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Research Paper

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Flexural Behaviour of SIFCON with steel fibre and Replacement of Cement with Glass Powder

Saraswathy[1*], Umamaheswari R.[2]

[1]Dept. of Civil Engineering, Anna university Regional Campus, Madurai, Tamilnadu, India
[2]Dept. of Civil Engineering, University College of Engineering, Dindigul, Tamilnadu, India

[*]*Corresponding Author: saraswathydvns@gmail.com*

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***Abstract*—**Slurry Infiltrated Fibrous Concrete (SIFCON) is a new construction fibrous concrete material of high strength and high-performance concrete. SIFCON consists of volume of fibrous content as 5% to 25%. The fibre network is infiltrated by liquid-based slurry. It is not having Coarse aggregate only have cement, sand and cementitious materials. In this Experimental study the strength properties of SIFCON is investigated. SIFCON is produced with Mortar ratio of 1:1.5 and 2.5%,5%, 7.5% of volume of Steel fibers were used. Here hooked end Stainless steel were used with an aspect ratio of 50 then 20% Glass powder is replaced with weight of Cement. The strength characteristics like Compression test, Spilt Tensile strength and Flexural strength test were evaluated and the results obtained from these tests were compared with M30 Concrete.

Keywords—SIFCON, Steel fiber,Glass Powder.

I. INTRODUCTION

Slurry Infiltrated Fibrous Concrete is one among special type of concrete and recently developed construction material. The matrix is typically consisting of cement slurry or flowing mortar. This research is performed a mechanical test like Compression strength, Split tensile Strength and Flexural strength test. The mortar mix combined of ordinary Portland cement, M sand, steel fibre, Glass powder and super plasticizer. In FRC the fibre content is typically varies from 4% to 20%. The matrix of SIFCON accommodates low viscosity, Cementitious slurry as opposition regular concrete in FRC. These makes the assembly of SIFCON far different from FRC.

The fibre concentration is increased together with fibre aspect ratio (Length/Diameter), it becomes difficult to combine and place these materials. In practice it has been found that the number of fibres must kept fewer than 2% by volume and aspect ratio must be kept less than 100. The glass powder is often utilized in place of cement or within the place of coarse aggregate. The waste Glasses are generated mainly from doors, Windows, Bottles ad Glass containers. during this work Glass powder is employed as a replacement of cement for the percentage of 20 and behaviour of SIFCON is studied.

The matrix is typically consisting of cement slurry or flowing mortar. SIFCON was applied in areas where high ductility and resistance impact are needed. To realize uniform fibre distribution small length of fibres are used. The short fibres are preplaced within the mould to its full capacity or to the required volume fraction thus forming the network. To enhance the flow characteristics, controlled quantity of super plasticizer also used.

A. AIM AND OBJECTIVE OF THE STUDY

Aim of the present work is to investigate the strength and behavioral characteristics of SIFCON using M sand and replacement of cement with Glass powder.
The objective of this experimental study is to evaluate the mechanical properties of SIFCON the following are the objectives are categorized in this study

- To make more strength.
- Develop suitable Mix design.
- Increase fatigue, impact and absorption resistance.
- To study the compatibility of fibers in obtain a high strength concrete.
- To study Compression, Tensile and Flexural characteristics of SIFCON.

B. NEED FOR PRESENT STUDY

In SIFCON the desired volume of fibers are first placed inside the mould then the slurry poured over the steel fibers. The SIFCON has ability to resists more loads is much superior to traditional reinforced concrete. SIFCON was used within the application of pavement, Bridge repair works and defense structures.

II. LITERATURE REVIEW

Rakesh kumar chaudhary, R.D.Patel, had conducted Experimental investigation of SIFCON with Low tensile steel fibres. The steel fibres are used 6%,12% and 18% by volume to found out the optimum strength and compare it with strength of SIFCON produced by partial replacement

of cement with Glass powder.The Replacement of glass podwer initially increases the strength and become 15% of glass powder beyond which compressive strength decreases..

B.D.Elavarasi,K. Saravana Raja Mohan (2016), had conducted Experimental program of SIFCON contain 10% of fiber content with different percentages of Silica fume (5%,10%,15%,20% and 25%) partially replaced by cement on compressive strength and split tensile strength. The optimum strength obtained at 15% of replacement of Silica fume. Silica fume improves the consistency and workability of fresh slurry, because an extra capacity of fineness is added to the mixture. Silica fume modify the micro structure of concrete and reduce its voids thereby increasing the load carrying capacity.

