INFLUENCE OF GLASS FIBER ON THE STRENGTH OF CONCRETE

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Abstract - *The effect of glass fiber on flexural strength, split-tensile strength and compressive strength was studied for different fiber content on M-20 grade concrete designed as per IS 10262.The maximum size of aggregates used was 20mm. In this experimental program the effect of glass fibers on the compressive, split tensile strength and flexural strength of concrete was studied. The concrete mix gets harsher and less workable with increase of fiber content therefore use of admixture become necessary. However even after giving dosage of admixture as high as 1.5 % proper workability could not be obtained and some segregation was observed. Therefore it was not possible to go beyond 70% fiber content. The various observation based on the experimental result are as follows: The compressive strength of concrete without admixture is not affected by the presence of glass fibers with fiber content in the range 10% to 30 % of fiber content by weight of concrete. The split tensile strength of concrete increases with the addition of glass fibers. The flexural strength of concrete increases with increase in fiber content and as such the tension carrying capacity of concrete may increase in flexure.*

Key Words: glass fiber, flexural strength, compressive strength, split tensile strength

1. INTRODUCTION

One of the main structure material is concrete and its utilization has been truly expanding in the whole world. The reasons being that it is generally modest and its constituents are effectively accessible, and has ease of use in wide scope of common framework works. Anyway concrete has certain hindrances like weakness and helpless protection from break opening and spread. Concretes have extremely low elasticity and hence filaments are utilized in some structure to build its rigidity and reduction the fragile conduct. With time a great deal of examinations have been done to improve the properties of cement both in new state just as solidified state. The essential materials continue as before however superplasticizers, admixtures, miniature fillers are additionally being utilized to get the ideal properties like usefulness, Increase or lessening in setting time and higher compressive strength.

1.1 Glass Fiber Reinforced Concrete

Glass fiber supported cement (GFRC) is a cementitous composite item built up with discrete glass filaments of changing length and size. The glass fiber utilized is soluble safe as glass fibers are vulnerable to salt which diminishes the solidness of GFRC. Glass strands are used generally for outside claddings, facade plates and various parts where their supporting effects are needed during development. GFRC is firm in new state has lower droop and henceforth less functional, accordingly water lessening admixtures are utilized. Further the property of GFRC relies upon different boundaries like technique for creating the item. It very well may be finished by different strategies like showering, projecting, expulsion methods and so forth Concrete sort is likewise found to have extensive impact on the GFRC. The length of the fiber, sand/filler type, concrete proportion techniques and span of restoring likewise impact the properties of GFRC. The primary task of this study is to investigate the compressive strength, split-elasticity and flexural strength properties of cement supported with short discrete strands. The examination was completed on M-20 evaluation concrete the size of glass filaments utilized was 30mm and the fiber content was differed from 0% to 0.3% of the absolute load of cement. In examining the over three properties no admixture was utilized. Likewise the impact of glass fiber on concrete and solid tiles was examined whose fiber content was fluctuated from 0% to 0.7% of the weight of cement.

2. MATERIALS AND METHODS

2.1 Concrete

Concrete is the most broadly utilized construction material. The fundamental materials of cement are Portland concrete, water, fine totals for example sand and coarse totals. The concrete and water structure a glue that solidifies and bonds the totals together. Concrete in new state is plastic and can be effortlessly formed to any shape, over the long haul it solidifies and gains strength. The underlying increase in strength is because of a compound response among water and Dicalcium silicate and last addition in strength is because of response among Tricalcium silicate and water. Concrete is delivered by either following ostensible blend extents in which the blend extents are fixed according to review of cement required or blend configuration extents, last creates more conservative cement.

In our work Portland slag cement (PSC) -43 grade cement was used. Standard consistency, initial setting time, final setting time, 28-day compressive strength tests were carried out as per the Indian standard specifications.

2.2 Cement

Cement is an extremely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients. The processes used for manufacture of cement can be classified as dry and wet. The cement commonly used is Portland cement, it is also defined as hydraulic cement, i.e. a cement which hardens when it comes with water due to chemical reaction but there by forming a water resistant product. Portland cement is obtained when argillaceous and calcareous materials are grounded to fine powder and mixed in definite proportion and fused at high temperature. When blast furnace slag is also used as one of the ingredients than the cement obtained is called Portland slag cement (PSC). Portland slag cement (PSC) – 43 grade was used for the experiment.

