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EFFECT OF GRINDED GLASS FIBER STRANDS ON THE STRENGTH OF CONCRETE TILES

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ABSTRACT

The impact of glass fiber on compressive strength, flexural strength and split-tensile strength was contemplated for various fiber strands content on M25 Grade concrete planned according to IS 10262. The largest size of aggregate utilized was 20mm.
To learn about the impact on compressive strength, flexural strength and split-tensile strength, cubes and cylinders each were casted and tested. The water cement ratio was kept equal to 0.45.
Various strength tests like compressive strength test, flexural strength and split-tensile strength test were conducted after the initial tests on concrete were carried out respectively.
The same was done on concrete tiles, to learn about the impact of fibers on the same. The greatest size of aggregates used was 8mm. Water-Cement ratio was kept same at 0.45. Like cubes and cylinders, respective tests on tiles were conducted on tiles.

***Key Words**: compressive strength, split-tensile strength, cubes, cylinders, aggregates, water-cement ratio*

INTRODUCTION

Architects in the construction industry, incite their work from aesthetic point, while (structural) engineers incite our work from strength and longevity point. So as to keep up the aesthetic perspective of a structure without influencing its quality and strength, numerous efforts have been made in this field. In the standpoint of accomplishing reasonable sustainability, fibers have been used to enhance the strength of concrete to a large extent.
A standout amongst the most imperative building material is concrete and its utilization has been regularly expanding in the whole world. The reasons being that it is moderately cheap and its constituents are effectively accessible, and has convenience in extensive variety of common infrastructure works. Anyway concrete has certain hindrances like fragility and poor protection from break opening and spread. Concrete is weak by nature and have low elasticity and in this manner strands are utilized as a part of some frame to build its rigidity and lessening the fragile conduct. With time, a great deal of investigations has been done to improve the properties of cement both in new state and also solidified state. The fundamental materials continue as before however super plasticizers, admixtures, smaller scale fillers are additionally being utilized to get the coveted properties like usefulness, increase or decrease in setting time and higher compressive strength.
When un-reinforced concrete is to tensile stresses, it is probably going to crack and fizzle. Due to low tensile strength and ductility of concrete, it can't be utilized directly for structures. Reinforcements are given to maintain a strategic distance from any deficiencies in construction.
Fibers which are connected for structural cement are ordered by their material as Steel fibers, Alkali-Resistant Glass fibers (AR), Synthetic fibers, and Carbon, Pitch and Polyacrylonitrile (PAN) fibers.
Steel reinforcement has widely been used, which when mixed with concrete, behaves as a composite group with each bearing tensile and compressive stresses respectively.

OBJECTIVE

1. To study the strength properties of glass fibers when added to concrete cubes and cylinders.
2. To study the strength properties of glass fibers when added to concrete tiles as a whole.
3. To devise the optimum quantity of glass fibers required to affect (increase/decrease) the strength and durability of (fiber-added) concrete.

MATERIALS

1. Concrete:

It is the most used construction material. In our work, OPC 43 Grade (Khyber Cement) was used. Standard consistency, initial setting time, final setting time, 28-day compressive strength tests were accomplished as per IS specifications. . For our work, M25 concrete was designed as per IS.

Sand passing through 4.75mm IS sieve was used as fine aggregate. The specific gravity of sand was 2.65 and grading was of Zone III as per IS specifications. Angular stones of 20mm were used as coarse aggregate and their specific gravity was 2.68.
Tap water was used for mixing of cement and respective materials, and also for curing of concrete.

2. Cement:
Cement is to a great degree a material having adhesive and cohesive properties which give a coupling medium to the discrete items. The concrete usually utilized is Portland cement, which is additionally characterized as hydraulic cement, i.e. a concrete which solidifies when it accompanies water because of synthetic response however there by shaping a water resistant product. OPC 43 Grade (Khyber Cement) was utilized for the exploratory program. Standard consistency, initial setting time, final setting time, 28-day compressive strength tests were accomplished as per IS specifications.

3. Fine Aggregate:
Aggregates are commonly obtained from natural deposits of gravel, sand or from cutting quarry rocks. Fine aggregates are the ones which pass through 4.75mm IS sieve by the process of sieving. Aggregates were used from the laboratory provided, which were transported from a nearby facility. Their specific gravity was measured to be 2.65. As per IS specifications, the aggregate used was tested to be of Zone III, as specified from the tally of test results and the Zone Chart provided.

