Utilization of Copper Wire & Steel Binding Wire as Fibers for Analysis of Mechanical Properties of M40 Concrete

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Abstract— A study on M-40 grade of concrete with mix proportion 1:2.38:3.04:0.4 with water cement ratio 0.4 to analyze mechanical properties of Fiber Reinforced Concrete (FRC), where fibers are steel binding wires and copper wires having fibers of 0%, 1%, 2% and 3% volume fraction. Aspect ratio of fibers is taken as 50. An outcome information acquired is examined and related with a conventional sample (0% fiber). A relationship between % of fibers strength of concrete represented graphically. Finally, strength of concrete shows better results at 2 % fibers, further increased in % of fibers will lowers the strength of concrete.

Key words: Fiber Reinforced Strength Concrete, Copper Wire, Steel Binding Wire

I. INTRODUCTION

A. General

Concrete is most generally utilized building material on the planet because of its capacity to become throw in whatever casing & profile. It likewise substitutes previous building materials, for example, block workmanship. The quality & solidness of concrete may be altered via rolling out proper improvements in its parts like cementitious substances, aggregates and water and by including some unique components. Consequently, concrete is extremely well reasonable for an extensive variety of utilizations. The solidifying is brought about by chemical response amongst water and cement and it proceeds for quite a while, thus the concrete becomes more solid with time. Concrete is solid in compression however fragile in tension. This shortcoming in concrete prompts splitting. These splits are fundamentally micro cracks. The occurrence of these cracks is in charge of the natural shortcoming of concrete. The shortcoming can be expelled by incorporation of fibers in the blend. Such a blend is known as FRC.

B. Types of Fibers:

steel, glass, asbestos, carbon, polypropelyene

C. Objectives

1) Many research has been done and ongoing on the fiber reinforced concrete by incorporating number of fibers, in this research an effort is composed to aid copper wires and steel binding wires both in combination as fiber for reinforcing the concrete.
2) To check the fresh and harden state properties of concrete which involves both copper wire and steel binding wire as fibers with appropriate proportions.
3) To check the fresh state properties i.e. Workability of this type of concrete where we will be knowing, how ease of working with concrete can be done i.e. Nothing but the slump of concrete.
4) In this study fiber percentage is varied so that we will come to know the optimum percentage of fiber which will give maximum strength of concrete.
5) And also to analyses design for M40 design mix by which high strength concrete can be achieved when this type of fibers is used.
6) To analyses the mechanical characteristics results at 7 days, 14 days and 28 days of casting and knowing % increase in strength from number of varying % of fibers, there by coming to know how much % strength has increased at standard curing.

II. LITERATURE REVIEW

A. R.V. Balendran et. al (2001):

The test "discoveries shows fewer vol “fibers have slight effect on comp quality yet enhance astoundingly part rigidity, flexural quality and strength. The expansion in part elasticity, flexural quality and sturdiness list for lightweight cement appears to be considerably higher than that of typical total cement. The size effect on crystal part rigidity is not noteworthy past a basic (move) estimate. There is obvious size effect on flexural quality and strength list. As the example estimate increments, part and flexural qualities seem to abatement, and crack conduct has a tendency to be weaker.

B. Yuh-Shiou Ta (2011):

This review examines the pressure–tension connection of RPC in semi still stacking subsequently a lifted hotness. The barrel examples of RPC with ϕ 50mm×100mmare inspected at the room temperature and after 200–800 ◦C. Test comes about demonstrate that the remaining compressive quality of RPC in the wake of warming from200–300 ◦C expands more than that at room temperature, at the same time, significantly diminishes once heat surpasses 300ºC. The lingering crest tensions of RPC additionally at first increment up to 400–500 ◦C, then abatement bit by bit past 500 ◦C. In the meantime, Es reduces by an expanding warmth. In view of the relapse investigation comes about, this review additionally creates relapse principles to evaluate the strength of RPC when a raised hotness, subsequently giving an important reference to modern applications and plan.

