5.8 POLYMER CONCRETE

Polymer concrete is a special composite concrete, in which a polymer binder mixed with aggregates together form the concrete. It is used in construction projects to provide added strength.

Polymer concrete provides very good resistance against corrosion and minimal chemical reactivity, commonly used in areas subjected to heavy wear and high loadings such as car parks, roadways and industrial areas.

Polymer concrete, (Artificial Granite), is a composite material consisting of dry aggregate fillers and a monomer system, polymerized in place by catalyzed peroxide decomposition. The components of polymer concrete are gravel, sand and calcium carbonate bound together with a polymer resin.

Types of polymer concrete

1. Polymer Concrete (PC)
2. Polymer Cement Concrete (PCC)
3. Polymer Impregnated Concrete (PIC)

Polymer Concrete (PC)

- ✓ In PC, polymer/monomer is employed to act as binder in place of cement.
- ✓ The monomer and aggregate are mixed together and the monomer is polymerized after placement of concrete in position.

Application

- Nuclear power plants
- Kerb stones
- Prefabricated structural element
- Precast slabs for bridge decks
- Roads
- Marine works
- Pre-stressed concrete

- Irrigation works
- Sewage works
- Waterproofing of buildings
- Food processing buildings etc.

Polymer Cement concrete (PCC)

- PCC is produced by incorporating an emulsion of a polymer (or) a monomer on OPC.
- The ingredients consisting cement, aggregates and monomer are mixed with water and monomer in the concrete mix is polymerized after placing concrete in position.

The resultant concrete has empowered:

i. Strength
ii. Adhesion
iii. Chemical resistance
iv. Impact resistance
v. Abrasion resistance

Application:

- Marine works

Polymer Impregnated Concrete (PIC)

- PIC is hardened Portland cement concrete that has impregnated with a monomer.
- In this case, the cement concrete is cast and cured in the conventional manner.
- After the concrete product gets hardened, air from its voids is removed. The concrete product is then finally subjected to polymerization by radiation (or) by heat treatment.

Applications:

- Precast slabs for bridge decks
- Roads
- Marine structures

5.8.1 GEOPLOYMER CONCRETE

Geopolymer concrete is an innovative, eco-friendly and special concrete, which is made from utilization of waste materials such as fly ash and ground granulated blast furnace slag (GGBS). Fly ash is the waste product generated from thermal power plant and ground granulate blast furnace slag is generated as waste material in steel plant.

Composition of Geopolymer concrete

- Fine aggregates and coarse aggregates as required for normal concrete.
- GGBS – A byproduct of steel plant
- Fly ash – A byproduct of thermal power plant
- Alkaline activator solution for GPCC as explained above. Catalytic liquid system is used as alkaline activator solution. (It is a combination of solutions of alkali silicates and hydroxides, besides distilled water. The role of alkaline activator solution is to activate the geo-polymeric source materials containing Si and Al such as fly ash and GGBS.

Mechanical properties of Geopolymer concrete

- Compressive strength – up to 70 N/mm^2
- Strength gains and faster than ordinary portland cement concrete
- Drying shrinkage – les, compared to cement concrete. This makes it well suited for thick and heavily restrained concrete structural members
- Low heat of hydration in comparison with cement concrete.
- Fire resistance is better than OPC concrete
- Very high acid resistance when tested under exposure to 2% and 10% sulphuric acids.
- High Chloride resistance, and hence it provides better protection to reinforcement steel from corrosion as compared to traditional cement concrete.

Applications of Geopolymer Concrete

- ✓ Construction of Pavements
- ✓ Retaining Walls

- ✓ Water Tanks
- ✓ Precast Bridge Decks

Factors affecting the compressive strength of Geopolymer Concrete

- ❖ Silicon oxide (SiO_2) to aluminum oxide (Al_2O_3) ratio by mass
- ❖ Activator liquid to source material (fly ash) ratio by mass
- ❖ Concentration of sodium hydroxide NaOH liquid measured in terms of Molarity (M)
- ❖ Sodium silicate to sodium hydroxide liquid ratio by mass
- ❖ Curing temperature in the range of 30^o to 90^oC
- ❖ Curing time in the range of 6 to 48 hours.
- ❖ Water content in the mixture.