Experimental Inspection on Strength of Concrete using Fibers

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Abstract - *Concrete is the most important and historic discovery of man when it comes to construction. Concrete has allowed humans to build structures which are providing us with the resources to sustain our populated planet. Dams, Bridges and many more structures which have improved after the introduction of concrete have been monumental in making our lives easier. The main ingredient in production of concrete – cement. Cement is the binder which when mixed with water binds all the ingredients in concrete i.e. aggregates, sand together and forms a mixture we call concrete. In this paper strength of concrete is found by adding two different fibers in 0.2, 0.6, & 1%, and results showed that Steel fibers give more strength with 1% addition as compared to Glass & Conventional Concrete.*

***Key Words*: Glass fiber, Steel fiber, , Compression, Split tensile strength.**

1. INTRODUCTION

Concrete is the basic engineering material used in most of the civil engineering structures. Its popularity as basic building material in construction is because of its economy of use, good durability and ease with which it can be manufactured at site. We can say that, it is the life of concrete but its production leads to emission of CO_2 which is having hazardous impacts on our environment due to which the need to find its replacement is becoming more prominent day by day. There are many experiments carried out so as to replace cement partially or fully in order to improve the properties of concrete as well as reduce the consumption of cement. For this purpose, many waste products are used like fly ash, plastic waste, silica fumes etc. One such experiment is introduction of fibers. Fibers like that of steel, glass, polypropylene, asbestos, carbon etc. are introduced in concrete by partial replacement of cement by weight and the concrete formed is known as Fiber Reinforced Concrete(FRC).

1.1 Fiber Reinforced Concrete(FRC)

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers may generally be classified into two: organic and inorganic. Inorganic fibers include steel fibers and glass fibers, whereas organic fibers include natural fibers like coconut, sisal, wood, bamboo, jute, sugarcane, etc and synthetic fibers based on acrylic, carbon, polypropylene, polyethylene, nylon and polyester. Within these different fibers the character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities.

Fibers are usually used in concrete to control plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete.

2 OBJECTIVES

The main objective of the present investigations is to study the effect of steel fiber reinforced concrete and glass fiber reinforced concrete with the conventional concrete.

- To prepare the base concrete mix for M_{25} grade.
- To study the mechanical properties of Glass, Steel, fibers reinforced concrete for 7 & 28 days strength.
- Conclusions are made from key results by comparing Glass, Steel fibers reinforced concrete with conventional concrete.

3. MATERIALS & METHODOLOGY

Cement – PPC 43 grade
Coarse aggregate- 20mm downsize
Fine aggregate- 4.75mm downsize
Water
Steel fibers- Hooked ends
Glass fibers- 6mm

Fig 1. Steel fibers

Fig 2. Glass fibers

- Preparation of the mix design for M25 grade of concrete.
- Conduction of basic material tests.
- The different ratios of Steel fibers and glass fibers with respect to weight of cement was used , which is as tabulated below,

Table 1. Fiber Proportions

GLASS	STEEL
0.2%	0.2%
0.6%	0.6%
1.0%	1.0%

- Casting cubes of 150*150*150mm and cylinders of 150mm diameter and 300mm length.
- Curing of conventional and fiber reinforced concrete is done normally with water.
- Testing for compression and Split tensile strength.

4. MIX DESIGN

Table 2. Test Data

1	Grade of concrete	M_{25}
2	Maximum size of aggregate	20mm
3	Workability	100mm slump
4	Exposure condition	Mild
5	Cement type	PPC 43 grade
6	Specific gravity of cement	3.12
7	Specific gravity of fine aggregate	2.61
8	Specific gravity of coarse aggregate	2.68
9	Water absorption of coarse aggregate	2.04%
10	Sieve analysis of fine aggregate	Zone II
11	Fineness Modulus	2.3%
12	Normal Consistency of Cement	32%
13	Initial & Final setting time of cement	50 min & 325 min