C. A.M. Shende et. al (2012):

This paper concluded that It is detected that strength (compressive, flexural, split tensile) is on greater level for 3% fibers as related to that made by 0, 1 and 2%. Altogether the power features are detected to be on upper side for L/D of 50 as linked to 60 and 67. It is seen that compressive strength rises from 11 to 24%and flexural strength escalates

from 12 to 49% and STS upsurges by 3 - 41% by way of surcharge of fibers.

D. Syed Rahemath Peer Quadri et. al (2016):

In this venture we utilized the modern steel slag set up of common sand with expansion of steel fiber in bond concrete for M30 review of cement. From this examination, we infer that, common waterway sand can be incompletely supplanted by steel slag up to 40% with 1.5% of steel fiber.

III. MATERIALS USED AND MIX DESIGN

A. Materials Used

For the current investigation for the high strength concrete of M 40 grade mix design with copper wires and steel binding wires with appropriate proportions the following materials were used to prepare the mix

- Cement: Ultratech (02/17)
- Fine Aggregates (sand): Shahapur pit
- Coarse Aggregates (metal or jelly): Size 20mm, 10mm, 4.75mm
- Water: Portable water
- Copper wires: Waste from electrical wires
- Steel binding wires.: Regular Binding wires
- Superplasticizer: FosRoc (CONPLAST SP 430)

1) Cement:

Ordinary Portland cement(OPC) 53 Grade Ultratech cement confirming to IS: 12269 - 1987 was taken for use in this investigation

Sl no	Content	Particulars
1	Company name	ULTRATECH
2	Grade of cement	OPC 53 Grade
3	Standard Consistency in %	30%
4	Setting time (initial) in min	40 min
5	Setting time (final) in min	390 min
6	Sieve analysis (fineness) in %	8.4%
7	Comp strength in Mpa	
8	7 days	28
9	3 days	20

Table 1: Various Properties of cement Testing in Lab

2) Fine aggregate:

Natural river sand was taken from Shahapur pit to provisions of IS: 383-1970 (Zone I) having specific gravity 2.72 is utilized. Experiments on fine aggregate are performed on Government Polytechnic College Kalaburagi.

SL no	Sieve sizes	Wt. recollected (gm)	Increasing weight reserved (gm)	Increasing % wt preserved (%)
1	4.75mm	0	0	0
2	2.36mm	100	150	15
3	1.18mm	250	300	30
4	600 µ	350	650	65
5	300 µ	200	950	95
6	150 µ	100	1000	100
7	total			275

Table 2: Properties of Fine Aggregate as per IS: 383 and Sieve analysis

Water absorption= 1.1%, weight of sample = 1 kg Specific gravity = 2.72

∴ FM of FA = increasing % preserved / 100= 275/100 =2.75FM limits for zone 1 sand according to IS: 383 – 1970 is 2.71 – 4.0

3) Coarse Aggregate:

Fresh crushed aggregate should be utilsed to produce concrete which has to be free from organic matter, dirt and should not undergo any alkali reactions while mixing the mixture. Size of aggregates 20mm, 10mm, 4.75mm

Slno	Specific gravity	2.73
1	Shape	Angular diamond
2	Free surface moisture	Nil
3	Size of crushed aggregate	20mm,10mm, 4.75mm
4	Water absorption	0.6%
5	Aggregate crushing value	13

Table 3: Properties of Coarse Aggregate

4) Water:

Drinking water which is free from salts and which is clear and it should satisfy IS 450:2000 for the mixing of concrete

5) Copper wire:

For the present investigation, waste electrical copper wire was used as a fiber with a cut length of 50mm and its properties are as follows

- It gives greater confrontation to load and can survive without breaking or deformation under tensile stresses.
- It offers higher strength without crushing the metallic bond called ductility property.
- Creep confrontation: it gives steady buckling of concrete from expansion and contraction under load or no load pattern of condition.
- Rusting opposition: it offers confrontation to rusting action
- Length= 50mm and least lateral dimension= 1mm.
- Aspect ratio = L/D = 50.