4. Coarse Aggregate:
The aggregates most by far of which are held on 4.75mm IS sieve and contains only that a lot of fine material as is permitted by the code specifications are named as coarse aggregates. The coarse aggregates might be pulverized rock or stone acquired by the crushing of rock or hard stone; uncrushed rock or stone coming about because of characteristic breaking down of rock and incompletely squashed rock or stone got as a result of the mixing of the naturally deteriorated and smashed aggregates. For our experiment, crushed stone was utilized with most extreme size of 20 mm and specific gravity of 2.68.

5. Water:
Water is the one most essential element of cement. Water assumes the vital part of hydration of concrete which frames the coupling lattice in which the dormant aggregate are held in suspension medium until the grid has solidified, furthermore it serves as the lubricant between the fine and coarse aggregates and makes concrete workable. For our work, tap water was used which was locally available.

6. Fiber:
Fiber is a characteristic or synthetic string or utilized as a part of composite materials, or, when tangled into sheets. Concrete is fragile by nature and is feeble in flexure and in addition direct tension, thus, so as to enhance these properties, fibers are added to concrete. Fibers might be short discrete or in types of bars or might be even in type of material fibers or woven mesh fibers. In our experiment, AR-glass fibers were used. The glass fibers used had a density of 2.8gm/cm^3, tensile strength of 1950MPa, and Young's Modulus of 73GPa.

7. Admixture:
Admixtures are the chemical compounds that are utilized as a part of cement other than hydraulic cement (OPC), water and aggregates, and can likewise be called as mineral added substances that are added to the solid blend just previously or amid mixing to change at least one of the specific properties of the solid in the new or solidified state. The trial work comprises of casting cubes and cylinders to observe the impact of glass fibers on the compressive, flexural and split tensile strength of cement. The impact was examined by changing the fiber content from 0% to 0.5%, no water decreasing admixture was utilized for the test program.

METHODOLOGY

1. Collection of Materials
2. Mix Design
3. Preliminary Tests
4. Batching, Mixing, Casting and Curing
5. Results and Discussion
6. Conclusion.

TESTS

1. Compressive Strength Test
2. Split Tensile Strength Test
3. Flexural Strength Test
4. Initial and Final Setting Time Tests
5. Consistency Test
6. Specific Gravity Test
7. Fineness Test
8. Wet Transverse Strength Test

9. Water Absorption Test
10. Pulse Velocity Test.

RESULTS AND DISCUSSION

In this whole experimental program, the effect of adding glass fibers to concrete was studied; their effect on the compressive strength and split-tensile strength of concrete cubes and cylinders.
Furthermore, the effect of glass fibers on concrete tiles, produced by vibration method, was also studied; their effect on the compressive strength, wet transverse strength and water absorption were studied.
The different observations in light of the test results in case of concrete cubes and cylinders are as following:

1. The strength of cubes and cylinders is increased by the addition of fibers, but in case of tiles, only wet transverse strength is increased and all the other parameters showed a decrease.
2. The compressive strength, split-tensile strength and flexural strength of concrete cubes and cylinders without admixture was initially greatly increased by the presence of discrete glass fibers with fiber content of 0.2 % by weight of concrete.
3. An increase in the wet transverse strength of tiles, observed at 28 days, and the increase has been found with addition of fibers.
4. The 7 and 28 day compressive strengths, water absorption and pulse velocity of tiles is decreased by the addition of fibers.
5. All the parameters of cubes and cylinders showed an increase with the addition of fibers.
6. The 28 day water absorption of concrete decreases as the fiber content increases. It was concluded that fiber content and water absorption are inversely proportional to each other.
7. The average values of the velocities obtained in pulse velocity test carried out on the tiles were not varying more than 10-15%.

