TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 0-4502-S
URL: http://tti.tamu.edu/documents/0-4502-S.pdf

Project 0-4502: Microcracking Stabilizes Bases during Construction to Minimize Shrinkage Cracks

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PROJECT SUMMARY REPORT

Microcracking for Reduced Shrinkage in Cement-Treated Base

Shrinkage cracking such as that illustrated in Figure 1 occurs in cement-treated bases (CTB) due to desiccation and cement hydration. Eventually these cracks start to reflect through the pavement surfacing. While initially cosmetic in nature, these cracks open the pavement to water infiltration and increase the likelihood of accelerated pavement distress.

This project focused on evaluating the effectiveness of the microcracking concept for reducing shrinkage cracking in cement-treated bases. Microcracking can be defined as the application of several vibratory roller passes to the cement-treated base at a short curing stage, typically after 1 to 3 days, to create a fine network of cracks. The goal of microcracking is to prevent severe, wide cracks from forming and thus reduce the risk of problematic reflective cracking through the pavement surfacing.

Figure 1. Shrinkage Cracking Resulting from Problems with Cement-Treated Base.

What We Did...

In this project, Texas Transportation Institute (TTI) researchers monitored performance of microcracking test sites on SH 47 and IH-45 frontage road projects. The research team also coordinated construction and monitored performance of controlled test sites constructed with two different cement contents, 4 and 8 percent, at Texas A&M University's Riverside Campus.

In addition to microcracking test sites, the Riverside facility also included moist-cured, dry-cured, and asphalt-membrane-cured sites for comparison. The research team used falling weight deflectometer (FWD) tests to control the microcracking process, periodic crack surveys to monitor crack performance, and FWD tests through time to track base moduli.

What We Found…

On SH 47, pre- and post-microcracking FWD testing revealed that microcracking typically resulted in an immediate and temporary decrease in base modulus by 60 percent. Additional monitoring showed the base modulus rapidly recovers by continued cement hydration, and currently no significant difference in modulus exists among any of the SH 47 test sites. The average base modulus is 801 ksi. The crack performance of the sites overall is good. After more than 3 years in service, the worst site has approximately 21 linear feet of cracking per 1000 ft^2, and the best site only 0.2 ft of cracking for the same area.

The best opportunity to study microcracking occurred through the construction of test sites at Riverside Campus. For each of the sections, Figure 2 shows both the average backcalculated modulus and the 95 percent confidence interval. For a given cement content, no difference exists in the average modulus values among the different treatments. Microcracking did not harm the long-term in-service modulus.

At the Riverside Campus test sites, microcracking reduced crack severity (width) and crack length. Figure 3 illustrates the difference in crack severity between the moist-cured and the microcracked site with 4 percent cement. The cracks in the moist-cured sections are such that spalling is starting to occur. The best performance was at the 4 percent cement site microcracked after 2 days of curing.

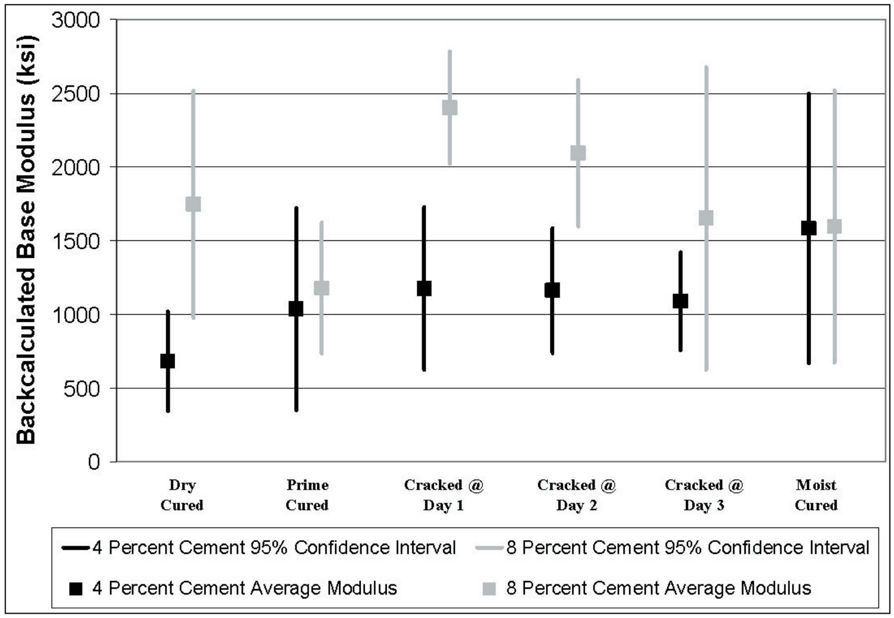

Figure 2. Backcalculated Moduli for Test Construction Sites.

On average, with a properly designed base, microcracking reduced the amount of cracking by 50 percent, with reductions ranging from 30 to 70 percent. Figure 4 illustrates the range of potential yearly net present value (NPV) savings to the Texas Department of Transportation (TxDOT) with varying levels of implementation of microcracking. The cost savings result from reduced amounts of crack sealing required on the section over the pavement life.

A secondary topic that resulted from this project was the investigation of CTB modulus at early curing times. TxDOT specifications require a 3-day

3a. Sample Cracking in Microcracked Pavement (top)

3b. Sample Cracking in Moist-Cured Pavement (right)

Figure 3. Differences in Crack Severity.

