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INVESTIGATION THE MECHANICAL PROPERTIES WITH STEEL FIBER AND GLASS FIBER IN CONCRETE

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Abstract— the purpose of this study was to use the steel fiber and glass fiber to improve the Strength and increase the bonding strength in concrete. This experimental program was planned to investigate mechanical properties of Fibre Reinforced Concrete (FRC), with and without using fibres. Furthermore, change in variation of temperature of water during mixing was done on the fibre ratio which showed most positive results during above experiments, and test for compressive strength was carried out for 14 and 28 days of curing. The steel fiber and glass fiber partial replacement with weight of cement at percentages of (0.5, 0.75, 0.8, 1, 1.5) %. The 1.5 % to 1 % quantity of steel and glass fiber were partially replaced with cement, this process ultimately increase the strength of specimen for (compressive, flexural and split tensile) strength of concrete.

Keywords— Steel fiber, Glass fiber, Compressive strength, spilt tensile strength, Flexural strength.

I. INTRODUCTION

Concrete is the most important and historic discovery of man when it comes to construction. Concrete has allowed humans to build structures which are providing us with the resources to sustain our populated planet. Dams, Bridges and many more structures which have improved after the introduction of concrete have been monumental in making our lives easier. Concrete is able to sustain immense load which could be mounted on the structure. Concrete strength lies in compression. It is weak to tensile forces. Though, efforts are being put into improving its strength in tension, compressive strength still remains the main forte when it comes to concrete. But, as they say every coin has two sides, every plus comes with a minus, concrete also has negative impacts. This is mainly due to the main ingredient in production of concrete – cement. Cement is the binder which when mixed with water binds all the ingredients in concrete i.e. aggregates, sand together and forms a mixture we call concrete. We can say that, it is the life of concrete but its production leads to emission of CO_2 which is having hazardous impacts on our environment due to which the need to find its replacement is becoming more prominent day by day. There are many experiments carried out so as to replace cement partially or fully in order to improve the properties of concrete as well as reduce the consumption of cement. For this purpose, many waste products are used like fly ash, plastic waste, silica fumes etc. One such experiment is introduction of fibres. Fibres like that of steel, glass, polypropylene, asbestos, carbon etc. are introduced in concrete by partial replacement of cement by weight and the concrete formed is known as Fibre Reinforced Concrete(FRC).

1.2 Concrete Reinforced with Fibres (FRC)

FRC is formed when fibres such as steel, glass etc. are added to concrete in addition or by partial replacement to improve the properties such flexural, split tensile as well as compressive strength. FRC was used in early 1900's with the introduction of asbestos in concrete. With the flow of time and numerous experiments various fibres were introduced in concrete. FRC had shown improvements in properties of concrete when the fibres were used up to an extent. It was noted that the compressive and tensile properties of concrete had improved together with the decrease in defects such as bleeding, surface cracking etc. Out of these fibres the most commonly used fibres are steel and glass. Steel fibres tend to give concrete more strength whereas glass properties give it anti rust properties. Mixing more than one fibre in different ratios provide different results in context to strength depending on the amount, orientation and other physical properties. Hence, the use of fibres could reduce the amount of cement content and also improve the properties of concrete.

1.2.1 FRC Applications

Fibres concrete is highly recommended for improving the tensile strength of concrete. Fibres which are smaller in size, improve the strength properties of concrete effectively. FRC has distinctive features and may intensify effect, abrasive resistance, firmness, burst, and vibration. In very starting, fibre concrete was used for pavement and industrial huge slabs. Besides in a frequent time or present time, uses of fibre-reinforced concrete have large diversity usage in structures equivalent to pavement, heavier-than-air craft runways, water tanks, water canals, and dam structure, water, parking decks and waste material treatment plants, channel, formed panels, pipes, structures to resist earthquake, and explosives also gives positive result in Shotcrete application.

Application for FRC:

• Floors, road and walks to scale back shrinkage and crack issues square measure.

- Enhancement of toughness in FRC is good for buildings and roads subjected to shatter, impact, abrasion, and shear.
- Improves the cracking management, and reservoir to decrease the porousness, shrinkage for moisture retention, and freeze & thawing circumstances.
- Its spare with supplementary usage steel in sanitary tunnels to avoids from corrosion and recovers malleability or ductility.
- The square measure created a lot of immune to fuel spills with very less (<) porous and shatter Resistance FRC.
- Heavy concrete project gets simple and less danger with fibre, creating concretes a lot of Cohesive and stop segregation.