C.M.Vijaya kumar, P.Dinesh Kumar (2017), had carried of investigation study of SIFCON with glass powder. The analysis provides information about strength characteristics of SIFCON, SIFCON resists the abnormal loads and earthquake loads. Here straight end stainless steel fiber and E type Glass fiber is used with different volume of fraction of 6%,8%,10% and 12% were used in the mortar ratio of 1:1.5:0.5, the compressive strength of SIFCON is increased 26% when compared with M30 concrete. The usages of steel fibers and glass fiber increasing the tensile and flexural strength of concrete by 28.73%

III. METHODOLOGY

The matrix of SIFCON has no coarse aggregate, but high cementitious content. The slurry must be properly penetrating within the fibers placed into the mould since otherwise large pores may form and it reduce the SIFCON properties. The Experimental study is to analyses the strength properties of SIFCON with various Percentage of Steel fiber. The methodology includes,

1. Collection of Literature review
2. Collection of Materials
3. Testing of Materials
4. Casting of SIFCON Specimen
5. Testing of SIFCON specimen
6. Result and Analysis.

MATERIALS USED

The Process of making SIFCON consider different materials such as Cement, Fine aggregate, Glass powder, Steel fiber and conplast sp-430.

A. CEMENT

Ordinary Portland cement 53 grade is used with specific gravity of 3.10 and fineness of cement is 2.33%. The initial and final setting time is 35 minutes and 480 minutes.

B. FINE AGGREGATE

Clean and dry M-Sand passing through 1.18mm Sieve conforming to IS:383-1970 used as Fine Aggregate. Specific gravity is 2.63 and Fineness modulus is 2.9.

C. GLASS POWDER

Waste Glass contain high Silica due to which glass is ground to powder react with alkalis in cement and form the cementitious product that help in strength contribution. Crushed glass powder used in this study.

Table 1: Chemical Properties of Glass powder

Sl. No	Chemical Properties of Glass Powder	% by Mass
1	Si_2	67.33
2	Al_2O_3	2.62
3	Fe_2O_3	1.42
4	Tio_3	0.157
5	CaO	12.45
6	MgO	2.732
7	Na_2O	12.05

Fig 1 – Glass Powder

D. STEEL FIBER

Stainless steel fiber of Diameter 1mm and length 50mm is used for this Experimental work. The Hooked end steel fiber is purchased from Jeetmull Jaichand lal Madras pvt Ltd, Chennai.

Table 2: Properties of Steel Fibers

Sl. No	Parameter	Capability
1	Shape	Hooked End
2	Diameter	1mm
3	Length	50mm
4	Aspect ratio	50
5	Density	7800kg/mm²
6	Tensile Strength	1100 MPA

Fig 2 : Glass fibers

E. WATER

Water play a very important role in concrete. Hydration of concrete depends on water. Hence the Quantity and Quality of water is required to be looked into very carefully. In this work clean portable water is used.

F. SUPER PLASICIZER

The Super Plasticizer utilized in this study is Conplast SP-430 to increase the workability of concrete. Super plasticizer makes possible to produce the mix with relatively lower cement content.

IV. MIX PROPORTION

The Three SIFCON mixes are used with mortar ratio of 1:1.5 such as Cement, Fine aggregate. The water cement ratio is 0.4. Different specimens are taken with variation of Steel fiber content. The strength characteristics like Compressive strength test, Spilt Tensile strength test and Flexural strength tests are evaluated. The specimens are casted and test were carried out after 7 days and 28 days of curing.

Cement and Fine aggregate: 1:1.5
Glass Powder : 20% by Weight of cement
Steel fiber : 2.5%,5%,7.5%.
Water cement ratio : 0.4

Table 3: SIFCON Mix Proportion

Mix id	Mix Proportion	Cement Kg/m³	Fine aggregate kg/m³	Coarse aggregate kg/m³	Glass powder kg/m³	Steel Fibre Kg/m³	W/c ratio
CC	1:1.3:2.36	456	638	1080	-	-	0.42
SIF2.5%	1:1.5	957	1435	-	191.4	195	0.4
SIF5%	1:1.5	957	1435	-	191.4	390	0.4
SIF7.5%	1:1.5	957	1435	-	191.4	585	0.4

A. CASTING AND CURING OF SPECIMEN

The SIFCON specimens were casted and compared with conventional reinforced concrete of grade M30. In this present work different specimens such as Cubes, Cylinders and prisms were casted. The Fibers are dispersed in a random manner to the volume of fraction. The slurry consists of cement, Sand mixed in the proportion of 1:1.5. Glass powder is equal to 20% by weight of cement was used. In this experimental work the strength of hardened concrete is determined.All the specimens were prepared with IS recommendation.Moulds are allowed to dried for 24 Hours and then hardened specimens are remoulded and kept in water for 28 days.

V. RESULT AND DISSCUSSION

A. COMPRESSIVE STRENGTH

The Compressive strength test was conducted on Cubes of size 150X150X150 mm for 7 days and 28 days of curing as per IS 516:1959. The test was done on hydraulic compressive testing machine. The bearing surface of the specimen is wiped clean and cubes is placed in the machine in such manner that the load is applied to side of cube as cast.