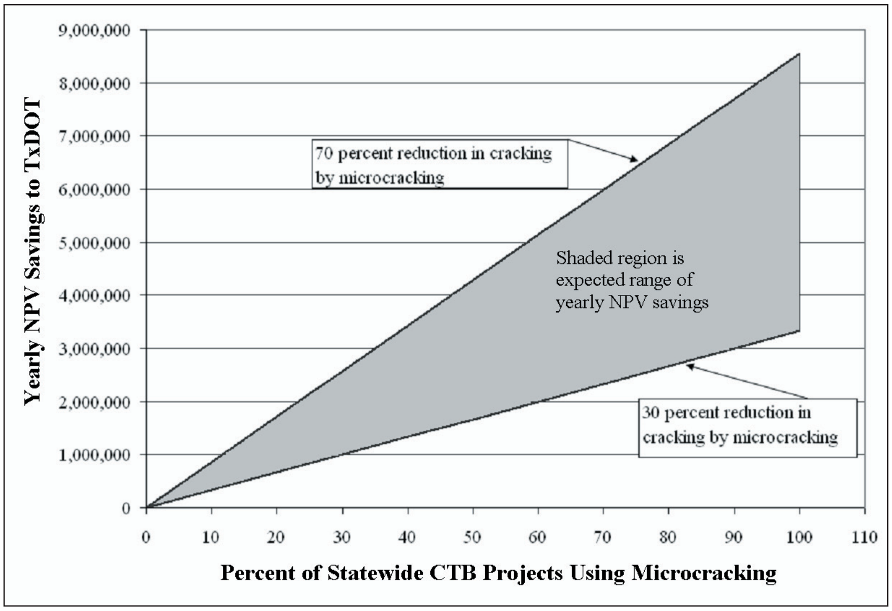

Figure 4. Yearly Net Present Value Savings.

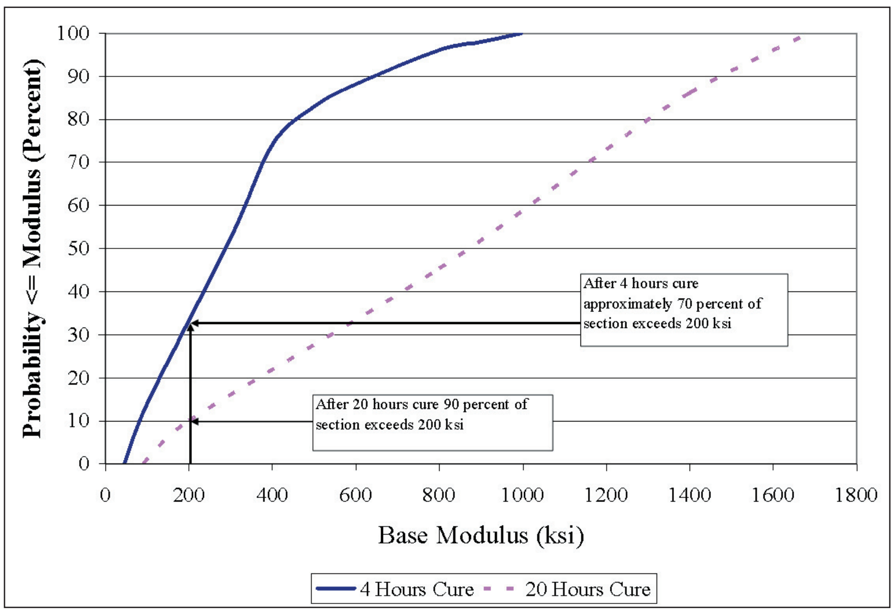

Figure 5. Comparison of Field Modulus at Early Curing Times.

moist cure as one option for curing; however, in some cases the road may need to be opened sooner. Figure 5 shows the cumulative distribution of the Riverside site with 4 percent cement at curing times of approximately 4 and 20 hours. If a minimum CTB modulus of 200 ksi was desired before allowing traffic on the section, then after 4 hours curing only 70 percent of the section would meet the desired modulus value. However, after 20 hours curing 90 percent of the section would exceed the minimum desired modulus. The data indicate that earlier trafficking of the cement-treated base than what is typically allowed should not pose a problem.

The Researchers Recommend…

Based upon the promising results from microcracking and the lack of negative impacts on pavement performance, microcracking provides a valid method for reducing the risk of problematic cracking in properly designed CTB. The research team recommends the following process for a successful microcracking project:

- Design the cement content through laboratory tests to meet the following criteria for strength and moisture susceptibility:
  - 7-day unconfined compressive strength: ≥300 psi and
  - final dielectric value after the tube suction test: ≤10.
- After placement and compaction of the base to project specifications, moist cure the base to an age of 48 hours before microcracking. If performing construction in winter months with average daily temperatures below 60 °F, cure the base for at least 96 hours prior to microcracking.
- Microcrack the section by using the same (or equivalent) vibratory steel wheel roller that was employed for compaction. A minimum 12-ton roller should be used.
- Perform three full passes (one pass is down and back) over the entire section traveling 2 to 3 mph with the roller vibrating on maximum amplitude, unless otherwise directed by the engineer.
- Follow curing requirements of Item 275 or 276 by sprinkling.

For More Details...

This information is documented in the following reports:

Report 0-4502-1: *Effectiveness of Minimizing Reflective Cracking in Cement-Treated Bases by Microcracking*

Report 0-4502-2: *Continued Evaluation of Microcracking in Texas*

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