1.2.2 Steel Fibres

Steel Fibres are manufactured fibres of stainless steel. They are used in many fields for construction and here they being used to replace cement by weight to test the changes in properties they incur on concrete. Fibres used are hook-end with length 50mm and dia. 0.5mm as shown in fig. 1.Steel known to display elastic properties could be used to improve the tensile deformation occurrence in concrete when subjected to load acting along tensile axis towards the outside.

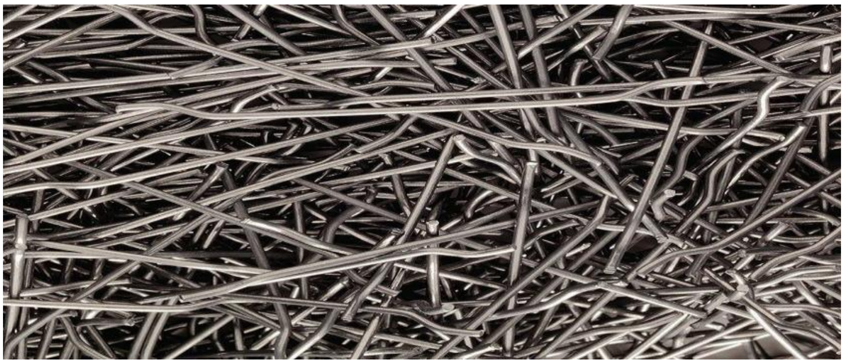

Fig. 1 *Steel (hooked end) Fibres*

1.2.3 Glass Fibres

Glass fibres are the fine filaments of glass which are manufactured using finer machine tool. Glass fibres have different properties which depend upon their manufacturing. The property of glass for which it is used in this experiment is known as anti-alkaline properties. This property provides resistance to steel within concrete towards the attack of water and unable it to form chemical reaction forming rust and weakening the steel. Glass fibre size used is 12mm as shown in fig. 2.

Fig. 2 *Glass Fibres with anti-alkaline properties*

II. EXPERIMENTAL PROGRAM

2.1 Material

2.1.1 Cement

Ordinary Portland Cement (OPC) of ACC (Associated Cement Companies) 43 Grade from a same lot was used for the study. Cement was carefully stored to prevent it from moisture. In table 3.1the physical properties of the cement are given.

Table 1 Physical Properties of Cement

Physical Properties	
Fineness (90 µ sieve)	5 %
Specific gravity	3.14
Soundness	1 mm
Standard consistency	32%

2.1.2 Fine Aggregates
River sand made of crushed aggregates was used as fine aggregate for concrete mixes. Table 2 holds sieve analysis results and other properties of the fine aggregates.

Table 2 Physical properties of Fine Aggregate

Characteristics	Result obtained
Fineness modulus	2.74
Specific gravity	2.65
Bulk density (Kg/m3)	1675

2.1.3 Coarse Aggregate
In surrounding locally available crushed stone aggregate was used for the concrete mixes. Homogenous aggregates or aggregates from same quarry were used. The aggregates which pass though the 20 micron sieve and retained on 12 micron sieve were used in the casting of samples.

3.3.4 Steel & Glass Fiber
Fibres used are hook-end with length 50mm and dia. 0.5mm. Glass fibres used were anti-alkaline with size 12mm. Ratios of Steel and Glass fibres used are as given below in Table 4.

Table 4 Ratio of steel and glass fibres used

Sr. No	Steel (%)	Glass (%)	Cement (kg/m^3)
1	0	0	418.5
2	0.75	0.5	413.3
3	0.5	0.75	413.3
4	0.8	0.7	412.2
5	0.7	0.8	412.2
6	0.75	0.75	412.5
7	1.5	1	408
8	1	1.5	408

3.3.5 Superplasticizer
Glenium 51, a brand new generation poly carboxylic ether hyper plasticiser was employed in the study to manage the workability of the concrete combine. It's a ready-to-use admixture additional to water and so into the concrete mix. It's supported a unique carboxylic ether polymer with long lateral chain that greatly improves cement dispersion. The dispersion properties of Glenium 51 build it the perfect admixture for formed and premixed concrete wherever low tide cement ratios square measure needed.

