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An Analysis on Load and Deflection of RCA Beam with Different Fiber Sheets

Hemant Bharti, Dr. Vishnu Sharma , Mr. Sanjeev Sipani

***Abstract*— FRP repair systems provide an economically viable alternative to traditional repair systems and materials. In this study experimental investigation on the flexural behavior of RC beams having recycled concrete aggregate (RCA) strengthened using polypropylene fiber and glass fiber reinforced polymer (GFRP) sheets are carried out.**

RCA concrete beams externally bonded with GFRP and polypropylene fiber sheets were tested to failure using a symmetrical two point static loading system. Five type RC beams were casted for this experimental test. All of them were having same reinforcement detailing. Experimental data on load, deflection and failure modes of each of the beams were obtained. The effect of GFRP, PPF on ultimate load carrying capacity and failure mode of the beams were investigated.

***Index Terms*— Polypropylene fiber Sheets, GFRP Sheet, RC, Flexural capacity.**

I. INTRODUCTION

Retrofitting of concrete structures by wrapping FRP sheets provide a more economical and technically superior alternative to the traditional techniques in many situations because it offers high strength, low weight, corrosion resistance, high fatigue resistance, easy and rapid installation and minimal change in structural geometry. Beams are the critical structural members subjected to bending, torsion and shear in all type of structures. Similarly, columns are also used as various important elements subjected to axial load combined with/without bending and are used in all type of structures considering from building to bridge as piers or abutments. Therefore, extensive research works are being carried out throughout world on retrofitting of concrete beams and columns with externally bonded FRP composites. Several investigators took up concrete beams and columns retrofitted with carbon fiber reinforced polymer (CFRP)/ glass fiber reinforced polymer (GFRP) composites in order to study the enhancement of strength and ductility, durability, effect of confinement, preparation of design guidelines and experimental investigations of these members.

FRP materials have higher ultimate strength and lower density as compared to steel. When these properties are taken together they lead to fibre composites having a strength/weight ratio higher than steel plate in some cases. The lower weight of FRP makes installation and handling significantly easier than steel. These properties are particularly important when installation is done in cramped locations. Other works like works on soffits of bridges and building floor slabs are carried out from man-access platforms rather than from full scaffolding.

Hemant Bharti, M.Tech. Scholar, Department of Structural Engineering, Yagyavalkya Institute Of Technology Jaipur
Dr. Vishnu Sharma , Professor, Department of Structural Engineering, Yagyavalkya Institute Of Technology Jaipur
Mr. Sanjeev Sipani, Professor, Department of Structural Engineering, Yagyavalkya Institute Of Technology Jaipur

II. LITERATURE REVIEW

Sukumar V, Sriram G.G et.al (2017) The present study focuses on the effect of strengthening the beam with Glass Fiber Reinforced Polymer [GFRP] (full width of beam) and Hybrid Fiber Reinforced Polymer [HFRP] (in strip pattern). It is observed that HFRP (strip pattern) takes almost equal amount of load for first crack formation.

Sujit Tare, Lavkesh Wankhade (2016) have tested that to strengthen the structure that have progressed toward becoming week over its life expectancy, Fiber-strengthened polymer (FRP) are utilized as a part of an extremely viable approach to repair. FRP repair frameworks gives a practical arrangement contrasting option to conventional repair frameworks and common development materials. In this exploration logical examination on the cyclic conduct of RC pillars fortified utilizing carbon fiber strengthened polymer (CFRP) sheets were completed. Strengthened solid shafts remotely reinforced with CFRP sheets with various setups had been demonstrated in ANSYS14 and broke down for the cyclic stacking framework. The impact of various sum and setup of CFRP on extreme load conveying limit, diversion and disappointment method of the pillars had been researched.

Rajamohan et al (2009) studied the effect of inclined GFRP strips epoxy bonded to the beam web for shear strengthening of reinforced concrete beams. He also studied the effectiveness in terms of width and spacing of inclined GFRP strips, spacing of internal steel stirrups, and longitudinal steel rebar section on shear capacity of the RC beam study to investigate the behaviour of structurally damaged full-scale reinforced concrete beams retrofitted with CFRP laminates in shear or in flexure.

Obaidat et al (2010) studied the Retrofitting of reinforced concrete beams using composite laminates and the main variables considered are the internal reinforcement ratio, position of retrofitting and the length of CFRP.

