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Strength characteristics of cementitious composites with addition of polypropelene fiber

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Abstract: Concrete is a non-homogenous material , and its "interface zone" is the weakest link in the structure, due to this, while on compression, that interface only serves to transfer compressive stresses from one aggregate to the next. Under tension, the aggregates are trying to pull away from each other so this interfacial transition zone has to bear tensile stresses to holds the whole system together. Since its strength significantly weaker than the aggregates, so the failure starts at much lower stresses and it behaves like a brittle material. To overcome these drawbacks Cementitious Composites has been developed. These are the concrete without coarse aggregate. They behave like ductile material. This paper reviews the work of the latest studies carried out on Cementitious Composites in strain hardening and its several applications in tension zone of the concrete. The literature demonstrates that Cementitious Composites possess higher energy absorption than normal concrete and also possess higher ductility ratios.
Keywords: Cementitious Composites, Polypropelene, Compressive Strength

1. Introduction

High Performance Fiber Reinforced Cementitious Composites are a group of fibre reinforced cement based composite which possesses the unique property to flex and self-strengthen before fracturing this special class of concrete was developed with the aim of solving the structural problem associated with normal concrete i.e. its tendency to fail as a brittle material under excessive loading and it lack of long term durability[1,2,3]. HPFRCCs also possess remarkable ability to strain harden under excessive loading. The several proportions are included in the HPFRCC class[4,5]. However the most of the HPFRCCs includes at least the following ingredients: fine aggregate, super plasticizer, fibre, cement, and water. Thus the principle difference between HPFRCC and Typical concrete composition lies in lack of course aggregate[6,7,8]. The strain hardening capability of HPFRCC occurs when a material is loaded past its elastic limit and begins to deform plastically .This stretching or straining action actually strengthens the material. This phenomenon is made possible to the development of multiple microscopic cracks[9].The design of HPFRCC mainly concerned with preventing crack propagation or increasing the length of the crack. There by ultimately leading to material fracture HPFRCC found its application in bridge deck, concrete pipes, roads and buildings. subjected to both seismic and non-seismic loads and also in places where light-weight, strong and durable building material is required[10].

2. Materials Used

2.1 Cement

Cement is the most important ingredient in concrete. Ordinary Portland cement of 53 grade which is locally available is used in this investigation. The cement is tested for various properties as per IS: 4031-1998 and it is found to be confining to various specifications of IS-12269:1987.

Table 2.1 Properties of Cement

S. No	Properties	Values
1	Fineness	303 m^2/Kg
2	Soundness	0.53 mm
3	Initial testing time	30 min.
4	Final testing time	555 min.
5	Standard consistency	32.5%
6	Specific Gravity	3.15

2.2 Rice Husk Ash

Rice husk is the outer cover of paddy and accounts for 20-25 % of its weight. It is removed during rice milling and is used mainly as fuel for heating in homes and industries. Its heating value of 13-15 MJ/kg is lower than most woody biomass fuels. However, it is extensively used in rural areas because of its widespread availability and relatively low cost.

Table 2.2 properties of rice husk ash

Colour	**Off White**
Specific gravity	2.25
pH of 10% Slurry	7.7
pH of 4% Slurry	7.4
Rate of filteration per minute	5.55 Lts
Material passing through 100mesh	77.55%
Material passing through 300mesh	38.52%
Moisture	0.11%

2.3 Fly Ash

Fly ash, the most widely used supplementary cementitious material in concrete, is a byproduct of the combustion of pulverized coal in electric power generating plants. Upon ignition in the furnace, most of the volatile matter and carbon in the coal are burned off. During combustion, the coal's mineral impurities (such as clay, feldspar, quartz, and shale) fuse in suspension and are carried away from the combustion chamber by the exhaust gases.

2.4 Micro Silica

Silica fume, also referred to as micro silica or condensed silica fume, is a byproduct material that is used as a pozzolana. This byproduct is a result of the reduction of high-purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as an oxidized vapor from the 2000°C (3630°F) furnaces. When it cools it condenses and is collected in huge cloth bags. The condensed silica fume is then processed to remove impurities and to control particle size.

