


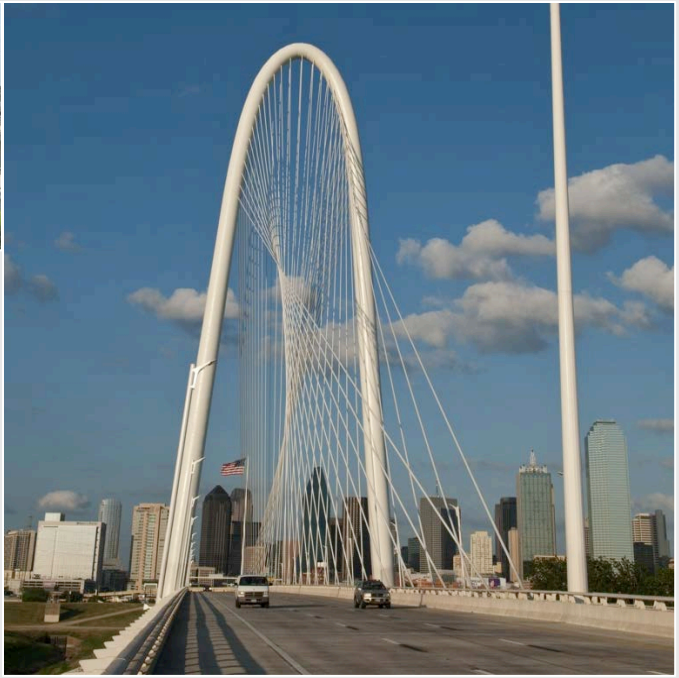

MICROCRACKING FOR CEMENT TREATED BASE - BRYAN

Darlene C. Goehl, P.E.

88th Annual Transportation Short Course

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Backgound Information

- TxDOT Research Project 0-4182(TTI),
  - Researcher, Tom Scullion
  - Looked at problems associated with Full Depth Recycling Projects,
    - Project Longitudinal Cracking on sections constructed on highly plastic soils
    - Bonding problems with fly ash treated bases
    - Excessive shrinkage cracking on cement stabilized bases
      - Reported on several sections, except in Bryan District
- Question – Why no shrinkage cracking on Bryan District Projects?

Example Shrinkage Cracks

Research Project 0-4502

- TTI performed the research
- Researchers
  - Tom Scullion and Stephen Sebesta

- Purpose of project:
  - Evaluating the effectiveness of the microcracking concept.
    - When to stop rolling?
    - Is the slab cracked?
    - Is structure damaged?

Test Sites

- SH 47
- IH 45 Frontage Roads
- Riverside Campus Test Site

Test Site – SH 47

- Constructed Spring 2002
  - 14” CTB
  - 4” HMA
  - 5 sections,
  - all microcracked after 1 to 3 days cure
  - Minimal transverse cracking

Test Site – SH 47

- 12 ton vibratory roller
- 1 –2 days after placement
- 2-3 mph
- High amplitude
- 2 – 4 passes
- Test after 2 passes

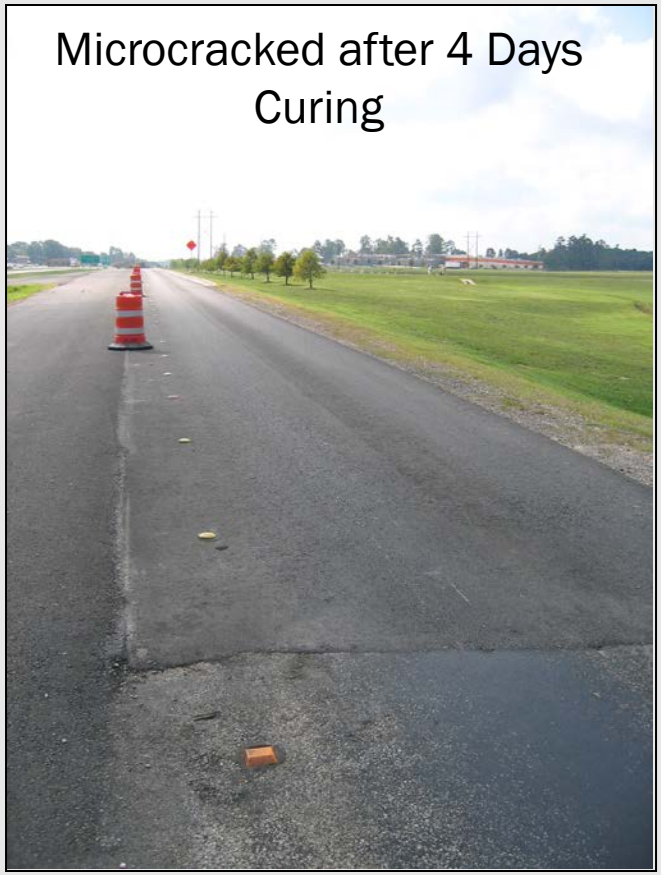
Test Site – IH 45 frontage Roads

- Outside Lanes constructed December 2004 (includes 200’ control)
  - TTI performed lab mix design (4% cement based on strength and moisture susceptibility)
  - TTI helped administer and monitor microcracking on outside lanes in December
- Inside Lanes constructed May 2005
- Structure:
  - 10” LTS
  - 14” CTB
  - 5” HMA
- During construction in December, noted longer than 3 days needed for CTB curing before initiation of microcracking
- Too early to evaluate long term performance (at time of Research) Still looks good with no shrinkage cracks observed in 2014.

