UNIT 5

Special Concrete

5.1 Introduction

- Special types of concrete are those with out-of-the-ordinary properties or those produced by unusual techniques. Concrete is by definition a composite material consisting essentially of a binding medium and aggregate particles, and it can take many forms.
- These concretes do have advantages as well as disadvantages.

5.2 Types of special concrete

1. High Volume Fly Ash Concrete.
2. Silica fumes concrete.
3. GGBS, Slag based concrete.
4. Ternary blend concrete.
5. Light weight concrete.
6. Polymer concrete.
7. Self-Compacting Concrete.
8. Coloured Concrete.
9. Fibre-reinforced Concrete.
10. Pervious Concrete.
11. Water-proof Concrete.
12. Temperature Controlled Concrete.

5.3 High Volume Fly Ash Concrete.

- Is used to replace a portion of the Portland cement used in the mix.
- According to IS: 456 – 2000 replacement of OPC by Fly-ash up to 35% as binding material is permitted.
- HVFAC is a concrete where excess of 35% of fly-ash is used as replacement.
- Use of fly ash is because of many factors such as
    a) Abundance of fly ash i.e. 110million tons of fly ash is produced in India every year.
    b) Fly ashes from major TPP are of very high quality i.e. quality of fly ash.
    c) Economic factor i.e. Cost of fly ash within 200 km from a TPP is as low as 10% to 20% of the cost of cement.
    d) Environmental factors i.e. reduction in CO_2 emission.

5.4 Silica fume concrete

- Very fine non-crystalline silica produced in electric arc furnaces as a by-product.
- Highly reactive pozzolana used to improve mortar and concrete.
- Silica fume in concrete produces two types of effect viz.
    - Physical effect
    - Chemical effect
- The transition zone is a thin layer between the bulk hydrated cement paste and the aggregate particles in concrete. This zone is the weakest component in concrete, and it is also the most permeable area. Silica fume plays a significant role in the transition zone through both its physical and chemical effects.

5.4.1 Physical Effect

- The presence of any type of very small particles will improve concrete properties. This effect is termed either "particle packing" or "micro filling".
- Physical mechanisms do play a significant role, particularly at early ages.

5.4.2 Chemical Effect

- Silica fume is simply a very effective pozzolanic material.
- Pozzolanic means a siliceous or siliceous and aluminous material, which in itself possess little or no cementious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementious properties.

5.5 GGBS, Slag based concrete

- By-product of the iron manufacturing industry, replacement of Portland cement with GGBS will lead to significant reduction of carbon dioxide gas emission.
- GGBS powder is almost white in colour in the dry state Fresh GGBS concrete may show mottled green or bluish-green areas on the surface mainly due to the presence of a small amount of sulphide.
- GGBS concrete requires longer setting times than Portland cement concrete, probably due to the smooth and glassy particle forms of GGBS. If the temperature is 23oC or replacement level of portland cement by GGBS is less than 30%, the setting times will not significantly be affected.

  When GGBS replacement level is less than 40%, bleeding is generally unaffected. At higher replacement levels, bleeding rates may be higher.
- GGBS concrete has lower early strengths because the rate of initial reaction of GGBS is slower than that of Portland cement. GGBS is therefore generally grounded to a finer state than Portland cement i.e. from around 4000 cm2/g to 6000 cm2/g resulting in significant increase in 28-day strength.
- It was also reported that the early strengths (up to 28 days) of concrete mixes (with 25%, 35%, 50%, and 60% GGBS replacements) were lower than that of Portland cement concrete mixes. By 56 days, the strength of 50% and 60% GGBS mixes exceeded that of

the Portland cement mix, and by one year all GGBS mixes were stronger than the Portland cement mixes.

- Due to its longer setting time, it can be transported to distant places but care should be taken while casting because there are chances that bleeding may take place.

