Challenging ASR predictive testing

Year-long comparison tests indicate large differences in results between two ASTM tests

For the past several years, producers and state materials engineers have struggled with ways to mitigate concrete damage caused by alkali-silica reaction (ASR). Some state agencies attempt to mitigate damage by adopting aggregate specifications based on predictive test methods.

Producers believe that these overly restrictive specifications unnecessarily disqualify aggregate sources and thus raise their material costs (see The Concrete Producer, April 1997, pp. 241-244). Producers stress that, while formal service records may not be available for many aggregate sources, if concrete structures had experienced failure due to ASR, design engineers would have discontinued use of aggregates supplied to those projects.

In 1994, the National Aggregates Association (NAA) asked members to send aggregate samples to the NAA/National Ready Mixed Concrete Association's Joint Research Laboratory (JRL) to develop data on two relatively new predictive ASTM test methods used to screen aggregates for ASR susceptibility. The results show that interpreting aggregate ASR predictive test results can be a challenge. The study's results may confirm producers' claims that service records may be a more reliable indicator of acceptability than accelerated laboratory tests.

Due to deficiencies in older aggregate screening tests like ASTM C 227 and ASTM C 289, many states, such as California, use ASTM C 1260, Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method), in their specifications because it provides a result in about two weeks. ASTM C 1260 measures the expansion of a mortar bar containing aggregates from a specific source as it undergoes severe exposure conditions that can accelerate any potential expansion that might occur in field concrete. In several cases material engineers have cited this predictive test as cause to reject aggregates that had good service records when used in concrete.

Some engineers, concerned with the poor correlation between aggregates with good service records and results of C 1260, are turning to a more recently published concrete test, ASTM C 1293, Standard Test Method for Concrete Aggregates by Determination of Length Change of Concrete Due to Alkali-Silica Reaction. Also known as the "concrete prism test," this predictive test measures a cylinder's expansion over a one-year period less aggressively than C 1260.

National Ready Mixed Concrete Association

Research performed at the National Aggregate Association/National Ready Mixed Concrete Association's Joint Research Laboratory suggests that an aggregate's service record is a more reliable indicator of acceptability than accelerated laboratory tests.

The Canadian Standards Association (CSA) found that this test produces results that better correlate with the field performance of aggregates relative to ASR (CSA A23.1, Appendix B). CSA further indicates that ASTM C 1260 results should be used only as a quick screening test and not as a basis for rejecting aggregates to be used in concrete.

Test cylinders, cast with aggregates from National Aggregate Association members' operations, undergo accelerated testing for alkali-silica reactivity.

ASTM C 1260 results

In its study, the JRL received 152 samples of coarse and fine aggregates currently produced in the United States and Canada. About 80% of the aggregate suppliers indicated that these aggregates have been used in concrete for 40 or more years. JRL technicians tested all the samples for ASR using ASTM C 1260.

Part of the problem in using ASTM C 1260 is selecting the primary failure criteria. According to the method's non-mandatory appendix, the recommended criteria for potential reactivity is 0.20% expansion after the exposure period. The JRL's results showed that, using a 0.20% guideline, 55% of the aggregates tested would be considered potentially reactive if judged by the ASTM C 1260 method. If specifiers attempt to add a safety factor and select a failure limit of 0.10%, then only 15% of the 81 sands and 40% of the 71 coarse aggregates would meet specifications.

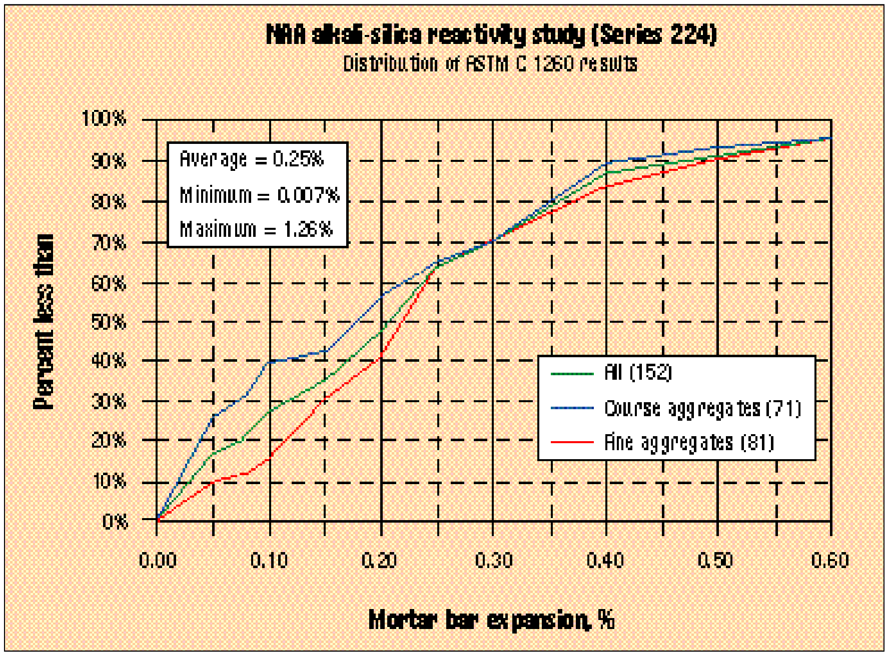
ASTM C 1293 results

JRL technicians also split 15 of the aggregate samples and tested for ASR by the ASTM C 1293 method (prism test). There was little correlation between results from the two methods (see table). JRL found only two aggregates to be potentially reactive by both test methods. Two samples were also found to be acceptable by both methods.

More research needed

Since most of the aggregates determined to be expansive by ASTM C 1260 were found to be acceptable when tested by the prism method, it is evident that more research is needed. The International Center for Aggregate Research, Austin, Texas, is developing a series of comparative tests on ASR screening procedures with results anticipated in three years. Meanwhile, producers should continue to encourage specifiers to use service records as an acceptance criteria for aggregates that fail the mortar bar test.

Furthermore, using any screening test ignores the holistic approach of concrete mix design. By developing the proper concrete mix design for different types of exposures and structures, engineers optimize each ingredient's characteristics. The holistic approach in mix design fully utilizes concrete's advantage as a high-performance material over other building materials. ■



When 150 aggregate samples were tested for expansion using ASTM C 1260, only 55% of the coarse aggregates and 40% of the sands experienced less than 0.20% mortar bar expansion.

Little correlation between ASR tests

Aggregate source	Expansion, % C 1260	Expansion, % C 1293
Dolomitic limestone from Pennsylvania	0.041	0.016
Natural siliceous sand from California	0.080	0.008
Crushed quartzite sand from Colorado	0.139	0.018
Crushed gravel from Wisconsin	0.154	0.020
Natural sand from Wisconsin (same source as above)	0.227	0.009
Crushed gravel from New York	0.154	0.038
Natural sand from South Dakota	0.250	0.012
Limestone from Oklahoma	0.265	0.008
Natural siliceous sand from Indiana	0.279	0.007
Natural carbonate sand from Canada	0.285	0.015
Natural siliceous sand from Michigan	0.316	0.005
Natural carbonate coarse aggregate from Canada	0.342	0.068
Natural siliceous sand from California	0.678	0.026
Crushed gravel from Colorado	1.061	0.196
Natural gravel from Nevada	1.072	0.016

Results from two methods of testing for expansion due to alkali-silica reaction yielded significantly different results. The expansion by C 1260 is at 16 days and that of C 1293 is at one year. Aggregates exceeding the typically recommended expansion criteria—0.20% for C 1260 and 0.04% for C 1293—are in bold.

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