Test Site – IH 45 frontage Roads

- Survey August 2005
  - No cracking ; FWD SB OL-Backcalculation values very high

Microcracked after 4 Days Curing



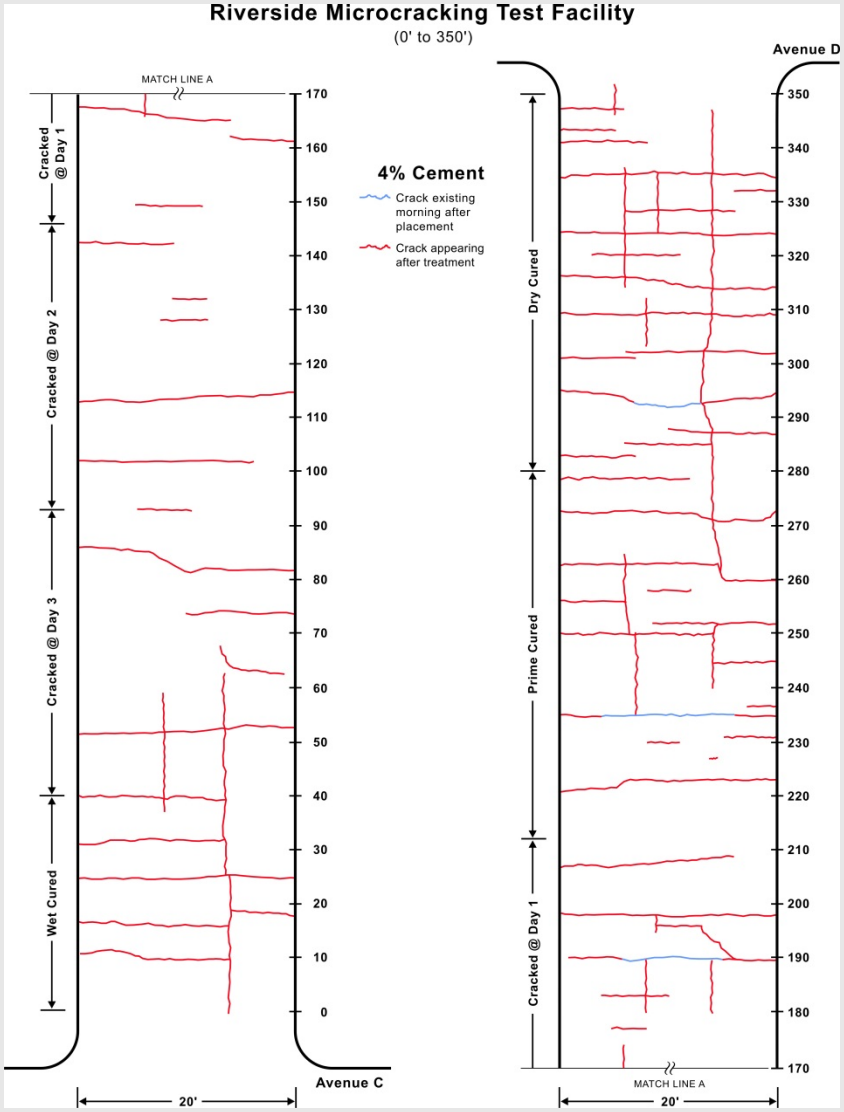
200’ Control
(not Microcracked)

