Available online at: http://www.ijmtst.com/vol4issue2.html

International Journal for Modern Trends in Science and Technology

ISSN: 2455-3778 :: Volume: 04, Issue No: 02, February 2018

An Experimental Study to Compare the Strength Characteristics of Concrete using Steel Fiber and Glass Fiber Admixtures

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To Cite this Article

Garudachalam Deepak Babu and Y.Anjaiah, "An Experimental Study to Compare the Strength Characteristics of Concrete using Steel Fiber and Glass Fiber Admixtures", *International Journal for Modern Trends in Science and Technology*, Vol. 04, Issue 02, February 2018, pp.-73-78.

ABSTRACT

Plain concrete possesses a 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 the propagation of such micro cracks, eventually leading to brittle fracture of the concrete.

The main objective of this experimental study is to "Determine & Differentiate" the strength of FRC with normal concrete. The Fiber Reinforced Concrete (FRC) contains randomly distributed short discrete steel fibers and glass fibers which act as internal reinforcement. The principal reason for incorporating short discrete fibers into a cement matrix is to reduce cracking, increase the tensile strength and deformation capacity and increase the toughness of the resultant composite. Compare to normal concrete, fiber reinforced concrete gives more compressive strength, flexural strength & split tensile strength. Various tests conducted on the standard concrete with steel and glass fiber added varying percentages ***0%, 3%, 4%, 5%*** *of total weight of the cement in the concrete mix.*

KEYWORDS: *Fiber reinforced concrete, Glass fibers, Compressive strength, Tensile Strength, Flexural Strength.*

I. INTRODUCTION

Concrete is the most commonly used construction material worldwide. In India, reinforced concrete is extensively used in the construction of variety of civil infrastructure applications including small and large buildings, houses, bridges, storage tanks, dams and numerous other types of structures in India.

Concrete is a brittle, composite material that is strong in compression and weak in tension. The tensile strength of plain concrete is about 10% of its compressive strength. Cracking occurs when the concrete tensile stress produced from the externally applied loads, temperature changes, or shrinkage in a member reaches the tensile strength of the material. Use of short discrete fibers in cementations composites (concrete) is one approach to mitigate the cracking and increasing the tensile straining capacity.

1.1 STEEL FIBER REINFORCED CONCRETE

Steel fiber reinforce concrete is a composite material which is made up from cement concrete mix and steel fibers as a reinforcing. The steel fibers, which are uniformly distributed in the cementations mix .This mix, have various volume fractions, geometries, orientations and material properties. It has been shown in the research that fibers with low volume fractions (<1%), in fiber reinforced concrete, have an insignificant effect on both the compressive and tensile strength.

Fig: 1.1 Steel Fibers

1.2 GLASS FIBER REINFORCED CONCRETE

Glass fiber–reinforced concrete is (GFRC) basically a concrete composition which is composed of material like cement, sand, water, and admixtures, in which short length discrete glass fibers are dispersed. Inclusion of these fibers in these composite results in improved tensile strength and impact strength of the material.

Fig: 1.2 Glass Fibers

1.3 SCOPE FOR THE PRESENT STUDY

- To study the physical properties of concrete using Glass fiber, Steel fiber.
- To establish the physical properties of constituents (cement, fine aggregate, coarse aggregate and fiber).
- To design the concrete mix using IS (Indian Standard).
- Evaluation of compressive strength and of splitting tensile strength of concrete with Steel fiber.
- Evaluation of compressive strength and of splitting tensile strength of concrete with Glass fiber.
- Evaluation of compressive strength and of splitting tensile strength of concrete without fiber.

II. LITERATURE REVIEW

Saluja et al (1992) conducted the experiments on steel fiber concrete to determine compressive strength and concluded that steel fibers are effective in increasing compressive strength up to 1.0 percent fiber content, beyond which the increase is not much effective.

AvinashGornale, et al studied the strength aspect of glass fiber reinforced concrete. The study had revealed that the increase in compressive strength, flexural strength, split tensile strength for M20, M30 and M40 grade of concrete at 3, 7 and 28days were observed to be 20% to 30%, 25% to 30% and 25% to 30% respectively after the addition of glass fibers as compared to the plain concrete

III. MATERIALS AND TEST RESULTS

CEMENT: - Ordinary Portland cement (53 grade) was used for this experimental investigation.

Specific Gravity of cement	Setting time minutes		Compressive Strength of Cement	
	Initial setting time	Final setting time	7 days	28 days
3.12	62 min	182 min	37.19	53.24

FINE AGGREGATE:- Locally available river sand having density of 1483 kg/m^3 and fineness modulus of 2.615 was used. The specific gravity was found to be 2.69 the fine aggregate was found to be confirming to zone-II as per Is 383:1970.

