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Mechanical Properties of Hybrid Fibre Reinforced Concrete

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Abstract— Concrete is brittle material. Reinforcement of concrete with haphazardly distributed short fibres could improve the toughness of cementious matrix by preventing or dominant the initiation and propagation of cracks. Adding one style of fibre into concrete has restricted functions, therefore 2 or a lot of fibres supplemental in concrete to get higher mechanical properties. the most reason for adding steel, plastic, volcanic rock fibre to boost energy absorption capability, plasticity and to produce crack resistance and crack management. This study examines the flexural strength of concrete with 3 completely different fibres with fibre content zero.45% of plastic fibre is unbroken constant in every mixes, 0.1-0.5% of volcanic rock fibre and zero.7-1.3% of steel fibre was varied in every mixes. The tests were carried with M25 grade of concrete and also the results were compared between typical concrete to hybrid fibre concrete and optimisation of Basalt fibre and steel fibre were obtained..

Keywords: Steel, polypropylene and basalt fibres, mechanical properties

I. INTRODUCTION

Cement mortar and concrete created with PPC could be a reasonably most typically used construction material within the world. These materials have inherently brittle nature and have some dramatic disadvantages like poor deformation and weak crack resistance within the sensible usage. To counteract the cracks, a fighting strategy has are available in that have a tendency to mixes the concrete with the addition of distinct fibres [4]. owing to commixture action, the fibres area unit uniformly distributed throughout the concrete all told directions, arrests plastic shrinkage crack in recent state and controls propagation of small crack from developing in to small cracks in hardened state of concrete, Fibre concrete is one among the material containing short distinct fibrous material uniformly distributed associate degree haphazardly orientated, that will increase its structural integrity [1, 3]. Combination of 2 or a lot of style of fibres area unit utilized in concrete to provide a material which can mirror the good thing about every of the individual fibre used, and eventually offer a synergistic response to the full structure [2, 6,7].

II. BALAST FIBRE

Basalt fibre could be a material made of extraordinarily fine fibres of volcanic rock, it's kind of like fibre glass, having higher physiochemical properties than fibre glass however considerably cheaper than carbon fiber. it's a high modulus of physical property and it's made of one material, crushed volcanic rock, from a fastidiously chosen quarry supply. volcanic rock of high acidity (over forty sixth percentage of silicon oxide content) and low iron content is taken into account fascinating for fibre production as shown in Fig.1.

Fig. 1. Basalt fibre.

III. STEEL FIBRE

Steel fibres mixed into the concrete will offer another to the availability of typical steel bars or welded cloth in some applications. The idea has been existing for several years. it's high modulus of physical property. Crimpled steel fibres area unit manufactured from low carbon cold drawn steel and have a minimum strength over 700Mpa it contains deformation that run the complete length of the fibres and provides a fantastic mechanical bond to the concrete matrix the steel fibre as shown in Fig.2.

Fig.2.Steel fibre.

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IV POLYPROPYLENE FIBRE

Polypropylene fibre could be a artificial fibre with tenuity, fine diameter, low modulus of physical property. it's some special characteristics like impact resistance, plasticity increase resistance to plastic shrinkage[5]. Polypropylene fibres area unit out there in 2 forms (i.e.) monofilament fibres, staple fibres are shown in Fig.3.

Fig.3Polypropylene fibre.

V. MATERIALS USED

Ordinary hydraulic cement of fifty three grade with relative density of three.12 was used for preparation of take a look at specimen, that satisfies the necessities of IS: 12269-1987 specifications. Regionally out there river sand passing through 4.75mm sieve was used as fine mixture having relative density 2.69 and fineness modulus 2.75 conformist to grading zone III of IS 383-1970 specification. Crushed angular stone of 20mm most size having specific gravity2.7, fineness modulus conformist to IS 383-1970 normal water is employed for each commixture and natural action the concrete. Conplast SP430 (NE) is employed as a brilliant softener in concrete. A dose vary of zero.6-1.5l/100kg of cement is employed to attain sensible workability. During this experimental investigation three styles of fibres (Basalt, Steel and Polypropylene) were utilized in appropriate mixtures. The properties of fibres area unit provided in Table 1

Table 1. Properties of fibre.

