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STRUCRURAL PROPERTIES OF POLYPROPYLENE FIBER REINFORCED CONCRETE

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ABSTRACT:

In this paper, the structural properties are studied for Compressive Strength of polypropylene fiber in concrete with natural sand. Different cut length of 20mm to 30mm with an increment of 5 and different volume fractions of polypropylene fiber 0.0% to 1% with an increment of 0.25% by weight of cement are used. Concrete mix prepared with locally available Natural sand as a normal mix is used.

Concrete mixes are designed for infrastructural development industry. It has a capacity to enhance its property with the help of other suitable materials like Polypropylene Fiber. Currently man-made micro fibers and natural fibers have been incorporated into concrete. Initially natural fibers were used in concrete but it has some drawbacks mainly in durability hence man-made fibres are preferred. Man Made Polypropylene fiber is adaptable thermoplastic material which is formed by polymerizing monomer units of polypropylene molecule into very long polymer molecules or chains in the presence of channel under carefully controlled heat & pressure. Concrete mixes are designed for M20 and M30 grades for the experimentation. Mechanical, thermal and other properties are studied. There is improvement in compressive strength by addition of Polypropylene fiber in concrete.

KEYWORDS: Compressive strength, Natural sand, Polypropylene fiber.

1. INTRODUCTION:

Concrete is a backbone of infrastructural development industry. Concrete has a capacity to enhance its property with the help of Man Made Fiber like Polypropylene fiber which are stronger and more ductile than concrete. Polypropylene fiber is helpful to arrest cracking and transfer the load across the cracks to achieve sufficient bonding between fiber and concrete. Other suitable material. Aggregate is maximum volume in concrete.

Few bitter properties of concrete can be minimized with some remedial measures. From centuries, fibers of different types have been used for various applications including building materials. The possibilities of using different fibers have been explored through most of the countries. In the field of civil engineering, Polypropylene fiber based composites are becoming important composite material due to light weight, high strength to weight ratio, corrosion resistance and other advantages. Concrete with fibrous material enhances the structural integrity. It includes short discrete fibers which are uniformly distributed and randomly oriented. In this study, natural sand is replaced by artificial sand i.e. the fine aggregates produced by crushing hard stone in the plain concrete. Also in the study use of Polypropylene fiber with different weight and different length procured from M/s Tashi India Ltd. Nagpur in different mixed proportions.

The major advantages of Polypropylene fiber are as follows:

- Inhibits Plastic Shrinkage Cracks & Settlement Cracks
- Provides Impact & abrasion Resistance
- Does not allow moisture or water to seep in due to reduction in permeability
- Fibrillated (Mesh) structure ensures better binding & anchoring with concrete aggregates
- Distributes localized stresses & increases fatigue resistance
- Reduces unequal bleeding so solids in concrete do not settle unevenly & enhances cement hydration in fresh concrete thereby increasing tensile & flexural strength
- Improves fire resistance characteristics in concrete thereby reducing risk of spalling
- Increases Overall Durability & Anti – Crack Strength

2. LITERATURE REVIEW:

Priyanka presents the fractional replacement effect of natural sand by manufactured sand on the compressive strength of cement mortar in proportion 1:2, 1:3 and 1:6 with water cement ratio are studied. In results, it is compared with reference mix as replacement 0% of natural sand by manufactured sand.

Vinayak R. presents the manufactured sand has a potential to provide alternative to natural sand and helps in maintaining the environment as well as economical

balance. The overall strength of mortar linearly increases and compared with reference mix.

Al 2 study shows for more than 60% replacement of natural sand by artificial sand causes reduction in compressive strength of concrete mixes with increase in the area of cracks. It is a possible to minimize the area of surface cracks of concrete, and hence achieving the durable concrete. Therefore, The replacement of natural sand with artificial sand will help to maintain the environmental balance of the nature.

Prakash Rao investigated the test conducted pertain to concrete with reverse sand of strength 28.1 mpa. The concrete with stone crusher dust which is available abundantly from crusher unit at low cost, and the granite stone crusher dust of strength 32.8 mpa.

Singh S.P. (2010) has computed the strength and flexure toughness of Hybrid Fibre Reinforced Concrete pertaining different combinations of steel and polypropylene fibres. It is identified the test on strength of concrete and on flexural behaviour of RC beam under 2 point loading sustained about 6 percent more load.In static flexural strength tests, it is observed a maximum increase in flexural strength of the order of 80%, centre point deflection corresponding to peak load of the order of 84% was observed for HyFRC with 75% steel fibres + 25% polypropylene fibres. The results obtained in this investigation indicate that, in terms of flexural toughness, concrete with fibre combination of 75% steel fibres with 25% polypropylene fibres produces the best concert.

Ezeokonkwo, J. C have studied to improve the compressive strength of sandcrete blocks w.r.to polypropylene fibres . This involved the reinforcement of sandcrete blocks with twisted polypropylene fibres of different length like 50mm, 75mm and 100mm resp. at 5 different volume fractions.Analysis of the results showed that, addition of fibre increased the compressive strength from 2.23 per cent to 35.78% and observed that it is dependent on the length, volume fraction of fibre and water/cement ratio.

