International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | Jun 2021 www.irjet.net p-ISSN: 2395-0072

STRENGTHENING OF COLUMN & BEAM BY CARBON FIBER REINFORCED POLYMER (CFRP)

[1]A. M. Kolekar, [2]S. S. Shinde, [3]Y. S. Nikam, [4]T. R. Patil, [5]R. V. Patil, [6]S. S. Patil, [7]S. R. Gavade,

[8]N.S. Pawar, [9]P.S. Patil

[1-7]PG Student, Nanasaheb Mahadik College of Engineering, Peth, Maharashtra, India
[8] Assistant Professor, Department of civil Engineering, Nanasaheb Mahadik College of Engineering, Peth, Maharashtra, India
[9] Assistant Professor, Department of civil Engineering, Nanasaheb Mahadik College of Engineering, Peth, Maharashtra, India

---

Abstract – *This research paper is prepared by studying previously published research papers covering area of study like shear failure of beam-column joints is identified as the principal cause of collapse of many resisting moment frame buildings during recent earthquakes. In this research paper, the efficiency and effectiveness of carbon fiber-reinforced polymer (CFRP) sheets which increasing the shear strength and ductility of seismically deficient beam-column joints have been studied. The first arranged scheme consisted of CFRP sheets epoxy bonded to the joint in beams, and part to the column regions.*

Key Words: **Column & Beam, Strengthening, Carbon Fibre Reinforced Polymer,**

1. INTRODUCTION

According to past researches it is proven that CFRP is abundantly used in strengthening of structural component. However, the binding CFRP have shown significant improvement in structural elements. Suppose, If the beam is designed for a particular load and later, if the load is increased for future expansion of structural; then dismantling and re - casting the beam is not the convenient alternative. Hence, retrofitting is a solution which can be adopted. If proper approach is chosen to define and analyze the problem and to carry out strengthening of structure, bonding of CFRP will show extensive increase in strength. In the current work, efforts have been made to highlight and manifest the improvement in structural response of beam.

1.1 Historical Background

The history of CFRP begins from Joseph Swan who produced carbon fibers to use in light bulbs in 1860 .

Further in 1879 , Thomas Edison used to bake the cotton threads or bamboo silvers at high temperature and carbonized them into an all-carbon fiber filament which is used in one of the first incandescent light bulbs and power up by electricity.

The objective of this research is to study the outcome of carbon fiber reinforced polymer on column and beam. To prepare this sample , M25 concrete is used . And the testing were carried out on total six beams and four cylinders. Out of these , two beams and two cylinders were control specimens. Other samples were strengthened with the CFRP sheets.

1.2 Significance of the investigation

Fiber - Reinforced Polymer is also known as composite material which is made by polymer matrix reinforcement with fibers.

Generally used fibers are carbon and glass. The fibers like wood and paper or asbestos are sometimes used. The polymers used are usually the epoxy, vinyl Ester or polyester thermosetting plastic, and phenol formaldehyde resigns. FRPs are often used in the aerospace, automotive, marine and construction industry.

2. LITERATURE REVIEW

Ratish Y Chengala, D. Vigneshkumar, B Soundara et al., (April 2018) have studied on External Strengthening of Reinforced Concrete Column with CFRP. This paper is carried out to investigate the overall actions of R.C columns, strengthened with wrapped CFRP. From the literature study One or two of them will be a control specimen and the other six specimens were strengthened with CFRP. The parameters considered are the number of composite layers and the compressive strength of unconfined concrete.

M. Velumani, J. Abdul Bari, S. Mrunnalika et al., (January 2017) have studied on Strengthening of Beams Using Carbon Fiber Reinforced Polymer (CFRP). This research investigates the potential of using Carbon Fiber Reinforced Polymer (CFRP) as reinforcement to Concrete members. In this study, use of CFRP as reinforcement was explored. The CFRP reinforcement is applied in strip form, which is more economical compared to wrapping or forming it into bar shape, because it easier and uses less fiber to achieve similar performance. Samples of CFRP reinforced concrete members were tested to failure in four-point bending test. The results obtained are compared with performance of steel reinforced concrete.

M.R.T Arruda et al.,Investigated on the bond between concrete and CFRP strengthening at giant temperatures. The

numerical study was evaluated using the commercial package of Abbacy's and consist of simulation of double lap shear tests.

The two types of specimens (EBR and NSM) were first heated up to giant temperatures , and the loaded up to breakdown.

They conducted double - lap shear tests and reported the following drifts -

(i) Increasing failure loads for temperatures than the Tg of the adhesive and (ii) decreasing failure loads for temperatures higher than the Tg of the adhesive. It is seen that the relative differences between predicted and experimental results are very low (relative differences ranging between 0.4% and 8.3%) , validating the precision of the proposed bond - slip relationship.

