"FIBER REINFORCED POLYMER SHEET WORK IN CONCRETE BEAM"

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Abstract - *Civil Engineering has a very important role in practical life because it creates a safe foundation and provides facility for smooth conduction of life. So it is very important that the structure under which the people breathe should resist all worst conditions and provide them safety. The purpose of, for maximum safety and achieve good strength of components of building during its maximum life period. Here we introduce a material Fiber Reinforced Polymer (FRP). FRP commonly used in the aerospace, automotive, marine and construction industries. This FRP sheet is not corrosion against water leakage and also increase the concrete strength.*

***Key Words*: CFRP sheet, Flexure strength of beam, With CFRP, Without CFRP**

1. INTRODUCTION

Before the 1990's, the use of Fiber Reinforced Polymer (FRP) materials for structures has increased steadily and there are currently hundreds of fields applications of FRPs in structures around the world. FRP used as:

- Externally-bonded FRP plates, sheets, and wraps for strengthening of reinforced concrete, steel, aluminum, and timber structural members.
- FRP bars, rods, and tendons for internal reinforcement of concrete.
- All-FRP structures
- FRP hybrid structures.

FRP composites first developed during the 1940's, for military and aerospace applications.Considerable advances have been made since then in the use of this material and applications developed in the construction sector. FRPs successfully used in many construction applications including load bearing and infill panels, pressure pipes, tank liners, roofs, and complete structures where FRP units are connected together to form the complete system in which the shape provides the rigidity.In last decade, polymer composites have found application in the construction sector in areas such as bridge repair, bridge design, mooring cables, structural strengthening and stand-alone components. These composites are materials often referred to as advanced composites and have properties considerably superior to those of earlier composites. The term is ambiguous, however, because it does not identify any specific material combination. In the construction industry, the term is generally used for polymers reinforced with high strength high modulus continuous fibers of glass, carbon or aramid lay up in layers to form an engineered material.
There are three types of FRP

1.1   CARBON-FIBRE-REINFORCED POLYMERS

The binding polymer is often a thermo set resin such as epoxy, but other thermo set or thermoplastic polymers, such as polyester, vinyl ester or nylon, are sometimes used. The composite may contain other fibers, such as aramid e.g. Kevlar, Tarpon, aluminum, or glass fibers, as well as carbon fiber. The properties of the final CFRP product can also be affected by the type of additives introduced to the binding matrix (the resin).
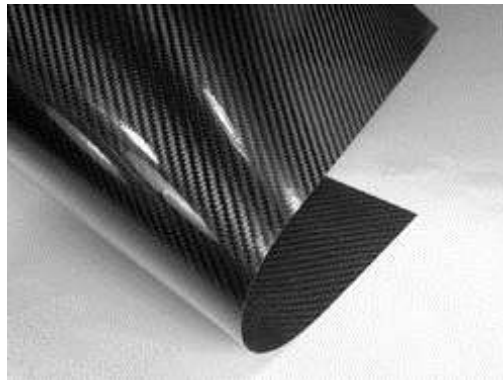
The most frequent additive is silica, but other additives such as rubber and carbon nanotubes can be used. CFRP are commonly used in the transportation industry, normally in cars, boats and trains, and in sporting goods industry for manufacture of bicycles, bicycle components, golfing equipment and fishing rods.

1.2   GLASS-FIBRE-REINFORCED POLYMERS

The glass fibers are divided into three classes -- E-glass, S-glass and C-glass. The E-glass is designated for electrical use and the S-glass for high strength. The C-glass is for high corrosion resistance, and it is uncommon for civil engineering application. Of the three fibers, the E-glass is the most common reinforcement material used in civil structures. It is produced from lime-alumina-borosilicate which can be easily obtained from abundance of raw materials like sand.

The fibers are drawn into very fine filaments with diameters ranging from 2 to 13 X 10^{-6} m. The glass fiber strength and modulus can degrade with increasing temperature. Although the glass material creeps under a sustained load, it can be designed to perform satisfactorily. The fiber itself is regarded as an isotropic material and has a lower thermal expansion coefficient than that of steel.

