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EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTH OF CONCRETE BY USING DIFFERENT FIBERS AT VARIOUS REPLACEMENT LEVELS

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ABSTRACT

Concrete is most widely used construction material in the world. Fiber reinforced concrete (FRC) is a concrete in which small and discontinuous fibers are dispersed uniformly. The fibers used in FRC may be of different materials like steel, G.I., carbon, glass, Aramid, asbestos, polypropylene, jute etc.

The addition of these fibers into concrete mass can dramatically increase the compressive strength, tensile strength, flexural strength and impact strength of concrete. In this study the results of strength properties of steel, glass, and polypropylene fiber reinforced concrete have been presented the compressive strength of concrete samples made with different fiber amounts varies from 0%, 0.25%, 0.5%, and 1% were studied. The samples with the addition of the different fibers showed better results with increase of fiber content.

KEY WORDS: Concrete, fiber reinforced concrete, steel fibers, glass fibers, polypropylene fibers, compressive strength.

INTRODUCTION

Deterioration of concrete structures is one of the major problems of the construction industry today. Since replacement of deficient structures brings in a lot of time and money strengthening has become the acceptable way of increasing the load carrying capacity and life. Concrete is the most widely used man-made construction material in the world, it is an economical material and the most utilized substance in construction industry. It is obtained by mixing cementing materials, water and aggregates, and sometimes add admixtures, in required proportions. The mixture when placed in forms and allowed to cure then it forms into a rock-like mass known as concrete. The strength, durability and other characteristics of concrete depend upon the properties of its ingredients, proportions of ingredients, the method of compaction and other controls during placing, compaction and curing.

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. Fiber Reinforced Concrete can be defined as it is a composite material consisting of mixtures of cement mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber-reinforced normal concrete are mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, piers, foundations etc.) either alone or with hand-tied rebar‟ s. Concrete reinforced with fibers (which are usually steel, glass or plastic fibers) is less expensive than hand-tied rebar, while still increasing the

tensile strength many times. Shape, dimension and length of fibers are important.

EXPERIMENTAL WORK

The experimental work was carried out to study the effect of strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7, 14 and 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 filled with steel glass, polypropylene fibers 0%, 0.25%,0. 5%,1% by volume of concrete. 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 room temperature.

MATERIALS AND ITS PROPERTIES:

The materials used in this project are given as follows

i. A 53 grade ordinary Portland cement
ii. Fine aggregate (Natural sand)
iii. Coarse aggregate
iv. Water (fresh water)
v. Fibers used

- Steel fibers
- Glass fibers
- Polypropylene fibers

MIX DESIGN

In this chapter, the concrete mix design is presented. The following mix design for grade M35 is based on Indian standard recommended method of concrete mix design IS: 10262-2009. In this introduced the methods of concrete mix design, factors to be effected on mix design and the outline procedure of the mix design.

Mix Design for M35 Grade:

STIPULATIONS FOR PROPORTIONING

a) Grade designation : M35

b) Type of cement : OPC 53 Grade
c) Maximum nominal size of aggregate : 2O MM, 10MM
d) Minimum cement content : 340 kg/m³
e) Maximum water-cement ratio : 0.42
f) Workability (slump value) : 100mm
g) Exposure condition : severe
h) Method of concrete placing : pumping
i) Degree of supervision : good
j) Type of aggregate :crushed angular
k) Maximum cement content : 470kg/m³

Test data for materials:

a)	Cement used	: OPC 53 grade
b)	Specific gravity of cement	: 3.15
c)	Specific gravity of:	
1)	Coarse aggregate	: 2.74
2)	Fine aggregate	: 2.55
e)	Water absorption:	
1)	Coarse aggregate	: 0.5 %
2)	Fine aggregates	: 1.0 %
f)	Free (surface) moisture	
1)	Coarse aggregate	: Nill
2)	Fine aggregate	: Nill

TARGET STRENGTH FOR MIX PROPORTIONING

f‟ ck = fck + 1.65 s (From table 1, IS 10262:2009 standard deviation, S=5N/mm²) Target strength = 35+1.65*5 = 43.25 N/mm²

SELECTION OF WATER-CEMENT RATIO

From table 5, of IS 456, maximum water- cement ratio = 0.45

Based on experience adopt water-cement ratio = 0.35, 0.35< 0.42, Hence ok.

