accelerating admixtures be added once the ready mix truck reaches the job site.
3. An Alternative M-Mix is recommended in lieu of the Standard M-Mix because of its higher early strengths, use of non-chloride accelerators, and lower shrinkage potential. The Alternative M-Mix includes 870 lbs. of cement, fine aggregate content of 45% (by

weight of total aggregate), and w/c of 0.32, and utilizes a high range water reducer, non-chloride accelerating admixture, retarder, and air entraining admixture.

4. It is recommended that Iowa DOT research the use of slump extending chemical admixtures, added on-site, for use in the high early strength mixes of full-depth repairs.
5. Reduce the maximum transverse joint spacing for pavement repairs using high early strength concrete mixtures. A maximum transverse joint spacing of 10 feet is recommended to minimize transverse cracking caused by the increased drying shrinkage and thermal cooling of the high early strength concrete compared with conventional PCC.
6. Reduce the amount of tie bars at longitudinal joints between new and existing concrete by increasing spacing and/or decreasing size to minimize restraint to longitudinal movement of the new concrete.
7. When high early strength concrete mixes are used, saw-cut transverse joints within 5 hours after finishing operations are complete to minimize the potential for transverse cracking caused by the increased thermal contraction and shrinkage during the early ages of these mixes as compared with conventional concrete mixes.

Partial-Depth Repair - Based on this applied research project, the following practices were recommended as priorities (additional recommendations are included in the Final Report) by the authors to supplement Iowa DOT standard practices in partial-depth concrete pavement repairs.

1. Customized PCC mixes and proprietary concrete mixes were found to have performed well based on the literature review and positive results are reported in the Midwest DOT survey. Several promising materials are presented in the Final Report; however, additional research that includes field trial repairs should be performed to

demonstrate performance of these materials.

2. Use rectangular patches including over-depth patches.
3. Extend patch boundaries at least 3 inches beyond deteriorated concrete boundary determined visually and by sounding techniques to ensure all unsound concrete is removed.
4. Keep vertical edges along patch boundaries, as opposed to 30-to-60-degree edges as in current Iowa DOT practices, to minimize debonding of the patch from existing pavement.
5. Patches not at transverse or longitudinal joint or crack:
  - a. Use patches of at least 12 inches in each direction.
  - b. Locate edges of patch at least 12 inches from transverse and longitudinal joints. If an edge of patch must be less than 12 inches from the joints, remove all unsound concrete and extend the edge to the joint.
6. For patches at transverse or longitudinal joints or cracks, a patch length of at least 12 inches in the direction of the joint or crack is recommended, and a patch width of at least 12 inches on the side of the joint or crack that needs repairing is recommended.
7. For over-depth patches:
  - a. When removal to one half of pavement thickness leaves unsound concrete within the patch area, remove the concrete for the full depth of the existing pavement and perform a full-depth patch.
  - b. The patch shall be rectangular and at least 4 feet in each direction.
  - c. 'BT-3' joints shall be used on edges of patch with No. 5 tie bars inserted into existing pavement with at least 9-inch embedment and extended 15 inches into the patch and spaced at 30 inches on centers.

## Implementation Benefits

The outcome of this study includes practical recommendations to the Iowa DOT on both full- and partial-depth repair materials, procedures, and QA/QC procedures. In addition, a web-based application was developed to communicate the recommended materials, drawings, practices, and QA/QC procedures to personnel designing, inspecting, and performing repairs on Iowa pavements.