STEP 1. TARGET STRENGTH FOR MIX PROPORTIONING:

Fck' = fck + 1.65 s

Where

Fck' = Target average compressive strength at 28 days,
fck = Characteristic compressive strength at 28 days,
s= Standard deviation
From Table 1 standard deviation, s = 4 N/mm^2
Therefore target strength = 25+ 1.65 x 4 = **31.6 N/mm^2.**

STEP 2. SELECTION OF WATER CEMENT RATIO:

From Table 5 of IS: 456-2000, maximum water cement ratio = 0.55
Based on experience adopt water cement ratio as 0.5
0.5 < 0.55 , hence ok.

STEP 3. SELECTION OF WATER CONTENT

From table NO: 02 of is 10262:2009, note down the value of quantity of water content for 20mm aggregate.
The required water content may be established by an increase of about 3% for every additional 25mm slump, i.e.3% for additional 100mm slump.
= 186+3%*186
=**191.58 litres.**

STEP 4. CALCULATION OF CEMENT CONTENT

Water cement ratio = 0.5
Cement content = 191.58/0.5 = 383.2 kg/m^3
From Table 5 of IS: 456, minimum cement content for mild exposure condition = 300 kg/m3
383.2 kg/m3 >300 kg/m3, hence OK.

STEP 5. PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

From Table 3, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone 2) for water-cement ratio of 0.50=0.62.
In present case water cement ratio is 0.5 therefore, corrected proportion of volume of coarse aggregate for water – cement ratio of 0.5 = 0.62*90%= 0.558
Volume of fine aggregate=1 – 0.558=0.442

STEP 6. MIX CALCULATIONS:

The mix calculations per unit volume of concrete shall be as follows
a. Volume of concrete = 1 m^3
b. Volume of cement = [383.2/3.15] x [1/1000] = **0.122m^3**
c. Volume of water = [191.6/1] x [1/1000] = **0.1916 m^3**
d.Volume of all in aggregates =a – (b + c)
=1 – (0.122 + 0.1916)

= **0.6864 m³**

e. Volume of coarse aggregates = d x Volume of CA x specific gravity of CA

= 0.6864 x 0.558x 2.84 x 1000

= **1087.75 kg/m3**

f. Volume of fine aggregates = d x Volume of FA x specific gravity of FA

= 0.6864 x 0.442 x 2.64 x 1000

= **800.94 kg/m3**

5. RESULTS & DISCUSSIONS

Table 3. Compression strength of conventional concrete

W/C ratio	Curing Age(days)	Weight of cube (Kg)	Average compressive strength (N/mm^2)
0.2	7	8.60	19.18
	28	8.60	32.31

Table 4. Split tensile strength of conventional concrete

W/C ratio	Curing Age(days)	Weight of cube (Kg)	Average tensile strength (N/mm^2)
0.2	7	13.1	3.35
	28	13.1	4.82

5.1 GLASS FIBERS

Table 5. Compression strength of Glass Fibers

% of Glass fibers	Curing Age(days)	Weight of cube (Kg)	Average compressive strength (N/mm^2)
0.2	7	8.62	17.30
	28	8.64	31.70
0.6	7	8.62	16.30
	28	8.64	31.13
1.0	7	8.62	20.55
	28	8.64	34.86

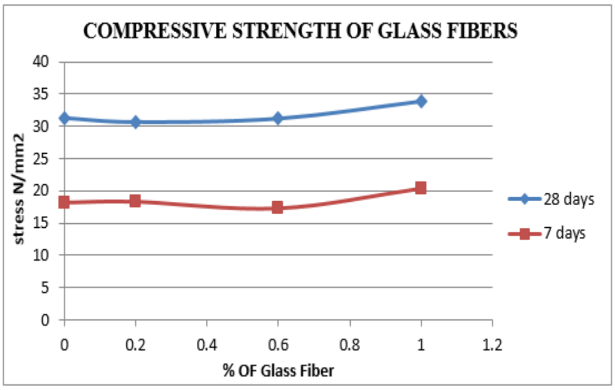

Chart 1. Compression strength of Glass Fibers

It is observed that there is linearly increasing in compression strength with 17.30 to 20.55 N/mm² (7days) & 31.70 to 34.86 N/mm² (28 days) for 0.2, 0.6, 1.0 % varying of glass fibers.

