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Evalution Of Mechanical Properties Of High Strength (M100) Fiber Reinforced Concrete Using Mineral Admixtures

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ABSTRACT :- High strength concrete is used in the construction in recent days due to rapid developments this is done by replacing ordinary Portland cement by mineral admixtures and super plasticizer that is Master Glenium. Mineral admixtures are used to replace the cement content in the mix. Chemical admixtures used to decrease the water content in the concrete such that its workability is improved even at low water cement ratio and increase the compressive strength of concrete. In this investigation M100 grade concrete mix is designed by adding fibers. The specimens are tested for compressive strength, split tensile strength, flexural strength at 7, 28, 56,90 days and the obtained results are compared with that of the normal concretes.

Based on experimental values, it is clearly identified that all the mixes were obtained target mean strength. Among this the mix of concrete that was added by alccofine with robo sand combination is has got 22% higher values than the target mean strength at the age of 28 days. Mechanical parameters like split tensile strength, flexural strength and compressive strength are also increased slightly.

In this project work, fibers of polypropylene were also used. Concrete is weak in tension so to overcome this fault fibers are added to the concrete. Fiber can increase the tensile behavior of the concrete beam. Experimental data shows that using fiber content from 0.5% to 1% can increase all mechanical properties but using more than above mentioned content will leads to decrement of strength parameters.

Keywords; High Strength Concrete, Split Tensile Strength, Flexural Strength, Compressive Strength, Target Mean Strength, GGBS, Alccofine, Micro Silica, Fibers.

I INTRODUCTION

Now-a-days the concrete plays a vital role and widely used in various types of structures like dams, bridges, commercial complexes, high raised buildings etc, in construction technology. To reduce usage of concrete with same compressive and flexural strengths we use different kinds of mix designs based upon the admixtures we use in mixing. Normally we use ordinary Portland cement for the residential buildings. If we go for high raised buildings and commercial complexes, these structures require more strength and durability as they have higher dead load and live load.

The materials used in the high strength concrete are as same as normal concrete but additional to it there are some more admixtures are mixed. Producing the admixtures may create the pollution to the environment. On the other hand the solid waste by human activities are also increasing in daily. To avoid ecological imbalance scientists have developed the techniques to produce the high strength concrete from the solid wastes produced by the human life.

By adding the mineral admixtures like GGBS, Fly ash, Master Glenium, we can enhance the stability, workability and compressive

strengths of the concrete. Mix designs which are higher than the M40 comes under the High Strength Concrete.

Realizing the importance of high strength concrete earlier in 1950's, only 34 N/mm2 is considered as high strength concrete, later on the developing the technologies and methodologies in 1960's it has increased to 52 N/mm2. After the huge research and experimental studies it has enhanced to 138 N/mm2 in late 1970's. Over the time period the awareness and usage of high strength concrete has increased in the market.

The admixtures likes silica fume and GGBS are the products of ferroalloys industry consists extremely fine amorphous silica particles. Replacement of cement with the silica fumes can increase the cement strength in compressive, split tensile, durability parameters. and reduce the porosity . The size of the silica particles are highly smaller when compared to cement grains.

Decades of ago, high strength concrete has only tested in the laboratories without any practical applications because of their uncertainties on structural behavior. High strength concrete is so far used in structural constructions in seismic regions.

Concrete is very bad in tensile strength, to avoid these type of problems fiber reinforced is used; it results in good fire resistance, high compressibility. Fiber reinforced concrete is a mixture of tiny discrete particle which are distributed uniformly in the concrete mix and oriented transversely. The materials mixed in FRC mix can be of concrete, steel, cellulose, propylene etc. The amount of fibers added to the total volume may be of 0.1 % - 0.3%.

The fiber reinforced concrete is considered as the hybrid, if there are two or more fibers combined and added in mixture and it results in the exhibiting the synergetic response.

PROPERTIES OF HIGH STRENGTH CONCRETE:

Properties of high strength concrete (HSC) can be different from one type of fibers to other type of fibers. The hardening of concrete can be considered in to account while designing the structures.

