Glass Fiber Reinforced Concrete

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Abstract
plain concrete possess very low tensile strength, limited ductility and little resistance to cracking .Internal micro cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks. Fibres when added in certain percentage in the concrete improve the strain properties well as crack resistance, ductility, as flexure strength and toughness. Mainly the studies and research in fiber reinforced concrete has been devoted to steel fibers. In recent times, glass fibres have also become available, which are free from corrosion problem associated with steel fibres. The present paper outlines the experimental investigation conducts on the use of glass fibres with structural concrete. CEM-FILL anti crack, high dispersion, alkali resistance glass fibre of diameter 14 micron, having an aspect ratio 857 was employed in percentages , varying from 0.33 to1 percentage by weight in concrete and the properties of this FRC (fibre reinforced concrete) like compressive strength, flexure strength, toughness, modulus of elasticity were studied.
Keywords-fibre, compressive strength, durability, tensile

1 INTRODUCTION

Concrete is the most widely used construction material has several desirable properties like high compressive strength, stiffness and durability under usual environmental factors. At the same time concrete is brittle and weak in tension. Plain concrete has two deficiencies, low tensile strength and a low strain at fracture. These shortcomings are generally overcome by reinforcing concrete.
Normally reinforcement consists of continuous deformed steel bars or pre-stressing tendons. The advantage of reinforcing and pre-stressing technology utilizing steel reinforcement as high tensile steel wires have helped in overcoming the incapacity of concrete in tension but the ductility magnitude of compressive strength.Fibre reinforced concrete (FRC) is a concrete made primarily of hydraulic cements, aggregates and discrete reinforcing fibres. FRC is a relatively new material. This is a composite material consisting of a matrix containing a random distribution or dispersion of small fibres, either natural or artificial, having a high tensile strength. Due to the presence of these uniformly dispersed fibres, the cracking strength of concrete is increased and the fibres acting as crack arresters.

2 DURABILITY OF FRP

FRP rebar is a composite material made up of high strength fibers embedded in a protecting matrix. It possesses very high strength to weight ratio and non-conductive/magnetizing nature. Glass Fiber Reinforced Polymer (GFRP) is an economically viable form of FRP and is being promoted widely as reinforcement for concrete. GFRP rebars are available in the market with high ranges of strength (up to 1500 MPa). FRP rebars are available in different surface texture (i.e. ribbed, sand coated, deformed, etc.) to achieve better bond strength with concrete and are manufactured by pultrusion process GFRP bars can be used in the area like coal and mining industries, tunneling, coastal construction, road construction, corrosive construction, etc

3 EXPERIMENTAL PROGRAMME

The details of materials used in the present programme are as follows.

3.1 Cement

Portland pozzolona cement of 43 Grade available in local market has been used in the investigation. The cement used has been tested and found to be conforming to the IS 1489 specifications. The specific gravity was 3.15.

3.2 Coarse aggregate

Crushed angular aggregates from a local source were used as coarse aggregate.

3.3 Fine aggregate

Zone 3rd sand was used as fine aggregate. The specific gravity was determined and was found as 2.74.

Table1. Properties Of Glass Fiber Cem-Fil Anti Crack HD.

1Fibre	AR Glass
2specific gravity	2.68
3elastic modulus(Gpa)	72
4tensile strength(Mpa)	1700
5diameter(micron)	14
6length(mm)	12
7number of fibre	235
(million/Kg)	**3.4 Glass fiber**

The glass fibers used are of Cem-FIL Anti-Crack HD with modulus of elasticity 72 GPA, Filament diameter 14 microns, specific gravity 2.68, length 12 mm (Properties as obtained through the manufacturer are shown on table1).

3.5 Water

Locally available portable water is used.

3.6 Test specimens

Test specimens consisting of 100×100×100 mm cubes

and 100×100×500 mm beams were cast as shown in figure 1 and tested as per IS: 516 and 1199.

3.7 CONCRETE MIX

The M20 grade in quantities used in per cubic meter are shown in table 2.the water cement has been fixed.

3.8 MIXING

After mixing in fully pan mixer, the mix was cast in moulds for each % of fiber sufficient no of cubes (table 3) and flexure beams (table 4) were cast for testing at the ages of 28 days.

Table 1

Table2. Properties Of Glass Fiber Cem-Fil Anti Crack HD.	
cement 33 grade ppc	350
fine aggregate	873
coarse aggregate (20mm)	444
coarse aggregate (10mm)	666
Water	140
Fiber	0-1% by total weight of mix
super plasticizer	5

Table.3

Number of beam specimen cast using different fiber content and different area of steel					
%fiber	0%	0.33%	0.67 %	1%	description
Dia					
10	4	4	4	4	Under reinforced
12	4	4	4	4	Under reinforced
16	4	4	4	4	Over reinforced

Table 4:-Number Of Cube Specimen Cast Using Different % Of Fiber Content

%fiber	0%	0.33%	0.67%	1%
number of cube	8	8	8	8

4 RESULTS AND DISCUSSION

4.1 Compressive Strength:-

The observation from our results shows that the increase in compressive strength is up to 37% in case of adding 0.33% fiber content in comparison of conventional concrete.