Properties	Steel fibre	PP fibre	Basalt fibre
Length (mm)	50	6	24
Diameter (mm)	1	38 µm	18 µm
Density (Kg/m3)	7680	980	2700
Tensile strength (Mpa)	800–900	>500	4100
Specific gravity	7.86	0.91	2.7

VI. MIX PROPORTIONING

Mix proportion utilized in this study is 1:1:2(M25) with water cement quantitative relation of 0.45 and super softener of 0.5% is used. The concrete mixture was ready by hand commixture. The coarse mass and fine mass were weighed to the current calculated amount of water and fibres were supplemental to create the concrete undiversified so needed amount of super plasticizer was supplemental to the combo to extend the workability of concrete. The concrete mix was placed within the several moulds by 3 layers. Every layer is tamped by 25 blows exploitation commonplace using tamping rod. The specimens were finished sleek at the highest. After 24 hours the specimens were demoulded and that they were allowed to the water natural curing action tank to be cure for 28 days. The assorted combine proportions of fibres area unit provided in Table 2.

Table 2.Mix proportions.

Batch number	Fibre mix proportions by volume (%)		
	Steel	PP	Basalt
M0	0.00	0.00	0.00
M1	0.00	0.45	0.10
M2	0.00	0.45	0.20
M3	0.00	0.45	0.30
M4	0.00	0.45	0.40
M5	0.00	0.45	0.50
M6	0.70	0.45	0.00
M7	0.85	0.45	0.00
M8	1.00	0.45	0.00
M9	1.10	0.45	0.00
M10	1.30	0.45	0.00

VII. TESTING OF SPECIMEN

The workability tests were performed exploitation slump cone as per IS: 1199-1999.The compressive strength specimens were of dimension 150 × 150 ×150 millimeter tests were conducted as per IS: 516-1979.The strength specimens were of dimension 150mm diameter and 300mm long tests were conducted as per IS: 5816-1999.Flexural strength specimens were of dimensions 100 × 100 × 500 millimeter tests were conducted as per IS: 516-1979.the specimens area unit tested for 28 days concrete strength. For every combine, 3 cubes, 3 cylinders and 3 prisms were tested up to failure and also the average load is taken.

VIII.EXPERIMENTAL RESULTS

A. Compression test result

Compressive strength is calculated manipulated formula of P/A N/mm2.The various compressive strength result for typical concrete and HFRC containing 0.45% of Polypropylene as constant in every combine, the basalt fibre was varied from 0.1% to 0.5% and also the steel fibre was varied from 0.7%, 0.85%, 1%, 1.15%, 1.30% to volume of concrete. The cubes were casted to work out the optimum price for compressive strength provided in Table 3 and the results as shown in Fig.4

Table 3.Compression test result.

Batch no	Compressive strength in N/mm^2	
	7 days	28 days
M0	20.6	32.3
M1	24.4	34.8
M2	24	35.3
M3	21	32
M4	25.8	36.4
M5	25.2	37.2
M6	19.5	29.5
M7	21.2	32.2
M8	23	34.2
M9	25	36.5
M10	24.2	36

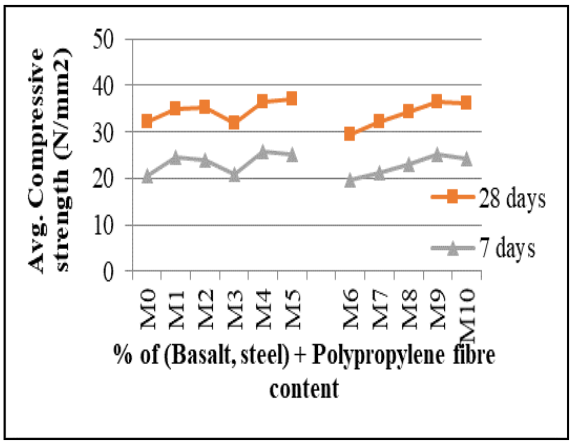

Fig.4. Compressive strength vs. % of HFRC

B. Split tensile test result

Split strength of the concrete is calculated exploitation the formula 2P/3.14 x d x l. The split strength of concrete will increase with increase in portion of hybrid fibre content. The test result shows HFRC (M4 & M9) provides higher strength than control specimen (M0) provided in Table 4 and also the results as shown in Fig.5

Table 4. Split tensile test result.

