Reusing non-admixtured returned concrete

Tests show old concrete can be reused with appropriate cautions

Many environmentalists view reuse as superior to recycling, although either is preferred to waste disposal. So a concrete producer with a similar mind-set should look first to reusing returned concrete. One option is to simply add fresh materials to the returned concrete, but that raises the question, Does such a practice compromise the quality of the blended concrete?

The National Ready Mixed Concrete Association carried out a study at the Joint Research Laboratory to answer that question. The first part, summarized here, studied non-admixtured concrete to find out whether blending old and freshly batched concrete had harmful effects on setting time or compressive strength. The second part (see reference) studied the effects of proprietary recycling admixtures.

Test conditions and variables

All tests used non-air-entrained concretes made with a low-alkali, Type II cement. Target slump was 4 to 6 inches, and initial temperature was 75° F. Aggregates were a 1-inch maximum size uncrushed gravel and a natural sand.

Principal variables were the amount of old concrete to be blended (5%, 25% and 50% by weight) and the age of the old (original mix) concrete being blended (45 minutes, 90 minutes, three hours and six hours). The 5% blend percentage might result from batching a short load into a truck that had just the "butter" remaining from a full load.

Lab personnel mixed the original batch and tested it after eight minutes for slump, air content, unit weight and setting time. They also made two 6x12-inch cylinders for 28-day strength tests.

After covering the mixer, they remixed the remaining concrete for one to five minutes every 20 to 30 minutes and retempered it as needed to maintain slump, which was visually estimated.

After the planned delay (45 minutes to six hours), they removed the amount of concrete needed for the desired blend percentage, put it in a different mixer, added the fresh materials and mixed the blended concrete for six minutes. They visually adjusted it to the proper slump. In addition, after each planned delay, they sampled the original unblended batch until it reached an age of three to six hours.

They also covered the mixer containing the blended concretes and agitated and retempered the mix only as necessary. Then, at 45 minutes, 90 minutes and three hours after the fresh concrete had been added to the old, they molded two 6x12-inch cylinders and a setting-time specimen.

The findings for non-admixtured concrete

Figures 1 through 3 show the effects on setting time and compressive strength.

Setting time. Between 45 minutes and three hours, setting time of the original concrete batch, as measured from the time of sampling, decreases from three and a half hours to two hours or slightly below two hours. When this original concrete is reused and mixed with fresh material, the older "original" concrete tended to control the resulting setting time of the blend concrete, but the amount of old concrete (5%, 25% or 50%) had only a minor effect on the set acceleration.

Adding an extended set-retarding admixture to the original concrete when it returns to the plant can offset the faster set of the blended material (see reference). Adding conventional retarders when batching fresh materials also slows the normally accelerated setting.

Strength. As might be expected, retempering the original concrete reduced 28-day strength. The solid curves in Figures 1, 2 and 3 show that original concrete strength decreased from about 5000 psi at a 45-minute

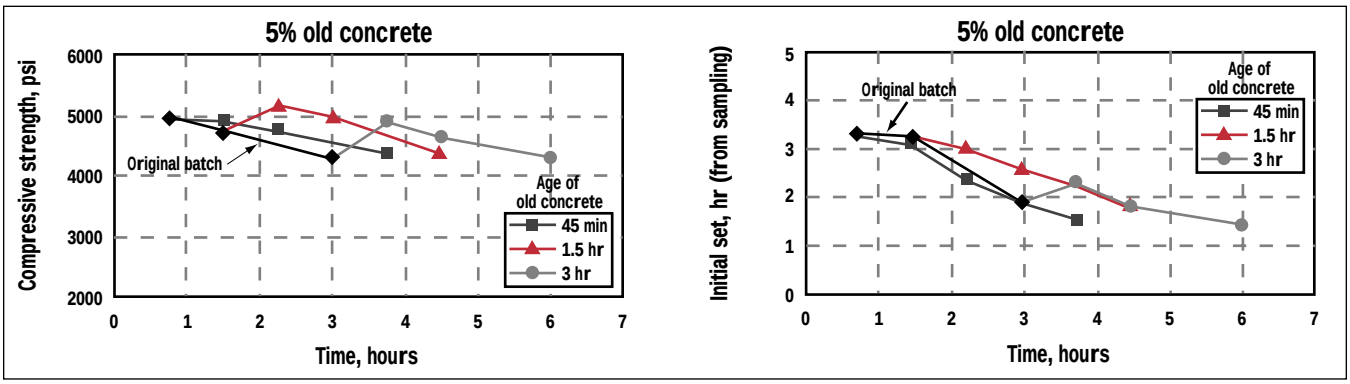

Figure 1. The solid line shows changes in 28-day compressive strength and setting time as the original concrete was retempered to maintain a 4- to 5-inch slump. The dotted lines show the effects when concrete that was 45 minutes, one and a half hours, and three hours old was blended. For instance, when 5% 45-minute-old concrete was blended with 95% fresh material and sampled 45 minutes later, its strength matched that of the unblended concrete at a 45-minute age. Setting time decreased for both the retempered, original concrete and blended mixtures.