Aditya Kumar Tiwary, Ashish Kumar Tiwary, Mani mohan et al. This paper reviewed the efficiency and effectiveness of carbon fiber- Reinforced Polymer (CFRP) sheets that increases the shear strength and ductility of seismically deficient beam - column joints.

For this purpose four as- built specimen corner were constructed. Between this for as- built specimens, two specimens were used as control specimens and another two were strengthened with CFRP sheets below two discrete strengthened specimen's arrangement.

The first arrangement strategy consisted of CFRP sheets epoxy bonded to the joint region in beams, and part to the column regions.

3. ADVANTAGES OF CFRP

- High Strength to weight ratio
- Good Rigidity
- Corrosion resistant
- Electrically Conductive
- Fatigue Resistant
- Fire Resistance/Not flammable
- High Thermal Conductivity
- Low coefficient of thermal expansion
- Non poisonous
- Biologically inert
- X-Ray Permeable
- Self-Lubricating

4. MATERIALS USED FOR CASTING

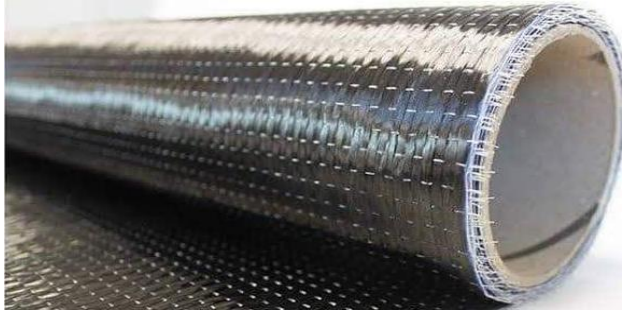

Fig -1 : Carbon fiber

4.1 CFRP Details

Density	=	1.8 Kg/m^3
Modulus of elasticity	=	600GPa
Tensile strength	=	35-60GPa
Elongation at break	=	1.5-2 %
Poisson's ratio	=	.27
Maximum temperature	=	2000°C

4.1 Adhesive Details

Adhesive is required to wrap FRP strip on section is the mixture of the epoxy resin and hardener. In general epoxies have high specific strength and dimensional stability. They are particularly known by their adhesion ability to many substrates and low shrinkage during the cure. Epoxies have excellent environmental and chemical resistance. The epoxy and hardener "Ripstar Saturent" were used. The proportion of resin and hardener was kept as 3:1. The epoxy has density of 1.15 Kg/m^3, Modulus of elasticity of 265 N/mm^2 and Poisson's ratio of 0.35.

Fig -2 : Epoxy Resin & Hardener

5. EXPERIMENTAL SETUP

The testing of beams is carried out in the loading frame of the structural engineering laboratory of college. For the testing of beam two - point loading aligned is used and for the testing of column (cylinder) compression alignment is used. Two - point loading provision made by the arrangement shown in the figure. The load is imparted through a load cell and the spherical seating on to a spreader beam. Installation of spreader beam is made on rollers seated on steel plates bedded on the test member with cement for the provision of smooth leveled surface.

The test member is braced on roller bearing acting on parallel spreader plates. Two dial gouges are set down just below the center of the mid spam of the beam i.e. just below the load point to take down the deflection of the beams.