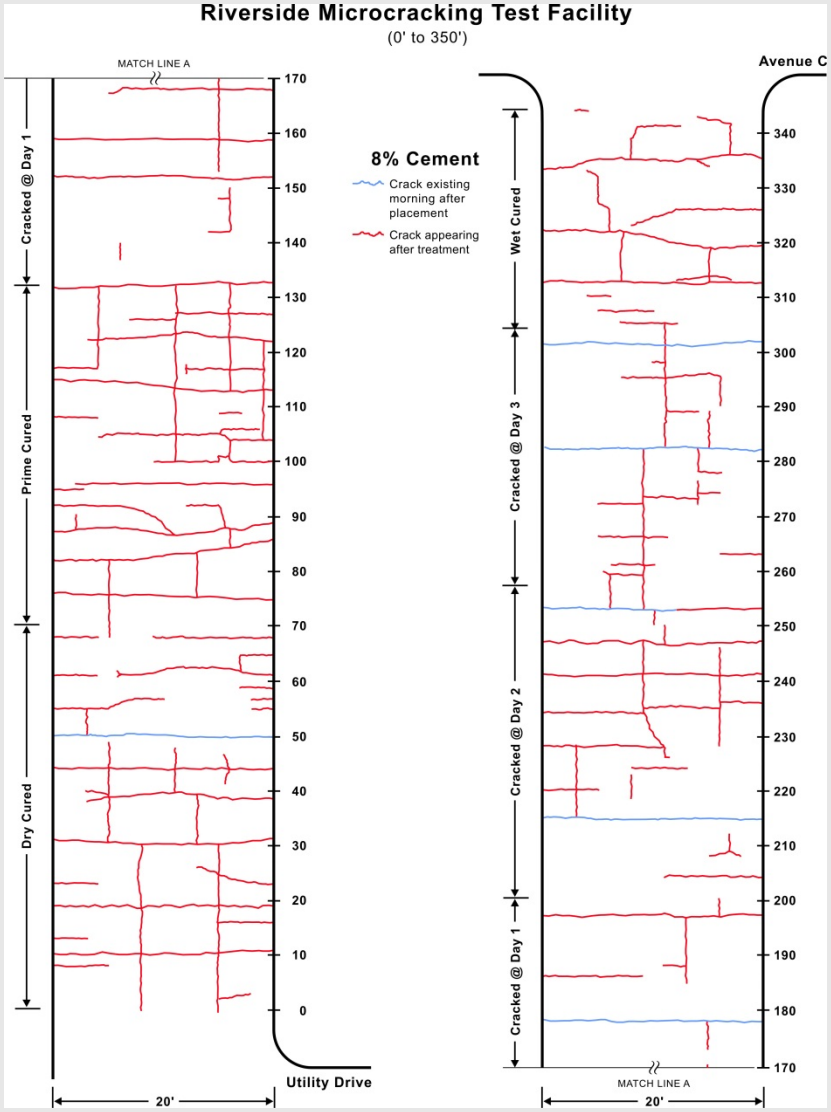
Test Site - Riverside

- Constructed September 2003
- Sites with both 4 and 8% cement
- Treatments include:
  - Dry cure
  - Prime cure
  - Microcrack at 1, 2, and 3 days cure
  - Wet cured for 3 days