Glenium 51 will increase -

- High early mechanical strength.
- Adhesion to reinforcement.
- Resistance from carbon and chloride attack.
- Resistance to worse weather conditions.

Glenium fifty one decreases

- Shrinkage.
- Reduces the Creep.

3.3.6 Water
Mixing water used for initial samples mixes was domestic water (Tap water) supplied in the concrete laboratory by the institute. The water was clean and free from oil, acids, alkalis, salts and alternative substances harmful to concrete. Same water was used for curing additionally. For last stage of experiment temperature was varied as given in table 5.

Table 5 Temperature of water with steel and glass ratios

Sr. No.	Steel (%)	Glass (%)	Temperature (mixing) ^{O}C
1	1.5	1	30
2	1.5	1	40
3	1.5	1	50
4	1.5	1	60

3.4.1 Compressive Strength

Cubes specimen forecasting for 150*150*150. Each specimen has casted a three sample for testing of samples were casted. After testing calculated the average value of specimens. Compressive Strength is find out in Compressive Testing Machine after curing period of 14 and 28 days. Cubes were dry 30 to 60 mint after curing.

Compressive Strength Calculated by
Compressive strength = P/A (N/mm^2)
P = load on specimen
A = Area of cubes mm^2

a) 14 Days Result

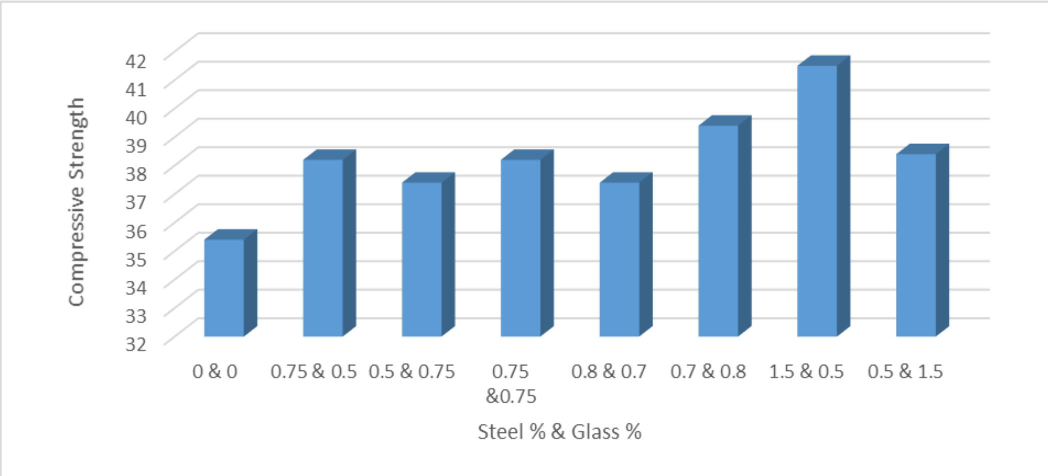

Fig 3 *Comparison of Compressive Strength (14 Days)*

b) 28 Days Result

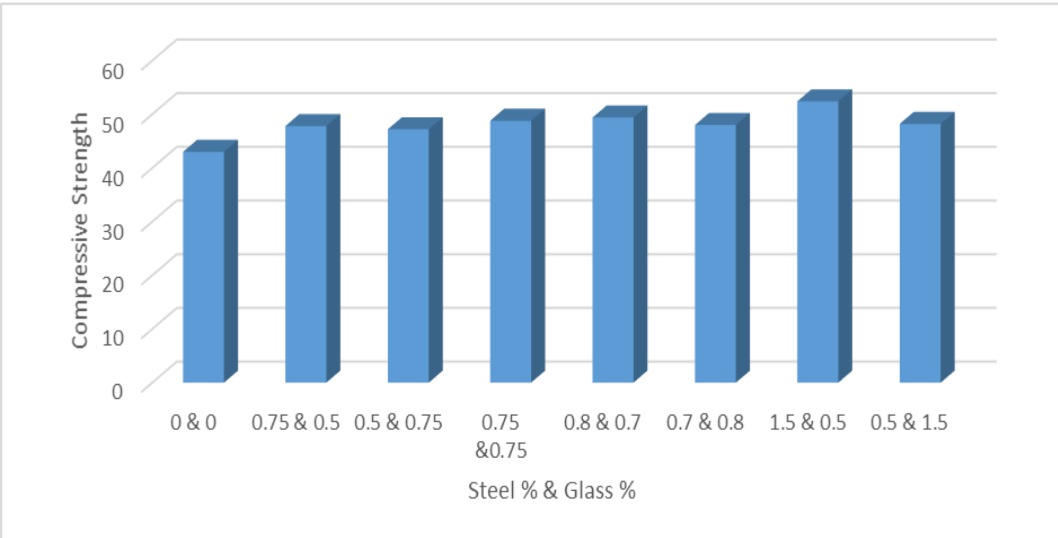

Fig 4 *Comparison of Compressive Strength (28 Days)*

3.4.2 Flexural Strength Test

Flexural Strength is calculated to find out the stress the material or sample (as used here) could take before it yields. It is also known as modulus of rupture. The strength is tested by casting a beam of size (varies) 500x100x100mm. The beam is marked 5cm from both sides with effective length remaining 40cm. And 6.66 cm from centre to both ends. The supports of the flexural test machine are aligned to the mark on the beam and load is applied at a rate of 180kg/min. This continues until the beam breaks.