Table 4: Compressive strength Test Results

Mix Designation	Average Compressive strength at 7 days in N/mm²	Average Compressive Strength at 28days in N/mm₂
CC	24.29	34.7
SIF2.5%	33.25	47.5
SIF5%	34.31	49.02
SIF7.5%	34.06	48.66

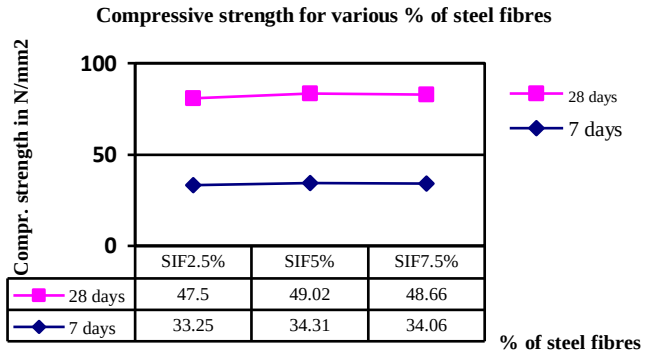

Fig 3. Testing of SIFCON Cube

B. *SPLIT TENSILE STRENGTH*

Split Tensile strength test was carried out on specimens of size 150mm diameter and 300mm height. The cylindrical shape specimen consists of a different percentage of steel fibres to specify the tensile strength of cylinders. Curing time was 7days and 28 days.

Table 5: Tensile strength Test results

Mix Designation	Average Tensile strength at 7days in N/mm²	Average Tensile strength at 28 days in N/mm²
CC	2.6	3.68
SIF2.5%	3.633	5.19
SIF5%	7.19	10.28
SIF7.5%	6.22	8.89

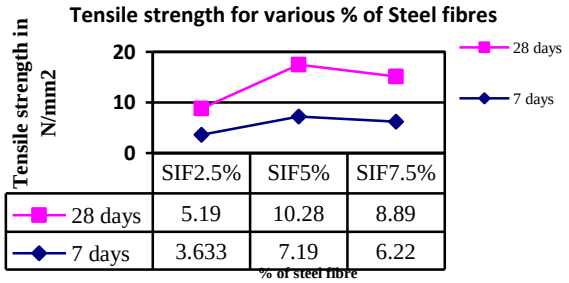

Fig 4. Testing of SIFCON Cylinder

C. FLEXURAL STRENGTH TEST

Flexural Strength was carried out on Prismatic specimen of size 100X100X500mm using Universal Testing machine as per IS 519:1959. The load was applied then increased up to the specimen failure.

Table 6: Flexural Strength Results

Mix Designation	Average Flexural strength at 7 days in N/mm²	Average Flexural strength at 28 days in N/mm²
CC	4.67	6.67
SIF2.5%	7.31	10.45
SIF5%	13.44	19.2
SIF7.5%	9.83	14.05

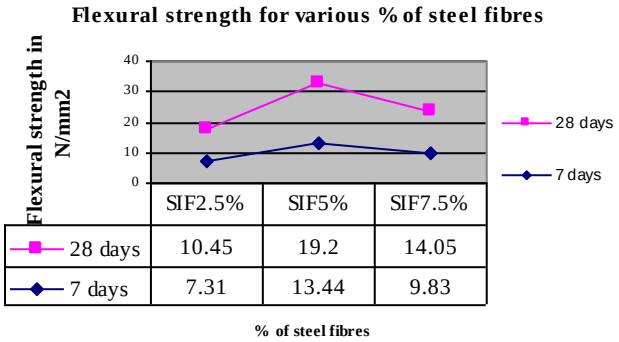

Fig 5. Testing of SIFCON Prism

VI. CONCLUSION

Based on the Experimental investigation the strength behaviour of SIFCON the following conclusion are drawn:

A. SIFCON IN COMPRESSION

It is observed that compressive strength increases with addition of steel fibres to certain limit beyond which compressive strength decreases. The optimum strength is achieved by 5% fibre which is 49.02N/mm² after 28 days curing. Percentage of increase strength is 41.26% when compared to conventional M30 concrete.

B. TENSILE STRENGTH OF SIFCON

From the Result it can be concluded that Tensile strength also increases with increase in percentage of steel fibre. Hence optimum strength is achieved at 5% of steel fibre. The maximum tensile strength was recorded as 10.28 N/mm². The percentage of increase strength is 76.5% compared to M30 concrete.

C. FLEXURAL STRENGTH OF SIFCON

It is observed that Flexural strength also increases with increase of steel fibres. The additional of steel fibre contribute the flexural strength up to a certain limit beyond 5% of steel fibre flexural strength decreases. The optimum strength achieved at 5%. The maximum flexural strength was recorded as 19.2 N/mm² after 28 days of curing.

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