National Concrete Pavement Technology Center

CP Tech Center

PCC Patching Techniques: Performance vs. Traffic Delay Time

tech transfer summary

Optimal patching techniques need to be balanced between adequate performance and minimal traffic delays.

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RESEARCH PROJECT TITLE
Portland Cement Concrete Patching Techniques vs. Performance and Traffic Delay

PRINCIPAL INVESTIGATOR
Jim Cable
Assoc. Prof., Civil, Construction & Environmental Engineering
Iowa State University
515-294-2862
jkcable@iastate.edu

CO-PRINCIPAL INVESTIGATOR
Kejin Wang
Assist. Prof., Civil, Construction & Environmental Engineering
Iowa State University
515-294-2152
kejinw@iastate.edu

MORE INFORMATION
www.cptechcenter.org

CP Tech Center
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-3230

The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

Objectives

- Optimize portland cement concrete (PCC) patching by comparing portland cement concrete patching techniques, traffic delays caused by PCC patching operations, and patch performance.
- Investigate the relationship between the thickness of PCC patches and the time allowable for opening concrete pavements to traffic.
- Investigate the effects of PCC patch thickness on the early traffic load capacity of concrete pavements.
- Determine whether maturity testing methods are suitable for determining concrete strength and the timing for opening concrete pavements to traffic.

Problem Statement

Initial experience with PCC patching operations included early failures, which were attributed to opening the pavement to heavy traffic and the environment prematurely. Patches developed various types of cracks and descended into the subgrade at an early age.

Transportation agencies responded by adding special subgrade preparations, drainage, and load transfer methods and devices between the patch and the existing slabs. Alternative patching times and the addition of rapid-setting agents in the patching mix were also tested. While these innovations helped improve patch performance, they also greatly increased patching costs and delay time.

Concrete industry representatives, public owners in Iowa, and state departments of transportation continue to seek an optimal balance between construction methods, materials, and costs that will minimize delay time and improve the performance of patching materials.

Research Description

This project studied various combinations of concrete mix design, pavement patch thicknesses, and times of opening to traffic. The existing roadway studied for this project consisted of a 2-lane, 24-foot–wide, 9-inch–thick pavement with doweled transverse joints. The 9-inch depth served as the default thickness, while additional patch depths of 11, 13, and 15 inches were tested to determine the effect of patch thickness on performance. Traffic opening criteria involved allowing traffic to begin driving over the patches at three, five, and seven hours. Additional patches were designed for opening at a maturity of 350 psi flexural strength.

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The concrete mixes used included 12 patches using the conventional C4 mix and 15 patches using the patching M4 mix. The common patch size selected for this project was 12 feet wide (the width of a lane) by 3 feet long to allow for the installation of dowels on each end of the patched areas. Dowels (1.5 inches in diameter) were inserted into the existing concrete and extended into the patch.

All patches but the 350-psi patches were opened at approximately the same time. Maturity was measured on each of the patches for seven days after placement or until the wires were lost due to vehicular traffic. Four types of tests were conducted during and after construction:

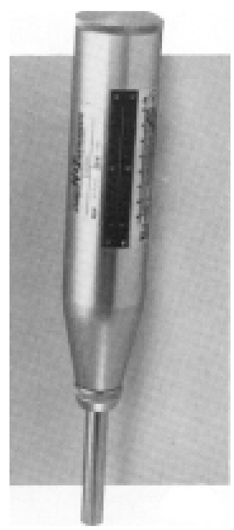
- Maturity testing of the plastic and hardened concrete during the first week after placement
- Concrete strength estimation using the Schmidt Hammer
- Load transfer and deflection of the patches and the surrounding hardened concrete
- Visual distress surveys of the finished product, including photos of the completed patches

Key Findings

- Increased patch depth enhanced the concrete strength gain associated with the heat of hydration and maturity testing.
- Deflection testing for load transfer and visual distress surveys indicated no differences in performance due to concrete mix, opening times to traffic, or concrete patch thickness.
- Maturity test methods consistently measured the resulting time-temperature factors (TTF) for each concrete mix used. Maturity testing determines opening times to traffic vs. achieved flexural or compressive concrete strength.
- The Schmidt hammer can monitor strength gain over time in concrete pavement patches or pavement construction. However, further development of the strength relationship between hammer rebound and concrete is needed.
- Near-surface concrete strength development may benefit from both the compression effect of early traffic loading and cement hydration. Before concrete starts to harden, proper compression from appropriate traffic loads may facilitate concrete early strength development by improving concrete density. However, if the load applied is too large or too early, it will damage the concrete.
- After the concrete hardens, applying traffic loads fails to make the concrete denser and requires the concrete to have sufficient strength to carry the load.
- An optimal time exists for pavement made with a given concrete mix to open to traffic. Rebound test results indicate that the optimal opening time is five hours after placement for the C4 mix patches, and three hours for the M4 mix patches.

Recommendations

- Conduct an expanded test of patching techniques on multiple pavements in Iowa. Pavements of different existing depths should be used to verify that patches with additional depth can save time and money in patching operations.
- Investigate the tolerable lower limits of TTF in terms of patch performance (resistance to cracking and tracking in the surface).
- Develop the Schmidt hammer or a similar device as a nondestructive testing method that can determine patch opening time to traffic.
- Develop a performance specification to provide incentives to contractors who utilize this method to develop patching.



Schmidt hammer

Pavement patching