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AN EXPERIMENTAL INVESTIGATION ON GLASS FIBER REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME IN M30 CONCRETE

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Abstract: As the human technology growing human being harshness the environment which cause a serious problem for all of us, overcome these problems we can use some materials with a alternate of construction materials some of them are silica fume, fly ash, rise husk etc. . Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. Hence an attempt has been made in the present investigations to study the influence of addition of glass fibers and replacement of cement by silica fume. In this connection an experimental investigation was carried out to determine the compressive, split tensile and flexural strengths with the use of glass fibers and Silica fume in concrete. The glass fibers were added by 0.4%, 0.8%, 1.2% and 1.6% by volume and cement was replaced by Silica fume in three different percentages of 4%, 8%, 12% and 16% by weight of cement. Glass fiber Reinforced Concrete (GFRC) is tested for Compression, split tension and flexural strengths. Experimental investigation has been do by using M30 mix and tests has carried out as per recommended procedure by with conventional concrete has been gain more tensile strength as well as compressive strength .concrete is weak in tensile strength and strong in compression so while we improve the tensile strength.
Keywords: Silica Fume, Glass Fiber, Compressive Strength, Split Tensile Strength, Flexural Strength

I. INTRODUCTION

In the world, concrete is most widely used construction material they are made in any form and shape. The strength and durability of concrete can be changed by making appropriate changes in its ingredient like cementation material, aggregate and water and by adding some special ingredient like silica fume and Glass fiber. They are produced better strength in concrete. The presence of micro cracks in the mortar aggregate produce weakness in concrete they can be removed by inclusion of silica fume with Glass fiber. They are composite material can be introduced into its resist crack growth. The Glass fiber are resist the axial compressive force in the cube form so they produce better compressive strength in concrete Silica fume is known to produce a high strength concrete and is used in two different ways as a cement replacement, in order to reduce the cement content (usually for economic reasons) and as an additive to improve concrete properties (in both fresh and hardened states).in general, the character and performance of fiber concrete changes with varying concrete formulation as well as the fiber material type. The fiber can be imagined as an aggregate with an extreme deviation in shape from the rounded smooth aggregate. The fibers interlock and entangle around aggregate particles and considerably reduce the workability, while the mix becomes more cohesive and less prone to segregation. The fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all direction. Fiber helps to improve the compressive strength. Hence in this research, Experimental investigations and analysis of results were conducted to study the compressive, split tensile and flexural behaviour of composite concrete with varying percentage of such silica fume and glass fibers added to it. The concrete mix adopted were M30 with varying percentage of the silica fume ranging from 0%, 4%, 8%, 12% & 16% in the partial replacement of cement weight and glass fibers of length 12 mm and diameter of filament is 14 microns with the aspect ratio 857 at various percentages ranging from 0%, 0.4%, 0.8%, 1.2% & 1.6% by weight of the concrete and in the mix proportions of 1:1.65:2.90 with water and cement ratio 0.45. On the analysis of the test results the normal concrete with silica fume and straight steel fibers has enhanced the performance of composite mixture as compared to the ordinary concrete with conventional silica fume and steel fibers which were easily available in the market. These sustainable improvements or modifications could be easily adopted in the regular constructions. Ordinary Portland Cement (OPC) 43 grade and fine aggregate with less amount of clay and silt with sand size is passing through 1.19mm sieve and retained on 900micron sieve. The coarse aggregate used in 20mm & 10mm size. It is well graded and potable water, free from impurities such as oil, alkalies, acids, salts, sugar, and organic materials were used.

Fig. 1.1 Silica Fume

Fig. 1.2 Glass Fiber

II. MATERIALS AND THEIR PROPERTIES

A. Cement

Ordinary Portland cement of 43 grade of Ultratech brand conforming to IS: 12269 standards was used in this investigation. The specific gravity of the cement was 2.99. The initial and final setting times were found as 37 minutes and 286 minutes respectively.

Table 2.1 Characteristics
Properties Of Cement

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1	Consistency of cement (%)	34%	---
2	Specific gravity	2.99	3.15
3	Initial setting time (minutes)	37	>30 As Per IS 4031-1968
4	Final setting time (minutes)	286	<600 As per IS 4031-1968
5	Compressive strength (N/mm^2) (I) 3 days (II) 7 days (III) 28days	 18.46 26.28 48.52	 >23 >33 >43
6	Soundness (mm)	1.00	10
7	Fineness of Cement	5%	10% As Per IS 269-1976

B. Coarse Aggregate:

Coarse aggregate of maximum size 20mm is used throughout the concrete. The specific gravity of course aggregate is 2.87.

