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"Fiber Reinforced Concrete"

Prof. R.R. Badeghar, Mr. Waghmare Shashikant, Mr. Yampale Pradip Mr. Awtade Raviraj, Mr. Chippa Pranav, Mr. Dhede Rohan, Mr. Kamble Krishna, Mr. Shinde Shubham,

Department of Civil Engineering, Punyashlok Ahilydevi Holkar University, N B Navale Sinhgad College *of Engineering, Kegaon*-Solapur. *Gat No. 38/1 B, Kegaon,* Solapur *Pune Highway,* Solapur-*413255 (Maharashtra)*

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ABSTRACT— The use of polypropylene and steel fiber in reinforced concrete to enhance the properties of concrete. In the present-day construction industry needs of finding effective materials for increasing the strength of concrete structures. In this present investigation the attempt has been made to study the fresh concrete properties of high strength fiber reinforced concrete. It includes wet density, Temperature and workability by addition of hooked end steel fibers at 0.5%, 0.7%, 0.9% and polypropylene at 0.1%, 0.2% and 0.3%.

I. INTRODUCTION

Concrete is weak in tension and has a brittle character. The concept of using fibres to improve the characteristics of construction materials is very old. Early applications include addition of straw to mud bricks, horse hair to reinforce plaster and asbestos to reinforce pottery. Use of continuous reinforcement in concrete (reinforced concrete) increases strength and ductility, but requires careful placement and labour skill. Alternatively, introduction of fibres in discrete form in plain or reinforced concrete may provide a better solution. The modern development of fibre reinforced concrete (FRC) started in the early sixties 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.

The failure modes of FRC are either bond failure between fibre and matrix or material failure. In this paper, the state-of-the-art of fibre reinforced concrete is discussed and results of intensive tests made by the author on the properties of fibre reinforced concrete using local materials are reported. Portland cement is a very commonly used construction material. Concrete made with this cement has certain characteristics. It is relatively strong in compression but weak in tension and tends to be brittle. Because of the load and environmental changes, a micro crack appears in cement products. Therefore, cement-based materials have low tensile strength and cause brittle failure.

The weakness in tension can be overcome by the use of sufficient volume fraction of certain fibres. In order to improve the mechanical properties of concrete it is good to mix cement with fibre which have good tensile strength. Adding fibres to concrete greatly increases the toughness of the material. The use of fibres also alters the behaviour of the fibre matrix composite after it has cracked, thereby improving its toughness. Incorporation of steel and polypropylene materials in concrete significantly improve its bleeding, plastic settlement, thermal and shrinkage strains, and stress concentrations imposed by external restraints. Under an applied load, distributed micro cracks propagate to produce macro cracks. When loads are further increased, conditions of critical crack growth are attained at the tip of the macro cracks and the crack becomes unstable. The micro and macro fractioning process described above can be favourably modified by adding short and randomly distributed fibres of various suitable materials.

II. LITERATURE REVIEW

1.Zoran J. Grdic (2011)

This paper presents a research of abrasive resistance of classic concrete and micro-reinforced concrete with two types of polypropylene fibers. Water/cement factor was varied from 0.5 to 0.7, while the content (in%) of the remaining components remained constant.

The research results demonstrate that the abrasive resistance of concrete is in an inverse function of the water/cement factor; the concretes with higher compressive strength and higher bending strength have also the higher abrasive resistance; the micro-reinforced concretes demonstrate higher abrasive resistance in comparison to the benchmark concrete. personalized features. Whereas, our proposed system saves energy & intelligently calculates the desired temperature every time.

2.S. C. Patodi, C. V. Kulkarni (2012)

In a Hybrid Fiber Reinforced Concrete (HFRC), two or more different types of fibers are rationally combined to produce a cementitious composite that derives benefits from each of the individual fibers and exhibits a synergistic response. The main aim of the present experimental investigation was to use different volume fractions of Recron 3S fibers (polyester fibers) and continuously crimped steel fibers to produce HFRC and thus to evaluate its performance under compression, tension, flexure, shear and impact types of loading. Total 12 different types of HFRC matrices were considered for performance evaluation. The improvement in mechanical properties of a matrix having volume fraction hybridization of 0.3 % Recron and 0.7% of steel fibers was found to be the best.

