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Experimental study on behaviour of Recron "3s" fibre

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Abstract: *The present investigation was carried out to determine the split tensile strength and also the resistance to cracking by determining the flexural strength of plain concrete and polyester fibre reinforced concrete by using "Recron 3s", a polyester fibre. This is aimed at increasing the tensile strength and flexural strength of concrete which weak in tension and only strong in compression. This is also increasing the ductility of concrete under tensile stresses. OPC 43 Grade Ultratech Cement was used in this work and all the necessary testes on cement and aggregates were conducted. Various fibre percentages of 0.25 percentage, 0.50 percentage, and 0.75 percentage by weight of cement were tested for compressive strength, split tensile strength, and flexural strength. These mixes were then compared with a nominal mix with 0% fibre. A comparative analysis was carried out so as to obtain the percentage increase/decrease in strength due to the addition of fibres for all the above tests. It was observed that addition of fibre percentage of 0.50 percentage gave the maximum strengths for all the three tests.*

Keywords: *Compressive Strength, Flexural Strength, Mix Proportion, Split Tensile Strengths, Water Cement ratio.*

I. Introduction

Concrete is one of the most important materials among the building materials in all types of civil engineering works. Since the adaptation of concrete as a building material, lot of researches and studies has been made to improve the quality, strength and durability of it. By the same time efforts are also being made to economize concrete construction compared to other materials. Plain concrete is good in compression but weak in tensile strength with very limited ductility and little resistance to cracking. Internal micro cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks, eventually leading to brittle fracture of concrete. Generally in case of rigid pavements cracks are formed due to the variation in temperature, shrinkage and heavy moving loads. Attempts have been made to reduce the cracks and impart improvements in tensile property of concrete members using conventionally reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to concrete members, they however do not increase the tensile strength of concrete itself. In plain concrete and similar brittle materials, structural micro cracks develop even before loading due to drying and shrinkage or other causes of volume changes. When loaded these micro cracks propagate and open up owing to effect of stress concentration. It has been recognized that the addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack resistance and substantially improve its static and dynamic properties. This type of concrete is known as FIBER REINFORCED CONCRETE. In these dissertations an attempt will be made to view the behaviour of concrete mixed with RECRON 3s FIBRE in comparison with plain concrete.

II. Materials And Methodology

Cement: In this experiment, 43 Grade Ordinary Portland cement (OPC) with brand name Ultratech Cement was used for all concrete mixes. Conforming to IS: 8112-1989.

Table 1: Physical properties of cement

Sr. No	Property	Values
1.	Fineness of cement	3.5 %
2.	Specific gravity of cement	3.14
3.	Consistency of standard cement paste	29 %
4.	i) Initial setting time	93 minutes
	ii) Final setting time	274 minutes
5.	i) Compressive Strength for 3 days	23.8N/mm^2
	ii) Compressive Strength for 7 days	35.67 N/mm^2
	iii) Compressive Strength for 28 days	45.91 N/mm^2

Fine Aggregate: The sand used for the experimentation was locally procured river sand and was confined to zone-II as per IS 383-1970.

Table 2: Properties of Fine aggregate (River sand)

Sr. No	Property	Values
1.	Specific gravity	2.65
2.	Fineness modulus	2.46 %
3.	Silt content	1 %
4.	Surface moisture	0.5 %
5.	Water absorption	1.40 %
6.	Bulk density (Loose state)	1534 kg/m^3
7.	Bulk density (Compacted)	1684.38 kg/m^3

Coarse Aggregate: The coarse aggregate used in this experimentation were 20mm and 10mm size and was confirming to IS 383-1970.

Table 3: Properties of Coarse aggregate

Sr. No	Property	Values
1.	Specific gravity	2.65
2.	Water Absorption	0.88 %
3.	Flakiness Index	13.24 %
4.	Elongation Index	20.35 %
5.	Crushing value	21.32%
6.	Impact Value	14.44 %
7.	Bulk Density (Loose state)	1552.07 kg/m^3
8.	Bulk Density (Compacted state)	1698.22 kg/m^3

Polyester Fiber: In this experiment, "Recron 3s" a 12mm long virgin triangular monofilament polyester fiber is used manufactured by Reliance Technology Centre Mumbai.

