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DIFFERENT TYPES OF ADMIXTURES IN CONCRETE STRUCTURE - A REVIEW

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ABSTRACT

Several mineral and chemical admixtures, commonly used in civil engineering, were studied here to assess their effect on the fresh and hardened properties of concrete. Over decades, attempts have been made to obtain concrete with certain desired characteristics such as high compressive strength, high workability, and high performance and durability parameters to meet the requirement of complexity of modern structures. Effective solution for purpose is to addition of other materials in concrete to offers certain beneficial effects.

Concrete Admixture is defined as a material other than water, aggregates and hydraulic cement and additives like Pozzolana or slag and fiber reinforcement, used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete in the plastic or hardened state. This review paper states various stages of admixtures on various levels. Different types are studied here on basis of different standards.

Keywords: Accelerators, Water-reducing agents, Super plasticizers, Fly-ash, Slag, Silica fume and Rice husk Ash

I. INTRODUCTION

Concrete consists of cement, sand, aggregate and water. Anything other than these if added in concrete either before or during mixing to alter the properties to our desired requirement are termed as admixtures. The use of admixtures offers certain beneficial effects to concrete like improved workability, acceleration or retardation of setting time, reduce water cement ratio, and so on

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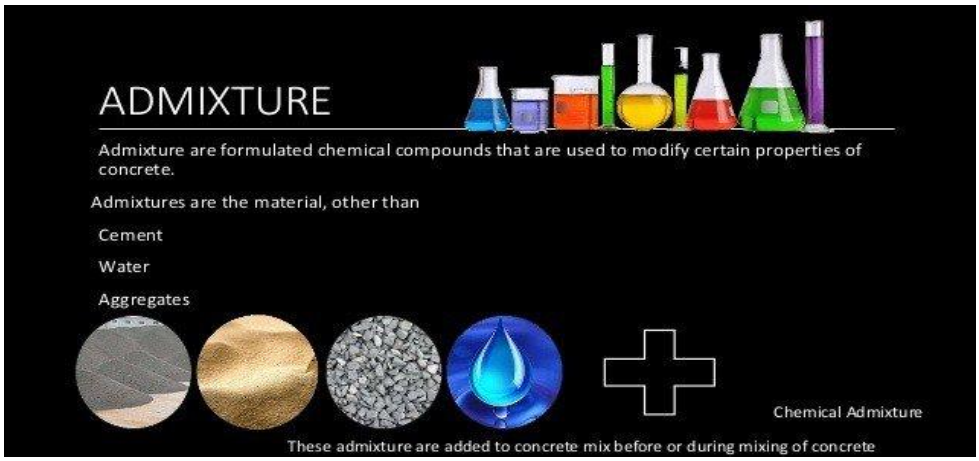

Fig 1.1: Introduction to Admixture

Admixtures are the special ingredients added during concrete mixing to enhance the properties and performance of fresh concrete. Various types of admixtures are available in the market which is used in construction work. Concrete admixtures are used to enhance the properties of concrete for applications in concrete works with special requirements. Concrete admixtures are used to modify the properties of concrete to achieve desired workability in case of low water cement ratio, and to enhance setting time of concrete for long distance transportation of concrete.

II. MAJOR ADVANTAGES AND DISADVANTAGES OF CONCRETE

The following are the advantages of concrete

1. Concrete ingredients are easy to available.
2. Concrete can be easy to handles and moulded to any desired shape.
3. Concrete can be easily transported from the place of mixing to another place of casting before initial set takes place.
4. Concrete can be pumped or sprayed to fill into cracks and lining of tunnels.
5. Using steel as reinforcement it is possible to build any structure.
6. The monolithic character of concrete gives it better appearance and much rigidity to the structure.
7. The property of concrete to possess high compressive strength makes a concrete structure more economical than steel structure.

III. DISADVANTAGES OF CONCRETE

The following are the disadvantages of concrete.

1. Concrete possess low tensile strength. Therefore concrete is required to be reinforced to avoid cracks.
2. In long structures, expansion joints are required to be provided if there is large temperature variance in the area.

