

WATER-REDUCING & SET-CONTROLLING ADMIXTURES

TECH NOTES



Water-reducing and set-controlling chemical admixtures are used to improve the fresh and hardened properties of concrete. These important chemicals can significantly reduce the water-cement ratio while decreasing the use of cement in the mix and increasing strength. Certain types of these chemicals are also used in producing self-consolidating concrete.



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The most common types of chemical admixtures are water-reducers and set-controlling admixtures. Water-reducers and set-controlling admixtures offer precasters real advantages for improving their production capabilities. Water-reducing admixtures are used to produce higher-strength concrete, obtain specified strength with lower cement content and increase the slump of a given mixture without an increase in water content. Water-reducing admixtures also improve the properties of concrete containing aggregates that are harsh or poorly graded, or they may be used in concrete that will be placed under difficult conditions. Water-reducing admixtures can be very beneficial in producing high strength concrete with a low water-cement ratio.

TYPES OF WATER-REDUCING & SET-CONTROLLING ADMIXTURES

The American Society of Testing and Materials (ASTM) specification C494 covers eight (8) types of chemical admixtures:

- Type A** – Water-reducing admixtures
- Type B** – Retarding admixtures
- Type C** – Accelerating admixtures
- Type D** – Water-reducing and retarding admixtures
- Type E** – Water-reducing and accelerating admixtures
- Type F** – Water-reducing, high-range admixtures
- Type G** – Water-reducing, high-range, and retarding admixtures
- Type S** – Specific performance admixtures

WATER REDUCTION

Each of these admixture types is defined by the range in which it decreases water. Types A, D and E must reduce the water content by at least 5%. Types F and G are high-range water-reducers (HRWR) and are required to reduce the water content of a concrete mix by at least 12% and may in some circumstances decrease the water content of a mix by 30% or more. Types B and C have no water-reducing requirements. There is also a class of water-reducers called mid-range



water reducers (MRWR) that reduce the water content from about 6% to more than 12% while maintaining slump and avoiding excessive retardation. Generally, this class of water-reducing admixtures falls into either a Type A or F category. Mid-range water reducers were developed to fill in the gap between Type A admixtures capable of producing 5-inch slump and Type F admixtures capable of producing 12-inch slump. They have proven very effective with the use of fly ash and other cement substitutes.

TYPE A – WATER-REDUCING ADMIXTURES

Type A water-reducers typically decrease the water content of a concrete mix by 5% to 10%. With all admixtures, the results and dosage rates will vary with the cement and other materials used. A typical dosage rate for Type A is between 2 and 6 fluid ounces per 100 pounds of cementitious materials (130 to 390 milliliters per 100 kilograms). Most Type A water

reducers are composed of organic materials that act as set retardants. Other ingredients are added during manufacture to provide normal setting time. Excessive dosage rates will retard the setting time of concrete. Dosage rates should conform to the manufacturer's recommendations and be tested in trial batches.

TYPE B – RETARDING, AND TYPE D – WATER-REDUCING AND RETARDING ADMIXTURES

Retarding admixtures cause a decrease in the rate of hydration of hydraulic cement and lengthen the setting time of concrete. Retarders are used to offset the effect of high temperature and improve the workability of concrete in warmer temperatures. Benefits of retarders include reduced cold joints and better finish in hot weather. While retarding admixtures can be beneficial, they are not a substitute for good hot weather concreting procedures.

There are some retarders that can stop or significantly slow the hydration of Portland cement. These are known as hydration stabilizers. Hydration stabilizers are used primarily in the ready-mixed industry to control the set-time of concrete wash water, unused, returned concrete, and for long hauls. Hydration stabilizers may be beneficial in concrete that is steam cured. Precasters who use ready-mixed concrete should check with their suppliers to see what admixtures are available.

TYPE C – ACCELERATING, AND TYPE E – WATER-REDUCING AND ACCELERATING ADMIXTURES

Accelerators are used to shorten setting time and to increase early strength development. Precasters can benefit from using accelerators to reduce bleeding and allow for earlier finishing. Accelerators also increase early strength which can protect the concrete from freezing, and they allow for faster removal of forms. Accelerators are available in chloride and non-chloride form.

The use of chloride-based accelerators in reinforced concrete subjected to weathering should be avoided. Accelerators do not act as anti-freeze for concrete.



High-Range Water-Reducers are efficient in producing self-consolidating concrete.

Good cold weather concrete practices must be followed.

TYPE F – HIGH RANGE WATER-REDUCING AND TYPE G – HIGH RANGE WATER-REDUCING AND RETARDING ADMIXTURES

Type F and G admixtures are known as high-range water-reducers (HRWR) or superplasticizers. They are capable of producing large water reductions or great flowability without causing undue set retardation or entrainment of air in cementitious mixtures. HRWRs must reduce the water content of a concrete mix by at least 12% and may reduce water by more than 30% from a control mix.

The composition of HRWRs has seen a great change during the last several years. In the past, the most common HRWRs consisted of products commonly referred to as melamine (MSFC) or naphthalene (NSFC) based chemicals. A problem with MSFC and NSFC based products was that they had limited slump-life capabilities. In the past several years melamine and naphthalene based high-range water reducers have been replaced by a new class of chemicals called polycarboxylates or PCs. Polycarboxylates consist of comb-shaped molecules that provide water

reduction without affecting setting time. PCs are highly engineered and provide a wide range of slump-life capabilities without affecting setting time. They are also very efficient in producing self-consolidating concrete (SCC).

High-range water reducers are very efficient at interacting with fine-grained materials such as cement, fly ash, slag and silica fume. This ability to disperse these finely ground particles creates strength that is higher than expected from just the decreased water-cement ratio.

PLASTICIZERS – ASTM C1017

ASTM C1017 is a subset of ASTM C494, Types F & G. It is a special class that requires the admixture to produce a slump in excess of 7.5 inches. These products are often referred to as superplasticizers. They may be beneficial to precasters in improving workability, increasing strength and decreasing permeability. Most products meeting ASTM C494 Type F or G also meet ASTM C1017 Type 1 or Type 2.

CONCLUSION

Water-reducing and set-controlling admixtures have proven themselves to be useful tools in the precast industry. They can significantly reduce the water-cement ratio while decreasing the use of cement, alter the set time to help in production, improve workability and decrease permeability. Their use does not, however, preclude the use of good concrete practices such as curing. The type of admixture and suggested dosage varies by manufacturer and must be considered with other materials used. Discuss the specifics of your operations with your admixture supplier and use trial batches to ensure that you are getting the properties you want in the most economical manner.

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