Experimental Investigation on Mechanical Properties of Glass Fibre Reinforced Concrete

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Abstract— A concrete has strong in compression and weak in tension, impact and flexure. To increase these properties we have add some addition to concrete like fibres. Fibres are giving some additional tensile and impact strength to concrete. In this investigation we are adding fibres like Glass with a fibre dosage of 0.5%, 1%, 1.5% were dispersed into the concrete of mix design M30 grade. The results are compared with conventional concrete so that here increasing the fibre dosage in concrete randomly increasing compressive strength, tensile strength and flexure strength .so finally while using fibres in concrete we are going to transfer brittle failure to ductility property.

Key words: Fibre Reinforced Concrete, Glass, Compressive Strength, Split Tensile Strength, Flexural Strength

I. INTRODUCTION

Concrete is the most widely used construction material in this world. Generally concrete has low ductility, tensile and impact resistance on bridge decks, Aircrafts etc., hence glass fibres are added with concrete mix. Due to an increasing use of FRC (fibre-reinforced concrete) in construction like bridge decks and military industries against impact loads, these concretes are important role in human life. Adding fibres to concrete increases its ductility, tensile strength, flexural strength and resistance against dynamic and impact loads. Sai abhinav et al.[1] concluded that increasing the fibre dosage there is increase in impact resistance of fibre reinforced concrete. The aspect ratio (L/d) and volume fraction (Vf) are important fibres parameters in FRC [2]. When cracks are initiated in FRC, the fibres bear the applied loads, when the load increases the fibres tend to transmit the excess stresses to the matrix [3]. If these stresses exceed the fibre-matrix bond strength, which in turn is influenced by fibre properties the fracture process may lead to fibres pullout or rarely rupture of the fibres[4]. Thus, fibre reinforced concretes are more ductile than other concretes.

It was reported that glass fibes were effective in improving strength properties of the concrete. The main objective of this project is to study the mechanical properties of fibre reinforced concrete with mix proportion of fibres for M30 grade concrete and comparing with the conventional concrete and to know the optimum percentage of addition of fibres to concrete and finding maximum ratios[7].

II. EXPERIMENTAL STUDY

The experimental investigation was focused on the effect of various fibre dosages on mechanical properties of FRC. Mix proportion was designed using IS 10262-2009 and IS 456-2000 with mean target strength of 38.25 MPa (M30) for control mix[10].

Ordinary portland cement (type 1) was used in this study. A coarse aggregate with a maximum nominal size of 19 mm and a fine aggregate with a fineness modulus of 3.4 were used in the experiment. Glass fibres were used; their geometry and apparent shape are shown in Fig. 1 and their properties are listed in Table 1. Super plasticizer of SP-430 was used to adjust the workability of mixtures.

Fig. 1: Glass fibres

Fibre	Diameter (μm)	Specific Gravity	Modulus of Elasticity (GPa)
Glass	9-15	2.6	70-80

Table 1: Physical Properties of Glass fibres

Crushed granite stones of size 20 mm and 10 mm were used as coarse aggregate and river sand was used as fine aggregate. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm were 2.58 and 0.3% respectively. The bulk specific gravity in oven dry condition and water absorption of the sand were 2.62 and 1% respectively.

III. MIX DESIGN

In this study, water cement ratio of 0.5 was adopted for M30 grade concrete and Glass of 0.5%, 1%, 1.5% volume fractions were used[10].

Constituents	Content KG/ m^3 of concrete
Cement	394.32
Fine aggregate	623.45
Coarse aggregate	1097.81
Water content	197.16
Fibres	
0.5%	11.56
1%	23.12
1.5%	34.69
Super plasticizer	9.38

Table 2: Content of mix proportions used

IV. TEST METHOD

A. Details of specimen preparation

Cubes of size 150 mm were used to evaluate the compressive strength of GFRC. Cylinders of size 150 mm x 300 mm were used to determine the split tensile strength. Flexural strength of GFRC was evaluated using 100 mm x 100 mm x 500 mm beams. Steel moulds were used for casting the specimens. Concrete was poured in mould in 3 layers and each layer was vibrated for 15 s after placing it on the vibrating table for

proper compaction. Smooth surface was ensured by properly levelling the surface of the specimen. Specimens were removed from the moulds after 24 hrs of casting and immersed in clean water for 28 days. Specimens were prepared for fibre dosages of 0.50%, 1.00% and 1.50% of volume of concrete in addition to samples of control mix. Three specimens were prepared for each test and average value was obtained.

Fig. 2: Compressive Strength

Fig. 3: Split Tensile Strength

Fig. 4: Flexure Set Up

V. RESULTS AND DISCUSSION

A. Compressive Strength

Compressive strength is the capacity of material to with stand loads tending to reduce size. The compressive strength of concrete cube of size (15cmx15cmx15cm) for dosage of fibre 0.5%,1%,1.5% is given by following table 2 for the curing period of 28 days[5][6][9].

