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Experimental study on behaviour of reinforced concrete beam reinforced with BRFP Rebar

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ABSTRACT

FRP m is the material type that is increasingly used in the construction field in recent years. Due to their properties lightweight, high tensile strength and corrosion resistance and easy to implementation make these material preferred solutions for increased the strength of reinforced concrete structural elements. This paper presents the test results of an experimental study carried out on the chain of simply supported beams under flexure and torsion, concrete beam reinforced with BFRP bars compared to the concrete beam reinforced with steel bars. The tested beams were cast of concrete and BFRP bar having 10 mm diameter. Tensile strength Obtained from a tensile test. Deflection of beams, cracking, and torsional behavior has been analyzed and presented. The result shows that various characteristics of the load-deflection relationship of BFRP beams with the conventional beam.

Keywords*— BFRP bar, Conventional bar, Flexure, Torsion, Tensile strength*

1. INTRODUCTION

Basalt bars are made by using basalt fibers and a resin epoxy binder. They are corrosion resistance, have a tensile strength three times that of the steel bar normally used in building construction. FRP materials are anisotropic and are characterized by high tensile strength with no yielding only in the direction of reinforcing fiber. Weight is one-third of the weight of steel and the thermal expansion coefficient is very close to that of concrete. The reinforced concrete structures suffering from corrosion of reinforcing steel problem. Steel reinforcement corrodes rapidly under aggressive conditions such as industrial, marine environments. Other materials, such as fiber reinforced polymers, have emerged as an alternative to steel reinforcement when the exposure situation of RC member requires durability under aggressive conditions. The high mechanical performance/price ratio of basalt fiber composite bar, combined with corrosion resistance to alkaline attack, are further reasons for replacing steel in concrete with basalt fiber composite bars.

Modulus of elasticity of basalt fiber is very high and basalt is excellent heat resistance, the fibers made of it has the significant capability of heat and acoustic resistance. Junker's technology is used for formation of basalt fiber by melting the basalt rock and then forming fibers out of it. In addition to good mechanical properties, basalt has a high chemical and thermal stability, good thermal, insulating, electrical and sound properties Basalt thermal insulation is three times greater than the asbestos' one. Due to Good insulating properties, basalt is successfully used for fire protection. Furthermore, basalt fibers have 10 times better electrical characteristics - insulating than glass fibers. Basalt fibers are also significantly better chemically resistant than glass fibers, particularly in a strongly alkaline environment.

The objective of this research was to clarify the effect of basalt flexural reinforcement on ductility, deformability, ultimate stresses and damage mechanisms of structures reinforced with BFRP compared to traditional structures, reinforced with Steel bars.

This study investigates the torsional behavior of the BFRP bar compared with conventional bar. Also, the tensile strength of the bar calculated.

2. EXPERIMENTAL PROGRAM

2.1 Raw materials

i. Cementitious Material

Cementitious material used was ordinary Portland cement of 53 grades conforming to the specification of IS 12269:1987. The fineness of the given sample of cement is found to be 2.24%. Also, specific gravity was 3.15.

ii. Aggregates

Locally available crush granite having specific gravity 2.81 also the aggregate crushing value of the given sample of the aggregate was found to be 8.975%. as Flakiness index of the sample was 6.26%, therefore value was within the limit. While the local crush sand having specific gravity was 2.61 and the percentage silt content of the sand to the nearest whole number IS 8%

iii. Water

In the experiment potable water was used. The requirements of IS 456:2000 was confirmed the test results.

iv. Reinforcement bars

The BFRP ripped bars of 10mm diameter was used. The tensile stresses of BFRP bars were determined as the average tensile strength of the BFRP bar specimen of diameter 10mm was found to be 568MPa.and the steel bar of 10mm diameter having average tensile strength was found to be 548MPa.

2.2 Test specimens

Eighteen BFRP reinforced concrete Beam of size 700mm x 150mm having an effective depth of 150mm. two 10mm BFRP bar was used as top and bottom reinforcement having 6mm steel are used to hold the rebar .also same no conventional beam are used with two steel bar used as top and bottom reinforcement with 6mm stirrups. A reinforced concrete element with a compressive strength of 30MPa

Fig 1: Basalt fiber reinforced polymer bar

Table 1: Details of test beams

Reinforcement bar	Dimensions (mm)	fcu (MPa)		Bottom reinforcement	Top reinforcement	Stirrups (steel)
		Target	Actual			
BFRP	150x150x700	30	28	2Nos -10mm	2Nos -10mm	6mm@ 90mm
STEEL	150x150x700	30	28	2Nos -10mm	2Nos -10mm	6mm@ 90mm

2.3 Test setups

The eighteen specimens were tested with Centre point bending with 700mm effective span. The sample was placed on two supporting pins a set distance apart. Load specimen continuously without shock. The load applied at a constant rate to the breaking point. The load applied at the rate of 0.9- 1.2 MPa/min. The specimens' cracks were mapped and the observations were recorded during the loading and at the time of failure. Remaining eighteen specimens were testing by torsional loading applied on the specimens. All the specimens are tested on a universal testing machine with a special arrangement for torsional testing. The load applied gradually for calculation of torsional strength.