SELECTION OF WATER CONTENT

From table 2, maximum water content for 20mmaggregates = 186litre

10mm aggregates = 208liter

Estimated water content for 100 mm slump = (60/100)186+ (40/100)208

= 195litres

CALCULATION OF CEMENT CONTENT

- Water – cement ratio = 0.42
- Cement content = 195/0.42

= 470 kg/m³

- From table 5 of IS 456 , minimum cement content for „severe‟ exposure condition

= 340 kg/m³

470kg/m^3 > 340 kg/m^3. Hence, ok.

PROPERTIES OF VOLUME OF COARSE AND FINE AGGREGATE CONTENT

Volume of coarse aggregate = (60/100)0.64+ (40/100)0.48

= 0.576

Volume of fine aggregate = 1-0.576

= 0.424

MIX CALCULATIONS

a) Volume of concrete = $1m^3$

b) Volume of cement = mass of cement/specific gravity of cement*1/1000

= 470/3.1*1/1000

= 0.1516 m^3.

c) Volume of water = mass of water/specific gravity of water*1/1000

= 195/1*1/1000

= $0.195m^3$

d) Volume of all in aggregates = (a-(b+c+d))

= 1-(0.1516+0.195)

= 0.6534 m^3

e) Mass of coarse aggregate = e*volume of coarse aggregate*specific gravity of coarse aggregate*1000

= 0.6534*0.57*2.74*1000

= 1025 kg

f) Mass of fine aggregate = e*volume of fine aggregate * specific gravity of fine aggregate*1000

= 0.6534*0.42*2.55*1000

= 700 kg.

MIX PROPORTIONS REQUIRED FOR COMBINED MIX

Cement: 470 kg/m^3

Water: 195 kg/m^3

Fine aggregate: 760 kg/m^3

Coarse aggregate: 1170 kg/m^3

Water-cement ratio: 0.42

GRADE	**PROPORTIONS**	**CEMENT(Kg/m³)**	**F.A(Kg/m³)**	**C.A(Kg/m³)**	**WATER(LT)**
M35	1:1.61:2.48	470	760	1170	195

Mix design

Grade	Type of Fiber	Proportions	Cement (Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)		%Water	%fiber (kg)
					20mm	10mm		
M35	Normal	0%	14.32	23.04	21.33	14.22	5.92	0
M35	Steel	0.25%	14.32	23.04	21.33	14.22	5.92	0.595
		0.5%	14.32	23.04	21.33	14.22	5.92	1.191
		1%	14.32	23.04	21.33	14.22	5.92	2.384

M35	Glass	0.25%	14.32	23.04	21.33	14.22	5.92	0.140
		0.5%	14.32	23.04	21.33	14.22	5.92	0.280
		1%	14.32	23.04	21.33	14.22	5.92	0.561
M35	Polypropylene	0.25%	14.32	23.04	21.33	14.22	5.92	0.073
		0.5%	14.32	23.04	21.33	14.22	5.92	0.147
		1%	14.32	23.04	21.33	14.22	5.92	0.294