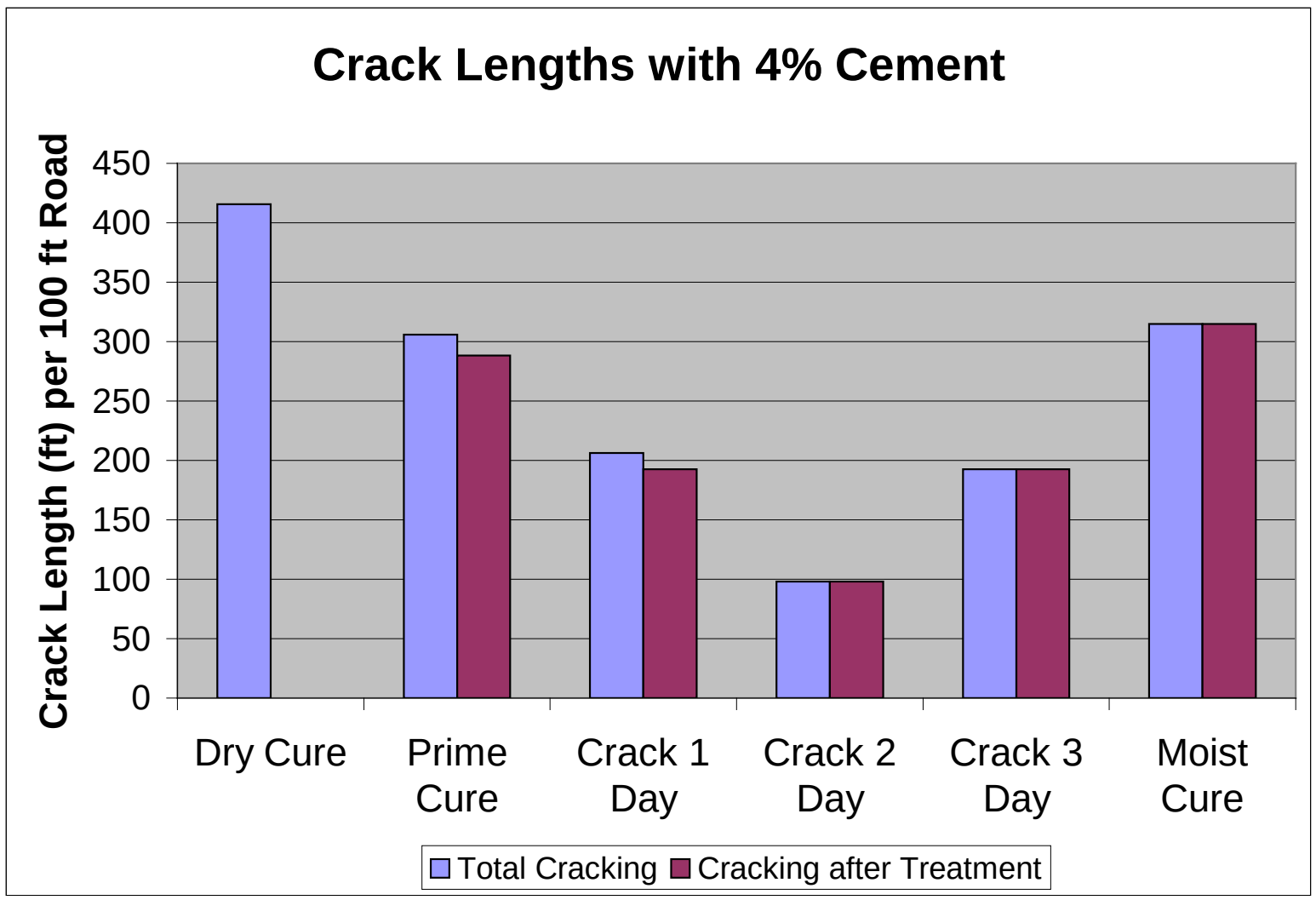
Test Site - Riverside

- Crack maps

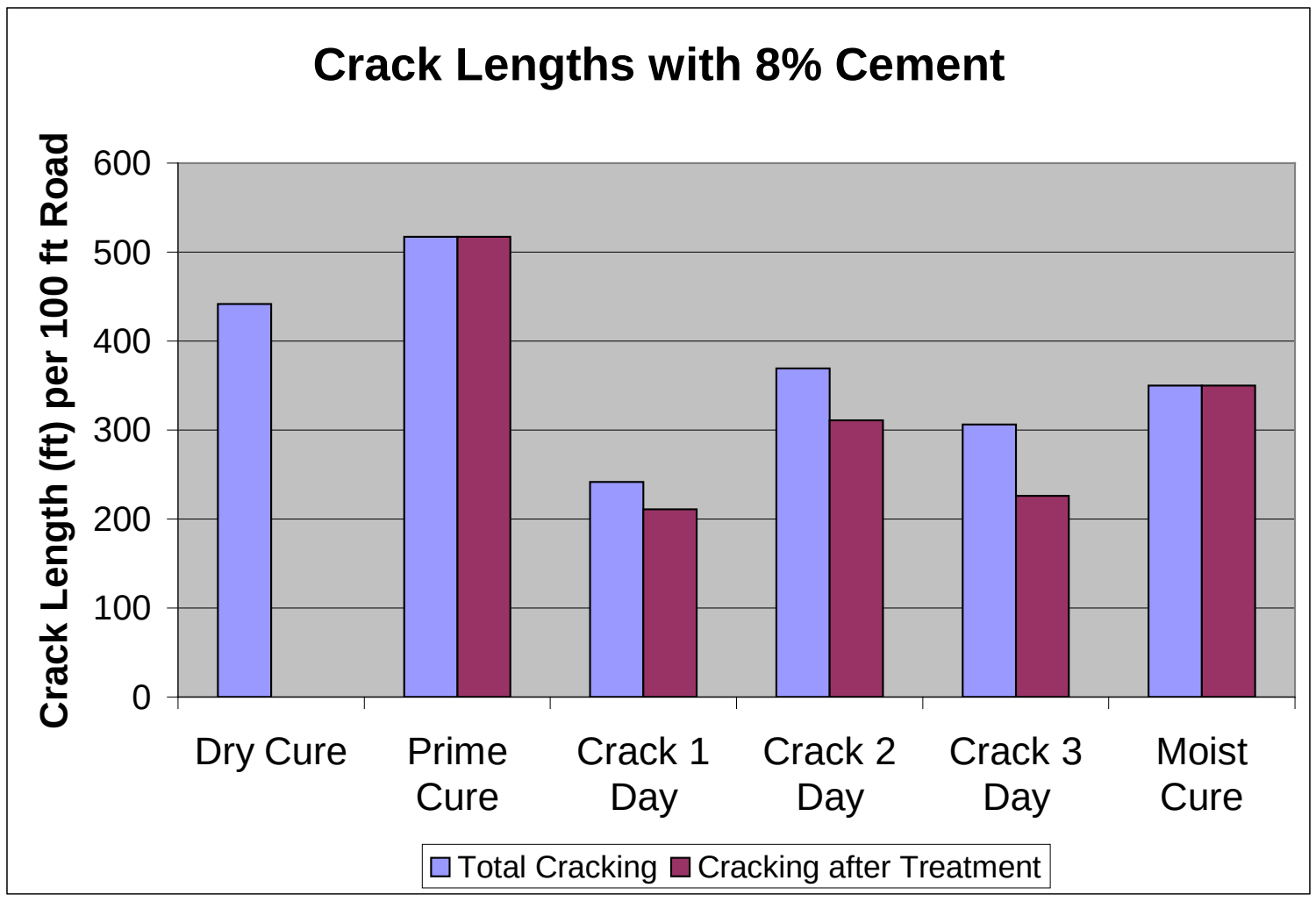




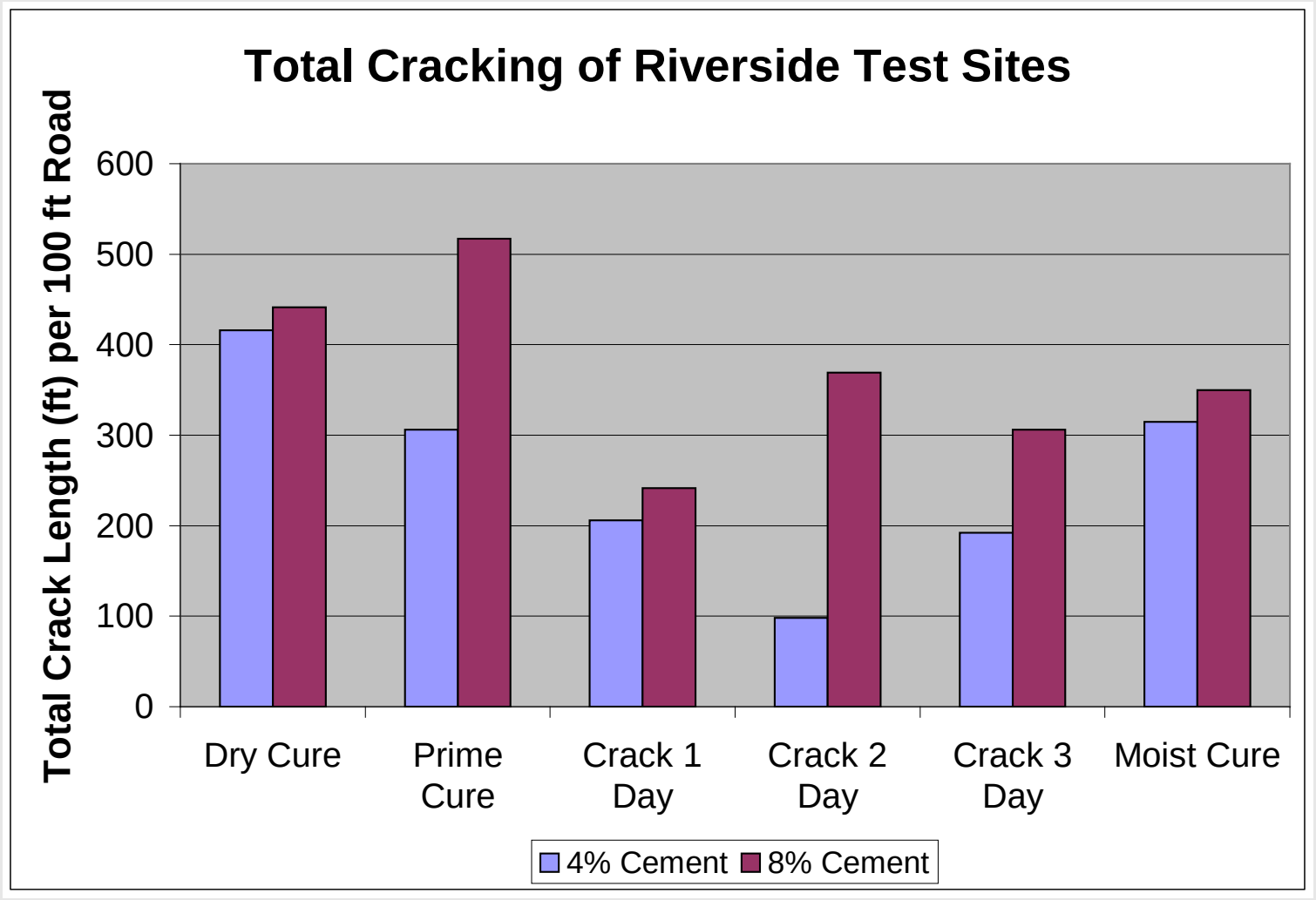
Test Site - Riverside



Test Site - Riverside

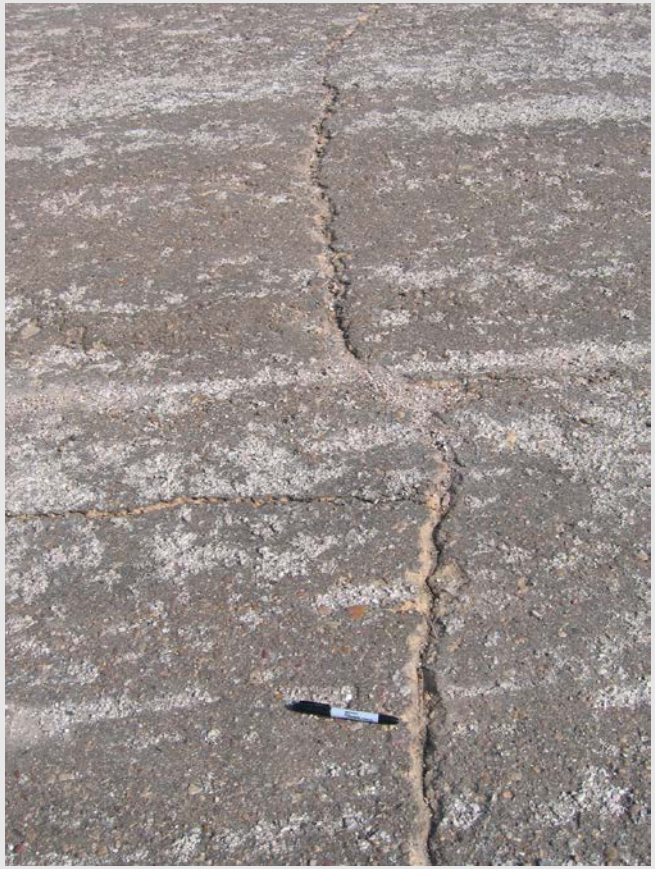


Test Site - Riverside



Test Site – Riverside

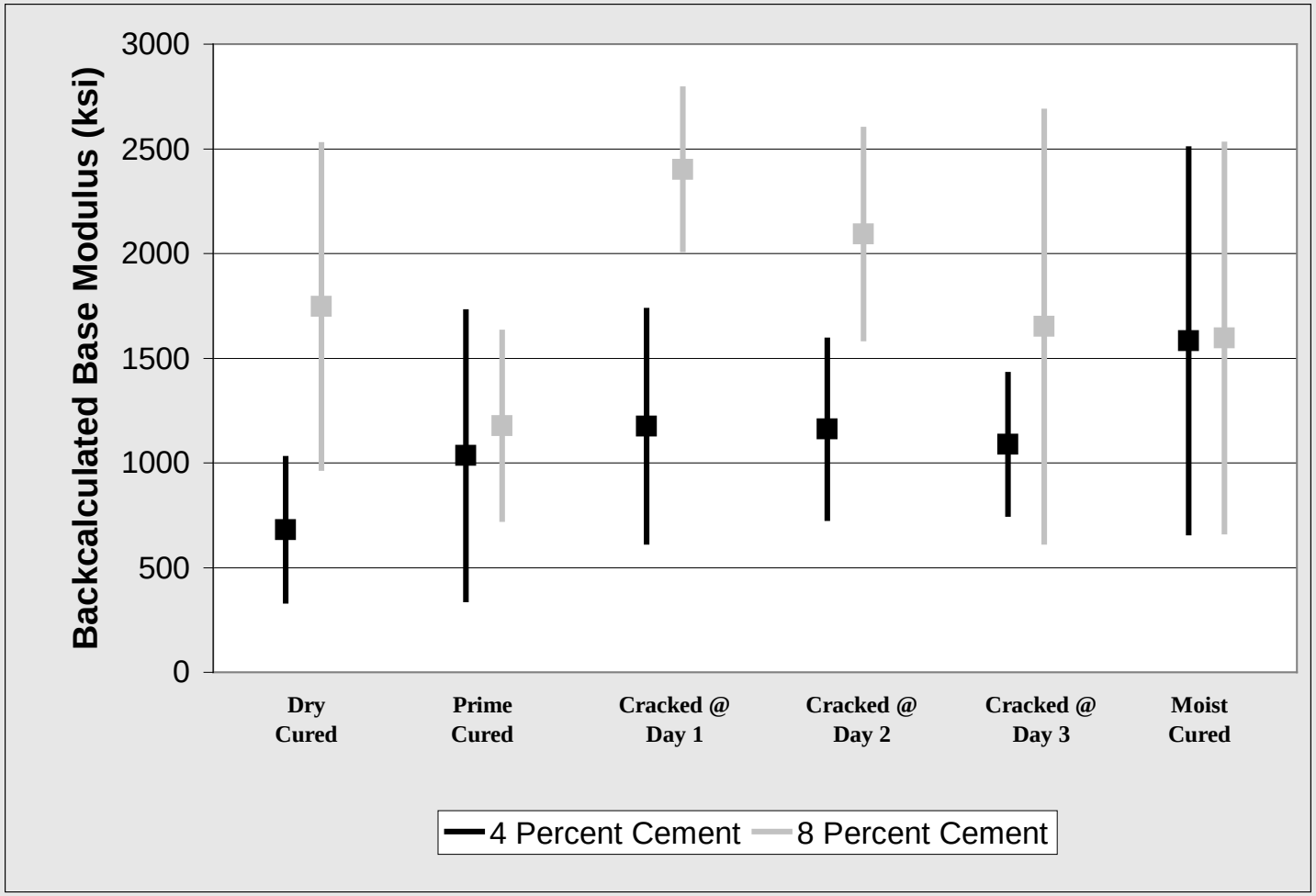
Microcracking influence on Crack Severity



Wet Cured

Microcracked

