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EXPERIMENTAL INVESTIGATION & STRENGTH OF CONCRETE BY USING FIBER GLASS

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Abstract – *In this experiment the effect of glass Fiber on compressive strength, split tensile strength, flexural strength and workability of concrete is studied for different fiber content on M-20 grade of concrete designed as per IS 10262. In this study the maximum size of aggregate is 20mm. In this study I observed that the compressive strength, split tensile strength and flexural strength of concrete is increased with the increasing of glass Fiber content up to 0.3% by weight of cement concrete & the workability of concrete is decreased with the presence of higher (above 0.1%) of glass Fiber content by of cement concrete.*

Key Words: Compressive strength, split tensile strength, flexural strength and workability of concrete…

1. INTRODUCTION

Concrete is one of the most important building material and its use has been ever increasing in the entire world. The reasons being that it is relatively cheap and its constituents are easily available, and has usability in wide range of civil infrastructure works. However concrete has certain disadvantages like brittleness and poor resistance to crack opening and spread. Concrete is brittle by nature and possess very low tensile strength and therefore Fibers are used in one form or another to increase its tensile strength and decrease the brittle behaviour. With time a lot of experiments have been done to enhance the properties of concrete both in fresh state as well as hardened state. The basic materials remain the same but super plasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength.

1.1 GLASS FIBER REINFORCED CONCRETE

Glass Fiber reinforced concrete (GFRC) is a cementitious composite product reinforced with discrete glass Fibers of varying length and size. The glass Fiber used is alkaline resistant as glass Fiber are susceptible to alkali which decreases the durability of GFRC. Glass strands are utilized for the most part for outside claddings, veneer plates and different components where their reinforcing impacts are required during construction. GFRC is stiff in fresh state has lower slump and hence less workable, therefore water reducing admixtures are used. Further the properties of GFRC depends on various parameters like method of producing the product. It can be done by various methods like spraying, casting, extrusion techniques etc. Cement type is also found to have considerable effect on the GFRC. The length of the Fiber, sand/filler type, cement ratio methods and duration of curing also effect the properties of GFRC.

1.2 APPLICATION

The main area of Fiber Reinforced Concrete applications are as following:

- Runway, aircraft parking and pavements.
- Tunnel lining and slop stabilization.
- Blast resistant structures.
- Thin walls, shell, pipes and manholes.
- Dams and hydraulic structures.
- Different applications include machine tool and instrument frames, lighting poles, water and oil tanks and concrete repairs.

1.3 ADVANTAGE AND DISADVANTAGE OF USING GLASS FIBERS IN CONCRETE

1.3.1 ADVANTAGE

- **Lighter Weight:** With glass Fiber reinforced concrete can be cast in thinner section and is therefore as much as 75% lighter weight than similar pieces cast with traditional concrete.
- High flexural strength and high strength to weight ratio.
- **Toughness:** Glass Fiber reinforced concrete does not crack easily it can be cut without chipping.

1.3.2 DISADVANTAGE

- **Durability:** According to ACI 544.1R-96, state of the Art report on Fiber Reinforced Concrete, "The strength of fully-aged GFRC composites will decrease to about 40% of the initial strength prior

to aging." The durability of concrete can be increased through the use of low alkaline cements and pozzolanas.

- GFRC as a material, however is much more expensive than conventional concrete on a pound-for-pound basis.

2. USED MATERIALS AND METHODS

2.1 MATERIALS

CEMENT
Pozzolana Portland Cement is used in this experiment. It is easily available in the local market. The cement has been tested for various proportions as per IS: 4031-1988 and found to be conforming to be various specifications of IS: 1489-1991.

FINE AGGREGATE
Coarse sand is used as a fine aggregate in this experiment. The fine aggregate has been tested as per IS: 383-1970 and found the various specifications.

COARSE AGGREGATE
Crushed stone aggregate 10mm and 20mm is used as a coarse aggregate in this experiment. The coarse aggregate has been tested as per IS:383-1970 and found the various specifications.

