

**CE6002**  
**CONCRETE TECHNOLOGY**

**Module 2**

**CONCRETE ADMIXTURES**

# CONCRETE ADMIXTURES

- Admixtures are material other than cement, aggregates & water that are added to concrete either before or during mixing to *alter its properties & performance* in fresh (workability, setting time etc) and hardened state (strength, durability etc.)

Concrete admixtures are generally divided into 2 types i.e.,

## 1. Chemical admixture

*(Accelerator, Retarder, Plasticizer, Superplasticizer and Water proofer)*

## 2. Mineral admixture

*(Fly Ash, Silica Fume, Ground Granulated Blast Furnace Slag and Metakaolin)*

# CONCRETE ADMIXTURES (Cont.)

## Effect of Chemical or Mineral Admixtures on the Properties of Fresh Concrete:

- To increase workability without increasing the water cement ratio.
- To retard / accelerate time of initial or final setting.
- To modify the rate of bleeding.
- To retard segregation or increase cohesion.
- To improve pumpability.

# CONCRETE ADMIXTURES (Cont.)

## Effect of Chemical or Mineral Admixtures on the Properties of Hardened Concrete:

- To accelerate the rate of strength development especially at early stage.
- To increase the strength, durability and permeability
- To control expansion by alkali-aggregate reaction.
- To improve bond with reinforcement.
- To improve bond with old /new concrete
- To improve impact or abrasion resistance.
- To resist corrosion of embedded reinforcement

# CHEMICAL ADMIXTURES

A chemical admixture is any chemical additive to the concrete mixture that *enhances* the *properties of concrete* in the fresh or hardened state.

## Types / Classifications

➤ Accelerators

➤ Retarders

➤ Plasticizer

➤ Superplasticizer

➤ Water proofers

} Water reducing agent

# 1. ACCELERATOR

Accelerating admixtures are added to accelerate the setting time and to increase the rate of early strength development.

Commonly used materials as an accelerator are:

- ❖ **Calcium chloride (Not used now)**
- ❖ **Soluble carbonates**
- ❖ **Silicates fluosilicates (Expensive)**
- ❖ **Organic compounds such as triethenolamine (Expensive)**

# 1. ACCELERATOR (Cont.)

## Advantages / Effects of accelerator on concrete properties:

- Reduced bleeding,
- Earlier finishing
- Improved protection against early exposure to freezing and thawing,
- Earlier use of structure
- Reduction of protection time to achieve a given quality,
- Early removal of form, and early load application.

# 1. ACCELERATOR (Cont.)

- Increases the rate of gain of strength.
- Enables earlier release from precast moulds thus speeding production.
- Reduces segregation and increase density and compressive strength.
- Cures concrete faster and therefore uniform curing in winter and summer can be achieved.
- Early use of concrete floors by accelerating the setting of concrete.
- Reduces water requirements, bleeding, shrinkage and time required for initial set.



## 2. Retarder

- These admixtures are used where setting time of concrete need to be delayed.
- Retarder delays the *hydration process* but doesn't affect the eventual process
- Initial setting time can be delayed by more than *Three hours.*

