

Discussion of “Full Rubblization” & “Modified Rubblization”



Prepared by Antigo Construction, Inc., September, 2014 (w/ Metric)

Rubblization defined

“The intent of rubblizing concrete pavement prior to a pavement overlay is to produce a structurally sound base which prevents reflective cracking by obliterating the existing pavement distresses and joints. . . . It is not a typical granular material and it is not an engineered material like crushed aggregate base course.”

*From “Rubblizing Concrete Pavement” section of Wisconsin DOT
Construction & Materials Manual*

Obliterating the existing pavement distresses and joints



Rubblized pavement behavior

“A rubblized and compacted PCCP is an assemblage of PCC segments that form a tightly keyed, interlocked, high-density material layer. A rubblized PCCP layer is fractured, lacks continuity, and cannot sustain flexural stress. However, it possesses high shear strength and rutting resistance. It is not a typical granular material.”

From “Hot-Mix Asphalt Overlay Design Concepts for Rubblized Portland Cement Concrete Pavements”, Marshall R. Thompson, Transportation Research Record 1684, Paper No. 99-0922

Professor Marshall Thompson inspecting rubblized pavement



Early research

“In summary, the most significant concept relative to the philosophy of Fractured Slab Techniques, illustrated by Figure 62, is that in order to achieve the best possible performance at minimum cost, the fracturing process should yield an effective modulus as high as possible while satisfying the E_{cr} criteria of having less than 5% of the project area exceed the critical threshold level of 1000 ksi.”

From “Guidelines and Methodologies for the Rehabilitation of Rigid Highway Pavements using Asphalt Concrete Overlays”, page 200, January 1991, PCS/LAW for National Asphalt Pavement Association.

Early research

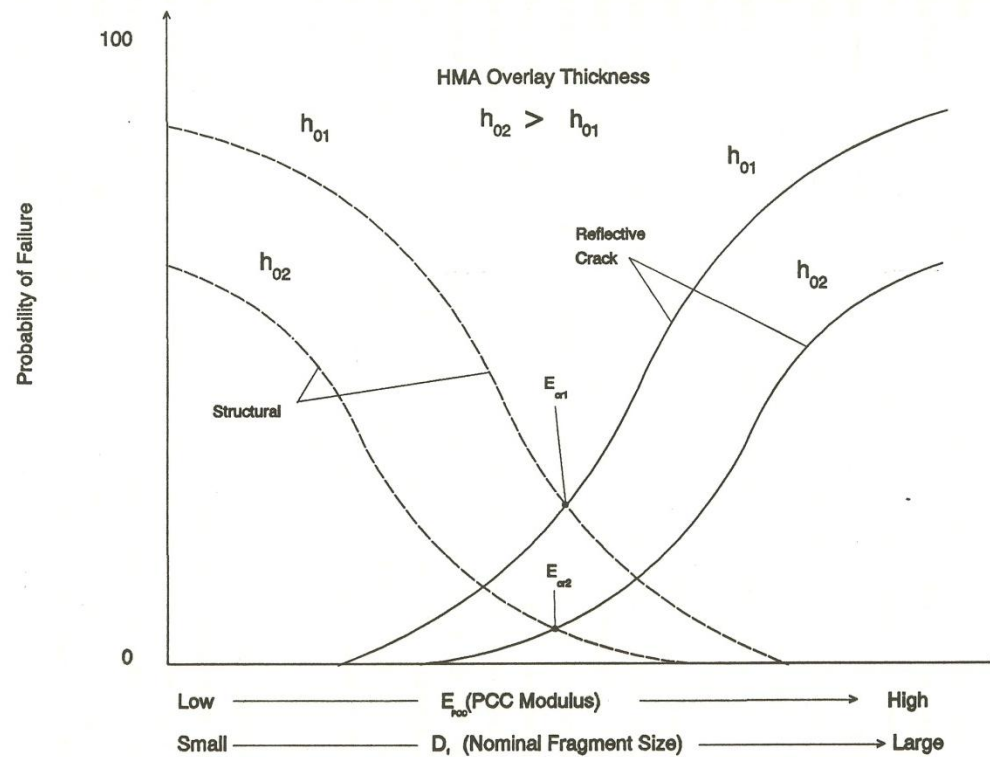


FIGURE 62 INFLUENCE OF PCC FRACTURED MODULUS AND HMA OVERLAY THICKNESS UPON STRUCTURAL AND REFLECTIVE CRACK FAILURE

Rubblization specifications

The previous slides describe the rubblized concrete layer and how its properties effect the performance of an asphalt overlay. Though the particle sizes of the rubblized concrete do not necessarily determine these properties, **ALL** rubblization specifications use particle sizes to define rubblization acceptance criteria. The required particle sizes vary by specification but the general emphasis is on achieving small particles. Very few specifications emphasize the concept of “producing a structurally sound base”.

