



PUTTING RESEARCH TO WORK

BRIEF

Rubblized Concrete: Good Support for Concrete Overlays

When old concrete pavement has fractured too much for cost-effective repair—with rough surfaces, broken corners and cracks across slabs—engineers often opt to rubblize the pavement completely and lay new pavement over it. The broken pavement becomes a strong, aggregate-like base course that doesn't reflect cracks into the new layers. This eliminates the need for time-consuming hauling operations and storage of mounds of concrete refuse.

Overlays are typically constructed of asphalt, and engineers around the country have been building knowledge and data on asphalt overlays for a number of years. Portland cement concrete is also an option for overlays, but it is less commonly used.

What's the Problem?

WisDOT constructs concrete overlays according to AASHTO 1972 design standards, which require a tedious and time-consuming process of graphing multiple properties to arrive at an overlay design. Furthermore, even with its 1993 update, the AASHTO design process does not fully account for the underlying elasticity (or, conversely, stiffness) of the rubblized layer in determining the thickness of a PCC overlay.

More sophisticated design methods, such as the new AASHTO Mechanistic-Empirical Pavement Design Guide that WisDOT is adopting, assign an elastic value to rubblized layers based on deflection testing data, and then use the elastic value of the new base structure to determine the required thickness of new concrete slabs. But little research has been done on characterizing rubblized concrete for use with concrete pavement overlays; more has been done on its use with hot-mix asphalt overlays.

Concrete is significantly stiffer than asphalt and should distribute less stress from traffic loading into the rubblized base. WisDOT engineers expect that PCC over rubblized concrete would be quite durable, but with little experience with new design approaches for concrete overlays, this expectation needed confirmation.

Research Objectives

This research sought to verify that PCC over rubblized concrete pavement is a strong, durable option for overlays of aging concrete roadways. The research specifically focused on the design implications of the rubblized layer for the thickness and durability of the concrete overlay.

Methodology

To investigate the design implications of rubblized concrete pavement layers for PCC overlays, researchers took the following steps:

- Reviewed current design procedures.
- Evaluated k-value, a measure of the combined elastic support strength of the rubblized layer and the subgrade, based on rubblized layer thickness and quality of subgrade support.
- Conducted a mechanistic evaluation of load-induced edge stresses with and without a rubblized PCC base layer.
- Evaluated the performance of an urban pilot slab of PCC over rubblized concrete pavement.
- Evaluated the performance of a rural Interstate project of PCC over rubblized concrete pavement.
- Prepared design recommendations for PCC over rubblized concrete pavement.

Investigator



"We found that rubblized concrete improves the quality of the slab support and may increase the durability of the PCC overlay. In certain situations, this can lead to a reduced concrete overlay thickness requirement."

—Jim Crovetto
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Rigid Pavements TOC Chair



“This study shows us that we can reasonably credit the underlying rubblized layer with greater support than our existing design guidelines allowed, and can expect longer service lives from our PCC overlays.”

—Jim Parry

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Developed by an affiliate of Wisconsin's Antigo Construction Company, this multiple drop hammer machine reduces concrete pavement to rubble in minutes. The aggregate-like rubble is left in place and a PCC overlay is placed over it. Photo courtesy of Antigo Construction.

Results

Based on the results of this study, researchers recommended that WisDOT continue to construct PCC overlays of rubblized concrete according to current practices outlined in the department's Facilities Development Manual. Specific findings and conclusions included:

- Depending on the thickness of the rubblized layer and the subgrade quality, incorporating rubblized concrete increased the composite elastic strength of the subgrade by two to four times.
- This increase in strength reduced the required concrete layer thickness by 0.25 to 1.45 inches, depending on subgrade quality and traffic loading expectations.
- Mechanistic evaluation showed a smaller reduction in required concrete thickness.
- The urban pilot slab, a 5-inch-thick bus pad over rubblized PCC pavement, has performed well during more than four years of service.
- The rural Interstate project, an 11-inch slab over a 4-inch open-graded separation layer over a 9-inch rubblized PCC base, has performed well during more than three years of service.
- Backcalculations from deflection tests confirmed that the support of the rubblized layer is significantly greater than current WisDOT design procedures assume.

Benefits

This study confirms the viability of overlaying rubblized concrete pavement with PCC, and the procedure may continue without design restrictions. Because the allowable thickness reduction based on this study is less than 1.5 inches, the main benefit of placing PCC over rubblized concrete pavement will likely be in increased durability rather than reduced concrete thickness. PCC overlays may be a viable alternative to HMA overlays of rubblized concrete where achieving long-term durability is critical.

Implementation and Further Research

Before this study's findings can be implemented, the WisDOT Pavement Design Group will examine the research results and determine their implications for use with the new mechanistic-empirical design guide. Researchers recommend further investigation to validate WisDOT's current practice of including an open-graded aggregate interlayer between the overlay and the rubblized base. Researchers also recommend that rubblized test sections along Interstate 39 near Stevens Point be monitored to identify performance characteristics of the PCC over rubblized concrete design.

This brief summarizes Project 0092-00-11, “Portland Cement Concrete Pavements Over Rubblized PCC,” produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

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