

Strengthening of Reinforced Concrete Beam Using Glass Fiber Mix and GFRP Sheet

Nibin.M, Prof.A.Kumar

P.G Student, Department of Civil Engineering, JCT College of Engineering and Technology, Pichanur,
Coimbatore, India

Head of Department, Department of Civil Engineering, JCT College of Engineering and Technology, Pichanur,
Coimbatore, India

ABSTRACT: Concrete is a composite material which is weak in tension and is often affected by cracking and scaling which are connected to plastic and hardened states and drying shrinkage. Worldwide a great deal of research is currently being conducted concerning the use of fiber laminates and sheets in the repair and strengthening of reinforced concrete members. Fiber-reinforced polymer (FRP) application is very effective way to repair and strengthen structures that have become structurally weak over their life span. FRP repair systems provide an economically viable alternative to traditional repair system and materials. In this paper Experimental investigations done on the behavior of the concrete strengthened using discontinuous chopped glass fiber are carried out with concrete mix (GF MIX) of two different length of glass fiber (6mm and 12mm) at various percentage (0.25%, 0.50%,0.75%) amount of addition by the total weight of concrete. Experimental data on load for compression, tensile and flexural tests have been carried out, strength variations and failure modes of each specimen were obtained. The purpose of this project to investigate the flexural and shear behaviour of reinforced concrete beam strengthened with configuration wrapping of GFRP sheets. Initially beams were tested of which one is controlled beam and other two beams were strengthened using continuous GF MIX Beams and GF MIX with GFRP sheets in flexure.

KEYWORDS: Compressive Strength Split Tensile Strength, Flexural Strength, Glass Fiber Mix, Optimum Value, Stiffness And Strength.

I. INTRODUCTION

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibers and other admixtures in concrete up to certain proportions .Many studies have shown that the mechanical properties of concrete can increase dramatically (by more than an order of magnitude) with the addition of fibers individually. This chapter deals with the details regarding the review of literature on studies pertaining to mechanical properties of glass fiber reinforced concrete

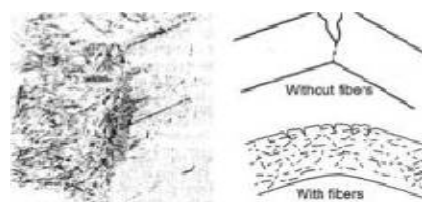


Fig 1: Effects of fiber

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

II. LITERATURE SURVEY

Presently many experimental investigations are having been carried out with the addition of glass fibers of various type, composition and thickness. The testing involves the compressive, split tensile and flexural strength tests. It has been analyzed that the glass fiber addition to the concrete has the ability to improve the compressive strength at its 0.5% fiber addition, but the split tensile and flexural strength has achieved the maximum strength at its 1% of addition. , Since we know that the glass fiber has good water absorption capacity .The significant increase in the flexural strength between 1% to 1.23% can be achieved by bonding GFRP sheets to the tension face of the RC beams. The significant increase in the shear strength up to 50% can be achieved by bonding GFRP sheets to the sides of the RC beams

III. MATERIALS

Cement: Ordinary Portland cement 53 grade was used for the experimental programme. It was tested for its physical properties in accordance with IS standards.

Fine Aggregates: The fine aggregates used for experimental programme was obtained from bed of river. The fine aggregates used passed through 4.75mm sieve and had a specific gravity of 2.68.The fine aggregates belonged to Zone II according to IS 383.

Coarse Aggregates: The coarse aggregates used were non-reactive and as per the requirements to produce a good and durable concrete .The coarse aggregates were of two different grading and as such a definite mix proportion was used to obtain the desire grading for coarse aggregates. One grade has maximum size of 12.5mm and minimum 10mm and for the other the maximum size was 20mm and minimum 12.5mm.This combination was used for casting cubes, cylinders and prisms. This is done to avoid the bailing effect of concrete mix.

Water: Ordinary tap water which is safe and potable for drinking and washing was used for producing the concrete.

Glass Fibers: Glass fiber also known as fiberglass is made from extremely fine fibers of glass. It is a light weight, extremely strong and a robust material. Glass fibers, the most popular of the synthetics, are chemically inert, hydrophobic, and lightweight. They are produced as continuous cylindrical monofilaments that can be chopped to specified lengths or cut as films and tapes and formed into fine fibrils of rectangular cross section Used at a rate of at least 0.1 percent by volume of concrete, glass fibers reduce plastic shrinkage cracking and subsidence cracking over steel reinforcement. Here we are using 0.25, 0.5, and 0.75 % addition to the mix of concrete.