## 2. Retarder (Cont.)

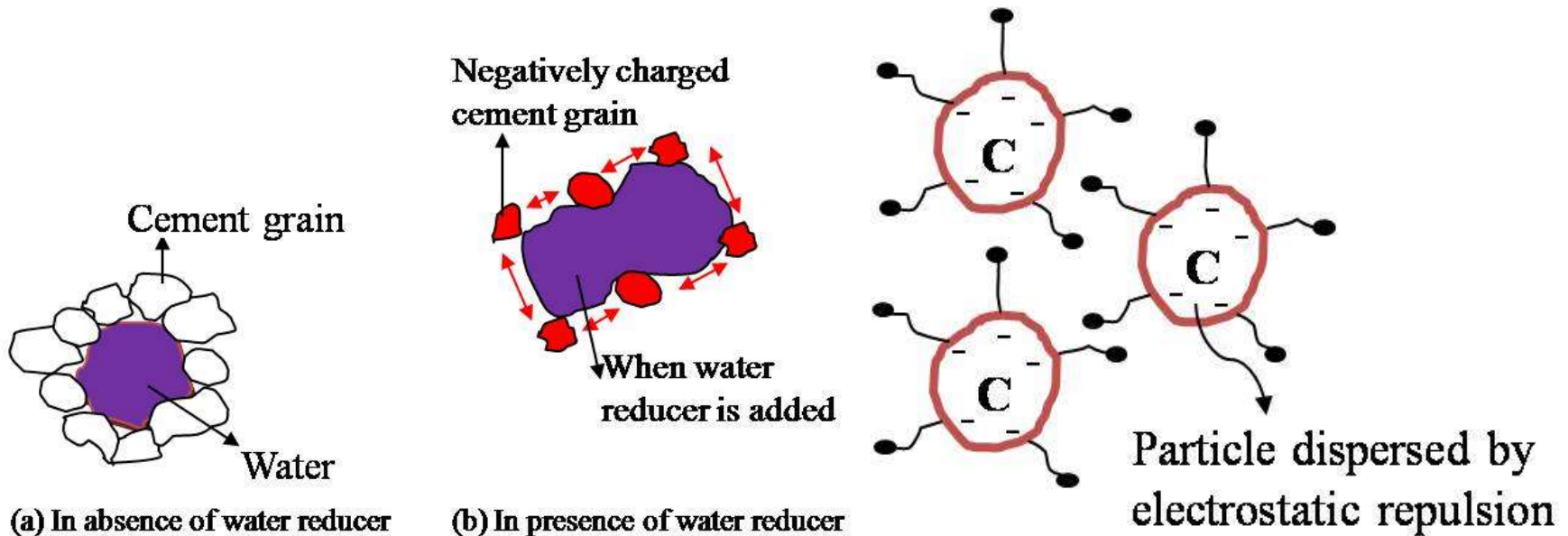
### Advantages of Retarders / Effect of retarders on concrete properties

- Retarding admixtures delay hydration of cement
- To delay or extend the setting time of cement paste in concrete.
- These are helpful for concrete that has to be transported to long distance, and helpful in placing the concrete at high temperatures.
- Used in casting and consolidating large number of pours without the formation of cold joints
- Used in grouting oil wells.

# WATER REDUCER

To decrease the water content with higher workability of concrete, some chemicals may be added to concrete is called water reducer.

## *Mechanism:*



# **WATER REDUCER**

**The water reducing admixtures are two types;**

- 1. Plasticizer**
- 2. Superplasticizer**

# 1. PLASTICIZER

Plasticizers are the organic or combination of organic and inorganic substances which reduces water content for certain degree of workability, when added in mix.

## The basic products consisting

- a. Lignosulphonates,
- b. Salts of sulphonates hydrocarbon
- c. Polyglycol esters,
- d. Hydroxylated carboxylic acid products

**Dosage: 0.1% - 0.4%**

**Water reducing capacity: 5% - 15%**

# 1. PLASTICIZER(Cont.)

## Effect of plasticizer on concrete properties:

- To achieve a higher strength by decreasing the water cement ratio
- To reduce the heat of hydration in mass concrete.
- To increase the workability so as to ease placing in accessible locations.
- Water reduction more than 5% but less than 15%

## 2. SUPERPLASTICIZER

Chemically different from the PLASTICIZER and capable of reducing water content by about 30% has been developed.

### Types of superplasticizers:

1. **Sulphonated melamine:** It is suitable in low temperature areas
2. **Sulphonated naphthalene:** It is more suitable in high temperature areas
3. **Ligno sulphates:** It is suitable for Indian conditions where temperature variation is high
4. **Carboxylated admixture:** It is suitable where workability is required to be retained for large duration.