2.3 Aggregates

Aggregates are generally obtained from natural deposits of sand and gravel or from quarries by cutting rocks. The least expensive among them are the regular sand and rock which have been lessened to present size by characteristic specialists, for example, water, wind and snow and so on. The stream stores are the most well-known and are of good quality. The second most regularly used source of aggregates is the quarried rock which is reduced to size by crushing. The size of aggregates used in concrete range from few centimeters or more, down to a couple of microns. Fine aggregates is the aggregate most of which passes through a 4.75mm IS sieve and contains just that much coarser material as allowed by the IS details. The fine aggregate passed through 4.75 mm sieve and had a specific gravity of 2.68. The sand belonged to zone III as per IS standards.

2.4 Coarse Aggregates

The aggregates the vast majority of which are held on 4.75mm IS sieve and contains just that a lot of fine material as is allowed by the code specifications are termed as coarse aggregates. The coarse aggregates may be crushed gravel or stone obtained by the crushing of gravel or hard stone; uncrushed gravel or stone resulting from natural disintegration of rock and partially crushed gravel or stone obtained as a product of the blending of the naturally disintegrated and crushed aggregates.

2.5 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 totals 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.

2.6 Fiber

Fiber is a natural or synthetic string or used as a component of composite materials, or, when matted into sheets, used to make products such as paper, papyrus, or felt. Concrete is brittle by nature and is weak in flexure as well as direct tension therefore in order to improve this properties fibers are added to concrete. Fibers may be short discrete or in forms of rods or may be even in form of textile fibers or woven mesh fibers. Various types of fibers have been added to concrete some have high modulus of elasticity some have low modulus of elasticity each category can improve certain properties of concrete. In our case short discrete glass fibers were used and as glass fiber is susceptible to alkali we used alkali resistant glass fibers. A fiber is a material made into a long filament with a diameter generally in the order of 10 tm. The main functions of the fibers are to carry the load and provide stiffness, strength, thermal stability, and other structural properties in the FRC. Glass strands are filaments generally utilized as a part of the maritime and mechanical fields to create composites of medium-elite. Their unconventional trademark is their high quality. Glass is basically made of silicon ($SiO2$) with a tetrahedral structure ($SiO4$). Some aluminum oxides and other metallic particles are then included different extents to either facilitate the working operations or change a few properties (e.g., S-glass strands show a higher elasticity than E- glass).

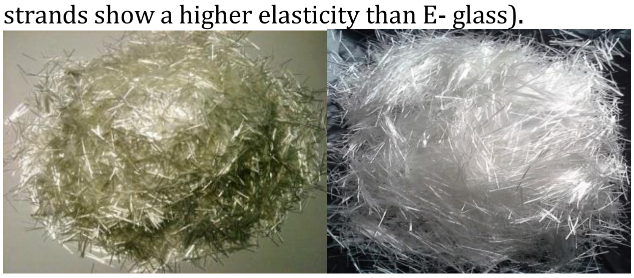


Fig -1: Glass Fiber

3. EXPERIMENTAL SETUP

Various tests conducted on the specimens are described below along with the description and importance. There were two ways in which the investigation was carried out one in which only cubes, cylinders and prisms were casted and the grade of concrete was M-20.The proportioning of the concrete was .The nominal maximum size of aggregate was 20mm and no admixture was used.

3.1 Compressive strength

The most important property of concrete is its compressive strength and durability. Concrete is mostly used in construction where load transferred is mostly via compressive strength. In order to check the effect of fibers on the compressive strength of concrete 150mm cubes were cast and tested .The cubes were tested at the age of 7days and 28 days and the variation was noted. Fiber content was varied from 0% to 0.3% when the nominal maximum size of aggregates was20mm and no admixture was used. The water cement ratio was fixed at 0.5.The workability of the mix was observed to come down but however no extra water was used.