6) Steel Binding Wire:

1) The properties of steel binding wires are as follows.
2) The dia of binding wire ranges from 0.8mm to 1.6mm.
3) It has great confrontation to corrosion.
4) It can survive secure abrasion.
5) It is more flexible and soft.
6) Tensile strength 240-430 N/mm$^{2.}$

7) Super Plasticiser :

It decrease W/C ratio and improves the workability of the concrete. CONPLAST SP 430 trade name is used for this study.

B. Mix computation

Vol of mix = 1 m^3

Vol of binding material = wt of cement / G of cement x 1/1000

= 370/3.15 x 1/1000

= 0.117 m^3

Vol of wate= wt of water / G water x 1/1000

= 140/1 x 1/1000

= 0.140 m^3

Vol of chemical = mass of chemical admixture/ sp gravity of admixture x 1/1000

admixture (superplasticiser)

(@ 1.5% by mass of cement)

= 7/1.21x 1/1000

= 0.0058 m^3

Vol of all in agg = (a – { b + c + d })
= (1 – (0.117 + 0.140 + 0.0058)) = 0.7372 m^3
Wt of CA = e x vol of ca x G of ca x 10^3
= 0.7372 x 0.56 x 2.73 x 10^3 = 1127 kg
Wt of FA = e x vol of F A x G of F A x 10^3
= 0.7372 x 0.44 x 2.72 x 10^3
= 882 kg
Cement = 370 kg/m^3
Water = 140 kg/m^3
FA = 882 kg/m^3
CA = 1127 kg/m^3
Chemical admixture = 7 kg/m^3
Water/Cement = 0.4
MIX RATIO 370:882: 1127: 0.4
Cement:Fine Aggregate:Coarse Aggregate: Water
1: 2.38: 3.04 : 0.4

IV. EXPERIMENTAL METHODOLGY

A. Tests On Fresh Concrete

1) Slump Cone Test

1) Remove the interior surface of the mould and put on oil.
2) Place the mould on a even flat non- permeable base plate.
3) Fill the mould with the ready concrete mix in 4 roughly identical deposits.
4) Compress every deposit with 25 hits of the curved end of the tapping rod in a even way over the cross section of the mould. For the following deposits, the compressing must enter into the beneath layer.
5) Eliminate the extra concrete and flatten the surface with a trowel.
6) remove the slurry out among the mould and the base plate.
7) Elevate the mould from the concrete as soon as possible and gradually in perpendicular path.
8) Note down the slump as the difference among the altitude of the mould and that of altitude point of the sample is tested.

2) Compaction Factor Test

1) It is done by means of compaction factor deviceconsisting 2 hoppers, top hopper and central hopper individually and in bottom the unfilled cylinders is kept to accumulate the concrete.
2) First concrete is positioned in top hopper up to its complete volumethenentrance of hopper is released and moveable concrete is allowed to drop in cylinder. additional concrete is detached off with trowel and mass the container with moveable compacted or partly compacted concrete.
3) Then cylinder is packed byfresh concrete in 3 depositsby completelycompressed concrete by means of shaking and mass the fully compacted concrete is noted
4) Using following formula we can find compaction factor:

Compaction factor{CF}

$$= \frac{\text{Weight of Partially Compacted Concrete}}{\text{Weight of Compacted Concrte}}$$

B. Tests On Harden Concrete

1) Compressive Strength

1) In this assessment, cube samples of sizes 15 x 15 x 15 cm are used for M40 mix . The samples are prepared by 0 , 1 , 2 , 3 percentage of fibres. Moulds are well vibrated.
2) The upper surface of the sample was smoothed and evenely levelled. Later 24 hr the samples are taken out of mould and are moved to curing tub in that they are permitted to cure for 28 days.
3) When 28 days of curing is done , the sample sare assessed on CTM as per I.S:516-1959. And breakage force is written.
4) In every kind 3 samples are examined & mean avg number is taken out. The comp str is find out as shown below.
5) Comp str (MPa) = Breakage force / C/S area. Mpa or N/mm^2

