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TO STUDY FLEXURAL BEHAVIOUR OF RC BEAM WITH GLASS FIBER REINFORCED POLYMER CONCRETE

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Abstract: *This study deals with use of Glass Fiber Reinforced Polymer into the in the form of sheet to strengthen the building components from outside. RC beam with the utilization of Glass Fiber Reinforced Polymer Sheet enhances its strength & durability hence the application of sheet with different sizes into the construction industry. Experimental studies were conducted by varying thickness of Glass Fiber Reinforced Polymer sheets to understand the effect of mechanical response of the RC members. Different types of wrapping are used like two-sided wrap, bottom wrap, U-wrap. The wrapping of beam increases its strength & load carrying capacity by 10-60%, which is cost effective with compare to new construction. The review paper summarizes the effect of GFRP wrapping to RC members to improve the durability and mechanical property of the concrete. The experimental results are studied, discussed, and presented.*

Keywords **–**Glass Fiber Reinforced Polymer sheets, wrapping, mechanical properties, Flexural Strength, durability.

I. INTRODUCTION

FRP gives excellent properties than traditional materials. They are light weight, non-metallic, corrosion resistant, feature strength and stability more than steel. FRP like GFRP (Glass Fiber Reinforced Polymer), CFRP (Glass Fiber Reinforced Polymer) etc. Provides an cost-effective & capable quick fix for increase existence of structures. FRP can use in different conditions in different forms like powder, sheets, laminates, FRP bars etc. Existing building life can increase by FRP external wrapping which improves strength and stability of structure. Wrapping patterns are finalize on cracking patterns like shear / flexural cracks which can observed by eyes after loading and then finalize the wrapping patterns like bottom wrap, two-sided wrap, special wrap etc. Wrapping should be done with proper precautions to avoid debonding between epoxy resin, fiber and concrete surface. The strength and stiffness of beams, slab, column etc. can be effectively increase with FRP.

II. NEED OF THE STUDY.

Glass fibers are formed by melting varied mixing by differentiating an amount of primal materials like sand for an silica, clay for clay for an alumina, calcite for an calcium oxide, and colemanite for an boron oxide. Hence there are various kinds of glass fibers which shows contrasting properties by different compositions like salts resistivity or high mechanized properties. Glass fibers are very versatile materials. Firmness of glass fiber is less than other fibers, yet this has high strength with low density with economical price. GFRP is made by weighed and mixed thoroughly, then from batch house pneumatic conveyor send blend to higher degrees at 14000C chamber for melt, tension is applied, drawing them into thin filaments, chemical coating is applied, then strands are gathered together into packet pack and shipped. GFR sheets have customized manufacturing as per size & purpose. Now-a-days, number of old constructions are lot more & we can't demolish them for minor cracks which can be leads to failure of construction after time period. So, buildings should repair in advance to avoid failure. There are many types of wrapping which are selected by cracking pattern by vision which increase the life span of buildings.

III. MATERIAL AND METHODOLOGY

A. Test Specimens

The strength property of concrete are determined by casting specimens of cube size 150 mm×150 mm×150 mm for compression, beam of size 700 mm× 100 mm× 200 mm for flexure strength and cured 28 days.

B. Materials

Cement

Ordinary Portland cement (53 grade) is used for the concrete specimen casting work.

Glass Fiber Reinforced Polymer sheet

the gfrp used for the present study is in sheet form, it is acquired from Fibro Polymers Gokul Shirgaon, Kolhapur.

Fine aggregate

Regionally sourced basalt stone by crushed sand confirming to IS 383-1970, was used.

Coarse aggregate

Angular aggregate of maximum size 10 mm to 20 mm, conforming to IS 383-1970 was utilized.

Water

Regionally sourced potable water is used for mixing and curing confirming IS 456-2000.

Steel

Fe500 steel of Kalika steel is used.

Properties of gfrp

The properties of gfrp 2mm sheet

Table 1 Properties of gfrp

Sr. No.	Properties	Nano silica
1	Specific Gravity	1.65+_0.1
2	Water absorption	0.13 %
3	Tensile Strength	120 N/mm^2
4	Compressive Strength	200 N/mm^2
5	Impact Strength	30 KG/m^2
6	Cross bearking Strength	160 N/mm^2
7	Shear Strength	50 N/mm^2
8	Glass content	35 to 40 %
9	Barcol hardness	55

C. METHODOLOGY

Concrete was planned for compressive & flexural strength of M30 standard strength concrete used because Indian structure are generally used those standard grade concrete.