3.2 Split Tensile Strength

Concrete may be subjected to tension in very rare cases and is never designed to resist direct tension. However, the load at which cracking would occur is important and needs to be determined. The tensile strength of concrete as compared to its compressive strength is very low and is found to be only 10-15 % of the compressive strength. There are various factors which influence the tensile strength of concrete like aggregates, age, curing, air-entrainment and method of test. To conduct the split tension test a cylindrical concrete specimen is loaded along its length as a result of the loading tensile stresses are developed along the central diameter along the lateral direction.

3.3 Flexural Strength

Flexural strength is also a measure of the tensile strength of concrete. In practical concrete may not be subjected to direct tension but it is subjected to flexure in many cases particularly in beams which is a flexural member. Flexural strength is also referred to as modulus of rupture.

3.4 Preparation of M-20 grade concrete

M-20 grade concrete was prepared using the mix design guidelines as per IS -10262 without using admixture. A water cement ratio of 0.50 was adopted as fiber reduces the workability of concrete to a great extent. Maximum .3% chopped fibers by weight of concrete were added to check the effect of fibers on the properties of concrete as even at 0.3 % the concrete turned very harsh and a great deal of vibration was needed. Total 4 different batches of M-20 grade concrete was prepared with 0, 0.1, 0.2 and 0.3 percent fiber.

4. RESULTS

4.1 Compressive Strength of Concrete (in N/mm2)

The 7 days compressive strength was studied and the values of 3 samples studied are shown in the tabular form. Table 1 shows the data of 7 days compressive strength obtained. Table 1 gives the 7 day compressive strength of concrete with maximum nominal size of aggregates 20mm.The 7 days compressive strength was also plotted Fig 2 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 1 7days compressive strength of concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	16.9	17.76	21.33	22.2
2	16.45	17.32	20.88	22.61
3	16.45	17.32	21.33	23.12

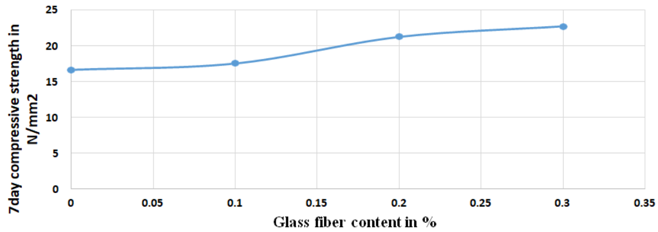


Fig- 2: Effect of Glass fibers on 7 day compressive strength

The 28 days compressive strength was studied and the values of 3 samples studied are shown in the tabular form. Table 2 shows the data of 28 days compressive strength obtained. Table 2 gives the 28 days compressive strength of concrete with maximum nominal size of aggregates 20mm.The 28 days compressive strength was also plotted Fig 3 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 2 28 days compressive strength of concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	25.31	28.1	28.8	30.21
2	25.76	31.2	28.8	28.8
3	25.32	28.1	31.1	30.65

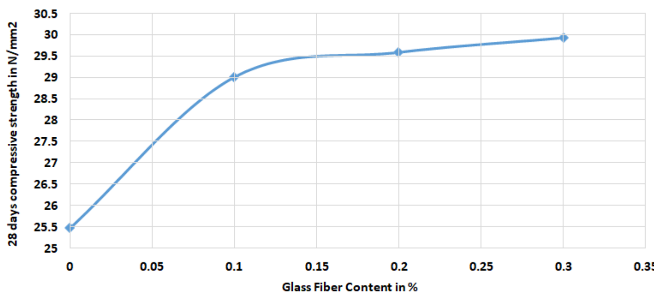


Fig- 3: Effect of Glass fibers on 28 day compressive strength

4.2 Split Tensile Strength comparison (in N/mm2)

The 7 days Split Tensile strength was studied and the values of 3 samples studied are shown in the tabular form. Table 3 shows the data of 7 days compressive strength obtained. Table 3 gives the 7 days compressive strength of concrete with maximum nominal size of aggregates 20mm.The 7 days compressive strength was also plotted Fig 4 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 3 7 days Split Tensile Strength of Concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	1.48	1.83	2.4	2.4
2	1.62	1.71	2.27	2.4
3	1.44	1.83	2.27	2.26