Hamid Rahmi and Allan Hutchinson (2001) explored the reasonableness of FRP for remotely fortified support of solid structures subjected to flexural stacking. Parts of glue holding innovation, composite material and numerical demonstrating were utilized and connected to plate holding innovation. From this investigation it was presumed that the firmness and quality of the pillars reinforced with composite plate was generously expanded. A definitive load limit of the bar is expanded as much as 230% over their non-plated partners and the solid bars that had preloaded before holding had a proportional execution of different pillars. This demonstrates the adequacy of plate holding strategy in repair arrangement.

Phalguni Mukhopadhyaya and Narayana Swamy (2001) has done the near investigation to upgrade the comprehension of the flexural conduct of the fortified solid bars reinforced remotely by GFRP plates and to build up an unmistakable photo of the part and the adequacy of the GFRP plates in the auxiliary execution of the composite shaft. In this examination an outline procedure was created to both the usage of the GFRP outside support and the general auxiliary conduct of the composite part. GFRP plated shaft is contrasted and the bar with steel plate to comprehend the advantages, inadequacies and viability of GFRP holding.

III. METHODOLOGY

For conducting experiment, five reinforced concrete beam specimen of size as shown in the fig (Length = 1m, width = 0.30m , depth = 0.30 m) and all having the same reinforcement detailing are casted. The proportion of 1: 1.8: 3.2 for water, cement, fine aggregate and course aggregate is taken. The mixing is done by using concrete mixture. The beams are cured for 28 days. For each beam three cubes are casted to determine the compressive strength of concrete for 28 days.

First the beams are cured for a period of 28 days then its surface is cleaned with the help of sand paper for clear visibility of cracks. The two-point loading arrangement is used for testing of beams. This has the advantage of a substantial region of nearly uniform moment coupled with very small shears, enabling the bending capacity of the central portion to be assessed.

The load is transmitted through a load cell and spherical seating on to a spreader beam. The spreader beam is installed on rollers seated on steel plates bedded on the test member with cement in order to provide a smooth leveled surface. The test member is supported on roller bearings acting on similar spreader plates. The specimen is placed over the two steel rollers bearing leaving 150 mm from the ends of the beam. The remaining 700 mm is divided into three equal parts of 233 mm. Two point loading arrangement is done as shown in the figure. Loading is done by hydraulic jack. Lines are marked on the beam to be tested at L/3, L/2 & 2L/3 locations from the left support (where L=700mm the center to center distance between the supports) Three dial gauges are used for recording the deflection of the beams. One dial gauge is placed just below the center of the beam at L/2 and the remaining two dial gauges are placed just below the point loads i.e at L/3 and 2L/3 to measure deflections.