1.3 ARAMID-FIBRE-REINFORCED POLYMERS

These are synthetic organic fibers consisting of aromatic polyamides. The aramid fibers have excellent fatigue and creep resistance. Although there are several commercial grades of aramid fibers available, the two most common ones used in structural applications are Kevlar 29 and Kevlar 49. The Young's Modulus curve for Kevlar® 29 is linear to a value of 83 GPa but then becomes slightly concave upward to a value of 100 GPa at rupture; whereas, for Kevlar 49 the curve is linear to a value of 124 GPa at rupture.

As an anisotropic material, it's transverse and shear modulus are an order of magnitude less than those in the longitudinal direction. The fibers can have difficulty achieving a chemical or mechanical bond with the resin.

2. Methodology
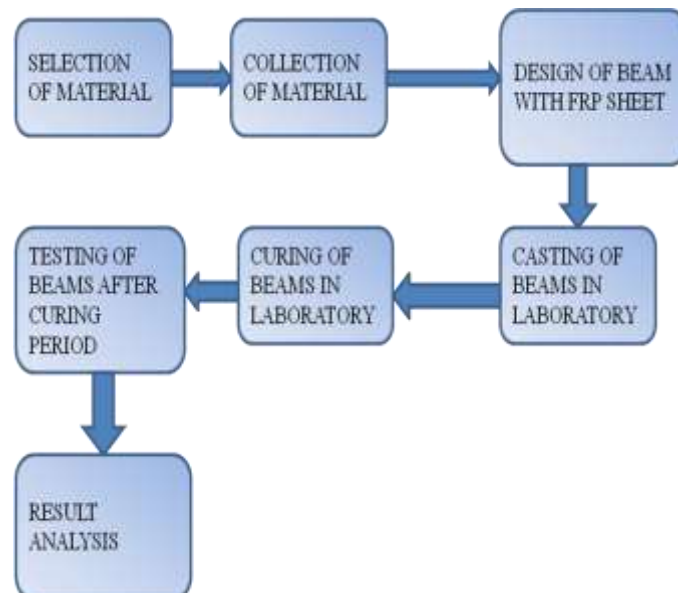
3. DATA FOR MIX PROPORTIONING:

The following data arc required for mix proportioning of a particular grade of concrete:

    a) Grade designation:
    b) Type of cement;
    c) Maximum nominal size of aggregate;
    d) Minimum cement content:
    e) Maximum water-cement ratio;
    f) Workability;
    g) Exposure conditions
    h) Maximum temperature of concrete at the time of placing:
    i)Method of transporting and placing;
    j) Early age strength requirements, if required:
    k) Type of aggregate;
    l) Maximum cement content; and
    m) Whether an admixture shall or shall not be used and the type of admixture and the condition of use.

3.1 MIX DESIGN OF CONCRETE:

Table -1: TEST DATA FOR COURSE AGGREGATE (20 mm)

I.S. Sieve Size	% of Sample Passing	Req. as per IS 383
25mm	100	100
20mm	098	85-100
16mm	067	-
12.5mm	033	-
10mm	010	0-20
4.75mm	000	0-5
Specific Gravity	2.963	-
Water Absorption	1.78%	Water Absorption < 2 %
Flakiness Index	24.00%	Flakiness < 35%
Elongation Index	18.00%	Impact value < 45 %
Impact value	15.00%	

Table -2 TEST DATA FOR COURSE AGGREGATE(10 mm)

I.S. Sieve Size	% of Sample Passing	Req. as per IS 383
12.5mm	100	100
10mm	98	85-100
6.3mm	33	-
4.75m	13	0-20
2.67mm	02	0-5
Specific Gravity	2.920	-
Water Absorption	1.64 %	Water Absorption < 2 %

Table -3 TEST DATA FOR FINE AGGREGATE (Black)

I.S. Sieve Size	% of Sample Passing	Req. as per IS 383
4.75 mm	100	90-100
2.36 mm	96	75-100
1.18 mm	83	55-90
0.600 mm	47	35-59
0.300 mm	20	8-30
0.150 mm	04	0-10
Fineness Modulus	2050	-
Specific Gravity	2.735	-
Silt Content	0.00%	Max 3%
Grading Zone	∏	-
Water Absorption	1.60%	Water Absorption < 2 %

TABLE – 4TEST DATA FOR CEMENT (Ultratech OPC-53 Grade)

