Experimental Investigation on Hybrid Fiber Reinforced Concrete (M25) and its Effects on properties of Strength and Durability

K. Mogileswar[1], B. Veni[2]

[1]M. Tech Student, Department of Civil Engineering, Shree Rama Educational Society Group of Institution, Tirupati, Andhra Pradesh, India.

[2]Assistant Professor, Department of Civil Engineering, Shree Rama Educational Society Group of Institution, Tirupati, Andhra Pradesh, India.

ABSTRACT : Among all the construction materials that are available for construction, we know that concrete is a widely used construction material for building of various civil engineering structures. Concrete will give better durability and also its costs during construction as well as maintenance are very low when compared to other construction materials. As we know that concrete is strong in construction and weak in tension and tends to fail because of its deficiencies such as low tensile strength, low strain at fracture. The weakness of concrete is due to the presence of micro cracks at mortar aggregate interface. To overcome the existing problems addition of fibers in the concrete has been come in to practice. In fiber reinforced concrete the fibers are added to the concrete mix so that those are discontinuous fibers will be uniformly distributed in the mix and improve the concrete properties in all directions. To get more improvement in the mechanical properties work has been done by combining two different types of fibers knows as hybridization.

Key words: Compressive strength, Split tensile strength, Flexural strength, Impact test, Sorpativity test, hybrid fiber reinforece

1. INTRODUCTION

In ancient days the most of the construction are of mud and lime. Later in the construction field Concrete became a boon of construction and its strength properties created tremendous revolution in construction practice. Due its high strength and durability properties it is largely used inall the sectors (like multi story buildings, irrigation structures, pavements, reservoirs, foundations, dams etc.). As Concrete is exposed to different environmental condition to with stand the environmental effects the properties of conventional concrete had to be increased. This may be achieved by introducing admixtures or fibers to concrete.

Conventional concrete have good compressive strength and it is poor in tension as well as in flexural strength. So for increasing concrete tension as well as flexural strength it's required to add any innovative materials like fibers, admixture, and waste material having good pozzolanas properties, construction chemical. Cement mortar and concrete made with Portland cement is akin of most commonly used construction material in the world. These materials have inherently brittle nature and have some dramatic disadvantages such as poor deformability and weak crack resistance in the practical usage. Also their tensile strength and flexural strength is relatively low compared to their compressive strength. The weakness in tension can be overcome by the use of sufficient volume fraction of certain fibers like steel, polypropylene, nylon, polyester, glass; carbon fibers are used to increase the strength of normal concrete.

1.1 FIBER REINFORCED CONCRETE:

Fiber reinforced concrete (FRC) is concrete obtained by the addition of fibers to concrete (short discrete fibers that are uniformly distributed). Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. The weakness in tension can be overcome by the use of sufficient volume fraction of certain fibers. In order to improve the mechanical properties of concrete it is good to mix cement with fiber which have good tensile strength. Adding fibers to concrete greatly increases the toughness of the material. The use of fibers also alters the behavior of the fiber matrix composite after it has cracked, thereby improving its toughness. In the beginning, FRC was primarily used for pavements and industrial floors but currently, the FRC composite is being used for a wide variety of applications including bridges, tunnel and canal linings, hydraulic structures, pipes, explosion-resistant structures, safety vaults, cladding and roller compacted concrete. The use of FRC in structural members such as beams, columns, connections, slabs and pre-stressed concrete structures is being investigated by a number of researchers at present in India and abroad.

1.2 TYPES OF DIFFERENT FIBERS

Different type of fibers is manufactured with different technology. Every fiberhas different properties with good strength parameters and most commonly used fibers in concrete are as follows.

1. Steel fiber.
2. Polypropylene fiber.
3. Nylons fiber.
4. Polyesters fiber.
5. Asbestos fiber.
6. Glass fiber.
7. Carbon fiber.

Steel fibers are probably the most widely used fibers for many applications, other types of fibers are more appropriate for special applications. Fiber addition in the concrete brings a better control of its cracking and improves its mechanical properties. Particularly, it imparts to the material a post cracking load carrying capacity, ductility. The metal and, more particularly, steel fibers are most largely employed. Initially used in pavements and slabs on soil, their applicability is now extended to the case of structural elements such as piles, beams and self-supporting cladding elements (generally prefabricated), spread linings, and repairs or reinforcements of tunnels, walls, or floors. Polypropylene/Nylon Fiber are Suitable to increase impact strength of concrete. Possess high tensile strength but their low modulus of elasticity and higher elongation do not contribute to the flexural strength.

