Implementation Report

ALKALI-SILICA REACTIVITY IN THE STATE OF MONTANA

https://www.mdt.mt.gov/research/projects/mat/alkali_silica.aspx

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MORE INFO:

Principal Investigator

Michael Berry
berry@montana.edu
406.994.1566

MDT Technical Contact

Paul Bushnell
pbushnell@mt.gov
406.444.6267

MDT Research Project Manager

Vaneza Callejas
vcallejas@mt.gov
406.444.6338

Introduction and Purpose

Alkali-Silica Reactivity (ASR) is a deleterious reaction that takes place in concrete between alkalis present in the binder and reactive forms of silica in the aggregates. ASR can cause significant damage leading to reduced life span, costly repairs, and/or replacement of the concrete. This damage is initiated by the swelling (in the presence of water) of a gel that forms on the surface of the reactive aggregates, and typically results in significant cracking. While ASR has been documented as an issue in many states, little work has been conducted to determine the potential/presence of ASR in Montana.

The primary objectives of this research were to evaluate the potential for deleterious ASR in the state of Montana, to evaluate current and newly developed aggregate testing methodologies, to identify existing cases of ASR damage in the state, and to test the reactivity of several aggregate sources using the methodologies evaluated in this research.

The objectives of this research were realized through the following tasks:

1. An extensive literature review was conducted to determine ongoing regional and federal ASR practices. Current and newly developed aggregate testing methods, as well as techniques for identifying ASR in existing structures were investigated and summarized.

2. Several existing concrete structures exhibiting ASR-related distress were evaluated. Specifically, the sites investigated included two concrete aprons at the Billings Logan International Airport, a bridge on US-87/US-89/MT 200 near Belt, and the spillway for the Willow Creek Dam. Concrete cores were obtained from the sites and further examined in a laboratory setting to determine if ASR was the cause of deterioration and assess the extent of damage. Several of the cores were tested using the Los Alamos Staining Method, and all were evaluated with petrographic analyses.

3. Aggregates from various locations around the state were evaluated in accordance with ASTM C1260 and AASHTO T380.

Overall, the research found very few examples of ASR distress, with only four ASR distressed projects discovered from the hundreds of statewide concrete projects considered by the research survey. However, all of the Montana aggregates tested showed some potentially reactivity (either with ASTMC 1260 or AASHTO T380). In addition to potentially reactive aggregates, the ASR reaction requires a sufficient amount of alkalis to take place, which mostly coming from the Portland cement. Historically, Montana concrete has been produced using low-alkali cements; however, an increasing focus on cement manufacturing sustainability and efficiency may, in the future, result in local cements with a higher alkali content. It should also be noted that at this time Class F fly ash is commonly used in Montana concrete mixes, which mitigates the potential for ASR. However, Class F fly ash is becoming increasingly more difficult to obtain as the country moves away from coal-fired power plants.

Implementation Recommendations

Recommendation 1:

MDT should not use the Los Alamos Staining method for determining the presence/severity of ASR in existing concrete. This methodology was found to be highly subjective, with inconclusive results.

MDT Response:

MDT agrees that the Los Alamos Staining method can be subjective and is reliant on the experience and knowledge of the assessor. MDT will only consider using Los Alamos Staining Method if an economically viable options for screening for potential ASR damage is needed.

Recommendation 2:

MDT should consider adopting the AASHTO T380 - miniature concrete prism test for aggregate testing when applicable. Previous research has clearly demonstrated the added benefits of this methodology; it provides more accurate, less conservative results than the ASTM C1260 methodology, in significantly less time than the ASTM C1293 methodology. Further, the miniature concrete prism test can be conducted with the same equipment used for the C1260 (less the forms), requiring a small upfront commitment to make the change.

MDT Response:

MDT does not currently require or conduct ASR testing for concrete aggregates. MDT will consider adopting AASHTO T380 if this changes.

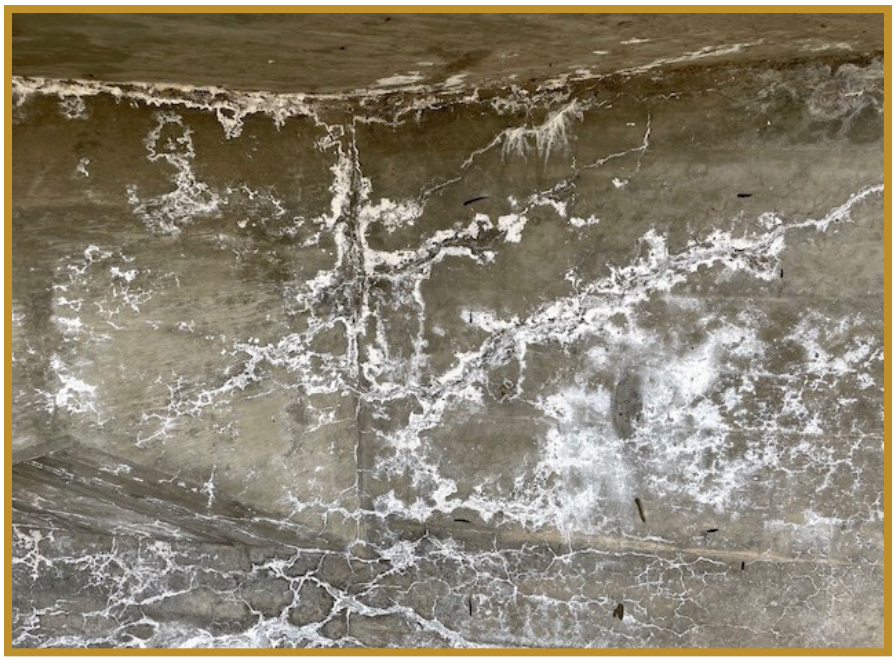
Recommendation 3:

The current practice in Montana (limiting the alkalis in cement) seems appropriate/effective for mitigating ASR in Montana and should be continued.

It should be noted that the current cement alkali loading limits prescribed by MDT are similar to the limits prescribed for Prevention Level X by AASHTO R80 (Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction). However, if the availability of low alkali cements becomes problematic MDT should revisit this approach and consider adopting the methodology prescribed by AASHTO R80 or at least some aspects of this methodology (e.g., prescriptive total alkali loading limits).

MDT Response:

MDT will continue its current practice of limiting the alkali content of the cements used in its concrete mixtures and will consider revising this approach when our current practices are no longer viable.



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