- Shrinkage of concrete
- Setting time and hardening
- Heat development
- Elastic deformation & crack growth characteristics

EFFECTS OF FIBERS USED IN CONCRETE:

The concrete can be increased by adding the small pieces of fibers materials which are described as a convenient parameter called "aspect ratio". The wide range of usage in beams foundations alone are with hand tied bars.

The amount of fibers mixed in concrete should be measured as total volume of composite which ranges from the 0.1% to 3%. The modulus of elasticity of fibers should be greater than concrete binders. The flexural and toughness strengths of the matrices, the reinforced concrete is itself the composite material in which reinforcement acts as the Strengthening concrete. Similarly the differential deformations of concrete and reinforcement are decreased to minimum.

The difference between the orientation of the fibers and reinforcement is the direction of fibers randomly placed. The effect of mortar specimens reinforced with 0.5% volume of fibers. The alignment of fibers parallel to applied load and offered more tensile strength along with the toughness which are randomly distributed fibers.

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II LITERATURE REVIEW

Tara Rahmani, BehnamKiani, Farzaneh Sami, 2015. [1], has investigated the addition of Polypropylene, steel fibers on durability properties, which includes the water penetration, electrical resistivity, gas permeability, and scaling resistance. The results have shown that the fibers adding at fractions 0.125%, 0.5% can increase the electrical resistivity up to 61.9% and 11.8%.

J.ALarbi, R.B.Polder.[2], experimented by using the polypropylene fibers to decrease the explosive spallings when concrete is exposed to fire. He concluded that the effectiveness of the polypropylene fibers can increase the spalling and fire resistances.

A.A.Ramezanianpourab.[3], states that polypropylene reduces that compressive strength, tensile strength, and flexural strength. These results shows that firstly increases the capabilities and then excess adding of fibers will gradually decreases the capabilities.

O.kayali, M.Nhaque.[4], has studied about the effects of steel fibers and polypropylene in light weight high strengthened concrete. And their reports have shown that partial replacement of flyash, can also obtain the high capabilities of result.

XinchengPu and Chong Wang.2000[5], has undergone the experimental investigations and predicted that pozzolanic effects of silica fumes can obtain the strength of 50 MPa in 28 days of curing.

Saeidkakooei.[6], had studied the damage process of polypropylene FRC and PCC. The PPC should be added with a proportion of 1.5 kg/m3. He concluded that excess increase in micro silica content can also reduce the strengths and cannot be useful for the structural construction on seashore projects.

Amitrai.[7], has studied about the conventional concrete and the development of micro cracks before the structural loadings are analyzed. He concluded that decrease in crack widths, and increased in durability, toughness and shock resistance.

UmeshSharmaa,2014,[8], has gone the experimental tests on micro silica for both compressive and durability strengths by conducting the chloride test, sea water test, corrosion test. And he concluded that incorporating the silica fumes has increased the strength of the concrete cubes.

Dinakar.2013,[9], investigations has shown that mixing the 10% of metakaolin improved the compressive strength and durability of concrete.

Patil.2012,[10], has investigated that the performance of concrete mixtures, chloride attacks the compressive strength. The corrosion test in between the 28 - 56 days has accelerated the bearing capacity of concrete cubes.

Test results of aggregates

TEST RESULTS	FINE AGGREGATE	COURSE AGGREGATE
Fineness modulus	3.76	
Water absorbtion %	0.51	0.5
Specific garvity	2.62	2.70
Impact value %		23.10
Crushing value %		22.10

Cement Test Results

S.No	TEST ON CEMENT	Test Result
1	Fineness	**96.5%**
2	Standard consistency	**32%**
3	Initial setting time	**46Min**
4	Final setting time	**515Min**

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5	Soundness	**3MM**
6	Compressive strength	**58.1N/mm^2**
7	Specific gravity	**3.15**