Table 4: Properties of Recron 3s Fiber (As per supplier)

Sr. No	Property	Values
1.	Fiber type	Polyester CT2424
2.	Cut length	10mm
3.	Effective Diameter	10-30 µ
4.	Specific gravity	1.32-1.36
5.	Melting point	240-260 Deg.c
6.	Elongation	20-50%
7.	Young's modulus	>4000 MPa
8.	Alkaline stability	Very good
9.	Acid resistance	Excellent
10.	Dispersion	Excellent

Water: The water used was clean and free from oils, salts and acids. Portable water available in the laboratory was used for casting all the specimens in this investigation. The quality of water was found to satisfy the requirements of IS 456-2000.

III. Methodology

Preparation:

Mix Proportion: M20 Grade of concrete with the mix ratio (1:1.5:3) was adopted with and the water cement ratio was 0.45. The fiber quantity in concrete was varied in percentages like 0%, 0.25%, 0.50%, and 0.75% by weight of cement.

Workability of fresh concrete

1. Slump Test: The Slump test is carried out as per IS 1199-1959 and noted the slump values.

2. Compaction Factor Test: The Compaction factor test is performed as per IS 1199-1959.

3. Vee Bee Consistometer Test: The Workability of fresh concrete was determined by using Vee Bee Consistometer per IS 1199-1959.

Strength study on hardened concrete:

1. Compressive strength of concrete: For the compressive strength test, the specimens of size 150 X150 X150mm were cast and tested on compressive testing machine of capacity 2000KN as per IS 516: 1959.

Compressive Strength (F) = $\frac{L}{A}$ ----------(1)

Where, F = Compressive strength of the specimen (In N/mm^2)

L = load (in N)

A = cross-sectional area (in mm^2).

2. Flexural strength of concrete: For the flexural strength, the beam specimens of size 100 X 100X 500mm were cast. Two point loading was adopted on an effective span of 400mm as per IS 516-1959.

Flexural strength of concrete (F_b) = $\frac{PL}{bd^2}$ ----------(2)

Where, F_b = Flexural strength of concrete (In N/mm^2)

P = Failure load (in N)

d = depth of the beam (100mm)

L = Effective span of the beam (400mm)

b = Breadth of the beam (100mm).

3. Split tensile strength of concrete: For the tensile strength, the cylindrical specimens of size 150mm diameter and 300mm length were cast. Split tensile strength was obtained by testing the specimen on CTM of capacity 2000KN as per IS 5816: 1999.

Split Tensile Strength of Concrete (F) = $\frac{2P}{DL}$ ----------(3)

Where, F = Tensile Strength of Concrete (in N/mm^2)

P = load of failure (in N)

D = Diameter of cylindrical specimen (150mm)

L = Length of the cylindrical specimen (300mm)

