FLEXURAL BEHAVIOR OF RC BEAM USING CARBON FIBER REINFORCED POLYMER

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***Abstract*—The performance of reinforced Concrete Beam wrapping with carbon fiber reinforced polymer mesh with epoxy will be evaluate. It can be used for compare the flexural behavior of conventional beam and carbon fiber beam. The performance of concrete beam is to be identified and crack control measures will be provided by strengthen with Epoxy and carbon fiber mesh. The CFRP material prevents the de-bonding of the concrete beam. The wire mesh component is fabricate with epoxy laminate and pasted on the beam and it improve the mechanical properties of beam. Both wrapped and unwrapped beams will be tested with loading frame and flexural strength of concrete beam will be identified.**

***IndexTerms*—CFRP, Epoxy, Flexural strength, RC Beams**

I. INTRODUCTION

Concrete is a composite material composed of Fine and coarse aggregate bonded together with a fluid cement , that hardens over time . Most concretes used are lime based concretes such as Portland cement concrete or concrete . When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easy poured and molded into shape.

Composite materials have been existence from a quite long time in civil Engineering Infrastructure is new and advanced technology in its developing phase. The high performance carbon fiber composite are accepted due to incomparable advantages over the material employed in the strengthening of structures.

Fiber Reinforced polymer is rapid increasing in the construction of buildings and other structures. The fiber reinforced polymer which use of strengthening material called Carbon Fiber Reinforced Polymer. The CFRP composites are directional , in which the maximum mechanical properties and strength is offered in fiber direction . These materials are light weight , parts consolidation and formable as they can be shaped to any desired and surface texture. The CFRP material is increases the strength of the beams, ductility and resistance to corrosion .Epoxies are used for fabricating high performance composites with superior mechanical properties of UV resistance and therefore need to be protected with temperature, good adhesion to substrate , or a combination of these benefits.

Carbon Fiber is created using Poly acrylonitrite, rayon Fiber precursor.PAN based fibers offer good strength and modulus values upto 620 Gpa. These fibers are used for coal tar . They are the good for compressive strength and high modulus of rigidity. Composite materials are having the long life span and high durability become critical stage.

A. Rahman Muhammad Muklesur et al 2013

This literature study focuses on the application of carbon fiber reinforced polymer laminate for strengthening the tension zone of RC T beam constrained by the presence of a stump and the effect of varying the length of strengthening laminates. The result shows that the load carrying capacities of the tension zone strengthened beams were increased by about 50% compared to un strengthened beam. The reinforcing bars are smoothed by grainding machine, CFRP laminates are cleaned with acetone and concrete surface of smooth ed before fixing strain gauges. All strain gauges were connected with data logger to record the strain values during the test. About 70% load carrying capacity was increased over un-strengthened beam by strengthening both the tension and the compression zone. The un-strengthened beam revealed the conventional flexural failure mode of the end peeling of the CFRP laminate.

B. M.B.S Alferjanil , et al 2013

The author says the fiber reinforced polymer is becoming a widely accepted solution for repairing and strengthening ageing in a field of civil Engineering. Several Researches have been carried out reinforced concrete beams strengthened with fiber reinforced polymer composite. The external bonding of high strength fiber reinforced plastic to structural concrete members has widely gained popularity in recent years, flexibility over steel plates. It is evident that epoxy resin is favoured in strengthening and also the end of anchorage was used to eliminate the de-bonding failure.

C. Study of literatures

- Carbon Fiber Reinforced Polymer pasted on concrete gives the better strength compared with conventional concrete.
- It provides 30% more flexural strength compared to conventional concrete.
- Many existing reinforced concrete members are found to be deficient in shear strength and need to strengthened.

- CFRP may used to retrofit the existing reinforced concrete beam and provide the missing continuity need to resist progressive collapse.
- Cracks are reduced when the specimen is wrapped with Carbon fiber mesh.
- The cracking load increased linearity with the increase of force. For PCC beam specimen, the average deflection based ductility of the beam reinforced with hybrid reinforcement is 52% higher than beams reinforced with steel only.
- After reinforced with CFRP sheet the capacity of energy absorption is greatly enhanced with seismic resistance for structures.
- Strengthening measures are required in structures when they are required to accommodate increase loads.
- When there are changes in the use of structures, individual support and wall may need to remove.
- The significant of the study is to improve the strength of the conventional concrete by carbon fiber.
- When the strength of the concrete can be controlled, the long life of the building also can be controlled.
- It is easily can manage the life king it more safety and good strength and improved to maximum.

