Experimental Study of Strength & Durability Properties of Hybrid Fiber Reinforced Concrete for M25 Grade

S Syed Basha
Department of Civil Engineering
Sree Rama Engineering College, Tirupathi, Chittoor District, Andhra Pradesh, India- 517507

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. In present experimental work for M25 grade of concrete can be designed according to IS 10262:2009 with four different proportions of hybrid fibers are added with concrete ingredients. The proportion of steel and polypropylene fibers are added by 50% each with different hybridization ration i.e. 0%,0.5%, 1.0 %, 1.5% and steel fibers are added by volume of concrete and polypropylene is added by weight of cement. For strength parameters compressive, tensile, flexural, impact strength specimens are casted and cured for 28 days and tested for hardened concrete and for fresh concrete slump and compaction factor test is carried to know the workability of hybrid fiber reinforced concrete. For durability study Sorptivity test is carried out to know the absorption of water by capillary. To evaluate the strength parameters different tests are conducted and results are tabulated. From the present work results show that 1.5 % addition of hybrid fiber gives maximum results in all the strength parameters compare to other different hybrid ratios.

Key words: Hybrid Reinforced Concrete, Polypropylene Fiber, Steel Fiber, Sorptivity Test, Tensile Strength, Impact Strength, Flexural Strength, Compressive Strength, Capillary

I. 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 in all 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 pozzolan as properties, construction chemical. Cement mortar and concrete made with Portland cement is a kind 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.

A. 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.

B. 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.

II. MATERIALS

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. The materials which are used for the project are discussed and also along with their permissible limits according to the standards. The following are the materials used in the experimental work.

1) Cement.
2) Fine aggregate.
3) Coarse aggregate.
4) Water.
5) Steel fibers.
6) Polypropylene fibers.

A. *Cement*

Cement used is ordinary Portland cement (OPC) having 53 grade as per IS 12269-1987 cement used as a binding material in the present investigation. The preliminary tests like normal consistency (amount of water to be added), specific gravity, initial and final setting time, soundness of cement tests is conducted and results are listed below.

Properties	Results
Specific gravity	3.12
Soundness of cement	5 mm
Normal consistency	32%
Initial setting time	42 minutes
Final setting time	300 minutes

Table 2.1.1: Physical Properties of Cement

B. *Fine aggregate*

Locally available sand used as fine aggregate for experimental work and passing through 4.75mmas per IS 383-1978.Sand is brought from Swarnamukhi river bed near Tirupathi. The preliminary tests like specific gravity, water absorption, and fineness modules are tested and results are tabulated below.

Specific gravity	2.40
Water absorption	1.5%
Fineness modules	2.0
Type of sand	River sand
Zone	III

Table 2.2.1: Properties of Fine Aggregate

C. *Coarse Aggregate*

Locally available 20 mm down size coarse aggregate with retained on 4.75mm sieve has been used in the present work. It is brought from Perruru crusher, Bangalore highway road. Different test conducted on coarse aggregate are specific gravity, water absorption, fineness modules. The properties of coarse aggregate as follows.

Specific gravity	2.73
Water absorption	11%
Shape of aggregate	Angular
Fineness modules	4.0

Table 2.3.1: Properties of Coarse Aggregate

D. *Water*

Potable water which is available in laboratory is used for casting of specimen and as well as curing of specimen as per IS 456-2000.

E. *Steel Fibers*

Steel fibers are short, discrete lengths of steel with different aspect ratio from about 30to 150 with different cross sections. Different types of Steel fibers are hooked ends, crimped, glue hooked end etc these are most commonly used fibers. Their shape will be Round of diameter 0.25 to 0.75mm. They Enhances flexural, impact and fatigue strength of concrete. Thin shells and plates have also been constructed using steel fibers. In the present work crimped steel fiber with flat end used. These steel fibers are brought from Bharat Steel Chennai Pvt. Ltd (BSC). The properties off steel fibers with their specifications are mentioned in the table below.

