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AN INVESTIGATION ON HIGH PERFORMANCE CONCRETE WITH SILICA FUME AND DIFFERENT FIBRES

[1]Syed sarfaraz ali ,[2]B. Sumalatha,[3]B. Sharath Chandra
[1]Student,[2]Assistant Professer,[3]HOD
Department of Civil Engineering
Ellenki College of Engineering and technology ,
Patelguda, patancheru, sangareddy, Telangana

ABSTRACT
Using silica fume as a cement component, the experiment assesses cement for M40 grade concrete. We are adding concrete with 0%, 5%, 10%, and 15% cement by weight to the list of materials, along with glass fiber and coconut fiber. The goal of the research is to determine if it is feasible to combine glass and coconut fiber with other concrete ingredients and strength-boosting qualities. The impacts of each 1%, fiber content by mass of cement, aspect ratio 857, and fiber cut length 12mm are investigated in order to evaluate the impact of glass fibers on concrete quality. For the compression strength test and split tensile strength, the appropriate amounts of glass fiber and silica fume are 2% and 10%, respectively, with a water cement ratio of 0.45. Each batch of concrete contains 1% coconut fiber and 1% glass fiber. The concoctions were all formed into cylinders and cubes. Coconut fiber makes the material harder to deal with. In terms of results, the 10%silica fume and 2% fiber combination performed better than the control mix. Fibers are utilized in concrete to delay and avoid the tensile cracking of composite materials. Here, an attempt is made to reuse coconut fiber materials as fiber composites in concrete, which solves the ductility problem as well as the waste disposal issue in part. Instead of cooling the surroundings, coconut fiber cools the temperature of a space. Concrete's tensile strength and mechanical properties have been shown to be enhanced by silica fume.

Keywords: Silica fume, Glass fiber, Coconut fiber

1. INTRODUCTION

Concrete, the material used for building the most often globally, may be made in any size or form. Concrete's strength and durability may be altered by altering its constituent parts, such as the cement, aggregate, and water, as well as by adding specific substances like silica fume and glass fiber. They boost the strength of the concrete. Microfractures in the mortar aggregate are what weaken concrete; they may be fixed by using silica fume and glass fiber. To prevent fractures from occurring, they are composite materials that might be applied to the object. Because they can bear axial compressive force in cube form, glass fibers provide concrete a better compressive strength. High strength concrete is known to be produced by using silica fume, either as a cement substitute or as an addition to improve the qualities of concrete (in both the fresh and cured phases). The characteristics and performance of fiber concrete typically vary depending on the concrete formulation and fiber material type. They stand out due to their high amorphous silica content and sizable surface area of the highly reactive pozzolana silica fume. It is a fine substance that functions well as filler. As a byproduct of reducing high-quartz to make silicon material or silicon alloys in an electric arc furnace using coal, coke, and wood chips, silica fume is created. Concrete uses silica fume in two separate ways: as an addition to improve the qualities of the concrete and as a cement substitute to lower the cement content. When fibers are added to a mixture, concrete's flexural and tensile strength may rise, and a novel kind of binder may be produced that binds Portland cement with cement matrices).

1.1 Objectives of the study

- The main objectives of the research are outlined below.
- To assess the freshness of the concrete using the slump and compaction factor tests.

- To evaluate the compressive strength of control concrete of grade M20 and silica fume concrete produced by replacing cement with glass fiber in quantities of 0%, 0.5%, 1%, and 1.5% by weight in lieu of cement in the ratios of 5%, 10%, 15%, and 20%, respectively.

To compare the split tensile strength of silica fume concrete prepared by substituting glass fiber for cement in quantities of 0%, 0.5%, 1%, and 1.5% by weight with control concrete of grade M20.

2. Review of Literature

Paramasivam et.al Corrugated slabs with coconut fiber reinforcement that are 10 mm thick, 460 mm wide, and 915 mm long were studied for low-cost housing. The cement to sand ratio was 1:0.5, whereas the cement-to-water ratio was 0.35. Flexural strength testing employed third point loading. The recommended parameters for producing slabs with a nominal flexural strength of 22 MPa were 2.5 cm fiber length, 3% volume fraction, and 0.15 MPa casting pressure. The low frequency sound absorption and heat conductivity were comparable to asbestos-containing boards.