III MIX DESIGN

Stipulations for proportioning
Grade designation - M100
Type of cement -Ordinary Portland Cement(OPC)
Maximum size of the aggregate -20mm
Minimum cement content - 430kgs
Maximum water cement ratio -0.30
Workability -75mm slump
Exposure condition -Good
Degree of supervision -Good
Type of aggregate -Crushed angular
Maximum cement content -450Kgs
Water absorption of C.A -0.5%
Water absorption of F.A -0.51%

Target mean strength:-
Target strength = fck + 1.65xS
= 100 + 1.65 x 5 = 108.25N/mm2 .
Water cement ratio for target mean strength 108.25N/mm2
Selecting the water content & fine to total aggregate ratio:-
Taken fine aggregate is belongs to zone II IS10262:2009 of table-3
Maximum water content = 186liters as per the code IS10262:2009 from table-2
Hence maximum water content used is 186liters
If 3% water is added 25mm of slump will be increased. Assumed the slump as 75mm, for this 3% of water is added.
=186+ [186x(3/100)]=191.58liters

Super plasticizers used then 24% of water is decreased
=191.58- [191.58 x (24/100)]=145.6liters
Let us take 145liters Selection of cement content W/c = 0.23
145/c = 0.23 (c = cement content) C = 630kgs
Use 450 kg cement, 150 Kg GGBS and 30Kg Alccofines

Calculation of coarse aggregate and fine aggregate content
Volume of coarse aggregate at 0.23% W/c = 0.62m3 After correction the volume of CA=0.674Cum Volume of fine aggregate = 1-0.674 = 0.326m3 Volume of materials for 1 m3 volume of cement
Volume of cement = (mass of cement/specific gravity of cement) x (1/1000)
= (450/3.15) x (1/1000)
= 0.142m3
Volume of GGBS = (mass of GGBS/specific gravity of GGBS) x (1/1000)
= (150/2.8) x (1/1000)
= 0.053m3
Volume of Alccofine = (mass of Alccofine/specific gravity of Alccofine) x (1/1000)
= (30/2.9) x (1/1000)
= 0.01m3
Volume of water = (mass of water/specific gravity of water) x (1/1000)
= 145/1000
= 0.145m3
Admixtures=0.8%
Quantity= [(0.8x630)/(100x1.1)] x [1/1000]
= 0.0045

Volume of materials except aggregates = volume of cement + volume of GGBS+ volume of Alccofines+ volume of water+ volume of admixtures
= 0.142 + 0.053+0.01+0.145+0.0045
= 0.354m3

Absolute total aggregate = 1- volume of materials
=1- 0.354
=0.6455

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Weight of coarse aggregates = (volume of absolute total aggregate)x(volume of coarse aggregate)x(specific gravity of coarse aggregate)x1000
= 0.645 x0.62x 2.70 x 1000
= 1080kgs
Weight of fine aggregate = (volume of absolute total aggregate)x(volume of coarse aggregate)x(specific gravity of coarse aggregate)x1000
=0.645 x 0.326 x 2.62 x 1000
= 550kgs

MIX PROPORTIONS OF CONVENTIONAL CONCRETE FOR 1 M3 OF CONCRETE

Cement	450kg/m^3
GGBS	150kg/m^3
Alccofine	30kg/m^3
Coarse aggregate	1080kg/m^3
Fine aggregate	550kg/m^3
Admixture	0.0045
Polypropyelene fiber	0.5%,1.0%,1.5% of binding material
Water	145liters

Hence materials required for 13 cubes volume are as follows

Cement content	0.0439x450=19.75kgs
GGBS content	0.0439x150=6.58kgs
Alccofine content	0.0439x20=1.317kgs
The content of coarse aggregate	0.0439x1080=47.41kgs
Fine aggregate content	0.0439x549=24.14kgs
% of admixture	0.8%
Water content	0.0439x145=6.36liters

Hence materials required for 13 cylinders volume are as follows

Cement content	0.0689x450=31.00kgs
GGBS content	0.0689x150=10.33 kgs
Alccofine content	0.0689x30=2.06kgs
The content of coarse aggregate	0.0689x1080=74.41kgs
Fine aggregate content	0.0689x550=37.89kgs
% of admixture	0.8%
Water content	0.0689x145=9.99liters.