WATER
Water is the one most essential element of cement concrete. So that potable water available at site is used for experiment.

GLASS FIBER
In this experiment AR-glass fibers is used. The filament diameter of glass Fiber is 14 micron and length 12 mm having the aspect ratio of 857.1. The glass fibers used had a density of 2.7 gm/cm3, tensile strength 1700 MPa and Young's Modulus 72 GPa.

2.2 METHODS

WORKABILITY
The workability of cement concrete is tested as per using standard sizes of Slump Molds as per IS: 1199 - 1999.

Figure-1: Slump Test by Slump Cone

COMPRESSIVE STRENGTH

For find out compressive strength of cement concrete we casted steel cube mold of size of 150mm*150mm*150mm. After 24 hour casting of cube removing the mold and allowed for curing in a curing tank for a period of 28 days. After 7days & 28 days of curing of cube we tested the cube on Universal Testing Machine. The test procedure is used as per IS: 516-1979.

Figure-2: Compressive Testing Machine Set

SPLIT TENSILE STRENGTH

For find out split tensile strength of cement concrete we casted steel mold of cylinder with 150mm diameter and 300mm long. After 24 hour removing the mold and allowed for curing in a curing tank for a period of 28 days. After 7days and 28 days of curing of specimen we tested on Universal Testing Machine. The test procedure is used as per IS: 5816 – 1999.

Figure-3: Split Tensile Strength Set

FLEXURAL STRENGTH

For find out the flexural strength of cement concrete we casted steel mold of size 500mm*100mm*100mm. After 24 hour removing the mold and allowed for curing in a curing tank for a period of 28 days. After 7days 28 days of curing of specimen we tested in 200 tones electro-hydraulic closed loop machine. The test procedure is used as per IS: 516-1979.

Figure-4: Flexural Strength testing set at UTM

3. RESULTS

3.1 Compressive Strength of Concrete (in N/mm^2)

The 28 days compressive strength is studied and the values of 3 samples studied are shown in the tabular form. Table-1 shows the data of 28 days compressive strength obtained. Table-1 gives the 28 days compressive strength of concrete with maximum nominal size of aggregates 20mm.The 28 days compressive strength is also plotted Fig-5 by taking the average of this three values overall an increase in the compressive strength is observed with addition of fibers.

Table-1: 28 Days compressive strength of concrete

Description of Cube	Without Fiber	0.1% Fiber	0.2% Fiber	0.3% Fiber	0.4% Fiber
Weight of Cube (Kg)	8.065	8.085	8.100	8.105	8.125
	8.075	8.100	8.115	8.105	8.120
	8.080	8.105	8.110	8.150	8.115
Gauge Reading / Load on Cube (KN)	569.9	676.1	770.6	826.9	691.9
	579.8	678.4	777.4	809.8	696.4
	569.9	680.6	766.1	815.6	697.5
Compressive Strength of Cube (N/mm^2)	25.33	30.05	34.25	36.75	30.75
	25.77	30.15	34.55	35.99	30.95
	25.33	30.25	34.05	36.25	31.00
Average Compressive Strength of Cube (N/mm^2)	**25.48**	**30.15**	**34.28**	**36.33**	**30.90**