Quantities of materials

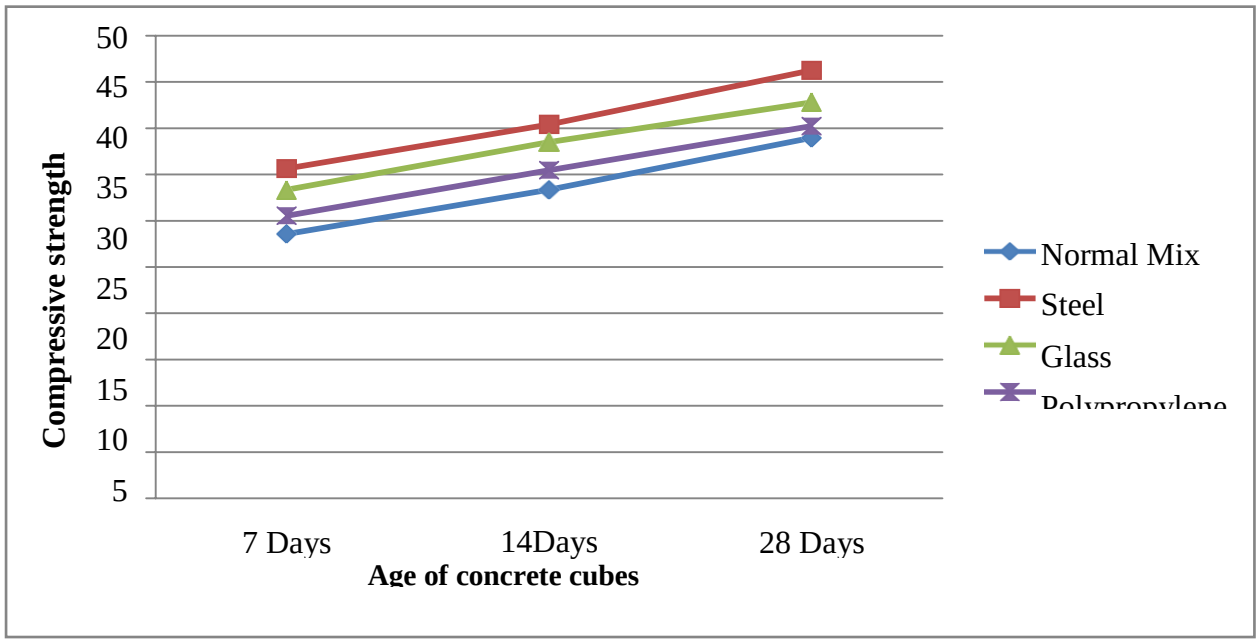
RESULTS AND DISCUSSIONS

The cubes were tested on the CTM under load rate control. All the cubes were tested under the load rate control. A photograph of the test setup (Fig:5.6). To understand the behavior of concrete cubes with and without fibers the following graphs were drawn, compressive strength Vs Age of concrete for 0%, 0.25%, 0.5%, and 1%fibers. (Fig 6.1, 6.2, and 6.3). The, maximum load and amount of fiber content added for the cubes subjected to loading were calculated and reported as follows.

S.no	Mix	% of fibers added	7 days	14 days	28 days
1	Normal mix	0%	28.56 N/mm^2	33.35 N/mm^2	38.96 N/mm^2
2	Steel fibre	0.25%	35.65 N/mm^2	40.43 N/mm^2	46.26 N/mm^2
		0.5%	38.5 N/mm^2	43.60 N/mm^2	50.25 N/mm^2
		1%	42.85 N/mm^2	46.87 N/mm^2	55.36 N/mm^2
3	Glass fibre	0.25%	33.35 N/mm^2	38.52 N/mm^2	42.80 N/mm^2
		0.5%	36.53 N/mm^2	40.85 N/mm^2	45.65 N/mm^2
		1%	39.46 N/mm^2	43.45 N/mm^2	49.83 N/mm^2

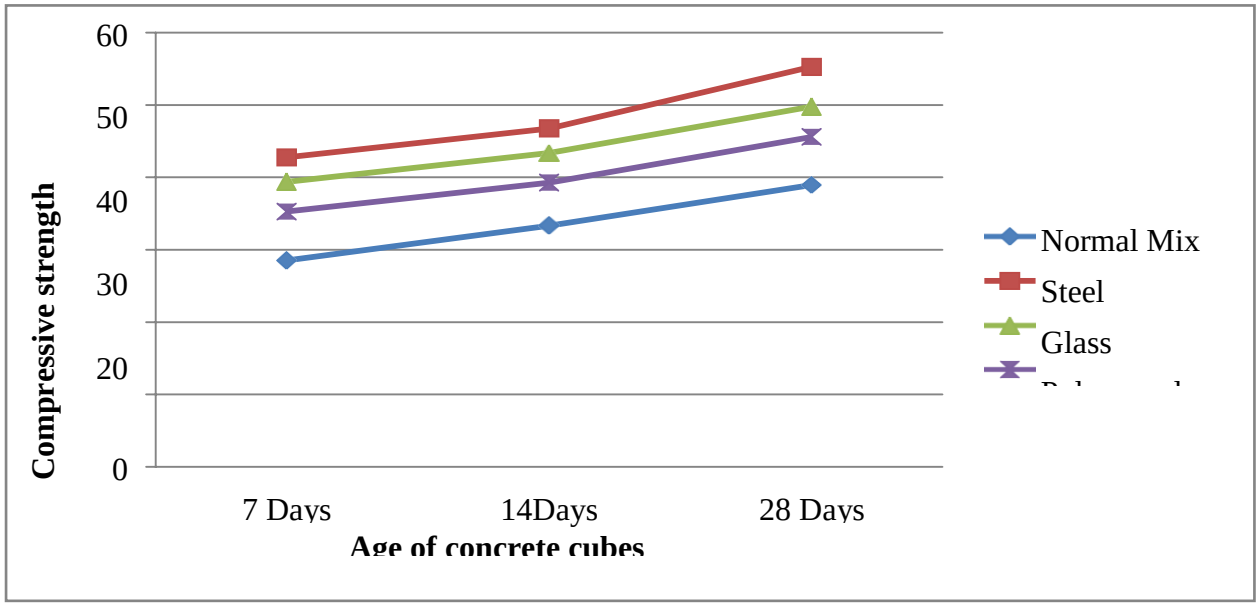
Compressive Strengths of Different Fiber Concrete Cubes