Hence materials required for 12 beams volume are as follows

Cement	0.065x450= 29.25kgs
GGBS	0.065x150 =9.75kgs
Alccofines	0.065x30 =1.95kgs
Coarse aggregate	0.065x1080 =70.20kgs
Fine aggregate	0.065 x550 =35.75kgs
Admixtures	0.8%
Water	0.065 x 145=9..42liters

IV RESULTS

Compressive strength testing results for cubes

S.No.	% of fiber used	Days	Compressive strength (MPa)	Avg Strength(MPa)
1	0	7	75.90	76.92
			77.10	
			77.77	
		28	108.92	109.85
			110.20	
			110.43	
		56	111.17	111.92
			113.9	
			110.92	
		90	112.15	112.89
			113.83	
			112.71	
		7	76.92	77.53
			77.12	
			78.54	
		28	110.43	110.75
			111.02	
			110.81	
		56	112.21	
			112.69	

2	0.5		112.53	112.47	2	0.5		9.63	9.87
		90	113.67	113.90			90	9.77	9.96
			113.12					10.32	
			114.91					9.78	
3	1.0	7	77.81	77.94	3	1.0	7	7.25	7.44
			78.04					7.76	
			77.99					7.31	
		28	111.33	111.36			28	9.17	9.30
			111.05					9.60	
			111.71					9.13	
		56	112.77	112.96			56	9.95	10.22
			113.62					10.60	
			112.47					10.10	
		90	114.49	114.38			90	10.37	10.55
			114.44					10.95	
			114.19					10.30	
4	1.5	7	76.49	76.58	4	1.5	7	7.17	6.89
			77.12					6.78	
			76.15					6.73	
		28	109.75	109.50			28	8.50	8.69
			109.10					9.04	
			109.66					8.55	
		56	110.52	110.95			56	10.04	9.65
			110.98					9.50	
			111.35					9.43	
		90	112.01	112.11			90	10.17	9.80
			112.39					9.65	
			111.93					9.58	

Split tensile strength results for Cylinders

S.No.	% of fiber used	Days	Tensile strength (MPa)	Avg Tensile strength(MPa)
1	0	7	6.55	6.68
			6.71	
			6.80	
		28	8.41	8.50
			8.55	
			8.54	
		56	9.65	9.47
			9.31	
			9.45	
		90	9.86	9.69
			9.52	
			9.69	
		7	6.88	7.04
			6.94	
			7.31	
		28	8.67	8.83
			9.21	
			8.77	
		56	9.71	
			10.26	

Flexural strength results for beams

S. No.	% of fiber used	Days	Flexural strength(MPa)	Avg flexural strength(MPa)
1	0	28	8.64	8.79
			8.60	
			9.15	
		90	9.57	9.75
			10.15	
			9.54	
2	0.5	28	8.74	8.97
			8.85	
			9.33	
		90	9.64	9.83
			9.60	
			10.25	
3	1.0	28	8.90	9.00
			8.84	
			9.14	
		90	9.77	10.01
			10.40	
			9.84	
		28	8.74	8.88
			9.22	