IV. Results

1. Workability in terms of slump test:

Table 5: Workability in terms of slump cone test

S. No	1	2	3	4
Mix Design	M20			
% of Recron 3s fiber	0	0.25	0.50	0.75
Slump (mm)	42	38	32	25

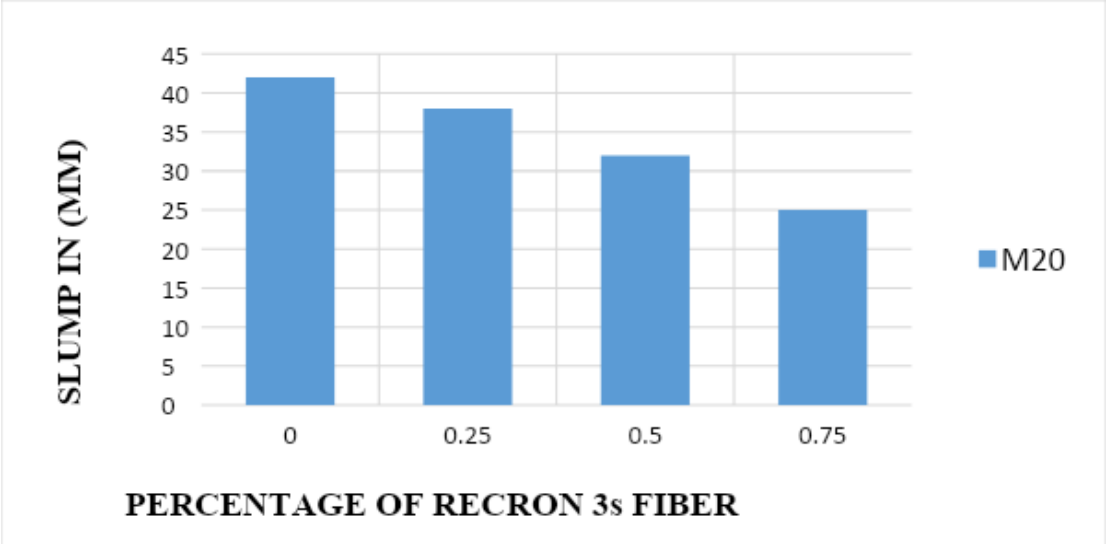

Fig. 1: Slump for M20 grade of concrete

2. Workability in terms of compaction factor test

Table 6: Workability in terms of compaction factor test

S. No	1	2	3	4
Mix Design	M20			
% of Recron 3s fiber	0	0.25	0.5	0.75
Compaction Factor	0.84	0.82	0.81	0.80

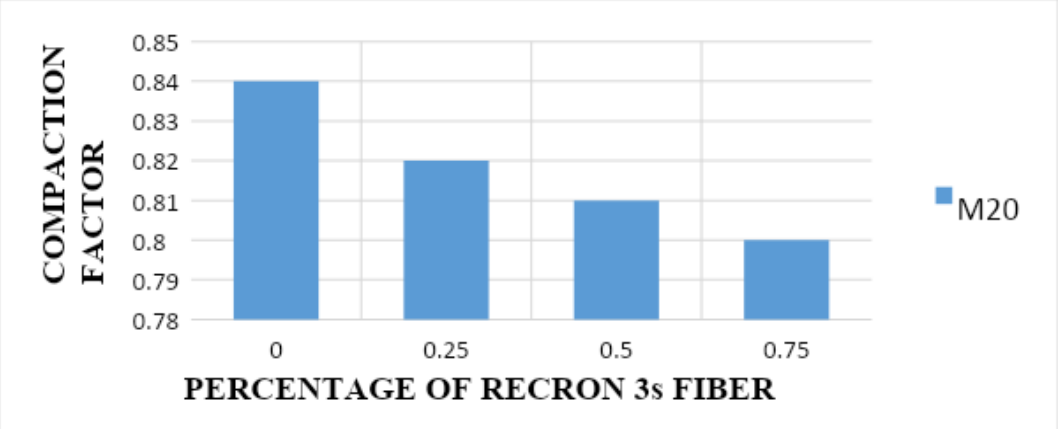

Fig. 2: Compaction Factor for M20 grade of concrete

3. Workability in terms of Vee-Bee time

Table 7: Vee-Bee time for M20 Grade of concrete

S. No	1	2	3	4
Mix Design	M20			
% of Recron 3s fiber	0	0.25	0.5	0.75
