Reactive Solutions

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Illinois DOT Develops Specification After ASR Discovery in Structure

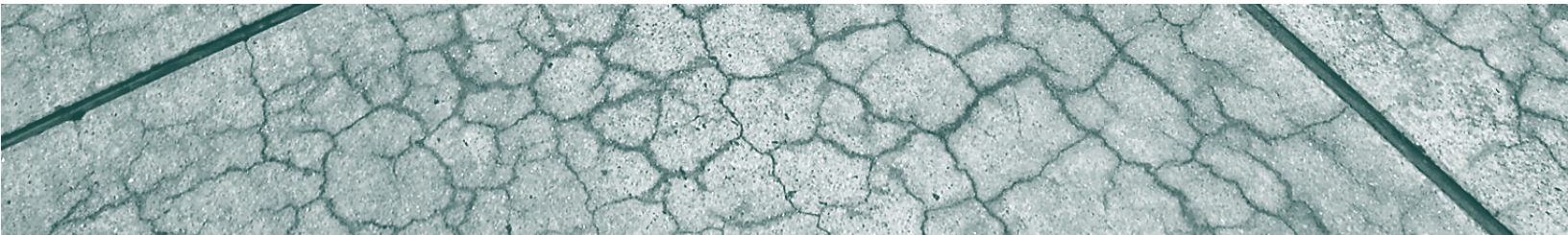
Presence of ASR in bridge member initiated research

In 1996, a bridge parapet in Illinois was found to be exhibiting severe cracking and early deterioration after only 8 years of service, making the first case of alkali-silica reactivity (ASR) known to the department of transportation. A petrographic examination of concrete cores determined that the ASR was attributed to the reactive fine aggregate. This discovery initiated ASR-related research in the state, yet no immediate action was taken to develop a specification. Over a period of years it became evident that ASR was an issue in the state. Since the reaction is normally slow and hard to identify without petrographic examination of cores, any concrete distress identified in the field was previously assumed to be a result of poor freeze/thaw aggregate or a lack of air entrainment. However, field investigations proved that these assumptions were false. Another important discovery was that some of the most reactive aggregates in the state was being used with low alkali cement.

Development of an ASR specification can be a slow process, since the need for research, aggregate testing, and field investigations can require a considerable amount of time. In 2007, Illinois DOT (IDOT) finally issued a statewide specification; by this time, sufficient evidence had been gathered to demonstrate to upper management and industry that a specification was needed.

Bridge parapet in Illinois exhibiting ASR cracking 8 years after construction

IDOT's ASR specification is intended to reduce the risk of a deleterious alkali-silica reaction in concrete exposed to humid or wet conditions. Each coarse and fine aggregate, except for limestone and dolomite aggregates, is tested for alkali reaction using American Society for Testing and Materials (ASTM) C1260 for 14 days. Expansion values for limestone and dolomite aggregates are 0.05 % (coarse) and 0.03% (fine). According to IDOT aggregates are considered non-reactive if the ASTM C1260 expansion test result is less than 0.16%. The ASTM C1293 test may be used to evaluate ASTM C1260 test results if a contractor or aggregate producer wants to challenge the ASTM C1260 value, due to its reputation for "false positive" results. *(continued on next page)*



Editor's Corner

Dr. Michael Thomas, University of New Brunswick

Readers,

This issue includes the interesting story of how a DOT discovers and responds to ASR in its State, an announcement to the new ASR Reference Center developed by the FHWA, and descriptions of two of the four new ASR research projects funded by FHWA. Illinois DOT's Doug Dirks highlights the need to tailor specifications for the materials available in a region and the need to allow aggregate producers the option of testing aggregates in concrete to overcome the high risk of a "false positive" in the accelerated mortar bar test. Hopefully, the research project that has just commenced at Clemson University will provide an answer to the existing dilemma of whether to use a quick but unreliable test or a slow but trusty test. The prime objective of this research is to produce a test that combines the speed of the accelerated mortar bar test with the reliability of the concrete prism test. The new research at Purdue University is aimed at developing a better understanding of the fundamental mechanisms of ASR. Finally, there has been a good response to the FHWA's solicitation for demonstration projects (see announcement in last quarter's issue) and the FHWA is now working with a number of states to evaluate potential projects.

