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ijmrset@gmail.com





## An Investigation on the Partial Replacement of Cement in Glass Fiber Concrete with Nano-Silica and Silica Fume

Pradeep Kumar Chaturvedi, Prof. Kamlesh Kumar Choudhary

PG Student, Department of Civil Engineering, Saraswati Institute of Engineering & Technology, Jabalpur, India

Assistant Professor & HOD , Department of Civil Engineering, Saraswati Institute of Engineering & Technology,

#### Jabalpur, India

**ABSTRACT:** Researchers from all over the world are experimenting with different proportions and admixtures to create unmatched concrete. There are many ways to use fiber- reinforced concrete in structural elements. Some fibers, such as those made of glass, carbon, polypropylene, and aramid, improve the abundance of qualities like hardness, durability, stiffness, toughness, and shrinkage. This study's goal is to investigate the characteristics of glass fiber-reinforced high-performance concrete (GFRHC), which is used to prepare high-performance trail mixes with silica fume (SF) replacements ranging from 0% to 25%. An ideal mixture is selected, which replicates cement at a constant 1.15 percent with nano-silica. Glass fibers are induced at 1 percent, 2 percent, 3 percent, and 4 percent by weight of cement for that optimized mix along with nano-silica. Cube moulds measuring 150x150x150 mm, cylinder moulds measuring 100x300 mm, and beam moulds measuring 100x100x500 mm are made, cured for 7 to 28 days, and then their hardened strength is assessed. The compressive strength 29.10 MPa of Mix-15% SF in concrete without Glass fiber and Nano Silica at 7 days (increase 8.86 %). The compressive strength 43.05 MPa of Mix-15% SF in concrete without Glass fiber and Nano Silica at 28 days (increase 7.54 %). The compressive strength 29.60 MPa of 15%SF+2%NS+3%GF in concrete without Glass fiber and Nano Silica at 28 days (increase 7.54 %). The compressive strength 43.40 MPa of 15%SF+2%NS+3%GF in concrete without Glass fiber and Nano Silica at 28 days (increase 8.41 %).

KEYWORDS: Nano-Silica, Silica fume, Glass-fiber reinforced high-performance concrete, Compressive strength.

#### **I.INTRODUCTION**

Concrete is mostly frequently used material in construction sector due importance an special concrete such as selfcompacting concrete and glass fiber reinforced concrete for different applications. A tiny number of short and randomly dispersed fibers, such as steel, glass, synthetic and natural, can overcome cement concrete's brittle failure properties. This type of concrete can be used in situations where concrete has vulnerability, such as low durability or excessive shrinkage cracking. As a result of its low tensile strength, poor post cracking capability, and brittleness, as well as its large porosity, concrete is particularly sensitive to chemical and environmental assault. Worldwide building of more complex engineering structures has become a reality in recent years. Because of this, concrete must have high strength as well as a high degree of workability. By adding different fibers and admixtures in varying amounts, researchers all around the world are creating high-performance concrete. A broad range of filaments, for example, aramid, polypropylene, glass, carbon, and polypropylene, improve cement properties like as stiffness and exhaustion blockage. As a result of its intriguing characteristics, fiber-supported cement offers a variety of applications in the structural design sector. The glass fiber Because of its low weight, reinforced concrete (GFRC) is a relative advancement in the significant innovation area. GFRC has both strong compressive and twisting strength. Fiber-built-up concrete is a relatively new composite material in which the substantial is supported by short, consistently conveyed discrete strands (up to 35 mm long), enhancing many design properties such as flexural and shear qualities, as well as weakness, effect, and temperature and shrinkage breaks. Fibers of 25mm length and spray applications employ fibers up to 35mm in length. Renewed concrete comprises twisted steel bars or high-tension wires that are woven into a continuous pattern.



High-tension wires for pre-stressing technology using glass reinforcing have helped overcome concrete's inability to withstand the strain; nonetheless, concrete's compressive strength is excellent. High rigidity (2-4 GPa) and young's modulus (70-80 GPa) of glass fiber, strain properties (2.5-4.8 percent stretching at break), and a negligible owner at encompassing temperature are large elements of glass fiber. This material has a measurement of somewhere in the range of 0.005 and 0.15 millimeters. 1.3 mm is the measurement of the groups. Zhu Yuan and Yanmin Jia (2020), the study of the impact of glass fiber (GF) and polypropylene fiber (PPF) on the mechanical and microstructural properties of concrete as a function of water/binder ratio and fiber concentration During the experiment, the concrete samples were produced with varied water/binder ratios (0.30 and 0.35), GF and PPF concentrations (0.45, 0.90, and 1.35 percent by volume fractions), and curing times (7 and 28 days). The effect of GF on water absorption was much greater than that of PPF. When the water-binder ratio was 0.30.Barham.

