Flexural And Direct Tensile Behavior of Slurry Infiltrated Fibre Reinforced Concrete(Sifcon)

Palani Mohan V[1], Dharmaraju G[2], Anand Raj G[3], Pon Balakumar S[4], Sarvana Karthika V[5]
[1, 2, 3, 4] Dept of Civil Engineering
[5]Assistant Professor, Dept of Civil Engineering
[1, 2, 3, 4, 5] Easwari Engineering College, Chennai 600089 India

Abstract- *Slurry infiltrated fibre reinforced concrete (SIFCON) is recently developed construction material. It can be rightly thought as pre placed fibre concrete, analogous to pre placed aggregate concrete. In fibre reinforced concrete (FRC), the fibres are mixed along with the other ingredients maximum of two percent volume but the placement of steel fibres in a form or mould is the initial step in the preparation of SIFCON could be considered as a special type of fibre concrete with high fibre content up to 20 percent of volume. The matrix consists of cement slurry of flowing cement mortar. This material has been used for repair of pre-stressed concrete beams, security vaults, bridge deck rehabilitation, pavement rehabilitation, refractory application, subjected to blast loading etc. Because of its high strengths, excellent energy absorption, ample stiffness and many other good properties, pre-cast SIFCON slabs will have a wide range of structural engineering applications where high energy elements are required. This study's main objective is to find out the mechanical properties of SIFCON for various types of volume fraction of micro steel fibres. The aim of present investigation is to study the flexural and direct tensile behaviour of Slurry Infiltrated Fibre Reinforced Concrete (SIFCON). The matrix in SIFCON has no coarse aggregates, but a high cementitious content. If percentage of steel fibres in cement matrix could be increased, one could get a material with very high strength properties which can be called as SIFCON.*

Keywords- SIFCON, Cement, Micro steel fiber, Direct Tensile strength, Flexural strength.

I. INTRODUCTION

SIFCON is unique construction material possessing high strength as well as large ductility and far excellent potential for structural applications when accidental (or) abnormal loads are encountered during services SIFCON also exhibit new behavioral phenomenon, that of “Fiber lock” which believed to be responsible for its outstanding stress-strain properties. The matrix in SIFCON has no coarse aggregates, but a high cementitious content. However, it may contain fine (or) coarse sand and additives such as fly ash, micro silica and latex emulsions. The matrix fineness must be designed so as to properly infiltrate the fiber network placed in moulds, since otherwise, large pores may form leading to substantial reduction in properties. A controlled quantity of high range water reducing admixtures (super plasticizer) may be used for improving flowing characteristics of SIFCON. All steel fiber types namely straight, hooked and crimped can be used. The fibers are subjected to frictional and mechanical interlock in addition to the bond with the matrix. The matrix plays the role of transferring the forces between fibers by shear, but also acts as bearing to keep fibers interlock. Proportions of cement and sand generally used for making SIFCON are 1:1, 1:1.5 (or) 1:2 cement slurry alone have some applications. Generally, fly ash (or) silica fume equal to 10 to 15% by weight of cement is used in mix. Water cement ratio varies between 0.3 to 0.4. Percentage of super plasticizers varies from 2 to 5% by weight of cement. The percentage of fibers by volume can be anywhere from 4 to 20% even though the current practical ranges from 4 to 12%. The process of making SIFCON is different, because of high steel fiber content. While in SFRC the steel fibers are mixed intimately with wet (or) dry mix of concrete, prior to mix being poured into forms. SIFCON is made by infiltrating low viscosity cement slurry in to a bed of steel fibers “pre packed” in forms (or) moulds.

II. LITERATURE REVIEW

M. Vijayakumar et al., investigated strength properties of SIFCON. The efficiency of SIFCON affected by fiber alignment, slurry strength, fiber volume, fiber type. Energy absorption capacity, durability, toughness, abrasion resistance and impact value of SIFCON high. Compressive strength of SIFCON mixes increasing the percentage volume of fiber. Tensile strength of SIFCON is higher than M30 grade concrete. Flexural strength of SIFCON is 5.5 N/mm^2 for using 12% volume fraction of steel fiber. If using 14% of steel fiber this value also getting increase, so economy purpose and structural adequacy 12% of steel fiber safer side adopted and tested. **B. Vidivelli et al.,** investigated mechanical and durability properties of concrete with GGBS and steel fiber. Cube specimen 150mm. The replacement materials of GGBS

20% by volume of cement & steel fiber use 1% by volume of cement. Conplast SP-430 is used for maintaining workability. Strength of concrete specimens were tested at 28 days, 56days and 90days. They used OPC-53 grade cement, GGBS, fine aggregate, course aggregate, steel fiber, chemical admixture and water. Hooked end type of steel fiber is used. Aspect ratio is 50. The study on the effect of steel fiber with GGBS. Can still be a promising work as there is always a need to overcome the problem of weakness of concrete.**Akshay et al.,** investigated effects of replacement of metakaolin with cement on the mechanical properties of SIFCON. The volume of fibers 2%, 3% and 4% of concrete. The metakaolin at 5% and 7.5% by weight of cement replacement. The compressive strength, flexural test and split tension strength of SIFCON specimen were tested after 7 and 28 days of curing. Fiber addition result s in more closely spaced cracks reducing the cracks width and improved resistance to the cracks.

