

Chemical Admixtures for Concrete

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Background of Admixtures

A famous concrete technologist once said any concrete which is made up of 4 ingredients (cement, fine aggregate, coarse aggregates and water) should be kept in museum. As a result the 4 ingredient concrete has slowly transformed into six ingredients of concrete with admixture playing an important role for the additional two ingredients.

A survey was conducted in Japan to find out the reason for deterioration of concrete structures and it was concluded that the reason for failure of many structures was due to improper compaction. To eliminate or to reduce the effort of compaction many special concretes have come into place such as Self compacting concrete or smart dynamic concrete. These special concretes cannot be formed without the use of admixtures.

These developments in concrete industry made people to use admixture extensively admixture to improve many properties of concrete both in fresh state and hardened state.

The first concrete admixture was used in 1930 to resist freezing of pavements. Earlier to this blood, sugar and other natural sources were used as admixture.

Admixtures are those ingredients in concrete other than Portland cement, water, and aggregates that are added to the mixture immediately before or during mixing.

Admixtures can be broadly classified as mineral and chemical admixtures.

Mineral admixtures are usually the by product from various manufacturing industries where as chemical admixtures are usually manufactured with various raw materials.

The major reasons for using admixtures are:

- 1) To improve the workability of concrete.
- 2) To enhance the compressive strength of concrete.
- 3) To improve cohesiveness of the concrete mix.
- 4) To maintain the quality of concrete during the stages of mixing, transporting, placing.
- 5) To overcome certain emergencies during concreting operations.

Mechanism of Admixtures

Cement particles will generally get flocculated where certain amount of water will be trapped between the cement grains.

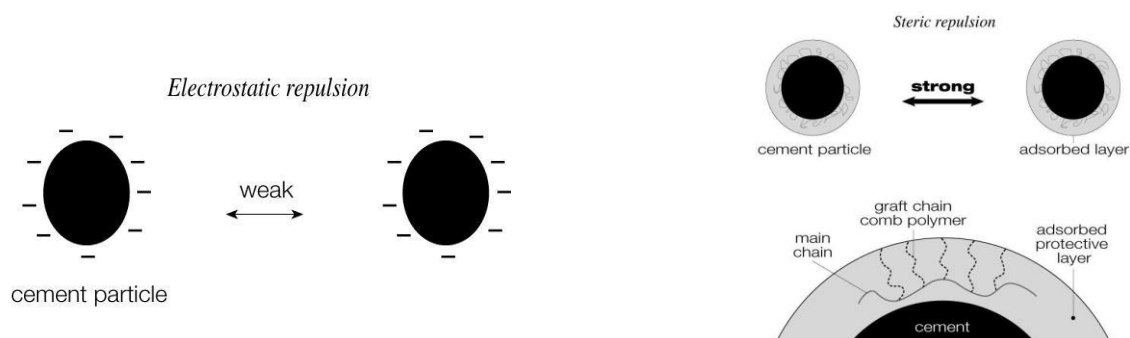
A water-reducing chemical belongs to a group of chemicals known as dispersants. The action of the dispersant is to prevent the flocculation of fine particles of cement.



These dispersants get adsorbed on the cement grains and induce negative charge on the cement particles. Due to this negative charge the cement particles repel and trapped water will be released. This additional water will be used by concrete for improving workability of concrete. The adsorbed chemical will keep the particles apart by electrostatic repulsion and the potential developed is called as zeta potential.

Lignosulphonates (normal, and sugar-refined), SMF, and SNF based superplasticizers work on the mechanism of lowering zeta potential that leads to electrostatic repulsion.

On the other hand, polymers with backbone and graft chains, such as PCEs, cause dispersion of cement grains by steric hindrance. This phenomenon relates to the separation of the admixture molecules from each other due to the bulky side chains. Steric hindrance is a more effective mechanism than electrostatic repulsion.



Types of Admixtures

The admixtures which are generally used are-

- 1) Air entraining admixture
- 2) Water reducing admixture.
- 3) Accelerating admixture.
- 4) Retarding admixture.
- 5) Super plasticizing admixture.

Air Entraining admixture –

Air-entraining admixtures are used to purposely introduce and stabilize microscopic air bubbles in concrete. Air entrainment will dramatically improve the durability of concrete exposed to cycles of freezing and thawing. The workability of fresh concrete is improved significantly due to the lubrication between coarse aggregates and fine aggregates.

Water reducing admixture –

Water-reducing admixtures (plasticizer) are used to reduce the quantity of water required to produce concrete of a certain slump. Thereby reduce water-cement ratio and hence increase strength. Adding a water-reducing admixture to concrete without reducing the water content can produce a mixture with a higher slump. These admixtures can reduce water up to 15%.

High range water reducing admixtures (Super plasticizers), are usually used for high strength concrete, high slump concrete and special concretes such as Self compacting etc. These admixtures also give higher strength compared to other admixtures. These admixtures can reduce water up to 40%.

Accelerating Admixture –

An accelerating admixture is used to accelerate the rate of hydration (setting) and strength development of concrete at an early age. These admixtures are generally used in construction of tunnels or in case of precast industries.

Retarding admixture –

Retarding admixtures is used to delay the rate of setting of concrete. High temperatures of fresh concrete are often the cause of an increased rate of hardening that makes placing and finishing difficult. In present case, concrete is mixed at RMC plants and will be placed at some other location, hence the concrete has to be retarded for certain time so that it can be placed easily at the site.

Types of water reducing admixtures

Different types of Water reducing admixtures are

- 1) **Ligno Sulphonates** – These chemicals are derived from neutralization, precipitation and fermentation of liquor. The water reducing capability is upto 15%.
- 2) **Sulphonated Naphthalene Formaldehyde** - These chemicals are produced from naphthalene by oleum or SO₃ sulphonation. The water reducing capability is up to 25%.
- 3) **Sulphonated Melamine Formaldehyde** – These chemicals are manufactured by normal resinification of melamine - formaldehyde. The water reducing capability is up to 20%.
- 4) **Poly Carboxylic Ether** – These chemicals are manufactured by polymerization process of free radical mechanism using peroxide initiators. The water reducing capability is up to 40%.

Standard Code of Practice

The standards to which chemical admixture conforms to are

- a) IS 9103
- b) ASTM C 494
- c) BS EN934

According to IS 9103 admixtures are classified as

- 1) Accelerating admixture
- 2) Retarding admixture
- 3) Water reducing admixture
- 4) Air-entraining admixture
- 5) Super plasticizing admixture

According to ASTM C 494 admixtures are classified as

- 1) Type A – Water reducing admixture
- 2) Type B – Retarding admixture.
- 3) Type C – Accelerating admixture
- 4) Type D – Water reducing and retarding admixture
- 5) Type E – Water reducing and accelerating admixture.
- 6) Type F – Water reducing, high range admixture.
- 7) Type G – Water reducing, high range and retarding

Product Selection

Selection of different type of water reducers will depend greatly on water to cement ratio. Generally for lower water to cement ratio we use PCE based admixture.

W/C	0.6	0.5	0.4	0.3	0.2
LS					
SNF & Mid range PCE					
PCE					