3.Dharani.N (2013)

Hypo sludge was used as a replacement to cement. Replacement percentages used during the study were 10%, 20%, 30%, 40%, 50%. For each replacement percentage of cement with hypo sludge, 0.2%, 0.3%, 0.4% of Recron 3s fibres were added and specimens were cast to determine the mechanical properties. The optimal replacement percentage of cement with hypo sludge was found to be 30% when Recron 3s fibers are not added. On addition of Recron 3s fiber with cement matrix, the compressive strength and split tensile strength decreased with increase in fiber content, however the flexural strength increases with increase in fiber content. When hypo sludge and Recron 3s fiber added, the optimum dosage of Hypo sludge was 20% and optimum Fiber content was 0.4%.

4.S. Sharmila (2014)

When concrete is reinforced with random dispersed fibres which prevent micro cracks from widening. Addition of two fibres of different properties can improve the properties of fresh concrete. This paper deals with the flexural behaviour of Hybrid Fibre Reinforced Concrete beams (Namely RCC, SFRC, HFRC1, HFRC2) cast with Steel, Glass and Recron-3s fibres under cyclic loading. The various parameters such as load carrying capacity, stiffness degradation, ductility characteristics and energy absorption capacity of FRC beams were compared with that of RC beam. The companion specimens were cast and tested to study strength properties and then the results were compared. In general, it is concluded that the effect of adding hybrid fibres influence the behaviour of beams by increasing the ductility characteristics by 80% and energy absorption characteristics by more than 160%.

5.T. Sandeep (2015)

Hypo sludge was used as a replacement to cement. Replacement percentages used during the study were 10%, 20%, 30%, 40%, 50%. For each replacement percentage of cement with hypo sludge, 0.2%, 0.3%, 0.4% of Recron 3s fibres were added and specimens were cast to determine the mechanical properties. The optimal replacement percentage of cement with hypo sludge was found to be 30% when Recron 3s fibers are not added. On addition of Recron 3s fiber with cement matrix, the compressive strength and split tensile strength decreased with increase in fiber content, however the flexural strength increases with increase in fiber content. When hypo sludge and Recron 3s fiber added, the optimum dosage of Hypo sludge was 20% and optimum Fiber content was 0.4%

III. METHODOLOGY

- **Material properties**
- **Cement**

Cement used is **Pozolona Portland cement (PPC)** having **53 grade** as per **IS 12269-1970** cement. This cement is brought from **ULTRATECH CEMENT PVT.LTD.** The preliminary tests like normal consistency, specific gravity, initial setting time and final setting time test conducted and result are listed below.

- **Properties of cement**

Sr.No.	Properties	Test Result
1	Specific gravity	3.14
2	Normal consistency	35%
3	Initial setting time	30min
4	Final setting time	5 hrs
5	Compressive strength	53Mpa (28 days)

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- **Coarse aggregate**

Locally available coarse aggregate passing through 20mm sieve and retained on 4.75mm sieve were used for this experimental study. Differential test is conducted on coarse aggregate are specific gravity, water absorption, fineness modulus is tested and resulted are tabulated below.

- **Properties of Coarse Aggregate**

Sr. No	Properties	Test Result
1	Shape of aggregate	Angular
2	Specific gravity	2.67
3	Water absorption	0.5%
4	Fineness modulus	4.5

- **Fine aggregate**

Locally available sand with zone 2 specification passing through 4.75mm sieve as per IS 383-1983. Different test are conducted on fine aggregate as per specific gravity, water absorption, fineness modulus are tested and resulted are tabulated below

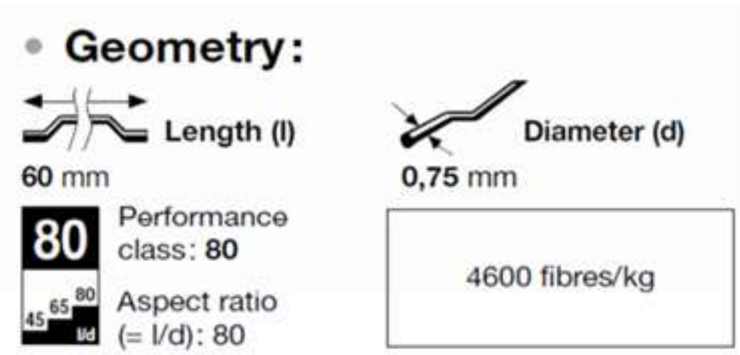
- **Properties of Fine aggregate**

Sr. No	Properties	Test Result
1	Specific gravity	2.91
2	Water absorption	1%
3	Fineness modulus	2.5
4	Type and zone	M-Sand and Zone 2

- **Water**

Portable water used for this experimental study during both casting as well as curing of specimen as per IS 456-2000.