III. MATERIAL COLLECTION AND TESTING

The materials required for the project are cement, sand, silica fume and super plasticizer to produce cement slurry. The preliminary testing on these materials are done.

Properties of cement:

- Grade of cement = OPC (53 Grade)
- Specific gravity of cement = 3.125
- Normal consistency of cement = 32%
- Initial setting time = 35mins
- Final setting time = 450mins
- Fineness of cement= 94%
- Specific gravity of river sand = 2.75
- Specific gravity of silica fume = 2.28

Properties of micro steel fibre:

- Type of Micro steel fibre = crimped fibre
- Density of Micro steel fibre = 7.8 gm/cm^3
- Diameter of Micro steel fibre = 0.5mm
- Length of Micro steel fibre = 12.5mm
- Aspect ratio = 25

Fig 1: Micro steel fibre

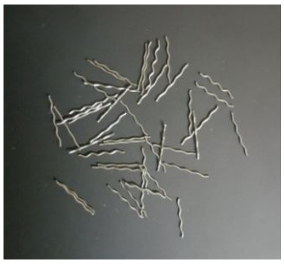

Fig 2: crimped type

Micro steel fibre

IV. MIX PROPORTION

Mix proportions of cement slurry:

Cement sand ratio = 1:1
Silica Fume = 10%
Poly carboxyl ether (superplasticizer) = 0.8%
Water cement ratio = 0.35

Fig 3: mixing of cement slurry

V. EXPERIMENTAL PROGRAM

Preparation of the Mould:

The compressive strength of the concrete was determined by cubes of size 40mmx40mmx40mm. So the mould of such size prepared with water tight and oil applied to ease of demoulding before casting of concrete. For flexural strength, beam specimen of dimensions 40mmx40mmx160mm was used. For tensile strength I-shaped specimen were used.

The process of making SIFCON is different, because of high steel fiber content. While in SFRC (Steel Fiber Reinforced Concrete), (or) dry mix of concrete, prior to mix being poured into forms. SIFCON is made by infiltrating low viscosity cement slurry in to a bed of steel fibers “pre packed” in forms (or) moulds.

Step1: steel fibers are preplaced in the mould.
Step2: Cement, sand, fly ash is weighted and mixed with water, superplasticizer for making slurry.
Step3: Concrete is poured into the mould.

Demoulding

The cube specimens are demoulded after 24 hours from the process of moulding. If the concrete has not achieved sufficient strength to enable demoulding the beam specimens, then the process must be delayed for another 24 hours' care should be taken not to damage the specimen during the process because, if any damage is caused, the strength of the concrete may get reduced. After demoulding, specimen is marked with a legible identification, on any of the faces by using paint.

Curing

After demoulding of specimen, the cubes are placed inside the water tank.

VI. RESULTS AND DISCUSSIONS

The details of the experimental investigations carried out on the test specimens to study the mechanical properties of SIFCON. The strength related tests were carried out on hardened SIFCON concrete for 28 days to ascertain the strength related properties such as cube compressive, cylinder compressive strength, flexural strength.

Compressive strength:

The tests were carried out at a uniform stress after the specimen has been centered in the testing machine. Loading was continued till the dial gauge needle just reverses its direction of motion.

The reversal in the directions of motion of the needle indicates that the specimen has failed. The dial reading at the instant was noted, which is the ultimate load. The ultimate load divided by the cross section area of the specimen is equal to the ultimate cube compressive strength. The compressive strength of SIFCON mixes and M30 concrete are presented in Figure 2.

Compressive strength = load / area (N/mm2)

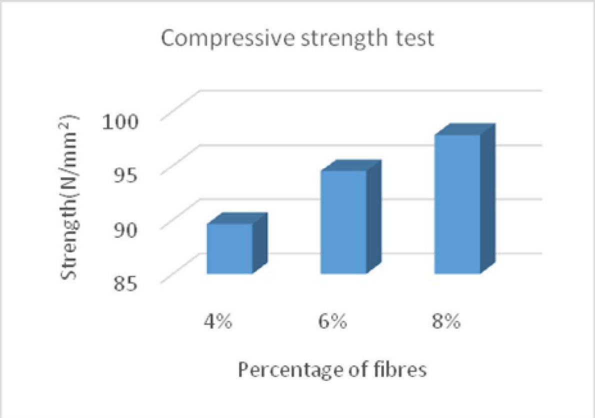

Fig 4: 28 day compressive strength of specimen

Flexural strength:

The test is carried out by placing a prism specimen in a compression testing machine and load is applied until failure of the prism. The two-point loading method is applied for finding the flexural strength of the specimens.