1.3 HYBRID FIBER REINFORCED CONCRETE

Every Fiber has different strength characteristic and gives strength to concrete.When two different fibers added to concrete to make the composite structure gives maximum strength to concrete that type of concrete is hybrid fiber reinforced concrete (HFRC). Addition of fibers like steel and polypropylene, steel and glass, glass and polypropylene, steel and polyester etc these are hybrid ratio of HFRC with different mix proportion and variation of fibers in concrete. By using HFRC the concrete become stronger because of the fibers which we added they may have good in tensile strength, crack resistance, avoids initial cracks, shrinkage of concrete may be reduced.

HFRC gives more strength and gives best results compare to fiber reinforced concrete due to the addition of two different fibers in concrete. one type of fiber which is stronger and stiffer helps in improving first crack stress and ultimate strength, and second type of fiber improves in toughness and strain in post cracking zone of the concrete. HFRC concrete may increases the tensile strength with holding the crack of concrete. HFRC improves the strength of toughness of concrete due to addition of fibers in concrete compare to other normal concrete.

2. MATERIALS AND METHODOLOGY

2.1MATERIALS

The materials used in the project and the various tests conducted on them and also along with methodology of mix proportion with various proportions of addition of steel fibers in the concrete. In this chapter properties of the materials which are used for the project are discussed and also along with their permissible limits according to the standards.

Cement:

S.NO	Particulars	Results
1	Normal Consistency	32 %
2	Fineness of cement	6 %
3	Setting time	
	Initial setting time	30 min
	Final setting time	10 hours
4	Specific gravity of cement	3.15
5	Soundness of cement	6 mm

Fine aggregate:

S.No	Particulars	Results
1	Specific gravity	2.61
2	Bulk density	
	Bulk density without compaction	1.618 Kg/lit
	Bulk density with compaction	1.763 kg/ lit
3	Water absorption	1.2 %
4	Bulking of sand	14%
5	Fineness Modulus	2.6

Coarse aggregate:

S.No	Particulars	Results
1	Crushing value	19.689 %
2	Impact value	16.380 %
3	LOS ANGELS ABRASION TEST ON COARSE AGGREGATE	32.267 %
4	Shape test	
	Flakiness index	9.019 %

	Elongation index	10.116 %
5	Bulk density	
	Bulk density without compaction	1.390 Kg/lit
	Bulk density with compaction	1.517 Kg/ lit
6	Specific gravity	2.681
7	Water absorption	0.3%

Properties of Steel Fibers.

Types of Steel Fiber	Crimped
Materials	Low carbon drawn flat wire
Length of Fiber	25mm
Diameter of Fiber	0.5mm
Aspect ratio	50
Tensile Strength	500-750mpa
Appearance	Clean, bright, flat end crimped steel fiber

Properties of Polypropylene Fibers.

Geometry of Fiber	Fibrillated
Length	12mm
Tensile strength	500-750 mpa

3. METHODOLOGY

3.1 MIX DESIGN

S.No	Cement Kg/m³	Water Kg/m³	Coarse Aggregate Kg/m³	Fine Aggregate Kg/m³	W/C Ratio
1	625.6	191.5	1161	625.6	0.5

Percentage Variation of Fibers in Mix

Percentage of fiber added in overall concrete mix (%)	Steel Fibers by Volume of Concrete (%)	Polypropylene Fibers by Weight of Cement (%)
0		0
0.5	0.25	0.25
1	0.50	0.50
1.5	0.75	0.75

The strength parameters of concrete it's necessary to conduct the certain tests on concrete. Concrete can be tested in fresh state as well as in hardened state with different mix proportion of fibers.

3.2 TESTS ON CONCRETE

1. Slump cone test.
2. Compaction factor.
3. Compressive strength.
4. Split tensile strength.
5. Flexural strength.
6. Impact test.
7. Sorpativity test.