Hanumesh B M, et.al. The authors of this study want to determine how much cement may be substituted in M20 grade concrete by using silica fume as an addition for cement. The main objective of this study is to evaluate the mechanical properties of M20 grade control concrete with silica fume concrete that contains increasing amounts (5, 10, 15, and 20%) of silica fume in place of cement. The study discovered that silica fume, used as a 10% replacement for cement, increased concrete's compressive strength and split tensile strength. Beyond 10%, both the split tensile strength and the compressive strength decrease. The amount of silica fume has a big effect on compressive strength because of its strong pozzolanic properties and capacity to produce a C-S-H gel that is packed more tightly. The increase in split tensile strength is mostly attributable to better packing or its usage as a filler material**.**

Pshtiwon N. et.al To demonstrate the differences in compressive strength and flexural strength between concrete with and without glass fiber, this study performs trial tests using cubes of different sizes. Numerous applications of GFRC in the research, results of experimental tests, techno-economic comparisons with other types, and offered budgetary estimations all indicate to the material's immense potential as a replacement for conventional construction materials. Glass fiber The strength, fire resistance, beauty, and low weight of reinforced concrete are only a few of its many advantages. Glass fibers made up 0, 0, 11, 1.5, and 2.0% of the cement in this experiment, respectively, by weight. According to this study, 1.5% glass fiber brought concrete's average compressive strength to its maximum point. Additionally, the maximum flexural strength of concrete with 2% glass fiber was 10% greater than that with 1.5%.

3. RESEARCH METHODOLOGY

3.1 Materials

- Cement
- Fine aggregate
- Coarse aggregate
- Silica fume
- Glass fibre
- Coconut fibre

3.1.1 Cement: Cubes and cylinders were cast in the present project utilizing Ultratech cement of 43 grade ordinary Portland cement for all concrete combinations. There are no hard lumps in the cement, and the color is consistent. Cement is subjected to a variety of tests, including standard consistency, beginning and final setting times, specific gravity, fineness, and compressive strength.

Table-1 Physical Properties of Cement

S.N0	Physical Property	Test Result
1	Standard Consistency	30.00%
2	Fineness	5.00%
3	Special Gravity	3.15
4	Initial Setting time	28 min

3.1.2 Fine Aggregate (FA): As fine aggregate, river sand that is locally accessible and meets the requirements of grading zone II of table 4 of IS 383-1970 has been employed. The tests were conducted in accordance with IS 383-1970. Fine aggregates are simply any unrefined sand that has been extracted from the earth through mining. Natural sand or any broken stone fragments that are 4" or smaller make up fine aggregates. Due to the size, or grade, of this specific aggregate, this product is often referred to as 1/4"' minus. BoDean Company offers fine aggregates in the following sizes: 14" minus, C33, Mark West Quarry Clay, and "Quarry Fines." There are no huge aggregates or rock particles in this material, which is highly graded for optimum compaction.

Table-2 Physical Properties of Fine aggregate

Physical Properties	Value
Fineness Modulus	2.5
Water Absorption	0.8%
Specific Gravity	2.65
Bulk Density	1610 kg/m^3

3.1.3 Coarse Aggregate (CA): The current study uses locally accessible coarse aggregate with a maximum particle size of 20 mm. Water absorption is determined to be 4% and the specific gravity of coarse aggregate is 2.69.

Table-3 Physical Properties of Coarse aggregate

S.N0	Coarse Aggregate	Result Achieved
1	Specific Gravity	2.7
2	Unit Weight(kg/m^3)	1580
3	Fineness	6.63
4	Water Absorption	1.09

3.1.4 Silica fume:

Silica fume is produced as a byproduct of the production of ferrosilicon alloys or silicon metal. Concrete constructed from silica fume has the potential to be exceedingly robust and long-lasting.

A highly pozzolanic byproduct of the ferrosilicon industry known as silica fume is used to enhance the mechanical and durability properties of concrete. It may be blended with silica fume and Portland cement, or it can be used straight in concrete. In the United States, silica fume is mostly used to make concrete that is more resistant to chloride penetration for applications such as parking garages, bridge decks, and bridges.

Table-4 Physical Properties of Silica fume

Properties	Cement	Silica Fume
Specific Gravity	3.15	2.25
Surface area, m^2/kg	320	20,000
Size,micron	_	0.1
Bulk density,kg/m^3	_	576
Initial setting time(min)	45	_
Final setting time(min)	375	_
Sio_2	90-96	20-25
Al_2o_3	0.5-0.8	8-Apr

3.1.5 Glass fiber: Glass fiber is a substance made up of multiple, very fine glass fibers. By varying the quantity of raw ingredients, such as sand for silica, clay for alumina, calcite for calcium oxide, and colemanite for boron oxide, glass fibers may be produced in a variety of compositions. Therefore, utilizing varying proportions of silica or other sources, distinct glass fiber types exhibit varying capabilities, such as alkali resistance or high mechanical qualities. Products made of glass fiber are categorized according on the kind of composite at which they are used. Additionally, the most crucial components employed in the injection moulding, filament winding, pultrusion, sheet moulding, and hand layup processes to create glass fiber-reinforced composites include chopped strands, direct draw rovings, assembled rovings, and mats.

Table-5 Physical Properties of Glass fiber

Property	**Units**	**Glass fibre**
Density	Gr/cm^3	2.56
Tensile Strength	Mpa	3,445
Modulus of elasticity	Gpa	76
Tensile elongation	%	2.75
Fibre diameter	um	13
Chopped length	mm	3
Chemical Composition	%(weight)	52.4 Sio_2
		14.4 Al_2o_3

3.1.6 Coconut fibre:

Using a cutting machine, uniform fiber length was achieved. Vernier scales were used to measure the fiber length and micrometers to measure the diameter. Using a pycnometer, the specific gravity and density of coir fibers were calculated. The specific gravity and density of the coir fiber were determined after 24 hours of immersion in water because of its propensity to absorb water, particularly in the initial few hours.