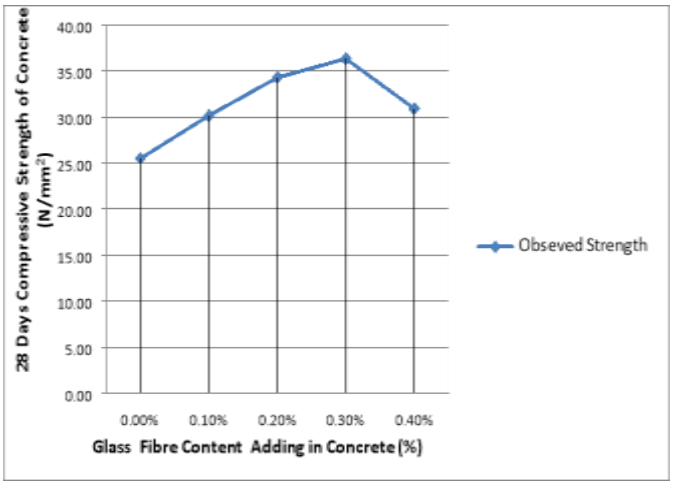

Figure-5: Effect of Glass fibers on 28 day compressive strength

4.2 Split Tensile Strength comparison (in N/mm2)

The 28 days Split Tensile strength is 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 is maximum nominal size of aggregates 20mm.The 28 days Split Tensile strength is also plotted Fig-6 by taking the average of this three values overall an increase in the compressive strength is observed with addition of fibers. The split tensile strength of concrete is calculated from the following formula –

Split Tensile Strength of concrete (f_{ct}) = $2P/(\pi*l*d)$
Where,
P = Maximum applied load at the specimen (In Newton)
l = Length of the specimen (In millimeter)
d = Diameter of the specimen (In millimeter).

Table-2: 28 Days split tensile strength of concrete

Description of Cube	Without Fiber	0.1% Fiber	0.2% Fiber	0.3% Fiber	0.4% Fiber
Gauge Reading / Load on Specimen (KN)	192.8	207.4	224.3	222.2	213.0
	194.3	211.6	231.0	232.8	219.4
	193.2	209.8	240.6	222.9	212.3
Split Tensile Strength of Concrete (N/mm²)	2.729	2.935	3.175	3.145	3.015
	2.750	2.995	3.270	3.295	3.105
	2.735	2.970	3.405	3.155	3.005
Average Split Tensile Strength of Concrete (N/mm²)	**2.738**	**2.967**	**3.283**	**3.198**	**3.042**

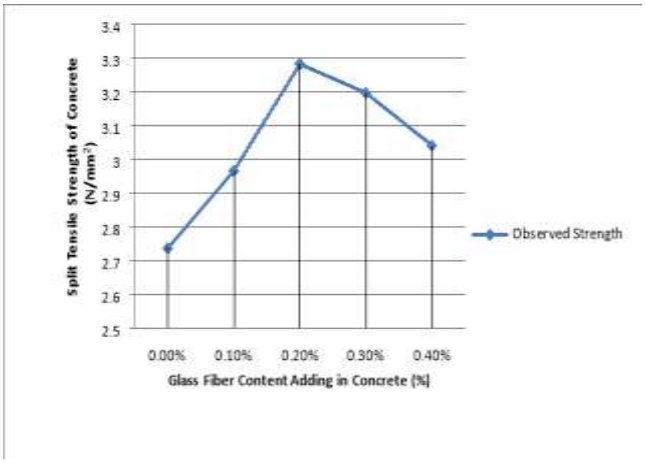

Figure-6: Effect of Glass fibers on 28days Split Tensile Strength

4.3 Flexural Tensile Strength (in N/mm^2)

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

Flexural Strength of Concrete (f_b) = $P*l/(b*d^2)$

Where,
P = Maximum applied load at the specimen (In Newton)
l = Length of the span on which the specimen is supported (In centimeter)
b = Width of the specimen (In centimeter)
d = Depth of the specimen (In centimeter)

Table-3: 28 Days flexural strength of concrete

Description of Cube	Without Fiber	0.1% Fiber	0.2% Fiber	0.3% Fiber	0.4% Fiber
Gauge Reading / Load on Specimen (KN)	25.3	29.8	33.4	31.2	29.3
	26.4	28.6	33.8	31.3	29.2
	27.2	29.1	33.7	31.0	29.2
Flexural Tensile Strength of Concrete (N/mm²)	3.213	3.784	4.241	3.962	3.721
	3.352	3.632	4.292	3.975	3.708
	3.454	3.695	4.279	3.937	3.708
Average Flexural Tensile Strength of Concrete (N/mm²)	**3.339**	**3.704**	**4.271**	**3.958**	**3.712**