Smaller is not always better

The PCS/Law report emphasized the important concept of rubblizing the concrete slabs to the degree necessary to achieve an effective modulus low enough to eliminate reflective cracking yet high enough to provide adequate support for the asphalt overlay.

The PCS/Law critical threshold of 1000 ksi (6900 MPa) was a provisional value back in 1991. The report states, “(F)uture studies pertaining to this parameter will hopefully lead to a more accurate assessment of the proper value to be used in design.” More recent FWD analyses typically report modulus values for the rubblized concrete layer in the 50 to 100 ksi (350 to 700 MPa) range for typical 9- to 12-inch (225 to 300 mm) thick highway pavements.

Localized failure – weak subgrade



Rubblized particle size consideration & “modified rubblization”

The particle size acceptance criteria are generally met when rubblizing over subgrade/base providing fair to good support. At times it is impossible to meet these criteria when support is fair to poor. It is often counterproductive to try to achieve small particle sizes in these situations because the resulting rubblized concrete layer would not provide adequate structural support for the overlay. Experience has shown that a “**modified rubblization**” that employs less fracture energy in order to produce a somewhat stiffer rubblized concrete layer (larger concrete particle sizes) will maintain enough of the concrete layer’s strength to support construction operations and the new asphalt overlay and still effectively eliminate reflective cracking.

WisDOT addresses modified rubblization in engineer guidance

“Attention must also be paid to constructability. Even if it is possible to produce small particle sizes, the resulting layer must still provide a working platform for paving operations and a stable foundation for the pavement overlay. In cases of isolated, very weak subgrade, subgrade correction may be appropriate. Another way to compensate for weak subgrade is to modify the rubblizing pattern to produce larger particle sizes which maintain more of the existing concrete pavement’s structural support. Experience has shown that segments of twelve to eighteen inches in the lower half of the slab are still effective for eliminating reflective cracking.”

From Section 3.50 “Rubblizing Concrete Pavement” of the Wisconsin DOT Construction & Materials Manual

WisDOT addresses modified rubblization in rubblization specification

“The engineer may direct or allow larger maximum particle dimensions.”

From “Section 335 Rubblized Pavement” of Wisconsin DOT 2014 Standard Specifications

Keys to a successful modified rubblization project

- Achieve full-depth slab fracture while maintaining good particle interlock
- Maintain adequate structural support in rubblized concrete layer to compensate for low subgrade support
- Minimize construction traffic on rubblized concrete until at least the first lift of asphalt is placed

Characterizing full rubblization & modified rubblization

Antigo uses the following descriptions to describe the range of fractured slab techniques performed with the MHB Badger Breaker®:

Full rubblization: typically 2" (50 mm) minus particles at the surface, typically 6" to 12" (150 to 300 mm) particles at the bottom of the slab.

Modified rubblization – significant spalling: 12" (300 mm) minus particles at the surface, significant surface spalling, surface appearance ranges from smooth to pulverized, typically 75% of the particles at the bottom of the slab are 15" (375 mm) minus size.

Modified rubblization – occasional spalling: full-depth and clearly visible cracks, crack spacing of 12" to 18" (300 to 450 mm), occasional surface spalling.

Crack & seat with MHB: full-depth, hairline cracks at the surface (sometimes only visible with the aid of water), crack spacing of 24" to 36" (625 to 900 mm), minimal surface spalling.

Full rubblization



Full rubblization



Modified rubblization – significant spalling



Surface after rolling with grid roller



More significant surface spalling



Modified rubblization – occasional spalling



Clearly visible cracks



Crack & seat with MHB



Visible hairline cracks



Intermediate base layers to compensate for weak subgrade

The majority of rubblization and asphalt overlay projects in Iowa have been constructed over subgrade providing low support. A modified rubblization pattern is typically chosen by the engineer. This situation has also commonly been addressed in the design phase by including an intermediate base layer of crushed stone or RAP on the rubblized layer prior to the asphalt overlay. This layer provides additional structural support, integrates well with pavement widening, and provides a uniform surface for the asphalt overlay.

Crushed stone layer over rubblized



RAP layer over rubblized



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