Fig.1 Cement Coconut fiber Silica fume Glass fiber

4. RESULTS AND DISCUSSION

4.1 Split Tensile test

Table-6 (0% of silica fume concrete)

7 days	14 days	28 days
2.96	3.84	4.73
2.86	3.79	4.79
2.93	3.72	4.81

Table-7 (5% of silica fume concrete)

7 days	14 days	27 days
3.72	3.98	5.12
3.69	4.02	5.09
3.65	4.06	5.16

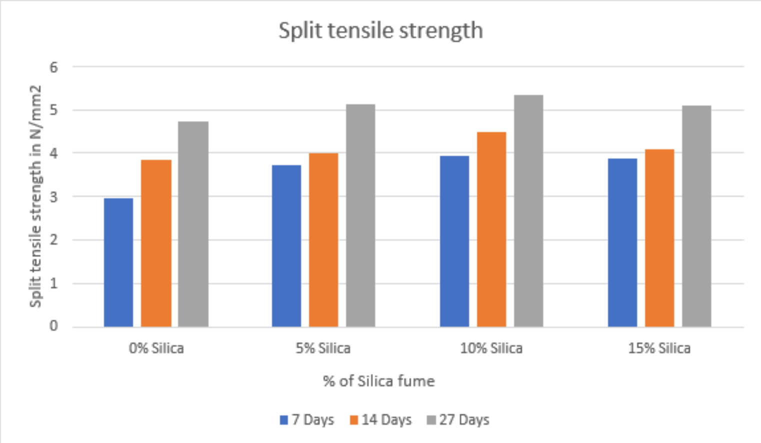
Table-8 (10 % of silica fume concrete)

7 days	14 days	27 days
3.92	4.48	5.34
3.98	4.44	5.31
3.89	4.06	5.29

Table-9 (15% of silica fume concrete)

7 days	14 days	27 days
3.86	3.98	5.06
3.89	4.04	5.11
3.88	4.09	5.08

Fig.2 Split tensile Test



Graph 1: Split tensile test results

4.2 Compressive Strength

Table-10 (0% of silica fume concrete)

7 days	14 days	28 days
25.97	35.68	39.61
26.11	35.72	39.49
26.17	35.85	39.63

Table-11 (5% of silica fume concrete)

7 days	14 days	27 days
29.92	41.23	46.23
30.19	41.41	46.18
30.24	41.23	46.14

Table-12 (10% of silica fume concrete)

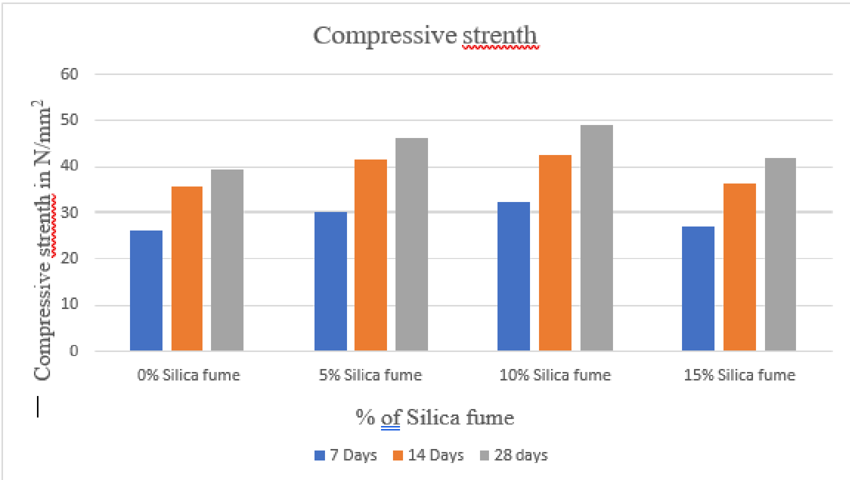
7 days	14 days	27 days
32.34	42.39	48.21
32.41	42.42	48.92
32.36	42.48	47.96

Table-13 (15% of silica fume concrete)

7 days	14 days	27 days
27.16	36.72	42.10
27.19	36.43	41.98
27.24	36.48	41.86

Fig. 3 Compressive strength test

Graph 2: Compressive strength test results



4. CONCLUSION

Concrete gains strength when 10% silica fume and 2% fiber are added to it. When a 15% concentration of silica fume was applied, the fibers' strength decreased. Silica fume, glass fiber, and coconut fiber boost the mixture's strength, particularly its compressive and tensile strengths. These characteristics are highly helpful in any structure, thus adding them provides the concrete more strength. This opens up numerous possibilities for new construction, which presents many difficulties in practical applications. The new mix designs encourage engineers to use this mix for intricate buildings that support huge loads.

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