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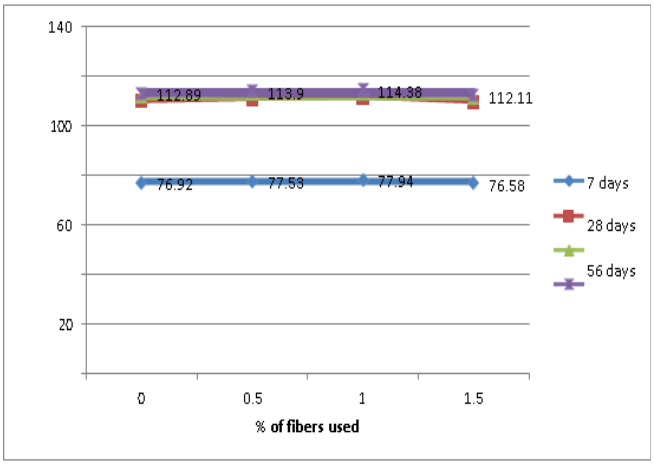
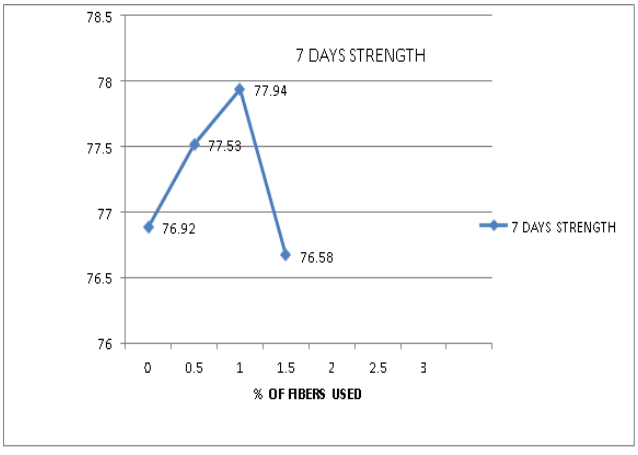
4	1.5	90	8.68	9.78
			9.57	
			9.63	
			10.16	

Graphs are generally shows the increase and decrease of values. In this graphs we shows the compressive, split tensile and flexural strength of the concrete. By comparison of above values at 7,28,56,90 days we get graph. In the using of fibers 0%, 0.5%,1.0% are the strength will be increased and adding of 1.5% fibers the strength had decreased