Fig. 1: Mixing of Concrete

Fig. 2: Casting of Concrete in Moulds

Fig. 3: Demoulded Concrete Cube Samples

Fig. 4: Curing of Cubes, Prisms, and Cylinders

Fig. 5: Testing of Concrete Cube Samples

C. Flexural Strength

1) Regarding this experiment beam samples of size of 100x100x500 mm are casted . The samples are taken out of moulds later 24 hrs of casting & are moved to water tub where its permitted to cure upto 28 days.
2) Then samples are assessed in 2 pt loading w.t.r I.S. 516-1959, with an efficient length of 40cm in FTM.
3) Force & its equivalent bendingare listed until breakage. In everykind3 beams are tested and its mean avg value is taken. The flexural strength is find out by :

Flexural str = (P x L) / (b x d2), N/mm^2

P = breakage force ,
L = C/C length among the provision = 400 mm,
b = thickness of sample=10 cm,
d = hieght of sample = 10 cm.

Fig. 19: Testing of Prism

D. Split Tensile Strength

- For this experiment, cylinder samples of size 150 mm dia and 300 mm longare casted.
- The samples are taken out of moulds later 24 hrs of casting & are moved to water tub where its permitted to cure @ 28 days.
- Then samples are assessed in CTM . In every kind 3 cylinders tested and its mean avg value is taken.
- Split Tensile strength is find by = $2P / \pi DL$, N/mm^2

P = breakdown force
D = dia of container
L = span of container.

Fig. 20: Testing of Cylinder

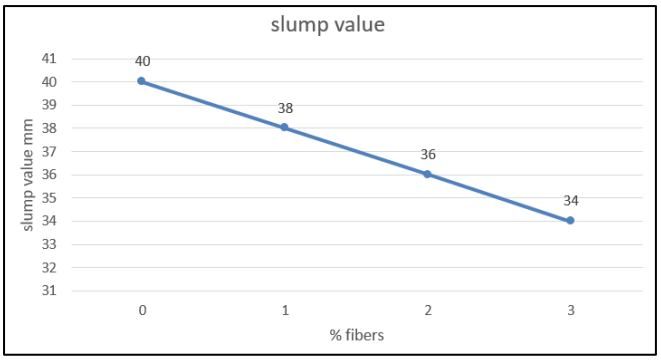
V. RESULTS AND DISUSSION

A. Fresh State of Concrete Tests Results

1) Slump test

Sl no	% of fibers	% of copper wires	% of steel binding wires	No of trials	Slump value (mm)
1	0	0	0	1	40
2	1	0.5	0.5	1	38
3	2	1	1	1	36
4	3	1.5	1.5	1	34

Table 5: Slump Test Values

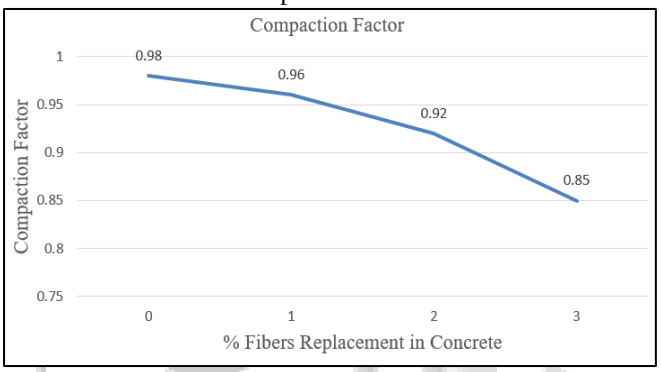


Graph 1: Calibration Slump Value

2) Compaction Factor Test

Sl no	% of fibers	% of copper wires	% of steel binding wires	No of trials	Compaction factor
1	0	0	0	1	0.98
2	1	0.5	0.5	1	0.96
3	2	1	1	1	0.92
4	3	1.5	1.5	1	0.85

