INVESTIGATION OF FRC BEAM REINFORCED WITH GFRP REBAR UNDER FLEXURE AND COMPARING WITH CONVENTIONAL BEAM

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ABSTRACT : This study compares the flexural behaviour of a fiber-reinforced concrete beam reinforced with GFRP rebar to that of steel reinforcement beams in an experimental investigation. Fibre-reinforced concrete was used to manufacture three beams, and GFRP rebar was used for longitudinal reinforcement. Additionally, three beams were cast using regular concrete and steel bar. Beams in six different numbers were cast and put through a two-point load test. Cube, cylinder, beam, and prism were also cast, and their compressive, split-tensile, and flexural strengths were evaluated. Glass fibres were used to increase the concrete's tensile strength. Calculations of load carrying capacity and stiffness were made through tests of beam load vs. deflection. Normal steel has an average load carrying capability of 99.2kN, while GFRP rebar has a load carrying capacity of 125.2kN. The GFRP rebar and normal steel reinforcement beam exhibit the largest deflections at their ultimate loads, measuring 21.5 mm and 16.87 mm, respectively. The GFRP beam was also discovered to return its original location.

Index Terms: Deflection, GFRP, Load Carrying Capacity, GFRC, Stiffness.

I. INTRODUCTION

1.1 GENERAL

Fibrous material is used in a type of concrete known as fibre reinforced concrete (FRC) to boost structural strength. It is made up of solitary, brief fibres that are consistently distributed and randomly orientated. Glass is one of the fibres. Steel, synthetic, and natural fibres are a few types of fibres. These include different fibres, concretes, materials, distributions, orientations, morphologies, and other elements that have an impact on how fibre reinforced concrete functions. Densities Concrete fibres are widely used to stop shrinkage in plastic, drying cracking, and shrinkage-related cracking. Concrete can be made more impact, abrasion, and shatter resistant by adding certain fibres.

3.1 COMPRESSIVE TEST RESULT:

Compressive strength is the maximum compressive stress that a solid material can withstand without cracking under a gradually applied force. In a compression test, compressive strength is estimated by dividing the greatest load by the original cross section area of the specimen. Table 5.1shows the results of the cube test.

FIG 3.1: Compressive strength testing of Cube

TABLE:3.1 Test result of compressive strength of concrete

SL. NO	SPECIMEN	DIMENSIONS (mm)	INITIAL LOAD (kN)	FINAL LOAD (kN)	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	GFRC-1	150x150x150	321	723	32	34.5
2	GFRC-2	150x150x150	340	812	36	
3	GFRC-3	150x150x150	505	802	35.6	
4	CC-1	150x150x150	130	459	20.4	21.9
5	CC-2	150x150x150	250	525	23.3	
6	CC-3	150x150x150	183	494	22	

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Area}}$$

3.2 SPLIT TENSILE TEST RESULT:

Concrete's tensile strength cannot be measured directly. The splitting tensile strength test on a concrete cylinder is a technique for determining concrete tensile strength. When concrete is subjected to tensile stresses, it cracks. As a result, the tensile strength of concrete must be determined in order to establish the load at which the concrete members may crack. Table 5.2shows the results of the cylinder test.