COARSE AGGREGATE:- Natural granite aggregate having density of 1520 kg/m^3 and fineness modulus (FM) of 5.88 was used which is available in Narasaraopeta quarries. The specific gravity was found to be 2.90 and the aggregate passing from IS Sieve 20mm and retaining on IS Sieve 12.5mm was used.

WATER: - Potable water, which is free from concentration of acid or organic substances, was used for mixing the concrete.

FIBERS:- Fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The fiber is often described by a convenient parameter called "aspect ratio". The aspect ratio of the fiber is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150.

STEEL FIBERS:- Different types of steel fibers are available in market but form those we can use Hooked End Steel Fiber & Crimpled Steel Fiber because these fibers are well anchored in the concrete matrix and demonstrates good load transfer in the crack.

GLASS FIBERS: - Glass fiber is a material consisting of numerous extremely fine fibers of glass. Glass fiber also called fiber glass. It is material made from extremely fine fibers of glass Fiberglass is a lightweight, extremely strong, and robust material. The material is typically far less brittle and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes.

Different types of Glass fibers are available in market from those we can use mostly AR-Glass fibers these fibers available for structural strengthening and reinforcement, AR-glass is far the most used and is the least expensive.

IV. MIX DESIG & TEST RESULTS

MIX DESIGN: - The PFRC mix was prepared by adding 0%, 3%, 4%, and 5% fibers of 12mm length by weight of cement to PCC mix. The fibers were added to the dry mix first and then water was added as this method appeared to produce a uniform PFRC mix. The PCC and PFRC mixes were used, for preparation of test specimen for tensile strength test, flexural strength test and for short term compressive strength.

PFRC has been provided with a design Mix of **1:1.437:3.1367**water cement ratio shall be as per IS specification mentioned for M20 grade concrete.

PREPARATION OF SPECIMENS:- A preliminary study on comprehensive strength, Flexural strength and Split tensile strength using different proportions of polypropylene fibers & polyester fibers in varying ratio of fiber dosage of 0%,3%, 4%, and 5%by weight of cement is carried. In the present study, experimental concrete cubes of size 150mm x 150mm x 150 mm, and beam dimensions of each specimen (700mm x 150mm x 150mm) and cylinder of diameter 150mm and height of 300mm, PFRC (polymer fiber reinforced concrete) with experimental fibers were cast and tested for compression & tensile strengths for 7 and 28 days of curing and flexural strength for 28 days of curing. Concrete cubes of size 150mm x 150mm x 150mm were casted and tested for compressive strength for 7 days and 28 days.

Fig 1 Cube Casting

Fig 2 Beam Casting

COMPRESSIVE STRENGHTH: The concrete cube specimens of size150mm x 150mm x 150mmwere placed in the compression testing machine and loaded. Loading at constant rate was applied on the specimen. The failure load obtained is the strength of the specimen. The average strength of set of three samples was taken as cube strength.

Compressive strength = P/A (N/mm^2)

P = Applied load (N)

A= Surface area = (b x d) = 150mm x 150mm

b = breadth of the cube = 150 mm

d = depth of the cube = 150 mm

Fig 3 Compressive Strength Testing Machine

FLEXURAL STRENGTH TEST: - The concrete beams were placed and loaded in the Universal Testing Machine. The beams were testes at the age of 28 days for the flexural strength. The beam dimensions were 700mm X 150mm X 150mm. The load was applied gradually till the beam got failed.

The failure load obtained was taken as strength of the specimen.

The flexural strength or modulus of rupture (f_b) is given by

f_b= pl/bd^{2}or fb= 3pa/bd^2

Where,

a = the distance between the line of fracture and the nearest support, measured on the center line of the tensile side of the specimen.

b = width of the specimen (cm)

d = failure point depth (cm)

I = support length (cm)

p = maximum load

Fig 4 Universal Testing Machine

SPLIT TENSILE STRENGTH TEST: - The concrete cylinder of 150mm diameter and depth 300mm was casted. The cylinder was placed and loaded in compression testing machine. The load was applied gradually till the cylinder got failed. The failure load obtained was taken as the strength of the specimen. The average strength of the two samples was taken as cylinder strength.