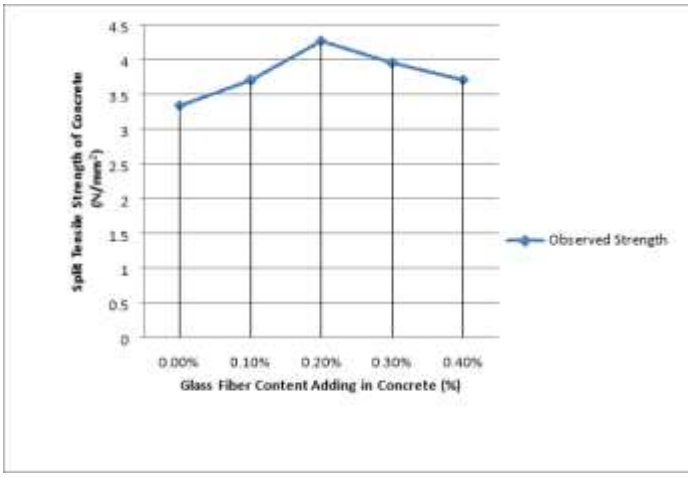

Figure-7: Effect of Glass fibers on 28days Flexural Strength

4.4 Workability of Concrete

This is very important to maintain the workability of concrete for the efficient working, strength of concrete and site finishing is the necessary part in the cement concrete at site. Use the slump cone method for measuring the workability of concrete at site.

The workability of concrete is studied and the values of 4 samples studied are shown in the tabular form. Table-4 shows the data of slump obtained. Table-4 gives the slump values of concrete with maximum nominal size of aggregates 20mm. The slump values are also plotted in Fig-8 by taking the values overall decrease is observed with the addition of fibers. The slump values of concrete are as following –

Table-4: Slump test of concrete

Fiber content (% of the total weight of concrete)	Slump Values (In mm)
0.00%	96
0.10%	92
0.20%	81
0.30%	61
0.40%	41

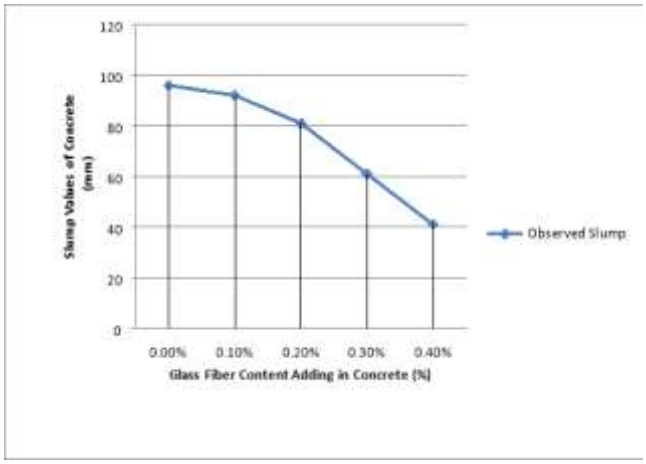

Figure-8: Effect of Glass fibers of Slump Test

4. CONCLUSIONS

In this experimental program the effect of glass fibers on the compressive, split tensile strength and flexural strength and workability of concrete is 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.

The various observation based on the experimental result are as follows:

1. The compressive strength of concrete without admixture is increased up to 42.58% by the presence of glass Fibers with the addition of Fiber content in the range of up to 0.30% by the weight of concrete and decreased with the presence of higher amount of glass fibers (above 0.3%).
2. The split tensile strength of concrete is increased up to 19.90% by the presence of glass Fibers with the addition of Fiber content in the range of up to 0.20% by the weight of concrete and decreased with the presence of higher amount of glass Fibers (Above 0.20%).
3. The flexural strength of concrete increases up to 27.91% by the presence of glass Fibers with the addition of Fiber content in the range of up to 0.20% by weight of concrete and decreased with the presence of higher amount of glass Fibers (Above 0.20%).
4. The workability of concrete is decreased with the presence of higher (above 0.10% glass Fiber content by weight of concrete) amount of fibers.

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