VIEWPOINT

HIGH-RANGE WATER REDUCERS

SHOULD MULTIPLE DOSES BE EMPLOYED TO ACHIEVE CONCRETE WORKABILITY AT THE JOBSITE?

BY LARRY MRAZEK

On a recent parking structure repair project, a procedure was employed which, in my experience, was contrary to good-quality concrete practice. This article describes the particular conditions and presents my recommendations to attain workable and acceptable concrete when using a high-range water reducer (HRWR) at the jobsite.

The approved concrete mixture for the post-tensioned concrete repair project included Type I/II portland cement, Class C fly ash, torpedo gravel, sand, water, an air-entraining admixture, and a plant added mid-range water reducer. The specified water-cementitious material ratio (*w*/*cm*) was 0.38 and specified slump ranged from 6 to 7 in. (150 to 175 mm). The specified air content was 6.0% ± 1.0%.

When the first concrete truck arrived, it was obvious to everyone that the concrete mixture was not workable. I requested a slump test (Fig. 1) which was 0.5 in. (13 mm), not acceptable for transporting, placing, or finishing. The batch ticket furnished by the driver had a warning: "NO WATER ADDED!"

Fig. 1: Testing for slump

It was not clear whether this note was intended for the concrete plant, the driver, or both. At any rate, the contractor initiated the addition of a high-range water reducer (HRWR), sometimes referred to as a superplasticizer. The first dose did little to affect the workability. Consequently, additional doses of HRWR were added before a workable mixture was achieved. There was no evidence that the HRWR was tested with the approved concrete mixture to ensure compatibility with other admixtures and the cement. In fact, the driver was reluctant to furnish the name of the HRWR admixture manufacturer.

In the past, I have read articles about certain problems which occurred when multiple doses of HRWR were employed at the site. These issues included cracking, scaling, and other surface defects. At that time, testing found that the problems were related to multiple doses of HRWR, the result of insufficient water in the mixture delivered to the jobsite. The articles did not elaborate on the problems related to *w*/*cm* or other environmental conditions.

Many engineers become obsessed with concrete compressive strength and have no issues when the tested concrete compressive strength exceeds the specified strength by several thousand psi (145 psi = 1 MPa). This thinking leads to the aforementioned approach of not adding sufficient water to the concrete mixture as delivered. The engineer should be aware that performance and proper bonding of repair concrete to the substrate is influenced by the compatibility of concrete substrate strength with the strength of the repair concrete.

A recommended approach to the workability of a concrete mixture as delivered is as follows:

1. Require the concrete producer to provide a batch ticket that includes total water (moisture in aggregates + water of convenience). I like to request less water added at the plant so that water may be added at the site to achieve the specified *w*/*cm*. Refer to the National Ready Mixed Concrete Association (NRMCA) and ASTM C94/C94M[1] for recommendations related to the addition of water on-site.
2. When the concrete truck arrives, require an initial slump test. If the slump is low, add a small

amount of water, not to exceed design water amount and the *w*/*cm*. Take another slump test.

3. If the concrete mixture does not meet the specified slump (but is within the HRWR manufacturer minimum slump requirements prior to dosing) and workability, add one dose of HRWR as recommended by the admixture manufacturer and as tested for compatibility with the concrete mixture.
4. Complete the specified air test (Fig. 2) for this mixture. This is very important! On several recent projects, air contents were found to be excessively high, which can result in a lower compressive strength and other problems. On one project, the HRWR was found to be the problem. In this case, after the admixture manufacturer researched the particular batch of HRWR, it was found that the contractor's HRWR had deteriorated during storage.

The aforementioned approach requires a knowledgeable engineer on-site to review the quality of the concrete delivered and transported to the placement location. This individual should be equipped with a calculator and a copy of the approved concrete mixture design so that informed decisions/adjustments can be made on-site.

REFERENCES

1. ASTM C94/C94M-14b, "Standard Specification for Ready-Mixed Concrete," ASTM International, West Conshohocken, PA, 2014, 13 pp.

This Viewpoint article has been selected by the editors as an offering to the interest of our readers. However, the opinions given are not necessarily those of the ICRI or of the editors of this magazine. Reader comment is invited.

Fig. 2: Testing for air content

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