2.5 Fine Aggregate

In this investigation, the commercially available river sand from Cauvery river is used as a fine aggregate. River sand should pass through 4.75sieve and retained on 150micron sieve. Fine aggregates used in eht concretts hluohst clean, free from clay, chemically statci. Fine aggregate tested as per IS: 2386 - 1963. Specific gravity and fineness modulus of sand is 2.66 and 2.85 respectively.

Table 2.3 Physical properties of sand

Test particulars	**Results obtained**
Specific Gravity	2.66
Fineness Modulus	2.85

2.6 Polypropylene Fiber

Synthetic fibers have attracted more attention for reinforcing cementitious materials in the recent years. Polypropylene fibers are characterized by low elastic modulus and poor physiochemical bonding with cement paste, it is quite apparent that the load carrying ability of a structure under flexural loading is considerably increased.s Considerable improvements in strain capacity, toughness, impact resistance, Crack control of concrete can be obtained through the use of polypropylene fibers. The polypropylene film consists of amorphous material and crystalline micro fibrils.

2.7 Super Plasticizer

In this investigation, Super plasticisers (SP)are used in the concrete mix and composite mix to make it at adequate workability in the field Different SP will behave differently with different cements because of the variability in the minor components of the cements Figure 4.6 shows the super plasticisers used in this project.

3. Experimental Methods

The materials were tested for its properties and were collected for required quantity. The cylinder were casted for each mix. The mold were removed after 24 hours of casting and cured for 14days and 28 days under normal condition. The specimens were tested for compressive strength, split tensile strength and flexural strength.

3.1 Mix Proportion

This chapter deals with the mix design of the Composite mixes used in this project. Two mixes are used. This mixes are selected on the trial and error basis.

TRAIL MIX 1

Ratio 1:1

CEMENT: SAND: FLY ASH: MICRO SILICA:

RICE HUSK ASH

REF 1 - 1:0.25:0.25:0.25:0.25 (PP FIBRE 0%)

M1 1% - 1:0.25:0.25:0.25:0.25 (PP FIBRE 1%)

M1 1.5% - 1:0.25:0.25:0.25:0.25 (PP FIBRE 1.5%)

M1 2% - 1:0.25:0.25:0.25:0.25 (PP FIBRE 2%)

TRIAL MIX 2

Ratio 1:0.8

CEMENT: SAND: FLY ASH: MICRO SILICA:

RICE HUSK ASH

REF 2 - 1:0.20:0.20:0.20:0.20 (PP FIBRE0%)

M2 1% - 1:0.20:0.20:0.20:0.20(PP FIBRE1%)

M2 1.5% - 1:0.20:0.20:0.20:0.20 (PP FIBRE 1.5%)

M2 2% - 1:0.20:0.20:0.20:0.20 (PP FIBRE 2%)

3.2 Compressive Strength Test

The specimen of size100mm dia and 200mm height is placed in the testing machine and load is applied axially until the cylinder collapse. The maximum load at which the cylinder specimen breaks is taken as a compressive load. The HPFRCC cylindrical specimen under compressive load after 14days and28 days of curing.

3.3 Split Tensile Strength Test

The specimen of size100mm dia and 200mm height is placed in the testing machine and load is applied laterally until the cylinder collapse. The maximum load at which the cylinder specimen breaks is taken as a split tensile s load. The HPFRCC cylindrical specimen under split tensile load after 14days and 28 days of curing.