FWD Results at Riverside



Research Conclusions on Microcracking

- For a given cement content, microcracking improves crack performance (length and severity)
- Greatest potential long-term benefit when combined with current lab mix designs (lowered strength targets)
  - The best performer at a higher cement content had over twice the amount of cracking as the best performer with the reduced strength target

Research Conclusions on Microcracking

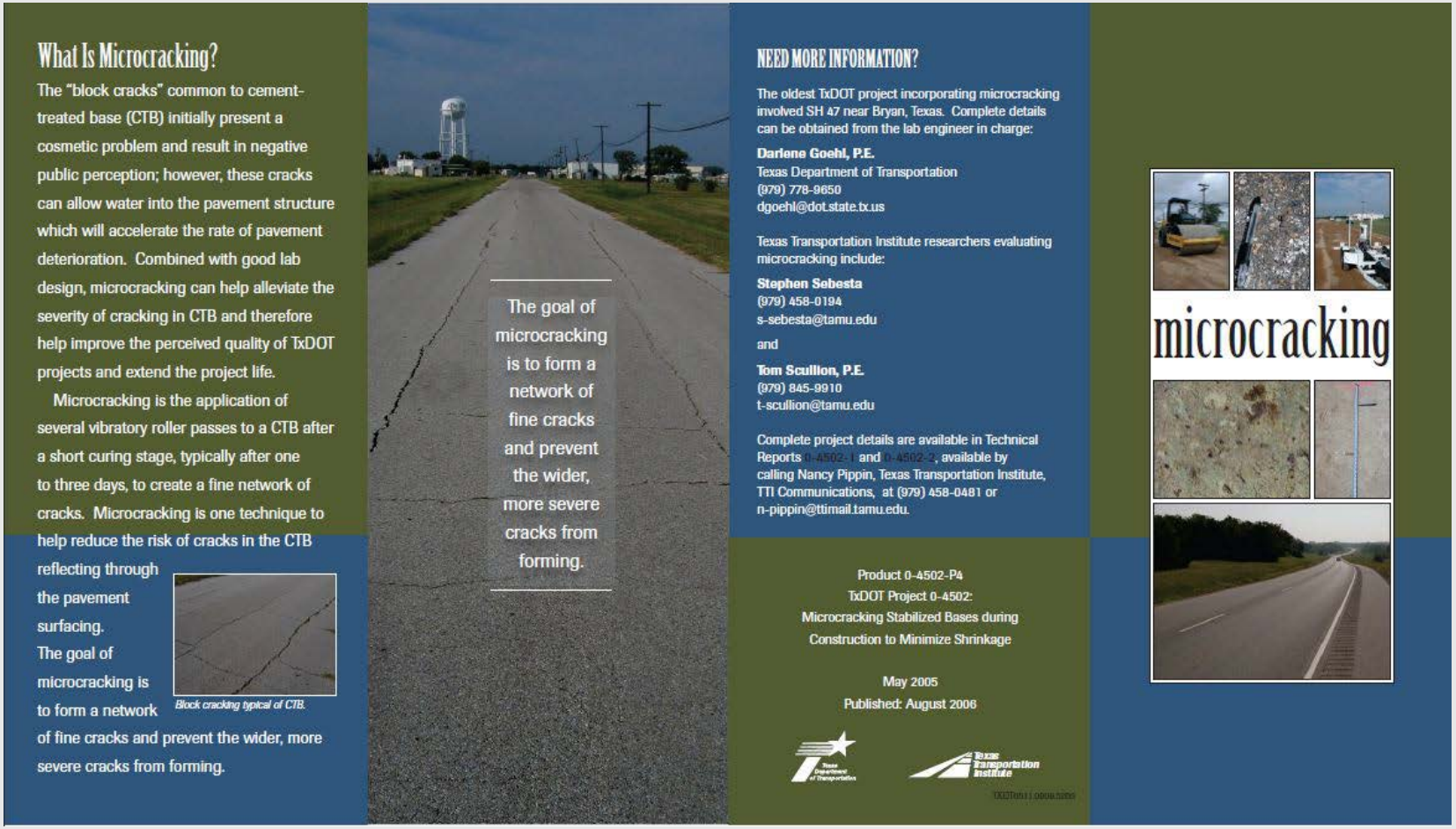
- With high cement contents, two microcracking sessions may be needed as suggested in European literature
- Microcracking does not hurt the in-service base stiffness
- In most conditions, perform microcracking with 3 passes after two days curing
- When constructing in cooler seasons (avg daily temp <60 F), wait 4 days before microcracking