Beam-1 Standard Beam

Beam-2 RCA Concrete Beam with 15% replacement with NCA with polypropylene Fibers

Beam-3 Single Layered GFRP bonded externally

Beam-4 Single Layered PFRP bonded externally with Polypropylene Fibers

Beam-5 Single Layered PFRP at cracked Standard beam

IV. RESULTS

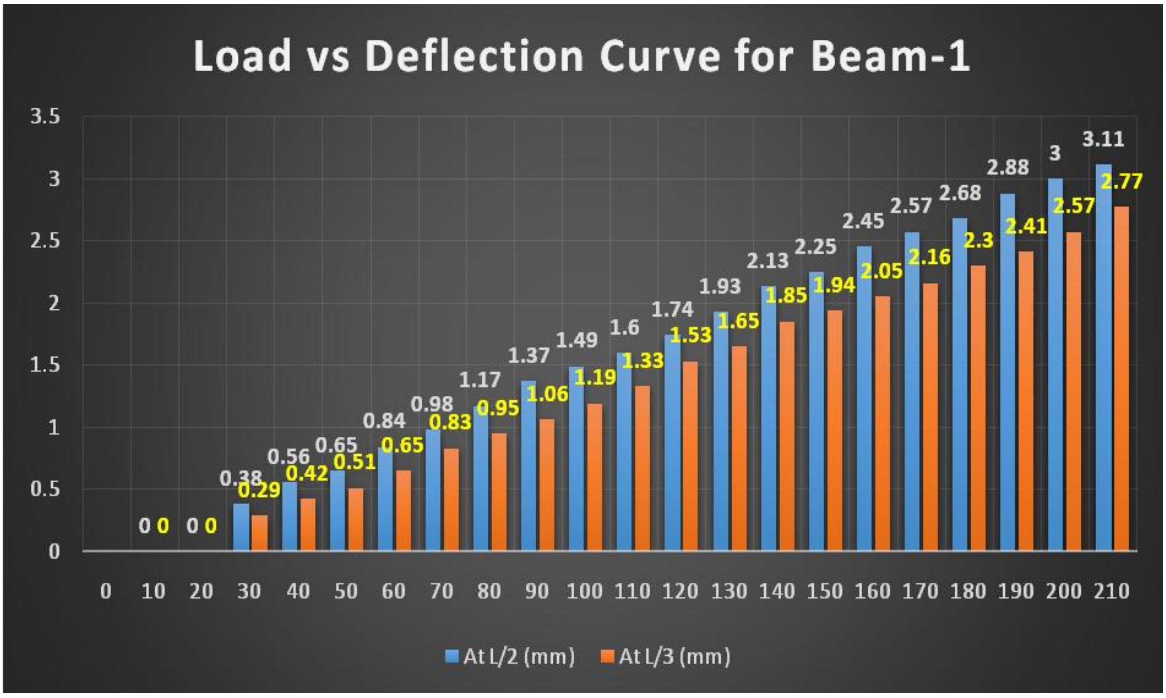

Fig.1 Load vs. Deflection Curve for Control Beam1

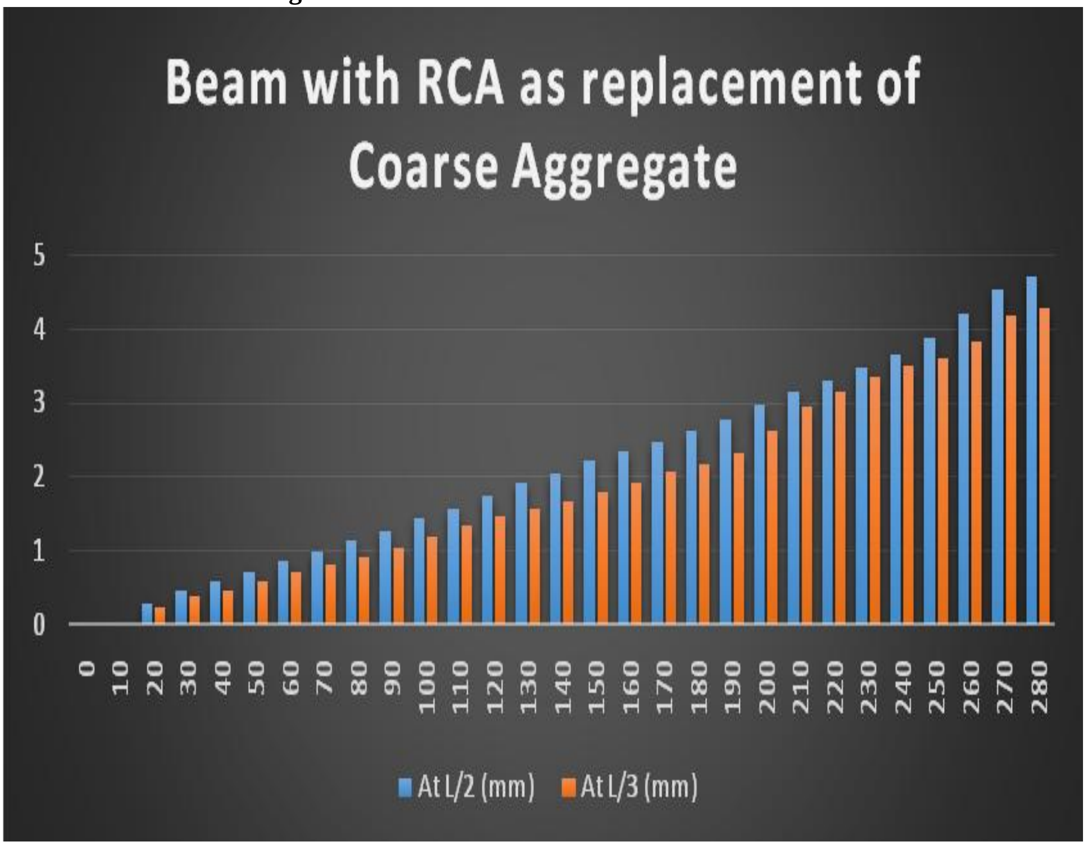

Fig.2 Loadvs.DeflectionCurve forBeam 2

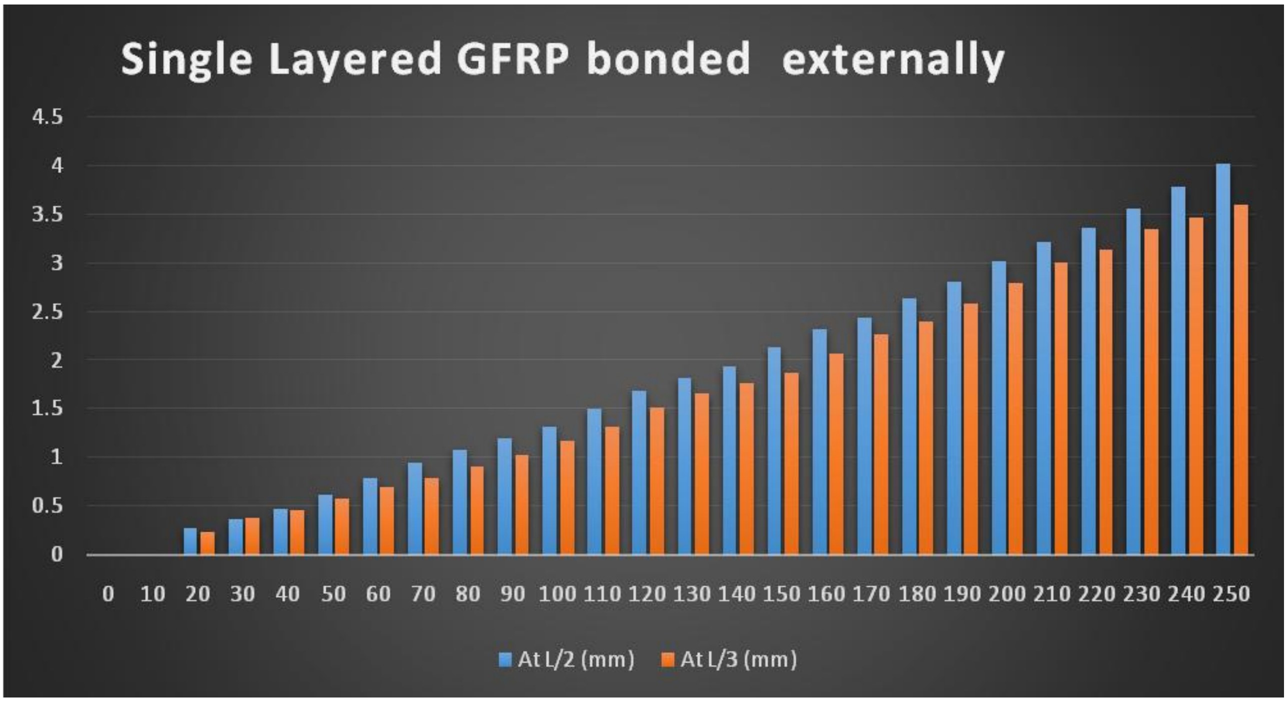

Fig.3 Load vs. DeflectionCurvefor Beam3

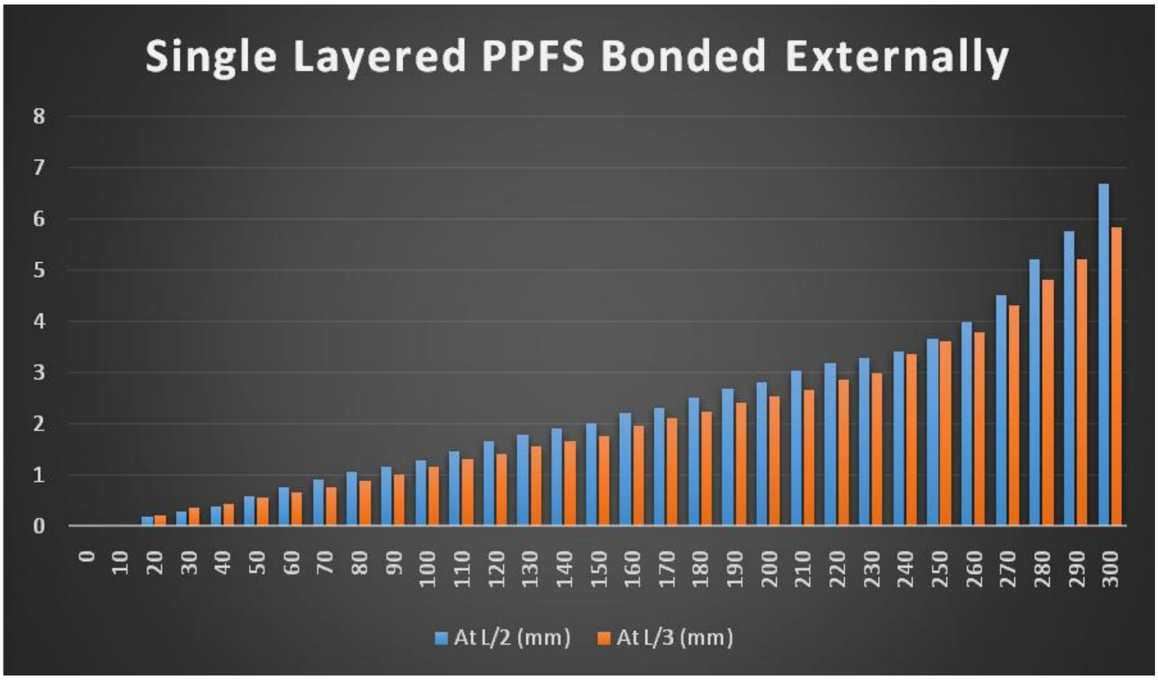