## 2. SUPERPLASTICIZER (Cont.)

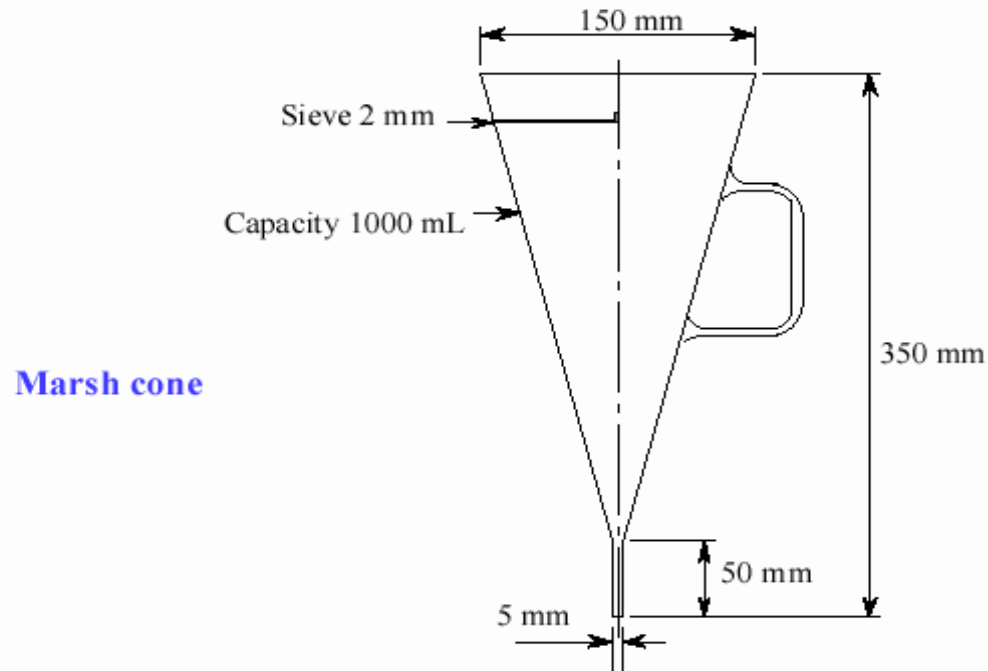
### Effect of superplasticizer on concrete properties:

- Significant water reduction
- Reduced cement contents
- Reduce water requirement by 12-30%
- Increased workability
- Reduced effort required for placement
- More effective use of cement
- More rapid rate of early strength development
- Increased long-term strength
- Reduced permeability



# DOSAGE OF CHEMICAL ADMIXTURES

- Marsh cone test is reliable and simple method to study the rheological properties of cements and dosage of chemical admixtures (Superplasticizer).
- Apparatus:



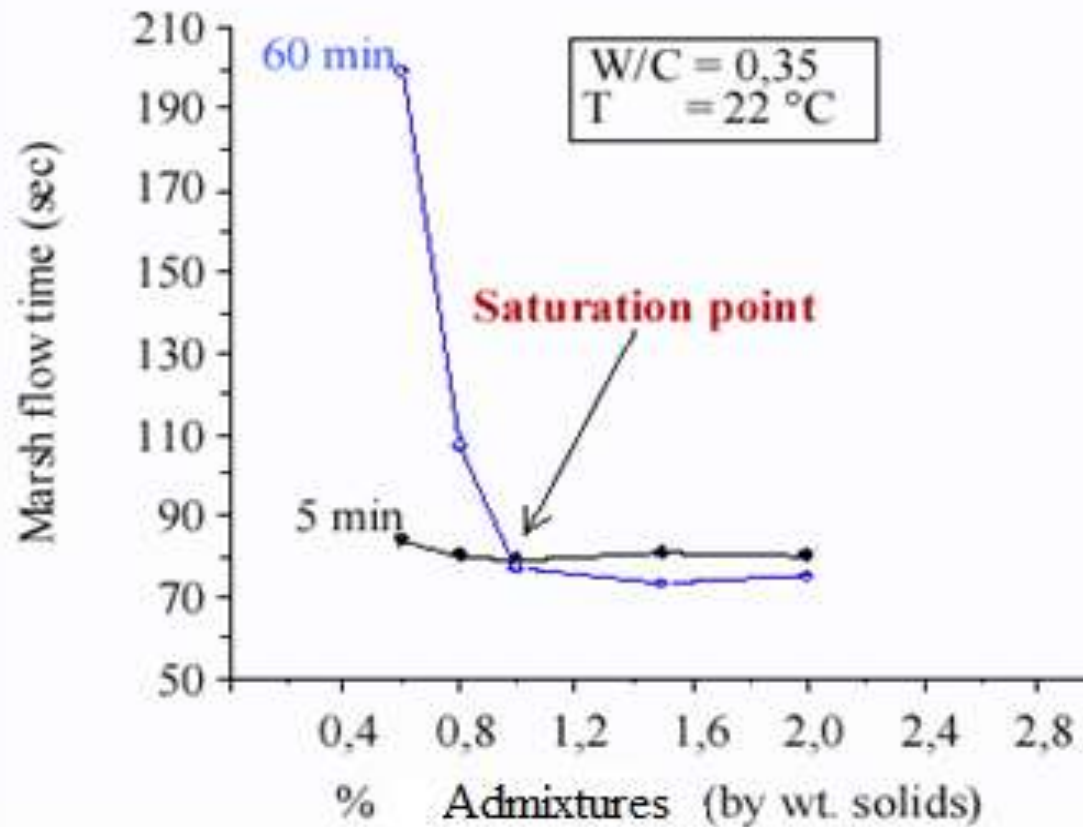
# DOSAGE OF CHEMICAL ADMIXTURES

- 1 litre of cement paste is prepared in mortar mixer using 2 kg of cement and w/c ratio of 0.32-0.35.
- Water is added in two steps- 70% of water is added in beginning of mixing and rest 30% of water is mixed with chemical admixture
- Cement slurry is prepared with the w/c ratio of 0.32 and admixture dosage of 0.5 %.
- 1 litre of cement slurry is made to flow through marsh cone after 5 min and 60 min of mixing and time in seconds is measured using a stopwatch.

# DOSAGE OF CHEMICAL ADMIXTURES

- The procedure is repeated gradually increasing the chemical admixture dosage in steps of 0.2%.
- Similar tests are conducted for rest of admixture and graphs are plotted with time as Y axis and S.P. dosage as X-axis.
- The ***saturation dosage*** of super plasticizer can be defined as that point beyond which there is no significant decrease in the flow time

# DOSAGE OF CHEMICAL ADMIXTURES



# WATER PROOFER

- It is essential to water proof a structure to prevent the seepage of water for its durability.
- Provide water proofing solutions for basements, sunken portions, roofs, terrace gardens and expansion joints etc.

## Water proofers:

- Polymer Modified Cementitious Membranes
- Polyurethane Membranes
- Injection Grouting
- Bituminous membranes
- EPD (ethylene-propylene-diene) Membrane
- PVC Membrane

# Water Proofer

Effect of water proofer on concrete properties:

- To reduce either the surface adsorption into the concrete and the passage of water through the hardened concrete.
- Reducing the size, number and continuity of the capillary pore structure
- Blocking the capillary pore structure
- Lining the capillaries with a hydrophobic material to prevent water being drawn in by absorption / capillary suction.

# POZZOLANIC or MINERAL ADMIXTURES

- Siliceous or siliceous-aluminous materials
- In finely divided form and in the presence of moisture, chemically react with calcium hydroxide liberated on hydration at ordinary temperature

## TYPES OF MINERAL OR POZZOLANIC ADMIXTURES

<b>Natural Pozzolans</b>	<b>Artificial Pozzolans</b>
a. Clay and Shales b. Opalinc Cherts c. Diatomaceous Earth d. Volcanic Tuffs and Pumicites.	a. <b>Fly ash</b> b. <b>Silica Fume</b> c. <b>Ground Granulated Blast Furnace Slag (GGBS)</b> d. <b>Metakaoline</b> e. Rice Husk ash f. Surkhi

# 1. FLY ASH

- Fly ash is finely divided residue resulting from the combustion of powdered coal in thermal power plant.
- Fly ash is the most widely used pozzolanic material all over the world.

## Types:

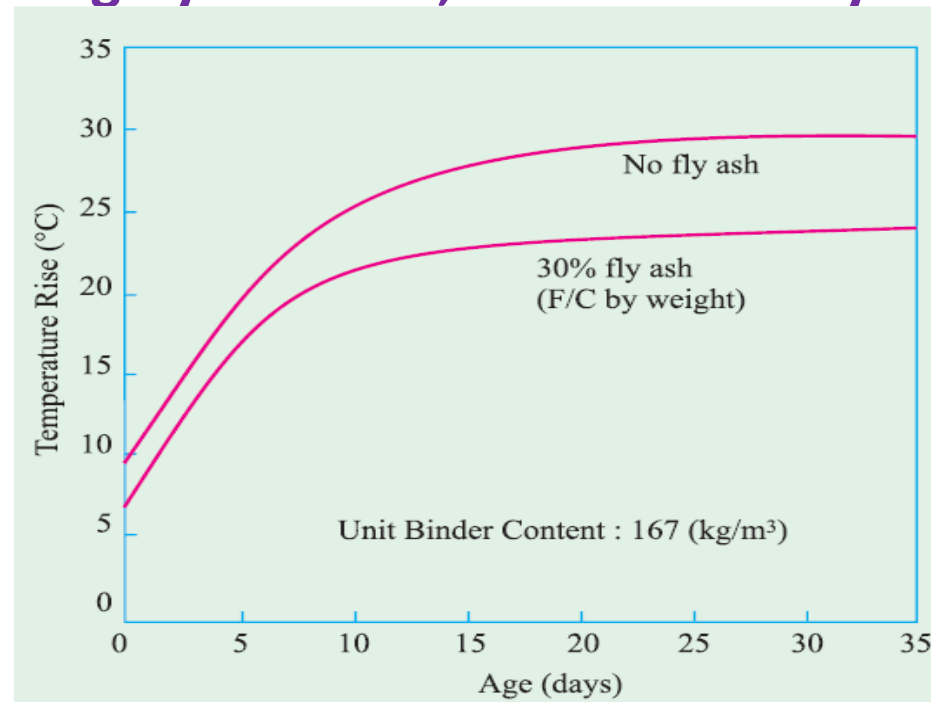
- **Class F:** Fly ash normally produced by burning bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only.
- **Class C:** Fly ash normally produced by burning lignite or sub-bituminous coal. Some class C fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possesses cementitious properties.