Fibre Dosage (%)	Compressive strength after 28 days	% Growth
PCC	40.62	-
0.50%	42.13	3.58
1.00%	43.71	7.07
1.50%	45.07	9.87

Table 3: Compressive strength of GFRC at 28 days curing

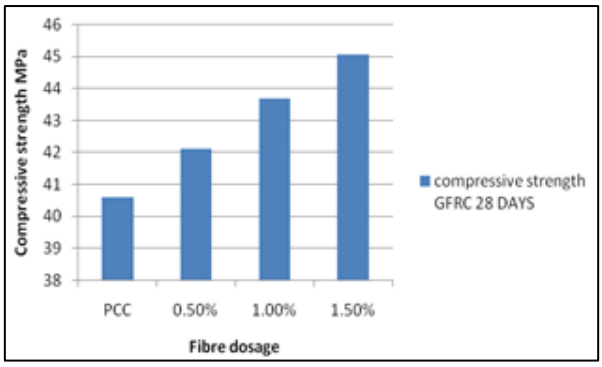

Fig. 5: Compressive strength of GFRC at 28 days curing

By observing the table readings we can say that, with the increase in dosage of fibre and with curing period of concrete the compressive strength of concrete cube gradually increases. The compressive strength of concrete starts increases at minimum percentage of dosage is 0.5%.Ihe percentage growth for all dosages are 3.58, 7.07 and 9.87.

B. Split Tensile Strength

Fibre Dosage (%)	Split tensile strength after 28 days	% Growth
PCC	3.13	-
0.50%	3.32	5.72
1.00%	3.58	12.57
1.50%	4.13	24.21

Table 4: Split tensile strength of GFRC at 28 days curing

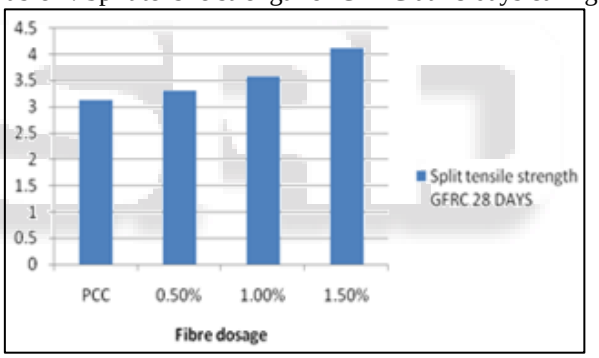

Fig. 6: Split tensile strength of GFRC at 28 days curing

From the table observation we can say that with increase of fibre dosage and curing period fibre reinforced concrete the split tensile strength of fibre reinforced concrete increased. The maximum split tensile strength of fibre reinforced concrete is 4.13 N/mm^{2}and is occurred at 1.5% dosage of fibre at a curing period of 28 days. There percentage growth for all dosages were 5.72, 12.57 and 24.21.

C. Flexural Strength

The nature of bending of fibre reinforced concrete is estimated by using flexural strength of fibre reinforced concrete. It calculates an unreinforced concrete beam or slab to resist failure occurred under bending [8].

Fibre dosage (%)	Flexural strength after 28 days	% Growth
PCC	4.19	-
0.50%	4.21	0.48
1.00%	4.36	3.90
1.50%	4.53	7.51

Table 5: Flexural strength of GFRC at 28 days curing

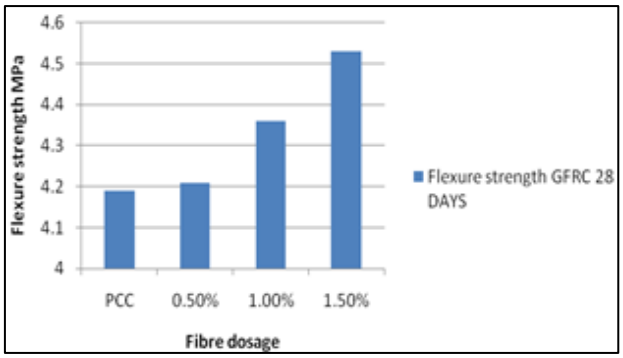

Fig. 7: Flexure strength of GFRC at 28 days curing

From the table observation we can say that with increase of fibre content and curing period of GFRC the flexural strength of GFRC increased slowly. The maximum Flexural strength of GFRC is 4.53N/mm2 and occurred at fibre dosage 1.5% and for a curing period of curing period of 28 days. There is rapid increase in percentage at dosage of 1.5% is 7.51

VI. CONCLUSIONS

Based on the results of this experimental investigation, the following conclusions can be drawn:

1) Glass fibers did not show influence great extent on improvement in compressive strength but while increasing in fibre dosage there is increasing strength.
2) Glass fibres are found to be effective in enhancing split tensile strength properties of concrete. Increase in fibre dosage resulted in increase of split tensile strength.
3) Flexural strength improved substantially with the addition of Glass fibres. Increase in fibre dosage showed increase in flexural strength of concrete.
4) Split tensile strength having more percentage growth when compared to Flexure strength and compressive strength

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