Investigation on the comparison of Conventional Concrete & Fibre Reinforced Concrete

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Abstract—The production rate of concrete as well as the growth rate of infrastructure highlight and reflect the economic strength and the degree of civilization. It is well known that concrete is one of the most far used construction material all over the globe. Fibres have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. They can be effectively controlled cracking and use the concrete with crack free and also increase the overall properties like compressive, ductility, flexural, quality of the concrete. 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, which are resistant to most chemical attacks. Hence in this project Polypropylene fibres and glass fibres are used which are cheap and easily available type of fibres. In this project the scope and objective of the work has been finalized, the properties of materials such as cement, fine aggregate, coarse aggregate and fiber that are going to be used in the specimen preparation were determined and the values have been tabulated. The concrete cubes and beams are prepared and the strength properties such as compression strength and flexural strength are to be determined and compared with the conventional concrete.

Index Terms— Polypropylene, Glass fiber, Fibre-reinforced concrete.

I. INTRODUCTION:

Concrete is a construction material composed of cement as well as other cementetious materials such as fly ash and slag content, aggregate (generally a coarse aggregate such as gravel, limestone, or granite, plus a fine aggregate such as river sand), water, and chemical admixtures. 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. The promise of thinner and stronger elements reduced weight and controlled cracking by simply adding a small amount of fibres is an attractive feature of fibre-reinforced concrete. [1]The quality of good and durable concrete does not depend only on the quality of raw materials but also on proper mix-design, use of admixtures, placement, vibration and efficient curing. A number of additives are being used with concrete to enhance structural properties. The amount of fibres added to a concrete mix is measured as a percentage of the Cement. Weight of fiber fraction typically ranges from 0.1 to 3% of cement weight. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres – each of which lends varying properties to the concrete. [10]In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities.

Polypropylene is one of the cheapest and abundantly available polymers. [5]Polypropylene fibres are resistant to most chemical attacks and increase the flexural strength, compression strength as well as reduce the creep in concrete.

Early experimentation with[4] **glass fiber** reinforced concrete was unsuccessful because the type of glass that was used degraded when exposed to the high alkali matrix of the concrete. An alkali resistant glass that contained zirconia was experimented with and has been used since the 1970s. Over the past 40 years, studies have shown that the addition of glass fibers can increase the tensile and compressive strengths of concrete. A single glass fiber that is used in concrete can have anywhere from 50 to 200 strands, which increases the ductility because the matrix only bonds to the outer strands. Unlike steel fibers, corrosion of glass fibers is not a concern when using them in a concrete mix

II. PREPARATION OF CONCRETE MIX:

For **conventional concrete**: Proportioning of raw material was done for M20 concrete, produce of making concrete of desired quality and under assumed conditions of mixing, placing and curing.

For **Polypropylene Fiber concrete**: [9]Proportioning of raw material was done for M20 concrete, produce of making concrete of desired quality and under assumed conditions of mixing, placing and curing. Weight of coir **is taken as 0.25% by weight of cement.**

For **glass fiber concrete: [6]**Proportioning of raw material was done for M20 concrete, produce of making concrete of desired quality and under assumed conditions of mixing, placing and curing. The different dosages of glass fibre are 0.2% and 0.4% are used.

III. TESTS PERFORMED ON VARIOUS FRC:

Following tests were performed on concrete mix prepared by mixing different proportions of different fibers:

(1) Slump Test
(2) Compaction Factor Test
(3) Compressive strength Test
(4) Flexural strength Test

Workability Test for Concrete-

American Concrete Institute (ACI) Standard 116R-90 defines workability as "that property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, consolidated, and finished." [3][ACI 116R (1990)]

Table 1: Slump of different concrete type

S.NO.	Concrete Type	Slump
1.	Conventional Concrete	60mm
2.	Glass fibre reinforced concrete(0.2%)	80mm
3.	Glass fibre reinforced concrete(0.4%)	30mm
4.	Polypropylene Reinforced Concrete	20mm

Slump Test

[2]Workability is the measure of the ability of concrete to be mixed, handled, transported, placed, and consolidated. Slump test is used to determine the workability of fresh concrete. Slump test is performed per IS: 1199 – 1959 is shown in table no.1.

Compaction Factor Test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by Compacting factor test as per IS: 1199 – 1959. From Compaction factor Apparatus specified in IS: 1199-1959, all four concrete mixes were tested for workability & results are shown in table no.2[6]

Table 2: Compaction Factor for different concrete type

S.NO.	Concrete Type	COMPACTION FACTOR
1.	Conventional Concrete	0.94
2.	Glass fibre reinforced concrete(0.2%)	0.825
3.	Glass fibre reinforced concrete(0.4%)	0.821
4.	Polypropylene Reinforced Concrete	0.88

Compressive Strength Test- Compressive strength of concrete depends on many factors such as water-cement ratio, admixture, cement strength, quality of concrete material, and quality control during production of concrete etc.[8] The effect of fibres on the compressive strength of concrete has been discussed in many studies and resulted that these fibres either decrease or increase the compressive strength of concrete. For this, 24 cubes of different concrete of 15cm dimension was casted and tested in compression testing machine after curing of 7 & 28 days. From this results were obtained & tabulated in table no 3.

