

# AN INVESTIGATION IN TO THE BEHAVIOUR OF SIFCON INCORPORATING LOW TENSILE STRTENGHT STEEL FIBRE

<sup>1</sup>Shikha Singh, <sup>2</sup>Supriya Pandey  
<sup>1</sup>Research Scholar, <sup>2</sup>Assistant Professor  
Suyash Institute of Information Technology  
Gorakhpur, India-273001

**ABSTRACT** - Slurry Infiltrated Fibre Concrete - that's what SIFCON means. Not just another mix, this type of fibre concrete holds way more fibres than usual. From five up to twenty percent of the space inside a block can be fibre, unlike regular FRC. Regular versions top out around two to five percent due to clumping issues. More strands packed in mean less empty gaps when built. Durability jumps sharply because of how tightly woven the interior becomes. Wear-heavy spots handle stress better thanks to its tough makeup. High fibre levels create a stretchable yet firm structure underneath. Performance under constant rubbing or impact improves noticeably. Thick layers resist breakdown far longer than standard types do. Even though it carries no structural load because applied in minimal thickness. This study tested steel fiber at 6%, 12%, and 18% by volume using concrete cubes measuring 150 mm on each side, aiming to measure strength while comparing results against SIFCON made by swapping part of the cement with finely crushed glass. What sets glass apart is its amorphous nature - brittle, rigid, often see-through - crafted through melting raw components where silicates and silica blend together along with soda and lime. Since discarded glass holds abundant silica, reducing it into ultrafine dust allows it to interact with alkaline compounds found in cement, forming a binding substance that adds to overall durability. For this experiment, portions of cement were substituted with glass powder at levels of 5%, 10%, 15%, and 20%.

**Keywords**—SIFCON, Flexural strength, Glass powder, Compressive strength, Steel fibre, FRC

## 1. INTRODUCTION

One way to make strong concrete involves filling a mesh of fibers with wet cement mix - people call it slurry infiltrated fibrous concrete. A person named Haynes came up with this idea back in 1968. Later on, Lankard took what Haynes did and changed parts of it during 1979. When more steel fibers go into the mixture, results show much tougher material forms. Concrete like this holds many fibers packed tightly together. More fiber means better performance under stress. Strength jumps when the amount of fiber grows inside the structure. What happens is workers set fibers in place before anything else. After placing those fibers neatly, they pour liquid cement around them so it seeps through completely.

Fibres go into FRC either during a dry blend or while mixing with water, yet SIFCON works differently - cement slurry gets applied after fibres are already set in place. Unlike regular concrete, coarse stones never show up in SIFCON, though you will find cement, water, steel fibres, and now and then extras like super plasticizers. Fine sand might slip in, along with materials such as ground glass or leftover ash from power plants. Flow improves when super plasticizers enter the mix, making movement through forms easier.

Every ton of Portland cement made sends nearly that much carbon dioxide into the sky. This gas piles up, warming the planet over time. Instead of using only cement, mixing in different binders helps reduce harm. Some substitutes act like cement when mixed with water. Fly ash shows promise, coming from burned coal. Glass dust works too, ground fine enough to react. Blast furnace slag, left over from steel making, also fits the role. Each option cuts emissions just by taking part. Less new cement means fewer fumes released. These materials step in without changing how concrete forms.

Studies lately suggest glass powder works instead of gravel or even replaces cement. From broken windows, drinking glasses, lamps, fluorescent tubes, booze bottles, car shields, jars - waste piles up fast. Cities struggle to store it safely; tossing it causes headaches across regions. Recycling kicks in because letting it pile up just isn't practical anymore.

## 2. MATERIALS USED

### 2.1 Water

Water you can drink goes into mixing cement slurry. Most often, one part water for every three parts cement helps the chemical reaction happen. A bit more slips in just to keep things moving smoothly. That liquid must stay clean, clear of gunk when blending or during hardening. Clean flow keeps strength on track.