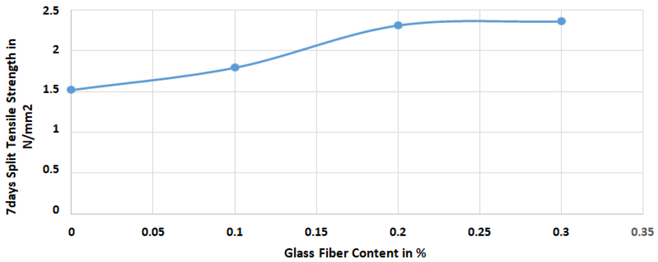


Fig- 4: Effect of Glass fibers on 7days split tensile strength

The 28 days Split Tensile strength was studied and the values of 3 samples studied are shown in the tabular form. Table 4 shows the data of 28 days compressive strength obtained. Table 4 gives the 28 days compressive strength of concrete with maximum nominal size of aggregates 20mm.The 28 days Split Tensile strength was also plotted Fig 5 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 4 28 days Split Tensile Strength of Concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	2.83	2.84	2.98	2.98
2	2.75	2.84	2.98	2.98
3	2.83	2.98	3.36	2.98

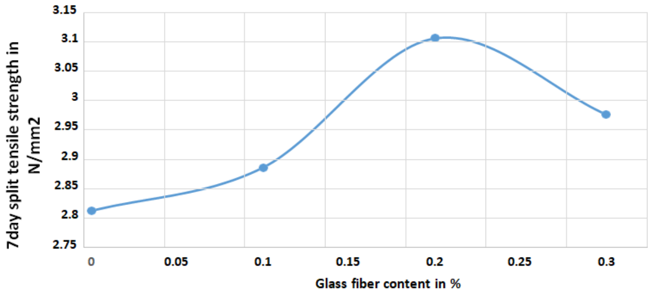


Fig-5: Effect of Glass fibers on 28 days Split Tensile Strength

4.3 Flexural Tensile Strength (in N/mm²)

The 7 days Flexural Tensile strength was studied and the values of 3 samples studied are shown in the tabular form. Table 5 shows the data of 7 days flexural tensile obtained. Table 5 gives the 7 day compressive strength of concrete with maximum nominal size of aggregates 20mm.The 7 days compressive strength was also plotted Fig 6 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 5 7 days Flexural Strength of Concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	4.6	4.744	4.988	5.744
2	4.7	4.776	4.988	5.424
3	4.8	4.756	4.9	5.704

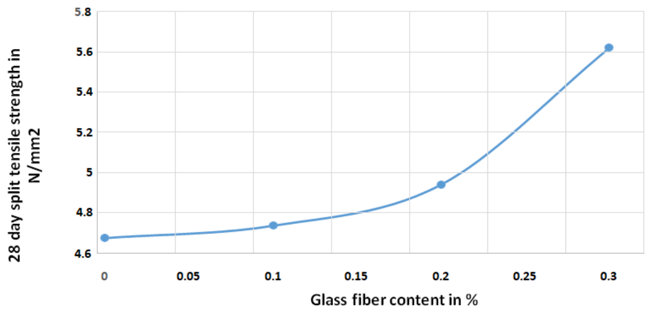


Fig-6: Effect of Glass fibers on 7 days Flexural strength

The 28 days flexural tensile strength was studied and the values of 3 samples studied are shown in the tabular form. Table 6 shows the data of 28 days compressive strength obtained. Table 6 gives the 28 days flexural tensile strength of concrete with maximum nominal size of aggregates 20mm.The 28 days flexural tensile strength was also plotted Fig 7 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table 6 28 days Flexural Strength of Concrete

Serial number	Without fiber	0.10%	0.20%	0.30%
1	5.104	6.368	7.544	7.156
2	5.204	6.456	7.104	7.96
3	5.242	6.652	6.844	8.32