Table 3: Compressive Strength for different concrete

S. No.	Concrete type	Days	Compressive strength (N/mm²)
1.	Conventional concrete	7 days	16.0
		28 days	25.11
2.	Glass fibre reinforced concrete(0.2%)	7 days	17.21
		28 days	28.26
3.	Glass fibre reinforced concrete(0.4%)	7 days	18.12
		28 days	32.21
4.	Polypropylene Reinforced Concrete	7 days	25.11
		28 days	39.33

Flexural Test

Flexure strength is one of the measures of tensile strength of concrete.[9] Flexural test provides values for the modulus of elasticity in bending , flexural stress , flexural strain and the flexural stress-strain response of the material. It is the ability of a beam or slab to resist failure in bending. It is measured by loading un-reinforced concrete beams with a span three times the depth. The flexural strength is expressed as "Modulus of Rupture" (MR) in psi. Flexural MR is about 12 to 20% of Compressive strength. However, the best correlation for specific materials is obtained by laboratory tests. (As per IS: 516-1959 – Methods of tests for strength of concrete)

Beam mould of size 15 x 15x 75 cm (when size of aggregate is less than 38 mm) or of size 10 x 10 x 50 cm (when size of aggregate is less than 19 mm) is used for the test. Results are shown in table no

Table 4: Flexural Strength for different concrete

S. No.	Concrete type	Days	Flexural strength (N/mm²)
1.	Conventional Concrete	7 days	3.33
		28 days	5.11
2.	Glass fibre reinforced concrete(0.2%)	7 days	3.47
		28 days	5.60
3.	Glass fibre reinforced concrete(0.4%)	7 days	3.82
		28 days	6.28
4.	Polypropylene Reinforced Concrete	7 days	4.0
		28 days	6.44

IV. CONCLUSION

Based on the objectives set in the present study and the experimental work carried out in the laboratory, the following conclusions are drawn. As the fiber content was increased, the mix became more cohesive. Workability decreased as the fiber content increased.

- At 7 days, As compared to conventional concrete, compressive strength increased 56.93 % for 0.25% of Polypropylene fiber content.
- At 28 days, As compared to conventional concrete, compressive strength increased 56.63 % for 0.25% of Polypropylene fiber content.
- At 7 days, As compared to conventional concrete, compressive strength increased 7.5 % for 0.2% of Glass fiber content.
- At 28 days, As compared to conventional concrete, compressive strength increased 12.54% for 0.2% of Glass fiber content.

At 7 days, As compared to conventional concrete, compressive strength increased 13.25 % for 0.4% of Glass fiber content.

- At 28 days, As compared to conventional concrete, compressive strength increased 28.27% for 0.4% of Glass fiber content.
- At 7 days, As compared to conventional concrete, flexural strength increased 20.12% for 0.25% of Polypropylene fiber content.
- At 28 days, As compared to conventional concrete, flexural strength increased 26.02% for 0.25% of Polypropylene fiber content.
- At 7 days, As compared to conventional concrete, flexural strength increased 4.2 % for 0.2% of Glass fiber content.
- At 28 days, As compared to conventional concrete, flexural strength increased 9.5 % for 0.2% of Glass fiber content.
- At 7 days, As compared to conventional concrete, flexural strength increased 14.7% for 0.4% of Glass fiber content.
- At 28 days, As compared to conventional concrete,

flexural strength increased 22.89 % for 0.4% of Glass fiber content.

V. FUTURE SCOPE

- We can use these fibers at different percentage by weight of cement.
- Admixtures can also be used to reduce the number of voids which are formed to the present of fibres in the concrete.

VI. REFERENCES

[1]. ACI Committee "State-of-the-Art Report on Fiber Reinforced Concrete (ACI 544.1R-82)". Concrete International,. Vol. 4, No. 5, pp. 9-30 (May,1982).

[2].Craig, R.J.," Structural Applications of Reinforced Fibrous Concrete", ACI Concrete International, 6(12): 28-323 (1984).

[3].Naaman, A.E., Fiber Reinforcement for Concrete, ACI Concrete International, 7(3): 21-25 (March,1985)

[4].Bentur, A., and Mindess, S., "Fiber Reinforced Cementations Composites", Elsevier Applied Science, Amsterdam, The Netherlands (1990).

[5].Shah, Surendraand Rangan "Effect of Fiber addition on concrete strength", Indian Concrete Journal (1994),.

[6]. Saxena.A.K and Seema Singh- Effect of Strength in Grade Concrete with Partial Replacement of Glass Fibre-International Journal for Scientific Research and Development, Vol.3, Issue 09, 2015

[7]. Kumar A.D and Upendre Varma.A - Glass Fibre Reinforced Concrete-International Journal Of Engineering Reasearch and Application, Vol.3, Issue 5, Sept-Oct 2013

[8]. Bharti Tekwani and Komal Chawla - Studies of Glass Fibre Reiforced Concrete-International Journal of Structural and Civil Engineering Research,Vol.2, No.3, August 2013.

[9].Banthia, N. & Dubey, A. "Measurement of flexural toughness of fiber reinforced concrete using a novel technique", Part 1& 2 (1999).

[10].Bentur, A. & Mindess, S. Fibre Reinforced Cementitious Composites. London & New York: Taylor & Francis(2007).