%	compressive strength in N/mm^2	flexure strength in N/mm^2
	without RCC	10mm 12mm		16mm
0	30	3.19	14.85	17.325	24.075
0.33	41	7.31	11.7	18.225	20.25
0.67	30	7.59	15.7	17.325	17.325
1	28.67	7.07	18.45	18.65	25.5

Figure2 and Table5 shows the variation in compressive strength by adding fibre.

Table 5:-Variation between Percentage Increase In Compressive Strength

fiber content	% increase in compressive strength
0%	0%
0.33%	36.67%
1%	-4.40%

4.2. Flexure Strength

The percentage increase in flexure strength of glass fibre is observed to be 130%when compared with ordinary plain concrete

The percentage increase in flexure strength of glass fibre reinforced concrete using fibre content 0.33% and 1.25% steel (12mm reinforcement bar) is observed to be 150% when compared with glass fibre concrete(without reinforcement).

Table 6:- Compressive and Flexure Strength For Different Fiber Content at 28 days

Table 7:- Percentage Increase of Compressive, Flexure Strength of Glass Fiber Concrete In Comparison With Ordinary Concrete Mixes at 28 days

4.3 Modulus of Elasticity

Young's modulus is increased by 4.14% for fiber reinforced concrete(0.33% fibre content and 1.25% steel or using 12 mm diameter reinforcement bar) over plain concrete.(refer Table8)

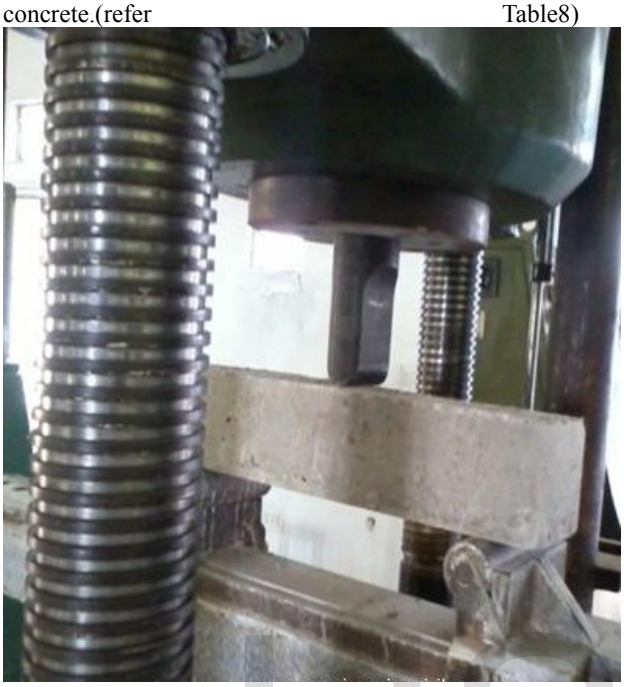

Table 8 Observed Modulus Of Elasticity

dia mm	fiber	observed modulus of elasticity KNmm^2
10	0	11.53
12	0	20.98
16	0	20.12
10	0.33	21.49
12	0.33	21.85
16	0.33	12.85
10	0.67	14.12
12	0.67	20.31
16	0.67	20.31
10	1	8.2
12	1	18.09
16	1	16.46

4.4.Toughness

It can be observed from the Table9 that the best performance is given by glass fibre reinforced concrete containing 0.67% fibre and 1.25 percent steel the highest value of toughness is 272.41KNmm.(refer Table 9)

Table 9 Toughness in KNmm

	Fibre %			
diameter in mm	0	0.33	0.67	1
10	11.506	63.99	144.6	19.36
12	59.06	83.98	272.4	75.69
16	116.28	218.6	215.7	72.26

Table10 Percentage Increase In Toughness

		Fiber	
diameter in mm	0.33	0.67	1
10	456%	1157%	68.26%
12	42.19%	361.20%	28.15%
16	88.06%	85.48%	0%

5 CONCLUSION

1. Addition of glass fibre in reinforced concrete increases the toughness by 1157%compare with conventional reinforced concrete. The value of toughness observed maximum 272.4KNmm when using fibre content 0.67% and 1.25% steel(12mm reinforcement bar).
2. The modulus of elasticity of glass fibre reinforced concrete is increases 4.14% compared with conventional reinforced concrete.
3. The percentage increase of compressive strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed 37%.
4. The percentage increase of flexure strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed 5.19%.

6 REFERENCES

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