C. Fine Aggregate:

Fine aggregate is used in this experimental study for concrete is river sand conforming to zone- II. The specific gravity of fine aggregates 2.67

D. Silica Fume

Silica fume having the fineness by residue on 45 micron sieve = 0.8%, specific gravity =2.2, moisture content =0.7% were used. The chemical analysis of silica fume (Grade 920-D): silicon dioxide =89.2%, LOI at 975* Celsius = 1.7% and carbon = 0.92%, are conforming to ASTM C 1240-1999 standards.

E. Glass Fibre

Glass fibre also called fibreglass. It is material made from extremely fine fibres of glass. Fibreglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fibre and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes

F. Water :

Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable tap water was used for the preparation of all concrete specimens.

Table No.-2.2
Physical Properties of Aggregates

Sr. No.	Properties of Material	
1	Specific Gravity of Cement	2.99
2	Specific Gravity of silica fume	2.2
3	Specific Gravity of Coarse Aggregates	2.87
4	Specific Gravity of fine aggregate	2.67
5	Free Moisture Content	2.31%
6	Water Absorption	1.79%

III. EXPERIMENTAL PROGRAM

As recommended by the IS Standard of a particular size cubical moulds of size 150mm×150mm×150mm and cylinder mould of depth 150mm was ,height 300mm and dia of 100mm and beam mould of 150mm×150mm×700mm made of cast iron were used to cast concrete specimens to test compressive strength ,split tensile strength and flexural strength respectively. The quantities of cement, fine aggregates, coarse aggregates, and water for each batch were weighted to an accuracy of 1kg separately. Silica fume and quarry glass fibre is added to this mixture in dry form. Finally, coarse aggregates were added and thoroughly mixed to get a uniform mixture throughout the batch. Required dosage of water was added in the course of mixing.foe eliminate the voids a proper vibration was doing by the vibrating machine.. Surface of concrete was finished level using a trowel and date along with batch number was marked properly on it. Finished specimens were left to harden and removed from moulds approximate after 24 hours of casting. They were then placed in water tank containing portable water and were left for curing.

Fig 3.1 Silica Fume Mixing in Concrete

Fig 3.2 Addition of Glass Fibre into Mix

IV. TESTING OF CONCRETE

The test compression and split tensile strength was checked at the age of 7 and 28 days of moist curing and were then tested. Specimens were tested on 1000 tones capacity of universal testing machine (UTM). The load was applied gradually without any shock and increased at constant rate of 14 N/mm²/minute until failure of specimen takes place, thus the compressive strength of specimen was found out by dividing the compressive load to area under compression. For flexural strength testing a flexural testing machine was used as recommended by IS code.

Fig. No.4.1: Testing of Cube

Table-4.1: Compressive Strength by Adding Glass Fibre & Silica Fume in Concrete

Sr. No.	%GlassFibre	%Silica Fume	Compressive strength in 7 days	Compressive Strength in 28 days
1	0	0	24.06	31.93
2	0.4	4	24.96	33.04
3	0.8	8	25.47	33.85
4	1.2	12	26.15	35.40
5	1.6	16	24.88	32.70

Table-4.2: Flexural Strength by Adding Glass Fibre & Silica Fume in Concrete.

Sr. No.	%GlassFibre	%Silica Fume	Flexural strength in 7 days	Flexural strength in 28 days
1	0	0	1.62	3.11
2	0.4	4	1.66	3.19
3	0.8	8	1.69	3.30
4	1.2	12	1.80	3.36
5	1.6	16	1.75	3.14

Table-4.3: Split Tensile Strength by Adding Glass Fibre & Silica Fume in Concrete

Sr. No.	%GlassFibre	%Silica Fume	Split Tensile strength in 7 days	Split Tensile strength in 28 days
1	0	0	1.72	3.70
2	0.4	4	1.95	4.01
3	0.8	8	2.33	4.43
4	1.2	12	2.64	4.79
5	1.6	16	2.23	4.37