SR. No.	Tests	Result	I.S. Requirements
1	Standard Consistency	30.30%	-
2	Setting Time	125 Min	> 30 Min
3	-Initial	240 Min	< 600 Min
	-Final	29.00	> 27 N/mm²
	Compressive in	49.50	> 37 N/mm²
	N/mm²		> 53 N/mm²
	- 3 days		
	- 7 days		
	- 28 days		

3.2 COMBINED AGGREGATE GRADATION

I.S. sieve size (mm)	Percentage Passing
25	100.00
20	099.14
10	061..5
4.75	035.05
2.36	031.22
1.18	026.56
0.6	015.04
0.3	006.40
0.15	001.28

For maximum size of aggregate of 20 mm, the different quantities worked out are as under:

$V = [W + C / Sc + (1 / p) \times (fa / Sfa)] \times 1/1000$

Where,

V = absolute volume of fresh concrete, i.e gross volume – entrapped air.

W = mass of water (kg) per m3 of concrete,

C = mass of cement (kg) per m3 of concrete,

Sc = specific gravity of cement,

p = ratio of aggregate to total aggregate by absolute volume,

fa = mass of aggregate (kg)

Sfa = weighted specific gravity of aggregate

TABLE – 5 DATA FOR CONCRETE AFTER DESIGN MIX TESTS

Grade of Concrete	M-20
Type of Cement	Ultra-tech
Cement (kg)	18.85
Water (Liters)	9.89
Sand(kg)	42.61
10 Dn (kg)	23.10
20 Dn (kg)	43.22
Water cement Ratio	1.23

4. Design Considerations

A direct substitution of FRP reinforcing bars instead of steel bars is impossible due to many differences in the mechanical properties of the two materials. Fiber reinforced polymer bars are anisotropic materials. Factors such as type and volume of fiber and resin, fiber orientation and quality control during the manufacturing play a major role in the mechanical characteristics.

- FRP composites show a linear elastic behavior until failure and no ductility. This is contrary to the steel which shows yielding.
- ACI Committee 440 recommends a minimum amount of FRP rebar. The concrete will be the weak link and the member will fail in concrete crushing in compression. At this stage FRP will still hold a good tensile strength. In traditional steel reinforcement design, steel yielding prior to crushing of concrete is ensured by provisions in standard design codes.
- Another major difference is that serviceability will be more of a design limitation in FRP reinforced members than in steel reinforced members. Due to its lower modulus of elasticity, deflection and crack width will affect the design. Deflection and crack width serviceability requirements will provide additional warning of failure prior to compression failure of the concrete.
- Service limits in FRP reinforced concrete elements such as deflection, crack width and crack spacing
- are directly influenced by the bond properties of the reinforcement in concrete.FRP reinforced concrete member is normally designed based on its required strength and then checked for serviceability and ultimate state criteria (e.g., crack width, deflection, fatigue and creep rupture endurance

5. Results

SAMPLE	DATE OF CASTING	DATE OF TESTING	L (mm)	B (mm)	D(mm)	SPAN IN MM	LOAD IN KN (P)	FLEXURAL STRENGTH IN N/MM²
beam-1	11/1/19	25/1/19	700	150	150	600	20	3.55
beam-2	4/2/19	18/2/19	700	150	150	600	20.2	3.59
beam-3	4/2/19	18/2/19	700	150	150	600	20.4	3.63
Beam with FRP	6/3/19	20/3/19	700	150	150	600	37.5	6.67
Beam with FRP	6/3/19	20/3/19	700	150	150	600	34.3	6.10
Beam with FRP	6/3/19	20/3/19	700	150	150	600	35.7	6.35

CALCULATION FOR FLEXURE STRENGTH OF CONTROL BEAM :

FLEXURAL STRENGTH $= p * l / bd2$

$$= \frac{20.2 * 1000 * 600}{150 * 150^2}$$

$$= 3.59 \text{ N/mm}^2$$

6. CONCLUSION

Externally bonded FRPs are an effective strengthening method for use in the retrofit and rehabilitation of existing structures. These fiber wrap materials have been used for civil engineering applications for more than 20 years and have a well- documented performance record. By understanding the basic engineering principles and practices needed to implement this technology, designers can feel more confident implementing its use. With the use of well-tested materials, expert installation crews, and proper design guidelines, fiber wrap will provide a unique solution to many structural problems.

7. REFERENCE

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