Type of Steel fiber	Crimped
Material	Low carbon drawn flat wire
Length of fiber	25 mm
Diameter of fiber	0.5 mm
Aspect ratio	50
Tensile strength	500-750 mpa
Appearance	Clear, bight, flat end crimped steel fibers

2.5.1: Table Properties of Steel Fibers

Plate 2.5.1: Steel Fibers

F. *Polypropylene Fibers*

Polypropylene fiber is composed of crystalline and non-crystalline (amorphous) regions. The fiber range in size from fractions of a micrometer to centimeters in diameter. The manufacturing of this fiber have to two different types. First one is pulling wire procedure with circular cross section or by extruding the plastic film with rectangular cross section. And appearance of this fiber in fibrillated bundles, mono filament. These fibers have different length 12mm, 24mm; 40mm cut length is available.

In the present investigation the polypropylene fibers with 12mm cut length is used. These polypropylene fibers are brought from Bharat Steel Chennai Pvt Ltd (BSC). The properties off polypropylene fibers with their specifications are mentioned in the table below.

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

Table 2.6.1: Table properties of polypropylene fibers

Plate 2.6.1: Polypropylene Fibers

III. Objectives of the Study

1) To study the different strength parameters like compressive strength, tensile strength, flexural strength of hybrid fiber reinforced concrete with different mix proportion of fibers for M25 grade concrete.
2) To determine impact resistance properties on the hybrid fiber reinforced concrete and comparing with the conventional concrete.
3) To know the optimum percentage of addition of fibers to concrete and finding maximum hybrid ratio.
4) To determine workability of hybrid fiber reinforced concrete by the addition of fibers in concrete mix.
5) To study the durability properties of hybrid fiber reinforced concrete.

Concrete Mix Design for M25 Concrete (IS-10262:2009)
Stipulation for mix proportioning

1	Grade designation	M25
2	Type of cement	OPC 53 grade
3	Maximum nominal size of aggregate	20 mm
4	Minimum cement content	300 kg/m^3
5	Workability	75 mm
6	Exposure condition	Severe
7	Method of concrete placing	Normal
8	Degree of supervision	Good
9	Type of aggregate	Crushed angular aggregate
10	Maximum cement content	450 kg/m^3

Table 1: Stipulation for Mix Proportioning

Test data for materials
1) Cement used: OPC 53 grade
2) Specific gravity of cement: 3.12
3) Specific gravity of
a) Coarse aggregate: 2.73
b) Fine aggregate: 2.40
4) Water absorption
a) Coarse aggregate: 11%
b) Fine aggregate: 1.5 %
5) Free (surface) moisture:
a) Coarse aggregate: Nil
b) Fine aggregate: Nil

A. Target Strength for Mix Proportioning

$f^1ck = fck + 1.65s$
Where
f^1ck = Target average compressive strength at 28 days.
fck = Characteristic compressive strength at 28 days, and
s= standard deviation.
From IS 10262: 2009, table 1, standard deviation s=4
Therefore, Target strength (f^1ck) =25+1.65×4
= 31.6 N/mm^2

B. Selection of Water –Cement Ration

From IS 456-2000, table 5, maximum water cement ratio=0.50

1) Selection of Water Content

From IS 10262:2009, table 2, maximum water content for 20mm aggregate= 186 liter (for 25 to 50mm slump range)
Estimated water content for 75mm slump=186+ (3/100)×186 =191.5 liters.

C. Calculation of Cement Content

Water cement ratio=0.50
Cement content =191.5/0.50=383 kg/m^3 <450 kg/m^3

D. Volume of Coarse Aggregate & Fine Aggregate Proportion Content

From IS 10262:2009,table 3, volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (zone 2) for water-cement ratio 0 .50

1) Mix Calculation

1) Volume of concrete=1 m^3
2) Volume of coarse aggregate=0.62
3) Volume of fine aggregate=1-0.62=0.38
4) Volume of cement = mass of cement / specific gravity of cement ×1/1000
= 383/3.10×1/1000
= 0.1215 m^3
5) Volume of water = mass of water /specific gravity of water×1/1000
= 191.5/1×1/1000
= 0.1915 m^3
6) Volume of all in aggregate= (1-(0.1215+.1915))=0.686 m^3
7) Mass of coarse aggregate=volume of all in aggregate×volume of coarse aggregate×specific gravity of coarse aggregate×1000
= 0.686×0.62×2.73×1000
= 1161.12 kg
8) Mass of fine aggregate=volume of all in aggregate×volume of fine aggregate×specific gravity×100
= 0.686×0.38×2.40×1000
= 625.63kg.

