

Carbon fiber reinforced polymer (CFRP) is a type of composite materials consist of carbon fiber and polymer. The carbon fiber provides the strength and stiffness while the polymer acts as cohesive matrix to protect and held the fibers together. CFRP are manufactured as a strips, bars, and sheets using different production technique like filament winding, pultrusion, and hand lay-up processes.

CFRP materials possess good rigidity, high strength, low density, corrosion resistance, vibration resistance, high ultimate strain, high fatigue resistance, and low thermal conductivity. They are bad conductors of electricity and are non-magnetic.

The CFRP provide remedies for many problems associated with the deterioration and strengthening of infrastructure such as bridges and buildings. Using CFRP reinforcing bars in new concrete can eliminate potential corrosion problems and substantially increase a member's structural strength.

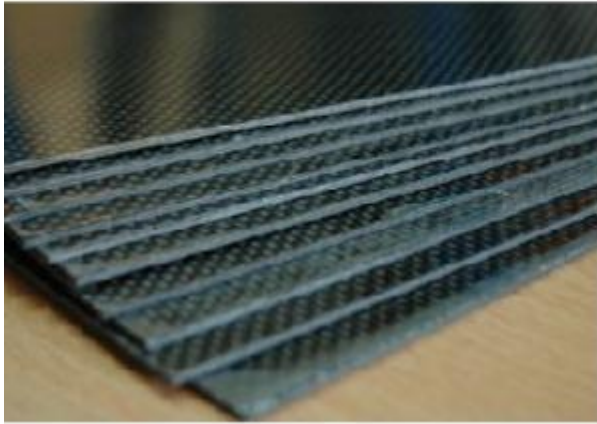
Effective use of carbon fiber reinforced polymer could significantly increase the life of structures, minimizing the maintenance requirements. Carbon fibers have also been used as reinforcement for ablative plastics and for reinforcements for lightweight, high strength and high stiffness structures.

Properties of CFRP

1. Alkali resistant.
2. Corrosion resistance that is why it is used for corrosion control and rehabilitation of reinforced concrete structures.
3. It has low thermal conductivity.
4. CFRP has high strength to weight ratio and hence it eliminates requirements of heavy construction equipment and supporting structures.
5. It needs short curing time. Therefore, the application takes a shorter time. This reduces the project duration and down time of the structure to a great extent.
6. CFRP possess high ultimate strain
7. High fatigue resistance. So, they do not degrade, which easily alleviates the requirement of frequent maintenance.
8. CFRP is bad conductor of electricity and is non-magnetic.
9. Due to its lightweight, prefabricated components in CFRP can be easily transported. This thus encourage prefabricated construction, reduce site erection labor cost and capital investment requirements.



CFRP Strips



CFRP Sheet



CFRP Bars

Fig. 1: CFRP Strips, Sheets, and Bars

Applications of CFRP in Concrete Structures

1. CFRP Strips

There are many techniques that use CFRP strips, laminates for strengthening concrete structures such as Externally bonded CFRP sheets and Near Surface Mounted FRP.

The performance of the strengthening methods depends on the strength of the adhesive used to bond CFRP to the concrete surface and the degree of stress at the interface of the concrete and CFRP.

CFRP is used to strengthen steel road bridges more easily and cheaply. The CFRP strips are only 20% of the weight of the strips of similar products made from high-strength steel but are at least four times as strong. Their high-strength-to-weight ratio makes the CFRP strips easily to handle and reduces installation costs. Strips of CFRP measuring just 8 mm in thickness have been used to strengthen a road bridge in Rochdale, UK



Fig.

2: CFRP Strips Used for Strengthening of Reinforced Concrete Slab

2. CFRP Wraps

CFRP wrapping is used for rehabilitation of masonry columns. CFRP wraps are used for corrosion control and rehabilitation of reinforced concrete columns. They are also used for construction of earthquake resistant structures.

The addition of CFRP sheets greatly increases the ultimate flexural moment capacity of the retrofitted shear wall. However, in order for the FRP sheet to carry the high axial loads resulting from the bending moment imposed on the shear wall, the CFRP sheets must be adequately anchored at the base of the wall.



Fig. 3: Wrapping RC Columns with CFRP

Sheets

3. CFRP Laminates

Low Thermal Expansion CFRP Laminates are used for strengthening of structural members such as beams in buildings and girders in bridges. CFRP is used to strengthen steel road bridges more quickly, cheaply and easily.

4. CFRP Bars

CFRP bars have been in the construction of new buildings and strengthening reinforced concrete structures using Near Surface mounted CFRP Reinforcement technique.



Fig. 4:

Application for CFRP bars in Reinforced Concrete Elements

Manufacturing Methods for CFRP

1. Continuous reinforcement process
2. Filament winding
3. Pultrusion
4. Hand lay-up processes
5. Moulding processes
6. Matched-die moulding
7. Autoclave moulding
8. Vacuum bagging
9. Resin injection processes
10. Resin transfer moulding
11. Reaction injection moulding