Effect of Steel and Polypropylene Fiber on Mechanical Properties of Concrete

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Abstract— This experimental work describes the mechanical properties of concrete on addition of steel and propylene. Steel and polypropylene fiber together are known as Hybrid Fiber Reinforced concrete(HFRC). HFRC is prepared by adding any two fibers to the conventional concrete to make it a composite mixture and that derives benefits from each of the added fiber and exhibits significant response. Here the polypropylene fibers help in resisting initial cracks and shrinkage, steel fibers helps in increase the strength of concrete. In present work M35 grade of concrete can be prepared according to the IS 10262:2009 reference code. these steel and polypropylene fibers are added by 50% each with different hybridization from 0% to 1.5%. For calculating strength parameters specimens are casted and cured for 28 days and tested in the lab for Compressive Test, Split Tensile Test and Flexural Test. From the present investigation the strength parameter increases with the percentage of increase in fiber. Therefore, here the hybrid ratio of 1.5% gives the more result when compared to other hybrid ratio.

Key words: Hybrid Fiber Reinforced Concrete, Fibers, Steel Fibers, Polypropylene Fibers, Shrinkage, Compressive Strength, Flexural Strength, Tensile Strength

I. INTRODUCTION

Concrete is the most desirable material used now a days in construction in India. A mixture of cement, Fine Aggregate, Coarse Aggregate and water is concrete. This type of concrete is known as conventional concrete. The conventional concrete is strong in compression and weak in tension and flexural strength. Apart from the stated strengths concrete is brittle, has low ductility and low impact strength. To overcome its deficiencies various experiments are being carried out by mixing different types of materials.

Previously by mixing single kind of fiber improved the strength of concrete. Now a day's two kind of fibers are mixed together which gives more effective results. The mix of two fibers in concrete is called as Hybrid Fiber Reinforced Concrete (HFRC). This mixture transforms concrete nature from brittle to ductile.

II. EXPERIMENTAL WORK

A. Materails Properties

1) Cement

Cement used is Ordinary Portland Cement (OPC) having 53 Grade as per IS 12269-1970 cement. The preliminary tests like normal consistency, specific gravity, initial and final setting time tests are conducted and results are listed below.

S. No	Properties	Test results
1	Specific gravity	3.14
2	Normal Consistency	35%
3	Initial setting time	25min
4	Final setting time	4hrs
5	Compressive strength	63mpa (28 Days)

Table 1: Properties of Cement

2) Coarse Aggregate

Locally available coarse aggregate passing through 20mm sieve and retained on 4.75mm sieve were used for this experimental study. Different tests are conducted on coarse aggregate are specific gravity, water absorption, fineness modulus are tested and resulted are tabulated below.

S. No	Properties	Results
1	Shape of aggregate	Mix
2	Specific Gravity	2.74
3	Water Absorption	13%
4	Fineness modulus	4

Table 2: Properties of coarse aggregate

3) Fine Aggreagate

Locally available sand with zone II specification passing through 4.75mm sieve as per **IS 383-1983**. Different tests are conducted on coarse aggregate are specific gravity, water absorption, fineness modulus are tested and resulted are tabulated below.

S. No	Properties	Results
1	Specific Gravity	2.62
2	Water Absorption	1%
3	Fineness modulus	2.5
4	Type and Zone	River and Zone II

Table 3: Properties of fine aggregate

4) Water

Portable water used for this experimental study during both casting as well as curing of specimen as per **IS 456-2000**

5) Steel Fibers

Steel Fibers have aspect ratio from 30-150 with different cross section. The different types of steel fibers are Hooked End, Crimped, Glue Hooked and etc. In work presented end hooked steel fibers are used.

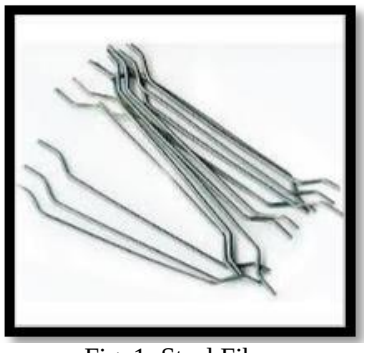

Fig. 1: Steel Fiber

S. No	Properties	Result
1	Type of fiber	Hooked End
2	Length of fiber	100mm
3	Diameter	1 mm
4	Aspect ratio	100
5	Tensile strength	1.160MPa

Table 6L Steel fiber properties

6) Polypropylene Fiber

Polypropylene fiber is composed of crystalline and non-crystalline regions. The fiber ranges in size from micrometer to centimeters in diameter. In present work the polypropylene fibers with 11mm cut length is used.

