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A Study on EFFCT of Glass Fiber on Mechanical Properties of Concrete

AZMIRA NARESH[1], DR. S. SUNIL PRATAP REDDY[2]
[1]PG Scholar, Dept of Civil Engineering, Vaagdevi College of Engineering, Warangal, TS, India,
E-mail: azmeeranag123@gmail.com.
[2]Professor, Dept of Civil Engineering, Vaagdevi College of Engineering, Warangal, TS, India.

Abstract: Throughout the past periods the construction field has experienced a growing interest in the advantages offibre reinforcement in concrete. Amongst the diverse fibres available, worldwide, a great deal of research is currently being conducted concerning the use of glass fibre as reinforcement in concrete. Glass fibre reinforced concrete composites contain high strength glass fibres that are surrounded by a cementitious medium. In this shape, both the fibres and the environment maintain their natural individual chemical characteristics. In the present experimental investigation the alkali resistance Glass Fibres has been used to study the effect on compressive strength and spilt tensile strength on M25 and M50 grades by 0.01%, 0.03%, 0.06%, 0.1%of concrete Keywords –strength properties.

Keywords: GFC, Glass Fibres, Compressive Strength, Spilt Tensile Strength.

I. INTRODUCTION

Glass fibre reinforced concrete composites contain high strength glass fibres that are surrounded by a cementitious medium. In this shape, both the fibres and the environment maintain their natural individual chemical characteristics. However, the concrete produced has improved resultant properties that cannot be attained if either of the components is used individually.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. Glass fiber reinforced concrete (GFRC) also called GRC or FRC is a cementitious, composite material, cast in thin shell shapes for use in construction. Glass fibre reinforced concrete is one of the most versatile building materials available.

II. REVIEW OF LITERATURE

Shah Surendra and Rangan [1-4], in their investigations conducted uni-axial compression test on fiber reinforced concrete specimens. The results shown the increase in strength of 6% to 17% compressive strength, 18% to 47% split tensile strength, 22% to 63% flexural strength and 8% to 25% modulus of elasticity respectively. Byung Hwan Oh [5], in their investigations, the mechanical properties of concrete have been studied, these results shown the increase in strength of 6% to 17% compressive strength, 14% to 49% split tensile modulus of elasticity respectively. Barrows and Figueiras [6], in their investigations the mechanical properties of concrete have been studied. These results shown the increase in strength of 7% to 19% compressive strength, 19% to 48% split tensile strength, 25% to 65% flexural strength and 7% to 25% modulus of elasticity respectively. Chen S.[7] investigated the strength of 15 glass fiber reinforced and plain concrete ground slabs. The slabs were 2x2x0.12m, reinforced with hooked end steel fibers and mill cut steel fibers. Dwaraknath and Nagaraj [8] predicted flexural strength of glass fiber concrete by these parameters such as direct tensile strength, split cylinder strength and cube strength. James and Beaudoin [9] stated that the minimum fiber volume dosage rate for steel, glass and polypropylene fibers in the concrete matrix wascalculated approximately 0.31%, 0.40% and 0.75%. Patton and Whittaker [10] investigated on steel fiber concrete for dependence of modulus of elasticity and correlation changes on damage due to load. Rossi et. al [11], analyzed that the effects of steel fibers on the cracking at both local level (behavior of steel fibers) and global level (behavior of the fiber/cement composite) were dependent to each other.

III. MATERIALS USED

A. Cement

Ordinary Portland cement of 53 grades available in local market is used in the investigation. The cement used has been tested for various proportions as per IS: 4031-1988 [15] and found to be conforming to various specifications of IS: 12269-1987. The specific gravity was 3.15 and the fineness was 3200 cm2/gm.

B. Coarse Aggregate

Crushed stone metal with a maximum size of 12.5 mm from a local source conforming to IS: 383-1970 [13]was used. The specific gravity was found to be 2.7.