3. Due to drying shrinkage and moisture expansion concrete may crack. Therefore construction joints are provided to avoid these types of cracks.
4. If soluble salt is present in concrete then it may lead to efflorescence when comes in contact with moisture.
5. Concrete made with ordinary Portland cement, gets integrated in the presence of alkalies, sulphates etc.
6. Sustained loads develop creep in structures.

IV. FUNCTION OF ADMIXTURES

1. To accelerate or retard the setting time of fresh concrete.
2. To improve the workability or followability of concrete.
3. To increase the strength and durability of concrete.
4. To reduce the heat of hydration.
5. To reduce the segregation and bleeding.
6. To decrease the permeability.
7. To achieve other desired properties.

V. TYPES OF CONCRETE ADMIXTURES

Admixtures are classified according to the Indian Standard (IS 9103: 1999) are as follows:

a) Accelerating admixtures

b) Retarding admixtures

c) Water-reducing admixtures

d) Air-entraining admixtures

e) Super plasticizing admixtures

Classification according to American Concrete Institute Committee report.

a) Air-entraining admixtures

b) Accelerating admixtures

c) Water reducing and set controlling admixtures

d) Admixtures for flowing concrete

e) Miscellaneous admixtures

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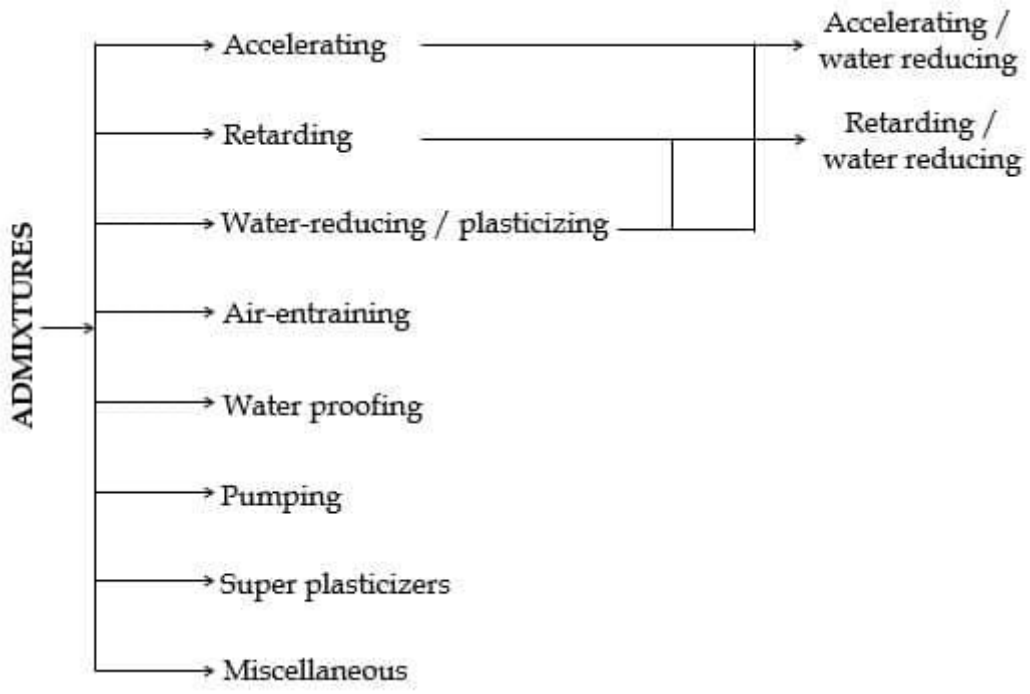

Fig: 1.2 Types of Admixtures

5.1 Air Entraining Agent Concrete Admixtures

These are generally used to improve workability, ease of placing, increased durability, better resistance to frost action and reduction in bleeding.

The common Air-Entraining agents are natural wood resins, neutralized vinsol resins, polyethelene oxide polymers and sulphonated compounds.

