Alkali Silica Reactivity (ASR) Risk Assessment

[Performance Period: 1/1/2016 - 3/31/2018]

RES #: 2016-03

Purpose of the Project

Alkali-silica reaction (ASR) is a chemical reaction in either concrete or mortar between hydroxyl ions of the alkalis (sodium and potassium) from hydraulic cement (or other sources), and certain siliceous rocks and minerals, such as opal, chert, microcrystalline quartz, and acidic volcanic glass, present in some aggregates. This reaction and the development of the alkali-silica gel reaction product can, under certain circumstances, lead to abnormal expansion and cracking of the concrete. This phenomenon affects the durability performance of concrete structures severely. ASR is known as the "cancer" within the concrete and recognized as a major cause of concrete deterioration in the USA.

Identifying the reactivity of an aggregate to ASR is one of the most efficient ways for preventing damage in practice. Many aggregates, especially the surface aggregates, used in Tennessee have a relatively high siliceous content (e.g. gravels, siliceous limestones, granites, and quartzite). Thus, the aggregates with ASR potential have the possibility to be used already in the past projects, and will be probably used even more in the future high volume transportation concrete projects due to the new requirements on the aggregates for riding surfaces in 2015 TDOT Standard Specifications. However, there is no category guideline on the ASR reactivity property of the aggregates within Tennessee so far.

Scope and Significance of the Project

A statewide aggregate ASR risk database is required to provide a solid foundation for guaranteeing a good long-term performance and a high-level safety of statewide transportation concrete structures. Therefore, the project is proposed to achieve the following objectives:

1) Establish an aggregate ASR risk database that includes the field and laboratory performance of different aggregates used in Tennessee. Determine ASR risk (i.e. non-reactive, marginally reactive or highly reactive) of each type of aggregates by using comprehensive analysis on the field performance and laboratory test results.
2) Document mitigation methods on the concrete mix design, alkali content in cement, environmental requirements and mitigation alternatives (e.g. fly ash, slag, air entrainment, lithium-based admixtures) to minimize or prevent the ASR effect from reactive aggregates.
3) Propose guidelines to modify the current TDOT Standard Specifications.

Expecting Outcomes

The project will benefit TDOT in the following aspects:

1) A guideline on the risk of ASR potential for different aggregates in Tennessee will be provided by this study. Based on this guideline, different aggregates can be used appropriately in TDOT projects according to their ASR reactivity properties.
2) Effective mitigation methods will be developed based on the published literature. These methods will permit an economic use of reactive aggregates that normally would be excluded.
3) Suggestions on the potential modifications for TDOT Standard Specifications will be provided based on the findings in this study. This will provide a solid foundation to a good long-term performance for the concrete projects and a safe transportation system for the motoring public. Long-term investment of TDOT will be maintained properly as well.

Project Schedule and Status

The performance period for the project is 27 months (January 2016 to March 2018). The project is on schedule, and so far 33% of project activities is completed. During the past nine months, the research team has been working on the following tasks:

1) Collect and review relevant literature on the state-of-the-art ASR test methods that have been used to evaluate aggregate reactivity.
2) A total of 76 aggregate samples were acquired from TDOT sources which included Region 1, Region 2, Region 3, and Region 4.
3) At this point, a total of 56 aggregate have been tested and classified according to the ASTM C1260 (Mortar-Bar Method). The aggregates were classified as innocuous (i.e. non-reactive) if the 14 days expansion was less than 0.10%, slowly reactive if it was 0.10 to 0.20%, or highly reactive if the expansion was greater than 0.20%. Of the 56 aggregates, 30% classified as innocuous, 34% classified as slowly reactive, and 36 % classified as highly reactive.
4) ASTM C 1260 results should not be used solely for rejecting aggregates. The test is very sever, therefore, negative results will be confirmed by using another test method (i.e. ASTM C1293). The ASTM C1293 (Concrete Prism Method) test will be performed on aggregates that failed ASTM C1260 (i.e 14 day expansion greater than 0.1%).The aggregates will be batched staring October 2016. The expansion of aggregates will be monitored for a period of one year.

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