TABLE I: Fineness Modulus Of Coarse Aggregate

Sieve Size(mm)	%weight retained	%weight of passing	Cumulative %retained
40	0	100	0
20	38.2	61.8	38.2
10	41.4	20.4	79.6
4.75	1.08	0	100
2.36	0	0	100
1.18	0	0	100
600 μ	0	0	100
300 μ	0	0	100
150 μ	0	0	100
Fineness modulus=7.1			

C. Fine Aggregate

Fine aggregate can be natural or crushed. Locally available river sand passing through 4.75 mm IS sieve and it conforms to zone II (As per IS 383 – 1970 [13]). The specific gravity and fineness was found to be 2.6 and 2.63.

TABLE II: Fineness Modulus of Fine Aggregate

Sieve size (mm)	% Weight Retained	Cumulative % weight retained	Weight retained(gms)
10	0	0	0
4.75	0	0	0
2.36	10	10	100
1.18	25	35	250
600μ	25	60	250
300μ	30	30	300
150μ	10	10	100
	Fineness modulus=2.9		

D. Water

Potable water was used in the experimental work for both mixing and curing specimens.

E. Glass Fibre

The glass fibres used are of Cem-fil-anticrack with modulus of elasticity 75 Gpa, filament diameter – 14 microns, specific gravity 2.66, length 12 mm and having the aspect ratio of 857.1.The number of fibres per 1 kg is 212 million fibre as shown in Fig.1.

Fig.1. Glass fibers used.

IV. MIX PROPORTIONS

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262- 2009[12]

TABLE III: Mix Proportions

Material	M 25 Proportions	M 50 Proportions
Cement	1.00	1.00
Fine Aggregate	1.48	0.91
Coarse Aggregate	3.33	3.16
Water	0.50	0.35

V. EXPERIMENTAL PROGRAM

In this study, the effect of glass fibers is studied on grades M25 and M50. The fibers were added at a dosage of 0.03%, 0.06% and 0.1% to the volume of concrete. An average of three cubes and three cylinders is taken to evaluate the compressive strength and split tensile strength of glass fiber reinforced concrete. The effect of glass fiber on the workability of concrete is evaluated by slump cone test. The compressive and spilt tensile strength were tested on universal testing machine as shown in Figs.2 to 4. A total of 24 cubes of standard size 150mm* 150mm*150mm were cast for compressive strength and 24 cylinders of standard size 300mm height and 150mm diameter were castspilt tensile strength. The testing of materials is done as per Indian standards [14,16].

Fig.2.Curing of specimens.

Fig.3. Testing of Cubes.

Fig.4.Testing of Cylinders.

VI. RESULTS AND DISCUSSIONS

A. Effect on Workability

Slump cone test is used to evaluate the effect of glass fiber on concrete. The slump cone values are represented in Table 2. Glass fiber have effected the workability of concrete. The effect has increased with the increase dosage of glass fibers. Addition of GLASS fiber has made concrete stiffer.

Table IV: Workability

Volume of fibres(in %)	Slump Cone (mm)	
	M25	M50
0	102	96
0.03	93	79
0.06	81	66
0.1	62	53

B. Effect of Compressive Strength

The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 28days. It is most common test conducted on hardened concrete as it is an easy test to perform and also most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. Steel mould made of cast iron dimension 150mm x 150mmx150mm used for casting of concrete cubes were used. The mould and its base rigidly damped together so as to reduce leakages during casting. The sides of the mould and base plates were oiled before casting to prevent bonding between the mould and concrete. The cube was then stored for 24 hours undisturbed at temperature of l8°C to 22°C and a relative humidity of not less than 90% (IS 516-1959). It also stated in IS 516-1959 that the load was applied without shock and increased continuously at the rate of approximately 140 Kg/sq cm/ min until the resistance of specimen to the increasing loads breaks down and no greater load can be sustained. The maximum load applied to the specimen was then recorded as per IS: 516-1959. The testing of cube under compression were shown in fig.5. Test results are shown in Table 5. The compressive strength was calculated as follows: Compressive strength (MPa) = Failure load / cross sectional area.

