CENTER OF EXCELLENCE FOR AIRPORT TECHNOLOGY

TECHNICAL NOTE

TECH NOTE NO:	29
TITLE:	Alkali Silica Reactivity of Selected Sands
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Introduction

Alkali-silica reaction (ASR), described in a previous Technical Note (TN 27, Nelson and Struble), is a common cause of premature deterioration in portland cement concrete. The objective of the study described here was to assess alkali-silica reactivity of aggregates in the northern Illinois area to help develop specifications for the O'Hare Modernization Program (OMP).

Previous studies in our laboratory on alkali-silica reaction conducted for the Illinois Department of Transportation (IDOT) have given us an understanding of reactivity of aggregates likely to be used on the OMP project. In that work, coarse aggregates were not found to be reactive, but fine aggregates were shown to have low to moderate reactivity. The reactive constituent in these fine aggregates appeared to be chert. With such aggregate, whether or not deleterious ASR expansion occurs depends on the alkali content of the concrete, the reactivity of the specific chert, and the proportion of chert in the specific aggregate. It is possible to use such aggregate in concrete, but only if the ASR expansion is mitigated—common mitigating strategies are to limit the portland cement alkali content and to replace some of the cement with mineral admixtures such as fly ash and slag.

Additional details on this study will be provided in the MS thesis of Francis Nelson, which will be released shortly as a Technical Note.

Materials

The cement and aggregates used in this study were selected to be representative of materials in the Chicago area.

A single cement was used in all experiments, the cement that is used in our concrete laboratory for routine tests. It is a commercial portland cement (Holcim, Clarksville, MO) that is classified as a low alkali Type I according to the Standard Specification for Portland Cement (ASTM C 150).

Based on our prior experience with ASR in Illinois, we selected only fine aggregates (sands) for this study. Five natural sands (numbered 1 through 5) and one manufactured sand were obtained for this study from the Chicago area. Although specific sources of the individual sands are not identified, it can be stated that they were all obtained from commercial sources (Materials Service Corporation, Vulcan Materials Company, Prairie material, and Elmhurst Chicago Stone Company). Two widely studied materials were also tested—a non-reactive orthoquartzite sand (US Silica, Ottawa, IL), and a highly reactive glass (Pyrex glass, Dow Corning).

Test Procedure

The sands were testing for ASR reactivity using the ASTM Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method) (C 1260), discussed previously in TN 27. Sands were prepared according to the gradation in the standard. Mortar bars were prepared using a water-to-cement ratio of 0.47. Bars were stored in the molds for 24 hours in a moist room, demolded, and stored in a water bath at 80°C for 24 hours, after which their initial lengths were measured. All length measurements were made using a dial gauge mounted on a stand for this purpose and in comparison to the length of a reference bar. Bars were then immersed in a concentrated (1 N) sodium hydroxide (NaOH) solution and stored at 80°C during the remainder of the test. At least four subsequent readings were made for each bar to monitor expansion up to an age of 14 days. The difference between the initial and the subsequent length value was used to compute expansion as a per cent, relative to the nominal gage length.

Because ASR expansion is known to show some uncertainty, three bars were tested for each mortar. Results here are the average of those three bars.

The standard (ASTM C 1260) states that any aggregate expanding less than 0.10% after 14 days is innocuous, any aggregate expanding between 0.10% and 0.20% may be potentially deleterious and requires further testing, any aggregate expanding more than 0.20% after 14 days is potentially deleterious, any aggregate expanding more than 0.30% after 14 days is deleterious.

Results and Discussion

The expansion values for the three individual bars prepared for each mortar differed by no more than 0.02%, and often by only 0.005% (that is, typical values for three bars were 0.122%, 0.109%, and 0.101% for an average value of 0.11%). Expansion results for the various sands are shown in Figure 1. Results shown there are for the average of the three individual bars prepared for each mortar. All samples produced expansion, and all were still expanding after 14 days.

The Ottawa sand showed less than 0.01% expansion at 14 days, indicating that it is innocuous, as expected. The Pyrex glass showed more than 0.35% expansion at 14 days, indicating that it is deleterious, as expected. These results gave confidence that expansion values for the other sands are reasonable and accurate representations of their reactivity.

The five natural sands showed expansion greater than 0.10% and less than 0.20% at 14 days. Thus they all fell in the range considered to be possibly deleterious and possibly innocuous. Therefore we cannot say with certainty whether these aggregates are reactive or non-reactive, and they should be treated as reactive unless evidence to the contrary is provided. These results are similar to our results with other natural sands from Illinois tested for IDOT.

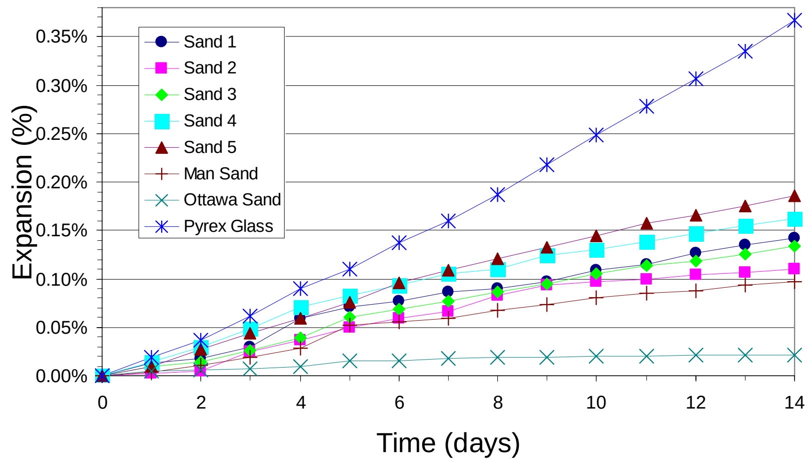

Figure 1. Expansions produced by various sands.

The manufactured sand showed an expansion below 0.10% at 14 days. This sand is made from limestone aggregate and was not expected to be reactive. This expansion fell in the range considered to be innocuous. Similar results were provided by the manufacturer of the sand.

Conclusions and Recommendations

All five natural sands showed expansion levels between 0.10% and 0.20% at 14 days, indicating potential alkali-silica reactivity. They should not be used without mitigation.