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Examination of mechanical properties of Hybrid fiber reinforced concrete

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Abstract - *There is a huge demand for natural materials due to this scarcity of materials happenings. Many researchers worked on replacement of materials in concrete to construct eco-friendly and cost-effective building. Recently researchers worked on this and come with some materials like GGBS, Fly ash, Lime etc. here, an attempt is made to fly ash as partial replacement material with the application of polypropylene and steel fibres in it with different proportions. In this paper obtained experimental results are discussed and tabulated the same. Conclusion of this paper is, we can replace cement by fly ash and fibres enhances the strength property.*

Key Words: Fly-ash, Polypropylene fibre, Steel fibre, properties of concrete etc.

1. INTRODUCTION

Concrete is brittle and moderately robust in compression but weak in tension. Its use has been limited due to these two flaws. The concentration of silica, calcium, and iron in the fly ash can be used to classify the FA. Category C fly ash develops a solid material in the presence of water, and after a period of time, it gains strength. In general, Category C FA contains more than 10% lime (CaO). Class C FA contains a lot of alkali and sulphate. (SO4). This FA is pozzolanic in nature and includes less than 5% lime (CaO). Fly ash is primarily kept in coal industries and discharged in landfills. [1] used fly ash as partial replacement of cement up-to 25% with the application of fibre. fibrous by incorporating 1.5% Polypropylene fibre into concrete Giving good results and giving less result in 2% fibre is added to the concrete [2]. FA will increase the concrete's toughness. In ordinary concrete, fly ash serves as non-air entertainment [3]. the concrete's compressive strength reinforced with 1.5 % mixed polypropylene fibres increased by 17 %. Split concrete has a 22% increase in split tensile strength, 24 % increase in split flexural strength, as well as an 11 percent decrease in split elastic modulus over ordinary concrete [4]. The shrinkage property of concrete was studied by [5] and has given future scope to study the, mechanical properties of concrete. However, in this study, test investigations were carried out to see how replacing cement with 20% fly ash and adding 1.5 % polypropylene and varying proportions of steel fibres (0.5, 1, 1.5, and 2 % by volume of concrete) affected the workability, strength, and durability of M30 concrete.

2 Materials

2.1 Cement: The cement employed in this study is JK Super cement of 53 grade OPC, which complies with IS code IS: 12269-2013.

Fig 1: Cement.

Table 1: Cement properties.

Sl. No	Particulars	Test outcomes
01	Cement	OPC 53
02	Brand	J K Super Cement
03	Sp. Gr.	3.18
04	Initial setting time	40 minutes
05	Final setting time	125 minutes
06	Fineness test	5.00%

2.3 Coarse aggregates:

The coarse aggregates are made from crushed Basalt rock and comply with IS: 383.

Fig 2: 20mm Size Aggregate.

Table 2: 20mm aggregate properties.

Particulars	GGBS
Sp. Gr.	2.67
Water absorption	0.38%
Shape	Angular
Finess modulus	3.49
Confirming to table 2 of IS 383:1970	20 mm

2.4 Fine Aggregates: Sand is made utilizing a rock-on-rock crushing procedure that employs state-of-the-art plant and machinery with cutting-edge technology. IS: 480 sieves have been used to collect river sand.

Fig 3: Fine aggregate.

Table 3: Properties of Fine aggregate.

Properties	Sand
Sp. Gr.	2.64
Fineness Modules	2.88
Water absorption	1%

2.5 Fly-Ash: FA is utilised to reduce the cost of PCC while also improving its performance. FA to Portland cement replacement ratios range from 1:1 to 1.5:1. Low calcium, low silica content class F dry fly ash from R.T.P.S silos adhering to IS: 3812(Part 1)-2003 was employed.

Fig 4: Fly-Ash

Table 4: Fly-ash properties

Characteristics	Fly Ash %
Specific gravity	2.1
Fineness	3%
Silica	62
Al2O3	23
Cao	5

2.6 Super Plasticizer: Super plasticizers utilized in the current study to improve the workability of concrete.

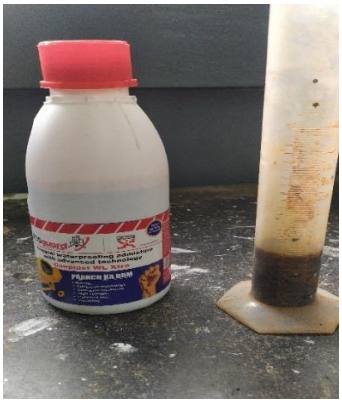

Fig 5. Super plasticizer

2.7 Polypropylene Fibre: Polypropylene (PP) is a thermoplastic polymer that is utilized in a several uses or wide range of applications.