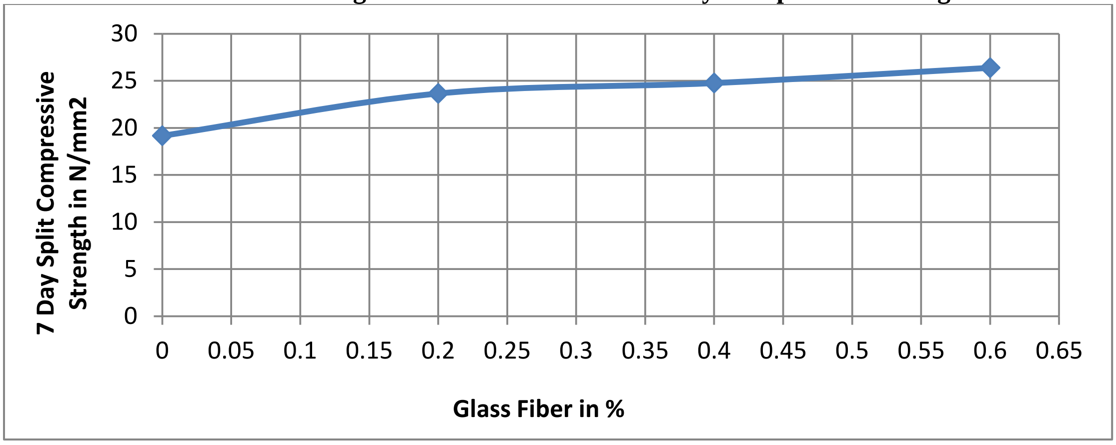
1. COMPRESSIVE STRENGTH TEST (in MPa)

The 7 day compressive strength was observed and the values of 3 samples observations are shown. Table 1 exhibits the 7 day compressive strength of concrete with maximum nominal size of aggregates of 20 mm.
The 7 day compressive strength was plotted on Figure 1 by taking the normal of these three qualities, and an increase in the compressive strength was seen with the addition of fibers.

TABLE 1 showing 7 Day Compressive Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	18.37	23.33	24.01	25.87
2	19.88	24.59	25.38	27.13
3	19.23	23.03	24.89	26.14

FIGURE 1 showing Effect of Glass Fiber on 7 Day Compressive Strength

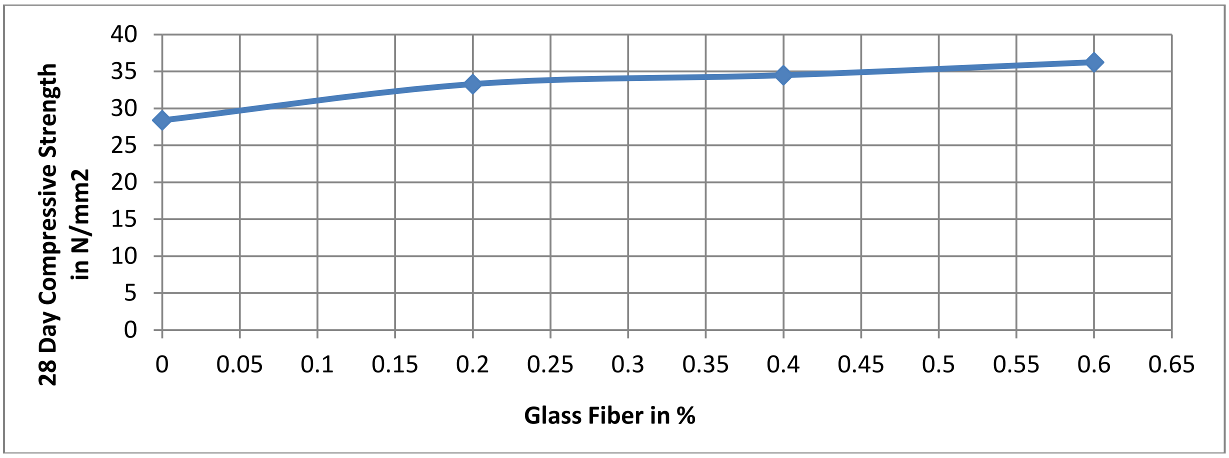


The 28 day compressive strength was observed and the values of 3 sample observations are shown. Table 2 demonstrates the information of 28 days compressive strength obtained. Table 2 exhibits the 28 day compressive strength of concrete with maximum nominal size of aggregates of 20 mm.
The 28 days compressive strength was additionally plotted Figure 2 taking the normal of these three qualities, and an increase in the compressive strength was seen with the addition of fibers.

