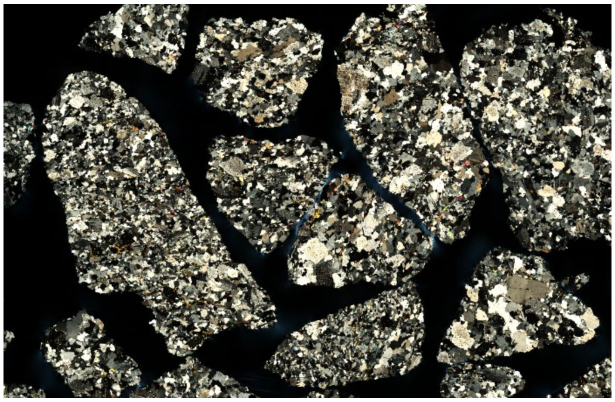
TN TDOT Department of Transportation

Research Summary

Alkali Silica Reactivity (ASR) Risk Assessment and Mitigation in Tennessee



Project Number:
RES 2016-03

TDOT Lead Staff:
Heather Purdy Hall
Materials & Test Division

Principal Investigator(s):
Z. John Ma | PI
University of Tennessee - Knoxville

Project Term:
January 2016 to November 2021

WHAT WAS THE RESEARCH NEED?

Higher levels of reactive silica in aggregates can be detrimental to concrete if it reacts with the alkaline cement paste. Many aggregates, especially the surface aggregates used in Tennessee, have a relatively high siliceous content (e.g., gravels, siliceous limestones, granites, and quartzite). Aggregates with Alkali Silica Reaction (ASR) potential have been used already in past projects and will be probably be used even more in future projects due to the requirements on the aggregates for riding surfaces in the Tennessee Department of Transportation (TDOT) Standard Specifications.

WHAT WERE THE RESEARCH OBJECTIVES?

The primary aims of this study were to build a statewide aggregate ASR risk database with detailed field and laboratory performance to provide a solid foundation for guaranteeing a good long-term performance and a high-level safety of statewide transportation concrete structures. In addition, the study aimed to investigate and propose effective mitigation methods based on the published literature and performance testing to permit an economic use of reactive aggregates that normally would be excluded.

WHAT WAS THE RESEARCH APPROACH?

The research team used a two-phase approach to address the issues of ASR. During Phase I, ASR reactivity of surface

Sponsored by Tennessee Department of Transportation Long Range Planning Research Office & Federal Highway Administration

aggregates from 76 different local sources in Tennessee was evaluated using common expansion tests including ASTM C1260 (mortar bars test) and ASTM C1293 (concrete prisms test). Mitigation alternatives to minimize the ASR risk of reactive aggregates were proposed in the second phase (Phase II). The field performance of some highly reactive aggregates was also investigated during Phase II to address the extent of ASR in existing structures.

WHAT WERE THE FINDINGS?

The research findings included:

- There is a potential ASR risk for concrete structures and pavement lifecycle in Tennessee, unless proper mitigation techniques are applied to mitigate the reactivity of aggregates.
- At least 65% of the tested aggregates are classified as reactive with different degree of reactivity (i.e., moderate to very highly reactive).
- The chemical composition of dolomitic limestones from Tennessee, namely the silica content (SiO2), shows a strong correlation with the expansion measured in the concrete prisms test, indicating that most of the silica within Tennessee limestones are reactive. The reactivity of limestones from Tennessee is mainly driven by alkali-silica reaction.
- Minimum replacement levels of fly ash class F are proposed based on performance testing to limit the deleterious ASR expansion for aggregates from Tennessee.
- ASR distress has been noted in at least eight transportation structures built with concretes containing reactive limestones aggregates.

IMPLEMENTATION AT TDOT

The research team made the following recommendations to TDOT:

- ASR reactive aggregates identified in this project should not be used in new concrete without proper ASR mitigation. This will limit the ASR risk in future transportation structures and will maintain the long-term investment of TDOT.
- The minimum recommended dosages of fly ash class F to mitigate ASR for several aggregate types are provided in the final report. These limits should be added to TDOT specification to minimize the risk of ASR in future concretes.
- The reactivity of aggregate quarries might not be constant over time. Chemical analysis or quick ASR testing (e.g., ASTM C1260 Expansion Test) should be conducted on a regular basis to detect any change in the quarry reactivity overtime. The chemical composition of carbonate aggregates such as limestones/dolomite seems to provide a good indication about aggregate reactivity.
- Due to the high risk of ASR in Tennessee, it is recommended to add a requirement in TDOT specification to perform quick ASR assessment testing (e.g., ASTM C1260, or chemical analysis for limestones) for any aggregates to be used in new concretes. Of course, further research is necessary to develop and/or to validate an ideal and accurate test method for assessing actual job concrete mixtures, in a relatively short period of time.

MORE INFORMATION

Find the final report here: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2016-final-reports/RES2016-03_Final_Report_Approved.pdf.

Sponsored by Tennessee Department of Transportation Long Range Planning
Research Office & Federal Highway Administration