II. METHODOLOGY

The concrete mix is the mixer of Cement, fine aggregate and the coarse aggregate were properly mixed with dry condition of M40 concrete. The RC beams are casted and cured with 28 days. After the curing period the specimens are subjected to loading frame and testing of the Flexural test. Two beams are casted and one beam is wrapped with carbon fiber mesh and other beam is conventional beam.

III. EXPERIMENTAL PROGRAM

A. Cement

Portland cement is the most common type of cement in the world. The cement is made by heating limestone with other materials to 1450 degree in klin, in a process known as calcinations. The molecule od carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quile lime. Concrete is a concrete material consisting of aggregate, cement and water. Portland cement may be white or grey in color. For casting of beam specimens, Portland Pozzolona Cement of ACC 53 grade was used.

Table 1 Properties of cement

Specific Gravity	3.15
Initial Setting Time	35 min
Final Setting Time	9.75 hrs

B. Fine Aggregate

Fine aggregate is locally available river sand which passes through 4.75mm.

Table 2 properties of Fine Aggregate

Specific Gravity	2.67
Fineness Modulus	2.62

C. Coarse Aggregate

Water absorption test for coarse aggregate is 0.33%

D. Carbon Fiber

Carbon fiber reinforced polymer is a polymer matrix, either thermo set or thermoplastic , that is reinforced with a fiber or other reinforcing material. CFRP are different from the construction materials of steel or Aluminum. FRP composite are anisotropic and reinforced concrete building may be vulnerable to progressive collapse due to a lack of continuous reinforcement.

Table 3 Properties

Typical properties	High Strength	High Modulus	Ultra-high Modulus
Density (Kg/m)	1800	1900	2000
Tensile Strength (GPa)	2.48	1.79	1.03

- Unidirectional sheets having fibers that are all aligned in a common direction.
- Multidirectional sheets are similar to unidirectional sheets except that fibers running in multiple directions are woven together.
- The fibers consist of the placement of multiple layer and the resin impregnated fibers on the different shape.

The fibers increase of high stiffness, strength and strengthening of existing structures and it is used in the rehabilation structures

IV. MIX PROPORTION

The mix proportion of RC beam is M40 is 1:1.62:2.96 designed as per IS 456:2000.

A. Test Procedure

The loading frame is 50 Ton capacity of load and measured in analog calculation of crack and deflection.
Araldite is the synthetic resin adhesive for bonding metals , glass, porecelain and other materials. Araldite is set with resin of Hardener. After cure different crack pattern is formed. It is not exact and also uni-tensional mixing of hardener.
Properties

- Toughened paste
- Ideal for bonding GRP
- Low shrinkage
- Gap filling, non sagging upto 10mm thickness
- High shear and peel strength.

The loading Frame is to find the flexural strength of RC beam of three point loading of Conventional beam and CFRP beam.

B. Casting of beam

The size of the beam is 1200x120x150mm of dimension. The reinforced concrete beam 10mm of main bar and 8mm of ties with 120mm of ties.

Figure 1 : Test setup for CFRP beam

V. RESULT

A. Conventional Beam Load Vs Deflection

Load deflection is the principle constituent of flexural behavior of the beam. As the load increases the deflection of the beam starts. Load is directly proportional to deflection Load deflection curve is to know the load carrying capacity, and to calculating many structural parameter like deflection , ductility etc.

Table 4 Load Vs Deflection for conventional beam

Load in KN	Deflection (mm) left	Deflection (mm) middle	Deflection (mm) right
10	4.6	6.09	5.27
20	6.43	8.72	7.5
30	7.93	10.42	8.8
40	9.85	12.32	10.4
50	11.43	13.91	12.7
60	13.36	15.02	14.2
62	14.43	16.89	15.6

