Journal of Advances and Scholarly Researches in Allied Education
Vol. XV, Issue No. 2, (Special Issue) April-2018, ISSN 2230-7540

Strengthening of RC Beam Using External Elements

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Abstract – Strengthening can be done by means of different materials. Steel plate is one of the most frequent materials for strengthening of RC structures. It increases the shear and flexural capacity of RC beam due to its cheapness, availability, high fatigue and high ductility strength. FRP materials are showing good results using epoxy glue for strengthening RC structures. This paper shows the strengthening of R.C. beams using CFRP sheets, GFRP sheets and Mild steel plate in different types. FRP sheets are bonded at tension side (bottom) and up to neutral axis (U shape) of the beam. Mild steel plates are bonded on bottom of beam in two different types i.e. with epoxy glue and bolt. Among all the type, CFRP gives better results than others. Mild steel plate also gives good results, but due to bad material properties of mild steel plate, CFRP will be the best for strengthening using epoxy.

Keywords: Mild Steel plate, CFRP Sheet, GFRP Sheet, Epoxy Glue, UTM.

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1. INTRODUCTION

Structural corrosion in RC structures is common and encouraged many researchers to seek other materials and healing techniques. In past decades many solutions have been investigated, there is always a demand to search for use of new technique and materials to upgrade the stability of structures. By using the traditional means, strengthening of existing structural members is more economical and requires less effort and time. As beam being an important member in the frame work of a structure, it should be strengthened to maintain the stability.

Concrete structures need to be strengthened for any of the following reasons.

- For superior loads to be placed on the structure, extra strength may be needed. This can occur if additional mechanical equipment, filing systems, planters, or other items are being added to a structure.
- Additional strength is needed due to a lack in the structure's capacity to carry the original design loads. Due to getting old of structural materials or fire damage, members get damage.
- Additional strength may be needed because of improvements in fittingness for use due to control of deflections, decrease of stress in steel reinforcement and decrease in crack widths.
- Further strength may be needed because of variation of structural system due to removal of walls/columns and openings cut through slabs.
- Further strength may be needed due to error in preparation of construction due to inadequate design dimensions and inadequate reinforcing steel.

2. REVIEW OF LITERATURE

In the past studies different researches have been made with various types of plates like FRP sheets (CFRP, GFRP) and MS plate are used for the improvement in strengthening.

D. P Singh [1] studied the repair and strengthening of damaged RCC element in a structure by means of epoxy jab and epoxy bonded steel strip. Investigational results of slope defection and stress strain variation in the creative beams that is before injure and repaired or strengthen beam after collapse are given.

Grace [2] has tested 14 beams including one conventional beam. CFRP sheets are used to strengthen the beam with the help of epoxy. Based on experiment, the load carrying ability has increased and deflection has reduced for strengthened beam over conventional beam.

V.P.V. Ramana, T. Kant, S.E. Morton, P.K. Dutta, A. Mukherjee, Y.M. Desai [3] summarized the grades of investigational and logical studies on the flexural strengthening of RC beams by the exterior bonding of CFRP laminates to the bottom face of the beam. The results show that the flexural strength of beams was considerably increased as the width of sheets increased.

Prof. N. Pannirselvam, P.N. Raghunath and K. Suguna [4] presented a study to evaluate the structural behaviour of reinforced beams with outwardly bonded FRP reinforcements. Total fifteen beams specimen having three dissimilar steel ratios, wrap thickness and wrap material were tested.

Prof. Tej Sai M, Kantha Rao M. [5] showed that many of the RC structures are being injured by the recurrent earthquakes and they need to be strengthened using external elements**.**