TABLE 2 showing 28 Day Compressive Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	28.87	32.12	34.11	35.82
2	29.35	34.47	35.87	36.97
3	26.92	33.22	33.43	35.90

FIGURE 2 showing Effect of Glass Fiber on 28 Day Compressive Strength



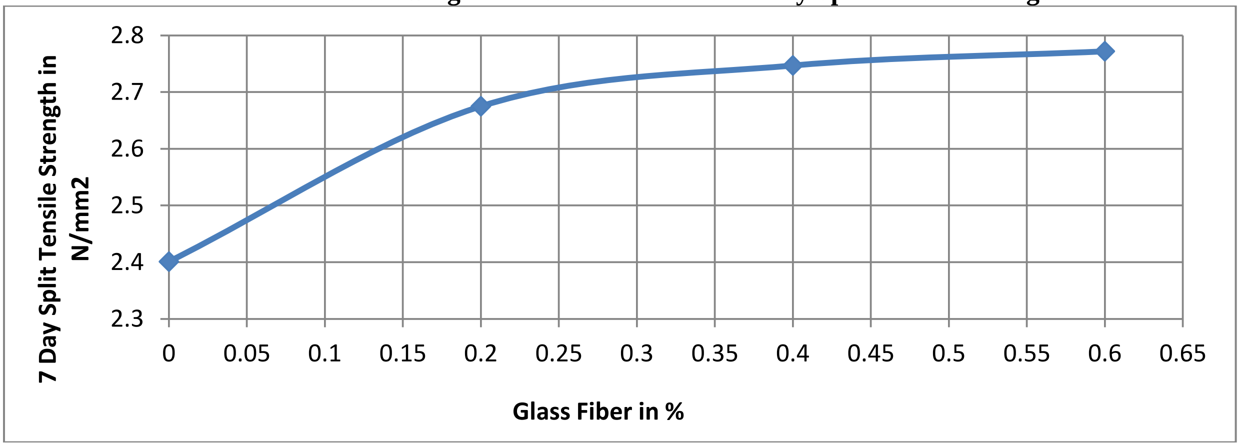
2. SPLIT TENSILE STRENGTH (in MPa)

The 7 day split tensile strength was observed and the values of 3 sample observations are shown. Table 3 exhibits the 7 day split tensile strength of concrete with maximum nominal size of aggregates of 20 mm.
The 7 day split tensile strength was plotted on Figure 3 by taking the normal of these three qualities, and an increase in the split tensile strength was seen with the addition of fibers.

TABLE 3 showing 7 Day Split Tensile Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	2.141	2.412	2.457	3.491
2	2.650	2.973	3.022	4.067
3	2.412	2.640	2.744	3.757

FIGURE 3 showing Effect of Glass Fiber on 7 Day Split Tensile Strength

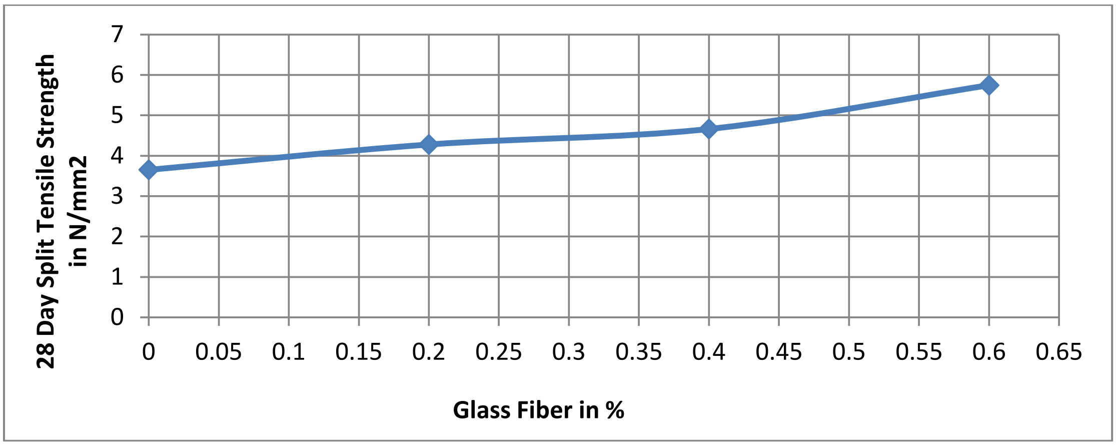


The 28 day split tensile strength was observed and the values of 3 sample observations are shown. Table 4 exhibits the 28 day split tensile strength of concrete with maximum nominal size of aggregates of 20 mm.
The 28 day split tensile strength was plotted on Figure 4 by taking the normal of these three qualities, and an increase in the split tensile strength was seen with the addition of fibers.