3.4 Flexural Strength Test

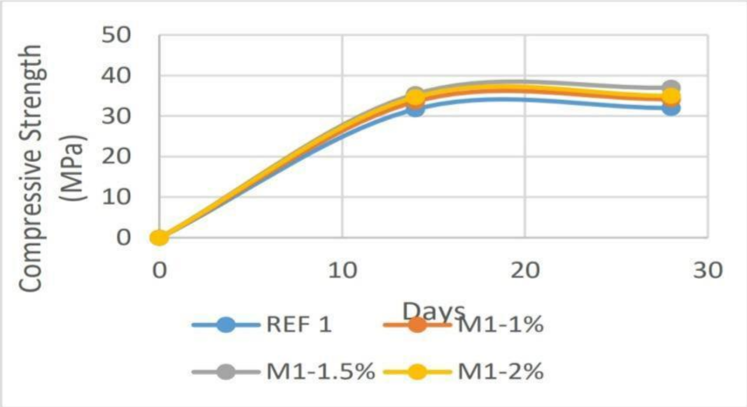
The specimen of size 100mmX100mmX500mm is placed in the testing machine and 4 point load is applied until the prism is collapse. The maximum load at which the prism specimen breaks is taken as a flexural load. The HPFRCC prism specimen under flexural load after 14days and 28 days of curing.

4. Result and Discussion

4.1 Compressive strength

4.1.1 Trail Mix 1

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 1 were tested using compression testing machine. Figure 4.1 shows the compressive strength of the trail mix 1.



4.1 compressive strength of mix 1

From the test results, it is seen that compressive strength of M1-1.5% increases at 28 days and 60 days for trail mix 1.

4.1.2 Trail Mix 2

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 2 were tested using compression testing machine. Figure 4.2 shows the compressive strength of the trail mix 2.

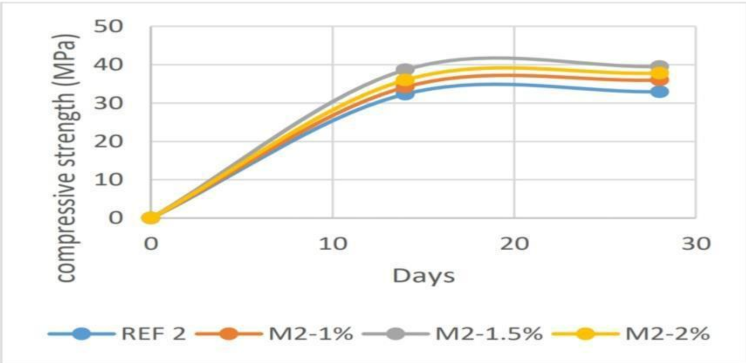


Figure 4.2 compressive strength of mix 2

From the test results, it is seen that compressive strength of M2-1.5% increases at 14 days and 28 days for trail mix 2.

4.2 Split tensile strength

4.2.1 Trail Mix 1

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 1 were tested using tensile testing machine. Figure 4.3 shows the tensile strength of the trail mix 1.

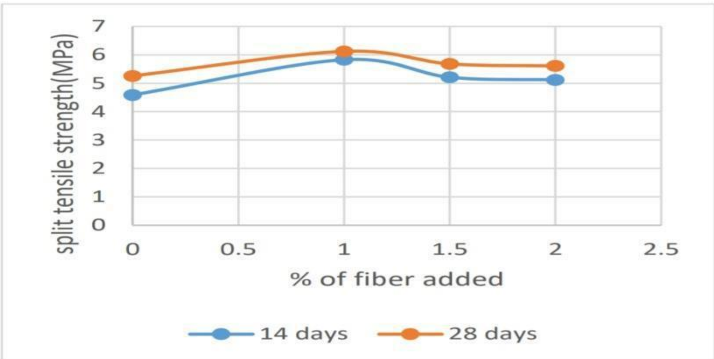


Figure 4.3 split tensile strength of mix 1

From the test results, it is seen that split tensile strength of M1-1% increases at 14 days and 28 days for trail mix 1.

