CENTER FOR TRANSPORTATION INFRASTRUCTURE SYSTEMS
THE UNIVERSITY OF TEXAS AT EL PASO

Project Summary Report 0-4188-S1
Project 0-4188: Development of Methods and Materials to Accelerate Construction and Opening of PCC Pavements
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PROJECT SUMMARY REPORT

A Nondestructive Methodology for Optimizing Opening of PCC Pavements to Traffic

Several TxDOT districts rely almost solely on portland cement concrete pavement (PCCP) for heavily traveled metropolitan highways and for the urban and suburban sections of the interstate. The goal of these projects is to provide smooth and maintenance-free roads to the public with a minimal closure time. Timely opening of the roads to traffic is extremely important. However, if the traffic, especially truck traffic, is allowed on the road before the PCC has gained adequate strength, the pavement performance may be compromised.

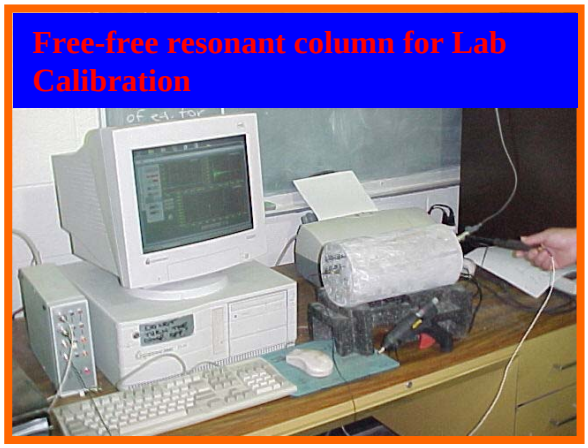
In this project, we have focused on the use of seismic technology in conjunction with maturity testing to address this concern.

The advantage of this method is that the same specimens used for laboratory calibration of the maturity data can be used for seismic calibration; however, instead of placing maturity sensors at isolated places during construction, a portable device can be used to test a large number of points. In that way, the variability in the curing of concrete due to possible differences in the materials, curing procedures, workmanship, and construction equipment can be measured and considered.

At the heart of the new protocol are a seismic laboratory test called the free-free resonant column test (FFRC) and a seismic field device called the Portable Seismic Pavement Analyzer (PSPA). Both tests are nondestructive, rapid (test time less than 1 minute), and accurate.

What We Did …

In the current maturity specifications, approximately one maturity sensor is placed for every 400 ft of a standard lane. Any variability in the



strength of concrete due to batching errors, construction, equipment-related problems, or the curing process might not be noticed with the maturity tests. A proposed protocol that combines the seismic method and maturity concept has been developed. The complete protocol consists of six steps: specimen preparation, maturity measurement, strength tests, lab seismic modulus tests, development of appropriate correlations, and field tests. Each is discussed below.

I. Specimen Preparation. Twelve standard cylinders (for compressive or tensile tests) and/or beams (for flexural tests) are prepared. Three specimens in each group are equipped with maturity sensors.

II. Maturity Tests: The specimens equipped with maturity sensors are connected to a maturity-meter to obtain the time-temperature factor.

III. Seismic Tests: Shortly before a specimen is subjected to strength test, its seismic modulus is measured with the FFRC device. Since the test is nondestructive, this activity should not impact the results from the strength tests.

IV. Strength Tests: The average compressive, tensile, and/or flexural strengths from three specimens are obtained at ages of 1, 3, 7 and 28 days.

V. Development of Correlations: A relationship between the average compressive, tensile, or flexural strength and average maturity values at corresponding times is determined to accurately estimate the strength of concrete based on maturity. Similarly, a relationship between the compressive, tensile, or flexural strengths and seismic moduli is developed.

VI. Field Testing: The relationships developed can be readily used with the PSPA and field maturity meters for predicting the strength of the concrete at any location on the slab or other structures.

