Reactive Solutions

A Technical Update on Alkali-Silica Reactivity

Welcome to the Newest Issue of *Reactive Solutions*, a Technical Update on Alkali-Silica Reactivity (ASR).

Features:

Also in This Issue:

Alkali-Silica Reactivity Outdoor Exposure Site Being Constructed in Texas

Site hopes to provide an "ASR link" between the laboratory and the field

The Rigid Pavements and Concrete Materials Branch of the Texas Department of Transportation has begun a large scale alkali-silica reactivity (ASR) study using exposure blocks as test samples. The first outdoor site, located at the TxDOT office in Austin, Texas, is being constructed to help engineers address a major concern about the number of concrete structures experiencing premature deterioration due to ASR within the state. The overall goal of this research is to evaluate multiple combinations of materials in order to determine the best means of preventing damage in concrete due to ASR. This research, upon completion, will rank as one of the most extensive ASR studies performed to date in Texas and is expected to provide information necessary to prevent future ASR problems.

The Need for an Exposure Site

A number of TxDOT mix design options have been proven to be insufficient or questionable in a number of cases involving pre-cast concrete members. ASTM International (formerly known as the American Society of Testing and Materials) and the American Association of State Highway and Transportation Officials (AASHTO) have developed test methods that provide guidance for the prevention and mitigation of ASR; in fact, the Federal Highway Administration (FHWA) developed the most current comprehensive guidance on ASR, which was later adopted by AASHTO as a

recommended practice. However, there is still not a distinct link between the laboratory and the field. This can be due to a combination of several factors including but not limited to the size of the specimen, materials involved, harsh environment imposed by test methods to shorten the time until test results are available, water to cement (w-c) ratio, and construction practices. In addition, none of these test methods can capture the potential role that climatic conditions have on these mechanisms, nor can they give guidance as to whether or not an aggregate may be susceptible to ASR in low alkaline environments.

Figure 1. Exposure Site in Austin, Texas

This growing concern led the state to consider the construction of an exposure site, which would more realistically represent the environment of which the mechanisms behind ASR take place. Key benefits that the exposure site can provide to TxDOT engineers include:

- Provides natural exposure conditions (e.g. temperature and humidity changes) and less harsh environment than defined in the accelerated test method (e.g. lower temperatures and less aggressive mix designs compared to laboratory testing).
- Allows the testing of a range of larger specimens to better simulate field structures and provides long-term monitoring (up to 10 years or more).
- Provides similar heat gain during hydration that is comparable to field structures.
- Allows testing of several durability issues, including ASR, delayed ettringite formation (DEF), and corrosion as well as combinations of these mechanisms.
- Serves as the ultimate test for determining the quantity of supplementary cementitious materials (SCMs) or lithium salts needed for durability.
- Serves as a potential method to determine if and what post-treatment application is appropriate for structures already affected by ASR.
- Provides field data to compare with that of laboratory test methods (e.g. ASTM C 1260 and ASTM C 1293) and serves as a method to validate or update interpretation of laboratory test results.

These benefits are essential in understanding how ASR mechanisms play a role in actual field structures and to understand what potential options are available so that deleterious expansion from ASR may be prevented or mitigated.

Implementation and Goals of Research

The exposure blocks are large in size (1.6 ft^3 or 3.9 ft^3), and steel pins embedded in the blocks are measured using a strain gage to determine the expansion. Large samples are critical because of the effects of leaching, which is a major problem with the test method ASTM C 1293 (currently regarded as the best indicator of field performance for ASR) particularly due to the sample size. In addition, one non-instrumented exposure block (1.6 ft^3) is cast along with the blocks that are instrumented, solely for the ability to core these blocks over time in order to monitor the formation of ASR gel petrographically.

Figure 2. Exposure Blocks

Several variables will be addressed, including the w-c ratio, admixtures, cement type, cement chemistry, cement amount, alkali loadings, fly ash dosage and composition, different fine and coarse aggregate mineralogies, post-treatment applications, lithium salts, and different exposure site locations. Different w-c ratios will be used, since lower w-c ratios may yield higher alkaline pore water concentrations that may be more susceptible to ASR. In terms of admixtures, different water reducers and retarders will be tested to determine if they may impact ASR. The cement types will include Types I, I/II, and III. The cement chemistry will also be addressed as two cements with similar alkali contents (based on Na_2O_{eq}) will be used; however, one cement will have a higher potassium/sodium ratio while the other will have a higher sodium/potassium ratio. In addition, the alkali loading will be addressed since the lowest alkali loading (lbs/cy) needed to prevent ASR from occurring in Texas is currently unknown. Fly ash dosage and composition will also be evaluated, as well as different fine and coarse aggregate mineralogies.