CONCRETE MIX DESIGN

Concrete mix design is prepared as per IS 10262-2019 and IS 456-2000 for the target strength respectively.

Table 2 Mix Proportions of M30 Concrete grade

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Content	Cement	FA	CA	w/c
Ratio	1	2	2.5	0.45

REINFORCEMENT DETAILS:-

1) Main steel - 2#12 at bottom
2) Top steel - 2#10 at top
3) Stirrups - 8T @ 125mm

TESTING

The compressive strength test of cube and beam are conducted respectively, the compressive strength in Compressive testing machine accordance with IS 516:1959 with rate of loading is 1.37 kN/min.the flexural strength testing according IS 516:1959 with centrally point loaded carried on Universal testing machine before wrapping & after wrapping.

WRAPPING PROCESS

1) Preparation of specimen surface:-
Surface of beam should be clean & smooth for proper application of FRP sheet.
2) Preparation of chemical:-
Resin & Hardner is mix together in proportion of 1:2.
3) Wrapping Process:-
Cut sheets in required sizes. Apply resin coat on beam with the help of brush then apply sheet & compress with the help of roller. Then keep beam specimen for drying 2 to 5 days.

IV. RESULTS AND DISCUSSION

A. Compressive strength of mix

Cube specimens were casted for *M30* and tested for 7 and 28 days on a compression testing machine for the purpose of determining compressive strength of concrete element.

Table 3 compressive strength at 7 days and 28 days of M30 concrete mix

Compressive strength (Mpa)	
7 Days	28 Days
27.11	37.78
28.89	38.67
28.00	39.56
28.00	38.67

B. BEFORE AND AFTER WRAPPING RC BEAM: FLEXURAL STRENGTH STUDIES

The flexural strength of M30 grades RC beams and this test is done on the 28 days in elasto-plastic zone before wrapping & after wrapping they fail up to failure of RC beam.

Table 4 Flexural strength of RC beam

Type of wrapping	Load carried	Load carried up to failure	Deflection	% increase in flexural strength	Average % increase
U1	82.380	101.790	7.7 mm	23.56	33.02
U2	96.900	123.647	7.38 mm	27.60	
U3	91.080	134.724	8.88 mm	47.92	
V1	70.67	124.548	8.83 mm	76.24	44.16
V2	93.804	118.644	7.61 mm	26.48	
V3	84.588	109.764	7.87 mm	29.76	
H1	61.824	95.436	6.54 mm	54.36	36.78
H2	70.764	88.692	6.63 mm	25.34	
H3	95.100	124.248	7.73 mm	30.65	

	Load carried up to failure	Deflection
CB1	114.02	7.13 mm
CB2	100.176	6.76 mm
CB3	104.280	7.82 mm

Note: U= U-wrap, V= Vertical Grain Wrapping, H= Horizontal Grain Wrapping, CB= Control Beam

DISCUSSION OF FLEXURAL STRENGTH

The flexural strength is increased for different types of wrapping like for U-wrap 33.02%, for Vertical grain wrap 44.16% & for Horizontal grain wrap 36.78%. External wrapping holds the beam & avoid increase in crack formation which in crease life of structure. Here we applied sheet below neutral axis which is cost effective.