# 1. Fly ash (Cont.)

## Effects of Fly Ash on fresh properties of concrete:

- Reduction of water demand for desired slump.
- Used to reduce unit water content, bleeding and drying shrinkage.
- Fly ash is not highly reactive; the heat of hydration can be reduced.



# 1. Fly ash (Cont.)

## Effects of Fly Ash on hardened properties of concrete:

- Contributes to the strength of concrete due to its pozzolanic reactivity.
- Continued pozzolanic reactivity concrete develops greater strength at later age not at initial stage.
- Decrease of water permeability and gas permeability.
- Contributes to the expansion due to alkali-aggregate reaction
- Gives more resistance against corrosion of steel
- Gives more resistance against various acid attack (Sulfuric acid, hydrochloric acid)
- Contribute durability by means of resisting of sulphate attacks

## 2. Silica fume

- Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys.
- Treated as very fine pozzolanic materials
- Cost of the product is high
  - At least 85% SiO<sub>2</sub> content
  - Mean particle size between 0.1 and 0.2 micron
  - Minimum specific surface area is 15,000 m<sup>2</sup>/kg
  - Spherical particle shape

## 2. Silica fume (Cont.)

### Effect of Silica Fume on fresh concrete:

- The increase in water demand of concrete.
- Lead to lower slump but more cohesive mix.
- Make the fresh concrete sticky in nature and hard to handle.
- Large reduction in bleeding and concrete with microsilica could be handled and transported without segregation.
- Plastic shrinkage cracking and, therefore, sheet or mat curing should be considered.
- Produces more heat of hydration at the initial stage of hydration.
- The total generation of heat will be less than that of reference concrete.

## 2. Silica fume (Cont.)

### Effects of Silica Fume on harden concrete:

- Modulus of elasticity of silica fume concrete is less.
- Improvement in durability of concrete
- Resistance against frost damage.
- Addition of silica fume in small quantities actually increases the expansion.

### **3. GROUND GRANULATED BLAST FURNACE SLAG**

- Blast-furnace slag is a non-metallic product consisting essentially of silicates and aluminates of calcium and other bases.
- The molten slag is rapidly chilled by water to form a glassy sand like granulated material.

#### **Effects of GGBS on fresh concrete**

- Reduces the unit water content necessary to obtain the same slump.
- Water used for mixing is not immediately lost
- Reduction of bleeding.

# 3. GROUND GRANULATED BLAST FURNACE SLAG (Cont.)

## Effects of GGBS on harden concrete

- Reduced heat of hydration
- Refinement of pore structures
- Reduced permeabilities to the external agencies
- Increased resistance to chemical attack.
- Continued pozzolanic reactivity concrete develops greater strength at later age not at initial stage

# 4. METAKAOLIN

- Highly reactive metakaolin is made by water processing to remove unreactive impurities to make 100% reactive pozzolan.
- Such a product, white or cream in colour, purified, thermally activated is called High Reactive Metakaolin (HRM).



# 4. METAKAOLIN (Cont.)

## Effects of metakaolin on fresh and hardened properties of concrete:

- The water demand will be increased in the concrete mix
- Early setting and strength than normal concrete
- Resistance against acid and sulphate attack
- Gives good resistance against corrosion of steel
- The cement paste undergoes distinct densification.
- Densification includes an increase in strength and decrease in permeability.

**THANK YOU**