TABLE 4 showing 28 Day Split Tensile Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	3.657	4.234	4.628	5.681
2	3.712	4.481	5.035	6.112
3	3.570	4.120	4.321	5.437

FIGURE 4 showing Effect of Glass Fiber on 28 Day Split Tensile Strength



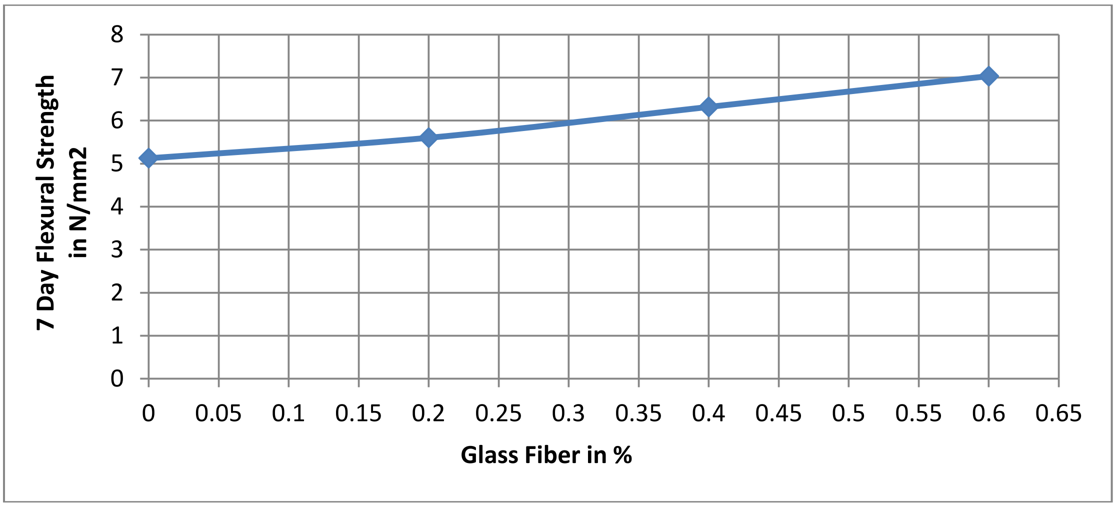
3. FLEXURAL STRENGTH (in MPa)

The 7 day flexural strength was observed and the values of 3 sample observations are shown. Table 5 exhibits the 7 day flexural strength of concrete with maximum nominal size of aggregates of 20 mm.
The 7 day flexural strength was plotted on Figure 3 by taking the normal of these three qualities, and an increase in the flexural strength was seen with the addition of fibers.

TABLE 5 showing 7 Day Flexural Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	5.112	5.636	6.331	7.031
2	5.037	5.479	6.203	6.980
3	5.231	5.692	6.417	7.082

