Chemical Admixtures

Chapter 9

Additive and admixture

- ***Admixture*** is a material other than water, aggregates, hydraulic cement and fiber reinforcement that is used as an ingredient of concrete or mortar and is added to the batch immediately before or during its mixing.
- ***Additive*** is a material that is interground or blended in limited amounts into a hydraulic cement during manufacture either as a processing addition or as a functional addition

Usage of chemical admixtures

Chemical admixture are used:

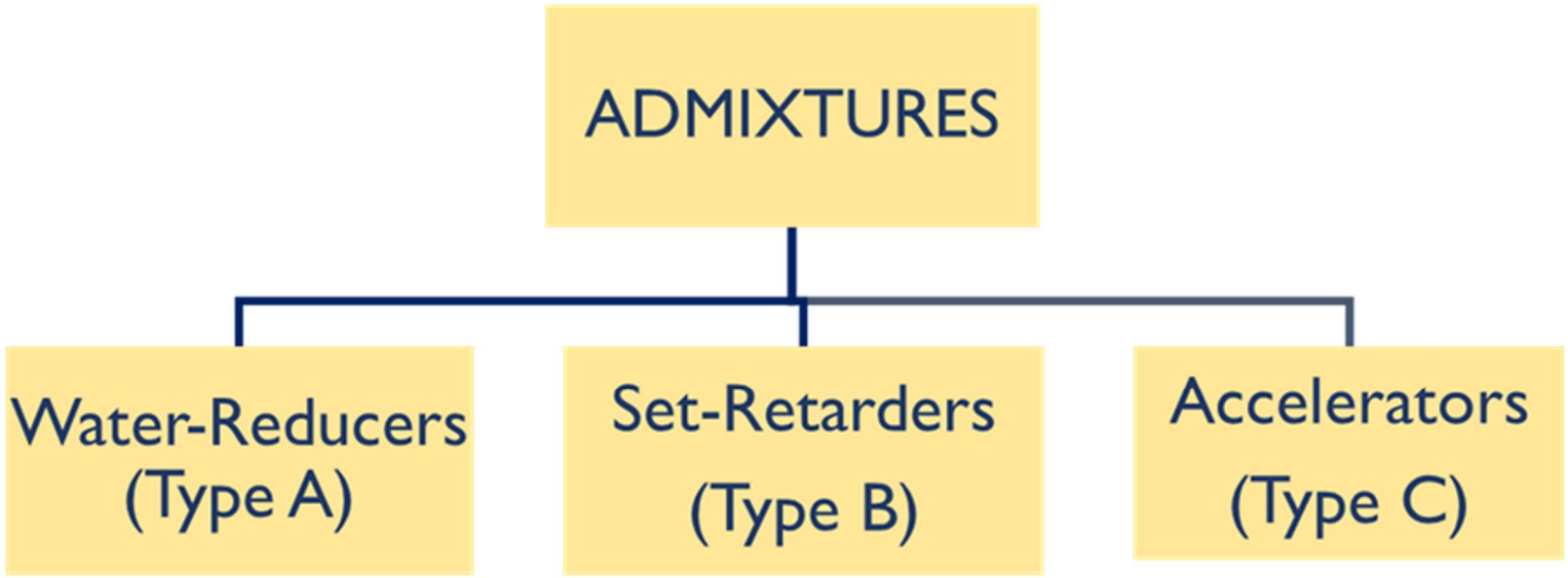
- To achieve certain properties in concrete more effectively than by other means.
- To maintain the quality of concrete during the stages of mixing, transporting, placing, finishing, and curing (especially in adverse weather conditions or intricate placements).
- To overcome certain emergencies during concreting operations.
- Economy of admixtures use compared with special cement.

Usage of chemical admixtures

Notes

- The effectiveness of an admixture depends upon several factors such as its composition, addition rate, time of addition; type, brand, and amount of cementing materials; water content; aggregate shape, gradation, and proportions; mixing time; slump; and temperature of the concrete.
- Despite admixtures benefits, no admixture of any type or amount is a substitute for good concreting practice.