4. RESULTS AND DISCUSSION

4.1COMPRESSIVE STRENGTH TEST

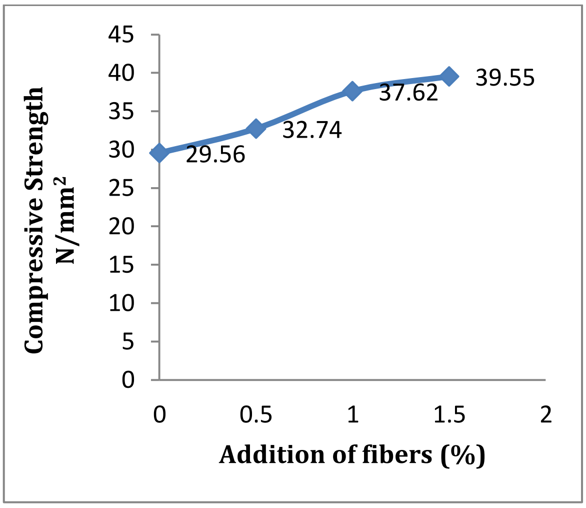

Figure 1: Graph Showing The Results of Compressive Strength Of HFRC.

4.2 TENSILE STRENGTH TEST

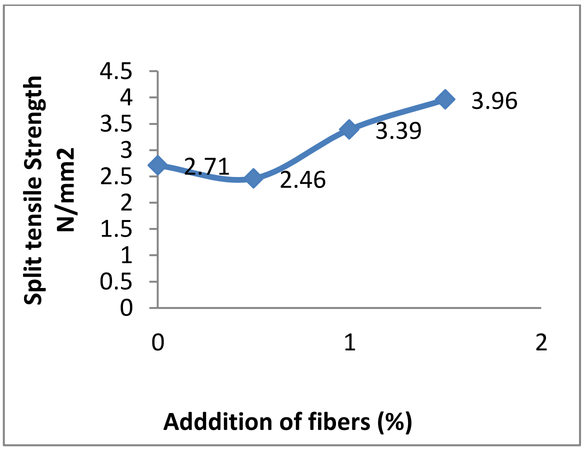

Figure 2: Graph Showing The Results of Split Tensile Strength Of HFRC.

4.3 FLEXURAL STRENGTH TEST

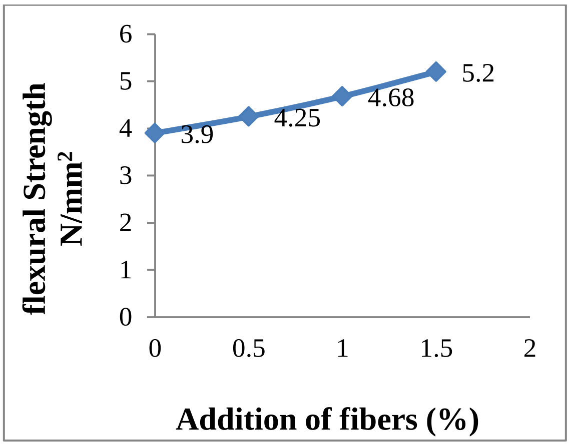

Figure 3: Graph Showing The Results of Flexural Strength Of HFRC.

4.4IMPACT STRENGTH TEST

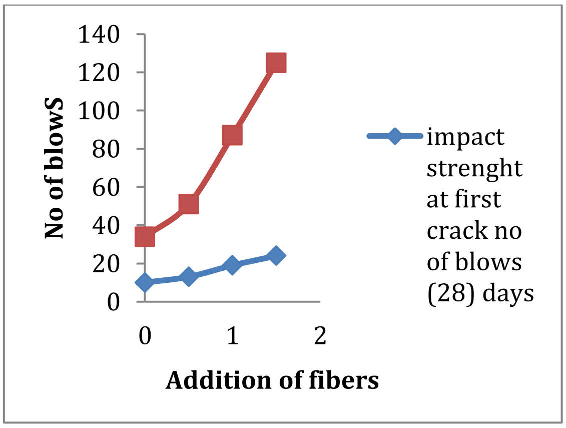

Figure 4: Graph Showing The Results of Impact Strength of HFRC.

4.5 SORPTIVITY TEST

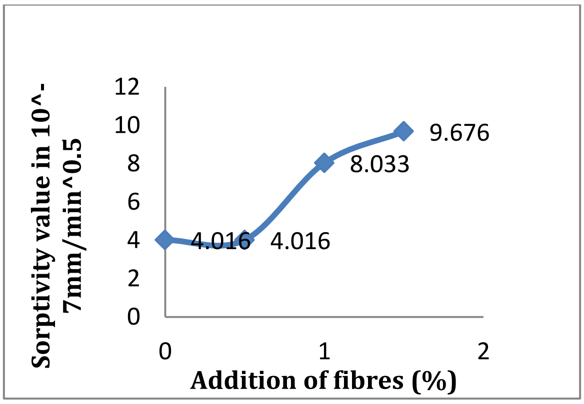

Figure 5: Graph Showing the Results of Sorptivity Test of HFRC.

