Project Summary

Texas Department of Transportation

0-5218: Extending Service Life of Large or Unusual Structures Affected by Premature Concrete Deterioration

Background

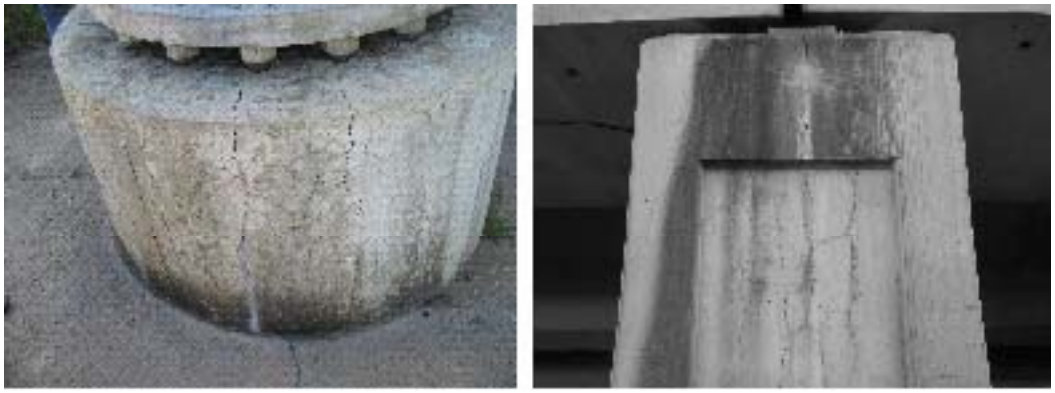

Figure 1 – Examples of structures affected by ASR and/or DEF in the state of Texas

Alkali-silica reaction (ASR) and delayed ettringite formation (DEF) are internal distress mechanisms that have affected various concrete structures in Texas (see Figure 1). TxDOT has aggressively attempted to prevent these durability problems by implementing test methods and specifications aimed at preventing ASR and DEF in new construction. However, there were many structures built in Texas prior to the discovery of these durability issues in the state, and the key issue is how best to evaluate and manage these deteriorating elements. This particular project focused on a few key issues, including the development of a materials-based protocol for evaluating structures affected by ASR and DEF, the evaluation of the structural impact of these deterioration measures, and the study of the levels of confinement needed to suppress expansion.

What the Researchers Did

TxDOT project 0-5218 focused on various aspects related to structures affected by ASR and DEF. Perhaps the most important product of this work was the development of a protocol for evaluating materials-related distress, which is already being used by various research groups and practitioners in Texas and throughout the United States. This protocol aims to identify the cause of distress to date, attempting to answer the age-old question of "Is it ASR, DEF, or both?" The protocol also provides guidance on how to monitor structures affected by ASR or DEF and provides information on how to estimate the remaining potential for expansion.

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Project Completed: 8-31-08

Another key point of emphasis of this project was to quantify stresses and strains generated by DEF and attempt to shed some light on the levels of confinement needed to suppress DEF-induced strains in field elements. To this end, this project has been quite successful. Through a variety of different approaches (steel fiber-reinforced concrete, Hoek cells, oedometers, FRP wraps, etc.), the researchers have been able to provide preliminary estimates for the levels of confinement needed to control DEF. The general conclusion is that although DEF can lead to significant levels of expansion, it appears to be possible and feasible to confine DEF-induced expansion in laboratory and small field-scale elements. Significant efforts were also devoted towards triggering ASR and DEF in realistic (albeit scaled down versions) structural elements to monitor the progression of expansion and cracking.

What They Found

A protocol was developed under this project for evaluating the cause and extent of deterioration due to ASR and DEF and for predicting future potential for expansion. This protocol documents methods for monitoring affected structures, selecting and procuring samples for subsequent laboratory evaluation, and for interpreting laboratory and field tests. It is hoped that this protocol will be of immediate use to TxDOT (and others dealing with ASR or DEF) and can be included in a broader program focused at managing and extending the service life of affected structures.

With regard to the structural impact of ASR and DEF, preliminary results have found that levels of confinement needed to suppress DEF tend to be on the order of those needed to confine ASR (around a maximum of 600 psi for data generated under this project). It should be noted that these results should be considered preliminary in nature, and that more work is needed to fully capture the behavior of DEF-affected concrete with regard to requisite levels of confinement. In separate TxDOT-funded research, it has also been shown that it is actually easier to suppress DEF than ASR when drying out concrete through the use of sealers or coatings. DEF can be suppressed at relative humidity below 90 percent, whereas ASR may require relative humidity as low as 80 percent to reduce expansion.

What This Means

This project has helped to gain a better understanding on how ASR and DEF can be evaluated, monitored, and managed in transportation structures. A great deal more work is needed on this topic, and this project was just one of several past and ongoing studies evaluating the structural effects of DEF and ASR. It is hoped that this study, coupled with the other efforts, will provide TxDOT with guidance on how best to manage structures affected by ASR or DEF. It is expected that data generated by those who use the materials protocol will help to provide key data and information that will be essential in managing the concrete infrastructure in Texas and beyond.

For More Information:
0-5218-1 Investigation of the Internal Stresses Caused by Delayed Ettringite Formation in Concrete

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