E. Mix Proportion

Cement	Fine coarse aggregate	Coarse aggregate	Water content	Water-Cement ratio
383 kg/m^3	625.63 kg/m^3	1161.12 kg/m^3	191.5 liters	0.50

1	1.63	3.03	191.5 liters	0.50

Table 4.2: Design mix proportion of M25 grade concrete.

F. Addition of Fibers

1) Addition of Steel Fibers

Steel fibers have different aspect ratio

Steel fibers having density of 7860 kg/m^3 has been used in the present work.

Steel fibers have been added with different variations such as 0.25%, 0.50%, and 0.75% of volume of concrete.

2) Steel fibers addition by 0.25% of volume of concrete.

The mass of fibers required for 1 m^3 are calculated and showed below and Fibers mass can be calculated by following formula.

Mass of fibers =density of steel fibers ×percentage of addition of fibers

= (7860×0.25/100)

=19.65 kg/m^3

3) For one cube

For calculating the mass of fibers for one cube,

First volume of cube is calculated (150×150×150) mm^3=3.375×10^{-3}M^3.

Mass of fibers needed for one cube =mass of fibers required for proportion ×volume of cube

=1965×3.375×10^{-3}

=66.415grams.

4) For one cylinder

For calculating the mass of fibers,

Volume of one cylinder $=\pi r^2 h$

$=\pi(0.15/2)^2 \times 0.30$

=0.0053m^3

Mass of fibers needed for one cylinder = mass of fibers required for proportion ×volume of cylinder

=19650×0.0053

=104.145 grams.

5) For one prism

For calculating the mass of fibers for one prism at first volume of prism is calculated.

Volume of prism= (L×B×H) = (0.1×0.1×0.5) =0.005m^3

Mass of fibers needed for one prism = mass of fibers required for proportion×volume of prism

=19650×0.005

=98.25grams.

G. For One Impact Specimen

For calculating the mass of fibers for one impact cylinder, first volume of one impact cylinder is calculated i.e.

Volume of one impact cylinder $=\pi r^2 h/4$

$$=\pi\left(\frac{0.15}{2}\right)^2 \times (0.30/4)$$

=0.00132 m^3

Mass of fibers needed for one impact cylinder =mass of fibers required for proportion X volume of impact cylinder

=19650×0.00132

=25.938 grams.

H. Addition of Polypropylene Fiber

1) Polypropylene Fibers

Polypropylene fibers having a density 0.95 kg/cm^3 were used for the present study. The fibers having a cut length of 12mm.

Additions of polypropylene fiber are done in different proportions such as 0.25%, 0.50% and 0.75% by weight of cement.

0.25% of weight of cement

The mass of fibers required for 1 m^3 are calculated and showed below.

Mass of fibers =0.25/100=0.0025 Kg

2) For one cube

Calculation of fibers needed for one cube is calculated as below

Weight of cement required for one cube = volume of cube ×cement content for 1 m^3

= 0.00337×383

= 1.290 Kg

Mass of fibers =weight of cement required for one cube ×percentage of addition of fibers

=1.290×0.0025

=3.225×10^{-3}kg

3) For one cylinder

Calculation of fibers needed for one cylinder is calculated as below

Weight of cement required for one cylinder =volume of cylinder ×cement content for 1 m^3

=0.0053×383 =2.03kg

Mass of fibers =weight of cement required for one cylinder ×percentage of addition of fibers

=2.03×0.0025

=5.07×10^{-3} Kg

4) For one prism

Calculation of fibers needed for one prism is calculated as below

Weight of cement required for one prism =volume of prism ×cement content for 1 m^3

