Concrete in Practice

What, why & how?

NRMCA

CIP 15 - Chemical Admixtures for Concrete

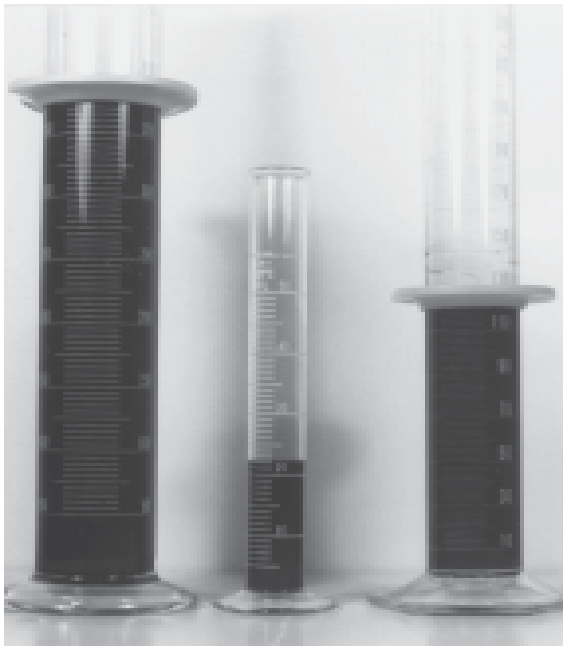
WHAT are Admixtures?

Admixtures are natural or manufactured chemicals which are added to the concrete before or during mixing. The most often used admixtures are air-entraining agents, water reducers, water-reducing retarders and accelerators.

WHY Use Admixtures?

Admixtures are used to give special properties to fresh or hardened concrete. Admixtures may enhance the durability, workability or strength characteristics of a given concrete mixture. Admixtures are used to overcome difficult construction situations, such as hot or cold weather placements, pumping requirements, early strength requirements, or very low water-cement ratio specifications.

Chemical Admixtures for Concrete



L to R: HRWR, Air-Entraining Agent, Retarder
Relative quantities for one cu.yd.

HOW to Use Admixtures?

Consult your ready mixed concrete supplier about which admixture(s) may be appropriate for your application. Admixtures are evaluated for compatibility with cementitious materials, construction practices, job specifications and economic benefits before being used.

Follow This Guide to Use Admixtures

1. **AIR-ENTRAINING ADMIXTURES** are liquid chemicals added during batching concrete to produce microscopic air bubbles, called entrained air, when concrete is mixed. These air bubbles improve the concrete's resistance to damage caused by freezing and thawing and deicing salt application. In plastic concrete entrained air improves workability and may reduce bleeding and segregation of concrete mixtures. For exterior flatwork (parking lots, driveways, sidewalks, pool decks, patios) that is subject to freezing and thawing weather cycles, or in areas where deicer salts are used, specify a normal air content of 4% to 7% of the concrete volume depending on the size of coarse aggregate (see Table on next page). Air entrainment is not necessary for interior structural concrete since it is not subject to freezing and thawing. It should be avoided for concrete flatwork that will have a smooth troweled finish. In high cement content concretes, entrained air will reduce strength by about 5% for each 1% of air added; but in low cement content concretes, adding air has less effect and may even cause a modest increased strength due to the reduced water demand for required slump. Air entraining admixtures for use in concrete should meet the requirements of ASTM C 260, *Specification for Air-Entraining Admixtures for Concrete*.
2. **WATER REDUCERS** are used for two different purposes: (1) to lower the water content in plastic concrete and increase its strength; (2) to obtain higher slump without adding water. Water-reducers will generally reduce the required water content of a concrete mixture for a given slump. These admixtures disperse the cement particles in concrete and make more efficient use of cement. This increases strength or allows the cement content to be reduced while maintaining the same strength. Water-reducers are used to increase slump of concrete without adding water and are useful for pumping concrete and in hot weather to offset the increased water demand. Some water-re-

ducers may aggravate the rate of slump loss with time. Water-reducers should meet the reuirements for Type A in ASTM C 494 *Specification for Chemical Admixtures for Concrete*.

Mid-range water reducers are now commonly used and they have a greater ability to reduce the water content. These admixtures are popular as they improve the finishability of concrete flatwork. Mid-range water reducers must at least meet the requirements for Type A in ASTM C 494 as they do not have a separate classification in an admixture specification.

