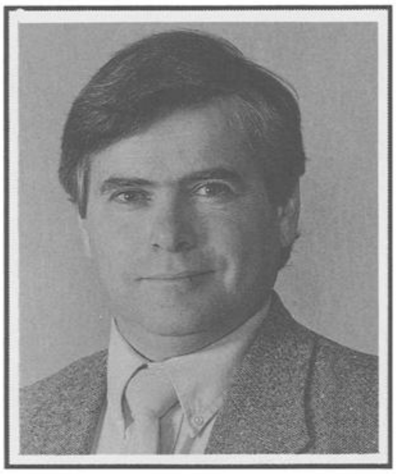
EDITORIAL
Some Limitations of Our Existing Standards



R. Doug Hooton

As incoming Chairman of Committee C-9, I believe in the importance of standards. However, the limitations of our existing cement, concrete and aggregate standards continue to become more apparent to me.

In October alone, I had three occasions to question the adequacy of our current standards. Most recently, I had to tell the manager of a construction company who wanted to evaluate the cracking potential of various concrete mixtures due to restrained shrinkage that there is no ASTM standard for restrained shrinkage even though this is probably one of the most common concerns related to shrinkage. I told him that we could measure the free shrinkage using ASTM C 157 (Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete), but there were other issues such as the tensile strain capacity that would influence cracking. I know that the C 878 method for Restrained Expansion of Shrinkage-Compensating Concrete could be used in reverse, but the degree of restraint offered by a 10-24 threaded rod embedded in a 75 by 75 cross-section beam would not necessarily simulate the situation of a reinforced concrete wall. I also knew that non-standard tests had been done using torus shaped molds (mmm . . . doughnuts) where the center mold was a thick ring of steel. The concrete doughnut would then shrink around it. But I didn't know where to look for details so first I consulted the human CD-ROM for concrete literature searches: Bryant Mather. He was quickly able to provide a rich history of information about various restrained shrinkage tests used by various researchers and was able to provide some dimensions for such a doughnut test previously used at the Waterways Experiment Station. This was very helpful but why hadn't anyone ever standardized such a procedure? A quick literature review (that is, I spent five minutes browsing through a few journals) also shows that there has been recent research in the area (Shan et al. 1992 and Bloom and Bentur 1995) but I am not aware of any standardization activity. Either none of the developed tests are considered adequate, or no one is interested in the problem, or more likely, there is noone on Committee C-9 who is interested enough to "champion" such a test procedure through the standardization process.

In October, I participate in an ASTM, ACI, CSA, and NIST sponsored workshop on the future of standards held at NIST. (How's that for packing acronyms into one sentence!.) The issues raised at the workshop were numerous and a summary report will be generated by NIST in 1996. I will conveniently ignore everyone else's concerns (mainly due to my poor short-term memory—it usually lasts until I get to the airport) and simply mention one of the points I raised there, which was that we don't do enough testing on the complete mortar fraction of conrete (including portland cement, mineral admixtures, slag, and chemical admixtures). The example that I used was on setting time. We typically see the setting time data on portland cement reports that are done to comply with C 150. While C 150 is a useful manufacturing standard, the setting time of portland cement has very little bearing on the setting time of concrete since most concrete also contains one to four chemical admixtures and most likely has at least one mineral admixture or slag as well. Most of the recent construction problems related to accelerated or delayed set that I am familiar with are related to the interaction of the combination of these materials. I don't care what the time of set of the portland cement component is if due to these interactions the concrete in practice sets anywhere between 5 min and 3 days. I've seen concrete set in a mixer because the combination of the cement, water reducer, and superplasticizer being used weren't compatible. The pair of admixtures in combination selectively suppressed the solubility of the sulfates and caused the quick stiffening. When we changed any one of these components, the problem disappeared. At the other end of the spectrum, a low *W-C* silica fume concrete didn't set for almost 48 hours because of the retarding effect of the particular superplasticizer and water reducer at the high dosages used. That concrete eventually reached 85 MPa at 28 days, but everyone was pretty upset after one day. Yes there is a test for measuring the time of set of concrete but what is needed is a standard method that would allow evaluation of compatibility in the laboratory (perhaps a mortar test with all the components of the "paste" included).

Lastly, later in October I attended a RILEM Workshop in France on chloride penetration. Of the approximately 50 people attending, my colleagues from the University and I were the only ones there from North America (Dale Bentz of NIST had a paper but couldn't get travel authorization). This amazed the organizers and us as well since chloride-related corrosion is such a big problem in North America; but in spite of that, very little research work is underway on measuring parameters, such as chloride diffusion rates, that can be input into quantitative service life prediction models. I know a lot of people are working on corrosion-related issues but very few are working to estimate the added service life provided by various protective measures. The owners of bridges and parking structures want to know what decisions have to be made to provide a given service life, but in North America at least, this need has not been seriously addressed. However, numerous European researchers have developed very sophisticated quantitative models and in Canada, we have already see two major precast tunnel liner specifications where new requirements were introduced by European design partners that contain chloride diffusion limits among other things in order to meet required service lives of 100 years. There are shortcomings and limitations to these service life models (Hooton 1995), but they are progressing rapidly and soon will likely be popping up in the United States.

The C09.69 task group on permeability methods is initiating standardization action on related test methods, but the lack of experience of the membership with the range of test methods is one of the serious impediments. There is the much criticized and maligned C 1202 "coulomb" test, which is in reality an awkward resistivity test (but resistivity provides a useful indirect indication of the fluid transport properties). There is also a current initiative to standardize the AASHTO T259. 90-day ponding test. In spite of the praise heaped on this test by some, the mechanisms of chloride ingress in this test are no less complicated than C 1202! In this test, a salt solution is ponded on a slab that has been dried in air for several weeks and after ponding, the bottom of the slab is also exposed to 50% relative humidity air. Therefore, there are components of surface absorption (sorptivity) and wicking occurring as well as chloride diffusion that will all contribute to the chloride penetration profile. These are all relevant mechanisms related to chloride ingress, but in this test the relative importance of each is undefined and appears to vary with different types of concrete. In fact, after 90 days, our data indicates that the first two mechanisms may dominate the resulting chloride profile. In addition, there will be chemical binding of the penetrating chlorides and the relative importance of these four issues will vary with the concrete materials and proportions. The other problem is that the half-inch thick chloride profiling used in AASHTO T259 is very crude (Flintstone-esque perhaps) and has not kept pace with new technologies. My students are regularly measuring representative chloride profiles at 1-mm horizons. This 1-mm data can then be used to actually calculate a diffusion-like penetration rate coefficient. However, for service life modeling, the sorption effects that dominated early chloride ingress will have a decreasing effect on the long-term penetration. So unless the diffusion component is separated out, the AASHTO ponding test is of limited use for predicting long-term chloride penetration.

These are a few examples of issues where existing standards are inadequate to address many of the problems we face or will soon face in the concrete industry.

I hope that as we recognize these weaknesses that we can get members excited enough to develop new standards or evolve existing ones to address the deficiencies and not simply continue to massage the existing ones. If we can do this it will ensure that standards move forward and are still relevant in the next millennium.

I invite your comments.

—R. D. Hooton, *Editor-in-Chief*

References

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