2.5 FRP – Fibre textiles

Fiber-Reinforced Polymer (FRP) materials are composite materials that typically consist of strong fibers embedded in a resin matrix. The fibers provide strength and stiffness to the composite and generally carry most of the applied loads.

FRP composites are different from traditional construction materials like Steel and Aluminum. FRP composites are anisotropic whereas Steel and Aluminum are isotropic. Therefore, their properties are directional, meaning that the best mechanical properties are in the direction of the fibre placement.

These materials have a high ratio of strength to density, exceptional corrosion resistance and convenient electrical, magnetic and thermal properties. However, they are brittle and their mechanical properties may be affected by the rate of loading, temperature and environmental conditions.

Types of Fibre Reinforced Polymer (FRP)

1. Glass Fibre Reinforced Polymer (GFRP)

Glass fibres are basically made by mixing silica sand, limestone, folic acid and other minor ingredients. The mix is heated until it melts at about 1260°C. The molten glass is then allowed to flow through fine holes in a platinum plate. The glass strands are cooled, gathered and wound. The fibres are drawn to increase directional strength. The fibres are then woven into various forms for use in composites.

Based on an aluminium lime borosilicate composition, glass produced fibres are considered as the predominant reinforcement for polymer matrix composites due to their high electrical insulating properties, low susceptibility to moisture and high mechanical properties. Glass is generally a good impact resistant fibre but weighs more than carbon or aramid. Glass fibres have excellent characteristics equal to or better than steel in certain forms.

2. Carbon Fibre Reinforced Polymer (CFRP)

Carbon fibres have a high modulus of elasticity, 200-800 GPa. The ultimate elongation is 0.3-2.5 % where the lower elongation corresponds to the higher stiffness and vice versa. Carbon fibres do not absorb water and are resistant to many chemical solutions. They withstand fatigue excellently and neither corrode nor show any creep or relaxation.

3. Aramid Fibre Reinforced Polymer (AFRP)

Aramid is the short form for aromatic polyamide. The modulii of the fibres are 70-200 GPa with an ultimate elongation of 1.5-5% depending on the quality. Aramid has a high fracture energy and is therefore used for helmets and bullet-proof garments. They are sensitive to elevated temperatures, moisture and ultraviolet radiation and therefore not widely used in civil engineering applications. Finally, Aramid fibres do have problems with relaxation and stress corrosion.

Applications of FRP

1. Carbon FRPs are used in prestressed concrete for applications where high resistance to corrosion and electromagnetic transparency of CFRP are important.
2. CFRP composites are employed for underwater piping and structural parts of offshore platform. Added to that, FRP declines the risk of fire.
3. Carbon fibre reinforced polymers are used to manufacture underwater pipes for great depth because it provides a significantly increased buoyancy (due to its low density) compared to steel.

4. The stairways and walkways are also made of composites for weight saving and corrosion resistance.
5. It is used in high-performance hybrid structures.
6. FRP bars are used as internal reinforcement for concrete structures.
7. FRP bars, sheets, and strips are used for strengthening of various structures constructed from concrete, masonry, timber, and even steel.
8. FRPs are employed for seismic retrofitting.
9. Fibre reinforced polymers are used in the construction of special structures requiring electrical neutrality.
10. The high energy absorption of aramid fibre reinforced polymer (AFRP) composites makes them suitable for strengthening engineering structures subjected to dynamic and impact loading.