Fig 6: Polypropylene fiber

Table 5: Physical Properties of PP (As per test report).

SL.NO	Properties	Dimensions
1	Length	6 mm
2	Diameter	10 mm

2.8 Steel Fibre: The fibres utilised are hooked end fibres with the parameters shown below, as provided by the manufacturer.

Fig 7. Steel fibre

Table 6: Properties of Steel fibre

Sl. No	Property	Values
1.	Length, Lf	30mm
2.	Df	0.6mm
3.	Aspect Ratio,	50
4.	Vf	0.5%

2.9 Water: Normal water is used for experimental works having IS standard pH. The concrete mix is mixed with potable water. pH levels should be in the range of 6 to 7.

3 Methodology:

Basic journals are followed to look forward for collection of materials and followed by tests conducted on future scopes suggested by researchers. Here, investigations were carried out to see how replacing cement with 20% fly ash and adding 1.5 % polypropylene and varying proportions of steel fibres (0.5, 1, 1.5, and 2 % by volume of concrete) affected the workability, strength, and durability of M30 concrete.

4 Result and Discussions

4.1 Slump test

This type of testing was used in accordance with IS 1199-1959.

Fig No 8: Slump Test

Table 7: Slump test results.

Mix Proportion	Sample 1 (Slump)
AO	73
A1	86
A2	83
A3	81
A4	80
A5	76

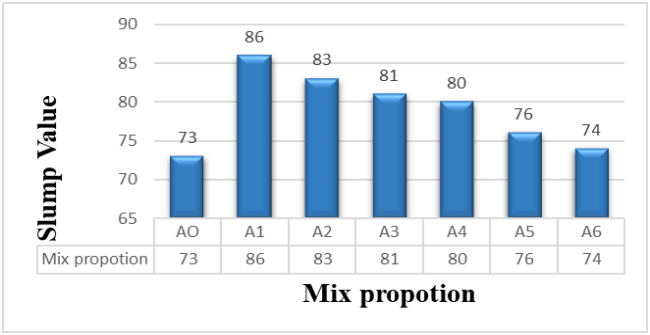

Fig 9. Slump results

When 20% of the cement in the concrete is replaced with FA, the workability of the concrete improves compared to regular concrete. After a 20 % partial replacement of cement by FA results in a slump, the workability of a mixture of 1.5 % polypropylene fibres and increasing %ages of Steel fibres steadily decrease (0.5,1, 1.5 and 2 %).

4.2 Compressive strength

The objective is to find the Compressive Strenght of the concete for 7, 14 and 28 days and Cube mould (150 X150mm) , tamping rode and Ctm mechine are required to perform this test.

Fig. Compressive testing

Tab. 8: Compression test results

Mix Proportion	7 days strength	14 days strength	28 days strength
	N/mm²		
A0	31.54	38.89	44.56
A1	30.07	36.59	43.41
A2	30.81	36.86	46.84
A3	31.82	38.41	47.61
A4	33.04	39.73	48.99
A5	30.24	37.87	43.29
A6	28.03	32.49	41.69

The compressive strengths of hybrid fibres reinforced concrete generated by replacing cement with 20% FA and adding 1.5 % polypropylene fibres together with 1% steel fibres are found to be the greatest (Mix Proportion A4). As a result, even at low water content, the concrete achieves good bonding strength and strength.

4.3 Split tensile strength

This test was conducted to examine the split tensile property of cylinder specimen. And the test was conducted for 7 and 28 days of curing period, obtained results are tabulate below,

Fig 11. Split tensile test

Tab. 9: Split tensile results

Mix Proportion	7 days strength	28 days strength
	N/mm²	
A0	2.69	3.8
A1	2.4	3.2
A2	2.83	4.02
A3	2.94	4.05
A4	2.99	4.18
A5	2.63	3.72
A6	2.42	3.5

The highest value is found in the SPT strength of hybrid fibres reinforced concrete generated by substituting cement with 20% fly ash and adding 1.5 % polypropylene fibres together with 1% steel fibres (Mix Proportion A4). As the amount of steel fibre combined with polypropylene fibre increases, the split tensile strength decreases. With the addition of 1.5 % polypropylene fibres and 1 % steel fibres, the split tensile strength is 4.18 at 28 days and 2.99 at 7 days, based on the number of days as a reference.