c) 14 Days Result

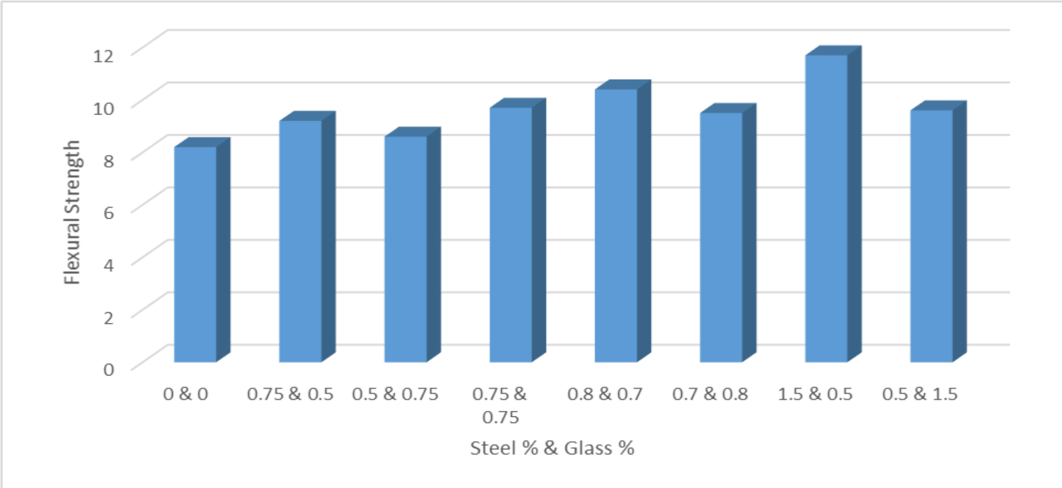

Fig 5 *Comparison of Flexural Strength (14 Days)*

d) 28 Days Result

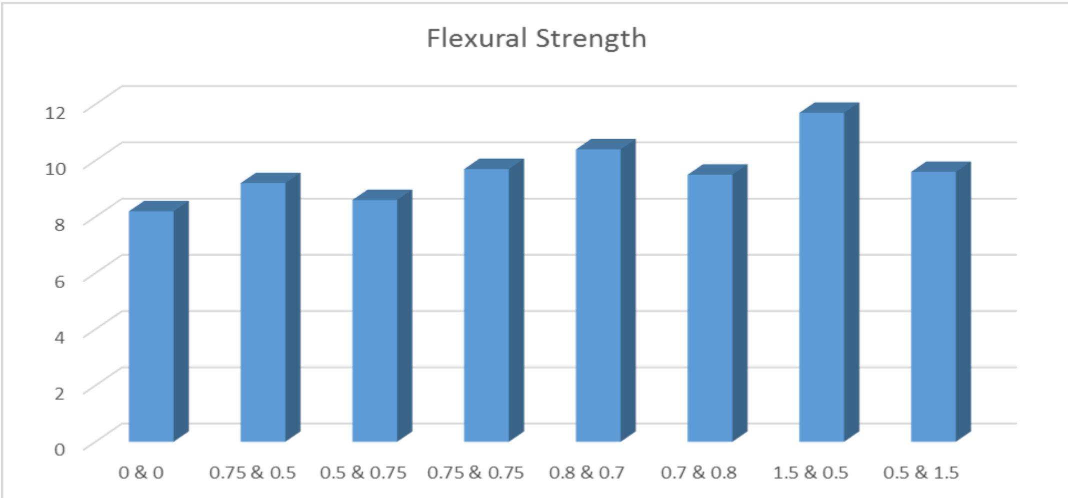

Fig 6 *Comparison of Flexural Strength (28 Days)*

3.4.3 Split Tensile Strength

The tensile strength is used for determining the indirect strength of concrete it also use for basic and important characteristics. Concrete being weak in tension, causing it to rupture easily when exposed to tensile forces. Cylinders were casted using different ratios and were tested after 14 and 28 days. Cylinders were placed along its length horizontally and load was applied at steady pace until it splits apart.