Vee-Bee time (seconds)	10	12	16	22

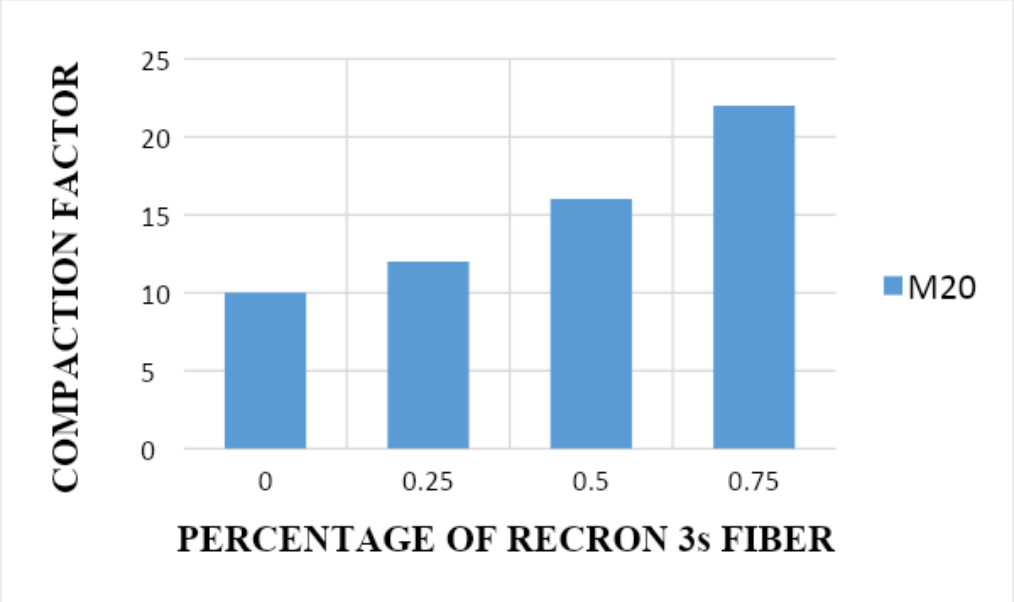

Fig. 3: Vee-Bee time for M20 grade of concrete (seconds)

4) Compressive strength for 7, 14 and 28 days

Table 8: Comparison of Compressive strength for 7, 14 and 28 days

	Compressive Strength in days		
% of fibers	7 days	14 days	28 days
0%	13.84	15.88	20.10
0.25%	15.42	19.20	22.74
0.50%	16.76	20	24.75
0.75%	15.10	18.30	22.20

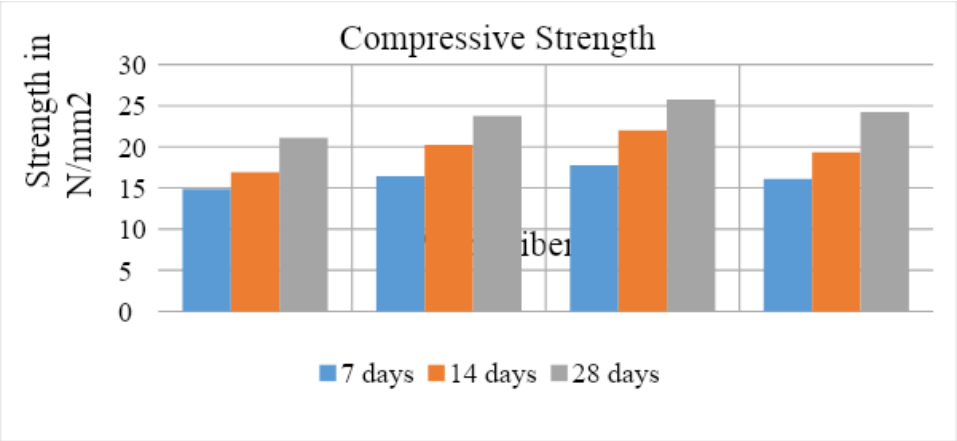

Fig. 4: *Comparison of Compressive strength for 7, 14 and 28 days*

5) Flexural strength for 7, 14 and 28 days

Table 9*: Comparison of Flexural strength for 7, 14 and 28 days*

% of fibers	Flexural Strength in days		
	7 days	14 days	28 days
0%	2.48	4.16	7.60
0.25%	2.82	4.74	8.60
0.50%	3.38	5.60	9.96
0.75%	3.10	4.5	6.60