Illinois DOT Develops Specification After ASR Discovery in Structure (cont.)

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However, the ASTM C1293 test is conducted at the contractor or aggregate producer's expense. If the expansion is less than 0.040% after one year, the aggregate will be assigned an ASTM C1260 expansion value of 0.08%, which will remain valid for two years, unless the state engineer determines the aggregate has changed significantly.

At IDOT each combination of aggregates used in a concrete mixture is assigned to an aggregate group, which reflects the reactivity of the combination of aggregates being used. Based on this group, up to five different mix options are permitted.

Detailed information about mix options can be found by accessing IDOT's specification on FHWA's ASR Reference Center website (http://www.fhwa.dot.gov/pavement/concrete/asr.cfm).

IDOT's ASR specification is a good starting point, but much work needs to be done. Other states have more stringent specifications than what is currently used in Illinois. The development of an ASR specification is somewhat of an art and needs to be based on the materials available in the state. For further information regarding this specification, please contact Doug Dirks by phone at (217) 782-7208 or by email at Douglas.Dirks@illinois.gov.

FHWA Unveils ASR Reference Center

Online reference database provides users with ASR-related information

In March, the Federal Highway Administration unveiled the ASR Development and Deployment's new ASR Reference Center, an online database that provides users with access to ASR-related information. Reports, guidelines, specifications and other documents can be obtained on the ASR Reference Center website. Users can access the material on the site for free, or will be provided a link where material can be purchased.

"The goal of the ASR Reference Center is to make information related to ASR readily accessible in one location," says Gina Ahlstrom with the Federal Highway Administration. "I believe we have succeeded. We are looking forward to expanding the Reference Center with more information."

The Reference Center will be updated regularly to provide users with up-to-date information. The Reference Center can be located through the ASR Development and Deployment website at http://www.fhwa.dot.gov/pavement/concrete/asr/reference.cfm. If there is information that you would like to see in the ASR Reference Center, please contact Gina Ahlstrom at Gina.Ahlstrom@dot.gov.

Ask The Experts.

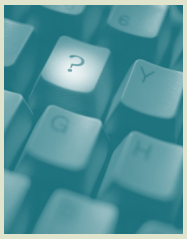
Q *I am going through the process of initiating a research project with the Electric Power Research Institute (EPRI) to study the effects of AC current and ASR in concrete foundation in electrical substations. I have found limited existing research in this area that suggests that there is a relationship. I will begin my literature search in a few months and I would appreciate any sources of existing or ongoing research that you may know of.*

Submitted by Mark S. Johnson, P.E., CenterPoint Energy

A There has been research to demonstrate that direct electrical current applied to reinforced concrete for the purposes of cathodic protection or electrochemical chloride extraction can exacerbate alkali-silica reaction. In both of these rehabilitation processes a direct current is applied to the embedded reinforcing steel and an anode placed at the surface of the concrete. The reinforcing steel becomes a cathode in this electrical system and hydroxyl ions (OH^-) are generated at the surface of the steel; furthermore, positively-charged alkali ions (Na^+ and K^+) in the concrete pore solution are drawn to the negatively charged cathode to maintain electroneutrality. The resulting increase in the concentration of alkali hydroxides at the cathode increases the potential for damaging reactions at this location if the concrete contains alkali-silica reactive aggregates. Damaging ASR has certainly been observed in numerous concrete foundations supporting electrical equipment and a number of investigators have suggested a causal relationship between ASR and the presence of electrical fields. However, the precise role played the electrical current in the damage to the concrete has yet to be established. The research you are planning will hopefully fill some gaps in our understanding of this phenomenon.