- ❖ **Type** – E- glass fiber
- ❖ **Length** – 6 & 12mm
- ❖ **Color** – White



Fig 2: glass fibers

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Glass fiber sheet:

The fiber sheet used in this experimental investigation was E – Glass, bi directional woven roving mat. It was not susceptible to atmospheric agents. It was also chemically resistive and anti corrosive

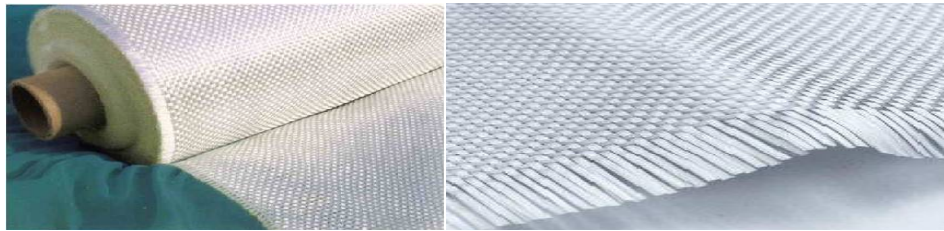


Fig.3 Glass fiber sheet

Concrete Mix: The Mix Design is as per IS code 10262:2009. Method of mix design is chosen to get mix ratio for M30 grade

Table 1. Mix Proportions

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER – CEMENT RATIO
1	1.676	2.85	0.45

IV. METHODOLOGY

In this study, a comparison has been made between plain concrete and high strength achieved by concrete using glass fiber of two lengths (6 & 12mm) for M30 grade of concrete. The test (compression test, split tensile test and flexural strength test) is to be done on the concrete with the addition of glass fibers of various percentages (0.25%, 0.50%, and 0.75%) to total weight of the concrete. Mix design of M30 concrete is to be designed as per IS 10262:2009.



Fig 4: Experimental pictures (compression, tension, flexural tests)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

EXPERIMENTAL AND TESTING (Beam Specimens)

All the beam specimens were tested in the loading frame. The testing procedure of the entire beam specimens was the same. After the curing period of 28 days was over, the beam as washed and its surface was cleaned off for the clear visibility of cracks. The most commonly used load arrangement for testing of beams will consist of two point loading. This has the advantage of a substantial region of nearly uniform moment coupled with very small shears, enabling the bending capacity of the central portion to be assessed. If the shear capacity of the number is to be assessed, the load will normally be concentrated at a suitable shorter distance from a support.

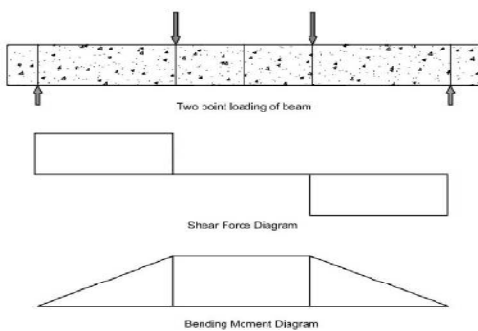


Fig.5 Typical two point loading reactions



Fig. 6 GFMIX Beam with GFRP SHEET



Fig. 7 Testing pictures

V. RESULTS AND DISCUSSION

The Tests on the concrete with and glass fibers showed considerable improvements in properties over the series of addition of fibers. Change of properties and behavior of blended concrete with fibers for 7, 14 and 28 days of curing are discussed in this chapter using the results obtained from the experimental program.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Fig.8 Graph on compression strength for cubes in N/mm²