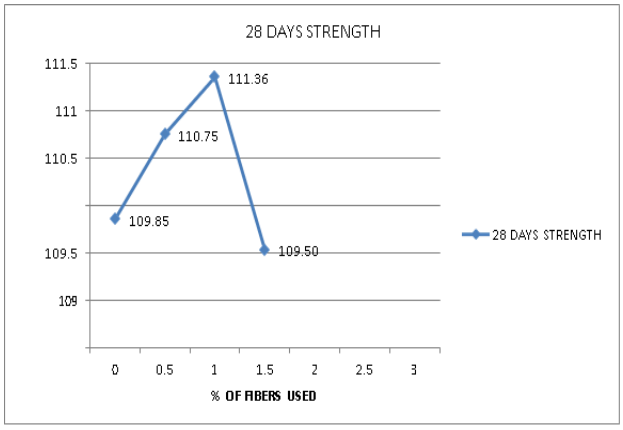
COMPRESSIVE STRENGTH



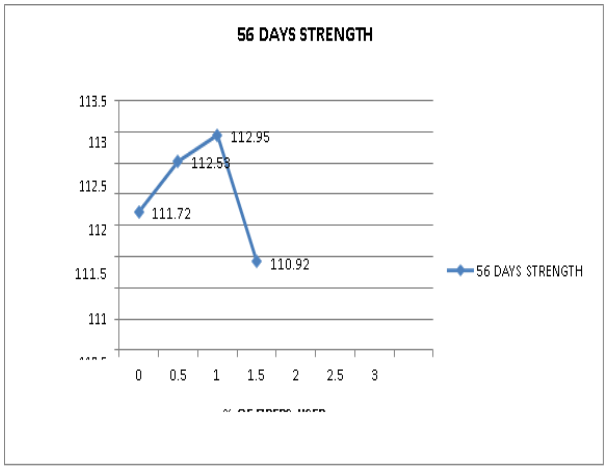
\Compressive strength of 7 days



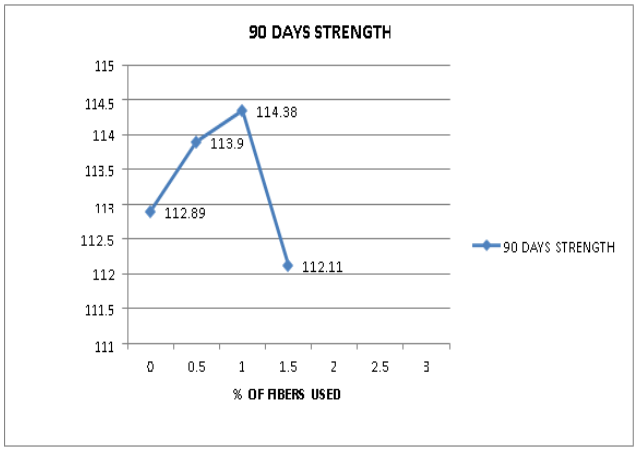
Compressive strength of 28 days



Compressive strength of 56 days



Compressive strength of 90 days



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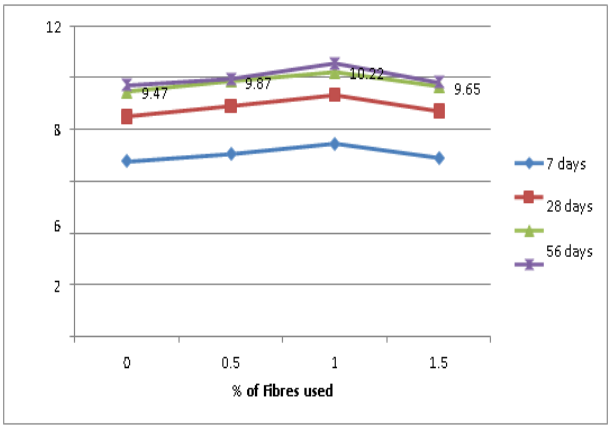
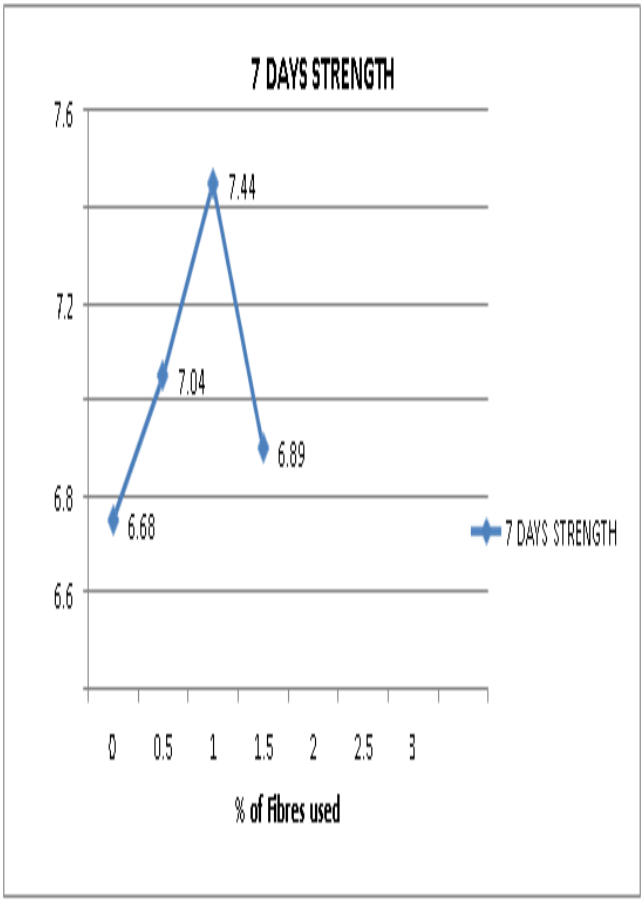
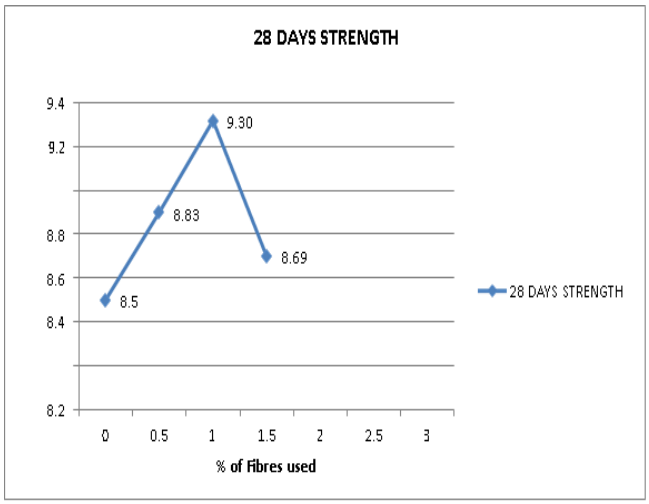
SPLIT TENSILE STRENGTH



