Behaviour of RC beam using CFRP wraps with and without End Anchorage and Replacement of Coarse Aggregate

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Abstract- **A beam is a horizontal flexural member which provides support to the slab and vertical walls. A normal beam (simply supported) consists of two zones generally arise, compression zone at top and tension zone at bottom. Our aim is to check the flexural deflection behaviour of conventional beam and the RC members reinforced using CFRP warps without anchorages without losing its strength and serviceability in the structural design. In this paper, an B experimental investigation of the Flexural behaviour of CFRP bond with a partial replacement of ceramic powder concrete placed below the neutral axis has been done to create reduction in weight and savings in materials. Hence we are comparing a reinforced CFRP concrete sandwich beam with a reinforced concrete solid beam in terms of flexural strength.The two specimens are to be casted with CFRP wrapping at bottom and another specimen is provided with CFRP wrapping at both bottom and sides.Both the specimens are to be tested in a loading frame for finding out the load deflection behaviour.The beam is investigated in terms of crack load and deflection curves.**

Keywords- **CFRP* ,(carbon fibre reinforced polymer), flexural strength, deflection, beam, compression zone, tension zone.**

I. INTRODUCTION

Fiber-reinforced polymer (FRP) reinforcements have been used extensively as an alternative reinforcement material to steel for new construction as well as for strengthening and repair of existing concrete structures. Externally Bonded FRP sheets and strips are currently the most commonly used techniques for flexural and shear strengthening of concrete beams and slabs. Externally bonded FRP reinforcements could be highly susceptible to damage from corrosion, fire, temperature, ultraviolet rays and moisture absorption. Retrofitting and strengthening structure member such as beam, column and slab with external application of FRP are one of the effective method use over a world.The FRP wraps are bonded along the sides of member throughout the length of beam with epoxy resin as an adessive to concrete beam with thickness of CFRP wraps ranging from and have adopted a thickness to ensure adequate flexural strength.

1.2 CARBON FIBRE REINFORCED POLYMER:

Carbon Fibre Reinforced Polymer (CFRP) materials are becoming increasingly popular for strengthening of reinforced concrete (RC) structures in flexural and shear. There are sever a advantages of using CFRP as externally bonded material over conventional steel such as high strength to weight ratio, outstanding durability in a variety of environment, ease and speed of installation, flexibility in application techniques, electromagnetically neutral, outstanding fatigue property and low thermal conductivity. FRP plates or sheets can easily be bonded to the exterior of reinforced concrete members using the wet lay-up procedure with an epoxy resin/adhesive. The FRP sheets or plates are generally bonded to the tension faces of flexural elements to increase their bending capacity, or to their side faces to increase the shear capacity. carbon fibers have the ability to retain its tensile strength even at high temperatures and are independent of moisture. Carbon fibers do not necessarily break under stress in contrast to glass and other organic polymer fibers. The carbon fibers offer a maximum strength of 55Gpa, axial compressive strength is 10-60% of tensile strength

II. EXPERIMENTAL INVESTIGATION

2.1 CEMENT

Ordinary Portland cement(OPC) of Grade53 conformingIS12269-1987 Shown in . Table 2.1

Table 2.1 Properties of Cement

PHYSICAL PROPERTY	RESULTS
Finess	91%
Normal Consistency	31%
Vicat initial setting time (minutes)	32 min
Vicat final setting time (minutes)	565 min
Specific gravity	3.1

2.2 FINE AGGREGATE

The properties of Fine aggregate is given in below Table 2.2.

Table 2.2 Properties of Fine aggregate

S.NO	PROPERTY	RESULTS
1	Particle size, shape	Round ,4.75mm,down
2	Fineness Modulus	4.14%
3	Silt content	1.67%
4	Specific Gravity	2.73
5	Bulking of Sand	4.16%
6	Bulk Density	1793 Kg/m^3
7	Water absorption	0.28

2.3 COARSE AGGREGATE

The properties of coarse aggregate is given in below Table 2.3.

Table 2.3 Properties of coarse aggregates

S. NO	PROPERTY	RESULTS
1	Particle size, shape	Angular,20 mm
2	Fineness Modulus of 20mm aggregates	7.13%
3	Specific Gravity	2.66
4	Water Absorption	0.62%
5	Bulk Density of 20 mm aggregates	Kg/m^3
6	Flakiness index	21.16%
7	Elongation index	38.22%

2.4 HIGH YIELDSTRENGTH DEFORMED BARS

The properties of HYSD bars were given in Table 2.4

Table 2.4 Properties of HYSD bars

S.NO	PROPERTY	RESULTS
1	Diameter	12 mm
2	Area	113 mm^2
3	Load For Yield	48.8 KN
4	Yield Strength	431.4 N/mm^2
5	Ultimate Load	64.8 KN
6	Ultimate Stress	573.5 N/mm^2
7	Changing Length	86mm
8	Original Length	600mm
9	Strain	0.14
10	Neck dia	7mm
11	% reduction in area	65.90%
12	% of Elongation	14%