4.6 SLUMP AND COMPACTION FACTOR

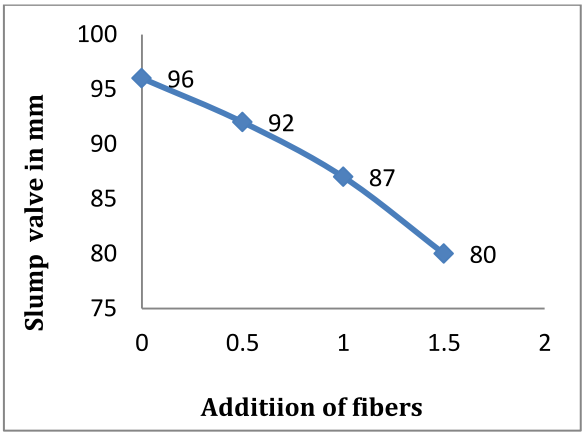

Figure 6: Graph Showing the Slump Cone Valves of HFRC

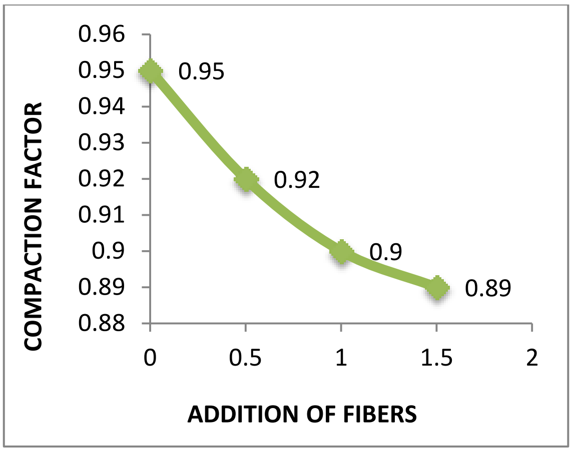

Figure7: Graph showing compaction factor results of HFRC

5. CONCLUSIONS

[1] There is change in Compressive quality of HFRC contrast with traditional cement on account of expansion of strands. The greatest increment in compressive quality saw at having mixture proportion 1.5 % i.e. 0.75 % steel fiber and 0.75 % polypropylene fiber and When contrasted and controlled cement the expansion in the compressive quality with fiber expansion in rates of 0.5%, 1%, 1.5% is 10.75%, 27.26%, 33.79% separately.

[2] Tensile quality might be abatement for the proportion 0.5 % of filaments contrast with ordinary cement, from that point it might increment in rigidity and half and half proportion having 1.5% gives greatest quality contrast with other extent. From this we can infer that for 0.5% expansion of strands there is decline in results from that point expansion of filaments i.e 1%,1.5% there may increment in quality When contrasted and controlled cement the expansion in the

split elasticity with fiber expansion in rates of 0.5%, 1%, 1.5% is 9.22%, 25.09%, 46.12% separately.

[3] Flexural quality might be most extreme for mixture proportion 1.5% thinks about to customary cement. From this we can reason that as there is an augmentation in the fiber content there is likewise an addition in the flexural quality. In this way flexural quality increments with the expansion of expansion of strands in the blend. At the point when contrasted and controlled cement the expansion in the flexural quality with fiber expansion in rates of 0.5%, 1%, 1.5% is 8.97%, 20%, 33.33% separately.

[4] Impact quality of HFRC increments as the rate of strands expands the no of blows required to disappointment the example additionally increments. Along these lines sway quality increments with the expansion of expansion of filaments in the blend. At the point when contrasted and controlled cement the expansion in the effect quality with fiber expansion in rates of 0.5%, 1%, 1.5% separately.

[5] Slump cone valves is diminishing with Addition of filaments is expansions. It is so in light of the fact that as the strands are included the draining will be decreased and the blend will get to be unforgiving. From this we can reason that as the rate of fiber substance is expanded the workability will be diminished. As the rate increment in filaments the compaction variable qualities diminishes. From this we can infer that the workability of the blend diminishes as the fiber content in the solid increments.

[6] Sorptivity will be more as the rate of strands expansion is increment. From results we can reason that 0.5% expansion of cross breed filaments gives same Sorptivity valve contrast with customary cement.

[7] The ideal rate of filaments expansion is 1.5%. Expansion of strands up to 1.5% gives best results in all quality parameters contrast with other blend extent.

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