Fig 2: Flexural test setup

3. RESULTS AND DISCUSSION

During the period of test, beams were visually observed until the development of the first crack and the corresponding load was recorded. The first cracking load was verified from the load-deflection and load- strain relationships.

Table 2: Flexural test results

Test specimen	Days	Sample No.	Load at first crack (KN)	Crushing load (KN)
150x150x700 Steel Reinforced	7 Days	1	58.18	74.54
		2	58.46	74.81
		3	57.68	73.12
	28 Days	1	91.45	106.98
		2	91.87	107.56
		3	89.38	105.89
150x150x700 2.3 BFRP Reinforced	7 Days	1	40.58	66.96
		2	38.04	61.07
		3	42.28	67.87
	28 Days	1	53.03	110.55
		2	47.52	100.78
		3	56.87	112.43

3.1 Cracks pattern

Fig. 3: Cracks development in Flexure (BFRP)

The cracks patterns are depicted in figure 3 the first crack were vertical flexural cracks in the area of tension one at load about 58KN for 7 days steel reinforced beam but the flexural crack in BFRP reinforced beam were developed at load about 40 KN. The first crack spreads towards compression zone. But at higher loading value the rate formation of cracks significantly decreases. Also, the width of crack developed is more in BFRP reinforced beam. But the crushing load carrying capacity is greater in BFRP reinforced beam compared to the conventional beam. While in case of torsional loading the cracks patterns are as shown in figure 3 in this case the cracks developed from the edge of the beam specimen. For 7 days BFRP beam the initial cracks developed at 20KN load.

3.2 Load Deflection Behaviour

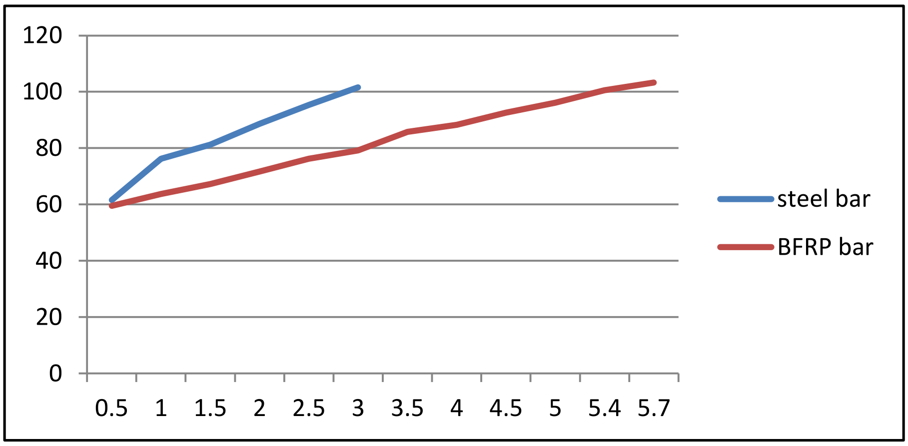

Fig. 4: Load deflection at 28 days

In beam with basalt reinforce the deflection is double than the conventional reinforced beam. The deflection beam increases with an increase in load is constant so that deformation of BFRP bar is linear.

3.3 Tensile Behaviour

The purpose of the primary scrutiny was to determine the tensile strength BFRP bars 10 mm in diameter and comparing the strength of the reinforcing steel bars. It should be noted that the average strength of the BFRP 10mm bars is more than a steel bar.