Patel Priti A (2012,) has ellaborate the properties like compressive, flexural, split tensile and shear strength of polypropylene fibre reinforced concrete. The material of compressive strength increases from 8% to 16% for PFRC with increasing fibre content.

Due to polypropylene fibre, the splitting tensile strength addition improved from 5% to 23%. The flexural strength also increased with increasing fibre content. The maximum increase in flexural strength of PFRC was 36%.

Vairagade Vikrant S. (2012,) have explored the compressive, flexural & tensile strength of fibrillated PFRC containing fibers of 0%, 0.25% and 0.4% volume fraction for15mm, 20mm and 24mm length.

It is observed that for M20 grade of concrete, the compressive strength for three different cut length fibers having same volume fraction shows almost same results with slight increase. with addition of 0.4%, 24 mm cut length fibrillated Polypropylene fibers showed maximum compressive strength. For longer length fibers, the split tensile strength was higher. with using of 24 mm long fiber with same volume of fraction had given maximum split tensile strength over fiber 15 mm and 20 mm cut length.

Ramujee Kolli (2013) have prepared samples of concrete with fine polypropylene monofilaments (Recron 3s) of 12mm length, the amounts varies from 0%, to 2.0%, to determine the compressive and splitting tensile strengths after 28 days of curing period. It was also observed that the cube compressive strength improved up to 1.5% fiber content and then strength was decreased at 2.0%.

Parveen (2013) have presented the effect of variation of PF lies between 0.1% to 0.4% along with 0.8% steel fibres on the behaviour of fibrous concrete. The mechanical properties of the concrete like compressive and tensile strength have been investigated The result shows that addition of polypropylene fibre has a small effect on the compressive strength, but considerable increase in the tensile strength with increase in fibre volume fraction. Hybrid (polypropylene and steel) fibre showed about 5.7% increase in compressive strength for 0.2% polypropylene fibre, an increase of 47% of split tensile strength and 50% of flexural strength for 0.3% polypropylene fibre.

Rajendra P. Mogre. study shows that there is viability of replacement of natural sand by artificial sand range from 60 % to 80%. It was seen from above research there was improvement in the strength of concrete. It was also commented that there is need to find optimum percentage replacement

2.1 MATERIAL:

1. CEMENT:

OPC of 53 grades confirming to IS 12269-1987 was used. The physical properties are Specific gravity 3.12, soundness 1.20 mm, Initial setting time 167 minutes, Final setting time 255 minutes, Normal Consistency 31%, Fineness 320 m^3/kg and compressive strengths 58.25 MPa for 28 days.

2. FINE AGGREGATE:

Locally available Natural sand was used. The physical properties are Specific Gravity for natural sand

is 2.6, Fineness Modulus for N.S. is 2.78 and Bulk Density is 15 KN/m^3.

3. COARSE AGGREGATE:

Rock stone aggregate of nominal size 10 mm and 20 mm mixed aggregate obtained from local market was used.. The physical properties are Specific gravity as 2.96, Density KN/m^{3}as 16.10 and F.M. as 6.95.

4. POLYPROPYLENE FIBER:

The Plast polypropylene fiber used for experimentation are supplied by Tashi India Ltd. Nagpur with following technical specifications are for Polypropylene fiber (table 1).

Table 1: Technical specification for Polypropylene fiber

Sr. No.	Property	Value
1	Specific gravity	0.91
2	Denier	1050
3	Tensile strength	0.67 kN/mm^2
4	Young's Modulus	4.0 kN/mm^2
5	Bulk density	910 kg/m^3
6	Fiber cut	20mm, 25mm, 30mm
7	Alkali resistance	Excellent
8	Chemical resistance	Excellent
9	Dispersion	Excellent

3. EXPERIMENTATION:

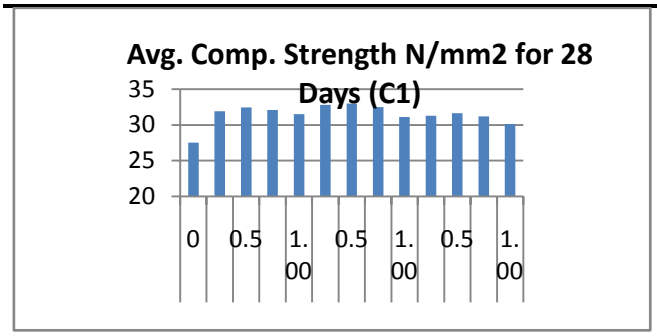
The physical Characteristics of material used that is cement locally available natural sand and course aggregate are tested initially and PP fiber are used as supplied by Tashi India Ltd. Nagpur with 0% to 1% with increment of 0.25 % of weight of cement and different aspect ratio of 20 to 30 with increment of 5. The exact amount of concrete ingredients (Table-1) and polypropylene fiber were weighed and mixed thoroughly with proper sequence to avoid balling action by using super plasticizer in laboratory concrete mixer till the consistent mix was achieved. The standard cube of 150 mm size steel mould compacted on vibrating table. Six cubes of natural sand with polypropylene fiber were casted for testing. The average strength was calculated as per acceptance criteria using IS 456 – 2000 is followed and the average values are illustrated in table 3 and as shown in Fig.