Admixtures Classification



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

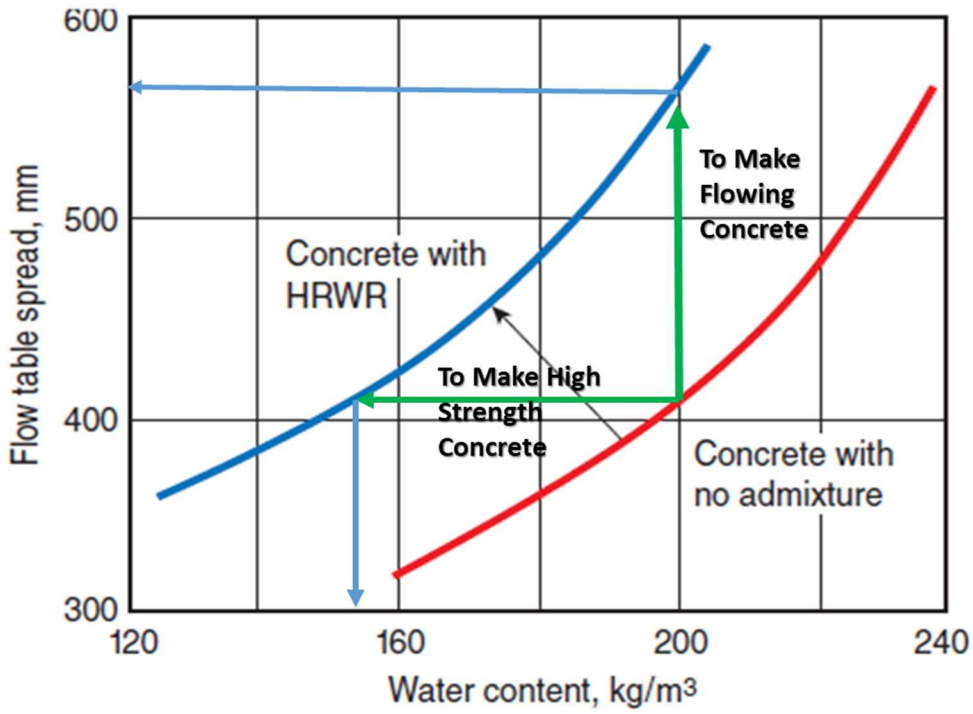
Type A: Water-Reducers

Water reducers can be used for three purposes:

I. To achieve a higher strength by decreasing the water/cement ratio at the same workability as an admixture-free mix.

II. To achieve the same workability by decreasing the cement content so as to reduce the heat of hydration in mass concrete.

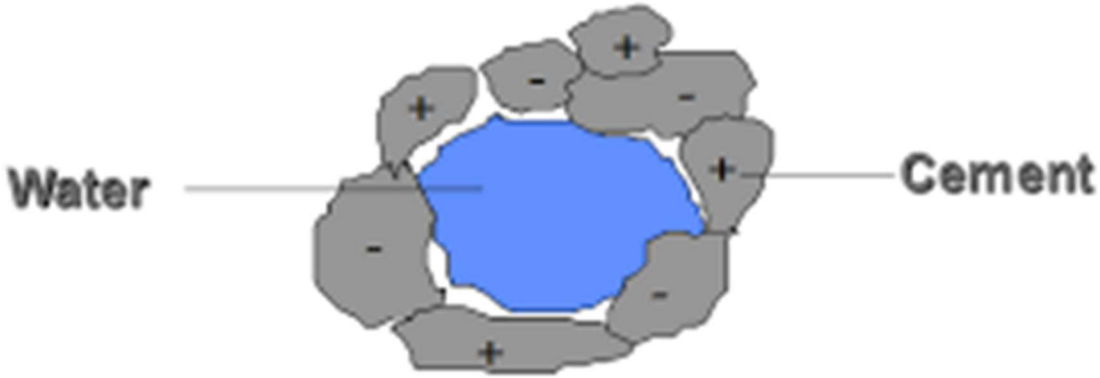
III. To increase the workability so as to ease placing in inaccessible locations.



Typical relation between flow table spread and water content of concrete made with and without superplasticizer

