Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 8; April-June, 2015 pp. 703-706

http://www.krishisanskriti.org/jceet.html

Comparative Study on Different Types of Fibres in Concrete

Gokilapriyadharshini.R[1], Lokesh.S[2] and Purushothoman.S[3]

[1,2,3]Student, Department of civil Engineering (PG) Dhirajlal Gandhi College of Technology Salem.
E-mail: [1]dharshini.raju@gmail.com, [2]lokeshselvam@hotmail.com, [3]purushothomanb6@gmail.com

Abstract—*Cement Concrete is the most extensively used material in construction, as it provides good ductility and can be moulded into any shape. Ordinary cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. It has been found that different types of fibres added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. The main objective is to study the physical properties of M 30 grade of concrete by adding glass fibre and polypropylene fibre and comparing with conventional concrete. The fibres are added from 0.1% to 0.5% to the volume of concrete. It has been observed that with the increase in fibre content up to the optimum value increases the strength of concrete. The concrete specimens were tested at different age level for mechanical properties of concrete, namely, cube compressive strength, split tensile strength, flexural strength of beams and other tests were conducted for cement, chemical admixture, coarse aggregate and fine aggregate.*

Keywords: *Glass fibre, Polypropylene, Super plasticizer, Compressive strength, Split tensile strength, Flexural strength.*

1. INTRODUCTION

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. Concrete is most widely used as building material because of its versatility. It has desirable engineering properties.

Fibre-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres – each of which lends varying properties to the concrete. In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. Addition of fibres to concrete makes it a homogeneous and isotropic material. When concrete cracks, the randomly oriented fibres start functioning, arrest crack formation and propagation, and thus improve strength and ductility.

Alkali Resistant Glass Fiber is a recent introduction in making fibrous concrete. Glass fiber which is originally used in conjunction with cement was found tobe affected by alkaline condition of cement. Therefore Cem-Fil (2002) alkali resistant glass fiber has been developed and used.

Polypropylene (PP), also known as polypropene, is a thermoplastic polymerused in a wide variety of applications including packaging and labeling, textiles(e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes.

Polypropylene fibers (at relatively low volume fractions <0.3%) are used for: secondary temperature shrinkage reinforcement, overlays and pavements, slabs, flooring systems, crash barriers, precast pile shells and shotcrete for tunnel linings, canals and reservoirs. According to the researches, the increase of formability and bending strength are the extra advantages of adding the fibers to the concrete.

2. MATERIALS

The material used in this project are discussed below briefly on their characteristic of physical and chemical properties.

2.1 Cement

The cement used in this investigation is Ordinary Portland Cement (OPC 53 grade) which was delivered from ‘‘Ultra tech’’. Testing of cement was carried out per the Indian Standard Specifications IS: 8112-1989. The Specific gravity of cement is 3.12.

2.2 Aggregate

Local dolomite and sand from natural sources were used in the experimental work. The used crushed dolomite has a nominal maximum size of 12 mm. Testing of natural coarse aggregate and sand were carried according to the Indian Standard Specifications The results are presented in Table 1.

Table 1: Properties of Aggregate

S. no	Property	Fine Aggregate	Coarse Aggregate
1	Specific gravity	2.613	2.625
2	Water Absorption	1.0%	0.5%
3	Fineness modulus	2.72	6.15
4	Moisture content	2%	--
5	Surface Texture	Smooth	--

2.3. Glass fibre

Cem-Fil ARC14 306HDglass fiber is used. The properties are shown in Table 2.

Table 2: Properties of glass fibre Cem-Fil ARC14 306 HD.

Fibres	AR – Glass
Density(t/m3)	2.6
Aspect ratio	600
Elasticmodulus(GPa)	73
Tensilestrength(MPa)	1700
Density(micron)	14
Length(mm)	6

Polypropylene

The fibres used were fine polypropylene monofilaments .The fibres were supplied by Reliance Industry by name RECRON 3s .In the present investigation 20mm fibre length is used.

Table 3: Properties of Polypropylene

Fibres	Polypropylene
Density(t/m3)	0.9
Aspect ratio	200
Elasticmodulus(GPa)	5
Tensilestrength(MPa)	450
Density(micron)	24
Length(mm)	20

2.5. Chemical admixture

The chemical admixture used for the investigation is super plasticizer Conplast sp430. For super plasticizer as per IS 456:2000, the dosage should not exceed 2% by weight of cement. In this experiment, 0.9% by weight of cement was used.