Fig 1:Vertical Grain Wrapped Beam

Fig 2:U- Wrapped Beam

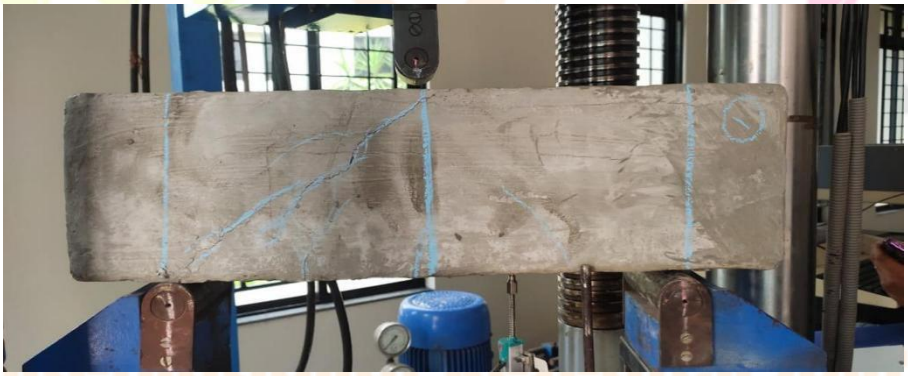

Fig3: Control Beam

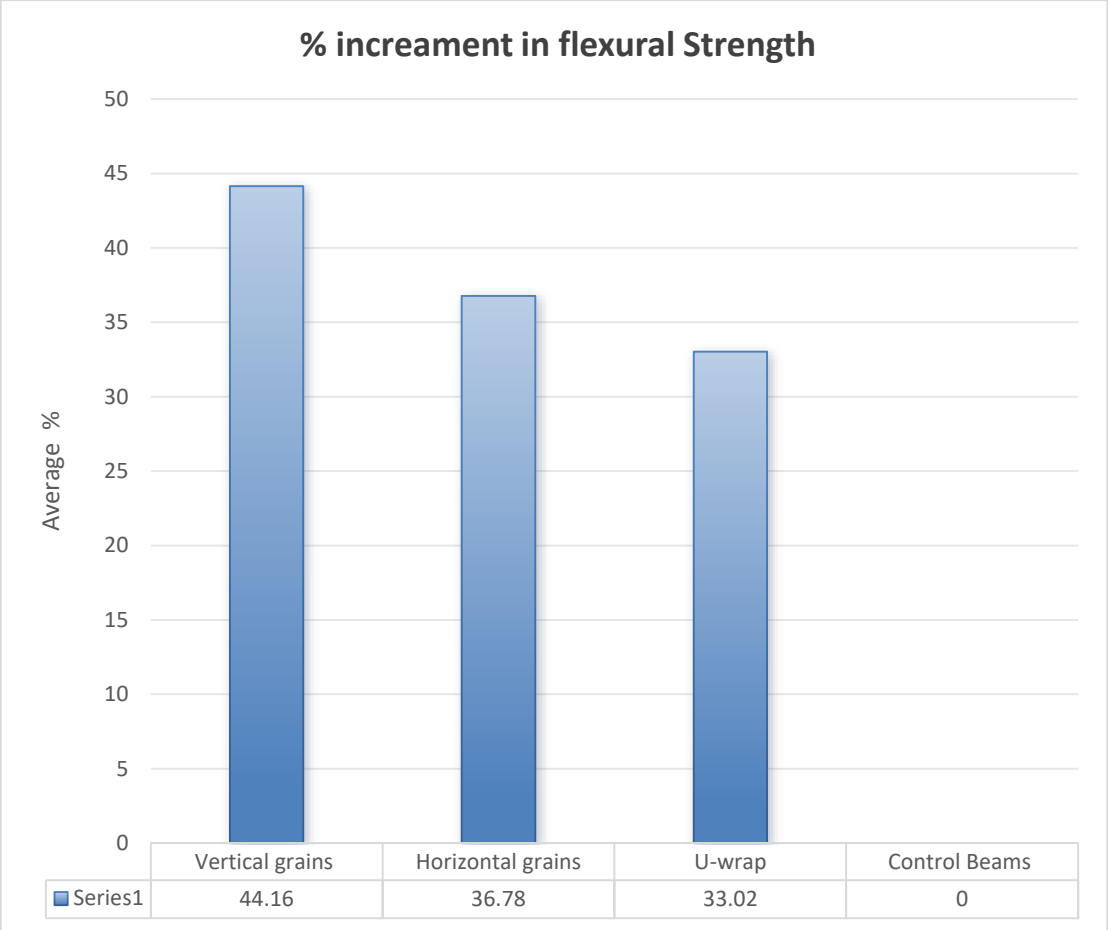

Fig 4. Average % increase in strength by different type of wrapping

Here we can say vertical grains wrapping can increase more strength than horizontal grain wrapping & U- wrapping. V- wrapping is more suitable than other type of wrapping.

V.CONCLUSIONS

The Final Conclusion are summarized as per objectives they explained below:

1) Initial flexural cracks appear at a higher load by strengthening the beam.
2) The ultimate load carrying capacity of the strengthened beam is 18.15% more than controlled beam.
3) The flexural strength increase averagely for vertical grains wrap is 44.16%, horizontal grains is 36.78% & U-wrap is 33.02%.
4) By strengthening up to the neutral axis of the beam, increase in the ultimate load carrying capacity of the beam is not significant and cost involvement is almost three times compared to the beam strengthen by GFRP sheet at the bottom only.
5) Use of FRP sheet improves load carrying capacity; delays crack formation and energy absorption capability of beam reinforced with FRP sheet.
6) The deflection of beam is comparatively very low with high load carrying capacity.

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