CASE STUDY:
MICRO-CRACKING
A CEMENT TREATED ROADWAY BASE TO MINIMIZE SHRINKAGE CRACKS

TEXAS A&M UNIVERSITY
THE CITIES OF BRYAN & COLLEGE STATION., TX
THE CITIES OF LA QUINTA & SANTA ROSA, CA
CEMEX

For decades, cement-amending a roadway base has been a way of employing economical local materials in place of imported, high cost aggregate. These bases have the strength and low water permeability to potentially out perform flexible aggregate bases. Unfortunately, cement-amended bases are prone to significant shrinkage cracking that concentrate and reflect traffic stress resulting in premature pavement cracking sufficient to warrant repair or rehabilitation. Consequently, cement-amended bases have seen limited use over the last twenty years.

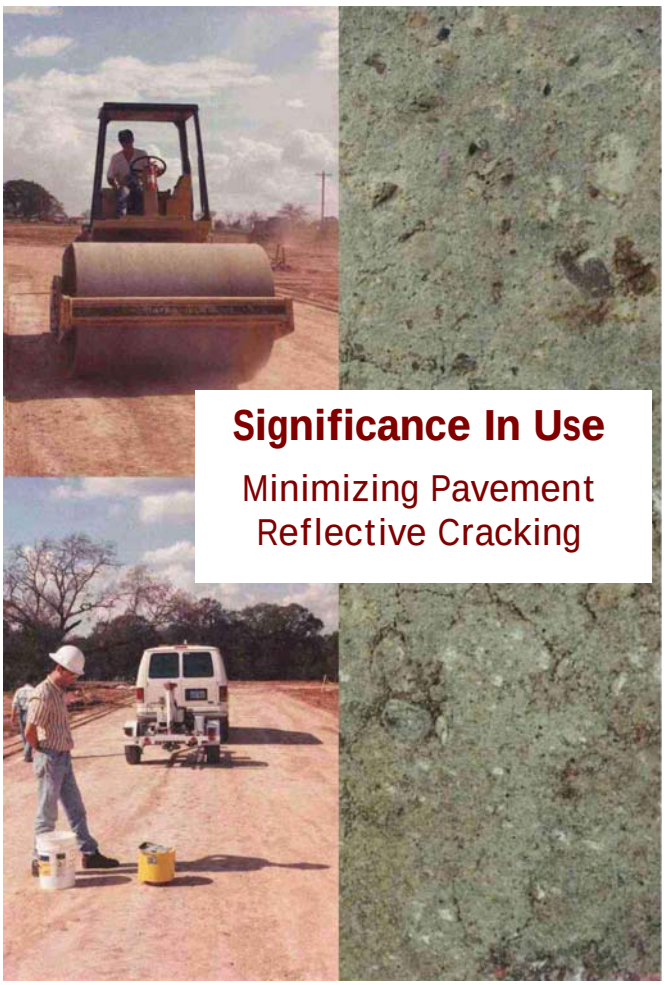
A simple and economical construction method has been developed in Europe and implemented in the United States that minimizes shrinkage cracking in these bases. Dr. Tom Scullion of Texas A&M University accomplished the implementation in response to a request from the City of College Station, Texas[1]. The method included aspects that have been under investigation for many years such as controlling the amount of cement used (3% to 9% by weight), the water content, the quality of the subgrade and the type & time of final surfacing. What was new in the method was the controlled induction of micro-cracks into the base. The micro-cracks prevent the development of the larger shrinkage cracks without significantly impacting stiffness of the base.

The performance of the mix was first verified through a series of unconfined compressive strength tests in the laboratory. A strength of 300 psi to 500 psi was required with around 300 psi considered optimal.

During the first two days of life, the stiffness of the base was evaluated to assure sufficient ultimate strength. The 6" to 12" lifts addressed by the method had to achieve a stiffness of about 50 to 60 Mega Newtons per meter (MN/m) during this period. At the end of this period, limited vibratory rolling (1 to 4 passes) using a 12-ton, steel wheel roller was conducted to lower base stiffness by about 40% and thereby induce a network of micro-cracks. Stiffness was directly measured in real-time without penetrating the base using the Humboldt GeoGauge.

The Humboldt GeoGauge is a 10" diameter, 11" tall, 22 lb. electro-mechanical instrument that when placed on the surface of the ground evaluates the stiffness of the top 9" to 12" of material. It vibrates the ground over a range of discrete frequencies, applies force, measures the resulting deflection and displays the results in about a minute. It was chosen by Texas A&M because measurements could be made quickly, it has no licensing or safety requirements and its performance (reliability, precision & bias) had been proven by FHWA Study 2(212).

Four sections of Salzburg Ct. Von Trapp Ct., Newburg Ct. and Sophia Lane in College Station, Texas were constructed during October of 2000. The construction consisted of 6" of lime-stabilized subgrade, 6" of soil-



Significance In Use

Minimizing Pavement Reflective Cracking

Humboldt GeoGauge™

[1] Field Investigation: Pre-Cracking of Soil-Cement Bases to Reduce Reflection Cracking, 2001, Tom Scullion, Texas A&M University, College Station, TX 77843

HUMBOLDT

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cement and a 2" HMA surfacing. The Salzburg Ct. Von Trapp Ct. and Newburg Ct. Sections received the stiffness control and the micro-cracking. The Sophia Lane section did not. Site conditions were generally wet during construction. Bob Mosley, City Engineer for College Station, supervised the work. Young Brothers, Inc. accomplished the construction.