3. MIXES FEATURES

The concrete mix design is made for M30 grade. The mix ratio is 1:0.43:1.76:2.68. In this research, the concrete samples are mixed with fibres in the ratio of 0.1, 0.2, 0.3, 0.4 and 0.5 % by volume of concrete.

4. METHODS OF INVESTIGATION

4.1. Determination of the fresh properties

In this experimental work, the following fresh concrete tests were carried out:

(i) Slump-flow test for flowability and viscosity

(ii) Compaction factor test

4.2. Determination of the hardened properties

In this research work, the following tests on hardened concrete were carried out:

a) Compressive strength
b) Splitting tensile strength
c) Flexural strength

5. EXPERIMENTAL PROCEDURE

5.1 Preparation and Casting of Test Specimens

The concrete mix proportions used in the testing program. In the preparation of concrete, pan mixer is used and the constituent materials were initially mixed without fibres. The fibres were then added in small amounts to avoid balling of fibres and to produce concrete with uniform material consistency and good workability. The glass fibre reinforced concrete and polypropylene fibre reinforced concrete were placed into moulds and a vibrator was used to decrease the amount of air bubbles. The specimens were demoded after 24 hours and then placed in a curing tank for 28 days and the specimens were removed from curing tank and allowed to air dry 12 hours prior to test.

For 150 mm x 300 mm cylindrical specimen, 150 mm x 150 mm cube specimen and 1000 mm x 100 mm x 150 mm beams were prepared and tested for the strength properties.

6. RESULTS AND DISCUSSIONS

6.1. Compressive strength

From the test results, it is observed that with increase in fibre percentage, the compressive strength also increases with age in case of glass fibres.

At the age of 7 days with 1.5% fibre, the compressive strength is 15.36% in excess over the strength of reference mix and for 28 days, it is 16.89% in excess of reference mix.

Table 4: Compressive strength of GFRC with various percentages of glass fibres.

Glass fibre (%)	Compressive strength (N/mm2) after 7 days	Compressive strength (N/mm2) after 28 days	% increase over the reference mix
0.00	34.45	46.20	
0.10	35.60	47.80	6.20
0.20	36.78	51.00	7.50
0.30	38.54	54.00	16.60
0.40	38.60	54.02	16.70
0.50	38.75	54.07	16.80

Table 5: Compressive strength of PFRC with various percentages of polypropylene fibres.

Polypropylene fibre (%)	Compressive strength (N/mm2) After 7 days	Compressive strength (N/mm2) After 28 days	% increase over the reference mix
0.00	34.45	46.20	
0.10	34.95	47.15	6.98
0.20	39.90	42.82	16.42
0.30	37.50	40.20	16.25
0.40	35.90	40.00	16.10
0.50	35.10	39.58	15.22

6.2. Split tensile strength

From the test results, it is observed that tensile strength of fibres increases for 1.5% fibre content.

Table 6: Split tensile strength of GFRC with various percentages of glass fibres.

S. No	Polypropylene fibre (%)	Split tensile strength (N/mm2) after 7 days	Split tensile strength (N/mm2) after 28 days
1	0.00	2.45	3.30
2	0.10	2.50	3.82
3	0.20	2.62	3.90
4	0.30	3.10	4.30
5	0.40	3.15	4.32
6	0.50	3.13	4.35

Table 7: Split tensile strength of PFRC with various percentages of polypropylene fibres.

S. No	Polypropylene fibre (%)	Split tensile strength (N/mm2) after 7 days	Split tensile strength (N/mm2) after 28 days
1	0.00	2.14	3.10
2	0.10	2.25	3.35
3	0.20	2.59	3.72
4	0.30	2.83	4.09
5	0.40	3.50	4.95
6	0.50	2.70	3.85

6.3 Flexural Strength

The strength effectiveness indicates that the values of all fibrous concrete were significantly higher than of control concrete. From the strength effectiveness in the below table shows that the improvement started from 15.58% to 37.54%. The polypropylene fibre (G70P30) shows 37.54% increase in strength effectiveness.