Compressive strength vs. age of concrete (0.25%)

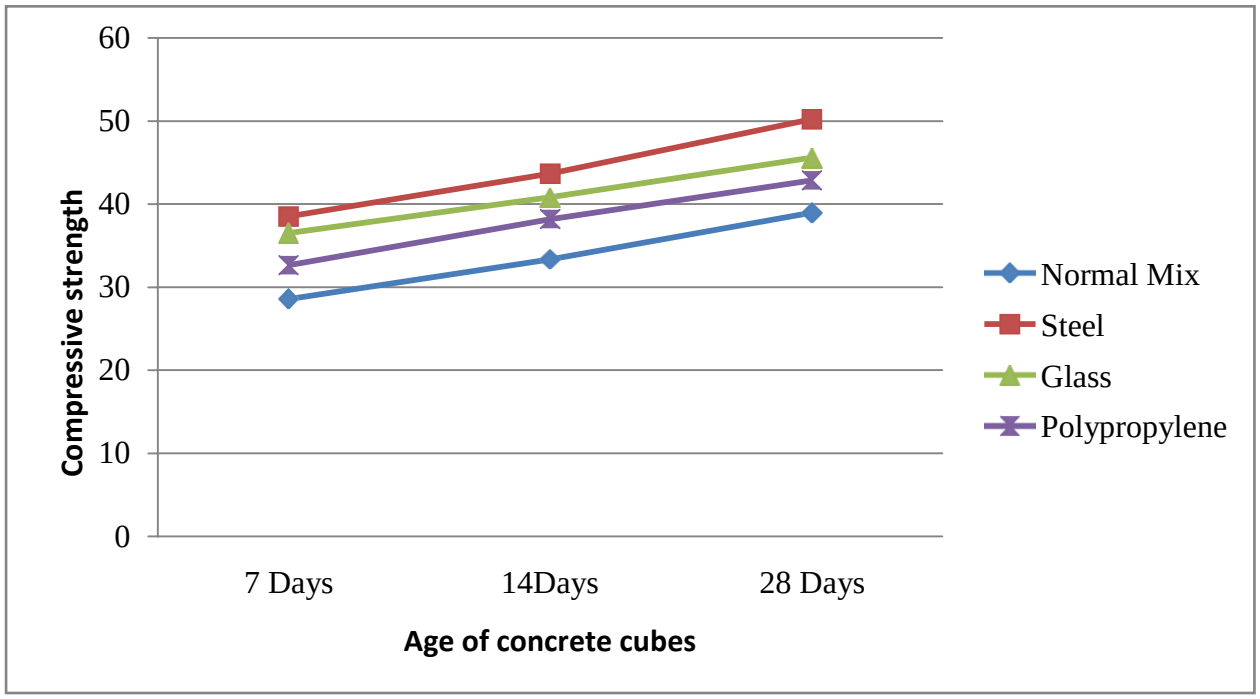


Compressive strength -Age of concrete cubes for 0.25% of fiber content Observations:

Compressive strength Vs age of concrete (0.5%)



Compressive strength vs. age of concrete (1%)



CONCLUSIONS

1. With the increase of fibre content the compressive strength increases.
2. The ultimate load behaviour is also improved due to the addition of fibres.
3. Steel fibres give more strength when compared to glass and polypropylene fibres.
4. The glass fiber reinforced concrete gives 21.8% with addition of 1% glass fiber volume of concrete with compared with normal mix.
5. The polypropylene fiber reinforced concrete gives 14.65% with addition of 1% polypropylene fiber volume of concrete with compared with normal mix.
6. The steel fiber reinforced concrete gives 22.48% with addition of 0.5% steel fiber volume of concrete with compared with normal mix.
7. The glass fiber reinforced concrete gives 14.65% with addition of 0.5% glass fiber volume of concrete with compared with normal mix.
8. The polypropylene fiber reinforced concrete gives 9.05% with addition of 0.5% polypropylene fiber volume of concrete with compared with normal mix.
9. The steel fiber reinforced concrete gives 15.78% with addition of 0.25% steel fiber volume of concrete with compared with normal mix.
10. The glass fiber reinforced concrete gives 8.97% with addition of 0.25% glass fiber volume of concrete with compared with normal mix.
11. The polypropylene fiber reinforced concrete gives 3.15% with addition of 0.25% polypropylene fiber volume of concrete with compared with normal mix.

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