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An Experimental Investigation on Mechanical Properties of Mixed Synthetic Fiber Reinforced Concrete

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Abstract

There is a tremendous demand for concrete which is highly workable and durable. Plain cement concrete is weak in tension and there is no minimum resistance to cracking in tension one. In order to overcome deficiencies in concrete to increase performance of concrete fibers were added. This project aims to study the synthetic fibers consisting of three different fiber combinations i.e. Polypropylene, HDPE, Recorn 3s. In this study the mechanical properties of concrete containing fiber were studied including workability of fresh concrete. The addition of synthetic fibers in concrete is by 0%, 0.25%, 0.5%, 0.75%, and 1% by volume of cement. These fibers are used in concrete to increase strength of the reinforced concrete.

In present work, an attempt is made to see effects of fibers on mechanical properties of concrete for 3 days, 7 days and 28 days and is compared with the strengths of nominal mix concrete of grade M40 with percentage variation along with orientation in plain concrete.

Keywords: *Concrete, Fibre, Recorn 3s, Polypropylene, HDPE, Compressive Strength, Split Tensile Strength, Flexural Strength.1*

I. INTRODUCTION

Concrete is used as building material, but fragile concrete has a disadvantage of relatively has less tensile strength, low resistance to cracking and propagation.

Tension defects in plastic cement concrete and hardened concrete can be overcome by using existing reinforcing steel reinforcements and by including a sufficient amount of specific fibers. So we are using fibers as secondary reinforcements.

Fiber reinforced concrete (FRC) contains fibrous material that increases the structural integrity of concrete[1]. It has uniform distribution and randomly oriented short discrete fibers. Fiber is considered as reinforcing material. Fiber is a building material which increases tensile and flexural strength and binds both Portland cement and cement matrix[2]. Fibers can classified as glass fibers, steel fibers, natural fibers and synthetic fibers depending on their various aspects like material, geometry, distribution, density and direction [3][6][7]. The aspect ratio of fibers is the ratio of

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length to diameter. Typical aspect ratios range from 30 to 150.

Why should we use Synthetic Fibers (SF)?

Fibers benefit the concrete in both the plastic and hardened state includes:-

- Low permeability
- Plastic precipitate crack reduction
- Increase in impact and abrasion resistance
- Plastic shrinkage crack reduction
- Provides shatter resistance.

Synthetic fiber (SF) work on hardened concrete: Synthetic fiber specially designed concrete for preventing the crushing force by tightly binding the concrete. When synthetic fiber is used, the water cement ratio becomes uniform bleeding because it gives abrasion resistance.

II. MATERIAL USED

1) Cement: OPC 53 Grade Deccan cement was used for this experiment..

2) Fine Aggregate (FA) : used in this investigation was clean river sand and the tests was carried out in sand according to IS. 2386:1968. Fine adjustment sizes less than 4.75 mm are considered fine aggregates.

3)Coarse Aggregate (CA): A dry angular coarse aggregate of 20 mm maximum size and 10 mm minimum size was used for experimental work.

4)Water: Water is an important ingredient in concrete because it is actively involved in chemical reactions with cement. This is due to the strength imparted to the cement gel and the workability of the concrete.

5)Recorn 3s: Recron-3 is a discrete discontinuous staple fiber that can be used for concrete to suppress and inhibit cracks. Recorn 3s is the incorporation of discontinuous and discrete staple fibers into the concrete matrix that provides a multipoint secondary reinforcement, distributed at random, resulting in three-dimensional crack control and a crack-arrest mechanism.

Table 2.1: Recorn 3s properties

Recorn 3s Fiber	Cut length	6mm
	Diameter	0.04mm
	Tensile strength	4000-6000 kg/cm^2
	Aspect ratio	150
	Specific gravity	1.34-1.40 cc/g
	Melting point	>250^{0}C
	Elongation	>100%

Fig1: Recron 3s

Fig.2: Polypropylene

6) Polypropylene:

Polypropylene is rigid, crystalline and hard (tough) thermoplastic produced from propene monomer.. PP is available cheaply in market.

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Table 2.2: Properties of polypropylene fibers

Diameter (D) mm	Length(l) mm	Aspect Ratio (l/D)	Tensile Strength Mpa	Specific gravity
0.0445	6.20	139.33	308	1.33

Fig3: HDPE

7) HDPE: High density polyethylene is a polyethylene thermoplastic made from petroleum. When used for pipes, it is sometimes referred to as "alkathene" or "polythene".

Table 2.3: HDPE properties

HDPE Fiber	Density	970 Kg/m^3
	Diameter	0.40mm
	Tensile strength	50-71 Ksi
	Elasticity Modulus	725 Ksi
	Water absorption	Nil
	Aspect ratio (30mm)	75

III. TABLES, RESULTS & GRAPHS

Table 3.1: Compressive Strength Test

S. no	Fiber percentage	3 days Compressive strength (N/mm^2)	7 days Compressive strength (N/mm^2)	28 days Compressive strength (N/mm^2)
1	0 %	18.46	32.56	49.53
2	0.25%	19.63	33.27	51.03
3	0.5%	20.78	33.75	51.93
4	0.75%	21.98	36.86	53.64
5	1%	19.18	32.19	50.46