- **Steel fiber**



- **Properties of hooked end steel fiber**

Properties of Fibers	Values
Length	60 mm
Diameter/Equivalent Diameter (mm)	0.75 mm
Aspect Ratio	80
Specific Gravity	7.85
Water Absorption (%)	0.0
Density in kg/m3	7850

The percentage of steel fiber was varied uniformly. 0.5%, 0.7%, 0.9% and 0.1%, 0.2%, 0.3% polypropylene fiber by volume of mix was added. Based on above properties the quantity of steel fiber to be used for each percentage was derived as follows: Quantity of steel fiber = percentage x mould size x density of fiber.

Evaluation of Quantity of Steel Fiber

Fiber Percentage (%)	Percentage X Mould Size X Density of Fiber	Quantity
0.5	0.5 /100 × 0.15 × 0.15 × 0.15 × 7850	0.132 Kg
0.7	0.7 /100 × 0.15 × 0.15 × 0.15 × 7850	0.185 Kg
0.9	0.9 /100 × 0.15 × 0.15 × 0.15 × 7850	0.238 Kg

Polypropylene Fiber

Properties of Fibers	Values
Density(g/cm3)	0.91
Elastic Modulus (MPa)	>3500
Length(mm)	24
Equivalent Diameter (micron)	100
Acid &Alkali Resistance	Strong
Water-Absorbency	No
Tensile Strength (MPa)	346-560
Melting Point(C)	160-170

The percentage of polypropylene fiber was varied uniformly with respect to steel fiber 0.5%, 0.7%, 0.9% and 0.1%, 0.2%, 0.3% polypropylene fiber by volume of mix were added. Based on above properties the quantity of steel fiber to be used for each percentage was derived as follows:

Evaluation of Quantity of Polypropylene Fiber

Fiber Percentage (%)	Percentage X Mould Size X Density of Fiber	Quantity
0.1	0.5 /100 × 0.15 × 0.15 × 0.15 × 7850	3.071 gm
0.2	0.7 /100 × 0.15 × 0.15 × 0.15 × 7850	6.143 gm
0.3	0.9 /100 × 0.15 × 0.15 × 0.15 × 7850	9.213 gm

- **Mix proportion**

A mix design was done as per IS 10262 – 1982 to achieve minimum target strength of **25 N/mm2.** The same mix design was used for fiber reinforced concrete. The quantities of different ingredients per cubic meter of concrete mix are given below.

Mix design for M25 grade concrete

1) Target strength:

Fck' = Fck +1.65s
= 25+1.65 x 4
= 31.6 Mpa...IS 10262- 2009

2) Selection of Water Cement Ratio

IS 456:2000 From tabling no 5 max. W/c ratio for M25 = 0.55 and min cement content 300 kg/m3. Select water content 0.55.

3) Selection of Water Content Max.

Water content for 25 mm aggregate is 186 liters for 25 to 50 mm slump.
For 100mm slump=186+ 6/100 x186=197.16 lit.

4) Cement content: -

W/C ratio =0.55
Cement content =197.16/0.55
=358.47 kg/m3
Adopting Cement content = 360 Kg/m³

5) Volume of coarse aggregate:

Zone of Sand is II from table no 2 IS-10262-2009 for 20 MSA aggregate is Coarse aggregate = 0.60

And volume of fine aggregate = 1-0.6 =0.4

Mix Calculations: -

The mix calculation per unit volume of concrete shall be as follows: -

A) Volume of concrete = 1 cu. meter

B) Volume of cement = mass of cement /Sp.gr.of cement x 1/1000

= 360/3.15 x 1/1000
= 0.1142 cu. meter.

C) Volume of water

=197.16 x (1/1000)
=0.19716 cu. meter.

D) Volume of all agg.