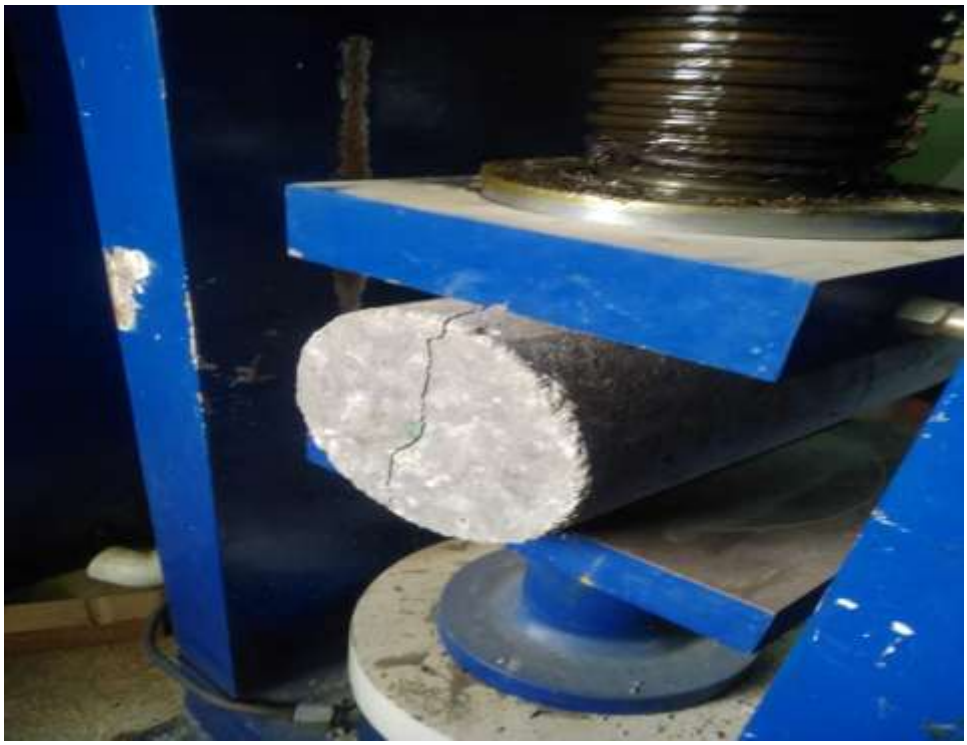

FIG 3.2: Split Tensile Test of Cylinder

TABLE 3.2: Test result of split tensile strength of concrete

S.NO	SPECIMEN	DIMENSIONS (mm)	FINAL LOAD (kN)	SPLIT TENSILE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1.	GFRC-1	150x300	190	2.68	2.67
2.	GFRC-2	150x300	185	2.61	
3.	GFRC-3	150x300	195	2.71	
4.	CC-1	150x300	150	2.12	2.24
5.	CC-2	150x300	170	2.40	
6.	CC-3	150x300	155	2.19	

Split tensitle strength=$\frac{2P}{\pi LD}$

3.3 FLEXURAL STRENGTH TEST RESULT:

The stress in a material right before it gives in a flexure test is defined as flexural strength, also known as modulus of rupture, bend strength, or transverse rupture. We can obtain modulus of elasticity from the stress strain curve obtained from the test. The below table 5.3 shows the results of the prism test.

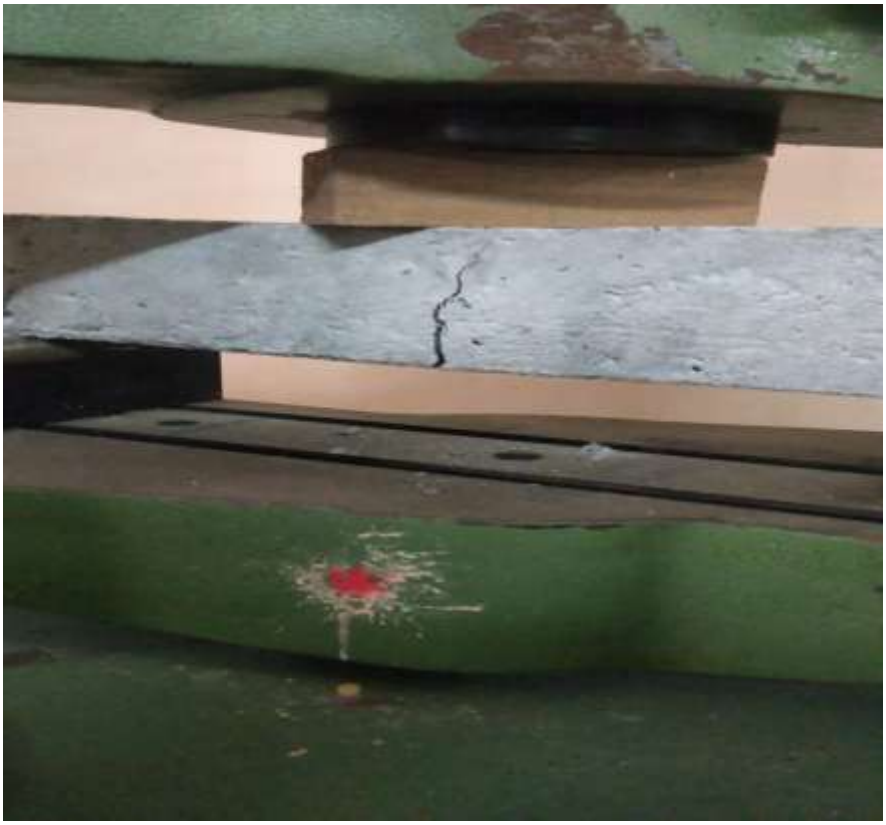

FIG 3.3: Flexural Strength Test of Prism

TABLE 3.3: Test result of flexural strength of concrete

SL.NO	SPECIMEN	DIMENSIONS (mm)	FINAL LOAD (KN)	FLEXURAL STRENGTH (N/mm^2)
1	GFRC-1	500x100x100	13.6	12.7
2	GFRC-2	500x100x100	12.6	
3	GFRC-3	500x100x100	12	
4	CC-1	500x100x100	9.50	9.1
5	CC-2	500x100x100	11	
6	CC-3	500x100x100	7	

3.4 LOAD CARRYING CAPACITY:

A beam is a structural element that resists loads that are applied laterally to the axis of the beam. Its primary mode of deflection is bending.