Research - What's Next...

- Pamphlet guide to Microcracking (4502-P4) should be sent to Area and District Offices
- Consider compilation of microcracking projects in Texas for long term performance assessment
- Simpler, more rapid means to determine when rolling has achieved microcracking
  - Instrumentation with accelerometers?
  - PFWD may be an option
  - Reportedly Geogauge modified and showing promising results in NCHRP study

Research Information

- http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-4502-P4.pdf



What Is Microcracking?

The "block cracks" common to cement-treated base (CTB) initially present a cosmetic problem and result in negative public perception; however, these cracks can allow water into the pavement structure which will accelerate the rate of pavement deterioration. Combined with good lab design, microcracking can help alleviate the severity of cracking in CTB and therefore help improve the perceived quality of TxDOT projects and extend the project life.

Microcracking is the application of several vibratory roller passes to a CTB after a short curing stage, typically after one to three days, to create a fine network of cracks. Microcracking is one technique to help reduce the risk of cracks in the CTB reflecting through the pavement surfacing.

The goal of microcracking is to form a network of fine cracks and prevent the wider, more severe cracks from forming.

Block cracking typical of CTB.

The goal of microcracking is to form a network of fine cracks and prevent the wider, more severe cracks from forming.

NEED MORE INFORMATION?

The oldest TxDOT project incorporating microcracking involved SH 47 near Bryan, Texas. Complete details can be obtained from the lab engineer in charge:

Darlene Goehl, P.E.
Texas Department of Transportation
(979) 778-9650
dgoehl@dot.state.tx.us

Texas Transportation Institute researchers evaluating microcracking include:

Stephen Sebesta
(979) 458-0194
s-sebesta@tamu.edu

and

Tom Scullion, P.E.
(979) 845-9910
t-scullion@tamu.edu

Complete project details are available in Technical Reports 0-4502-1 and 0-4502-2, available by calling Nancy Pippin, Texas Transportation Institute, TTI Communications, at (979) 458-0481 or n-pippin@ttimail.tamu.edu.

Product 0-4502-P4
TxDOT Project 0-4502:
Microcracking Stabilized Bases during Construction to Minimize Shrinkage

May 2005
Published: August 2006

Texas Transportation Institute

microcracking

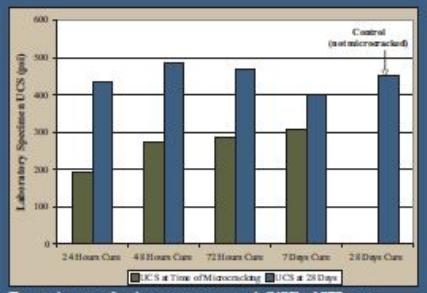
Reference TxDOT Research 0-4502, Researcher, Tom Scullion w/ TTI

Research Information

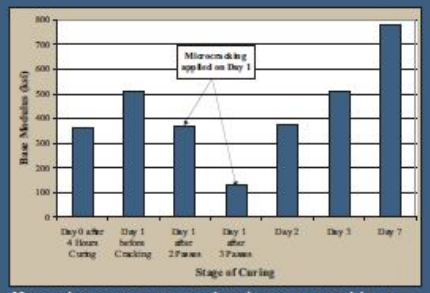
Microcracking in progress with the vibratory roller. TxDOT's FWD can serve as the control mechanism to determine when to stop rolling by measuring the reduction in average base modulus.

What Materials Should Be Microcracked?

Performance of microcracked field projects in Texas indicates no detrimental structural effects from microcracking. Even after failure at an early curing stage, the strength of the material recovers by continued cement hydration. At the end of the hydration stage, the strength of the previously failed material does not differ significantly from material simply cured to an age of 28 days. Additionally, the base modulus recovers after microcracking since the procedure takes place at an early curing stage. Microcracking imparts a temporary reduction in the base modulus. With additional curing time the base modulus rapidly recovers. Given the observed benefits and the lack of negative effects, microcracking can be considered for any properly designed CTB.



The 28-day unconfined compressive strength (UCS) of CTB is not harmed by microcracking at an early age.



Microcracking creates a temporary dip in the increase in modulus as curing progresses. (Modulus backcalculated from FWD with Modulus 6.0)

What Are the Benefits of Microcracking?

Microcracking reduces the severity of shrinkage cracking problems in CTB. Compared to moist curing alone, microcracking improves the performance of CTB by reducing the crack width, reducing the total crack length, or both. Through these mechanisms, microcracking reduces the risk of reflective cracking through the surface layer.