= (1-(0.1142+0.1971))
=0.6887 cu. meter

Sr. No.	Steel Fiber %	Polypropylene Fibers %	3^{rd} day's compressive strength of (150X150X150) mm cube.	Average
1	0	0	11.55	10.96
2		0	11.11	
3		0	10.22	
4		0.1	14.22	

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5	0.5	0.1	18.66	16.44
6		0.1	16.44	
7		0.2	13.77	15.7
8		0.2	17.33	
9		0.2	16	
10		0.3	11.56	12.73
11		0.3	12.88	
12		0.3	13.77	
13	0.7	0.1	24.88	23.10
14		0.1	21.77	
15		0.1	22.67	
16		0.2	13.33	12.88
17		0.2	12.88	
18		0.2	12.44	
19		0.3	15.11	15.70
20		0.3	16	
21		0.3	16	
22	0.9	0.1	15.11	15.55
23		0.1	16	
24		0.1	15.55	
25		0.2	16.44	15.40
26		0.2	14.22	
27		0.2	15.55	
28		0.3	14.66	14.96
29		0.3	16	
30		0.3	14.22	

E) Mass of C.A.
= D x vol. of C.A. x sp. Gr. C.A. x1000
=0.6887 x0.6x 2.67 x1000
= 1117 Kg

F) Mass of fine agg.
= D x vol. of F.A. xsp.gr. x1000
= 0.6887 x0.4 x2.91 x1000
= 714.92 kg
Therefore, for M25 concrete we get the proportions of cement: fine aggregate: coarse aggregate as 1:1.62:2.54.
Cement=360 kg/m3
Water=197.16 liters kg/m3
Fine Aggregate=714.92 kg/m3
Coarse Aggregate=1117 kg/m3

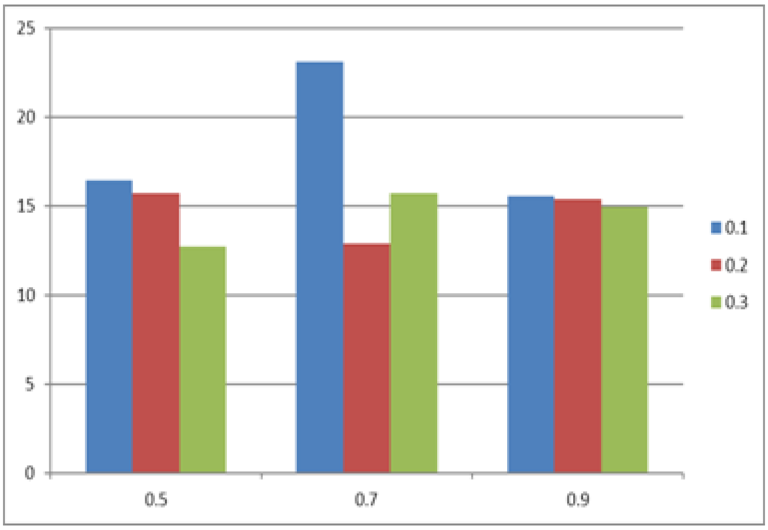
- **Compressive strength of concrete**

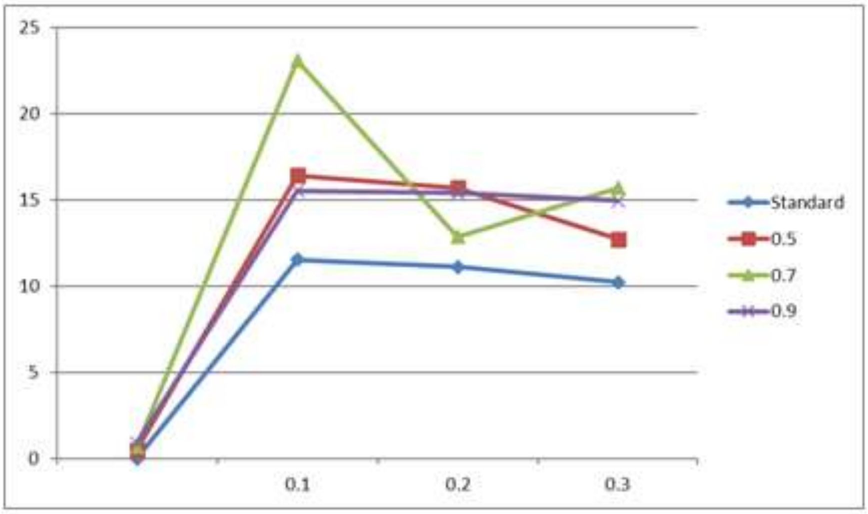
For compressive strength test, cube specimen of dimension 150x150x150 mm were cast using M25 grade of concrete with 0.5%, 0.7%, 0.9% of steel fiber, 0.1%, 0.2%, and 0.3% of polypropylene fiber. Vibration was given to the mould using table vibrator. The top surface of the specimen was 2083 levelled and finished. After 24 hours, the specimen was demoulded and transferred to curing tank wherein they were allowed to cure for 3 days, 7 days and 28 days of curing, these cubes were tested on compression testing machine.
The failure load was noted. In each category, there cubes
were tested and their average value is reported. The compressive strength was calculated as follows: Compressive strength (Mpa) =Failure load/cross section area Results compressive strength for M25 grade of concrete of concrete on cube specimen.