= 0.005 ×383

=1.915 Kg

Mass of fibers =weight of cement required for one prism ×percentage of addition of fibers

=1.915 × 0.0025

=4.7875 ×10^{-3} Kg

5) For one impact cylinder

Calculation of fibers needed for one impact cylinder is calculated as below

Weight of cement required for one impact cylinder =volume of impact cylinder ×cement content for 1 m^3

=0.00132 ×383

=0.505 Kg

Mass of fibers =weight of cement required for impact cylinder ×percentage of addition of fibers

=0.505×0.0025

=1.26×10^{-3} Kg

IV. EXPERIMENTAL METHODLOGY

To study 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.

A. Tests on Concrete

1) Hardened Concrete

1) Compressive strength.

2) Split tensile strength.
3) Flexural strength.
4) Impact test.
5) Sorpativity test.

2) Fresh Concrete

1) Slump cone test.
2) Compaction factor.

a) Compressive Strength Test

In the present work Compressive strength test can be carried out by using cube size of 150mm×150mm×150mm cubes are casted for M25 grade concrete with different type of hybrid fibers present in concrete. The cubes are then demoulded after 24 hours of casting and then cubes are kept in curing tank for 28 days. After 28 days curing period cubes shell be remove from water and keep it for drying. After that cubes should be tested in compression testing machine with machine having capacity of 2000KN and failure load of cubes can be note down with using appropriate formula compressive strength can be determined. For accurate valves 3 cubes shall be casted and tested and compressive strength can be calculated by following formula:

$$\text{compressive strength} = \frac{\text{failure load}}{\text{cross sectional area}}$$

Split tensile strength:For tensile strength test cylinders specimens can be casted with having dimension of 150mm diameter and 300mm length casted for M25 grade concrete with different type of hybrid fibers present in concrete. The cylinders are then demoulded after 24 hours of casting and then cylinders are kept in curing tank for 28 days. After 28 days curing period cylinders shell be remove from water and keep it for drying after that cylinders should be tested in compressive testing machine and taking of 3 average valve and tensile strength can be calculated using formula:

$$\text{Tensile strength(N/MM2)} = \frac{2P}{\Pi dl}$$

Where,
P = failure load,
D = diameter of cylinder,
L = length of cylinder and
h = height of cylinder.

b) Flexure Strength

For flexure strength test prisms should be casted with having an dimension of 100mm×100mm×500mm prisms are casted for M25 grade concrete with different type of hybrid fibers present in concrete. The prisms are then demoulded after 24 hours of casting and then prisms are kept in curing tank for 28 days. After 28 days curing period prisms shell be remove from water and keep it for drying. after that prisms should be tested in universal testing machine(UTM) having capacity of 1000KN failure load can be note down and flexural strength can be calculated by following formula:

$$\text{Flexural strength} = \frac{\text{Pl}}{\text{bd\^{}2}}$$

Where,
p= failure load,
l= length of specimen,
d= depth of specimens,
b= breadth of specimens.

c) Impact Test

This test is carried on cylindrical specimen ¼ height of cylinder (75mm) and having diameter 150mm.and cast specimen is cured for 28days and tested in impact testing equipment. Weight of hammer is 4.54 kg, height of the drop is 450mm and number of blows should be note down and graph should be plotted between number of blows and % of fibers.

d) Sorptivity Test

This test is conducted to find the water absorption rate. By measuring the capillary rise absorption rate by a homogeneous material the sorptivity can be determined. The fluid used for the test is water. The cube specimens were used for testing the absorption rate. The specimens having 150X150mm surface area were casted and cured for a period of 45 days. After curing the specimens were oven dried up to a temperature of 100 ℃ before used for testing.The specimen is coated with non absorbent material on all sides except on side of contact with the water. The liquid level should not be more than 5mm from the base of the specimen. The amount of liquid absorbed by the specimen in the time span of 30 minutes is noted by weighing the specimen in the weighing balance. The specimen is wiped cleanly before it is weighed with a piece of cloth. The property of a material which explains the nature of porous material to absorb and also transmit the water by capillarity can be defined as the Sorptivity. It is denoted by S.The increase in the cumulative water absorption per unit area of the inflow surface is due to the square root of the elapsed time " t"