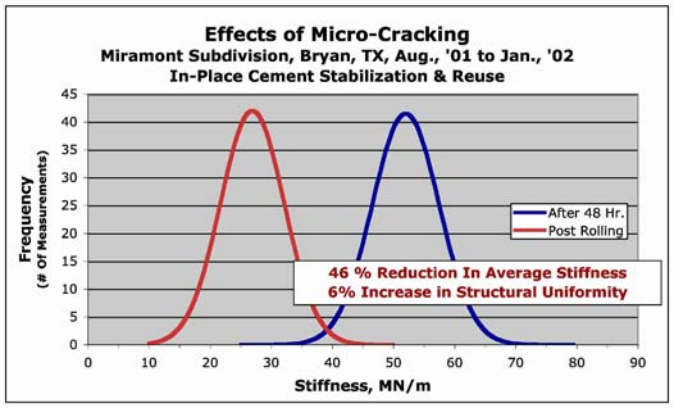
The micro-cracks were observed to greatly inhibit base shrinkage cracking. Laboratory testing of core samples indicated that the base reached its design strength. Apparently the micro-cracks were induced early enough in its life so as not to significantly inhibit strength gain. In more than 18 months of observations, the roadway sections constructed with the micro-cracking method exhibited at least 50% fewer reflection cracks in comparison to the section that did not. A corresponding reduction in roadway maintenance cost was also observed.

Texas A&M's results prompted the City of Bryan, Texas to specify the construction method in 2001[2]. As shown in the figure to the right, the QC test data followed the results achieved in the Texas A&M study. The City of Bryan has successfully used the method through the 2005 season. The City of College Station, Texas followed suit shortly after College Station, adopting the City of Bryan's specification for continuous use.

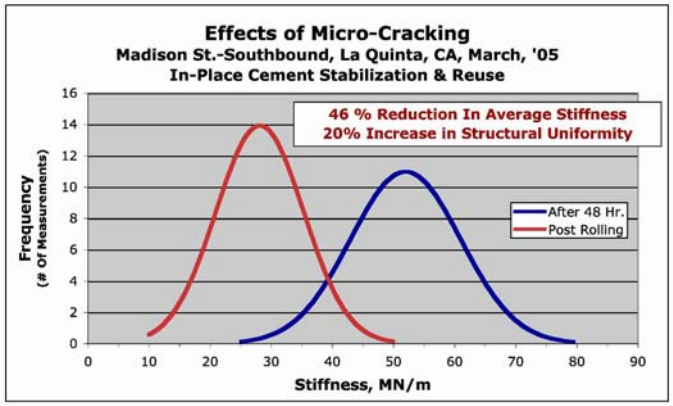
During 2004, CEMEX, the second largest supplier of cement products in North America, began to promote the use of the micro-cracking construction method in southern California. This prompted the adoption and successful use of the Bryan, Texas specification by the Cities of La Quinta and Santa Rosa, California in 2005. As shown in the figures to the right, the QC test data is very similar to that achieved in Texas 3 years earlier. The construction method apparently affords consistent results job-to-job even with the expected variabilities in materials and construction. CEMEX has also secured commitments from several other southern California cities to use the method. In 2006, CEMEX will expand its promotion of this construction method to include all of the southwestern United States and Mexico.

During 2005, the Montana Department of Transportation judged the benefits sufficient to adopt the Bryan, Texas specification for use during the 2006 construction season.

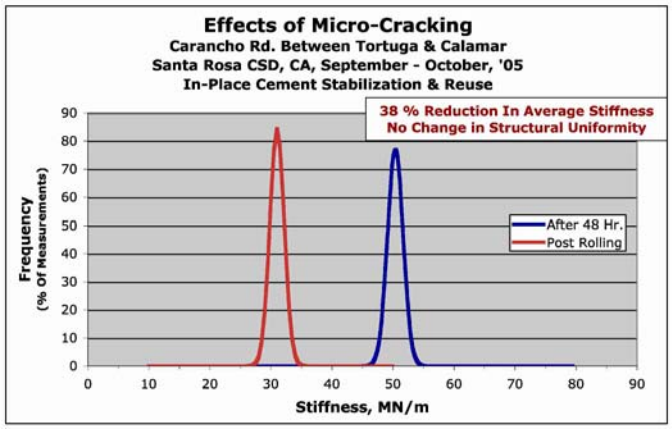
QC Test Data: Bryan, TX



QC Test Data: La Quinta, CA



QC Test Data: Santa Rosa, CA



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[2] Outline Specifications For Section 100 - Portland Cement Treated Base (Plant Mix), City of Bryan, TX, Rick Conlin, CME Testing & Engineering, College Station, TX 77840