### 2.2 Cement

The OPC 43 grade of cement is used in this study. The physical properties of the cement are shown in table 1.

Table 1: Physical properties of cement

S. No.	Characteristics	Standard Results (As per IS Code)	Test Results
1	Initial Setting Time	Minimum 30 Minutes	70
2	Final Setting Time	Maximum 600 Minutes	316
3	Consistency	30%	30%
4	Specific Gravity	3.15	3.157
5	F.M. (Fineness Modulus)	Maximum 10%	7%
6	Compressive Strength	Minimum 43 N/mm <sup>2</sup>	44.5

### 2.3 Steel Fibre

A thin steel thread, one millimeter thick, goes into this work. From nearby shops comes the material - common binding wire repurposed here. Fifty millimeters: that measures each piece cut for testing. Found in Gorakhpur's local markets, the steel strands arrive ready to mix. Steel fiber formed the base material here, its density measured at 7850 kilograms per cubic meter. One millimeter thick strands, drawn from low tensile strength steel, went into these tests. With an aspect ratio set at fifty, each piece got trimmed precisely to fifty millimeters long. Strength peaked at 410 megapascals under maximum pull. Found ready-made in black finish, such fibers often hold steel rebars together when poured into concrete structures.

### 2.4 Fine Aggregates

Fine grains meeting the size range outlined in IS 383:1970's Zone II are selected. Though only material within that classification makes the cut. Because consistency matters when building with such standards. So every batch follows those exact limits.

Fine grains add up to a total of 2.80 while density measures 2.62 times that of water

### 2.5 Admixtures

Water flows better through concrete when super plasticizers join the mix. CICO Plast super HS steps in, cutting how much cement needs to be used. Efficiency sneaks into every batch without asking for attention.

### 2.6 Glass Powder

Most of the broken glass holds plenty of silica. Because of that makeup, once crushed into dust, it begins to interact with alkaline parts in concrete mixtures. This interaction leads to a binding substance forming over time. That new compound adds support to the material's firmness. Researchers chose ultra-fine particles of glass for these tests.

**Table 2: Chemical composition of glass powder**

S. No.	Chemical Compound	Percentage by Mass
1	SiO <sub>2</sub>	67.33
2	Fe <sub>2</sub> O <sub>3</sub>	1.42
3	Al <sub>2</sub> O <sub>3</sub>	2.62
4	CaO	12.45
5	Na <sub>2</sub> O	12.05
6	MgO	2.74
7	K <sub>2</sub> O	0.638
8	SrO	0.016
9	ZnO	0.008
10	P <sub>2</sub> O <sub>5</sub>	0.05
11	CuO	0.009
12	NiO	0.014
13	Cr <sub>2</sub> O <sub>3</sub>	0.022
14	ZrO <sub>2</sub>	0.019
15	TiO <sub>2</sub>	0.157

### 3. TEST PROGRAMME

One batch began with twenty-seven SIFCON cubes, each 150 by 150 by 150 millimeters, made using fiber volumes of 6, 12, and 18 percent - fiber aspect ratio fixed at fifty. Though mix design stuck to a one-to-two cement-sand ratio, testing followed soon after casting. Strength peaked at a certain fiber percentage - that result marked the ideal mix. Where performance topped out, that specific fiber amount defined what counted as optimal. From there, forty-five more cubes plus fifteen prisms took shape, all built using that winning fiber rate.

### 4. FABRICATION, CASTING AND TESTING

A single millimeter thick steel fibre, fifty times longer than it is wide, got scattered inside the mold until reaching the needed amount. Shaking helped settle things while a wet mix of cement flowed on top. Water stayed steady at forty five percent during every test run. Fibers went in without order first, followed by a slow soak of cement and sand mixture spreading through them. A small amount of super plasticizer - just one percent of the cement's weight - was mixed in to make the slurry easier to handle. After a full day had passed, each formed sample emerged from its mold, then spent four weeks soaking in water.