The following formula is used for the calculation of sorptivity

$I=S.t^{1/2}$

$S=I\ /t^{1/2}$

Where; S= measure of sorptivity in mm
t= the elapsed time in minutes
$I=\Delta w/Ad$
Δw= difference in weights = W2-W1
W1 = Oven dry weight of cube specimen in grams
W2 = Weight of cube specimen in grams after 30 minutes of capillary suction of water
. A= surface area of cube specimen were the penetration of water takes place.
d= water density

3) Fresh Concrete

a) Slump cone test

The concrete slump test measures the workability or fluidity of the concrete. Slump test performed to check the indirectly measurement of consistency or stiffness of freshly made concrete. Consistency of concrete can measure the quantity of water added during the mixing of concrete and Concrete stiffness is the property of finish product quality. The test is carried out using a mould known as a slump cone with having 300mm height and base is 200mm in diameter and top cone having a 100mm diameter. The base is placed on a hard non-absorbent surface and This cone is filled with fresh concrete in three layers and each layer have tamped 25 times using a 16mm diameter steel rod. At the end of the third layer, concrete is struck off flush to the top of the cone. After complete filling of cone the cone is carefully lifted vertically upwards, an un supported concrete is slump of that concrete.

b) Compaction Factor Test

Compaction factor is to determine the workability of fresh concrete. This test can be carried out by using compaction factor apparatus having two hoppers, upper hopper and middle hopper respectively and in bottom the empty cylinders is kept to collect the concrete. First concrete is placed in upper hopper up to its full capacity after filling concrete the valve or door of hopper will opened and loose concrete is allowed to fall in cylinder. Excess concrete is stuck off with trowel and weight the cylinder with loose compacted or partially compacted concrete. Then the cylinder is filled with fresh concrete in three layers with fully compacted concrete by using vibration and weight the fully compacted concrete. Using following formula we can find compaction factor:

$$\text{compaction factor} = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

V. RESULTS & DISCUSSIONS

From the present work of experimentation results of all the parameters are calculated and tabulated below.

Compressive Strength Test Results

Sl. no	Percent age of steel fiber	Percentage of Polypropylene fiber	% Hybrid fibers	Compressive strength at 28 days (N/mm$^{2)}$	Percentage increase in strength
1	0	0	0	29.56	0%
2	0.25	0.25	0.5	32.74	10.75%
3	0.50	0.50	1	37.62	27.26%
4	0.75	0.75	1.5	39.55	33.79%

Table 5.1: Compressive Strength Test Results

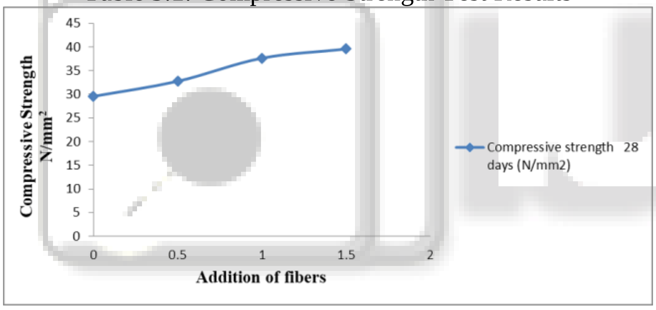


Fig. 5.1: Graph Showing the Results of Compressive Strength of HFRC

From the above fig 5.1 plainly at 0.5% expansion of filaments the compressive quality is 32.74 N/mm2.As the rate of strands is expanded to 1 % and to 1.5 % the compressive quality is 37.62 N/mm2, 39.55 N/mm2 separately. From this we can presume that as there is an augmentation in the fiber content there is additionally an addition in the compressive quality. In this way compressive quality increments with the expansion of expansion of filaments in the blend. At the point 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% individually.