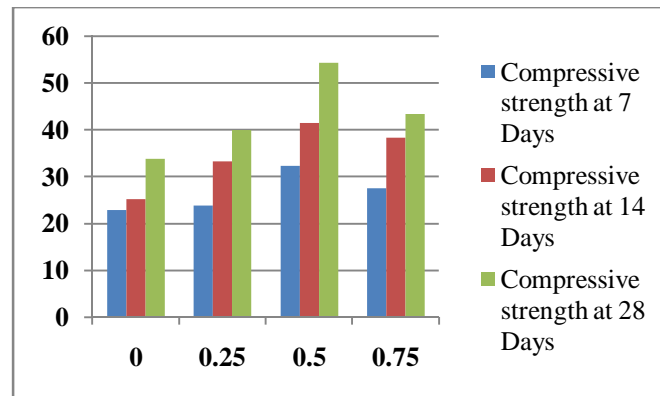


Fig.9 Graph on Split tensile strength for cylinders in N/mm²

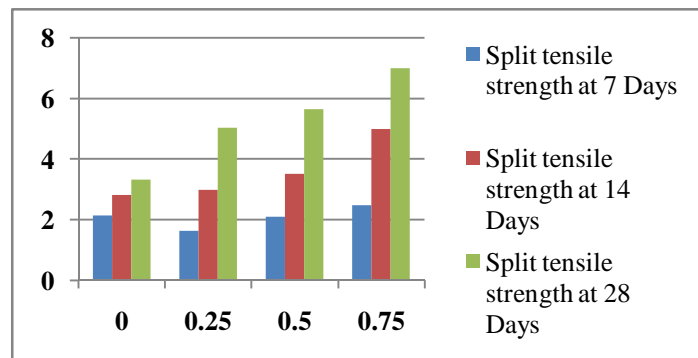
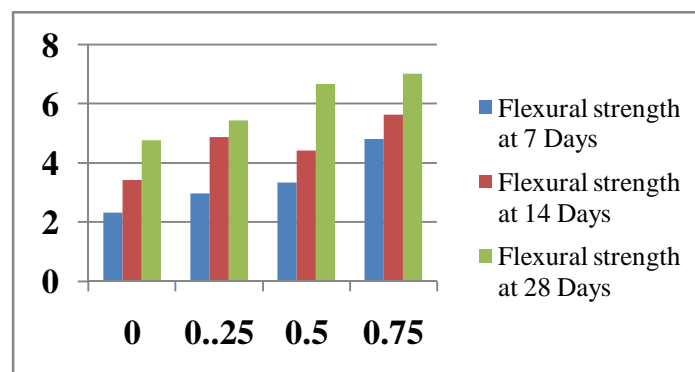


Fig.10 Graph on Flexural strength for prisms in N/mm²



Behavior study includes the 7, 14 and 28 day strength of concrete with maximum nominal size of aggregates 20mm. This days compressive, tensile and flexural strength was also plotted by taking the average of these three values overall an increase in the various strength was observed with addition of fibers. We can observe a quite gradual increase in strength as the percentages of fibers has been increased. The maximum optimum strength is at 0.5%. We can observe an initial decrease at 0.25% and gradual increase in strength as the percentages of fibers has been increased. The maximum optimum strength is at 0.75%. Whereas by using single fiber it gives max strength at 1%. Here we can observe a quite gradual increase in strength as the percentages of fibers has been increased. The maximum

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

optimum strength is at 0.75%. The maximum optimum strength is at 0.75%. Whereas by using single fiber addition it gives max strength at 1%.

Fig.11 Load and deflection for ordinary RCC Beam

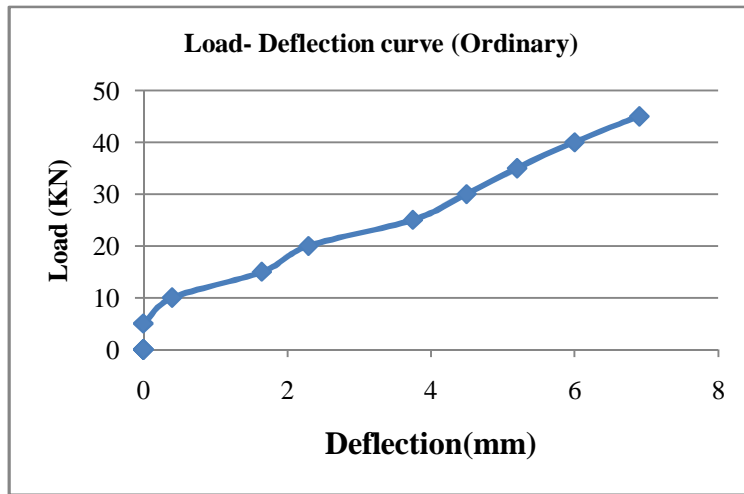
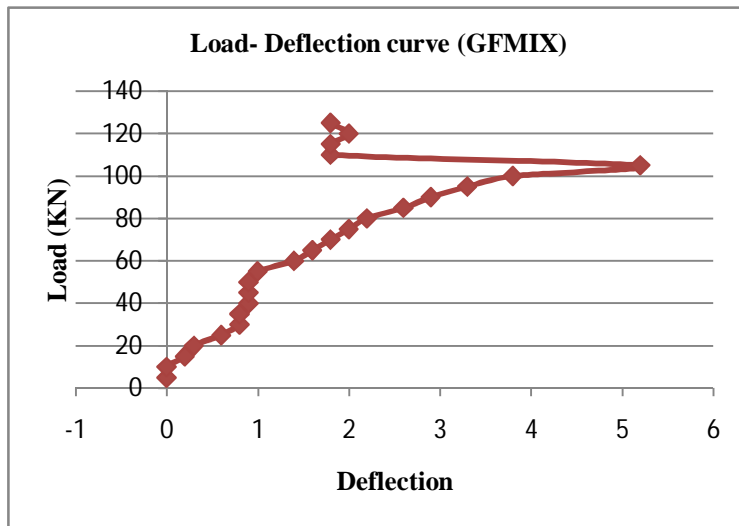


