A Contractor's Guide to Superplasticizers

Various brands affect set time and slump loss differently

BY TIMOTHY S. FISHER

You've won the job. Whether it be placing a wall with heavy reinforcement, pumping a foundation mat, or overlaying a bridge deck with silica-fume concrete, you've decided to use a high-range water reducer (HRWR), also known as a superplasticizer, or "super" for short. But what types of superplasticizers are there, and how do you choose the best type for the job? When should you add superplasticizers to the mix? How will a change of brands affect set time and slump loss?

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Superplasticizer Types

High-range water reducers are classified by ASTM C 494, "Standard Specifications for Chemical Admixtures for Concrete" (Ref. 2), as Types F and G. Type F is a water-reducing, high-range admixture, and Type G is a water-reducing, high-range, retarding admixture. It is important for the contractor to understand the difference. The improper use of a Type G admixture may require a finishing crew to wait three additional hours until the retarder has worn off.

Typically, within the different types, superplasticizers are salts of sulfonated melamine-formaldehyde condensates (melamine), salts of sulfonated naphthalene-formaldehyde condensates (naphthalene), or lignosulfides. Most HRWRs used in cast-in-place concrete today are naphthalenes. Lignosulfides, typically Type A water reducers, can also be used as HRWRs by increasing their dosage rate, but their use is no longer recommended because they can cause serious set retardation.

Within the different ASTM types, manufacturers offer many different brands. Different brands may produce different results.

Webster Dunlap Inc.

Superplasticized concrete pumps easily and arrives workable. For maximum effectiveness, however, superplasticizers must be added to the mix at the right time.

Plant or Site Addition

One admixture manufacturer states that if haul times are particularly long, a Type G HRWR added at the plant can minimize problems associated with ASTM C 94's limitations on delivery time and mixer revolutions. The retarder in a Type G will also delay the set for that long run. If unexpected delays are encountered in transit, however, the effects of the superplasticizer may not last until the contractor

is ready to place the load. Workers may then be unhappy with the slump, add water, and, consequently, reduce strengths. This can lead to rejection of the concrete.

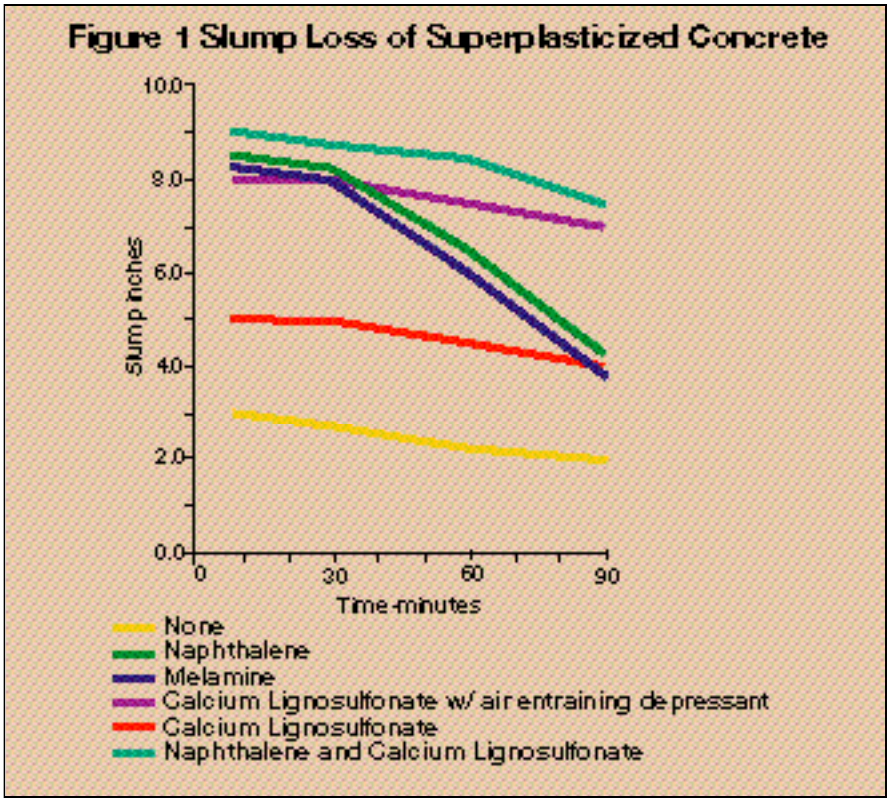
Superplasticizers can also be added on-site from an external tank on the ready mix truck or using on-site dispensing equipment. One manufacturer packages its supers in bags that can be tossed in the drum in the quantities needed. Advantages of adding supers on-site are that the contractor can see the effects, the inspector is assured that the super is going in, and the contractor can add the super when it will be most effective. After introducing a super on-site, rotate the drum 70 revolutions to ensure proper mixing. If problems are foreseen with meeting ASTM C 94's requirement of concrete placement before 300 revolutions, the contractor should bring this up in the prepour conference and request additional revolutions.

