PUTTING RESEARCH TO WORK

BRIEF

# When to Rubblize Before Overlay: Performance-Based Guidelines

After a few years, hot-mix asphalt overlays of portland cement concrete pavement can show reflection cracking, which occurs when existing cracks in the concrete layer reflect upward into the overlay. One method of preventing reflection cracking is to rubblize the concrete layer prior to overlay; crews use machines such as a multiple drop hammer to pound the layer into rubble.

Rubblizing a concrete slab creates a structural layer of interlocking particles ranging in size from sand to 3-inch aggregate near the surface, and from 12-inch to 15-inch aggregate at the base. This process requires no new materials, adds no slabs and rubble to landfills, and can be finished quickly; rubblizing and overlaying takes about one-third as much time as removing old concrete and reconstructing pavement. This aggregate-like layer handles thermal expansion and contraction without reflecting these pressures into the new top layer. Several countries and some 36 states now employ rubblized PCC, and Wisconsin is one of several states that have used rubblization somewhat extensively. WisDOT has completed around 80 rubblization projects since 1988.

## What's the Problem?

Though more agencies continue to employ rubblization of PCC, few studies have identified the factors in rubblizing that impact performance, or appropriate design parameters for the technique's use. WisDOT's specifications provide guidance on acceptable maximum particle sizes, but allow field engineers discretion in practice. No documented studies have correlated particle size distribution to performance, nor do guidelines exist to help engineers analyze the expected benefits of rubblization at a given site. Lacking this information, engineers may discount rubblization for a project when it may be promising, and may choose it when it is not appropriate.

## Research Objectives

This study seeks to fill gaps in data and design guidelines for rubblized pavement projects. Investigators sought to:

- Document historical information and data on the rubblization projects built in Wisconsin.
- Develop guidelines for the selection, design, testing and construction of rubblized PCC slabs.
- Identify conditions in which rubblization is feasible for rehabilitation of pavements.

## Methodology

Researchers approached this study in three steps. Using data from WisDOT's pavement management system, from available construction records, and from interviews with highway builders, researchers created a historical catalog of Wisconsin rubblization projects, and analyzed project performance.

## Results

Investigators found that HMA overlays of rubblized PCC in Wisconsin have performed well and should match or exceed their design lives. Pavement structure age and overlay thickness proved the most important variables in impacting performance. Researchers recommend that WisDOT continue to use rubblization and HMA overlay in pavement rehabilitation, and developed a manual for designing and constructing rubblized PCC pavements that WisDOT can incorporate into its Facilities Development Manual.

Specific findings and recommendations include:

- Projects built after 1998 perform even better than projects built before, which investigators attribute to the use of Superpave design methods, including performance-graded binders, and increased overlay thickness.

**Investigator**

*"This research should help guide WisDOT engineers in deciding when to rubblize and in designing effective overlays."*

**–Harold Von Quintus**
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Machines such as guillotines, frequency breakers and this multiple drop hammer unit can pound portland cement concrete into rubble prior to overlay with hot-mix asphalt.

**Flexible Pavements TOC Chair**

*"This study shows that HMA overlays of rubblized PCC can perform well, and points the way to further improvements."*

**–Len Makowski**
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- The minimum overlay thickness for HMA over rubblized PCC should be 4 inches. Rubblized PCC foundation layers should offer elastic modulus values of 10,000 psi or more to be effective.
- Under appropriate conditions, rubblization proves cost-effective as a rehabilitation strategy, costing 25% to 50% less over the life of the pavement than other options.
- Design guidelines appended to the final report include design inputs such as a structural layer coefficient of 0.22, which will ensure a sufficiently thick HMA layer; structural layer elastic modulus values of 65,000 psi should be targeted as a design goal.
- Site investigation including strength testing should be performed to identify pavement condition, presence of water, and soft spots in layers below the PCC, which can lead to performance problems.
- Longitudinal and transverse cracking can occur in HMA over rubblized PCC, and is believed to result from reflection above pavement joints due to insufficient fracturing of PCC at the bottom of the concrete layers at these joints.
- Drainage layers should be considered, and these systems should be placed prior to rubblization.
- Deflection testing data must be gathered before rubblization and after placement of the first HMA lift; other tests before and after rubblization are also recommended in the report.

## Implementation and Further Research

WisDOT pavement designers will make use of the supplementary design guidelines for rubblized pavements developed in this research. Since only four to six years of performance data was available for the better-performing pavements built after 1998—newer pavements that would not be expected to show substantial deterioration—WisDOT will monitor several of these project sites and use the data to determine the effect of certain design and site features on performance.

In addition, data should be collected during construction of some future rubblization projects to confirm the design parameters and performance characteristics identified in this study. Gradation of rubblized PCC should be measured via destructive testing, and deflection basin data should be measured after the first lift of HMA and after completion.

*This brief summarizes Project 0092-05-07, "Guidance, Parameters, and Recommendations for Rubblized Pavements," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.*

*James McDonnell, WisDOT Research and Communication Services*

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