#### 4.1 Flexural Strength Test

Beams sized 150 by 150 by 750 millimeters were chosen for bending tests. Without sudden impact, force began rising slowly till each sample broke apart. Peak value shown on the gauge at time of collapse got written down carefully. How broken surfaces looked after cracking was observed closely afterward. To check how well SIFCON resists bending, pressure came from a single central point instead of two.

Table 3: Flexural strength test for SIFCON

S. No.	Mix Designation	Flexural strength (7 Days)	Flexural Strength (14 Days)	Flexural strength (28 Days)
1	S-6%	4.50	5.60	6.40
2	S-12%	6.25	7.80	9.26
3	S-18%	5.70	7	8.30

As the Flexural strength of SIFCON is recorded maximum at 12% of steel fibre; so it is considered as optimum fibre content.

Table 4: Flexural strength test for SIFCON with glass powder

S. No.	Mix Designation	Flexural strength (7 Days)	Flexural strength (14 Days)	Flexural strength (28 Days)
1	S-0%	6.25	7.80	9.26
2	S-5%	6.45	7.90	9.45
3	S-10%	6.75	8.25	9.60
4	S-15%	7.15	8.60	10
5	S-20%	6.95	8.30	9.75

## 4.2 Compressive Strength Test

A small cube, measuring 150 by 150 by 150 millimeters, gets created for checking how much squeeze it can take. This check happens using a heavy machine powered by fluid force. When we talk about squeezing strength, we mean how well the concrete handles being pushed from both ends. Into the device goes the block, once secured, turning the knob leads to hitting the go switch, then slowly, pressure begins. When cracks show up on the cubes, that reading still gets recorded. Using P divided by A gives the compressive strength value. What matters is how much load was applied over the area. Even damaged samples contribute data points worth keeping

P stands for the force applied, while A refers to one face of the cube. The measurement depends on how much weight presses down across that surface.

Table 5: Compressive strength test for SIFCON

S. No.	Mix Designation	Compressive strength (7 Days)	Compressive strength (14 Days)	Compressive strength (28 Days)
1	S-6%	26.34	32.9	40.3
2	S-12%	35.10	42.2	47.9
3	S-18%	33	38	44.2

Also, here due to the value obtained at 12% level is maximum; thus, it is considered as the optimum fibre content value.

Table 6: Compressive strength test for SIFCON with glass powder

S. No.	Mix Designation	Compressive strength (7 Days)	Compressive strength (14 Days)	Compressive strength (28 Days)
1	S-0%	35.10	42.2	47.9
2	S-5%	40.30	43	48.35
3	S-10%	41.65	44.80	49.20
4	S-15%	44	46.50	50.65
5	S-20%	40.5	42.55	48.60

## 5. CONCLUSION

Based on the study carried out on the strength behaviour of SIFCON the following conclusions are drawn:

### 5.1 Flexural Strength of SIFCON

From the data, flexural strength climbs as more steel fibre is added. Yet above 12 percent, a drop begins to show. Strength peaks right at that point - twelve percent steel fibre delivers the best result. Swapping some cement with glass powder also shifts performance. At first, strength rises until hitting its peak at fifteen percent replacement. Past that level, gains fade away. After four weeks of curing, ten newtons per square millimeter stood out as the top measurement reached.

### 5.2 Flexural Strength of SIFCON

It turns out strength climbs when more fibres are added - up to a point. After that, adding even more fibres makes things weaker instead. Earlier studies saw similar patterns too. The strongest mix showed up at 12 percent steel fibre, hitting 47.9 N/mm<sup>2</sup> once cured for four weeks. Swapping some cement with ground glass has its sweet spot as well. At first, replacing helps. Strength peaks when 15 percent of the material is glass dust. Push past that, and performance drops again. That top mark reached 50.65 N/mm<sup>2</sup> under the same curing time.

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