Split tensile strength (σ_t) = 2P / π b d (N/mm^2)

Where, P = Applied load (Newton)

b = Diameter of the cylinder

d = Depth of the cylinder

Fig 5 Testing of cylinder

S. No	Name of Fibers	% of fibers added	Compressive strength (N/mm^2)	
			7 days	28 days
1	Steel fiber	0	13.2	20.4
		3	14	22
		4	17.5	28
		5	17	25
2	Glass fiber	0	13.2	20.4
		3	16	27
		4	15.8	26.4
		5	14	25.6
3	Steel and Glass fiber	0	13.2	20.4
		3	15.3	29.4
		4	16	31.06
		5	15	30.3

Table 1 Compressive strength of cube values

S. No	Fibers	% of fiber added	Flexural strength (N/mm^2)
			28 days
1	Steel fiber	0	2.5
		3	2.6
		4	3.95
		5	3.65
2	Glass fiber	0	2.5
		3	2.7
		4	3.65
		5	3.46
3	Steel and Glass fiber	0	2.5
		3	3.61
		4	4.04
		5	3.78

Table 2 Flexural strength of beam values

S. No	Fibers	% of fiber added	Split Tensile strength (N/mm^2)
			28 days
1	Steel fiber	0	3.3
		3	3.45
		4	3.8
		5	3.6
2	Glass fiber	0	3.3
		3	3.64
		4	3.6
		5	3.54
3	Steel and Glass fiber	0	3.3
		3	3.8
		4	3.9
		5	3.85