Table 6: Compaction Cactor Values



Graph 2: Calibration Compaction Factor Value

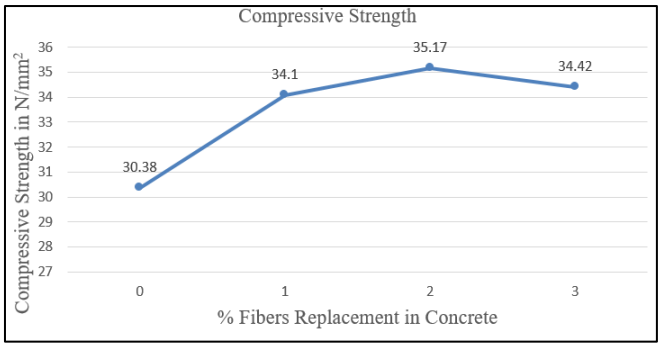
B. Harden State of Concrete Test Results

1) Compressive strength :

Compressive strength of concrete is tested for 7 days and 14 days and 28 days and all the results are tabulated as shown in below and also respective graphs are also plotted

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg Comp Str in N/mm^2
1	0%	0%	0%	3	30.38
2	1%	0.5%	0.5%	3	34.10
3	2%	1%	1%	3	35.17
4	3%	1.5%	1.5%	3	34.42

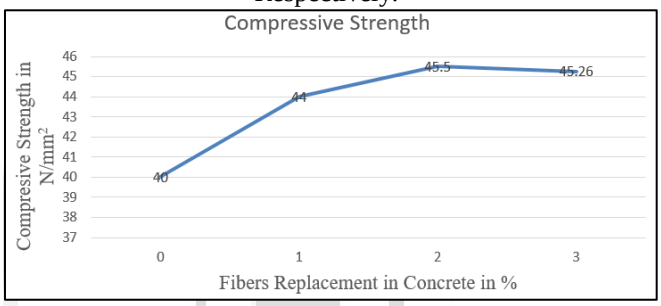
Table 7 : Test Results of Compresssive Strength of 7 days cube with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 3: Compresssive Strength at 7 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg Comp Str in N/mm^2
1	0%	0%	0%	3	40
2	1%	0.5%	0.5%	3	44
3	2%	1%	1%	3	45.5
4	3%	1.5%	1.5%	3	45.26

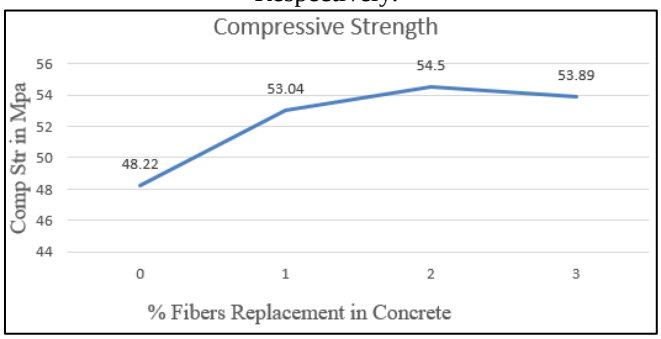
Table 8 : Test Results of Compresssive Strength of 14 days cube with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 4: Compresssive Strength at 14 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg Comp Str in N/mm^2
1	0%	0%	0%	3	48.22
2	1%	0.5%	0.5%	3	53.04
3	2%	1%	1%	3	54.5
4	3%	1.5%	1.5%	3	53.89

Table 9 : Test Results of Compresssive Strength of 28 days cube with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 5: Compresssive Strength @ 28 days

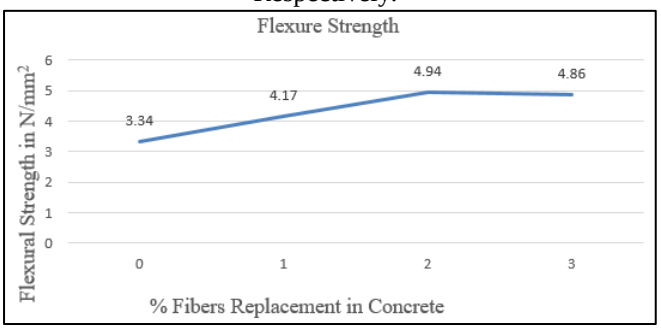
2) Flexural strength:

Flexural strength of concrete is tested for 7 days and 14 days and 28 days and all the results are tabulated as shown in below and also respective graphs are also plotted

SL	% of	% of	% of	No of	Avg

NO	Fibers	Steel Binding Wires	Copper Wires	Cubes	Flexural Strength in N/mm^2
1	0%	0%	0%	3	3.34
2	1%	0.5%	0.5%	3	4.17
3	2%	1%	1%	3	4.94
4	3%	1.5%	1.5%	3	4.86

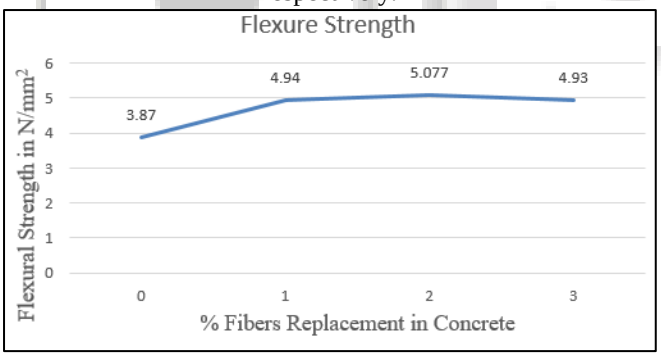
Table 10 : Test Results of Flexural Strength of 7 days Prism with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 6: Flexural Strength at 7 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg Flexural Strength in N/mm^2
1	0%	0%	0%	3	3.87
2	1%	0.5%	0.5%	3	4.94
3	2%	1%	1%	3	5.077
4	3%	1.5%	1.5%	3	4.93

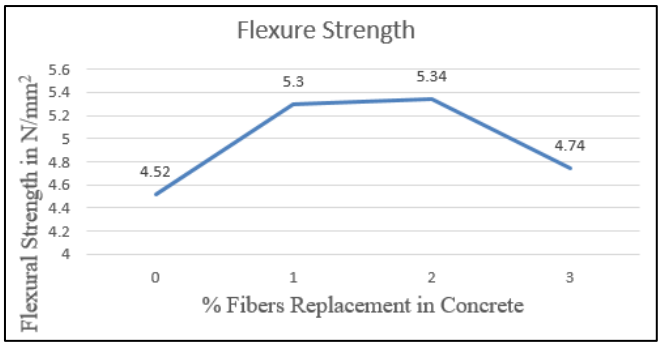
Table 11 : Test Results of Flexural Strength of 14 days Prism with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 7: Flexural Strength at 14 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg Flexural Strength in N/mm^2
1	0%	0%	0%	3	4.52
2	1%	0.5%	0.5%	3	5.3
3	2%	1%	1%	3	5.34
4	3%	1.5%	1.5%	3	4.74

Table 12 : Test Results of Flexural Strength of 28 days Prism with percentage variation of 0% , 1% , 2%, and 3% Respectively.



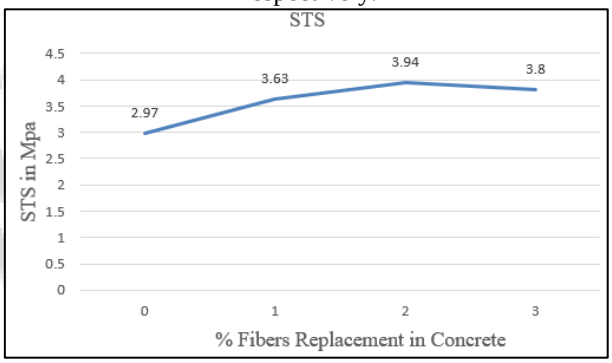
Graph 8: Flexural Strength at 28 days

3) Split Tensile Strength (STS):

of concrete is tested for 7 days and 14 days and 28 days and all the results are tabulated as shown in below and also respective graphs are also plotted

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg STS in N/mm^2
1	0%	0%	0%	3	2.97
2	1%	0.5%	0.5%	3	3.63
3	2%	1%	1%	3	3.94
4	3%	1.5%	1.5%	3	3.8