5.6 Light weight concrete

- Structural lightweight concrete is similar to normal weight concrete except that it has a lower density.
- Made with lightweight aggregates.
- Air-dry density in the range of 1350 to 1850 kg/m^3
- 28-day compressive strength in excess of 17 Mpa.
- Structural lightweight concrete is used primarily to reduce the dead-load weight in concrete members, such as floors in high-rise buildings.
- **Structural Lightweight Aggregates:**
  - Rotary kiln expanded clays, shales, and slates
  - Sintering grate expanded shales and slates
  - Pelletized or extruded fly ash
  - Expanded slags
- **Compressive Strength:**

  The compressive strength of structural lightweight concrete is usually related to the cement content at a given slump and air content, rather than to a water-to-cement ratio. This is due to the difficulty in determining how much of the total mix water is absorbed into the aggregate and thus not available for reaction with the cement.
- **Slump:**

1. Due to lower aggregate density, structural lightweight concrete does not slump as much as normal-weight concrete with the same workability.
2. A lightweight air-entrained mixture with a slump of 50 to 75 mm (2 to 3 in.) can be placed under conditions that would require a slump of 75 to 125 mm (3 to 5 in.)
3. With higher slumps, the large aggregate particles tend to float to the surface, making finishing difficult.

5.7 Polymer concrete

Polymer concrete is part of group of concretes that use polymers to supplement or replace cement as a binder. The types include polymer-impregnated concrete, polymer concrete, and polymer-Portland-cement concrete.

- In polymer concrete, thermosetting resins are used as the principal polymer component due to their high thermal stability and resistance to a wide variety of chemicals.
- Polymer concrete is also composed of aggregates that include silica, quartz, granite, limestone, and other high quality material.
- Polymer concrete may be used for new construction or repairing of old concrete.

- The low permeability and corrosive resistance of polymer concrete allows it to be used in swimming pools, sewer structure applications, drainage channels, electrolytic cells for base metal recovery, and other structures that contain liquids or corrosive chemicals.
- It is especially suited to the construction and rehabilitation of manholes due to their ability to withstand toxic and corrosive sewer gases and bacteria commonly found in sewer systems.
- It can also be used as a replacement for asphalt pavement, for higher durability and higher strength.
- Polymer concrete has historically not been widely adopted due to the high costs and difficulty associated with traditional manufacturing techniques.

5.8 Self compacting concrete

- Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement.
- The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.
- Very close to the Kolhapur there is project of steel industry, sand used for the formation of mould when the moulds are opened the waste sand is dumped for the filling the low lying areas while doing this the agriculture areas is converted into barren area. Because there is no space for the waste other than the land filling. similar case is in case of aluminium industry where red mud is concluded to be waste, which contains lot amount of bauxite and that is why red mud is also dump in the nearby areas here it is causing big threat for the society and it is disturbing the eco system of the environment. So it is the need to use this particular otherwise waste material for the constructive in such fashion in the case of concrete so that concrete which became cost effective as well as eco-friendly.

5.8.1 Types

1. **Powder type of self-compacting concrete**: This is proportioned to give the required self-compactability by reducing the water-powder ratio and provide adequate segregation resistance.
2. **Viscosity agent type self-compacting concrete**: This type is proportioned to provide self-compaction by the use of viscosity modifying admixture to provide segregation resistance.
3. **Combination type self-compacting concrete**: This type is proportioned so as to obtain self-compactability mainly by reducing the water powder ratio.

5.8.2 Fresh SCC Properties

1. Filling ability (excellent deformability)
2. Passing ability (ability to pass reinforcement without blocking)
3. High resistance to segregation.

- It has been observed that the compressive strength of self compacting concrete produced with the combination of admixtures goes on increasing up to 2% addition of red mud.

- After 2% addition of red mud, the compressive strength starts decreasing, i.e. the compressive strength of self-compacting concrete produced is maximum when 2% red mud is added.

  The percentage increase in the compressive strength at 2% addition of red mud is +9.11 .

5.9 Fibre reinforced concrete

- Fibre reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres.
- The role of randomly distributes discontinuous fibres is to bridge across the cracks that develop provides some post- cracking “ductility”.
- The real contribution of the fibres is to increase the toughness of the concrete under any type of loading.
- The fibre reinforcement may be used in the form of three – dimensionally randomly distributed fibres throughout the structural member when the added advantages of the fibre to shear resistance and crack control can be further utilised.