Table 2: Quantity of Material (For Mix)

Sr. No.	**Grade of Concrete**	**M20**	**M30**
1	Cement kg/m^3	315	380
2	Fine aggregate kg/m^3	615	592
3	Coarse Aggregate (10 mm and 20mm) kg/ m^3	1300	1259
4	Aggregate cement ratio	6.07	4.87
5	Water cement ratio	0.49	0.46

Table 3: Compressive Strength with polypropylene fiber for M20 and M30 grade of concrete

Sr. No	Grade of concrete	Length of fiber	Volume of fiber	Average Compressive Strength N/mm2	
				28 Days (C1)	% increase (C1-I)
1	M 20	20	0	27.5	0.00
			0.25	31.9	16.00
			0.5	32.45	18.00
			0.75	32.1	16.73
			1. 00	31.5	14.55
		25	0.25	32.8	19.27
			0.5	33	20.00
			0.75	32.5	18.18
			1. 00	31.1	13.09
		30	0.25	31.3	13.82
			0.5	31.62	14.98
			0.75	31.2	13.45
			1. 00	30.1	9.45
2	M 30		0	39.3	0.00
		20	0.25	41.9	6.62
			0.5	43.01	9.44
			0.75	42.7	8.65
			1. 00	41.6	5.85
		25	0.25	43.1	9.67
			0.5	43.9	11.70
			0.75	43.1	9.67
			1. 00	42.9	9.16
		30	0.25	42.8	8.91
			0.5	43.01	9.44
			0.75	42.8	8.91
			1. 00	42.4	7.89



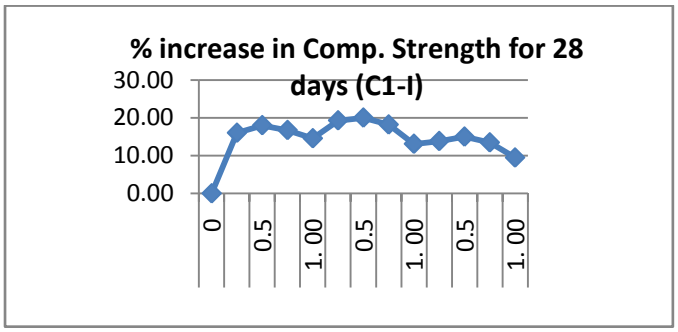


Fig.1: Compressive Strength and % increase with PP fiber for M20 grade

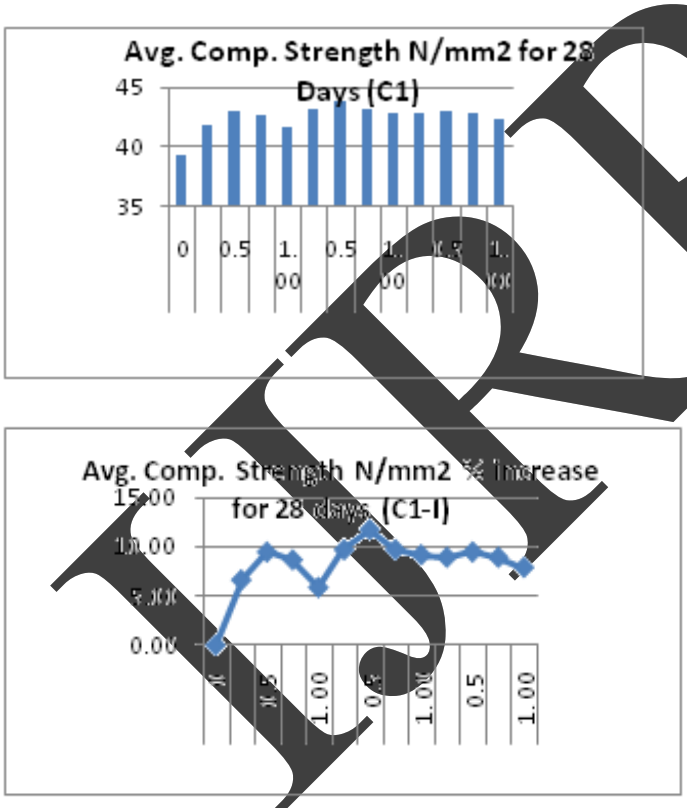


Fig. 2: Compressive Strength and % increase with PP fiber for M30 grade

4. APPLICATION:

i. Concrete slabs, beams and columns
ii. Concrete Roads/Pavements
iii. Structural Repairs and Restoration
iv. Precast Products – Pipes
v. Water Storage Tanks, Swimming Pools
vi. Pre-stressed concrete electricity poles
vii. Canal Lining Works
viii. Internal & External Plaster

5. CONCLUSION:

The conclusion based on experimental results is as below:

1. The Compressive Strength is increased up to 20%.
2. The % increase in compressive strength is maximum for 0.5% V.F. and 25mm cut length of polypropylene fiber.
3. The percentage increase in Compressive Strength is more for M20 grade of concrete.

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