Fig .12 Graph on Load and deflection for GFMIX Beam



International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Fig. 13 Graph of Preloaded GFmix with GFRP Sheet

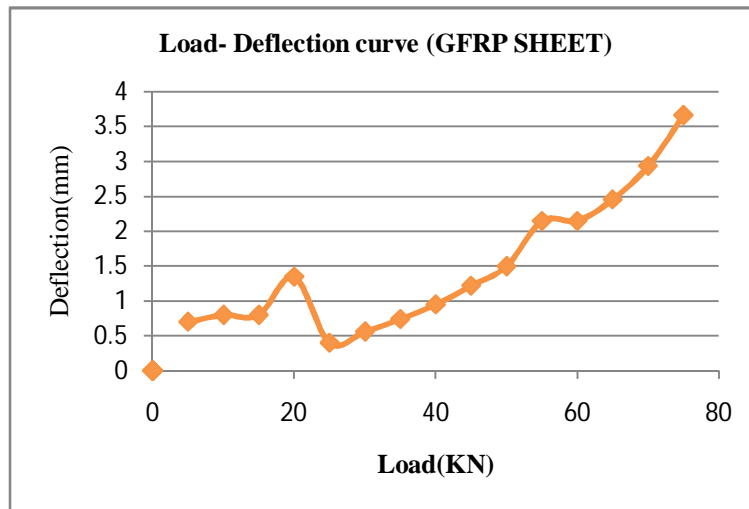


Table.2 Experimental Results for Various Beam Results

Sl.no	Load (KN)	Deflection of R,C.C Beam	Deflection of GF MIX Beam	Deflection of GF MIX Beam + GFRP SHEET
1	5	0	0	0.7
2	10	0.4	0.1	0.8
3	15	1.65	0.2	1.35
4	20	2.3	0.3	0.40
5	25	3.75	0.6	0.56
6	30	4.5	0.8	0.74

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

7	35	5.2	0.8	0.95
8	40	6	0.9	1.22
9	45	6.9	0.9	1.5
10	50	4.5	1	2.15

Figure .14 Load –Deflection curve (comparison of RCC Beam with GFMIX Beam)