Calibration for Combined Maturity Seismic Method

Existing Steps for Maturity Calibration (Tex-426-E)

- **Prepare about 2 Dozen Specimens**
- **Conduct Maturity Tests**
- **Conduct Strength Tests**
- **Develop Strength/Maturity Relationship**

Approx. 1 Month

Added Steps for Seismic Calibration

- **Conduct Seismic Test Before Strength Test (3 min./sample)**
- **Develop Seismic Modulus/Maturity Relationship**
- **Develop Strength/Seismic Modulus Relationship**

Adds a Few Hours

What We Found …

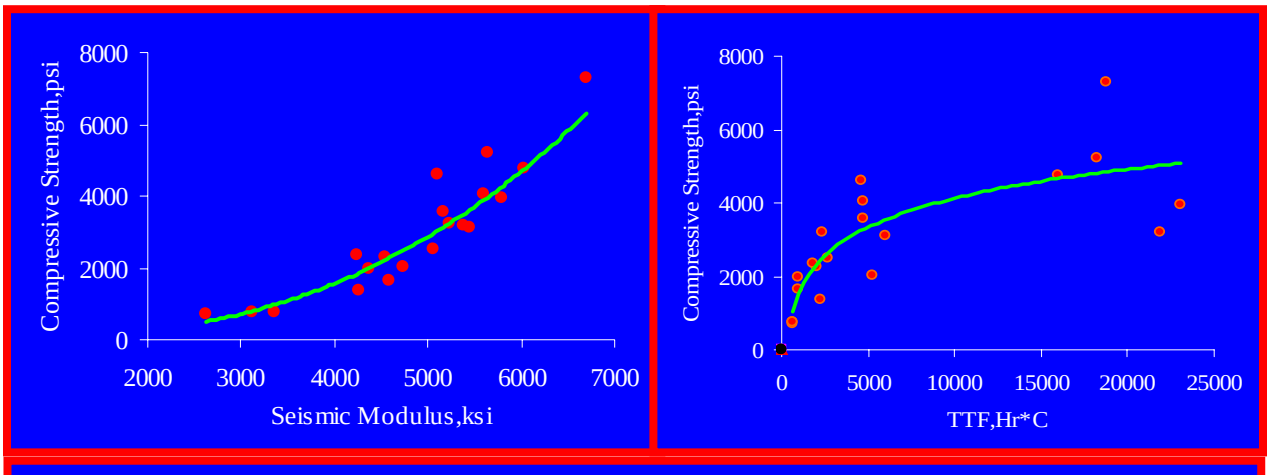
So far we have applied the methodology to a number of controlled studies. In all cases, good correlations have been found in the laboratory between the maturity and strength and seismic modulus and strength. The field maturity-strength relationship may differ from the one developed in the laboratory when the temperature, moisture, or curing condition is different from the corresponding lab condition. On the other hand, as shown below, the strength-modulus relationship is reasonably unique and more or less independent of curing temperature, moisture, or method. Furthermore, our study shows that a reasonably unique relationship between the strength and seismic modulus exists when the same coarse aggregates are used. It seems that, unlike strength-maturity relationship, the type of cement, water-cement ratio, and type of additives have small influence on the strength-modulus relationship. If this is proven true in the long term, one can utilize this relationship more readily than those developed for maturity.

The results from a number of mixtures are accumulated in the figure below. The trends from all mixtures follow a similar pattern. All these mixtures have one thing in common: they are made from dolomite aggregates from the El Paso area. The R^2 value of the global best-fit curve is about 0.89. This data trend indicates that it may be possible to develop a unique calibration curve for preliminary assessment of the concrete work in a given region with large monetary and time savings. The variations in compressive strength with maturity parameter for the same mixtures are also shown in the figure. Large deviation from the general trend is observed.

The Researchers Recommend …

The initial implementation of the program at several projects has shown great potential. We recommend that TxDOT implement the new process in a number of sites for evaluation purposes.

Lab Seismic Testing at High Five Project



Reasonably unique strength-modulus trends can be observed. A strong trend is not apparent for the strength-maturity relationship

For More Details…

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The research is documented in the following report:
4188-2 *A Methodology for Optimizing Opening of PCC Pavements to Traffic*

To obtain copies of a report: Center for Transportation Infrastructure Systems**,**
(915) 747-6925, email ctis@utep.edu**.**

TxDOT Implementation Status
October 2004

The new method to access PCC quality will be implemented on a pilot basis in some projects in the future. TxDOT has already purchased several units of the free-free resonant column (FFRC) and the Portable Seismic Analyzer (PSPA) for this purpose.

For more information, contact: Dr. German Claros, P.E., Research and Technology Implementation Office, (512) 465-7403, or e-mail gclaros@dot.state.tx.us.

Your Involvement Is Welcome!

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