Severe ASR in a concrete foundation at an electrical sub-station. Could stray electrical currents have exacerbated ASR?

Submit your questions—email us at **asrnewsletter@transtec.us**



A.sk
S.end
R.eceive

This Issue's Question:

Has your state placed an overlay on an ASR-affected pavement? How did it perform?

Submit your answers to: asrnewsletter@transtec.us

Ongoing FHWA ASR Research

Study hopes to develop fast, reliable lab test and better understand ASR mechanism

In light of the shortcomings of existing test methods to determine alkali-silica reactivity of aggregates, FHWA-sponsored researchers at Clemson University are working to develop an alternate rapid and reliable laboratory test method through FHWA's ASR research program. This alternate test method would not only develop a protocol for assessing aggregate reactivity, but would also evaluate the potential ASR reactivity of a job concrete mixture. In addition to this endeavor, simultaneous efforts are being conducted at Purdue University to identify better techniques in characterizing damage in ASR. It is anticipated that this combined effort will result in a more effective means to monitor and identify effects of ASR in test specimens.

Researchers at Clemson University intend to create an alternate test method that is shorter in duration than the American Society of Testing and Materials (ASTM) C1293 concrete prism test (CPT), yet more reliable than the ASTM C1260 accelerated mortar bar test (AMBT) procedure. In order to understand factors that cause variability and unreliability in both these test methods, a series of fundamental studies has been initiated in this research program. Research is being conducted to study the relationship between aggregate properties (gradation, mineralogy, etc.) and their reactivity, as well as the relationship between reactivity and temperature, alkalinity, pessimum alkali levels, and deicing chemicals. The knowledge obtained from these studies will help define better testing conditions for an alternate method. Under this research, 27 different aggregates representing a broad range of mineralogy and geographic locations are being evaluated. A protocol will be developed to assess reactivity of aggregates and concrete.

(continued on next page)

Schedule of Events

May

4-5
17th Annual ICAR Symposium
Austin, TX
13-15
NRMCA 2009 Concrete Technology Forum
Cincinnati, OH

June

3-7
2009 American Society of Highway Engineers National Conference
Atlanta, GA
29-July 2
8th International Conference on the Bearing Capacity of Roads, Railways and Airfields
Champaign, IL

July

7-10
ACPA Mid Year Meeting
Oak Brook, IL

Ongoing FHWA ASR Research (cont.)

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Under FHWA's program, research is also being conducted at Purdue University, which focuses on advancing the understanding of the mechanism behind ASR and on the development of a concrete mixture design process that can prevent or greatly reduce the risk of ASR damage. The scope of this research consists of six different tasks, focused on:

Close-up of mortar bar containing reactive aggregate after 7 days in modified ASTM C1260 test (deicer soak solution)

- Examining various interactions that may influence the role of lithium treatments in mitigating ASR.
- Examining relationships between the potentially available calcium hydroxide and its susceptibility to ASR.
- Exploring the influence of several types of deicers on the activities of hydroxyl ions in the pore solution and contribution of the increased activities to ASR.
- Examining the role of chemical composition, structure and mineralogy of aggregates in the overall mechanism of the ASR reaction and mitigation.
- Relating changes in fluid transport (i.e., wetting and drying rates) to the morphology of the crack network that develops as a result of ASR induced cracking and damage.
- Monitoring crack formation by listening for the cracks as they form using a technique called acoustic emission. An advantage of acoustic emission is that it may be able to detect crack development and propagation in concrete undergoing ASR damage before this would become visible with substantial expansion. Acoustic based tests have the potential to be used as a screening test to detect the potential for ASR damage or to assess the extent of damage in field concrete.

For more information about FHWA's ASR research program, please contact Paul Virmani at (202) 493-3052 or by email at Paul.Virmani@fhwa.dot.gov.

Technical Editor Michael Thomas
Managing Editor Bebe Resendez

FHWA Contact Gina Ahlstrom
FHWA—Office of Pavement Technology
Gina.Ahlstrom@dot.gov