e) 14 Days

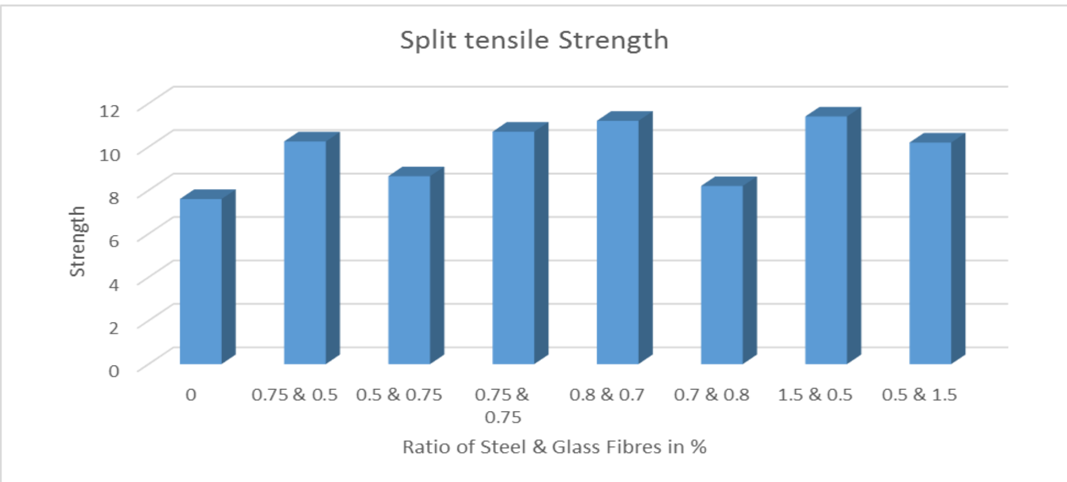

Fig. 7 *Comparison of Split Tensile Strength (14 days)*

f) 28 Days

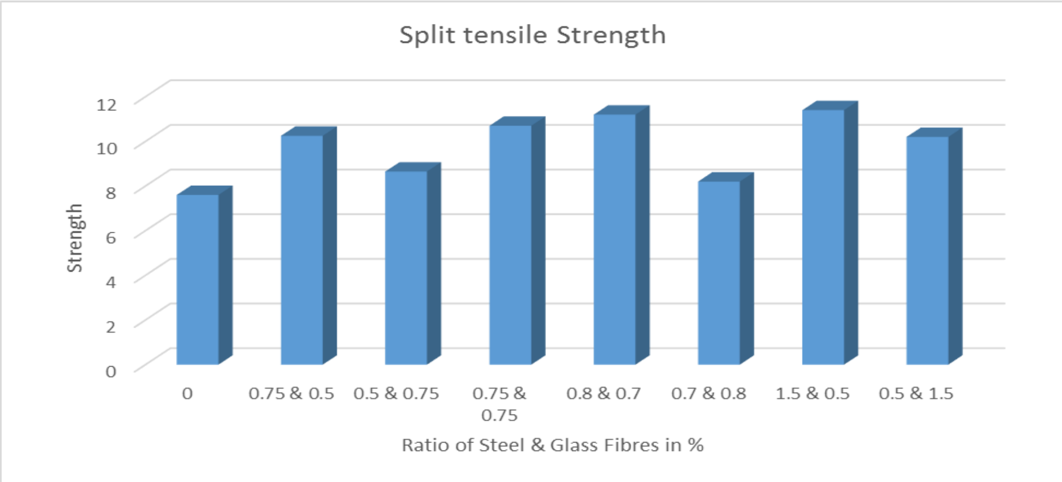

Fig. 8 *Comparison of Split Tensile Strength (28 days)*

3.5 Temperature Variation in Water during Mixing of Concrete

Water temperature has been varied from room temperature to up to 700C during mixing of concrete. The ratio selected was obtained from results above i.e. Steel 1.5% & Glass 1%.

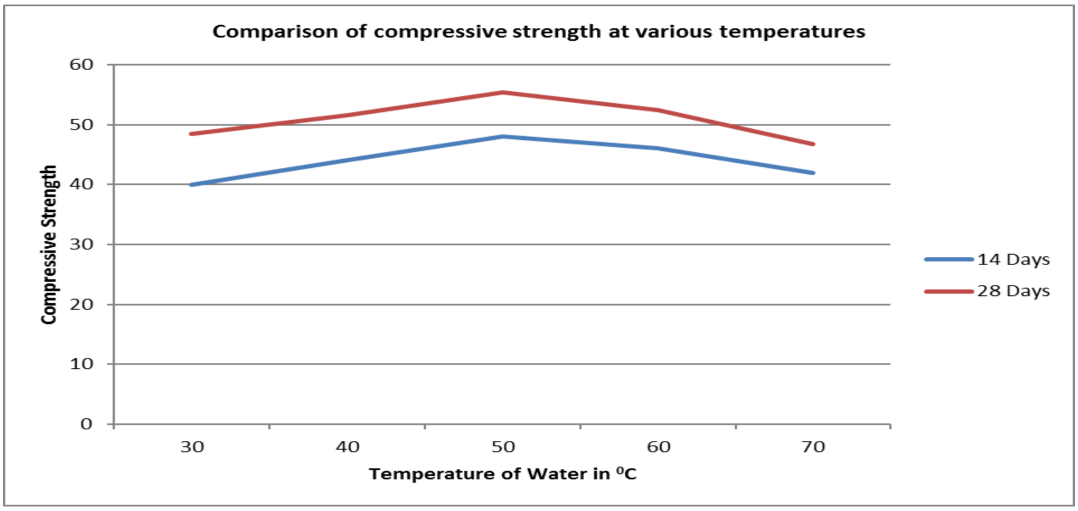

Fig. 9 Comparison *of compressive strength at various temperature*

III. CONCLUSIONS

The following conclusion can be drawn from this research study:

- The use of fibres in replacing cement can increase the properties of concrete significantly. An increase of up to 22% was seen in compressive strength when the steel and glass fibres were used in the ratio 1.5% and 1% respectively.
- Flexural Strength in Fibre Reinforced Concrete also show improvements with the peak result increasing the strength up to 42.7% when compared to conventional concrete when the fibres were added in ratio Steel& Glass 1.5 %& 1% respectively.
- Split tensile strength showed a huge improvement in Fibre Reinforced Concrete by increase in strength up to 50% for the Steel and Glass Fibre ratio 1.5% and 1% respectively
- Use of steel fiber in more quantity when compared to glass fibres in the mix showed better results in the properties of concrete. It can be noted that whenever the ratio of glass fiber to steel was kept more the strength properties of concrete showed a significant amount of downfall to when steel fiber was used more.
- Change in temperature of water during mixing showed improvement in the compressive strength of concrete in which steel and glass fibres were used in the ratio 1.5% and 1% respectively. As the temperature was increased the compressive strength also increased showing peak value at around 500C and then started to decrease again as the temperature was further increased.
- An increase up to 5% was recorded at 500C when compared to room temperature.
- Hence, we can clearly state that fiber reinforced concrete improves the properties of concrete and use of right temperature during mixing could further enhance the properties.

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