FIGURE 5 showing Effect of Glass Fiber on 7 Day Flexural Strength

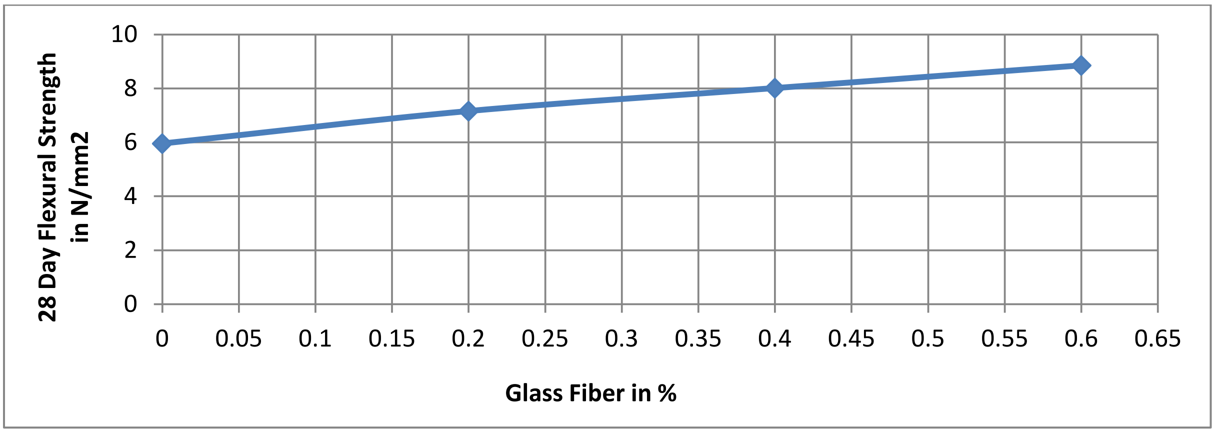


The 28 day flexural strength was observed and the values of 3 sample observations are shown. Table 6 exhibits the 28 day flexural strength of concrete with maximum nominal size of aggregates of 20 mm.
The 28 day flexural strength was plotted on Figure 6 by taking the normal of these three qualities, and an increase in the flexural strength was seen with the addition of fibers.

TABLE 6 showing 28 Day Flexural Strength

S. No.	0% Fiber	0.2% Fiber	0.4% Fiber	0.6% Fiber
1	5.992	7.193	8.029	8.919
2	5.826	7.072	7.891	8.623
3	6.038	7.203	8.103	9.004

FIGURE 6 showing Effect of Glass Fiber on 28 Day Flexural Strength



TESTS ON CEMENT AND CONCRETE TILES

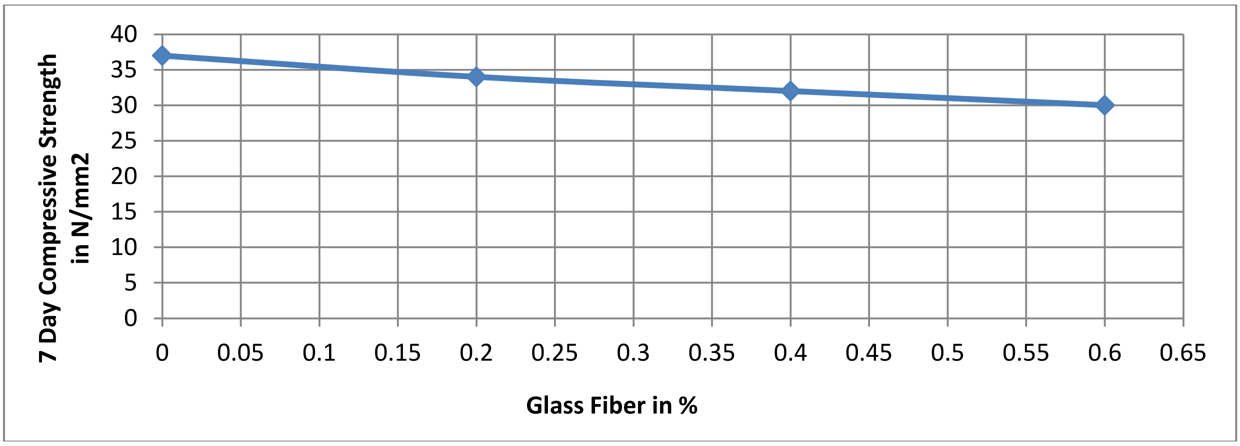
1. Compressive Strength Test

The 7 day compressive strength was observed and the values of 3 sample observations are shown. Table 7 exhibits the 7 day compressive strength of concrete with maximum nominal size of aggregates of 8 mm.
The 7 day compressive strength was plotted on Figure 7 by taking the normal of these three qualities, and a decrease in the compressive strength was seen with the addition of fibers.