Table 6. Split tensile strength of Glass Fibers

% of Glass fibers	Curing Age(days)	Weight of cube (Kg)	Average tensile strength (N/mm^2)
0.2	7	12.4	3.36
	28	12.4	4.91
0.6	7	12.6	3.97
	28	12.6	5.26
1.0	7	12.8	4.40
	28	12.8	6.18

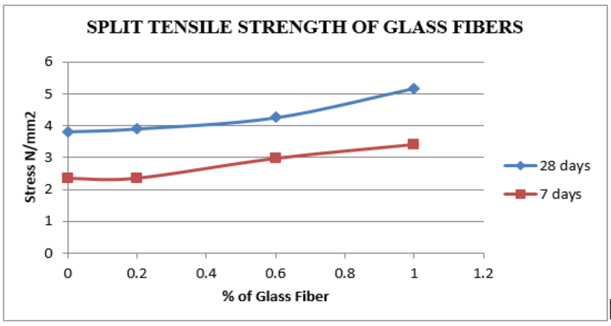

Chart 2. Split tensile strength of Glass Fibers

It is observed that there is a linearly increasing in split tensile strength with 3.36 to 4.40 N/mm² (7days) & 4.91 to 6.18 N/mm² (28 days) for 0.2, 0.6, 1.0 % varying of glass fibers.

5.2 STEEL FIBERS

Table 7. Compression strength of Steel Fibers

% of Steel fibers	Curing Age(days)	Weight of cube (Kg)	Average compressive strength (N/mm^2)
0.2	7	8.61	19.52
	28	8.59	31.6
0.6	7	8.41	22.78
	28	8.39	31.04
1.0	7	8.54	23.35
	28	8.49	35.42

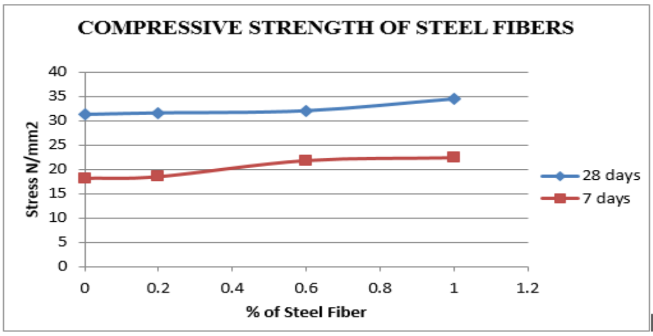

Chart 3. Compression strength of Steel Fibers

It is observed that there is a linearly increasing in compression strength with 19.52 to 23.35 N/mm^2 (7days) & 31.6 to 35.42 N/mm^2 (28 days) for 0.2, 0.6, 1.0 % varying of steel fibers.

Table 8. Split tensile strength of Steel Fibers

% of Steel fibers	Curing Age(days)	Weight of cube (Kg)	Average tensile strength (N/mm^2)
0.2	7	12.5	3.78
	28	12.5	5.7
0.6	7	12.70	3.85
	28	12.71	6.62
1.0	7	13.17	4.78
	28	13.17	7.88