4.1 INTERPRETION OF TEST RESULTS

4.1.1 Compressive strength

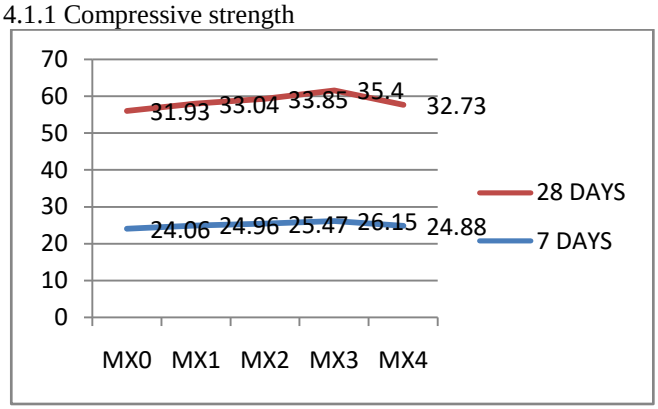

Fig.4.1 : Graph comparing compressive strength for 7 and 28 days

4.1.2 Flexural Strength

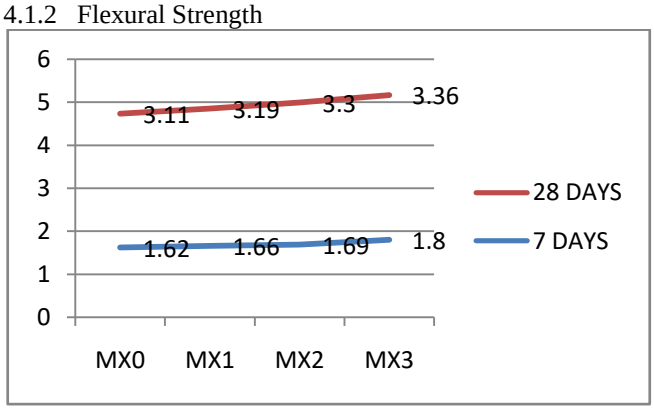

Fig 4.2 Graph comparing Flexural strength after 7 & 28 days

4.1.3 Split Tensile Strength

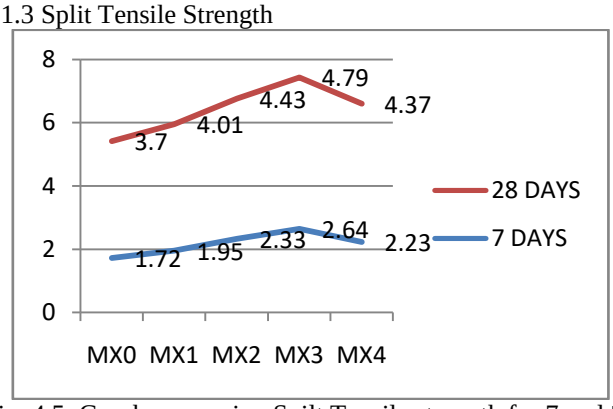

Fig. 4.5: Graph comparing Spilt Tensile strength for 7 and 28 days.

V. CONCLUSION

From the results of the present research the following conclusion may be drawn:-

- The Experimental work shows that properties of normal concrete (M-30) gets enhanced due to addition of silica fume and glass fibers.
- The Experimental work shows that workability of normal concrete gets reduced as we increased the silica fume and glass fibers quantity.
- While testing the specimens, the ordinary cement concrete specimens have shown a usual crack propagation pattern which leaded into splitting of beam in two-piece geometry. But due to adding of silica fume and glass fibers in concrete cracks gets arrested which results into the ductile performance.
- It is also observed that during testing the specimens, the specimen does not collapse as compared to ordinary concrete.
- From the experimental investigation, it has been found that the flexural strength of normal concrete containing silica fume and glass fibers; increases very much as compared to compressive strength.
- When we added silica fume with glass fibers to the mixture it was seen that the weight density of the concrete is increased.
- The compressive strength increases with the increase of silica fume as compared to the normal concrete.
- Increases the cube compressive strength of concrete in 7 days to an extent of 7.99%.
- Increases the cube compressive strength of concrete in 28 days to an extent of 9.80% at the dosage of 1.6% of addition of glass fibre.
- Increases the split tensile strength of concrete in 28 days up to 22.75% at the 1.6% of fibre addition. It is much higher strength increment at last specimen in our study .it shows that as per our objective we can gain better tensile strength.
- In this the flexural strength of concrete at 1.6% of waste steel fibre addition in concrete at 28 days at a percentage of 7.44%.
- The increases in flexural strength are directly proportional to the fiber content and also the flexural deflection decreases with increase in glass fiber as compared to the normal concrete.
- The optimum replacement level of cement by silica fume is found to be 12% by weight, there is a significant improvement in the compressive strength of concrete using silica fume at both 7 and 28 days as compared to the normal concrete. The workability in case of silica fume concrete is slightly enhanced.
- Workability of concrete decreases as increase with percentage of silica fume Beyond optimum silica fume level the strength decreases but the workability increases so The optimum replacement level of cement by 12% of silica fume and 1.4% of glass fiber by weight.
- It is also notified that normal concrete specimens showing irregular cracks and breaks in two parts during testing but normal concrete specimens contains silica fume and glass fibers get closely packed which shows the ductility property.

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