3. MATERIAL USED

3.1 Epoxy Resin:

Fig 3.1: Epoxy Resin

3.2 Mild Steel Plates:

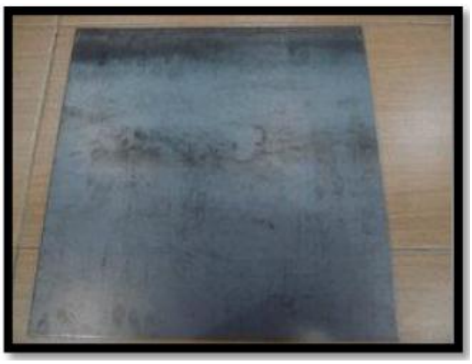

Fig 3.2: Mild Steel Plate

3.3 Carbon Fibre Reinforced Polymer (CFRP):

Fig 3.3: CFRP Sheet

3.4 Glass Fibre Reinforced Polymer (GFRP):

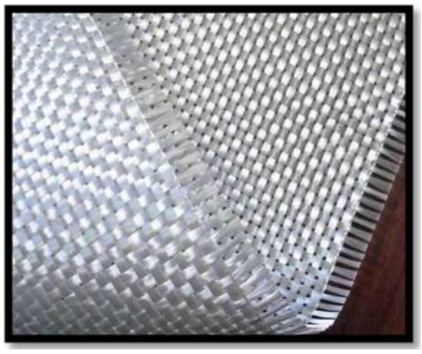

Fig 3.4: GFRP Sheet

4. FOUR POINT LOADING TEST

Four point loading test has been done on all beams. As per **Clause 8.3** of **IS 516:1959** the test specimens are tested. The sample shall then be placed in the machine in such a way that the load shall be apply to the topmost surface as casted in the mould, along two lines spaced 200 mm or 133 mm apart. The alliance of the sample shall be cautiously aligned with the axis of the loading machine.

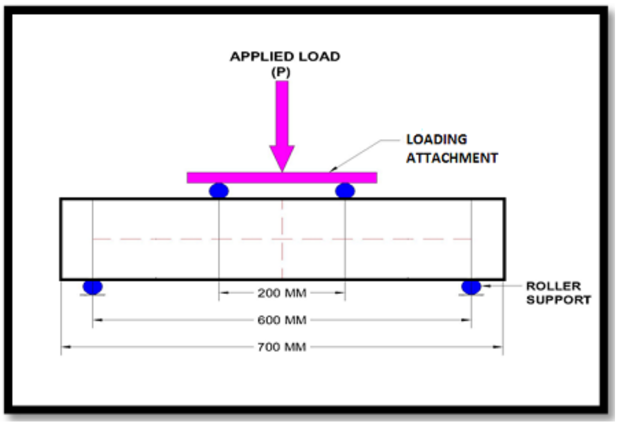

Fig 4.1: Schematic diagram showing Four Point Loading

Fig 4.2: Beam under Four Point Loading

5. METHODOLOGY

The experimental study is conducted on the modulus of rupture of R.C.C beam strengthened by various elements as per the following specifications:

- Concrete grade: M 25 using **IS 10262:2009**
- Beam size: 150mm × 150mm × 700mm as per **IS 10086:1982 Cl. 2.1**
- Total of 21 beams casted of grade M 25 and water curing for 28 days was done.
- External elements i.e sheets are bonded at the tension side of the beam using two part epoxy glue.
- First three beams are the conventional type of beams. They were experienced after 28 days curing.
- Six beams were wrapped with CFPR sheets. Three beams are glued at the tension face of the beam. Three beams are glued in U shape till the neutral axis of the beam.
- Six beams are wrapped with GFPR sheets. Three beams are glued at the tension face of the beam. Three beams are glued in U shape till the neutral axis of the beam.
- Six beams are wrapped with mild steel plates. Three beams are glued at the tension face of the beam. Three beams were drilled at the bottom face.
- These beams are then placed on the UTM and tested for flexure by four points loading.
- The load and displacement was noted and flexural strength was calculated.
- The results were then compared.

Table 1: Test specimen details

Sr. No	Beam ID	Description	W/c ratio
1.	1.2.3	Control specimen	0.45
2.	4,5,6	CFRP bonding (U Shape)	0.45
3.	7,8,9	CFRP bonding (at bottom only)	0.45
4.	10,11,12	GFRP bonding (U Shape)	0.45
5.	13,14,15	GFRP bonding (at bottom only)	0.45
6.	16,17,18	MS Plate bonding (at bottom only)	0.45
7.	19,20,21	MS Plate drilled (at bottom only)	0.45