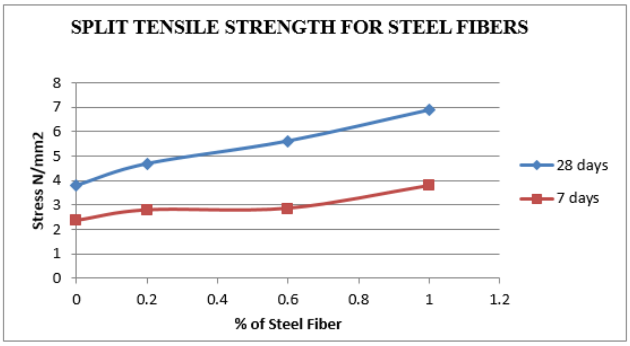

Chart 4. Split tensile strength of Steel Fibers

It is observed that there is a linearly increasing in split tensile strength with 3.78 to 4.78 N/mm^2 (7days) & 5.7 to 7.88 N/mm^2 (28 days) for 0.2, 0.6, 1.0 % varying of steel fibers.

5.3 COMPARISON OF GLASS & STEEL FIBERS WITH COMPRESSION & SPLIT TENSILE STRENGTH

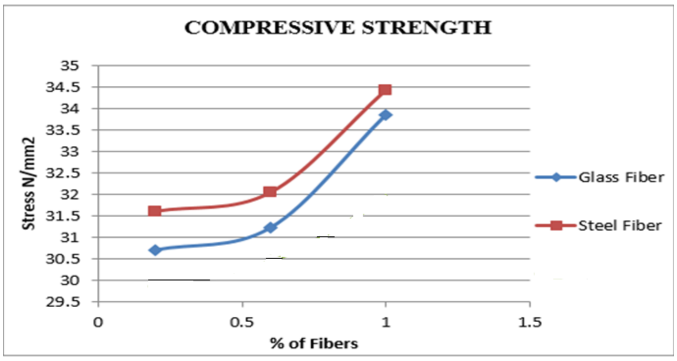

Chart 5. Comparison of Compression strength of Glass & Steel Fibers

It is observed that there is a linear increasing in compression strength with varied % of fibres. Compared to glass and steel fibers, the steel fibers has shown better results.

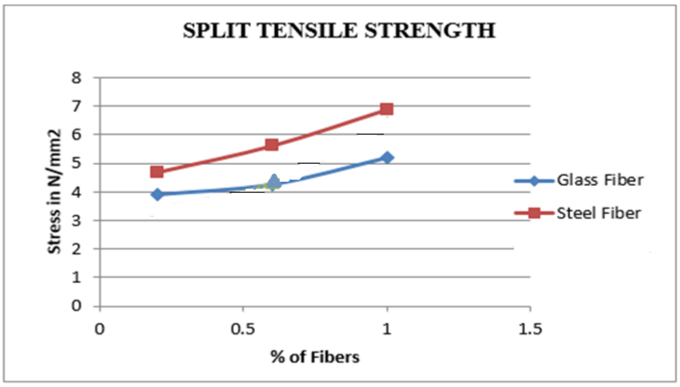

Chart 6. Comparison of Split tensile strength of Glass & Steel Fibers

It is observed that there is a linear increasing in tensile strength with varied % of fibers. Compared to glass and steel fibers, the glass fibers are not significant enough in increasing the tensile strength.

6. CONCLUSIONS

- The compression & tensile strength of Glass, Steel fiber reinforced concrete has increased significantly for varying % of fibers for 7 & 28 days.
- From the Compression strength test results it is shown that there is an increase in 8% strength in glass fiber reinforced concrete, 10% in steel fiber reinforced concrete as compared to that of conventional concrete.
- From the Split tensile strength test results it is shown that there is an increase in 28% strength in glass fiber reinforced concrete, 63% in steel fiber reinforced concrete, as compared to that of conventional concrete.
- From the Compression strength test results it shown that there is a decrease in 2% strength in glass fiber reinforced concrete as compared to that of steel fiber reinforced concrete.
- From the Split tensile strength test it shown that there is a decrease in 22% strength in glass fiber reinforced concrete as compared to that of steel fiber reinforced concrete.
- Based on the above discussions it is stated that steel fiber reinforced concrete gives the better strength compared to glass fiber reinforced concrete & conventional concrete.

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