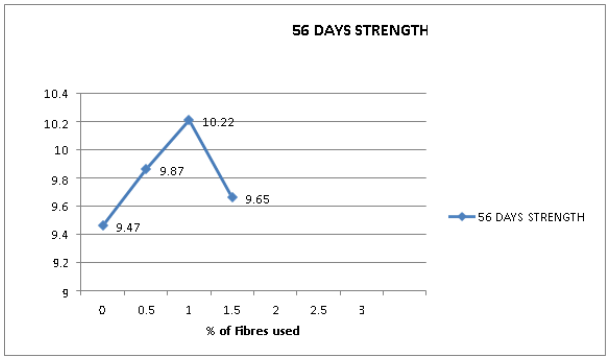
Split tensile strength of 7 days



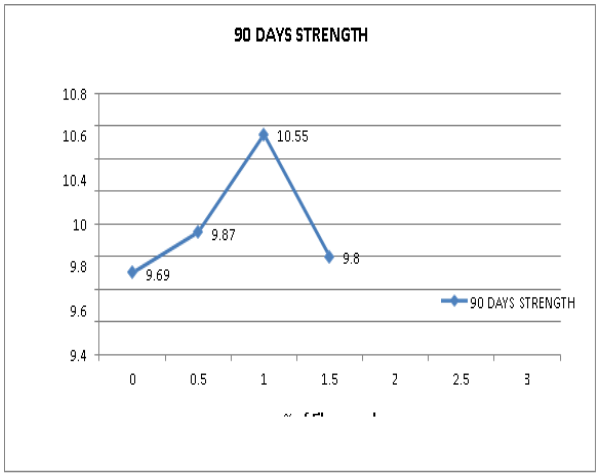
Split tensile strength of 28 days



Split tensile strength of 56 days



Split tensile strength of 90 days



CONCLUSION

High strength concrete (M100) was obtained in this project. Strength parameters of concrete like flexure, compressive and tensile strength of the concrete was studied, also the effect of fiber on concrete was tested and observed. The noticeable results are came by the mix proportion with materials (cement: fine aggregates: coarse aggregates) ratio1:1.22:2.4 with super plasticizer master glenium0.8%by preferring water cement ratio as 0.23.

Plasticizers has the capability to increase the workability by reducing water cement ratio. This specific reason helps to gain high strength concrete.

When it polypropylene fiber are added to mix then there is gain of strength up to the amount 1.0% and then strength parameters are decreased. High target mean strengths are achieved when fiber content is added by 1.0% to the concrete mix.

The various observations based on the experimental results are mentioned below:

- The compressive strength of cubes for the age of 28 days obtained as 109.85MPa.
- The compressive strength of cubes for the adding of fiber amount of 0.5%,1.0%,1.5% for the age of 28 days obtained as110.75MPa,111.36MPa,109.50MPa.
- Split tensile strength of concrete specimen for the age 28 days can obtained as 8.50MPa.
- Split tensile strength of concrete specimen for the adding of fiber amount of 0.5%,1.0%,1.5% for the age of 28 days obtained as 8.83MPa, 9.30MPa, 8.69MPa.
- Flexural strength of concrete specimen for the age 28 days can obtained as 8.79MPa

Further study can be done by using the higher grade superplasticizers , different mineral admixtures and fibers. As the strength increases it will be easy to design heavy load bearing structures, high rise buildings, long bridges etc.

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