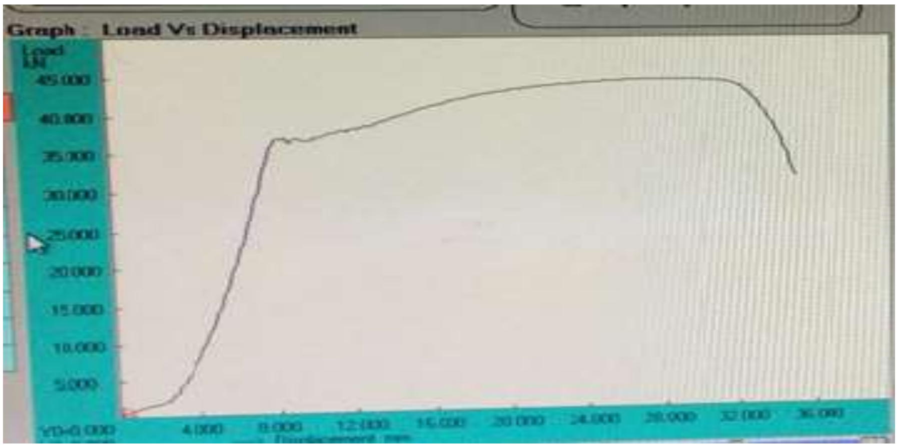

Fig. 5: The load-displacement curve of BFRP bar

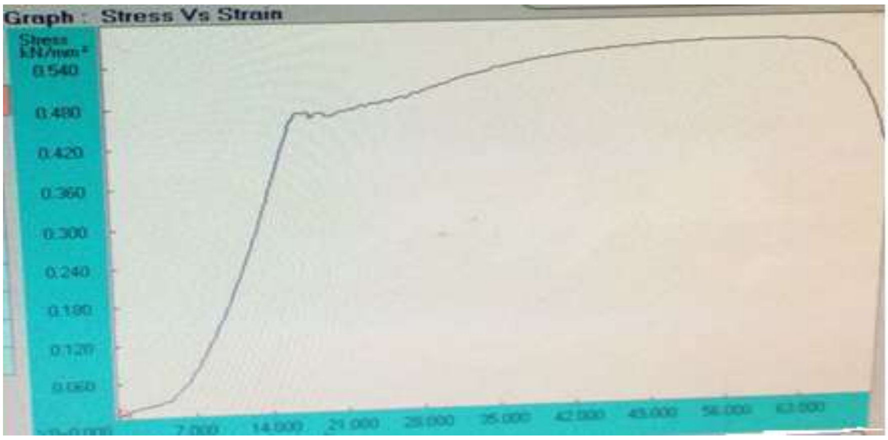

Fig. 6: Stress-strain curve of BFRP bar

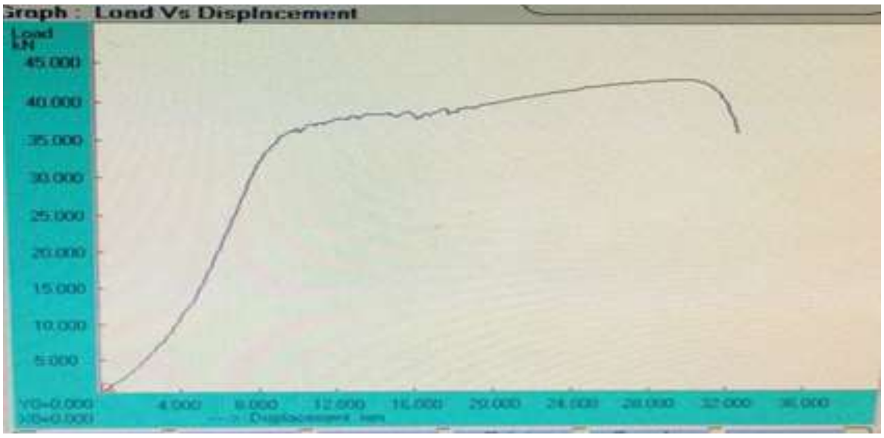

Fig. 7: The load-displacement curve of steel bar

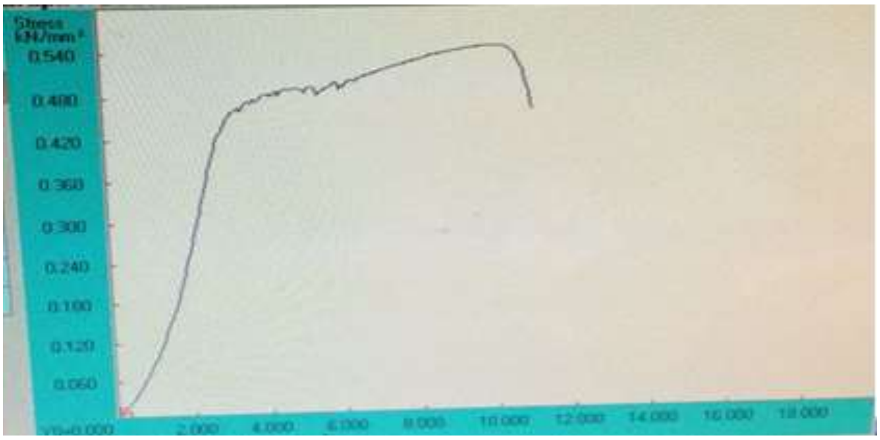

Fig. 8: Stress-strain curve of steel bar

4. CONCLUSION

- The BFRP bar exhibits reasonable mechanical properties compared with the conventional beam.
- As steel bar has a high modulus of elasticity compared to BFRP bar due to that the deflection of BFRP reinforced beam is higher than the conventional beam.
- The crushing load of BFRP reinforced concrete beam is 10 % greater than the carrying capacity of beams with steel reinforcement.
- A crack developed on the BFRP beam section is higher as compared to the steel beam section average width is 2-3 times greater than the conventional beam.
- Deflection is higher (double) in BFRP specimen than Conventional beam due to lower modulus of BFRP than steel.

5. ACKNOWLEDGMENT

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