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Enhancing the Flexural Strength of beam by using Fiber Reinforced Polymer material

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Abstract -Now a day's structural strength is very important parameter to construct a high rise building. Strength of reinforced concrete structure is directly proportional to its structural members like beam and column. So in the research work, fiber reinforced polymer material are used with the RCC square cross sectional beam member to provide a lateral confinement of FRP composite material to enhancing its flexural strength. For the test, the 15 numbers of beam specimens are used of size 150×150×700 mm. test specimens are wrapped with 0, 2, 4, 6, 8 FRP layers in sets and their flexural strength increases 3.8, 6.1, 9.8, 11% respectively.

Key Words: - Square cross sectional beam, Flexural strength, Fiber reinforced polymer, confinement

1. INTRODUCTION

The use of fiber reinforced polymer (FRP) materials in civil infrastructure for the repair and strengthening of reinforced concrete structures and also for new constructions has become common practice. Strength and life of the structures effected due to regular environmental effect. The repair of structurally deteriorated RC Structures become necessary since the structural element ceases to provide satisfactory strength and serviceability, a technique are typically adopted for the strengthening of beams, relating to the flexural strength enhancement desired:. For the flexural strengthening of a beam, FRP sheets are applied around the external face of the beam and also Principal tensile fibers are oriented in the beam longitudinal axis, similar to its internal flexural steel reinforcement. This increases the beam strength and its stiffness (load required to cause unit deflection), however decreases the deflection capacity and ductility. . Fiber reinforced polymers (FRP) composites comprise fibers of high tensile strength within a polymer matrix such as vinyl ester or epoxy. The epoxy resin is used to align the fibers in proper direction and bond the wrap with the structural member. The advantage of the FRP includes high strength to weight ratio, high stiffness, corrosion resistance, high specific strength, and durability. While FRP can be used to strengthen many different structural members such as beam, column, slab and chimney.

1.1 The concept enhancing the strength of square cross sectional RC beam by FRP materia: -

FRP sheets are wrapped around the beam with fibers oriented perpendicular to the longitudinal axis of beam is fixed to the beam using epoxy resin. FRP composites are different from traditional construction By confining the concrete using a continuous FRP jacket, i.e. wrapping of RC beam By high strength low weight fiber wraps to provide passive confinement, the fibers resist the transverse expansion of the concrete and provide passive confinement which increase both flexural strength and ductility.

2. EXPERIMENTAL INVESTIGATION

Test specimen details: - Experiments were conducted on beam specimen. The 150 mm x 150mm in cross section and 700mm height of specimen were used Reinforcement used for the beam is shown in fig.1 and the details of the specimens tested are given in table 1. The ingredient used in concrete was OPC of 43 grade (JP cement), Local River sand confirming to zone II (specific gravity 2.61) and clean portable water. A design mix of M-40 (1:1.65:2.92) were used to prepare the specimens. Fe 415 grade steel is used as longitudinal reinforcement and lateral ties. Specimen was wrapped externally by 2, 4, 6 and 8 layers of GFRP sheets. Before strengthening the specimens with GFRP sheets, a surface preparation was carried out, which included cleaning, and then epoxy adhesive was used for bonding GFRP sheets on the specimens. Additional layers of epoxy adhesive were applied between GFRP sheets.

Reinforcement and confinement details: -

Fig 1 show reinforcement details of beams

Table-1 Reinforcement details of beam

Specimen No.	No of GFRP layers	Specimen size(mm x mm)	Reinforcement in specimen	
			Longitudinal Reinforcement	Stirrups
B-1	0	150X150	2 Nos of 10mm dia at top 2 Nos of 12mm dia at bottom	8mm dia at 100mm c/c
B-2	2	150X150	2 Nos of 10mm dia at top 2 Nos of 12mm dia at bottom	8mm dia at 100mm c/c
B-3	4	150X150	2 Nos of 10mm dia at top 2 Nos of 12mm dia at bottom	8mm dia at 100mm c/c
B-4	6	150X150	2 Nos of 10mm dia at top 2 Nos of 12mm dia at bottom	8mm dia at 100mm c/c
B-5	8	150X150	2 Nos of 10mm dia at top 2 Nos of 12mm dia at bottom	8mm dia at 100mm c/c