Set Times of Concrete Treated with Various HRWR

Concrete No.	Admixture	Time of Set (Min.) Initial	Final
1	none	281	382
2	naphthalene	355	435
3	melamine	350	440
4	calcium lignosulfonate with air-entraining depressant	625	770
5	calcium lignosulfonate	430	532
6	naphthalene and calcium lignosulfonate	390	475

CHECK SLUMP AND AIR CONTENT AFTER EACH REDOSING OF SUPERPLASTICIZER TO BE SURE THEY ARE WITHIN PROJECT SPECIFICATION LIMITS.

Some specifications call for concrete to be placed within 60 minutes after batching during hot weather. In some cases, the use of a superplasticizer with a retarder will allow that time limit to be extended to 90 minutes. Bring this to the attention of the engineer at the prepour conference.



Delayed Addition

Delayed addition or redosing of superplasticizers is not a problem for most products. One manufacturer recommends limiting redosing to two times after initial dose. Another manufacturer does not put a limit on the amount of additional doses but warns that too much superplasticizer can cause delayed set times. Manufacturers recommend checking slump and air content after each redosing to be sure they are within project specification limits. Typically, within a few redoses, the slump will reach that of the original dose.

Additional doses can be costly, ranging from $3 to $5 a cubic yard. A contractor that redoses often should evaluate why. Are the trucks coming too soon and waiting in line on-site while the effects of plant-added superplasticizer are wearing off? Is enough manpower or the proper equipment available on-site when the trucks arrive?

Set Time

Your ready mix producer is supplying quality superplasticized concrete and your finishers are quickly

Wall Pours and Superplasticizers

Using high-range water reducers to increase slump may be necessary for difficult wall placements. Conditions like narrow forms, heavy reinforcement, and sections with many blockouts, penetrations, or embedded items require the use of high-slump concrete. Superplasticized concrete also works well for pumping operations. The fluid concrete consistency reduces pump pressures and eliminates the need for altering mix designs for pumping great heights. It can also eliminate the need to use staging pumps.

A contractor can often turn in a lower bid and produce a higher-quality wall by using superplasticized concrete. Usually wall placement lift heights are restricted to 2 or 3 feet and free fall is held to under 3 to 5 feet. With the use of properly proportioned superplasticized concrete, it is acceptable to increase lift heights to 7 feet and free fall to over 15 feet.

Because superplasticizers allow concrete to be placed faster due to its flowing consistency, allow the placement of higher lifts, and retard set, the conservative design approach would be to use full liquid head when determining wall form pressures. ACI committee report 347R-88 "Guide to Formwork for Concrete" does not include equations for concrete mixes with superplasticizers. Reference 4 offers a less conservative equation to calculate form pressures with the use of superplasticized concrete.

The paste in superplasticized concrete can leak through even small form joints and cause fins and discoloration. Therefore, for architectural concrete, it is important that the formwork joints be tight.

gaining experience on how this concrete sets. Then something changes and the concrete is not setting like it usually does. Either it sets too fast and is getting away from the finishers, or it's delayed and the crew must work overtime. What causes this change in set time?

ASTM C 494 allows a Type F HRWR to exhibit initial set within a 3½-hour window, 1 hour earlier or 2½ hours later. Similarly, for a Type G HRWR, initial set times can vary from 1 hour later to 3½ hours later. Similar time deviations are allowed for final set. What does this mean? If for some reason a ready mix supplier switches superplasticizer brands in the concrete loads to your jobsite or between projects, the set time can vary by 3½ hours. Set times also can vary if the contractor buys a different superplasticizer brand thinking all brands are the same. The table lists typical set times for different superplasticizers. By using the super, initial set time has increased at least 69 minutes with melamine or as much as 344 minutes with lignosulfonate. Final set times increased as little as 53 minutes or as much as 388 minutes. The use of superplasticizers and their effect on set time does not affect finishing operations, but can change the timing of finishing.

Slump Loss

Superplasticizers normally increase concrete slump for 30 to 45 minutes, depending on brand and dosage rate. This usually gives the contractor enough time to place and finish the concrete. However, when using a super to increase the slump from 4 inches to 7 or 8 inches, which is a typical situation, the concrete may lose that additional slump after 30 minutes. Figure 1 shows slump loss at various mixing times of concretes treated with different superplasticizers. In the 90-minute time frame, the smallest slump loss is 1 inch compared to the largest slump loss of over 4 inches.

References

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3. Vance Dodson, *Concrete Admixtures,* Van Nostrand Reinhold, New York, 1990.

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