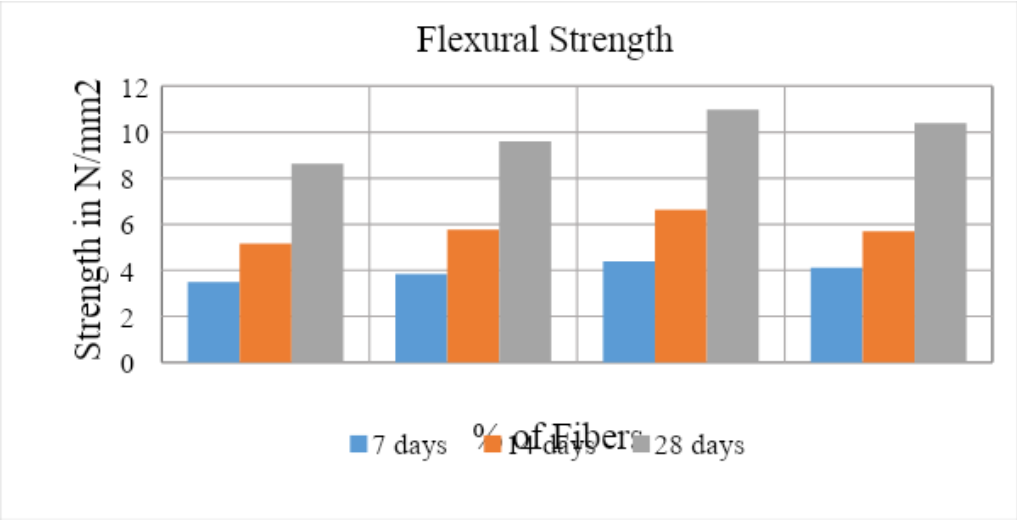

Fig. 5*: Comparison of Flexural strength for 7, 14 and 28 days*

6) Split Tensile strength for 7, 14 and 28 days

Table 10: *Comparison of Split Tensile strength for 7, 14 and 28 days*

% of fibers	Split Tensile Strength in days		
	7 days	14 days	28 days
0%	0.746	0.373	1.462
0.25%	0.04	0.656	1.464
0.50%	0.40	0.868	1.710
0.75%	0.05	0.807	1.575

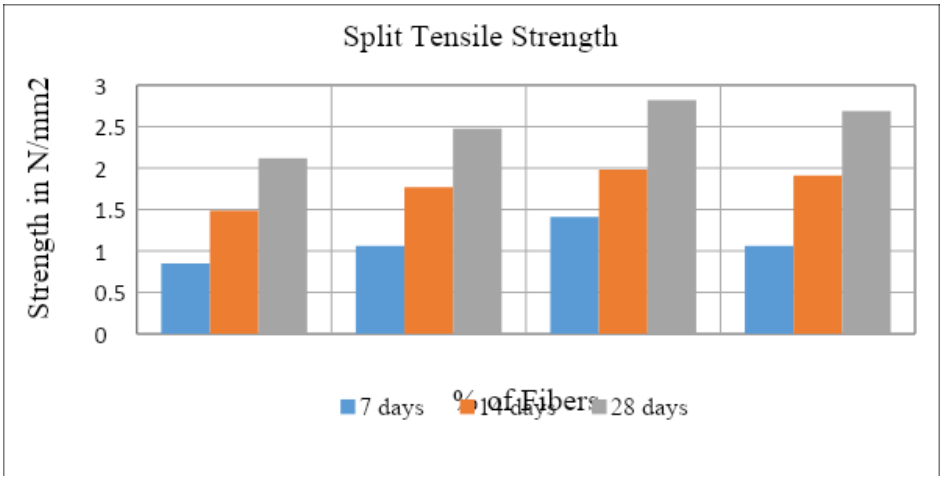

Fig. 6: *Comparison of Split Tensile strength for 7, 14 and 28 days*

V. Conclusion

- The Workability of concrete measured from slump cone test, as the percentage of Recron 3s fiber increases in mix slump value decrease. Hence it can be concluded that with the increase in the fiber content workability decreases. To evaluate flexural strength of plain cement concrete and fiber reinforced concrete.
- The workability of concrete measured from compaction factor test, as the percentage of Recron 3s fiber increases in mix the compaction factor decreases. Hence it can be concluded that with the increases in the fiber content workability decreases.
- The maximum compressive strength is obtained when the percentage of fiber added is 0.50%; the maximum compressive strength being 24.75N/mm2. To evaluate flexural strength of plain cement concrete and fiber reinforced concrete.
- The maximum flexural strength is obtained when the percentage of fiber added is 0.50%; the maximum flexural strength being 9.96N/mm2.
- The maximum split tensile strength is obtained when the percentage of fiber added is 0.50; the maximum split tensile strength being 1.710N/mm2. To evaluate flexural strength of plain cement concrete and fiber reinforced concrete.
- It is found that the compressive strength, flexural strength and split tensile strength is the highest at 0.50% addition of fibers and reduces when the percentage of fiber added exceeds beyond 0.50%. To evaluate split tensile strength of plain cement concrete with fiber reinforced concrete.
- At 0.50 addition of fibers, the compressive strength is found to be increased by 22.06% Since the 28 days split tensile strength is found to be increased by 33.01%, these fibers can be used as secondary replacement with steel. These fibers when used as secondary reinforcements can lead to considerable cost savings. At higher percentage of addition of fibers, due to less bonding of the fibers with the concrete mix results in lower strengths.

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