Mechanism of Air Entraining Concrete Admixtures

These are anionic, because the hydrocarbon structures contain negatively charged hydrophilic groups, such as COO, SO3 and OSO so that large anions are released in water. Conversely, if the hydrocarbon ion is positively charged, the compound is cation active or cationic.

In other words, anionic surface active agents produce bubbles that are negatively charged, cationic charged cause bubbles to be positively charged, surface active agents of all classes can cause air

Strength development in freshly cast concrete.

5.2 Accelerating Concrete Admixtures

- These admixtures are suitable for concreting in winter conditions
- During any emergency repair work
- In case of early removal of formwork
- Disadvantages of Accelerating Concrete Admixtures
- It has increased drying shrinkage
- It offers reduced resistance to sulphate attack

- CaCl2 high risk of corrosion of steel – not permitted in reinforced concrete
- It is more expensive and less effective
- Water Reducing Admixtures

Mode of Action

The principal role on mechanism of water reductions and set retardation of admixtures are usually composed of long-chain organic molecules and that are hydrophobic (not wetting) at one end and hydrophilic (readily wet) at the other.

5.3 Water Reducing Admixture

a) Concrete having greater workability be made without the need for more water and so strength losses are not encountered

b) By maintaining some workability, but at a lower water content, concrete strengths may be increased without the need for further cement addition

c) While maintaining the same w/c ratio and workability concrete can be made to a given strength as in the reference concrete at lower cement content.

Effect on durability

The straight addition of admixtures of this type does not came any increase in permeability and indeed where the admixture is used to reduce the w/c, then permeability is considerably reduced.

Effect on shrinkage

Admixture of this type when used as workability aids on water reducers do not adversely affect the shrinkage.

Effect on creep

Materials of this type of admixture have no deleterious effect on the creep of concrete.

Detrimental effect

a) While using water reducing agent. Care must be taken in controlling the air content in the mix. Most water-reducing agent entrain air due to their surfactant properties.

b) At high dosages of lignosulphonate material, retardation of the mix occurs.

Applications of Water Reducing Concrete Admixtures

The application of the type of admixtures are as follows —

a) When concrete pours are restricted due to either congested reinforcement or this sections.

b) When harsh mixes are experienced such as those produced with aggregates (crushed). Then considerable improvement in the plastic properties of concrete can be obtained.

c) When required strengths are difficult to obtain within specified maximum cement content and where early lifting strengths are required.

d) By addition of this admixture in concrete cement economics of about 10% can be obtained.

5.4 Retarding Concrete Admixtures

The function of retarding concrete admixture is 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 in transit mixers and helpful in placing the concrete at high temperatures, specially used as grouting admixture and water reducer's results in increase of strength and durability.

Chemical type for Retarding Concrete Admixture

a) Unrefined lignosulphonates containing sugar, which of course the component responsible for retardation.

b) Hydroxyl carboxylic acid and their salts

c) Carbohydrates including sugar

d) Soluble zinc

e) Soluble borates etc.

Mode of action

It is thought that retarding admixtures are absorbed on to the C_3A phase in cement forming a film around the cement grains and presenting or reducing the reaction with water. After a while thus film breaks down and normal hydration proceeds. This a simple mixture and there is a reason to believe that retards also interact with C_3S since retardation can be extended to a period of many days.

Advantage of Retarding Concrete Admixture

a) The hydroxyl carboxylic acid type admixture normally produces concrete having a slightly lower aim content them that of a control mix.

b) Materials of this class (lignosulphonate containing sugar and derivatives of hydroxyl carboxylic acid) in some cases have a much higher dispersing effect and hence water reducing capacity.

c) Durability increases.

Detrimental effect

a) When lignosulphonate based material used, then the air content might be 0.2 to 0.3% higher unless materials of the tributyle phosphate type are added.

b) As the water content increases, so there is a tendency for drying shrinkage.

