Concrete in Practice

What, why & how?

NRMCA

CIP 15 - Chemical Admixtures for Concrete

WHAT are Admixtures?

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

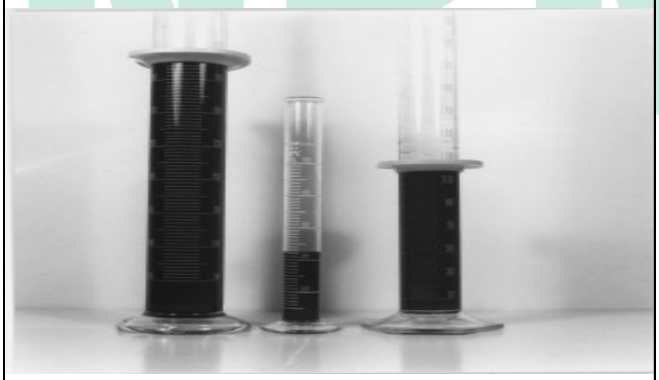
WHY Use Admixtures?

Admixtures are used to give special properties to fresh or hardened concrete. Admixtures may enhance the workability of fresh concrete and the durability strength of hardened concrete. Admixtures are used to overcome difficult construction situations, such as hot or cold weather placements, pumping requirements, early-age strength requirements, or specifications that require low water-cementitious materials ratio. Admixtures can be used to optimize the cementitious composition of concrete mixtures for performance and sustainability.

HOW to Use Admixtures?

Consult your ready mixed concrete supplier about admixture(s) appropriate for your application. Admixtures are evaluated for compatibility with cementitious materials, construction practices, job specifications and economic benefits before being used. Purchasers of ready mixed concrete should avoid requiring the use of specific brands or using products of their own accord.

Chemical Admixtures for Concrete



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

Follow This Guide to Use Admixtures

1. **AIR-ENTRAINING ADMIXTURES** are liquid chemicals added when batching concrete to produce microscopic air bubbles, called entrained air, produced by the mixing action. These air bubbles improve the concrete's resistance to damage caused by exposure to cycles of freezing and thawing and deicing salt application. In fresh concrete entrained air improves workability and reduces bleeding and segregation. For exterior flatwork (parking lots, driveways, sidewalks, pool decks, patios) subject to freezing and thawing cycles, or in areas where deicer salts are used, an air content of 4% to 7% of the concrete volume is used 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. Entrained air should be avoided for concrete flatwork that will have a smooth troweled finish. In concretes with higher cementitious materials content, 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 can reduce segregation and result in a modest increased strength due to the reduced water needed for required slump. Air entraining admixtures for use in concrete should meet the requirements of ASTM C260, *Specification for Air-Entraining Admixtures for Concrete*.
2. **WATER REDUCERS** are used for two different purposes: (1) to lower the water content in fresh concrete and to increase its strength; (2) to obtain higher slump without adding additional water. Water-reducers reduce the required water content of a concrete mixture for a target slump. These admixtures disperse the cement particles in concrete and make more efficient use of cement. This increases strength or allows the use of less cement to achieve a similar strength. Water-reducers are useful for pumping concrete and in hot weather, to offset the increased water demand. Some water-reducers may cause an increased rate of slump loss with time. Water-reducers should meet the requirements for Type A in ASTM C 494 *Specification for Chemical Admixtures for Concrete*.

   Mid-range water reducers are now commonly used and are used for a greater water reduction than typical water reducers. 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 C494. There is separate classification for these products in ASTM C494.

3. **HIGH RANGE WATER REDUCERS** *(***HRWR***)* is a special class of water reducer. Often referred to as superplasticizers, HRWRs reduce the water content of a given concrete mixture between 12 and 40% to maintain the same slump. HRWRs are therefore used to increase strength and reduce permeability of concrete by reducing the water content in the mixture; greatly increase the slump to produce "flowing" concrete or self-consolidating concrete (CIP 37) by using less water. These admixtures are essential for producing high strength and high performance concretes that contain higher contents of cementitious materials and mixtures containing silica fume. Some HRWRs may cause a higher rate of slump loss with time. In some cases, HRWRs may be added at the jobsite in a controlled manner to provide the required slump for placement. HRWRs are covered by ASTM Specification C494. Types F and G, and Types 1 and 2 in ASTM C1017 *Specification for Chemical Admixtures for Use in Producing Flowing Concrete*.
4. **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, concrete with retarder allows more time for placing and finishing. Retarders are typically a component of water reducers. Retarders should meet the requirements for Type B or D in ASTM C494.
5. **ACCELERATORS** reduce the initial setting time of concrete and produces higher strength at early ages. Accelerators do not prevent concrete from freezing; rather, they speed up the setting to permit finishing concrete earlier; and increase the 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 should conform to ASTM C494 Types C and E. There are two kinds of accelerating admixtures: chloride based and non-chloride based. Calcium chloride is a commonly used effective and economical accelerators, which is available in liquid or flake form. Calcium chloride must meet the requirements of ASTM D98. 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.

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, permeability reducing admixtures, workability retaining admixtures, rheology and viscosity modifying admixtures and a variety of colors and products that enhance the aesthetics of concrete. Consult with your local ready mixed concrete producer on admixture products that add value to your project.

Recommended Air Content in Concrete

Nominal max aggregate size, mm (in.)	Air Content, percent	
	Moderate Exposure	Severe Exposure
9.5 (⅜)	7.5	6.0
12.5 (½)	7.0	5.5
19.0 (¾)	6.0	5.0
25.0 (1)	6.0	4.5
37.5 (1½)	5.5	4.5

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

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

References

1. *ASTM* C 260, C 494, C 1017, D 98, ASTM International, 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, Alexandria, VA, *www.nrmca.org*.
6. *Self Consolidating Concrete,* CIP 37, NRMCA Concrete in Practice Series, Alexandria, VA, *www.nrmca.org*.

1987,1989, 2001, 2014