Montana Department of Transportation *January 2022*

RESEARCH PROGRAMS

Project Summary Report: FHWA/MT-21-006/9577-607

Authors: Ashton Siegner
Michael Berry, Ph.D.
Kirsten Matteson, Ph.D.

Montana State University
Bozeman, MT

ALKALI-SILICA REACTIVITY IN THE STATE OF MONTANA

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

Introduction

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.

Figure 1: Typical ASR Crack Pattern

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 map cracking similar to that shown in Figure 1.

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.

What We Did

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 (Figure 2), 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 (Figure 3).

3. Aggregates from various locations around the state were evaluated in accordance with ASTM C1260 and AASHTO T380 (Figure 4).

Figure 2: Coring of Backwall on Belt Creek Bridge

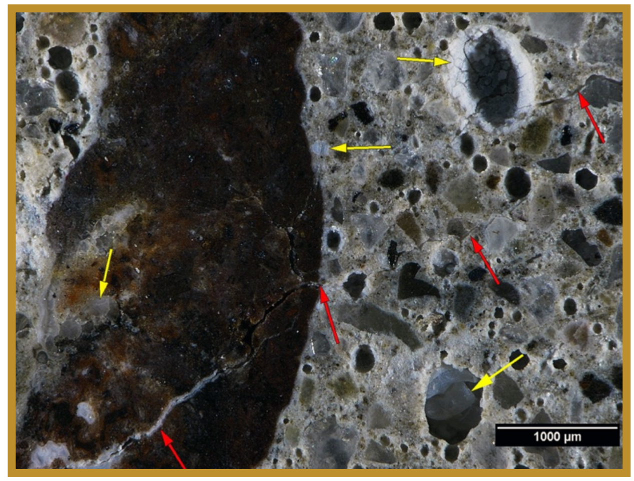
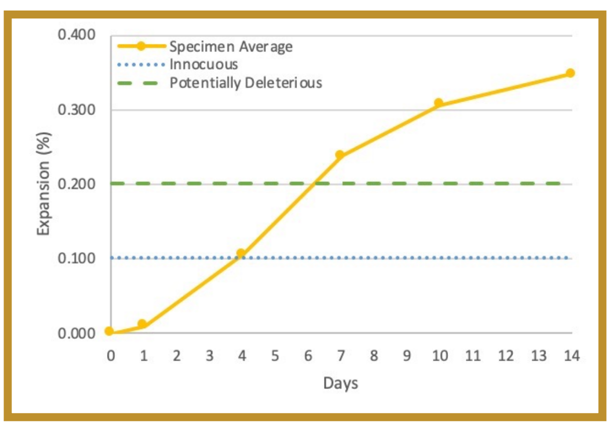
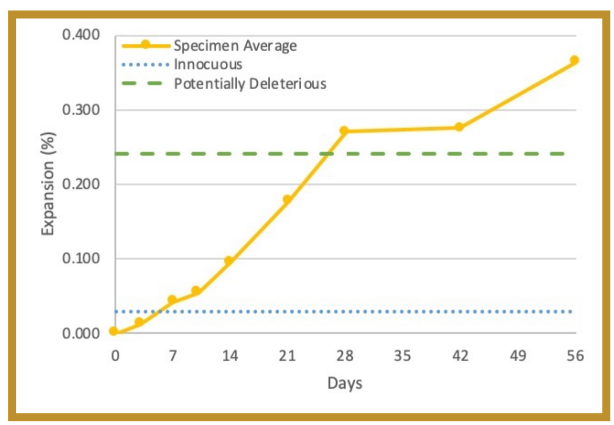


Figure 3: Petrographic Image of Apron Core from Billings Airport.



(a)



(b)

Figure 4: Average Expansion of Knife River (Missoula) Concrete Fine Aggregate using (a) ASTM C1260 and (b) AASHTO T380

What We Found

Overall, while there is not an overwhelming amount of evidence of ASR being a major problem in Montana, this research clearly demonstrated the potential for deleterious ASR in the state.

Several sites around the state showed distress from ASR, and all of the tested aggregates showed some reactivity (either with ASTMC 1260 or AASHTO T380). Further, the potential for ASR in Montana may increase as less expensive cements from newer cement plants become more readily available. Cements from these newer plants typically have higher alkali contents than the older plants currently supplying cement in Montana.

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.

What The Researchers Recommend

Based on the findings from this research, the following recommendations are made.

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.

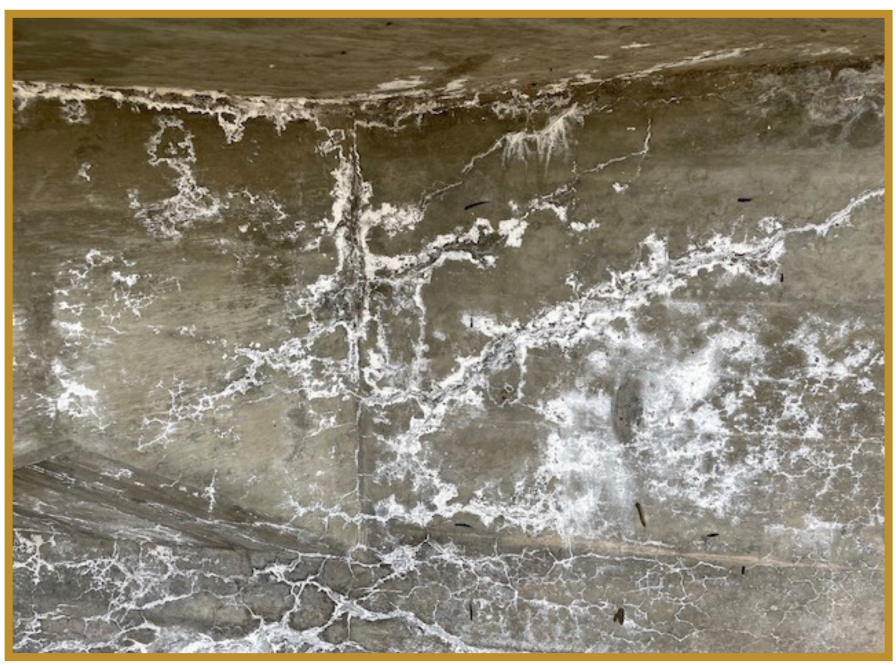
2. MDT should consider adopting the AASHTO T380 - miniature concrete prism test for aggregate testing when applicable. Previous research has clearly demonstrated the added benefits of this methodology; it provides more accurate, less conservative results than the ASTM C1260 methodology, in significantly 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.

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).



For More Details . . .

The research is documented in Report FHWA/MT-21-006/9577-607, https://www.mdt.mt.gov/research/projects/mat/alkali_silica.aspx.

MDT Project Manager:
Vaneza Callejas, vcallejas@mt.gov, 406.444.6338

Researcher's Organization Project Manager:
Michael Berry, berry@montana.edu, 406.994.1566

To obtain copies of this report, contact MDT Research Programs, 2701 Prospect Avenue, PO Box 201001, Helena MT 59620-1001, mdtresearch@mt.gov, 406.444.6338.

MDT Implementation Status: January 2022

Implementation will be documented in the Implementation Planning and documentation form for this project as per the implementation report, which can be found at the above URL.