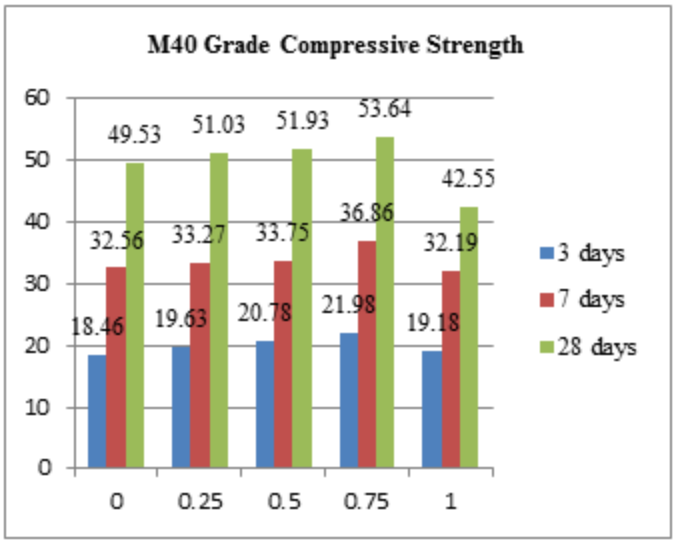

Fig .4: Graph of Compressive Strength Test

Table 3.2: Split Tensile Strength Test

S.no	Fiber percentage	3 days Split Tensile Strength (N/mm^2)	7 days Split Tensile Strength (N/mm^2)	28 day Split Tensile Strength (N/mm^2)
1	0	1.43	2.5	3.19
2	0.25	1.56	2.59	3.70
3	0.5	1.87	2.91	3.83
4	0.75	2.04	3.28	4.27
5	1	1.59	2.60	3.62

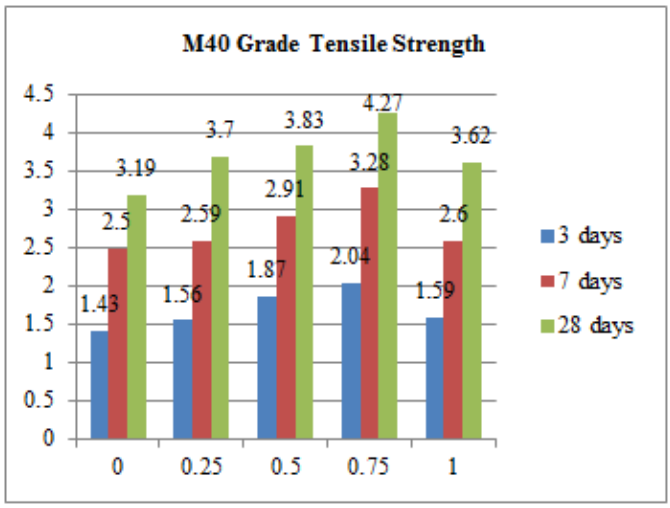

Fig 5: Graph of Split Tensile Strength Test

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Table 3.3: Flexural Strength Test

S.no	Fibers Percentage	3 days Flexural tensile strength (N/mm^2)	7 days Flexural tensile strength (N/mm^2)	28 days Flexural tensile strength (N/mm^2)
1	0%	2.07	3.19	4.81
2	0.25%	2.86	4.31	5.34
3	0.5%	3.04	4.46	5.87
4	0.75%	3.43	4.89	6.33
5	1%	2.27	3.93	5.28

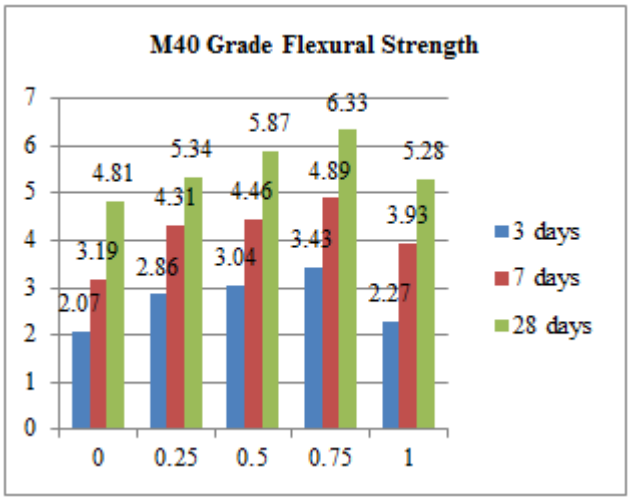

Fig 6: Graph of Flexural Strength Test

IV. CONCLUSION:

An experimental.study .on cubes, .cylinders, beams for Compressive Strength, Split tensile. Strength and flexural Strength respectively by mixing of Polypropylene, HDPE and Recorn 3s fibers.

Based .on the investigation the following conclusions are drawn they are:

1. From the results, it was observed that optimum percentage of fibers is at 0.75% .

2. There is a considerable increase in strength in terms of split tensile and flexure strength as 25.29% and 24.01% respectively, whereas the compressive increases 7.66% when compared with conventional concrete.

3. It has been found that cracking during spilt tensile testing is slower than conventional concrete. This shows that synthetic fibers are better in avoiding propagation of cracks.

4. There is typical crack propagation pattern which lead to splitting of beam in two piece geometry.

V. SCOPE OF STUDY:

Usage of fibers in concrete is proven to be worth as there is considerable amount of increase of mechanical strengths of concrete. These added fibers can be used in construction tanks and pavements. In future there is definite scope to study the further durability studies to make its mark.

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