Strengthening of beam before bonding the composite fabric on to the concrete surface the required region of concrete surface was made rough using a coarse Sand paper texture and cleaned with an air blower to remove all dirt and debris. One the surface was prepared to the required standard, the epoxy resin was mixed in accordance with manufacturer's instructions mixing was carried out in a plastic container and was continued until the mixture was in uniform color. When this was completed and the fabrics had been cut to size, the epoxy resin was applied to the concrete surface. The composite fabric was then placed on top of epoxy resin coating and the resin was squeezed through the roving of the fabric with the roller. Air bubbles entrapped at the epoxy/concrete or epoxy/fabric interface were to be eliminated. Then the second layer of the epoxy resin was applied and GFRP sheet was then placed on top of epoxy resin coating and the resin was squeezed thorough the roving of the fabric with the roller and the above process was repeated. This operation was carried out at room temperature. Concrete specimens strengthened with glass fiber fabric were tested after 24 hours at room temperature. Strengthening process of specimens is shown in figure 2, 3, 4 and 5.

Fig.2 Preparing beam mould

Fig.3 Compaction

Fig. 4 beam specimen after 28 days curing

Fig.5 various material used for strengthening

3. EXPERIMENTAL RESULTS AND DISCUSSION

The specimens were tested for flexural strength on a machine having 400KN capacity show in fig.7. In beam specimen total five sets of specimen B-1, B-2, B-3, B-4 and B-5 tested for flexural strength for different layer of GFRP i.e. 0,2,4,6 and 8 layers respectively. It was observed that the specimen B-5 has maximum strength when compared to that of the specimen B-1, which has zero layers GFRP.

Fig.6 specimen used for flexural strength testing

Fig.7 Flexural strength testing by UTM

Fig.8 Pattern of cracks due to testing

3.1 RESULTS

A flexural strength test conducted on beam specimens after 28 days proper curing the beam specimens are wrapped in layers of 2, 4, 6, 8 and tested in UTM which has capacity of 400KN and a least count of 0.2KN. The three point load method are used for testing of beam specimen which has size of 150×150×700mm.The test results are summarized in table no 2.

Table-2 Flexural strength of beam specimen

S. No.	Specimen designation (sets)	No. of GFRP layer	Average flexural strength of specimen) N/mm2
1	B-1	0	18.04
2	B-2	2	18.73
3	B-3	4	19.14
4	B-4	6	19.80
5	B-5	8	20.03

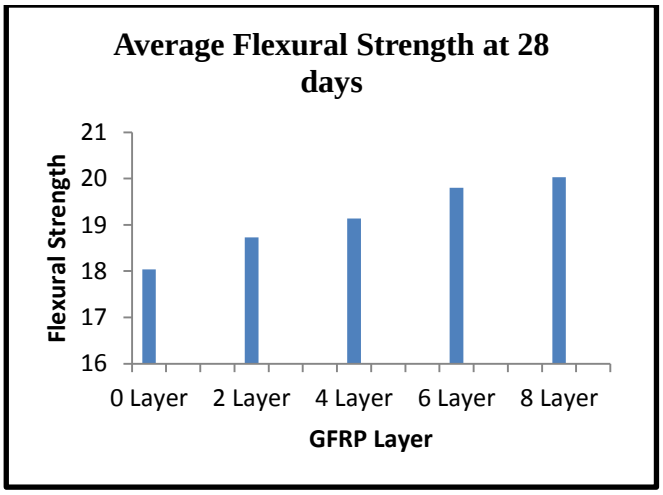

Fig.9- Average flexural strength of square specimens with different layers of GFRP

3.2 DISCUSSION

From the test result (shown in fig.9) it is clear that there is significant increase in flexural strength of specimens confined with GFRP layers. Specimen B-2 with 2 layer of GFRP attained an enhancement of 3.82% strength greater than the strength of specimen B-1 with zero layer of GFRP. Specimen B-3 attained an enhancement of 6.09% with 4 layer of GFRP, specimen B-4 attained an enhancement of 9.75% and specimen R-5 has 11.03% as compare to zero layer specimen i.e. specimens B-1.

4. CONCLUSIONS

From the series of tests conducted on the concrete beam specimens with different degree of confinement the following conclusions are drawn:

1. The confinement in the form of GFRP sheets increases the flexural strength of the square cross sectional beam specimens remarkably.

2. If the specimen is wrapped with 8 layers of GFRP sheets the strength increases to 11.03% of the strength without confinement

3. The graph of results shows that flexural strength of beam

From the study it can be concluded that the beam can be confined with GFRP sheets to increase their strength to a great extent. This material (GFRP) may be used in seismic retrofitting or new RCC construction work.

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