#### **II.LITERATURE REVIEW**

The main focus of this study, is the behaviour of the glass fiber reinforced high-performance concrete with silica fume and nano-silica

- 1. To study the properties of the glass fiber reinforced high-performance concrete with silica fume and nano-silica
- 2. To achieve durability of the glass fiber reinforced high-performance concrete with silica fume and nano-silica.
- 3. To achieve economy by selecting appropriate concrete ingredients.
- 4. To study the workability of the glass fiber reinforced high-performance concrete with silica fume and nano-silica.
- 5. To study the compressive strength and tensile strength of the glass fiber reinforced high-performance concrete with silica fume and nano-silica.

#### III.METHODOLOGY OF PROPOSED SURVEY

Methodology of Glass fibers Reinforced Concrete:

The methodology for incorporating Glass fibers into concrete involves several key steps to ensure the proper reinforcement and enhancement of the concrete properties. Here is a detailed outline of the methodology:

1. Selection of Glass fibers (GF):

Choose Glass fibers that are suitable for reinforcement based on their physical characteristics, such as fiber length, diameter, and aspect ratio.Consider the age of the Glass fibers as it affects the physical properties of the fibers.

2. Treatment of Silica fume & nano Silica:

Treat the Silica fume & nano Silica with appropriate methods to enhance their adhesion to the concrete matrix.

3. Mix Design:

Determine the optimal mix design considering the addition of nano-silica and silica fume in glass fiber concrete to partially replace cement. Adjust the water-cement ratio to accommodate the water retention properties of GFC.

4. Concrete Mixing:

Incorporate treated Glass fibers into the concrete mix gradually to ensure uniform distribution. Use appropriate mixing techniques to prevent fiber clustering and ensure homogeneity.

5. Casting and Curing:

Pour the concrete mixture into molds or formwork as per the construction requirements. Follow standard curing procedures to allow for proper hydration and development of strength.

6. Testing and Evaluation:

Conduct various tests to evaluate the mechanical properties of nano-silica and silica fume in glass fiber concrete to partially replace cement, including compressive strength, flexural strength, tensile strength, fatigue behavior, water absorption, and density.



#### 7. Application in Construction:

Implement nano-silica and silica fume in glass fiber concrete to partially replace cement in construction projects where enhanced mechanical properties are desired. Monitor performance over time to assess durability under different environmental conditions.



Figure 1: Methodology of concrete

Cement (Kg/m <sup>3</sup> )	Fine aggregates (Kg/m <sup>3</sup> )	Coarse aggregates (Kg/m3)	Water content
385	789	1102	158
1	2.04	2.86	0.41

 Table 1: Mix Proportion M35 Normal concrete

Mix-Type	Mix-ID	Cement	Silica Fume	Nano silica	Natural sand	Crushed aggregate	Water	SP	Glass Fiber
0%SF (CC)	Mix-CC	385.00	0	0	789	1102	158	1.54	0
5%SF	Mix-5%SF	365.75	19.25	0	789	1102	158	1.54	0
10%SF	Mix-10%SF	346.50	38.5	0	789	1102	158	1.54	0
15%SF	Mix-15%SF	327.25	57.75	0	789	1102	158	1.54	0
20%SF	Mix-20%SF	308.00	77.00	0	789	1102	158	1.54	0
25%SF	Mix25%SF	288.75	96.25	0	789	1102	158	1.54	0

#### Table 2: Mix Proportion M35 with use Silica Fume

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Mix-ID	Cement	Silica Fume	Nano silica	Natural sand	Crushed aggregate	Water	SP	Glass Fiber
Mix-CC	385	0	0	789	1102	158	1.54	0
Mix-15%SF+2%NS+1%GF	319.55	57.75	7.70	789	1102	158	1.54	3.47
Mix-15%SF+2%NS+2%GF	319.55	57.75	7.70	789	1102	158	1.54	6.93
Mix-15%SF+2%NS+3%GF	319.55	57.75	7.70	789	1102	158	1.54	10.4
Mix-15%SF+2%NS+4%GF	319.55	57.75	7.70	789	1102	158	1.54	13.86

#### Table 3: Mix Proportion M35 with use Nano-Silica & Glass Fiber

Compressive Strength

The experimental results obtained after the curing of 7 days and 28 days are shown in the table 2 & 3 Graph 1 & 2 represent the compressive strength for 7 days & 28 days without Glass fiber and Nano Silica.