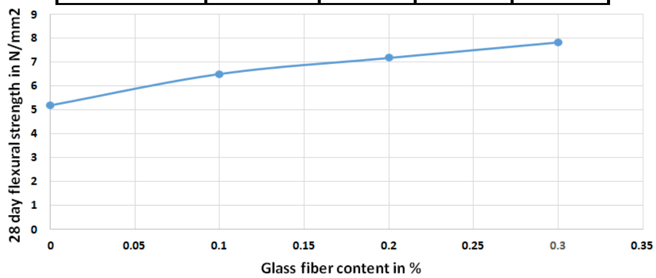


Fig- 7: Effect of Glass fibers on 28 days Flexural strength

4.4 Compressive strength test

The 7 days compressive strength was studied and the average values of 3 samples studied are shown in the tabular form. Table 7 shows the data of 28 days compressive strength obtained. Table 7 gives the 7 days compressive strength of concrete with maximum nominal size of aggregates 8mm.The 7 days compressive strength was also plotted as shown in Fig 8 overall a decrease in the compressive strength was observed with addition of fibers.

Table 7 7days Compressive Strength of Concrete

Fiber content(% of the total	Weight(kg)	Average 7 days compressive strength(N/mm2)
0	2.495	32.1
0.1	2.478	28.2
0.2	2.478	30.2
0.3	2.5	31.5
0.4	2.487	28.1
0.5	2.5	27.3
0.6	2.4	26.6
0.7	2.39	25.2

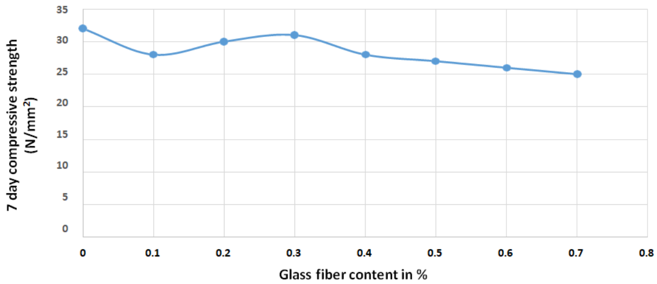


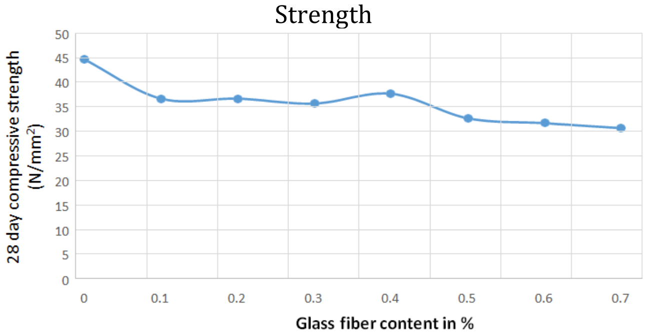
Fig- 8: Effect of Glass fibers on 7 days Compressive strength

The 28 days Compressive strength was studied and the average values of 3 samples studied are shown in the tabular form. Table 8 shows the data of 28 days compressive strength obtained. Table 8 gives the 28 days compressive strength of concrete with maximum nominal size of aggregates 8mm.The 28 days compressive strength was also plotted as shown Fig 9 overall a decrease in the compressive strength was observed with addition of fibers.

Table 8 28days Compressive Strength of Concrete

Fiber content(% of the total weight of concrete	WEIGHT(KG)	Average 28 days compressive strength (N/mm2)
0	2.495	45
0.1	2.478	37
0.2	2.478	37
0.3	2.5	36
0.4	2.487	38
0.5	2.5	33
0.6	2.4	32
0.7	2.39	31

Fig-9: Effect of Glass fibers on 28 days Compressive Strength



5. CONCLUSIONS

In this experimental study the effect of glass fibers on the compressive, split tensile strength and flexural strength of concrete was studied. The concrete mix gets harsher and less workable with increase of fiber content therefore use of admixture become necessary. However even after giving dosage of admixture as high as 1.5% proper workability could not be obtained and some segregation was observed. Therefore it was not possible to go beyond 0.7% fiber content. The various observation based on the experimental result are as follows: The compressive strength of concrete without admixture is not affected by the presence of glass fibers with fiber content in the range 0.1 to 0.3 % of fiber content by weight of concrete. The split tensile strength of concrete increases with the addition of glass fibers. The flexural strength of concrete increases with increase in fiber content and as such the tension carrying capacity of concrete may increase in flexure.

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