A. Tensile Strength Test Results

Sl. no	Percent age of steel fiber	Percentage of Polypropylene fiber	% Hybrid fibers	Compressive strength at 28 days (N/mm$^{2)}$	Percentage increase in strength
1	0	0	0	2.71	0%
2	0.25	0.25	0.5	2.46	9.22%
3	0.50	0.50	1	3.39	25.09%
4	0.75	0.75	1.5	3.96	46.12%

Table 5.2: Test Results of Tensile Strength

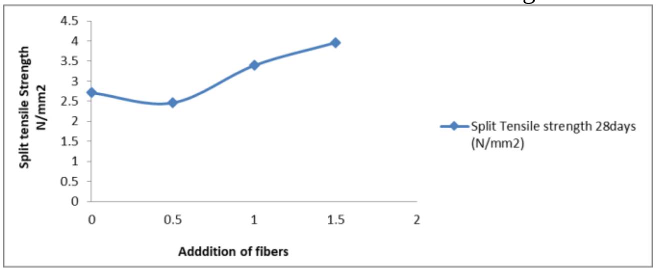


Fig. 5.2: Graph showing the results of split tensile strength of HFRC

From the above fig 5.2 plainly at 0.5% expansion of filaments the elasticity is 2.46 N/mm2 and at 0.5 % expansion of strands there is declarations in quality contrast with traditional cement i.e 2.71N/mm2.As the rate of strands is expanded to 1 % and to 1.5 % the split rigidity is 3.39 N/mm2, 3.96 N/mm2 individually. From this we can infer that for 0.5% expansion of filaments there is lessening in results from there on expansion of strands i.e 1%,1.5% there may increment in quality When contrasted and controlled cement the increment in the split elasticity with fiber expansion in rates of 0.5%, 1%, 1.5% is 9.22%, 25.09%, 46.12% individually.

B. Flexural Strength Test Results

Sl. no	Percent age of steel fiber	Percentage of Polypropylene fiber	% Hybrid fibers	Compressive strength at 28 days (N/mm$^{2)}$	Percentage increase in strength
1	0	0	0	3.90	0%
2	0.25	0.25	0.5	4.25	8.97%
3	0.50	0.50	1	4.68	20%
4	0.75	0.75	1.5	5.20	33.33%

Table 5.3: Test Results of flexural strength

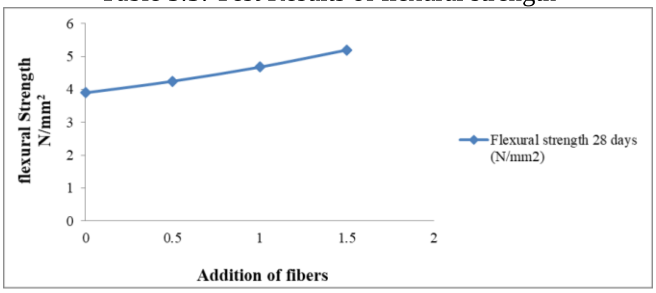


Fig. 5.3: Graph Showing the Results of Flexural Strength of HFRC

From the above fig 5.3 plainly at 0.5% expansion of strands the flexural quality is 4.25 N/mm2As the rate of filaments is expanded to 1 % and to 1.5 % the flexural quality is 4.68 N/mm2, 5.20 N/mm2 separately. From this we can presume that as there is an addition in the fiber content there is likewise an augmentation in the flexural quality. Hence flexural quality increments with the expansion of expansion of filaments 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% individually.

C. Impact Strength Test Results

Sl.no	Percentage of steel fiber	Percentage of Polypropylene fiber	% Hybrid fibers	Impact strength at first crack no of blows (28 days)	Impact strength at first crack no of blows (28 days)
1	0	0	0	10	34
2	0.25	0.25	0.5	13	51
3	0.50	0.50	1	19	87
4	0.75	0.75	1.5	24	125