Mechanism of Water Reduction

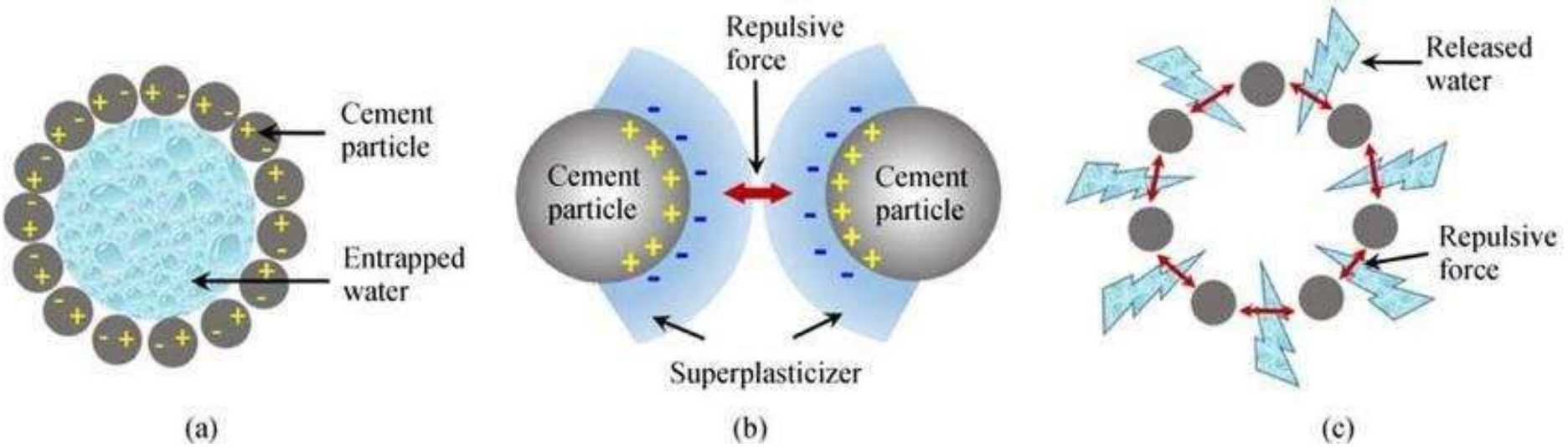
I. In cement paste, particles flocculate due to opposing charges on adjacent particles of cement, and a considerable amount of water is tied up leaving less water available to reduce the viscosity of the paste.



Charged Cement Particles Cling Together And Form Flocs Which Trap Water

Mechanism of Water Reduction

II. When Water-reducing admixtures (which are negatively charged organic molecules) are added They interact to neutralize these surface charges and cause all surfaces to carry uniform charges of like sign. Particles now repel each other, and remain fully dispersed in the paste. Hence, there is a greater particle mobility, and water freed and becomes available to lubricate the mix so that workability is increased.



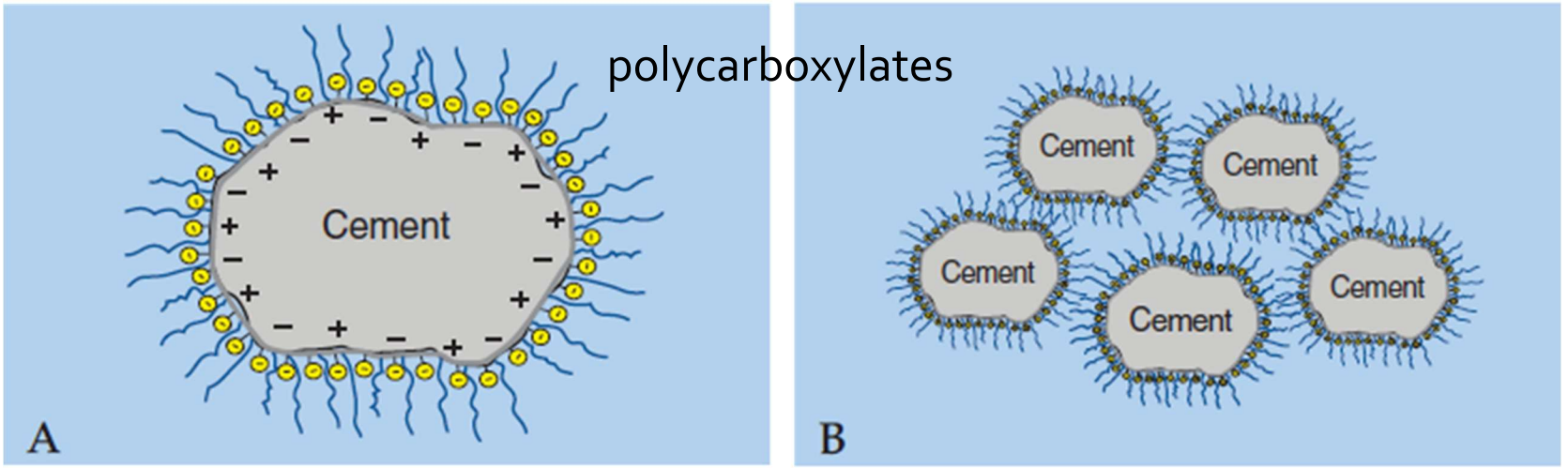
Classification of Water-Reducing Admixtures

- Normal-range: normal range, or conventional water reducers can reduce the water content by approximately 5% to 10% with slums from 75 mm to 150 mm.
- Mid-range water reducers bridge the gap between normal range water reducers and high-range water reducers. These admixtures provide significant water reduction, between 6% and 12%, for concretes with slumps of 125 mm to 200 mm.
- High-range water reducers can be used to impart properties induced by regular water reducers, only much more efficiently. A water reduction of 12% to 40% can be obtained using these admixtures and can generate slumps greater than 150 mm.