4.4 Flexural strength test

The flexural test was conducted for 7 and 28 days of curing on beam of size 700 x 150 x 150 mm.

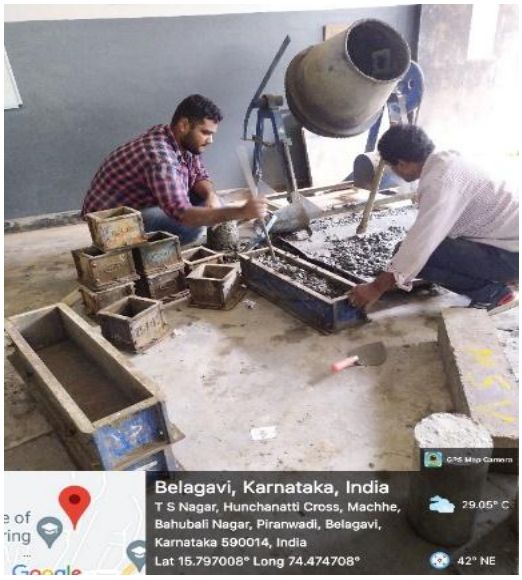

Fig 12. Beam casting

Tab 10: Flexural test results

Mix Proportion	7 days strength	28 days strength
	N/mm²	
AO	3.38	4.44
A1	3.08	4.33
A2	4.21	5.81
A3	4.09	5.33
A4	4.62	6.04
A5	3.73	5.21
A6	3.44	4.92

FLX strength of HFRC made by substituting cement with 20% fly ash has been found to be higher when 1.5 % polypropylene fibre and 1% steel fibre are added. The % increase in Flexural strength after adding 1.5 % polypropylene fibre and 1% steel fibre is 6.04 at 28 days age strength and 4.62 at 28 days age strength compared to the reference number of days. Flexural strength is reduced when steel fibres are added in excess of 1% combined with 1.5 % polypropylene fibres.

4.5 Water absorption

The test was carried out to see how much water is absorbed by concrete when it is replaced 20 % partial replacement of cement by FA results

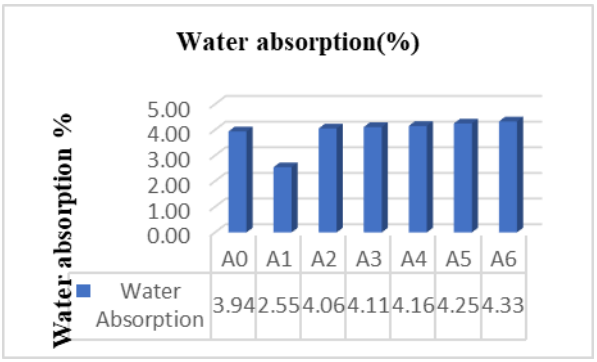

Fig 13: Water absorption results

When conventional concrete is compared to concrete made with 20% fly ash in water absorption experiments, the maximum amount of water absorbed is larger for traditional concrete. When compared to fly ash concrete, hybrid fibre reinforced concrete has a higher water absorption rate. Due to the vacancies generated by the hybrid fibres, this is the case.

5. Conclusions

- When 20% of the cement is replaced by fly ash, the concrete's workability improves by 20% compared to standard concrete. The workability reduces as the proportion of fiber increases, as evidenced by the results of a slump test.
- The hybrid fiber combination of 1.5 % polypropylene fiber and 1% steel fiber achieves the highest compressive strength. The compressive strength of the concrete is 33.04, 39.73 and 48.99 N/mm2 after 7, 14, and 28 days, respectively, which is higher than traditional concrete. As a result, the A4 mix proportion is the best mix proportion.
- In split tensile strength, hybrid fiber combinations with 1.5 % polypropylene fiber and 1 % steel fiber have higher split tensile strength values of 2.99 and 4.18 N/mm2 for 7 and 28 days, respectively.
- Flexural strength values of 4.62 and 6.04 N/mm2 for 14 and 28 days were observed for hybrid fiber combinations including 1.5 % polypropylene fiber and 1 % steel fiber. The fibers serve a crucial function in improving the beam's bending strength.
- In a water absorption test, the hybrid fiber combination of 1.5 % polypropylene fiber and 2 % steel fiber absorbs the most water (A6).

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BIOGRAPHIES

Mr. Jainul Habid P N Received the B E in civil Degree from ACS College of engineering Bangalore in the year of 2020 and currently pursuing M Tech in Construction technology in Jain college of engineering Belagavi, Karnataka, India.

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