The post-treatment study, for structures already affected by ASR, will determine the most effective products and the frequency of re-application that may help extend the service life of those structures already affected by ASR. The dosage of lithium salts will be

addressed to determine the amount of lithium needed as an alternative mitigation option. Different exposure site locations around the state (currently proposed in El Paso, Amarillo, Corpus Christi, and Beaumont—along with the current Austin location) are being proposed to help identify how climate may influence the initiation and progression of ASR, as well as its prevention.

Approximately 120 blocks have been scheduled as part of the work plan, although this plan does not currently include the exposure blocks placed around the State of Texas or the post-treatment study. For more information or details about the future exposure sites, please contact Brian Merrill at Brian.Merrill@txdot.gov.

FHWA's ASR Development and Deployment Technical Working Group Meets in Chicago

Meeting provides interim research progress and state experiences

The ASR Development and Deployment Program TWG (Technical Working Group) met in Chicago, IL on December 15 and 16 to discuss the progress of the program. Researchers contracted under the FHWA ASR BAA program presented interim results of their research as the program hits the halfway mark. Presenters included researchers from Purdue University, Georgia Institute of Technology, Sherbrooke University and the University of Texas at Austin. In addition, presentations from Nebraska DOT, Zycosil, and Turner-Fairbank Highway Research Center were also given, covering information about Raman Spectroscopy, Zycosil waterproofing systems, and the AASHTO ASR Recommended Practice (AASHTO RP 65-10). The AASHTO ASR Recommended Practice has been updated and can be found by visiting the AASTHO website here.

For more details about the information presented during the meeting, please contact Gina Ahlstrom (Gina.Ahlstrom@dot.gov) or Bebe Resendez (bebe@thetranstecgroup.com).

National Highway Institute Courses

Interested in taking a course or two? Here are a few courses now available that may be of interest:

Portland Cement Concrete Pavement Evaluation and Rehabilitation: This course will present state-of-the-practice and state-of-the-art techniques to identify the causes and patterns of different types of pavement distress, and techniques for rehabilitation selection, design, and construction that can be applied for those various types of distress. For more information, please click here.

Pavement Preservation: Design and Construction of Quality Preventive Maintenance Treatments: This course targets those field personnel involved in constructing preventive maintenance treatments, including both buying agency's inspectors and the contractors'

foremen and field crews. It contains modules on all of the categories of preventive maintenance treatments in widespread use today, focusing on the best practices for designing and constructing those treatments. For more information, please click here.

Pavement Preservation Treatment Series: Introduction to Pavement Preservation - WEB-BASED: This training is part of the "Pavement Preservation Treatment" series and is designed to provide participants with an introduction to the Pavement Preservation Treatment Construction Guide (PPTCG) and the basics of pavement preservation. Topics include: pavement structure, distresses, and differentiating pavement preservation from preventive maintenance. For more information, please click here.

Bridge Evaluation for Rehabilitation Design Considerations: The course will present innovative and state-of-the-art bridge rehabilitation technologies and procedures for a broad array of structural elements including bridge decks, girders, piers, and abutments. For more information, click here.

TCCC Hardened Concrete Properties - Durability - WEB-BASED: This training is provided by the Transportation Curriculum Coordination Council (TCCC) in partnership with NHI to review integrated materials and construction practices for concrete pavement. For more information, click here.

Schedule of Events

March
10-11
50th Annual CPAM Concrete Paving Workshop
Duluth, Minnesota

22-26
CONEXPO-CON/AGG 2011
Las Vegas, Nevada

April
3-7
ACI Spring 2011 Convention
Tampa, Florida

18-20
International Conference on Concrete Pavement Design, Construction, and Rehabilitation
Xi'an, Shaanxi Province, P.R. China

19-21
2011 Pacific Northwest Bridge Inspection Conference
Portland, Oregon

26-28
Technology Transfer Concrete Consortium (TTCC) and National Concrete Consortium (NCC)
Indianapolis, Indiana

To view this technical update on the web, please go to
http://www.fhwa.dot.gov/pavement/concrete/reactive/v04issue01.cfm

This material is based upon work supported by the Federal Highway Administration ASR Development and Deployment Program to share information related to alkali-silica reactivity.