IV. RESULT AND CONCLUSION:-

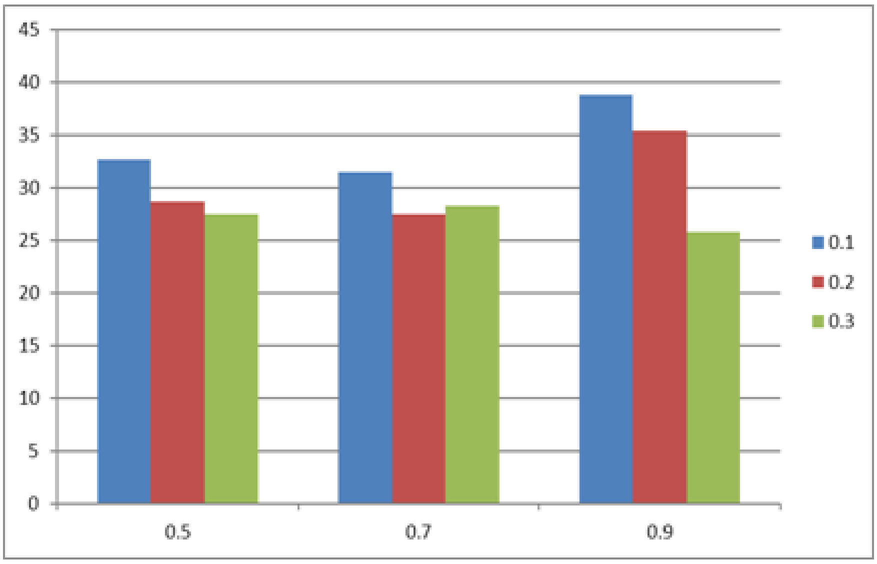
- **Result**

Compressive strength of concrete cube of size 150x150x150 mm for M25 for 3 days of compressive strength:





2.Compressive strength of concrete cube of size 150x150x150 mm for M25 for 14 days of compressive strength:



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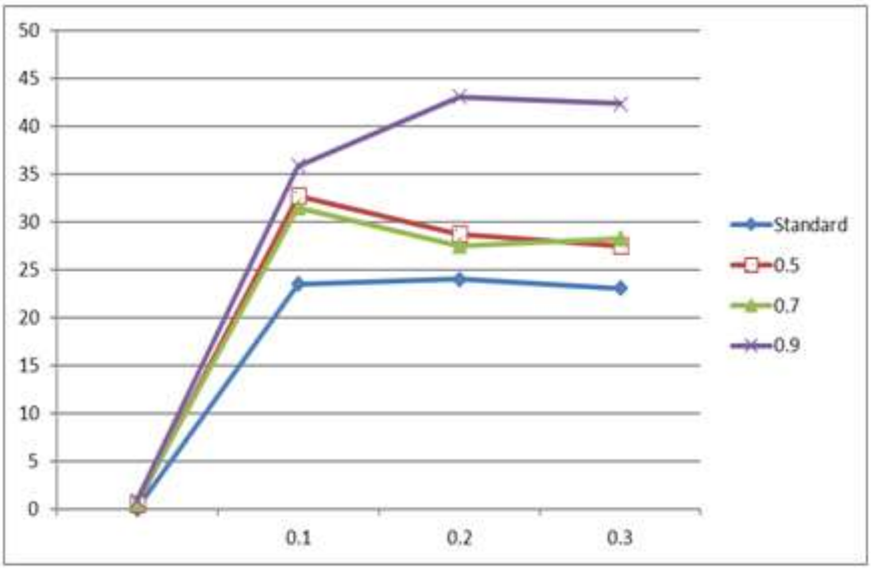
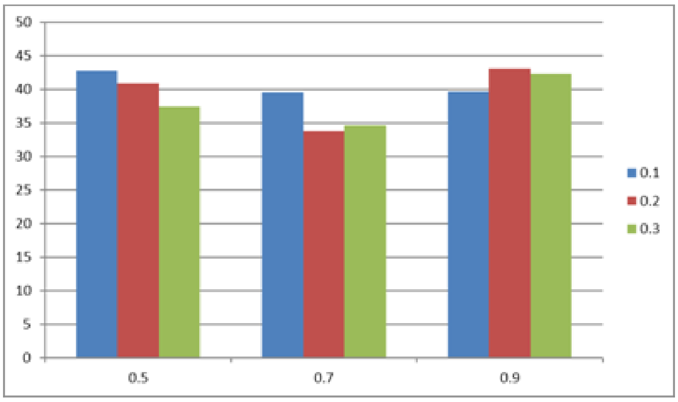
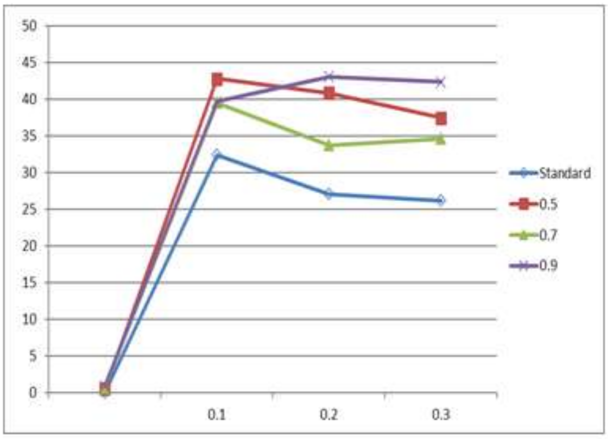


Sr. No.	Steel Fiber %	Polypropylene Fibers %	14th day's compressive strength of (150X150X150) mm cube.	Average
1	0	0	23.5	23.53
2		0	24	
3		0	23.1	
4	0.5	0.1	31.55	32.73
5		0.1	31.55	
6		0.1	35.11	
7		0.2	29.33	28.73
8		0.2	27.55	
9		0.2	29.33	
10		0.3	25.77	27.55
11		0.3	27.11	
12		0.3	29.77	
13	0.7	0.1	31.55	31.55
14		0.1	29.77	
15		0.1	33.33	
16		0.2	29.33	27.55
17		0.2	27.11	
18		0.2	26.22	
19		0.3	27.11	

20		0.3	29.77	28.29
21		0.3	28	
22	0.9	0.1	38.22	35.85
23		0.1	38.22	
24		0.1	31.11	
25		0.2	33.33	35.40
26		0.2	35.55	
27		0.2	37.33	
28		0.3	26.66	25.77
29		0.3	25.77	
30		0.3	24.88	

3.Compressive strength of concrete cube of size 150x150x150 mm for M25 for 28 days of compressive strength:





Sr. No.	Steel Fiber %	Polypropylene Fibers %	28th day's compressive strength of (150X150X150) mm cube.	Average
1	0	0	32.44	28.59
2		0	27.11	
3		0	26.22	
4	0.5	0.1	42.66	42.81
5		0.1	43.55	
6		0.1	42.22	
7		0.2	33.77	40.88
8		0.2	44.44	
9		0.2	44.44	
10		0.3	37.77	37.47
11		0.3	39.11	
12		0.3	35.55	
13	0.7	0.1	38.66	39.55
14		0.1	41.77	
15		0.1	38.22	
16		0.2	37.33	33.77
17		0.2	31.11	
18		0.2	32.88	
19		0.3	35.55	34.66
20		0.3	39.55	
21		0.3	28.88	
22	0.9	0.1	46.22	39.7
23		0.1	35.55	
24		0.1	37.33	
25		0.2	46.22	43.11
26		0.2	40	
27		0.2	43.11	
28		0.3	44.44	42.36
29		0.3	42.66	
30		0.3	40	