TABLE 7 showing 7 Day Compressive Strength

Fiber Content (% of total weight of concrete)	Weight (kg)	Average 7 Day Compressive Strength (in MPa)
0	2.613	37
0.2	2.597	34
0.4	2.482	32
0.6	2.445	30

FIGURE 7 showing Effect of Glass Fiber on 7 Day Compressive Strength

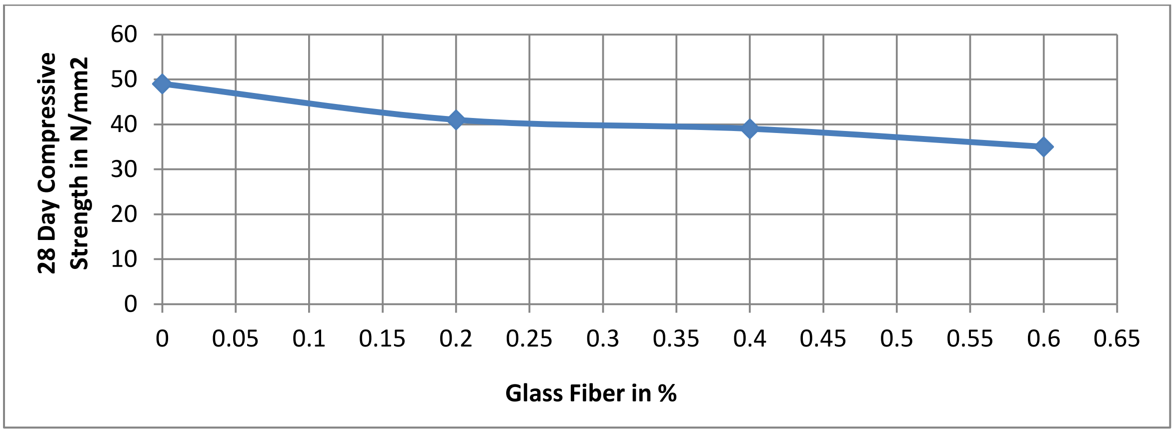


The 28 day compressive strength was observed and the values of 3 sample observations are shown. Table 8 exhibits the 28 day compressive strength of concrete with maximum nominal size of aggregates of 8 mm.
The 28 day compressive strength was plotted on Figure 8 by taking the normal of these three qualities, and a decrease in the compressive strength was seen with the addition of fibers.

TABLE 8 showing 28 Day Compressive Strength

Fiber Content (% of total weight of concrete)	Weight (kg)	Average 28 Day Compressive Strength (in MPa)
0	2.613	49
0.2	2.597	41
0.4	2.482	39
0.6	2.445	35

FIGURE 8 showing Effect of Glass Fiber on 28 Day Compressive Strength



2. Wet Transverse Strength

The 28 day wet transverse strength was observed and the values of 3 sample observations are shown. Table 9 exhibits the 28 day wet transverse strength of concrete with maximum nominal size of aggregates of 8 mm.

The 28 day wet transverse strength was plotted on Figure 9 by taking the normal of these three qualities, and a decrease in the wet transverse strength was seen with the addition of fibers.

TABLE 9 showing 28 Day Wet Transverse Strength

Fiber Content (% of total weight of concrete)	Average 28 Day Wet Transverse Strength (in MPa)
0	1.98
0.2	2.24
0.4	2.56
0.6	3.03

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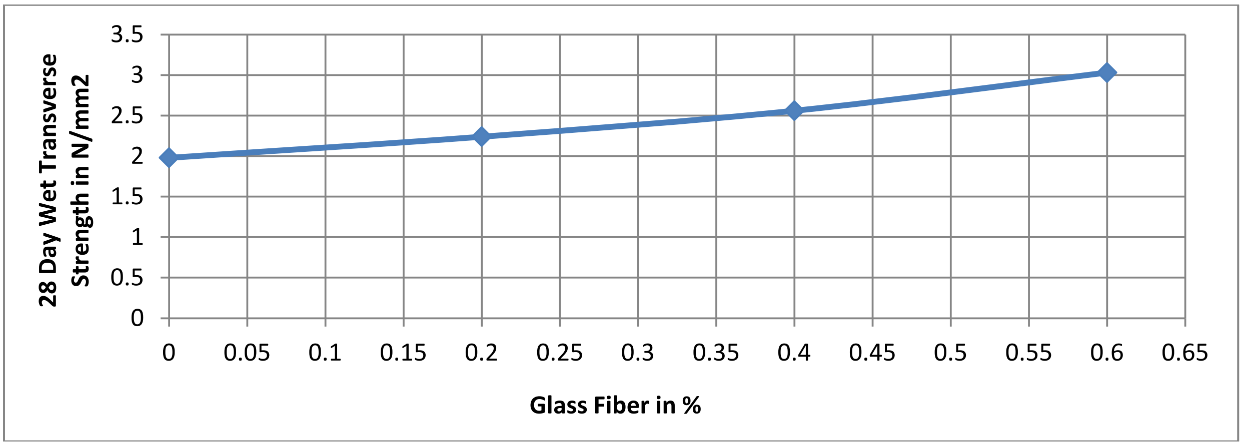
FIGURE 9 showing Effect of Glass Fiber on 28 Day Wet Transverse Strength