Batch no	Split tensile strength in N/mm^2	
	7 days	28 days
M0	2.0	2.6
M1	1.8	2.8
M2	2.4	3.4
M3	2.6	3.8
M4	3.2	4.6
M5	1.9	2.8
M6	1.7	2.61
M7	2.0	2.8
M8	2.4	3.2
M9	2.6	3.8
M10	1.8	2.6

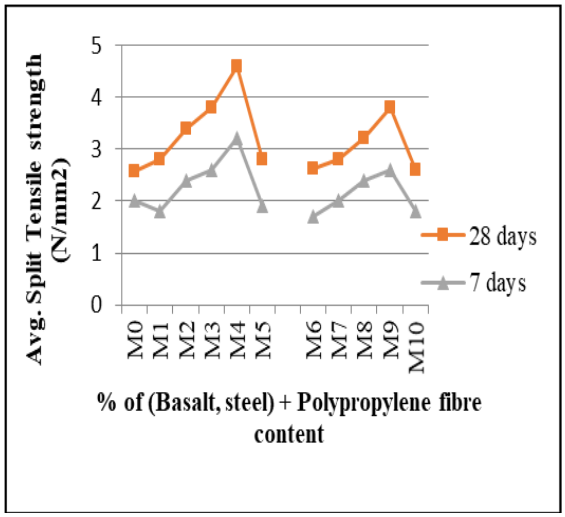

Fig.5 Split Tensile strength vs. % of HFRC

C. Flexural strength test result

The flexural strength of concrete will increase with increase in percentage of hybrid fibre content. The test result shows HFRC (M4 & M9) provides higher strength than control specimen (M0) provided in Table.5 and also the results as shown in Fig.6

Table 5. Flexural strength test result

Batch no	Flexural strength in N/mm^2	
	7 days	28 days
M0	2.4	3.5
M1	2.6	3.8
M2	2.9	4.2
M3	3.4	4.6
M4	3.5	5.2
M5	3.0	4.20
M6	2.5	3.8
M7	2.6	4.0
M8	2.8	4.2
M9	3.4	4.8
M10	2.9	4.2

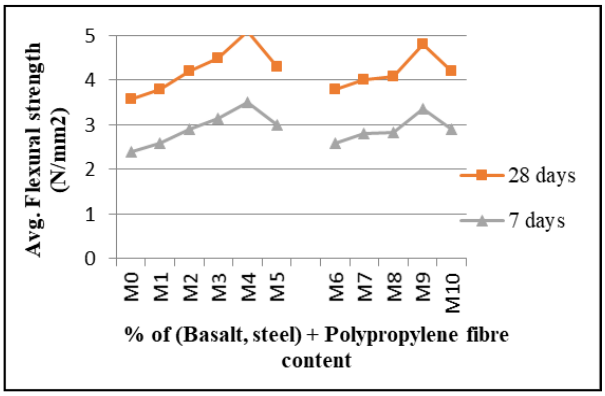

Fig.6 Flexural strength vs. % of HFRC

D. Optimum fibre content

From the tabulated results. It has been determined that there's a gradual increase in strength for split tensile and flexural strength of HFRC as compared to control specimen provided in Table.6.

Table 6.Optimum fibre content

Batch No	Fibre mix proportion by volume %		
	Basalt	Steel	Polypropylene
M4	0.4	–	0.45
M9	–	1.15	0.45

E. Flexural behavior of beam

Based on the optimum fibre content two HFRC (M4, M9) beam and one control beam (M0) were tested using 2 point loading of 28 days shown in Fig.7

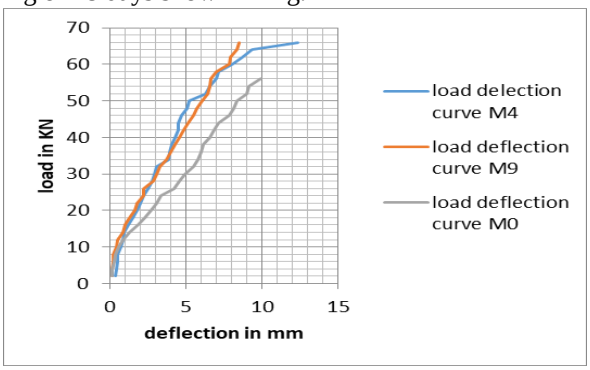

Fig.7 Flexural behavior of beam

IX CONCLUSION

The following conclusions are drawn based on analysis of test results.

- Addition of various fibres in concrete reduces the workability, however it's improved by adding super plasticizer.
- During experimentation it absolutely was found that crack formation in HFRC is slower than typical concrete. This shows that HFRC is healthier in avoiding propagation of cracks.
- Inclusion of polypropylene - Basalt fibres will increase the split strength, flexural strength and crack resistance of concrete.
- Addition of fibres improves the mechanical properties of HFRC than plain concrete.

The optimum fibre content for HFRC is obtained.

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