Table 3 Split Tensile strength of cylinder values

COMPRESSIVE STRENGTH TEST RESULLTS GRAPH:-

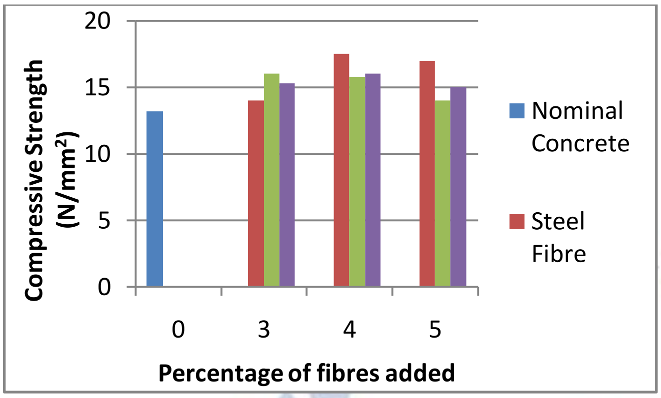

Chart 1: Compressive strength of cubes for 7 days

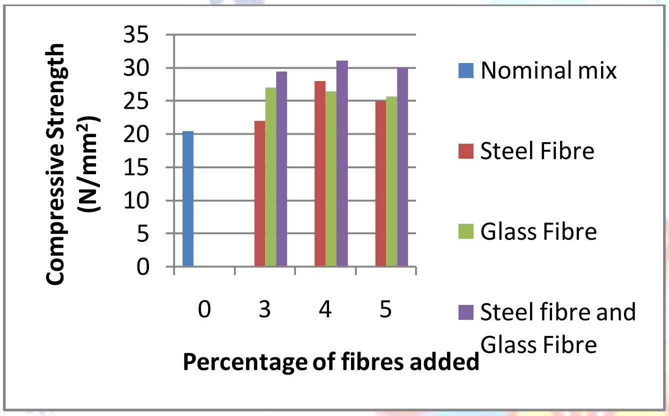

Chart 2: Compressive strength of cubes for 28 days

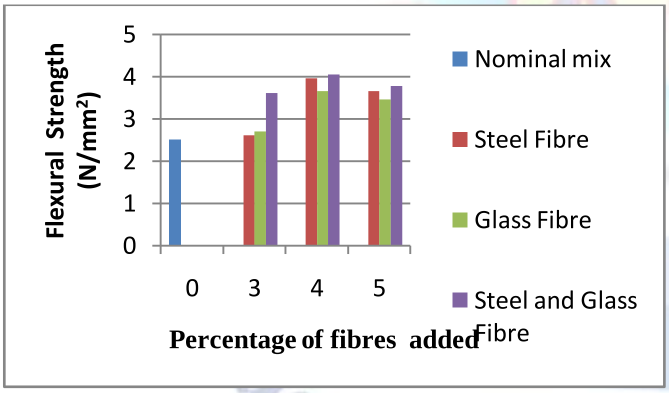

Chart 3: Flexural strength of beams for 28 days

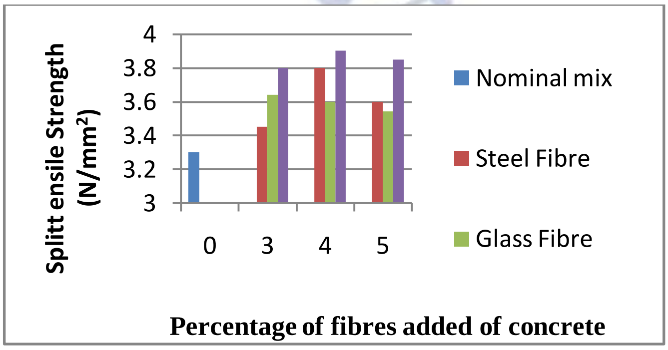

Chart 4: Split tensile strength of cylinders for 28 days

V. CONCLUSION

The following conclusions have been drawn based on the experimental investigation carried out on concrete mixture.

1. Higher compressive strength is obtained at 4 % of Steel fiber, 4% of Glass fiber and 4% of Steel and Glass fiber added to concrete.
2. Higher split tensile strength is obtained at 4 % of Steel fiber, 4% of Glass fiber and 4% of Steel and Glass fiber added to concrete.
3. Higher Flexural Strength is obtained for at 4 % of Steel fiber, 4% of Glass fiber and 4% of Steel and Glass fiber added to concrete.
4. The maximum compressive strength occurred at 4 % of Steel fiberis 28 N/mm².
5. The maximum compressive strength occurred at 4% of Glass fiber is 26.4 N/mm².
6. The maximum compressive strength occurred at 4% of Steel and Glass fibers are 31.06N/mm².
7. The maximum Split Tensile strength occurred at 4 % of Steel fiber is 3.8 N/mm².
8. The maximum Split Tensile strength occurred at 4% of Glass fiber is 3.6 N/mm².
9. The maximum Split Tensile strength occurred at 4% of Steel and Glass fibers are3.9 N/mm².
10. The maximum Flexural strength occurred at 4 % of Steel fiber is 3.95 N/mm².
11. The maximum Flexural strength occurred at 4% of Glass fiber is 3.65 N/mm².
12. The maximum Flexural strength occurred at 4% of Steel and Glass fibers are4.04 N/mm².

VI. REFERENCES

[1] Singh A.P. and DhirendraSinghal. (2001), 'Effect of Cement and Fiber Contents on Permeability of SFRC', Journal of Structural Engineering, Vol. 28, No.1, pp.49-54.

[2] Nataraja M C. Nagaraj T. S. and Basavaraja. (2005), 'Reproportioning steel fiber reinforced concrete mixes and their impact resistance', Cement and Concrete Research, Vol. 35, No. 12, pp. 2350- 2359.

[3] Malathy R. and Subramanian K. (2006), 'Effect of mineral admixtures and glass fibers on the impact strength of high strength of high performance concrete', New Building materials and Construction World, Vol. 11, No.9, pp .132-140.

[4] A Yogesh Murthy, B ApoorvSharda and C Gourav Jain (2012), Performance of glass fiber reinforced concrete, International journal of engineering and innovative technology, vol.1, and issue 6.

[5] A Dr. Srinivasa Rao, B Chandra Mouli K. and C Dr. T. SeshadriSekhar (2012), Durability studies on Glass Fiber Reinforced Concrete, International

Journal of civil engineering science, vol.1, no-1-2 A G.

[6] JyothiKumari, B P. Jagannadha Rao and C M. V. Seshagiri Rao (2013), Behavior of concrete beams reinforced with glass fiber reinforced polymer flats, international journal of research in engineering and technology, Vol.2, Issue 09.

[7] A .AvinashGornale, B S. Ibrahim Quadri and C Syed Hussaini (2012), Strength aspect of Glass fiber reinforced concrete, International journal of Scientific and Engineering research, vol,3, issue 7.

[8] A S. H Alsayed, B Y.A. Al-Salloum and C T. H. Almusallam (2001), Performance of glass fiber reinforced plastic bars as a reinforcing material for concrete structures, Journal of Science and Technology.

[9] ZiadBayasi and Heanning Kaiser (2001), 'Steel Fibers as Crack Arrestors in Concrete', Indian Concrete Journal, Vol. 75, No. 3, pp. 215-219.

[10] Job Thomas. (2002), 'Properties of plastic fiber reinforced concrete', Indian Concrete Institute Journal, Vol. 3, No. 3, pp.29-35. 63.

[11] John S. Lawler., divide Zampini, and Surendra P. shah. (2002), 'Permeability of cracked hybrid fiber – reinforced mortar under load', American Concrete Institute Materials Journal, Vol. 99, No. 4, pp. 379-385.