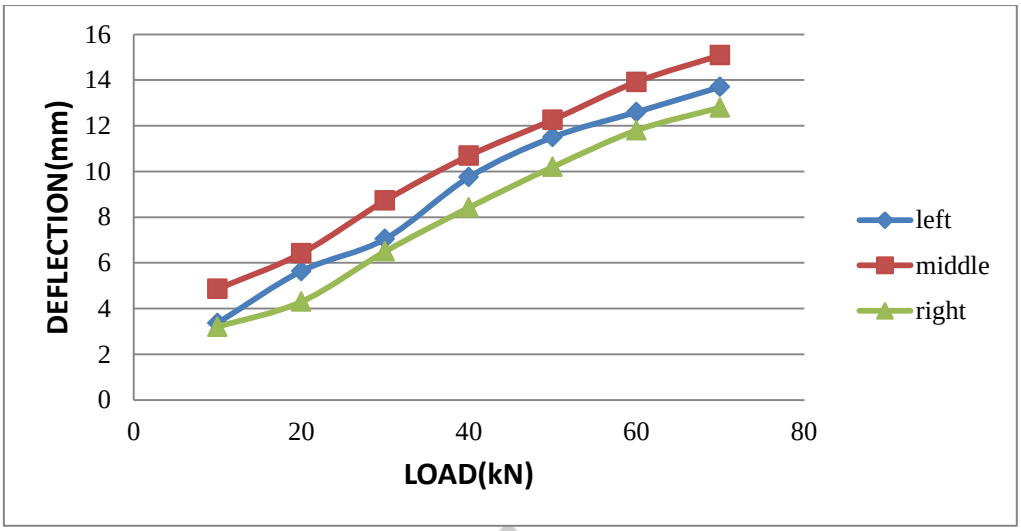

Figure 2 Load Vs Deflection for Conventional beam

The crack pattern is noted in the conventional beam and the direction is also noted. The bending of the beam leads to the crack pattern with the initial cracking pattern and ultimate cracking pattern. The initial cracking pattern is formed at the particular small load but the ultimate cracks are formed at the high loads of the loading frame

B. CFRP Beam

When the beam is wrapping of carbon fiber mesh applied with the help of epoxy resins of Araldite and ardor and with the proper ratio of 1:2.When wrap of beam is high temperature and cured for one week and then it is hardened. Then it is perfect testing of beam.

C. Load vs Deflection

When the load is applied on the CFRP beam load and deflection is calculated in the loading frame instrument. The crack pattern is not noted in the CFRP beam because it is wrapped.

Table 5 Load Vs Deflection for CFRP

Load (KN)	Left (mm)	Middle (mm)	Right (mm)
10	3.37	4.86	3.2
20	5.64	6.42	4.3
30	7.05	8.73	6.5
40	9.75	10.69	8.42
50	11.5	12.26	10.2
60	12.6	13.92	11.8
70	13.7	15.09	12.8
80	14.8	16.12	13.9
90	15.8	17.05	14.3
100	17.3	18.31	16.6
110	18.6	20.08	17.5
117	19.5	21.82	20.4

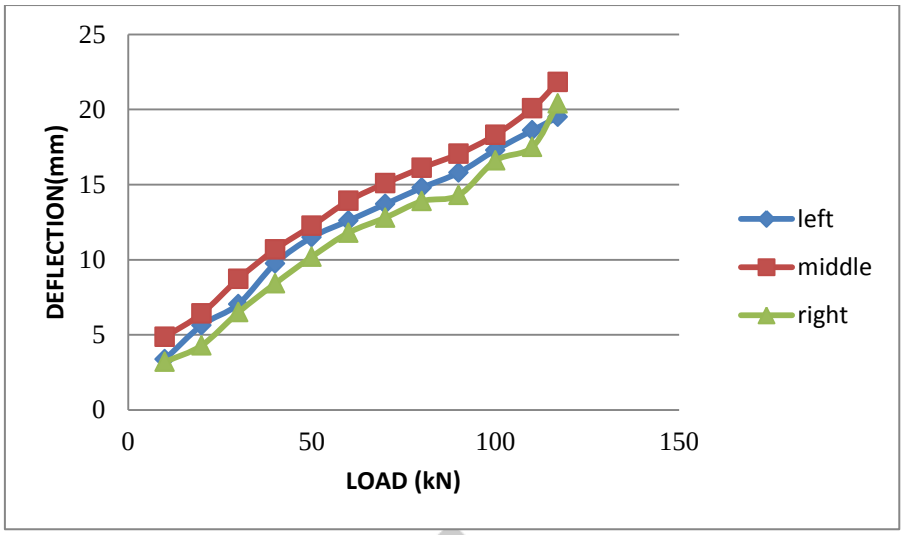

Figure 3 Load Vs Deflection For CFRP

VI. CONCLUSION

- Due to high stiffness, CFRP has less deflection when compared to normal beam.
- The ultimate load of Carbon Fiber beam is 117kN and conventional beam is 62kN.
- It concludes that, the strength of CFRP beam is better than Conventional beam.
- Flexural strength of conventional beam is 27N/mm^2 and CFRP beam is 52N/mm^2
- The flexural Strength of conventional beam is low and CFRP beam is high.

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