Applications of Retarding Concrete Admixture

Retarding admixtures are used

a) Where long transportation of ready mixed concrete is required then premature setting can be usefully avoided by this type admixture.

b) When concrete is being placed or transported under conditions of high ambient temperature.

c) In case of large concrete pours

d) Concrete construction involving sliding formwork

Advantages of Super Plasticizer Admixtures

a) The concrete using this admixture can be placed with little or no compaction and is not subject to excessive bleeding or segregation.

b) They can be used as high dosages became they do not markedly change the surface tension of water.

c) It does not significantly affect the setting of concrete except that when used the cements having a very low C_3A content.

d) They do not influence shrinkage, creep modulus of elasticity or resistance to freeing to thawing.

Disadvantage

The only real disadvantage of superplasticizer is their relatively high cost.

Applications of Super Plasticizer Admixtures

a) In very heavily reinforced sections, in inaccessible areas in floor or road slabs.

b) Where very rapid placing is desired.

5.5 Mineral Admixtures for Concrete

Mineral admixtures are finely divided materials which are added to the concrete in relatively large amounts, usually of the order of 20 to 100 percent by weight of Portland cement.

Source of Mineral Admixtures

a) Raw or calcined natural minerals

b) Industrial by products

Reasons for using mineral admixtures

a) In recent years' considerable efforts have been made by the cement industry worldwide to reduce energy consumption in the manufacture of Portland cement. Therefore, a partial replacement of Portland cement by mineral admixtures which can be of the order of 50 – 60% by weight of total cementitious material, represents considerable energy savings.

b) The ability of cement and concrete industries to consume mithions of tons of industrial byproducts containing toxic metal would qualify these industries to be classified as environmentally friendly.

c) Since natural Pozzolana and industrial by products are generally available substantially lower costs than Portland cement, the exploitation of the Pozzolanic and cementitious properties of mineral admixtures are used as a partial replacement of cement can lead to a considerable economic benefit.

d) Possible technological benefits from the use of mineral admixtures in concrete include entrancement of impermeability and chemical durability, improved resistance to thermal cracking and increase in ultimate strength.

Classification of Mineral Admixture

Mineral admixtures may be classified as follows —

a) Pozzolanic — Siliceon or siliceons and admixtures material which itself possesses little or no cementitious value but is the presence of moisture chemically react with $CalOH_2$ at ordinary temperature to form compounds possessing cementitious properties.

b) Pozzolanic & Cementitious — The materials which have some cementitious properties in itself.

ASIM specification C618 recognizes the following three classes of mineral admixtures.

a) Class N — Raw or calcined natural pozzolanic such as diatomaceous earths, clay and shales, tuffs and volcanic ashes.

b) Class F — Fly ash produced from burning anthracite or bituminous coal.

c) Class C — Ash normally produced from lignite or sub-bituminous coal which may contain analytical CaO higher than 10%.

Silica Fume as Concrete Admixture

Although the use of silica fume (SF) in concrete has increased significantly in the past few years, its beneficial properties were not well realized until comprehensive research was undertaken in the late 70's and early 80's at the Norwegian Ins. of technology to study the influence of SF on concrete properties.

VI.SELECTION OF CONCRETE ADMIXTURES (CONCLUSION)

Concrete admixtures shall be selected carefully as per the specifications and shall be used as recommended by the manufacturer or by lab testing report. The quantity of admixtures to be used for specific application of admixtures are recommended by the manufacturers.

For use in large construction projects, the quantity of the admixture to be used shall be obtained from tests reports for concrete mixed with admixtures at various percentage admixtures use. These tests are conducted to understand the behavior of admixtures on the desired quality and strength of concrete at different quantity of admixtures used. The selection of specific admixtures for use in concrete to alter properties of concrete should be selected carefully as per requirement of concrete works. Concrete admixtures should be used judiciously according to specification and method of application to avoid adverse effect on concrete properties at fresh and hardened state.

Concrete admixtures should be accepted with test certificate, manufacturing date and its chemical composition, should comply specifications given by the authorities.

It can be seen that proper use of admixtures offers certain beneficial effects to concrete including improved quality, acceleration or retardation of setting time, enhanced frost & sulphate resistance improves workability.

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