06. RESULTS OF BEAM

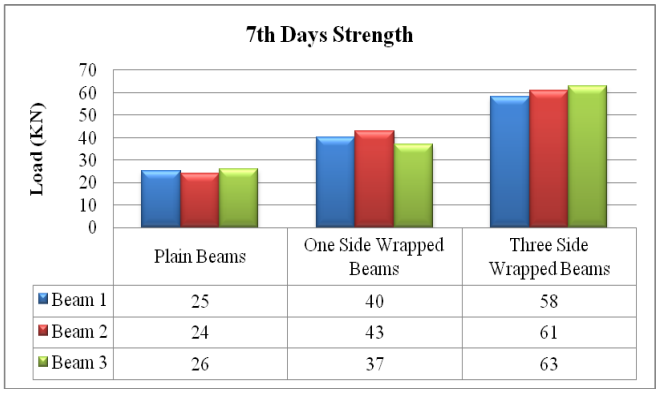

Chart -1: 7th Days Strength of Beams

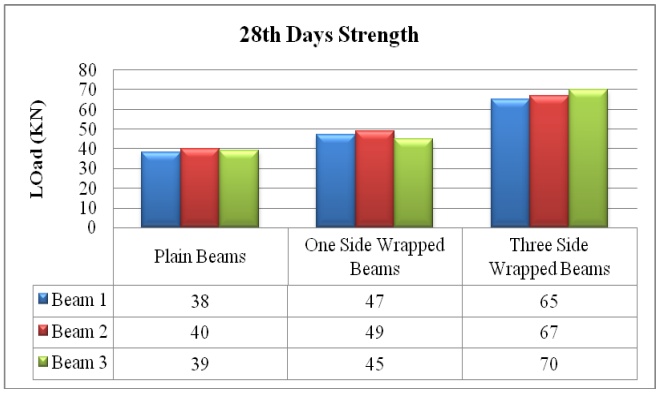

Chart -2: 28th Days Strength of Beams

7. RESULTS OF COLUMN

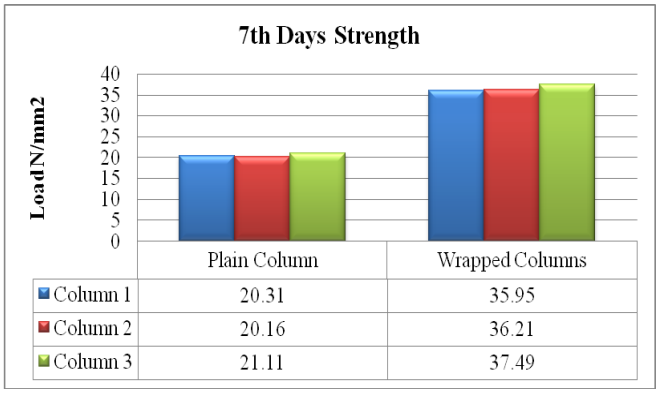

Chart -3: 7th Days Strength of Columns

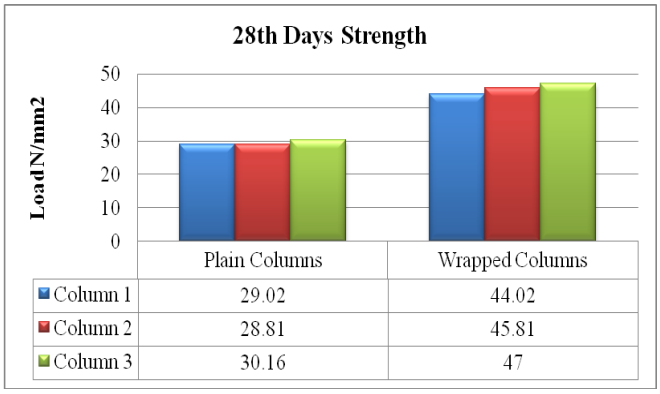

Chart -4: 28th Days Strength of Columns

Mix design for M30 grade is as follows:-
Proportions for 1m3 Concrete

Cement		F.A.		C.A.		Water
1	:	2.07	:	2.49	:	0.45
394 Kg	:	819 Kg	:	982 Kg	:	179 Kg

Quantity of material for casting Column, considering 15% wastage is as follows:

Materials		One Mould (Kg)
Cement	:	**2.27**
F.A.	:	**4.70**
C.A.	:	**5.65**
Water	:	**1.03**
Total	:	**13.65**

Quantity of material for casting Beam, considering 15% wastage is as follows:

Materials		One Mould (Kg)
Cement	:	**7.13**
F.A.	:	**14.84**
C.A.	:	**17.79**
Water	:	**3.24**
Total	:	**43.00**

8. CONCLUSIONS

1. The flexural strength of three side wrapped beam is 35.56% times than one side wrapped beam and 53.28 times than plain beam at 28 days of curing.

2. For beam, wrapping around three sides is very effective than wrapping at one (tension) side.

3. The crushing strength of wrapped column is increased by 43.28% than the plain column at 28 days of curing.

9. REFERENCES

[1] Ratish Y Chengala, D. Vigneshkumar, B Soundara "External Strengthening of Reinforced Concrete Column with CFRP." (April 2018)

[2] M. Velumani, J. Abdul Bari, S. Mrunnalika "Strengthening of Beams Using Carbon Fiber Reinforced Polymer CFRP." (January 2017)

[3] M.R.T. Arruda "Numerical investigations on the bond between concrete and CFRP strengthening systems at elevated temperatures." (2015)

[4] Aditya Kumar Tiwary, Ashish Kumar Tiwary, and Mani Mohan "A Review Paper on Strengthening of Beam Column Joint Upgraded with CFRP Sheets.

[5] Adrian K. Y. Hii "Torsional strengthening of solid and box-section reinforced concrete beams with externally bonded carbon fiber-reinforced polymer CFRP." (2013)

[6] Francesca "Ceroni Bond tests performed on concrete blocks externally strengthened with carbon fiber sheets." (2013)