Fig.4 Load vs. Deflection Curve for Beam4

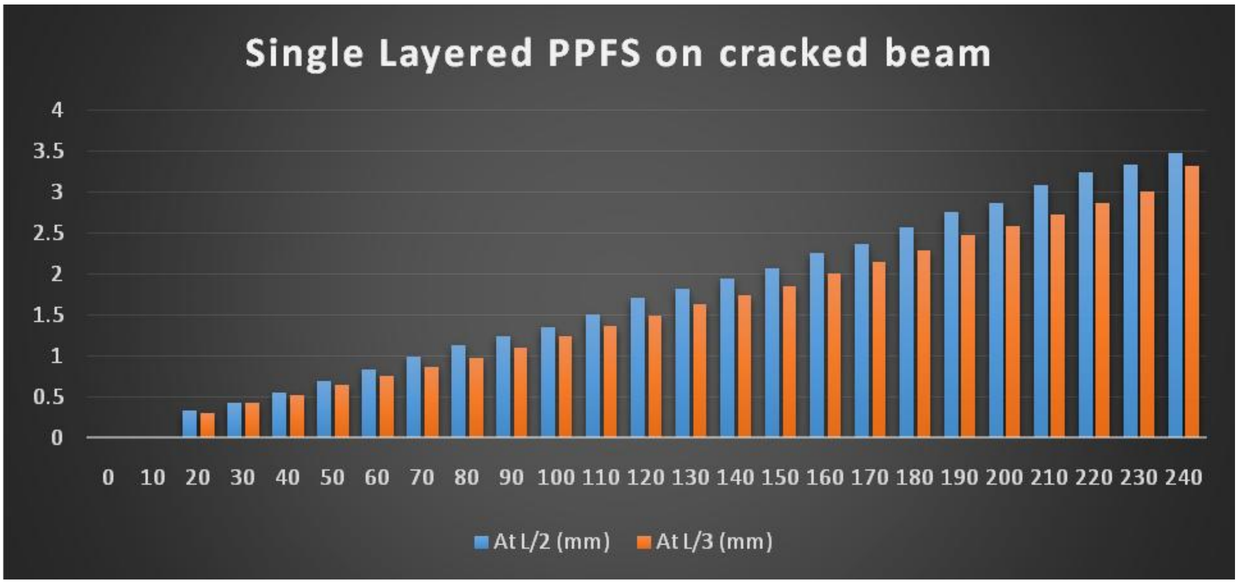

Fig.5 Load vs. DeflectionCurvefor Beam 5before retrofitting

V. CONCLUSION

The present experimental study is done on the flexural behavior of reinforced concrete beams strengthened by PPF and GFRP sheets. Five reinforced concrete (RC) beams weak in flexure are casted and tested. From the test results and calculated strength values, the following conclusions are drawn:

1. The ultimate load carrying capacity of all the beams strengthen by PPF sheet and GFRP were enhanced as compared to the Standard Beam.

2. In case of strengthened beams Initial flexural cracks appeared for higher loads.

3. The load carrying capacity of the strengthened Beam 4 was found to be maximum of all the beams. It increased up to 40 % more than the control beam 1, 10% more than

Strengthened beam 2 and 20 % more than the strengthened beam 5.

4. Beam 5 which was retrofitted, has minimum deflection value on same loads as compared to other strengthened beams and the control beam.

5. Beam 4 and Beam 5 were giving the best results in terms of load carrying capacity and deflection respectively.

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