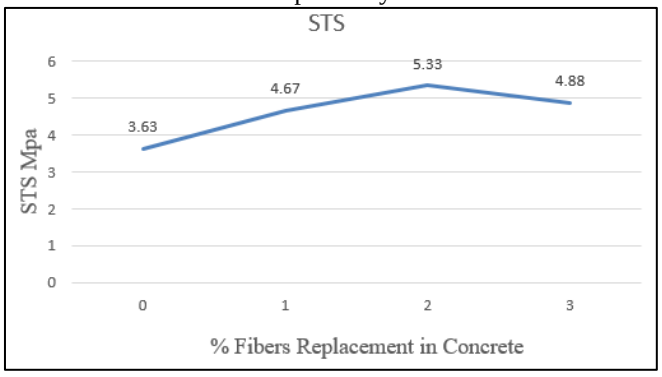
Table 13 : Test Results of Split TensileStrength of 7 days Cylinder with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 9: STS @ 7 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg STS in N/mm^2
1	0%	0%	0%	3	3.63
2	1%	0.5%	0.5%	3	4.67
3	2%	1%	1%	3	5.33
4	3%	1.5%	1.5%	3	4.88

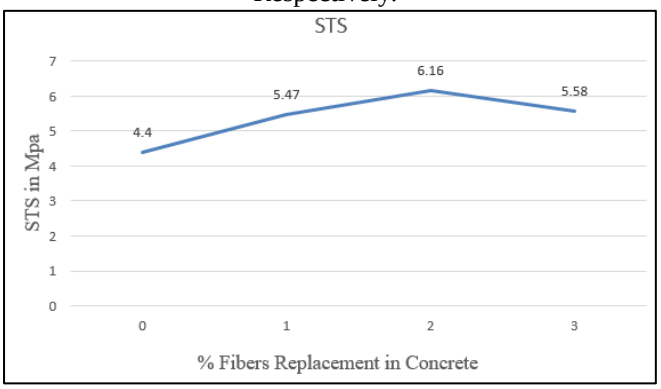
Table 14 : Test Results of Split TensileStrength of 14 days Cylinder with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 10 STS @ 14 days

SL NO	% of Fibers	% of Steel Binding Wires	% of Copper Wires	No of Cubes	Avg STS in N/mm^2
1	0%	0%	0%	3	4.4
2	1%	0.5%	0.5%	3	5.47
3	2%	1%	1%	3	6.16
4	3%	1.5%	1.5%	3	5.58

Table 15 : Test Results of Split TensileStrength of 28 days Cylinder with percentage variation of 0% , 1% , 2%, and 3% Respectively.



Graph 11: STS @ 28 day

VI. CONLUSION

The subsequent decisions might be drawn from the current study.

1) It is noticed that all strengths (compresssive and split tensile ans well as flexureal) is holds good at 2% fibres related to created by 0%, 1% & 3%
2) Since we are getting higher strength then that of conventional concrete the aspect ration 50 considered is holds good for producing concrete.
3) Compressive strength of concrte of 2 % fiber is almost 6 mpa morer then that of traditional concrete at 28 days.
4) flexural strength of concrte of 2 % fiber is almost 1.5 mpa morer then that of traditional concrete at 28 days.
5) Split tensile strength strength of concrte of 2 % fiber is almost 2 mpa more then that of traditional concrete at 28 days.
6) From this study we can conclude that addition of fiber i.e copper wires and steel binding wires have considerable increased the strength of concrete.

VII. FUTURE SCOPE

1) In this concrete we can change or replace the cement with some mineral admixture such as ggbs, flyash, rice husk etc and check the strength characteristics , making it more cost effective.
2) One can replace fine aggregates or coarse aggregate with M sand or other natural aggregates and investigate the fresh and harden properties of concrete .
3) By using different aspect ratio we analyse the strength parameters of concrete .
4) Changing the fiber content in different proportions one can analyse the properties of mix like taking 75% of copper wires and 25 % of steel binding wires , instead of taking 50% of copper wires and 50% of steel binding wires

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