Crack in moist-cured section.

Crack in section microcracked.

What Does a Microcracked CTB Look Like?

Upon introduction to the microcracking concept, most pavements personnel fear microcracking will rubblize or powder the base. Contrary to this fear, a properly microcracked CTB looks no different than an ordinary CTB. Typically, no visual changes are detectable in the base immediately after microcracking. On rare occasions, some visible hairline cracks may appear. However, use of some type of stiffness testing device, such as the falling weight deflectometer (FWD), is typically the only method to definitively detect a change in the base after microcracking.

Visible cracks in CTB after microcracking are rarely observed.

How and When Should Microcracking Be Performed?

After placement and satisfactory compaction of the CTB according to the applicable bid item, the base should be moist cured by sprinkling for 48 to 72 hours before microcracking. If performing construction during winter months when average daily temperatures are 60° F or below, moist cure the base at least 96 hours before microcracking. Microcracking should be performed with the same (or equivalent tonnage) steel wheel vibratory roller used for compaction. A minimum 12-ton roller should be used. Typically three full passes (one pass is down and back) with the roller operating at maximum amplitude and traveling approximately 2 to 3 mph will satisfactorily microcrack the section. After satisfactory completion of microcracking, the base should be moist cured by sprinkling to a total cure time of at least 72 hours from the day of placement.

A portable FWD (PFWD) provides a compact alternative to the standard FWD for controlling microcracking. Other stiffness devices may also be able to control microcracking.

What to Look for During the Microcracking Process

Inspect the microcracking operation and look for:

1. Satisfactory completion of three full passes that achieve 100 percent coverage.
2. Signs of cracking in the CTB. Although new cracks are rarely observed (oftentimes some transverse cracking will have already taken place during the moist-curing stage), hairline cracks imparted by the roller occasionally may be visible. If available, the FWD can be used to ensure adequate completion of microcracking by testing every station immediately before microcracking, then retesting at each station immediately after completion of the three microcracking passes. The average base modulus as backcalculated from the FWD should be reduced at least 50 percent by microcracking. If using a PFWD for controlling microcracking, target a 40 percent reduction in average base modulus.
3. Signs of detrimental damage to the CTB. If properly designed and cured, microcracking should not damage the CTB. However, if the base appears to start to break up excessively at the surface, stop microcracking and use a static roller until a satisfactory surface finish is obtained.
4. Satisfactory completion of continued moist curing to an age of at least 72 hours from the day of placement.

Bryan District Implementation

- Application of Microcracking:
  - Cement Stabilized Base – Road or Plant Mixed
  - Use General Notes
  - Do not require if opening to traffic at the end of the construction day
  - Example General Notes:
    - After compaction the finished cement treated base shall be kept wet for a period of 24 to 48 hours. During this time, but not sooner than 24 hours, the finished course shall be rolled with a vibratory roller to induce microcracking. The vibratory roller shall be type C with a static weight equal to or more than 12 tons and the vibratory drum shall be not less than 20 inches wide. The roller shall travel at a speed of 2 mph, vibrating at maximum amplitude, and make 2 to 4 passes with 100% coverage exclusive of the outside 1 foot of the surface crown, unless otherwise directed by the Engineer. Additional passes may be required to achieve the desired crack pattern as directed by the Engineer. The Contractor shall notify the District Laboratory 72 hours before the microcracking begins at xxx-xxx-xxxx. After completion of the microcracking, the section shall be cured for a period of 48 hours. Curing shall be as described in Item 276.

Bryan District Implementation

- Important Information to have a successful Microcracked Base
  - Determine optimum stabilizer content based on unconfined compressive strength and moisture susceptibility.
  - Timing to perform microcracking 2- 3 days after compacting unless the average ambient temperature is <60^F, the increase to 4 days.
  - Equipment, typically same vibratory roller used for compaction (12 Ton or larger)
  - Try 3 passes (down and back) unless have FWD to test before and after. With FWD look for 50% reduction in backcalculated modulus before stop rolling.

Other TxDOT Districts that have used micro-cracking

The Dominican Republic microcracks all of its highways

Microcracking based on TTI Research ($2B under construction)

Other Agencies using Microcracking

- Caltrans
- New Zealand
- Zambia DOT
- Utah DOT

Caltrans Microcracking Method Spec

30-2.03 FULL-DEPTH RECLAMATION-CEMENT

During the period from 48 to 72 hours after compaction, microcrack the surface by applying 3 single passes of a 12-ton vibratory steel drum roller at maximum amplitude travelling from 2 to 3 mph, regardless of whether asphaltic emulsion has been applied.

UC- Davis 2014
Initiating an HVS test program on Microcracking

2014 TxDOT Spec Book

- Items 275 and 276
- **Microcracking.** When shown on the plans, maintain moisture content of the finished cement treated base for a period of 24 to 48 hr.. During this time, but not sooner than 24 hr., roll the finished course with a vibratory roller to induce microcracking. The vibratory roller shall be in accordance with Item 210, “Rolling,” with a static weight equal to or more than 12 tons and the vibratory drum shall be not less than 20 inches wide. The roller shall travel at a speed of 2 mph, vibrating at maximum amplitude, and make 2 to 4 passes with 100% coverage exclusive of the outside 1 ft. of the surface crown, unless otherwise directed by the Engineer. Additional passes may be required to achieve the desired crack pattern as directed. Notify the Engineer 24 hours before the microcracking begins.

Questions