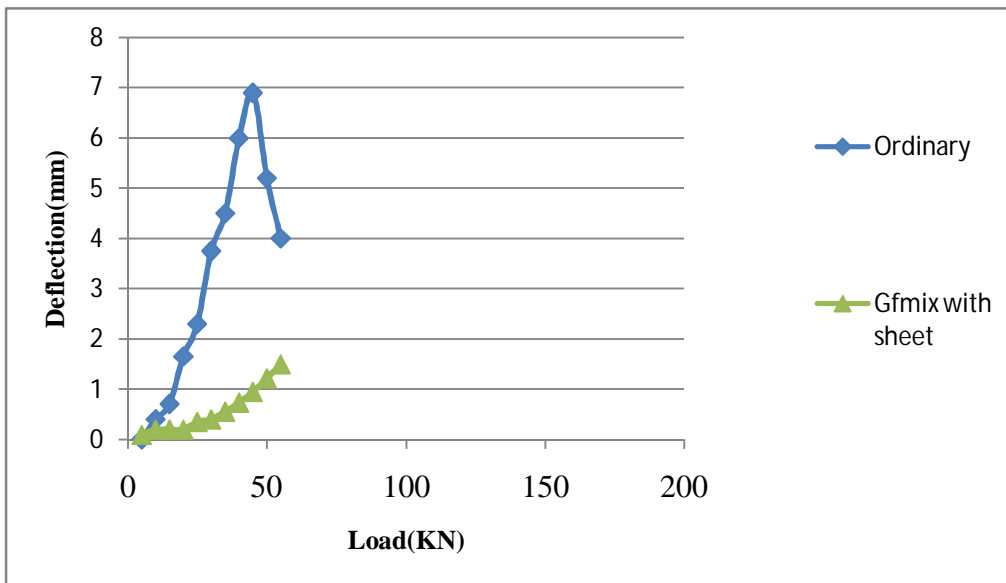
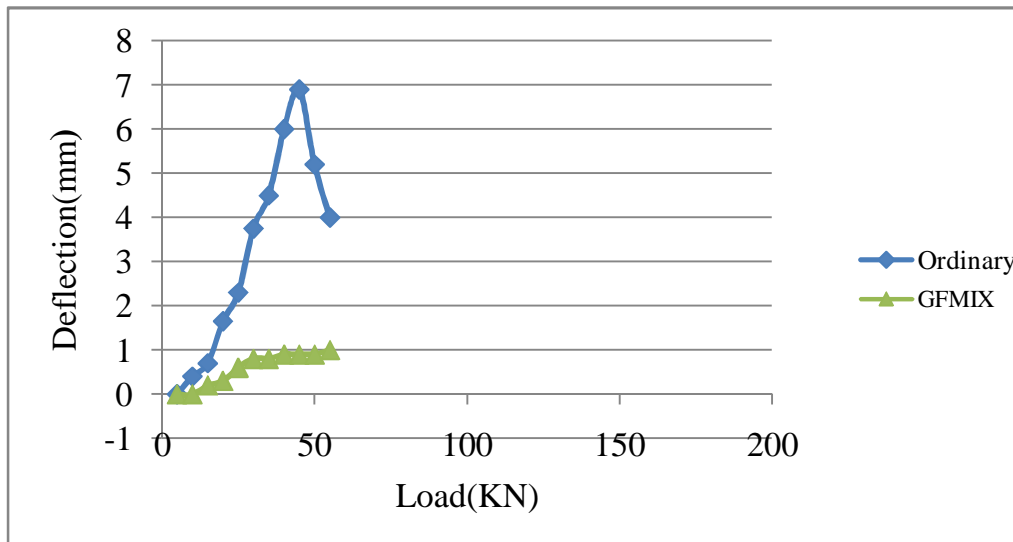


Figure .15 Load –Deflection curve (comparison of RCB with GFMIX with GFRP sheet)



VI. CONCLUSION

The following conclusions are made from the experimental study of addition of glass fibers of two lengths with same diameter and properties into the concrete mix. In this study of addition of combinational glass fibers greater strength and stiffness than the conventional concrete and also possesses good binding and strength to weight ratio.

- ❖ The compressive strength of concrete are increased with the addition of glass fibers to 0.50% by weight of concrete and further any addition of the glass fiber shows in decreases compressive strength (it is been evaluated by studying research paper and journals on this addition).
- ❖ Split tensile strength tends to improve for Material Concrete compared to plain concrete.
- ❖ Flexural strength shows tremendous increases from 0.5 to 0.75 % in Material Concrete compared to plain concrete. Whereas by using single fiber addition it gives max strength at 1%.
- ❖ Optimum combination of is 0 .75% is obtained as higher properties. With GFRP Sheet Strengthening.
- ❖ The overall performance of glass fiber concrete increased and durable strength compared to plain concrete.

REFERENCES

- [1] Kaushal Parikh and C.D.Modhera, "Application of GFRP on preloaded retrofitted beam for enhancement in flexural strength, International Journal of Civil and Structural Engineering", May-2012, pp 1070-80
- [2] Jiangfebg dong, Qingyuan wang, and Zhongwei Guan, "Structural behavior of RC beams with external flexural and flexural-shear strengthening by FRP sheets", Composites Part B,2013, pp 604-612
- [3] Rudy Djamaluddin, Mufti Amir Sultan, Rita Irmawati and Hino Shinichi, "Bond characteristics of GFRP sheets on strengthened concrete beams duo to flexural loading", International Journal of Engineering and Technology, April-2015, Vol. 7, pp 110-114
- [4] Anumol Raju and Liji Anna Mathew, "Retrofitting of RC beams using FRP", International Journal of Engineering Research and Technology, January-2013, Vol. 2, pp 1-5
- [5] M.A.A.Saafan, "Shear strengthening of reinforced concrete beams using GFRP wraps", Acta Polytechnica, 2010, Vol. 46, pp 24-32
- [6] E.Grande, M.Imbimbo and A.Rasulo, "Experimental response of RC beams strengthened in shear by FRP sheets", The Open Civil Engineering Journal, 2013, pp 127-135