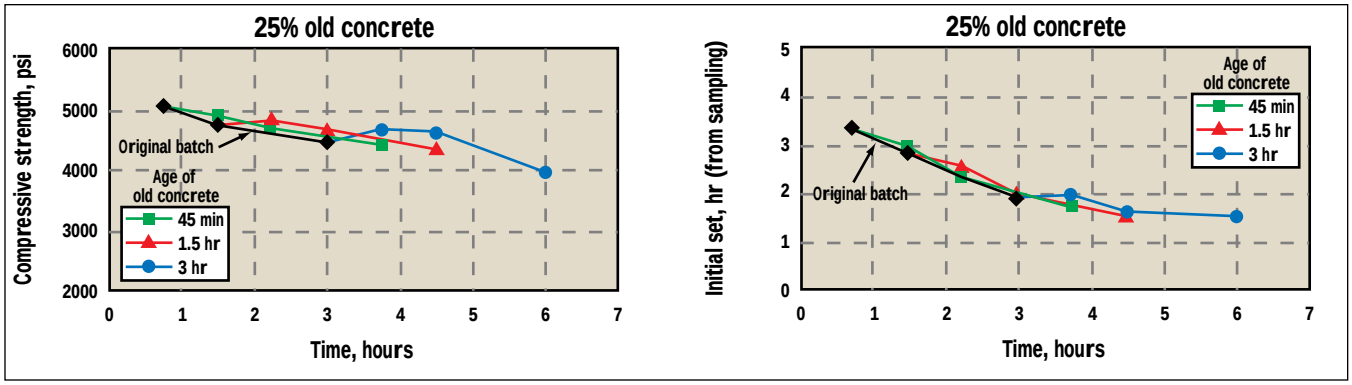

Figure 2. Trends for blends containing 25% old concrete are similar to those for blends with only 5% old concrete.

age to 4300 psi at a three-hour age—a loss of 14%. As a rule of thumb, retempering these 75° F concretes caused strength losses at a rate of about 6% per hour up to an age of three hours.

Blending 5% old concrete with fresh materials at either one and a half or three hours, however, restored the strength to its original 5000-psi level (Figure 1). A 25%-75% blend of old concrete and fresh material restored the strength to within 3% to 4% of that of the original concrete of the same age.

Up to three hours, a 50%-50% blend of old concrete and fresh material had a similar or marginally greater effect on strength. However, 50% blends of the three- to six-hour-old concrete and fresh materials had dramatically reduced strengths, as might be expected. Results indicate that if the blended concrete could be delivered and discharged within 45 minutes of blending, the strengths would be 4500 psi for three-hour-old blends and 3400 psi for six-hour-old blends. Additional delay in delivery past the 45-minute mark would reduce these strengths to 3200 psi and 2200 psi, respectively (Figure 3).

All strength reductions in the blended concrete can be attributed to increases in the water-cement ratio caused by the retempering needed to maintain slump.

Conclusions

These data and results of further tests given in the reference show that reuse of returned concrete in cool weather, under conditions where delivery and discharge are possible without excessive delay, doesn't significantly affect compressive strength. However, almost all the blended concretes in the study set faster. Thus, the blended concrete should be used in applications where setting characteristics are less critical.

Also, take caution when developing your own blending procedures. Results will vary with the temperature and with the cement and admixtures used. Take special caution in hot weather. Finally, on jobs requiring more than one truckload of concrete, we don't advise sending some trucks with blended and some with unblended concretes because the resulting variations in setting time could cause finishing and placement problems. ■

Colin Lobo is vice president of engineering for the National Ready Mixed Concrete Association and Richard D. Gaynor is now a consultant after retiring as NRMCA executive vice president.

Reference

Colin Lobo, William Guthrie and Raghu Kacker, "A Study on the Reuse of Plastic Concrete Using Extended Set-Retarding Admixtures," *Journal of Research of the National Institute of Standards and Technology*, September-October 1995, pp. 575-589.

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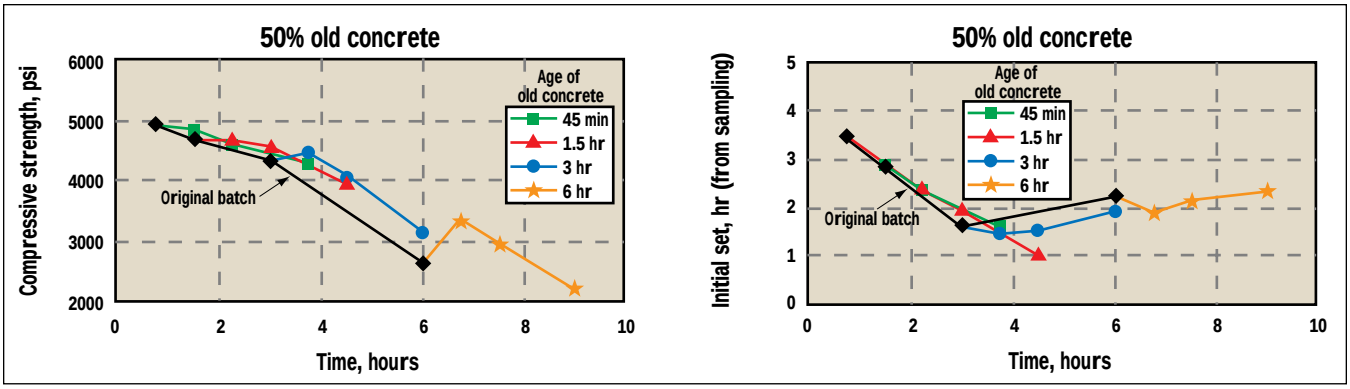

Figure 3. For blends containing 50% old concrete, using six-hour-old concrete significantly reduced compressive strength of cylinders taken 45 minutes, 90 minutes or three hours after blending. Strengths of concretes delivered more than 45 minutes after blending decreased markedly.