5.1 Bonding of External Elements

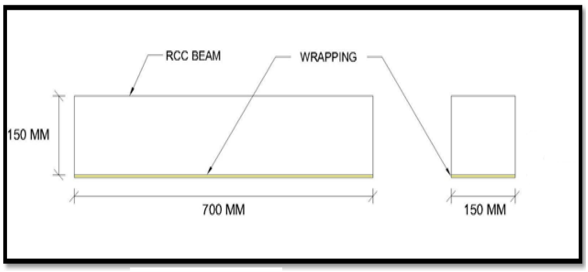

Fig 5.1: Beams Wrapped only at bottom

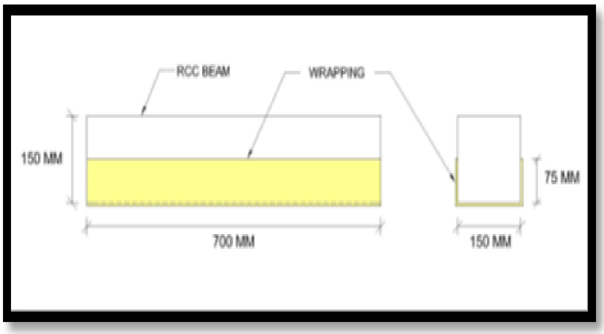

Fig 5.2: Beam wrapped in U shape

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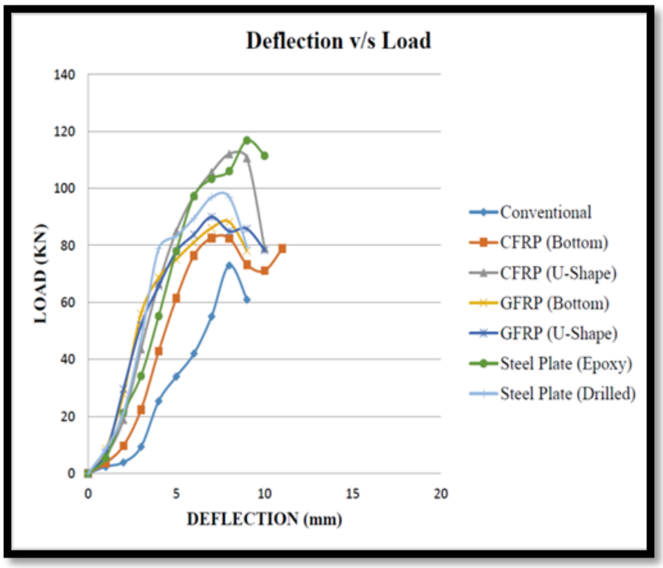
Fig 5.3: Bonding of external elements



Graph 1: Deflection V/S Load Comparison

6. CONCULSION

- The average maximum load taken by the beams is 114.67 KN. This beam is bonded with steel plate with the help of epoxy glue at the bottom.
- The average maximum deflection of the beams is 9.72mm. This beam is bonded with GFRP sheet in U shape up to the neutral axis with the help of epoxy glue at the bottom.
- The average flexural strength of the beams is 20.38 KN/mm2. This beam is bonded with steel plate with the help of epoxy glue at the bottom.
- After comparing the shape of bonding, it was observed that beams bonded by epoxy in U shape (upto the neutral axis) gives better results than the beams bonded at bottom.
- Steel plates bonded with epoxy show better results that the beams bonded with screws.
- The drawback of this experiment was that the epoxy glue hardened the sheets and made them brittle. Thus, the sheets, when tested, tore and came out.
- Finally, we conclude that CFRP sheets wrapped in U-shape gives the best results in FRP sheets.
- Steel plate bonded externally at bottom with epoxy glue gives the best results. But steel plates are susceptible to corrosion and are affected by weather conditions.

7. FUTURE SCOPE

FRP is repeatedly finding new application throughout industry. Development and innovation in resin technology will make sure an exciting and active future for FRP composites as a highly flexible and commercial alternative to traditional materials like metals, concrete and wood.

8. REFERENCES

D. P Singh (1992), **"**Repair and strengthening of reinforced concrete beams", Earthquake Engineering Tenth World Conference at Baikema, Rottenham.

Grace et al. (1996), "Strengthening Reinforced Concrete Beams Using Fiber Reinforced Polymer (FRP) Laminates", ACI Structural J., pp. 865-871.

Hamid Saadatmanesh, and Mohammad R. Ehsani "RC Beams Strengthened with GFRP Plates", ASCE. 11. "Repair, Restoration and Strengthening of Buildings", IAEE manual.

IS 10086 (1982) "SPECIFICATION FOR MOULDS FOR USE IN TESTS OF CEMENT AND CONCRETE", Bureau of Indian Standards, New Delhi.

IS 10262 (2009) "CONCRETE MIX PROPORTIONING — GUIDELINES", Bureau of Indian Standards, New Delhi.

IS 516 (1959), "METHODS OF TESTS FOR STRENGTIH OF CONCRETE", Bureau of Indian Standards, New Delhi.

Prof. N. Pannirselvam, P. N. Raghunath, K. Suguna (2008) "Strength modelling of reinforced concrete beam with externally bonded fibre reinforcement polymer reinforcement", American Journal of Engineering and Applied Sciences.

Prof. Shahul Mohammed, S. Natarajan (June 2016) "Experimental Study on Flexural Behaviour of RC Beams Strengthened with

G.F.R.P", International Journal for Research in Emerging Science and Technology, Vol.3, Issue-6.

Tej Sai M, Kantha Rao M. (September 2014) "Retrofitting of Reinforced Concrete Beams using MS Steel Plates and Modelling using Finite Element Approach", V R Siddhartha Engineering College Vijayawada, India.

V.P.V. Ramana, T. Kant, S.E. Morton, P.K. Dutta, A. Mukherjee, Y.M. Desai, (March 2 2000), **"**Behaviour of CFRPC strengthened reinforced concrete beams with varying degrees of strengthening".

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