TABLE V: Compressive Strength (MPa) for M25 and M50 Grade of Concrete At 28 Days

Volume of fibres (in %)	M25	M50
0	32.21	58.15
0.03	35.32	60.22
0.06	38.45	62.89
0.1	40.28	65.25

TABLE VI: Spilt Tensile Strength (MPa) for M25 and M50 Grade of Concrete At 28 Days

Volume of fibres (in %)	M25	M50
0	3.81	5.22
0.03	4.10	5.35
0.06	4.30	5.48
0.1	4.35	5.60

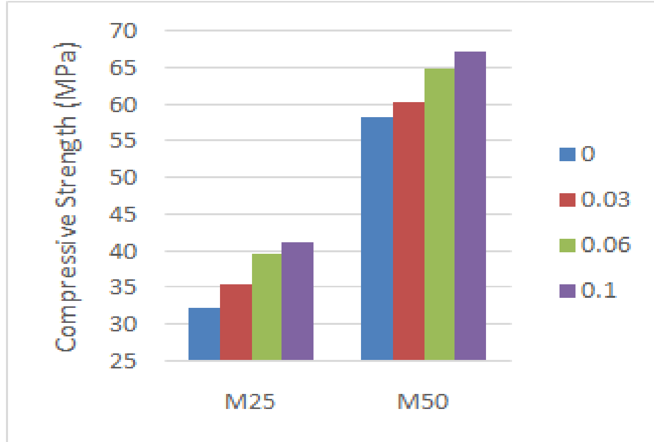

Fig.5. Percentage in increase in Compressive strength.

C. Effect of Split Tensile Strength

The test was conducted as per IS 5816:1999 [23]. For tensile strength test, cylindrical specimens of dimension 100 mm diameter and 200 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. In each category, three cylinders were tested and their average value was reported [10]. The split tensile test was conducted as shown in fig.6 and results are shown in Table 6. Split tensile strength was calculated as follows:

Spilt Tensile strength (MPa) = 2P / π DL

Where, P = Failure Load (kN)

D = Diameter of Specimen (100 mm)

L = Length of Specimen (200 mm)

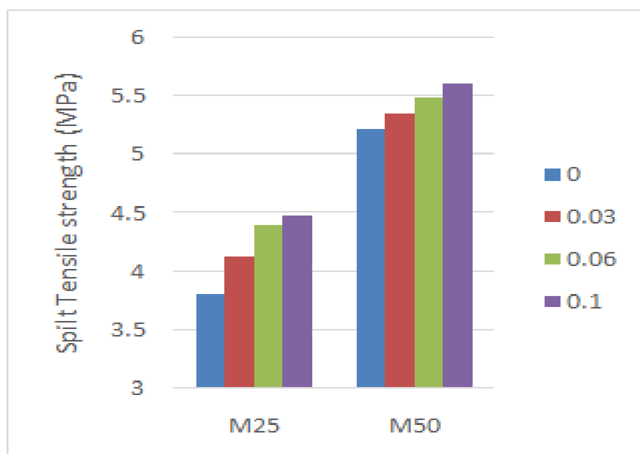

Fig.6. Percentage in increase in Split Tensile strength.

VII. CONCLUSIONS

The workability is effected marginally upto a dosage of 0.06% dosage but there is a significant effect on 0.1% dosage. Compressive strength for M25 grade of concrete has been increased with an increase in volume of glass of glass fibres by 0.03%,0.06% and 0.1% increased by 9.37%,19.37% and 25.05% respectively. Spilt tensile strength for M25 grade of concrete has been increased with an increase in volume of glass of glass fibres by 0.03%,0.06% and 0.1% increased by 7.60%, 12.86% and 14.17% respectively. Compressive strength for M50 grade of concrete has been increased with an increase in volume of glass of glass fibres by 0.03%,0.06% and 1% increased by 3.5%,8.15% and 12.20% respectively. Spilt tensile strength for M50 grade of concrete has been increased with an increase in volume of glass of glass fibres by 0.03%,0.06% and 0.1% increased by 2.49%,4.98% and 7.27% respectively. The resistance to cracking was increased with addition of glass fibers. Multiple crack failure in observed in specimens with higher dosages.

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