2.5 CARBON FIBER REINFORCED POLYMER

The properties CFRP wraps were given in Table 2.5

Table 2.5 Properties of CFRP

S.NO	PROPERTY	RESULTS
1	Youngs modulus	113N/mm2
2	Poissons ratio	0.1
3	Shear modulus	3.50 N/mm2
4	Tensile strength	3000 N/mm2
5	Ultimate Load	800kN
6	Ultimate Stress	642 N/mm2
7	Tensile Modulus	36 KN/mm2
8	Lateral Strain	0.0044

2.6 EPOXY RESIN

The nature of epoxy resin are discussed

Epoxy is the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly epoxides are a class of reactive pre polymers and polymers which contain epoxide groups. Epoxy has a wide range of applications, including metal coatings, use in electronics / electrical components, high tension electrical insulators; fiber reinforced plastic materials, and structural adhesives.

2.7 CERAMIC MATERIAL

The properties of ceramic materials, like all materials, are dictated by the types of atoms present, the types of bonding between the atoms, and the way the atoms are packed together. This is known as the atomic scale structure. Most ceramics are made up of two or more elements. This is called a compound. The atoms in ceramic materials are held together by a chemical bond. The two most common chemical bonds for ceramic materials are covalent and ionic.The bonding of atoms together is much stronger in covalent and ionic bonding than in metallic, metals are ductile and ceramics are brittle.

2.6 TESTS OF CONCRETE

Tests of concrete are

1. Compressive strength test
2. Flexural strength test
3. Split tensile strength test

2.6.1 COMPRESSIVE STRENGTH TEST

7 days and 28 days compressive strength was given in Table 2.6

Table 2.6 Compressive strength test

S.NO	LOAD	7 DAYS (KN)	LOAD	28 DAYS (KN)
1	480	21.3	650	28.9
2	410	18.2	675	30
3	470	20.9	710	31.6

2.6.2 FLEXURAL STRENGTH TEST

Flexural strength were given in Table 2.7.

Table 2.7 Flexural strength test

DAYS	FLEXURAL STRENGTH(N/mm2)
28 DAYS	2.8

Total length of the beam is 1500 mm with a rectangular cross section of width 150 mm and depth 200 mm. The beams design is based on IS456. 3Nos of 12 mm dia bars provided as main reinforcement and 2 Nos of 10 mm dia bars provided as Hanger bars. The stirrups are provided at 125 mm C/C distance. The using grade of concrete is M50 and the grade of steel is fy 500.

III. EXPERIMENTAL SET UP

The deep beams to be tested were placed in the loading frame of capacity 100 tons under two point loading and test set is shown in figure. The end condition of the beam was kept as a simply supported. The load cell was placed in the centre of the beam. Finding the deflection under the one third loading points, the deflectometers were Placed and dial gauge was placed in the centre of the beam measure the mid deflection.

IV. RESULTS AND DISCUSSION

Based on the experimental studies conducted on beam reinforced with High yield strength deformed bars and carbon fiber reinforced polymer wraps. The following observations can be summarized It is observed in beam with carbon fiber reinforced polymer has a lesser deflection than the normal Fe 415 High yield strength bars. The maximum load has given that is 100 KN for both beams. The two point under loading condition is to be applied .The load deflection values of both the beams were recorded. The mid span deflection of beam was compared with that of their respective control beams.

It was noted that the behavior of the flexure deficient beam when bonded with CFRP were better than the corresponding control beams. The use of CFRP wraps had effect in delaying the growth of crack formation.The comparison of using CFRP wraps bond bottom and covering bottom and side faces are tabulated in Table 2.8.

Table 2.8 Deflection values

LOAD	DEFLECTION (mm)		
	RC CONVENTIONAL	CFRP AT BOTTOM FACE	CFRP AT BOTTOM AND SIDE FACE
10	0	0	0
20	0.45	0.26	0.19
30	0.87	0.47	0.3
40	1.98	0.73	0.42
50	2.4	1.26	0.77
60	3.18	1.68	0.98
70	3.6	1.9	1.12
80	4.01	2.06	1.46
90	4.56	2.3	1.63
100	4.81	2.73	1.88

V. CONCLUSION

- his project concludes the use of CFRP beams (55kN) increases the ultimate load carrying capacity by 25% than that of RC conventional beam.
- Replacement of coarse aggregate with ceramic material reduces the self- weight of the beam improves the flexural capacity of beam member as compared to the normal conventional beam by 32%.
- Deflection of the beam is reduced with respect to the strength aspect.
- Deflection of CFRP beam at 28days is 2.5mm with ultimate load capacity of 25.6kN as less as compared to RC conventional beam of deflection 2.5mm for the flexural load of 22.8kN for 28days in strength aspect.
- The CFRP beam with end anchorages of wrapping at sides and bottom faces shows better results as as compared to the beam of CFRP wrapping at bottom faces.

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