3. Water Absorption Test

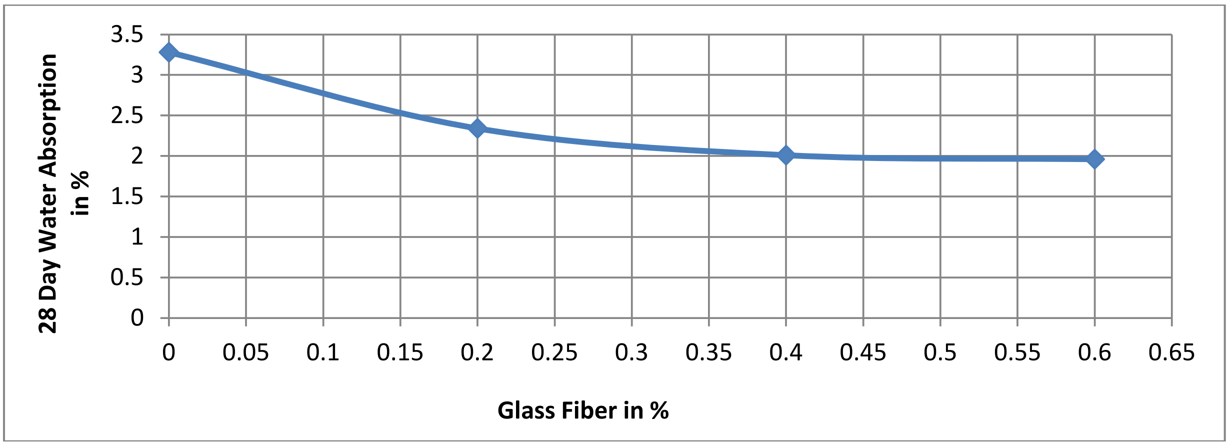
The 28 day water absorption was observed and the values of 3 sample observations are shown. Table 10 exhibits the 28 day water absorption of concrete with maximum nominal size of aggregates of 8 mm.

The 28 day water absorption was plotted on Figure 10 by taking the normal of these three qualities, and a decrease in the water absorption was seen with the addition of fibers.

TABLE 10 showing 28 Day Water Absorption

Fiber Content (% of total weight of concrete)	Average 28 Day Water Absorption (in %)
0	3.28
0.2	2.34
0.4	2.01
0.6	1.96

FIGURE 10 showing Effect of Glass Fiber on 28 Day Water Absorption



4. Pulse Velocity Test

The average values obtained of the velocities obtained in pulse velocity test carried out on the tiles were not varying more than 15%, and the values recorded are shown in Table 11.

TABLE 11 Obtained Pulse Velocities

Fiber Content (% of total weight of concrete)	Average Velocity (in m/s)	Grade of Concrete
0	4682	Good
0.2	4891	Excellent
0.4	4603	Good
0.6	4386	Good

CONCLUSION

The different observations in light of the test results are as following:

1. The strength of cubes and cylinders is increased by the addition of fibers, but in case of tiles, only wet transverse strength is increased and all the other parameters showed a decrease.
2. The compressive strength, split-tensile strength and flexural strength of concrete cubes and cylinders without admixture was initially greatly increased by the presence of discrete glass fibers with fiber content of 0.2 % by weight of concrete.
3. An increase in the wet transverse strength of tiles, observed at 28 days, and the increase has been found with addition of fibers.
4. The 7 and 28 day compressive strengths, water absorption and pulse velocity of tiles is decreased by the addition of fibers.

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