Fig. 2: Polypropelene fiber

	Properties	Results
1	Geometry of fiber	Fibrillated
2	Length of fiber	12mm
3	Tensile strength	500-750mpa
4	Specific Gravity	0.91-0.91 Kg/cm^2

Table 5: Polypropylene Fiber Properties

III. TESTS ON FRESH CONCRETE

A. Slump Cone Test

The workability or fluidity of freshly mixed concrete is calculated by slump test. It is a field method. Slump test is an indirect measurement of wetness and consistency of freshly made concrete.This test is carried out by slump cone having 300mm height and base 200mm diameter and top cone diameter is 100mm. The cone is filled by fresh concrete by three layers, each layer is tamped by tamping rod for 25 times which is having a diameter of 16mm. After completion of placing the concrete the cone is lifted vertically and slump of concrete is measured. The measured slump is tabulated below.

S. No	Addition Of Fibers (%)	Slump Value, Mm
1	0	94
2	0.5	86
3	1	80
4	1.5	75

Table 6: Slump Cone Test Results

IV. TESTS ON HARDENED CONCRETE

A. Compression Test

In present experimental work the compression test is carried for specimens 150x150x150 mm cube which are casted and cured for 28 days for M35 Grade of concrete. Cubes are dried in air and then they are taken to compressive test machine of capacity of 2000KN. after testing the failure loads are noted. For getting the accurate value 5 cubes are casted and results are noted.

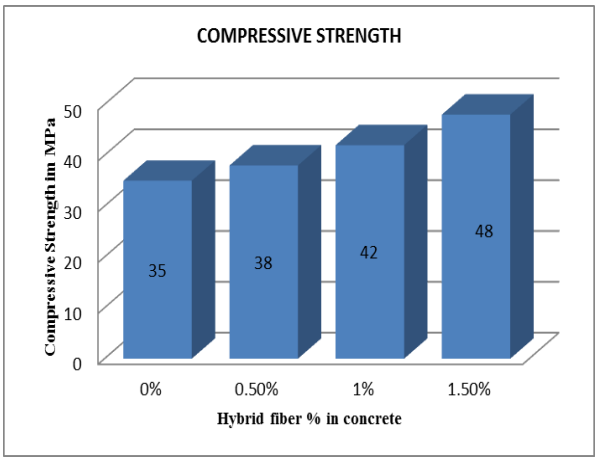

Fig. 3: Compressive Strength

B. Split Tensile Test

Although we as per IS 456:200 we do not consider tensile strength of concrete in design purpose. But by adding fiber and increasing plain concrete's tensile strength crack in concrete can be controlled. Cracks are caused due to shrinkage and creep. Cracking due to shrinkage and creep are of great concern while designing water tank, silo, bunker, bridges etc. Controlling cracks also proves to be cost effective.

For this test cylinder are tested at the end of 28days. The Tensile strength of the specimen was calculated by using the formula

Tensile strength = $2P/\pi LD$

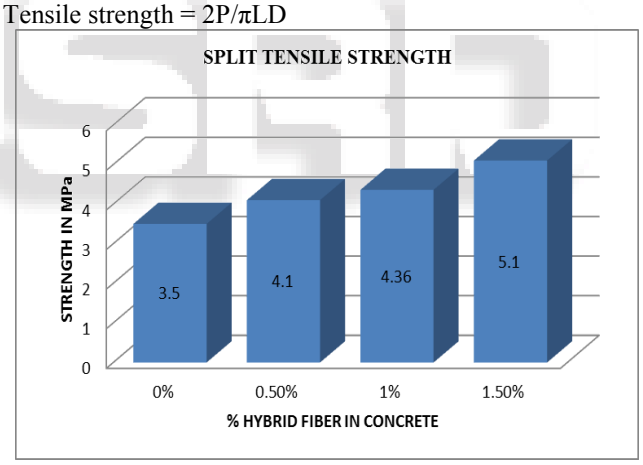

Fig. 4: Split Tensile Strength

V. CONCLUSIONS

From the above experimental work it concludes that:

1) There is an improvement in compressive strength of conventional concrete by adding 1.5% i.e.; 0.75% of polypropylene fibers and 0.75% of steel fibers.
2) Slump Cone test result also reduces gradually by the addition of fibers.
3) The slump cone results of hybrid ratios 0%, 0.5%, 1%, 1.5% are 97,91,84,79 respectively.
4) Therefore 1.5 % of addition of steel and polypropylene fiber (equally) gives high performance of conventional concrete.
5) Tensile strength also increases by adding hybrid fibers in concrete.

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