4.2.2 Trail Mix 2

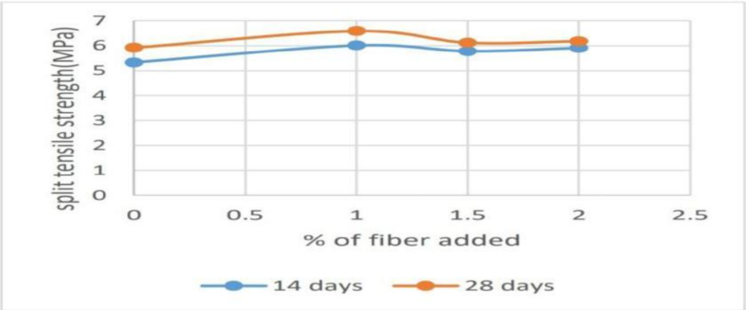


Figure 4.4 split tensile strength of mix 2

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 2 were tested using tensile testing machine. Figure 4.4 shows the tensile strength of the trail mix 2.From the test results, it is seen that split tensile strength of M1-1% increases at 14 days and 28 days for trail mix 2.

4.3 Flexural strength
4.3.1 Trail Mix 1

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 1 were tested using flexural testing machine. Figure 4.5 shows the tensile strength of the trail mix 1.

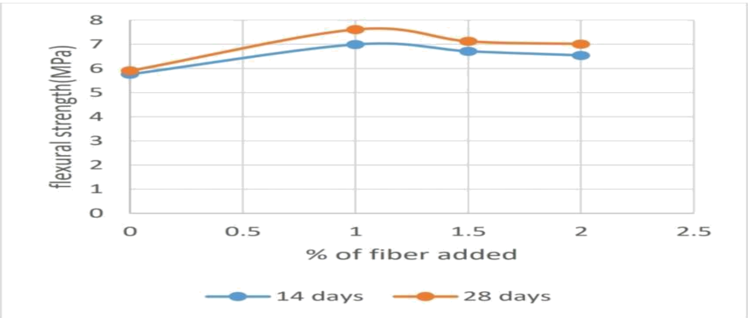


Figure 4.5 flexural strength of mix 1

From the test results, it is seen that flexural strength of M1-1% increases at 14 days and 28 days for trail mix 1.

4.3.2 Trail Mix 2

The casted specimens after 14 days and 28 days of curing the specimens of Trail mix 2 were tested using flexural testing machine. Figure 4.6 shows the tensile strength of the trail mix 2.

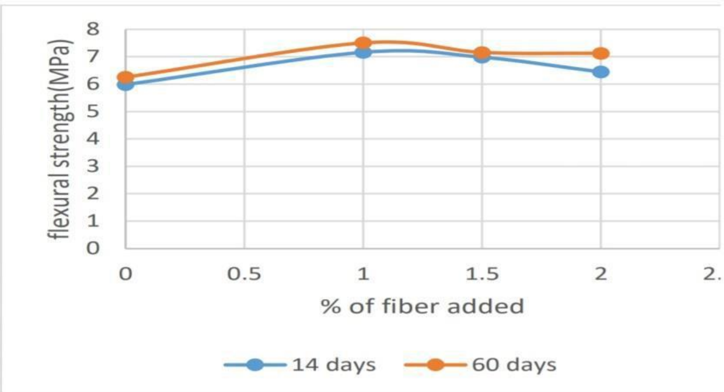


Figure 4.6 flexural strength of mix 2

From the test results, it is seen that flexural strength of M2-1% increases at 14 days and 28 days for trail mix 2.

5. Conclusion

For composite mix 1,

- The compressive strength of the mix1- 15% was found to be 11.77% and 15.56% more than the reference mix
- The flexure strength of the mix M1-1% was found to be 21% and 28.9% more than the reference mix
- The split tensile strength of the mixM1-1% was found to be 8.83% and 0.91% more than the reference mix For composite mix 2,
- The compressive strength of the mix2- 15% was found to be 19.69% and 20.11% more than the reference mix
- The flexure strength of the mix M2-1% was found to be 19.73% and 19.26% more than the reference mix The split tensile strength of the mixM2-1% was found to be 11.17% and 6.16% more than the reference mix

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