The experimental results obtained after the curing of 7 days and 28 days are shown in the table 4 & 5 Graph 3 & 4 represent the compressive strength for 7 days & 28 days with Glass fiber and Nano Silica.

Mould size : 150mm \*150mm \*150mm

## The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica

Table 4: The compressive strength of different percentagesof Silica Fume mixed in concrete without Glass fiber andNano Silica at 7 days

 Table 5: The compressive strength of different percentages

 of Silica Fume mixed in concrete without Glass fiber and

 Nano Silica at 28 days

Mix ID	Compressive Strength (MPa) 7 days		Mix ID	Compressive Strength (I	MPa) 28 days
	26.60			39.70	
Mix-CC	26.75	26.73	Mix-CC	40.10	40.03
	26.85			40.30	
	27.00			40.80	
Mix-5%SF	27.35	27.48	Mix-5%SF	42.55	42.05
	28.10			42.80	
	28.30		Mix-10%SF	43.10	42.57
Mix-10%SF	28.90	28.38		42.50	
	27.95			42.10	
	28.90		Mix-15%SF	42.60	
Mix-15%SF	29.60	29.10		43.60	43.05
	29.10			42.95	
	28.30		Mix-20%SF	42.80	
Mix-20%SF	27.65	27.48		43.10	42.80
	26.50			42.50	
Mix25%SF	25.90		26.07 Mix25%SF	42.45	
	26.45	26.07		41.90	41.87
	25.85			41.25	

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Graph 1: The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica at 7 days Graph 2: The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica at 28 days

Compressive strength compares between normal mix concrete and Glass fiber mix concrete Case 1;- The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica at 7 days (**increase 8.86** %)

0%SF (CC)	Mix-CC
15%SF	Mix-15%SF

26.73 MPa 29.10 MPa

Table 6: The compressive strength of different percentagesof Silica Fume mixed in concrete without Glass fiber andNano Silica at 7 days

Table 7: The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica at 28 days

Mix ID	Compressive Strength (MPa) 7 days		Mix ID	Compressive Strength (N	APa) 28 days
	26.60			39.70	
Mix-CC	26.75	26.73	Mix-CC	40.10	40.03
	26.85			40.30	
	27.40			41.15	
Mix-SNF-1	27.75	27.50	Mix-SNF-1	42.90	42.40
	28.50			43.15	
	28.70			43.45	
Mix-SNF-2	29.30	28.78	Mix-SNF-2	42.85	43.30
	28.35			42.45	1
	29.30		.60 Mix-SNF-3	42.95	
Mix-SNF-3	30.00	29.60		43.95	43.40
	29.50			43.30	
Mix-SNF-4	28.70	27.88		42.10	
	28.05		Mix-SNF-4	42.60	42.77
	26.90			43.60	

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Graph 3: The compressive strength of different percentages of Silica Fume mixed in concrete with Glass fiber and Nano Silica at 7 days Graph 4: The compressive strength of different percentages of Silica Fume mixed in concrete with Glass fiber and Nano Silica at 28 days

43.05MPa

Case 2;- The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber at 28 days (increase 7.54 %)

0%SF (CC)	Mix-CC	40.03 MPa
15%SF	Mix-15%SF	43.05MPa

#### **IV.CONCLUSION**

The following conclusions are made from the study:

- 1. Without reducing the water-cement ratio, the target mean strength of M35 grade concrete can be reached by using nano-silica and silica fume in glass fiber concrete to partially replace cement.
- 2. 35 MPa is typically used for a variety of structural applications.
- 3. Compressive strength compares between normal mix concrete and Glass fiber mix concrete
- 4. Case 1;- The compressive strength of different percentages of Silica Fume mixed in concrete without Glass fiber and Nano Silica at 7 days (increase 8.86 %)

0%	6SF (CC)	Mix-CC	26.73 MPa
15	%SF	Mix-15%SF	29.10 MPa
5.	Case 2;- The co	ompressive strength of different percentages of	Silica Fume mixed in concrete without Glass fiber at
	28 days (increa	ase 7.54 %)	
0%	SF (CC)	Mix-CC	40.03 MPa

0%SF (CC)	Mix-CC
15%SF	Mix-15%SF

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