Table 8: Flexure Strength for Fibre Reinforced Concrete

Designation	Fibre volume (%)			Flexural strength (MPa)	
	Glass fibre	Polypropylene fibre	Total	Measured value	Strength Effectiveness (%)
G0P0	0	0	0	6.74	0
G0P100	0	1.5	1.5	7.79	15.58
G30P70	0.45	1.05	1.5	8.75	29.82
G100P0	1.50	0	1.5	8.18	21.36
G70P30	1.05	0.45	1.5	9.27	37.54

Table 9: Yield Load and Yield Deflection

S. N o	Specimen designation	Yield load (kN)	Deflection (mm)
1.	G0P0	21.52	16.75
2.	G0P100	31.09	17.84
3.	G30P70	32.80	18.89
4.	G100P0	33.98	21.72
5.	G70P30	36.67	23.68

Table 10 Ultimate Load and Ultimate Deflection

Sl. No.	Specimen Designation	Ultimate Load (kN)	Ultimate Deflection (mm)
1.	G0P0	32.41	16.87
2.	G0P100	38.29	20.19
3.	G30P70	40.37	22.57
4.	G100P0	42.45	23.79
5.	G70P30	48.78	26.98

7. CONCLUSION

Based on the test results of this investigation, the following conclusions are drawn:

1. Addition of fibers in concrete improves strength when compared to the plain concrete.
2. The overall performances of reinforced concrete improved by adding of 1.5% with 70-30 glass polypropylene when compare with other proportions and conventional concrete.
3. An overall evaluation of the flexural test results and load deflection curves indicate that hybrid fiber reinforced concrete exhibit higher load carrying capacity.
4. The maximum yield load was found to be 70.40% with 1.50% high strength hybrid fiber G70P30 and 57.90% are found to be G100P0 mix when compare with conventional beam.
5. The increase in yield deflection was found to be 41.37% with 1.50% high strength hybrid fiber content when compared to the conventional beam and 29.67% when compared with specimens consisting of 100% glass fibers.
6. Ultimate load was found to be 50.51% with 1.50% hybrid fibre content when compared to the conventional beam and 30.98% when compared with specimens consisting of 100% glass fibers.
7. Ultimate deflection was found to be 59.93% with 1.50% hybrid fibre content when compared to the conventional beam.
8. The strength effectiveness at volume fraction of 1.50% for G70P30 showed a maximum for flexural strength, followed by split tensile strength and compressive strength.

9. From the experimental results clearly indicates that the addition of fibers enhances the load carrying capacity of beam when compared to the conventional beam. In that fiber mix particularly, G70P30 produces enhanced upshot.

8. SCOPE FOR FURTHER STUDY

1. The high strength beam with fibre volume fraction can be optimized for glass and polypropylene fibre.
2. The different types and different combination of fibers can be analyzed.

REFERENCES

[1] Alhozaimy, A.M., Soroushian, P. and Mirza.F, (1996), Mechanical Properties of Polypropylene Fibre Reinforced Concrete and the Effects of Pozzolanic Materials, Cement and Concrete Composites, 18, pp.85 - 92.

[2] Avinash Gornale, S. Ibrahim Quadri and Syed Hussaini (2012), “Strength aspect of Glass fiber reinforced concrete”, International journal ofScientific and Engineering research, vol, 3, issue 7.

[3] Balaguru. P and Najm. H, (2004), High Performance Fibre Reinforced Concrete Mixture Proportions with High Fibre Volume Fractions, ACI Material Journal, 101(4),pp. 281-286.

[4] Banthia N, Nandakumar N. Crack growth resistance of hybrid fibre reinforced cement composites. Cem Concr Compos 2003;25:3–9.

[5] Baruah.P and Talukdar.S, (2007), A Comparative Study of Compressive, Flexural, Tensile and Shear Strength of Concrete with Fibers of Different Origins, The Indian Concrete Journal, pp.17-24.

[6] Chandramouli K, Srinivasa Rao P, Pannirselvam N, Seshadri Sekhar Tand Sravana P, “Strength properties of glass fibre concrete”, ARPN Journal of Engineering and Applied Sciences, Vol. 5, no. 4, April 2010.

[7] Eswari.S, Suguna.K, and Jagannthan.A, (2008), Flexural Behaviour of Hybrid Cement Composites with Polyolefin fibre, Proceedings of Eighth International Symposium and Workshop on Ferrocement and Thin Reinforced Cement Composites, Thailand, pp.265-274.

[8] Eng. Pshtiwan, N. Shakor, Prof. S. S. Pimplikar, Glass Fibre Reinforced Concrete Use in Construction, International Journal of Technology and Engineering System (IJTES): Jan –March 2011- Vol.2.No.2.

[9] Gowri.R, AngelineMary.M, Effect of glass wool fibres on mechanical properties of concrete, International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue7- July 2013.

[10] Kawamata.A, Mihashi. H, and Fukuyama. H, (2003), Properties of Hybrid Fibre Reinforced Cement-Based composites, Journal of Advanced Concrete Technology, JCI, 1(3), 283-290.