Composition of Water-Reducing Admixtures

The chemistry of water-reducing or super plasticizing admixtures falls into broad categories:

- Lignosulfonates, hydroxycarboxylic acid, hydroxylated polymers, salts of melamine formaldehyde sulfonates or naphthalene formaldehyde sulfonic acids.
- The most recent breakthrough in this technology is the development of high-range water reducers based on polycarboxylates



Impact of Water Reducers on Properties of Fresh Concrete

- Adding a water-reducing admixture to concrete without also reducing the water content can produce a mixture with a **higher slump**.
- Water reducers increase the rate of **slump loss** that results in reduced workability and less time to place concrete. Accordingly, these admixtures are sometimes added to the concrete mixer at the jobsite.
- A significant reduction of bleeding can result with large reductions of water content; this can result in finishing difficulties on flat surfaces when rapid drying conditions are present

Impact of Water Reducers on Properties of Hardened Concrete

- Long-term strength of concrete may be improved by the using of water reducer because of a more uniform distribution of the dispersed cement throughout the concrete.
- When the admixture is used correctly, the durability can be improved.
- Despite reduction in water content, water-reducing admixtures may cause increases in drying shrinkage.

Type B: Set-Retarders

These are admixtures which delay the setting of concrete and extends the period during which concrete remains plastic.

Types of Set-Retarding Admixtures

Compounds used as set retarders fall into four general categories: lignosulfonates, hydroxycarboxylic acids, sugars and their derivatives, and selected inorganic salts.

Retarders benefits and use

i. Offset the accelerating effect of hot weather on the setting of concrete;
ii. Allows a large placement to be completed before setting occurs, and reduce the early temperature.
iii. Anticipating long transport time or delays between batching and placement.
iv. Extends the time allowed for finishing and joint preparation.

Type B: Set-Retarders

Effect on Concrete Properties

- Delays both the initial and final set of concrete.
- Some reduction in strength at early ages. However, increased long-term strength may result from retarding the initial rate of hydration.
- Excessive addition rates of a retarding admixture may permanently inhibit the hydration of the cement.

Type C: Accelerators

The admixtures used to accelerate the rate of hydration (setting) and strength development of concrete at an early age.

Types of Accelerators

- Calcium chloride ($CaCl_2$) is the most common material
- Organic compounds such as triethanolamine (TEA) and inorganic salts such as sodium and calcium salts of formate, and nitrite

Type C: Accelerators

Benefits

I. Regular accelerators are used to speed construction by permitting earlier finishing of flatwork and earlier attainment of sufficient strength to allow removal of formwork and to carry construction loads.

II. Accelerators are beneficial during winter concreting by partially overcoming the slower rate of hydration caused by low temperatures.

However, accelerators can negatively impact the properties of the concrete.

For example $CaCl_2$ can Increase corrosion; cause discoloration; Increase shrinkage; cause Long-term strength reduction and reduce durability

Specific performance Admixtures

Type of admixture	Desired effect
Air-entraining admixtures	Improve durability in freeze-thaw, sulfate, and alkali-reactive environments; Improve workability.
Anti washout admixtures	Cohesive concrete for underwater placements
Bonding admixtures	Increase bond strength
Coloring admixtures	Colored concrete
Corrosion inhibitors	Reduce steel corrosion activity in a chloride-laden environment
Damp proofing admixtures	Retard moisture penetration into dry concrete
Foaming agents	Produce lightweight, foamed concrete with low density
Fungicides, germicides, and insecticides	Inhibit or control bacterial and fungal growth

Specific performance Admixtures

Type of admixture	Desired effect
Gas formers	Cause expansion before setting
Grouting admixtures	Adjust grout properties for specific applications
Hydration control admixtures	Suspend and reactivate cement hydration with stabilizer and activator
Permeability-reducing admixtures non-hydrostatic and hydrostatic conditions	Water-repellent surface, reduced water absorption, Reduced permeability, increased resistance to water penetration under pressure
Pumping aids	Improve pumpability
Shrinkage reducers	Reduce drying shrinkage