3. **RETARDERS** are chemicals that delay the initial setting of concrete by an hour or more. Retarders are often used in hot weather to counter the rapid setting caused by high temperatures. For large jobs, or in hot weather, specify concrete with retarder to allow more time for placing and finishing. Most retarders also function as water reducers. Retarders should meet the requirements for Type B or D in ASTM C 494.
4. **ACCELERATORS** reduce the initial set time of concrete and give higher early strength. Accelerators do not act as an antifreeze; rather, they speed up the setting and rate of strength gain, thereby making the concrete stronger to resist damage from freezing in cold weather. Accelerators are also used in fast track construction requiring early form removal, opening to traffic or load application on structures. Liquid accelerators meeting requirements for ASTM C 494 Types C and E are added to the concrete at the batch plant. There are two kinds of accelerating admixtures: chloride based and non-chloride based. One of the more effective and economical accelerators is calcium chloride, which is available in liquid or flake form and must meet the requirements of ASTM D 98. For non-reinforced concrete, calcium chloride can be used to a limit of 2% by the weight of the cement. Because of concerns with corrosion of reinforcing steel induced by chloride, lower limits on chlorides apply to reinforced concrete. Prestressed concrete and concrete with embedded aluminum or galvanized metal should not contain any chloride-based materials because of the increased potential for corrosion of the embedded metal. Non-chloride based accelerators are used where there is concern of corrosion of embedded metals or reinforcement in concrete.
5. **HIGH RANGE WATER-REDUCERS** (**HRWR**) is a special class of water-reducer. Often called superplasticizers, HRWRs reduce the water content of a given concrete mixture between 12 and 25%. HRWRs are therefore used to increase strength and reduce permeability of concrete by reducing the water content in the mixture; or greatly increase the slump to produce "flowing" concrete without adding water. These admixtures are essential for high strength and high performance concrete mixtures that contain higher contents of cementitious materials and mixtures containing silica fume. For example, adding a normal dosage of HRWR to a concrete with a slump of 3 to 4 inches (75 to 100 mm) will produce a concrete with a slump of about 8 inches (200 mm). Some HRWRs may cause a higher rate of slump loss with time and concrete may revert to its original slump in 30 to 45 minutes. In some cases, HRWRs may be aded at the jobsite in a controlled manner. HRWRs are covered by ASTM Specification C 494. Types F and G, and Types 1 and 2 in ASTM C 1017 *Specification for Chemical Admixtures for Use in Producing Flowing Concrete*.

Recommended Air Content in Concrete[4]

Nominal max aggregate size, mm (in.)	Air Content, percent	
	Severe exposure	Moderate exposure
9.5 (3/8)	7.5	6
12.5 (1/2)	7	5.5
19.0 (3/4)	6	5
25.0 (1)	6	4.5
37.5 (1 1/2)	5.5	4.5
50 (2)	5	4
75 (3)	4.5	3.5

Severe exposure - concrete in cold climate will be continuously in contact with water prior to freezing or where deicing salts are used.

Moderate exposure - concrete in a cold climate will be only occasionally exposed to moisture prior to freezing and not exposed to deicing salt application.

Besides these standard types of admixtures, there are products available for enhancing concrete properties for a wide variety of applications. Some of these products include: Corrosion inhibitors, shrinkage reducing admixtures, anti-washout admixtures, hydration stabilizing or extended set retarding admixtures, admixtures to reduce potential for alkali aggregate reactivity, pumping aids, damp-proofing admixtures and a variety of colors and products that enhance the aesthetics of concrete. Contact your local ready mixed concrete producer for more information on specialty admixture products to discuss the benefits they provide for your project.

References

1. ASTM C 260, C 494, C 1017, D 98, American Society for Testing and Materials (ASTM), West Conshohocken, PA, *www.astm.org*.
2. *Chemical and Air-Entraining Admixtures for Concrete*, ACI Educational Bulletin, E4, American Concrete Institute, Farmington Hills, MI, *www.concrete.org*.
3. *Chemical Admixtures for Concrete*, ACI 212.3R, American Concrete Institute, Farmington Hills, MI.
4. *Building Code Requirements for Structural Concrete*, ACI 318, American Concrete Institute, Farmington Hills, MI.
5. *Understanding Chloride Percentages*, NRMCA Publication No. 173, NRMCA, Silver Spring, MD, *www.nrmca.org*.

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