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WHAT IS ALKALI-SILICA REACTION?

Alkali-Silica Reaction (ASR) is a chemical reaction between the alkalis in portland cement and certain siliceous aggregates. These aggregates, when placed in a highly alkaline solution and in



Figure 1: Alkali-Silica reaction causes expansion and cracking of concrete structures and pavements.

the presence of water and calcium, will expand and a gel will begin to form. As the aggregate particle expands, it causes the concrete to crack. As the concrete deteriorates, more water enters to fuel the reaction. This cycle continues until the concrete deteriorates past the point of serviceability.

Factors that affect the rate and severity of ASR are:

- Potential reactivity of the aggregate.
- Alkali content of the cement.
- Amount of water present in the concrete.
- Number of wet / dry cycles.
- Top size of the aggregate.

MITIGATING ASR

It is very difficult, if not impossible, to halt the ASR reaction once it begins. Two strategies that have been used are to limit the ingress of water into the concrete, or to draw lithium down into the concrete. Limiting the ingress of water into concrete is extremely difficult and usually proves impractical. The use of lithium has been found to be effective but is very costly. The best way to mitigate ASR is to prevent its occurrence through the proper use of materials in the concrete mixture.

There are several ways to mitigate ASR. One option is to use cements with alkalis of less than 0.60 percent. Another solution is to limit or prohibit the use of reactive aggregates. In reality, sources of both low alkali cements and non-reactive aggregates are limited, so it is often impractical to specify either of these options. A third alternative is to specify slag cement when concrete will contain reactive aggregates¹.

HOW DOES SLAG CEMENT MITIGATE ASR?

The use of slag cement will reduce the potential of ASR occurring by:

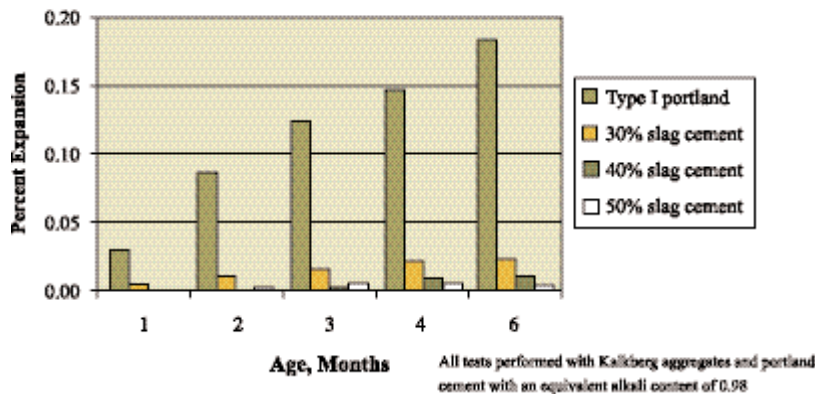
- Reducing the total alkalis in the system thus reducing the alkali-silica ratio.
- Consuming alkalis in the hydration process, making them unavailable for the alkali silica reaction.
- Reducing pore size and mobility of the alkali.
- Reducing the pore liquid that reacts with the aggregate.

MITIGATING ALKALI-SILICA REACTION

Proper concrete proportioning for ASR mitigation should be performed using local materials and accepted test methods such as the modified version of ASTM C227², ASTM C441³, or ASTM C1260⁴. Normally, slag cement replacement of 25 to 70 percent of the portland cement in a concrete mixture will result in effective

mitigation of ASR, depending on the portland cement, the slag cement and the aggregates used. Figure 2 shows the ability of slag cement to mitigate ASR with a highly reactive aggregate and a portland cement with relatively high alkali content.

Figure 2: Effect of Slag Cement on Alkali-Silica Reaction (ASTM C227)



As with all concrete mixtures, trial batches should be performed to verify concrete properties. Results may vary due to a variety of circumstances, including temperature and mixture components, among other things. You should consult your slag cement professional for assistance. Nothing contained herein shall be considered or construed as a warranty or guarantee, either expressed or implied, including any warranty of fitness for a particular purpose.

References

1. ACI 201.2R-92, *Guide to Durable Concrete*; American Concrete Institute, Farmington Hills, Michigan, 1992.
2. ASTM C227-97a *Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)*, American Society for Testing and Materials, West Conshohocken, PA, 2001.
3. ASTM C441-97e1 *Standard Test Method for Effectiveness of Mineral Admixtures or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction*, American Society for Testing and Materials, West Conshohocken, PA 2001.
4. ASTM C1260-01 *Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)*, American Society for Testing and Materials, West Conshohocken, PA 2001.

About the Slag Cement Association...

The Slag Cement Association is the leading source of knowledge on blast-furnace slag-based cementitious products. We promote the increased use and acceptance of these products by coordinating the resources of member companies. We educate customers, specifiers and other end-users on the varied attributes, benefits and uses of these products.

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