Table 5.4: Test Results of Impact Test

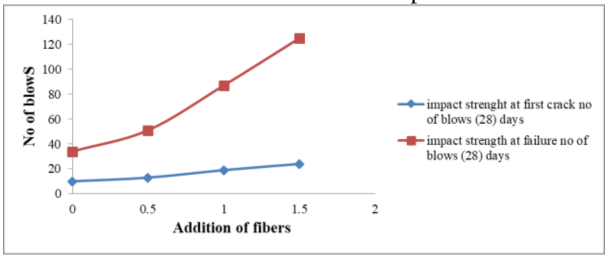


Fig. 5.4: Graph Showing the Results of Impact Strength of HFRC

From the above fig 5.4 obviously at as the rate of strands expands the no of blows required to disappointment the example additionally increments. From this we can infer that as there is an augmentation in the fiber content there is likewise an addition in the effect valve or quality. In this manner 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.

Plate 5.4: Iimpact Test Apparatus

D. Sorptivity Test Results

Sl.No	Percentage of fibers (%)	Dry weight in grams	Wet weight in grams	Sorptivity value in 10^{-7}/min$^{0.5}$
1	0	8018	8023	4.016
2	0.5	8757	8762	4.016
3	1.0	8784	8794	8.033
4	1.5	8846	8856	9.676

Table 5.5: Result of Sorptivity Test

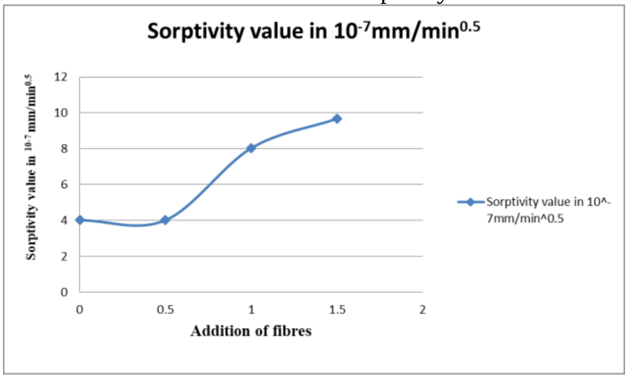


Fig. 5.5: Graph Showing the Results of Sorptivity Test of HFRC

In the above fig 5.5 as expansion of filaments is expanding there is a diminishing in the droop values. It is so in light of the fact that as the filaments are included the draining will be lessened and the blend will get to be cruel. From this we can infer that as the rate of fiber substance is expanded the workability will be diminished.

Plate 5.5: Sorptivity Test

E. Slump & Compaction Factor Results

Sl.No	% of fibers	Slump values in mm	Compaction factor
1	0	96	0.95
2	0.5	92	0.92
3	1.0	87	0.90
4	1.5	80	0.89

Table 5.6: Results of Slump and Compaction Factor Tests

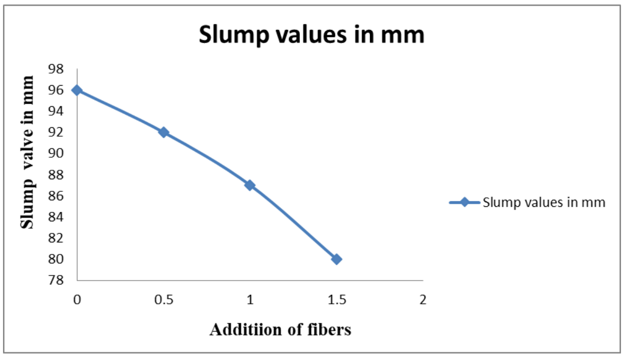
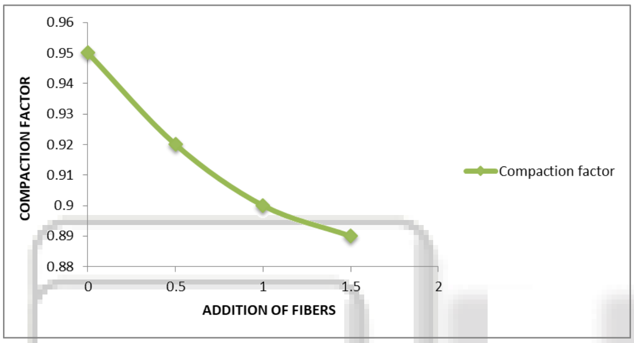


Fig. 5.6: Graph showing the slump cone valves of HFRC

In the above fig 5.6 as addition of fibers is increasing there is a decrease in the slump values. It is so because as the fibers are added the bleeding will be reduced and the mix will become harsh. From this we can conclude that as the percentage of fiber content is increased the workability will be decreased.