TABLE 3.4: Test result of Load carrying Capacity

SL.NO	SPECIMEN	INITIAL CRACK LOAD	ULTIMATE LOAD (kN)

		(kN)	
1	GFRC-1	39	159
2	GFRC-2	31	112
3	GFRC-3	34	103
4	CC-1	21.2	76
5	CC-2	20.5	93
6	CC-3	30.7	81

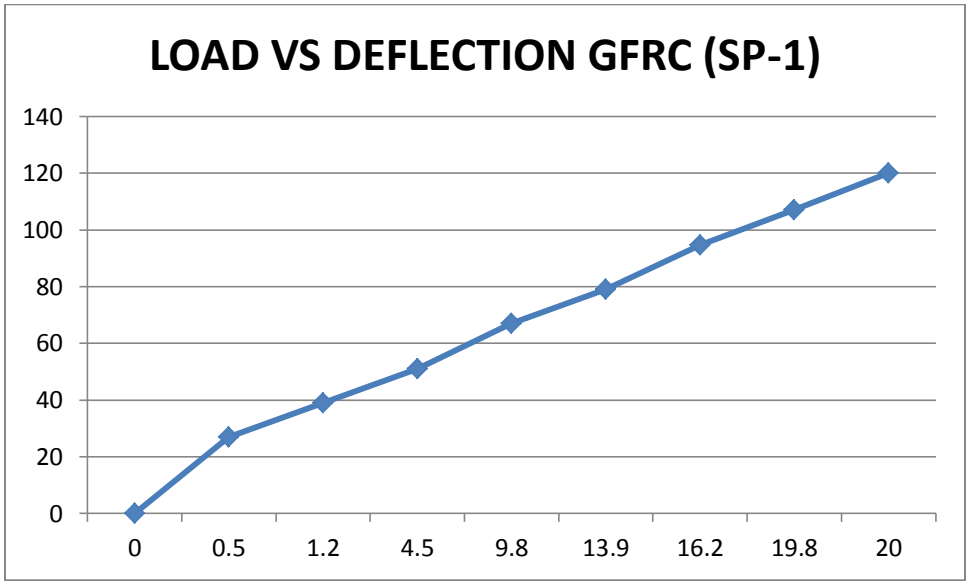

Fig 3.6: Load Vs Deflection GFRC - 1

- FOR SPECIMEN 2

TABLE 3.6 Various Deflection of GFRC-2

SL.NO	LOAD(KN)	DEFLECTION 1	DEFLECTION 2	DEFLECTION 3
1	0	0	0	0
2	10	0.1	0.1	0.1
3	20	0.3	0.5	0.3
4	30	0.9	1.1	0.8
5	41	1.0	1.8	0.9
6	50	4.6	5.0	4.4
7	61	7.9	8.4	7.5

8	70	11.3	12.3	10.2
9	81	13.6	15.2	14.8
10	91	18.9	19.4	18.6
11	102	19.9	20.2	19.8
12	112	20.1	21.3	20.3

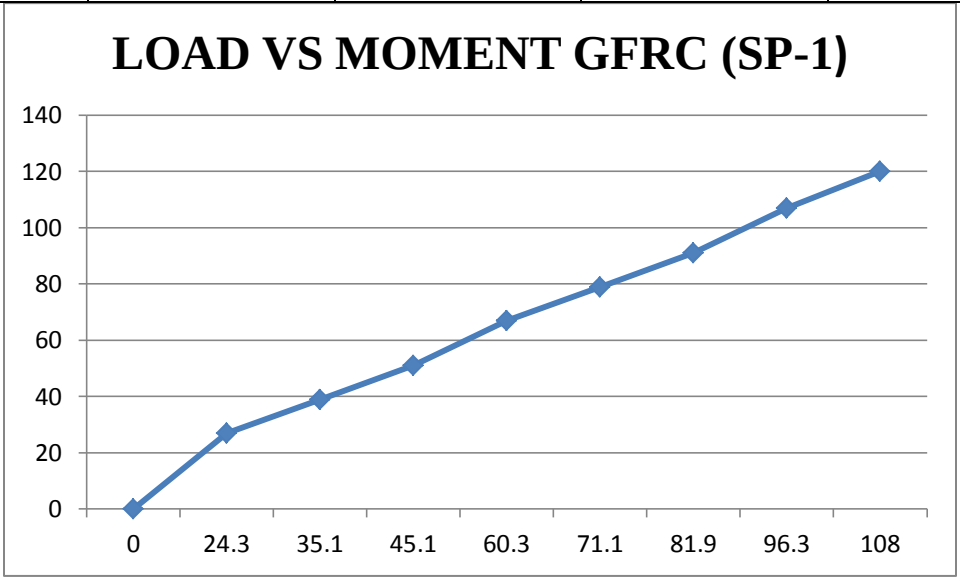

Fig 3.12: Load Vs Moment GFRC- 1

IV. CONCLUSION

Based on the experimental investigation conducted on beams under two point loading. The following conclusions are drawn:

- Glass Fibre Reinforced Concrete Beams have more compressive, tensile and flexural strength compare to normal concrete beam.
- The compressive strength of Glass Fibre Reinforced Concrete cube specimen is 14% greater than normalconcrete cube specimen.
- The split tensile strength for Glass Fibre Reinforced Concrete cylinder specimen is 0.5% greater than normal concrete cylinder specimen.
- The flexural strength for Glass Fibre Reinforced Concrete prism specimen is 4%greater than normal concrete prism specimen.
- Under loading conditions by adding Glass fibre to concrete minimize the cracks. The addition of Glass fibre to concrete can improve better brittleness.

- Load carrying capacity of Glass Fibre Reinforced Concrete Beam is 26% greater than the normal concrete beam.
- The highest deflection found in the Glass Fibre Reinforced Polymer rebar and standard steel reinforcement beam at their ultimate load is 21.5mm& 16.87mm respectively.
- Stiffness of Glass Fibre Reinforced Concrete Beam is 0.29% greater than conventional concrete beam.

V. REFERENCES

1. IS code 456: 2000 "plan and reinforced concrete".
2. IS code 10262-2019 "concrete mix proportion".
3. IS 383-1970 "Specifications of coarse aggregates and fine aggregates".
4. "Effect of Strengthening Schemes on Performance of Rc Beams Retrofitted With GFRP CFRP And Ultra High Strength Concrete"- **MEIKANDAAN, T P**
5. "New Suggestion of Effective Moment of Inertia for Beams Reinforced with the Deformed GFRP Rebar"- **Minkwan Ju**
6. "Structural performance of hyfrc beam reinforced with gfrp rebar under flexure**"- D Radhakrishnan**
7. "GFRP strengthening of rc continuous beams"-**Mihir Ranjan das**
8. "Failure Modes for I-Section GFRP Beams"-**Mamadou**
9. "Flexural behavior of SIFCON beams under three point loading**", V.S.Satheesh, S. Soundarya, S. Suresh Babu**
10. "Progressive Damage of GFRP Composite Plate under Ballistic Impact: Experimental and Numerical Study" – **M D Muslim Ansari**
11. "Rehabilitation of Reinforced Concrete beams by using Micro-cement and Glass Fiber Reinforced Polymer (GFRP)" – **K Mohandas**
12. "Comparative Study of GFRP Rebar and Steel Rebar used in Concrete Sections" – **Vipin George**
13. "An experimental study on the behaviour of GFRP pultruded I beam reinforced with CFRP laminates" – **G Ganesan**
14. "A Review on behavior of rcc beam exposed at elevated temperature" – **anita jessie**
15. "Behaviour of reinforced concrete beams strengthened with Glass Fibre Reinforced Polymer laminates subjected to corrosion damage" – **Patel Hemanth Kumar**
16. "Behaviour of reinforced concrete rectangular columns strengthened using GFRP"- **R Kumutha**
17. "Flexural Studies on Reinforced Concrete Beams with Glass Fiber Reinforced Polymer" – **R Anuradha**
18. "Flexural Behavior of Concrete Beam Reinforced with GFRP Bars Compared to Concrete Beam Reinforced with Conventional Steel Reinforcements" -**Sayan Sirimontree**
19. "Structural Performance of GFRP Bars Based High-Strength RC Columns: An Application of Advanced Decision-Making Mechanism for Experimental Profile Data" – **Muhammed Kashif**
20. "Behaviour of concrete beams reinforced with glass fibre reinforced polymer flats" – **G Jyothi Kumari**
21. "RETROFITTING OF REINFORCED CONCRETE BEAMS WITH GLASS fibre reinforced composite" – **Prashant Kumar**
22. "Comparison of RC Beam-Column Joint with GFRC Beam-Column Joint using Software ANSYS" – **Monisha**
23. "Influence of Longitudinal GFRP Reinforcement Ratio on Shear Capacity of Concrete Beams without Stirrups" – **Monika Kaszubska**
24. "Experimental Study on GFRC Beam Reinforced With GFRP Rebar Under Flexure" – **Yuvasankar**
25. "Experimental Study on GFRC Beam Reinforced With GFRP Rebar Under Flexure"- **Mahendra Kumawat**
26. "Study on flexural behaviour of rcc beam with minimum shear reinforcement and replacing different fibers"- **Manjusha M**

27. "Study on glass fiber reinforced concrete beams at different percentages"- **M Praveen Kumar**
28. "Behavior of concrete beams reinforced with gfrp bars"- **Kalpana V G**
29. "Design of flexural members reinforced with gfrp bars"- **Abinash Kumar Sethi**