

EDITORIAL

Use, Misuse, and Blind Faith: ASTM Test Methods and Guidance for Dealing with Alkali-Silica Reactivity

Largely as a result of the SHRP C-202 contract on "Eliminating or Minimizing Alkali-Silica Reactivity" conducted by Construction Technology Laboratories, there has been an increased awareness of "use, misuse, and blind faith" by state highway departments and other agencies. However, as a result of this new awareness, but without much in-house technical expertise, many states are adopting arbitrary and often draconian specifications related to both cements and aggregates. This has caused great concern amongst both cement producers and aggregate suppliers. I suspect that some of this is the result of both limited technical understanding of the problem and selection of inappropriate mitigative measures. But this has also resulted from inadequate guidance provided by ASTM as to proper use of the numerous test methods.

Currently, the only guidance to be found in the *Annual Book of ASTM Standards, Volume 04.02*, is the short appendix to C 33, Specification for Concrete Aggregates. This does little more than provide nonmandatory suggested limits for the various test methods and certainly does not provide much guidance as to the appropriateness of each test method or the proper sequence of test methods to be considered in an investigation.

I understand that both Subcommittee C09.20 on Normal Weight Aggregates and American Concrete Institute Committee C221 on Aggregates are currently working on new documents to address these deficiencies, so the purpose of this editorial is not to interfere with or diminish these efforts, but simply to bring this concern to the concrete community in the interim. Also, this is my view and not a committee view, and is based on my observations from experience with these test methods and test method development.

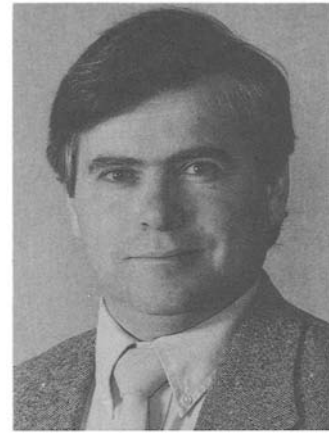
Test Methods

C 289—The quick chemical test is often specified due to the word "quick" (everyone wants results quickly), but with many aggregate types, especially those containing carbonate rocks, it can lead to erroneous determinations.

C 342—The so-called Conrow-test is a test for a specific problem in a few states that was originally thought to be due to some special type of reaction but was later found not to be. This test method should have been deleted years ago and only remains on the books for historical rather than technical reasons.

C 227—This classic mortar bar test is used around the world but has suffered from variability due to inadequate humidity conditions inside the storage container. An attempt was made to rectify this problem by introduction of a reference container design in C 227-87. Unfortunately, the container with wicks, as presently specified, can result in most of the alkalis being leached from the bars due to condensation before some aggregates react (see Rogers and Hooton, 1991), thus preventing expansion and resulting in erroneous results (a footnote has been added to C 227 to warn about this, but more definitive action is needed). This test method can, if used carefully, still provide useful information.

C 1260 (previously P 214)—This relatively new and rapid 14-day mortar bar test method is the one that some state highway



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agencies have latched on to with blind faith. I am partly to blame since I drafted the P 214 test method (based on the works of Oberholster and Davies in South Africa) and chaired the task group that eventually resulted in its standardization.

While I believe this test to be an excellent screening test with appropriate expansion limits (The appendix to C 1260 mentions 0.10% after 14 days in solution, while the Canadian CSA A23.2-M94 Appendix B uses 0.15% and Dave Stark from his SHRP experience with granite-gneisses in the Northeastern U.S. prefers 0.08%), it should not be used as the basis for rejection of aggregates. This is a very aggressive accelerated test, cooking mortar bars at 80°C in a 1 normal NaOH solution and should detect most, if not all, potentially deleterious aggregates, but it will also reject some aggregates with excellent performance in concrete. The number of good aggregates caught in this net appears to vary regionally and has been a source of concern in many states. Also, this method is not intended to evaluate portland cement-aggregate combinations for which it has been enormously used. However, it has been used to evaluate the effects of mineral admixtures.

The 1994 version of the new Canadian Standard CSA A23.1, Appendix B, instructs the user that if C 1260 (the CSA equivalent test method is A23.2-25C) expansion is less than 0.15%, then no further testing is required (a flow chart is provided in the standard to guide the user). If expansion exceeds 0.15%, the aggregate is then subjected to further, more realistic (and unfortunately longer term) concrete prism testing (CSA A23.2-14A) to determine whether it is really potentially deleterious in concrete. The Canadian standard also allows the producer to use documented evidence of good field performance to override laboratory test results since relevant field performance is the most convincing data.

This concrete prism test method has recently gone to ASTM C-9 main committee ballot (I chair that activity too, but at the time of writing, the results of this ballot were unknown), but presently there is no concrete test for detection of alkali-silica reactive aggregates in the *ASTM Book of Standards*. While there is general agreement that this is a good test in terms of detecting deleterious aggregates, and being far closer to reality than C 1260, it has been opposed due to the length of time it takes (up to 12 months) to obtain definitive results. In response to this criticism, I believe that this test will be useful if conducted by the aggregate producers on representative samples from various parts of their quarries or pits. Producers know that 12 months is a short period in the lifetime of most pits and quarries, but is an enormous time

for testing on a job-specific basis. Therefore, the producers should be prepared so that they are not at the mercy of unfavorable accelerated short-term test results.

Lastly, I would like to suggest that there are a number of mitigative measures that can be taken to control the deleterious effects of alkali-silica reactive aggregates other than specifying low-alkali portland cement. For example, mineral admixtures such as fly ash, ground-granulated blast-furnace slags, and silica fume at appropriate replacement levels can be used very effectively. Arbitrary limits on alkali contents of portland cements do not necessarily solve the problem and they often result in great environmental problems for cement producers in the eastern part of the continent.

Until the ASTM and ACI committees complete their new documents, very useful guidance can be found in two recent industry documents: (1) "Guide Specifications for Concrete Subject to

Alkali-Silica Reactions," developed by the Mid-Atlantic Regional Technical Committee (900 Spring St., Silver Spring, MD 20910) and (2) "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (Publication IS 415) published by the Portland Cement Association (5240 Old Orchard Road, Skokie, IL, 60077-1083), and in the Canadian Standard CSA A23.1-M94, Appendix B.

—R.D. Hooton, *Editor-in-Chief*

Reference

Rogers, C.A. and Hooton, R.D., "Reduction in Mortar and Concrete Expansion with Reactive Aggregates Due to Alkali Leaching," *Cement, Concrete, and Aggregates*, CCAGPD, Summer 1991, Vol. 13, No. 1, pp. 42-49.