Fig, 5.7: Graph showing compaction factor results of HFRC

It is seen from the above chart that as the fiber content in the blend build compaction element values diminishes. From this we can reason that the workability of the blend diminishes as the fiber content in the solid increments

VI. Conclusions

From my experimental examination I finished up the accompanying focuses.

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.

References

[1] Selina ruby g., geethanjali c., jaison varghese, p. Muthu priya"Influence of Hybrid Fiber on Reinforced Concrete"International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014.
[2] S.C.Patodi, C.V. Kulkarni "Performance Evaluation Of Hybrid Fiber Reinforced Concrete Matrix" International Journal of Engineering Research and Applications Vol. 2, Issue5, September- October 2012, pp.1856-1863.
[3] Wakchaure M. R., Rajebhosale S. H., Satpute M. B., Kandekar S. B, "Comparison of compressive strength and flexural shear strength for hybrid fiber reinforced concrete with controlled concrete" ,International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-02, Issue-09, September 2014.
[4] Avinash Gornale, S Ibrahim Quadri, S Mehmood Quadri, Syed Md Akram Ali, Syed Shamsuddin Hussaini "strength aspects of Glass fiber reinforced concrete" International Journal of Scientific & Engineering Research, Volume 3, Issue 7, July-2012 1 ISSN 2229-5518.
[5] A SivakumaR et.al, "Influence of hybrid fiber on the post crack performance of high strength concrete: part 1 experimental investigations" ISSN 2141-2634, Journal of Civil Engineering and Construction Technology Vol. 2(7), pp. 147-159, July 2011.

[6] Chandra mouli K.et al, "STRENGTH PROPERTIES OF GLASS FIBRE CONCRETE" ISSN 1819-6608, ARPN Journal of Engineering and Applied Sciences, VOL. 5, NO. 4, APRIL 2010.

[7] Mohammed Alias Yusof et al "Mechanical Properties of Hybrid Steel Fibre Reinforced Concrete with Different Aspect Ratio" ISSN 1991-8178,Australian Journal of Basic and Applied Sciences, 5(7): 159-166, 2011.

[8] C. Selin Ravikumar et al investigated on "Glass Fibre Concrete: Investigation on Strength and Fire Resistant Properties "IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 9, Issue 3 (Sep. - Oct. 2013).

[9] Amit Rai, Dr. Y.P Joshi, "Applications and Properties of Fibre Reinforced Concrete", International Journal of Engineering Research and Applications, Vol. 4, Issue 5 (Version 1), May 2014.

[10] Divyeshkumar D. Paradava, Jayeshkumar Pitroda, "Utilization Of Artificial Fibres In Construction Industry: A Critical Literature Review", International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013.

[11] Vikrant S. Vairgade, Kavita S. Kene, Sathish Sathawane, "Experimental investigation on hybrid fiber reinforced concrete", June- 2012.

[12] Selina Ruby G, Geethanjali C, Jaison Varghese, P. Muthu Priya, "Influence of Hybrid Fiber on Reinforced Concrete", International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014.

[13] Mr.Ranjith Kumar.R, Ms.Vennila.A, Mr.Southamirajan.S ,"Experimental Investigation on hybrid Fiber Reinforced Concrete" International Journal of Emerging Trends in Engineering and DevelopmentIssue ISSN 2249-6149 3, Vol.2 (March 2013).

[14] Kavita S Kene, Vikrant S Vairagade and Satish Sathawane "Experimental Study on Behavior of Steel and Glass Fiber Reinforced Concrete Composites "Bonfring International Journal of Industrial Engineering and Management Science, Vol. 2, No. 4, December 2012