Conclusions: -

1. There is improvement in compressive strength of fiber reinforced concrete when compare to conventional concrete by adding of fiber.
2. There is an increase in compressing strength of concrete when we added fibres 0.5%, 0.7% and 0.9% steel fiber and 0.1%, 0.2% and 0.3% polypropylene fibres.
3. Finally the addition of fibres will give better result when compared to conventional concrete.
4. 3 days Result Comparison: -

Sr. No.	Fiber Proportion Content	Strength Required	Strength Obtained	Increase of Strength in %
1	Standard	10	10.96	> 9.6%
2	0.5, 0.1		16.44	> 64.4%
3	0.5, 0.2		15.7	> 57%
4	0.5, 0.3		12.3	> 23%
5	0.7, 0.1		23.10	> 131%
6	0.7, 0.2		12.88	> 28.8%
7	0.7, 0.3		15.70	> 57%
8	0.9, 0.1		15.55	> 55.5%
9	0.9, 0.2		15.40	> 54%
10	0.9, 0.3		14.6	> 46%

5. 14 days Result Comparison: -

Sr. No.	Fiber Proportion Content	Strength Required	Strength Obtained	Increase of Strength in %
1	Standard	22.5	23.53	> 4.57%
2	0.5, 0.1		32.73	> 45.46%
3	0.5, 0.2		28.73	> 27.68%
4	0.5, 0.3		27.55	> 22.44%
5	0.7, 0.1		31.55	> 40.22%
6	0.7, 0.2		27.55	> 22.44%
7	0.7, 0.3		28.29	> 25.73%
8	0.9, 0.1		35.85	> 59.33%
9	0.9, 0.2		35.40	> 57.33%
10	0.9, 0.3		25.77	> 14.53%

6. 28 days Result Comparison: -

Sr. No.	Fiber Proportion Content	Strength Required	Strength Obtained	Increase of Strength in %
1	Standard	25	28.59	> 14.36%
2	0.5, 0.1		42.81	> 71.24%
3	0.5, 0.2		40.88	> 63.52%
4	0.5, 0.3		37.47	>49.88 %
5	0.7, 0.1		39.55	> 58.2%
6	0.7, 0.2		33.77	> 35.08%
7	0.7, 0.3		34.66	> 38.64%

8	0.9, 0.1		39.7	> 58.8%
9	0.9, 0.2		43.11	> 72.44%
10	0.9, 0.3		42.36	> 69.44%

7. We would suggest to use any %of steel fiber with only 0.1% of polypropylene because we have come under such observation that as the % of polypropylene increase the strength of concrete is achieved lesser.

V. ACKNOWLEDGMENT

We offer our sincere and heartily than, with a deep sense of guidance to our guide **Prof. R.R. BADEGHAR** for their valuable direction and guidance to our project, her meticulous attention towards our project work without taking care of his voluminous work.

We are grateful of the Head of Department **Prof. P.P. TAPKIRE** for providing all facilities to carry out this project work and whose encouraging, part has been prepared source of inspiration.

We are thankful to our project co-ordinator **Prof. G.C. JAWALKAR** and principal **Dr. S.D. NAVALE** for their encouragement and without whom these projects would not have been success.

A. **Advantage**s

- Increasing Concrete strength.
- Advantages of Fibre-Reinforced Concrete.
- Fibre-reinforced concrete has more tensile strength when compared to non-reinforced concrete.
- It increases the concrete's durability.
- It reduces crack growth and increases impact strength.
- Fibre-reinforced concrete improves resistance against freezing and thawing.

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Books Name:

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Photos Of during the work process: -

Fig: Steel fiber

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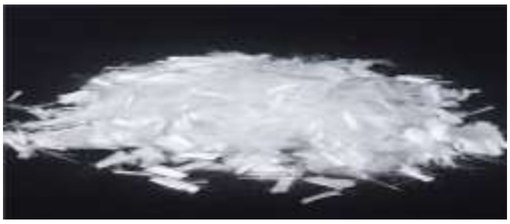

Fig: Polypropylene Fiber

Fig: test of concrete by using compressive testing machine with our Guide prof. R.R. BADEGHAR Sir.

Fig: Concrete cube casting by using Polypropylene Fiber and Steel fiber in the moulds.

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Fig: Cubes kept in water curing tank, testing of cubes by using Compressive testing m/c, Complesation of project work.