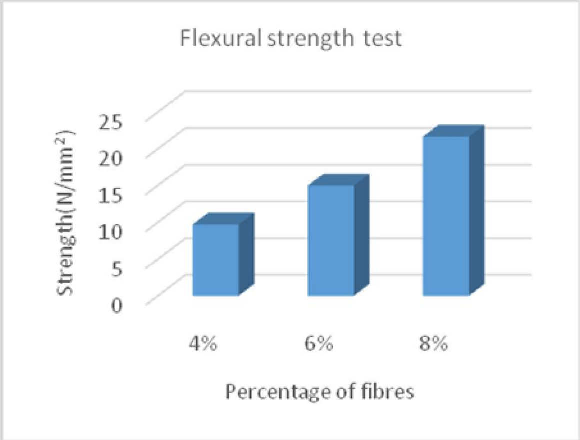

Fig 5: 28 day flexural strength of speimen

Direct tensile strength:

The test is carried out by placing a I-shaped specimen in a tensile testing machine and load is applied until failure of the specimen.

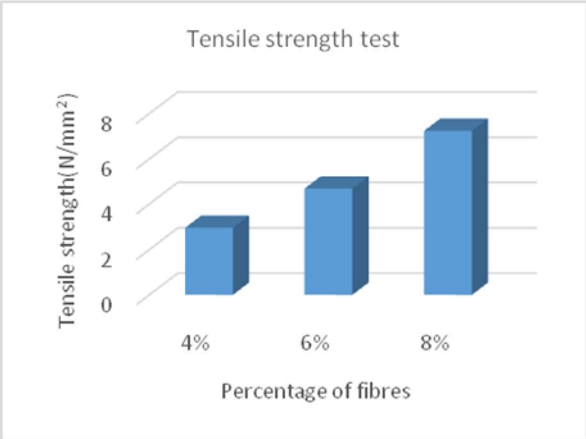

Fig 6: 28 day direct tensile strength of speimen

VII. CONCLUSION

From the test results the following conclusions are made:

- The compressive strengthhave little effect on adding the fibres.
- The Flexure strength increases up to 55% for specimen with 8% fibre content when compared with the specimen containing 4% fibre and 30% when compared with the specimen containing 6% fibre.
- The Direct tensile strength increases up to 60% for specimen with 8% fibre content when compared with the specimen containing 4% fibre and 40% when compared with the specimen containing 6% fibre.
- From the test results it is obtained that, the optimum percentage of fibre is 8%.

REFERENCES

[1] Azoom K T, "punching strength and impact resistance study of SIFCON with different fibers," *International Journal of Science technology & Engineering*, Volume 8, Issue 4, April 2017, pp. 1123–1131

[2] m.vijayakumar, p.dineshkumar, " study on strength properties of SIFCON," *International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 01 | Jan -2017*

[3] Olutoge F. A., Ofuyatan O. M, Olowofoyeku O. A. , Bamigboye G., and Busari A, " strength properties of slurry infiltrated fibrous concrete (SIFCON) produced with discrete bamboo and steel fibers" *ARPN Journal of Engineering and Applied Sciences ISSN 1819-6608VOL. 11, NO. 23, DECEMBER 2016*

[4] B Vidivelli, D. Dhanalakshmi and T Subbulakshmi, "study on mechanical and durability properties of concrete with GGBS and steel fiber," *International Journal of Science technology & Engineering ISSN 2319-5991 www.ijerst.com Vol. 5, No. 3, August 2016.*

[5] V. Prathima and Dr. T. Suresh Babu, "comparative analysis of compressive strength and stress-strain behavior of SIFCON with Ferro cement," in *International Journal of Emerging Technologies in Engineering Research (IJETER) Volume 4, Issue 8, August (2016).*

[6] Olufemi S. Awogboro, Oladipupo S. Olafusi, Festus A. Olutoge, Isaac B. Oni, "flexural strength properties of slurry infiltrated fibrous concrete (SIFCON) beams using miraculous berry fiber as reinforcement International Journal of Scientific & Engineering Research, Volume 6, Issue 11, November-2015 ISSN 2229-5518

[7] Mr. Vinayaka N.M, Sahana.N.S, Sandeep.S.S, Nagaraju.C, Syed Shahbaz, "an experimental investigation on SIFCON using mono fibers " *International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online) Vol. 3, Issue 1, pp: (267-272), Month: April 2015 - September 2015*

[8] R.Giridhar, P. Rama Mohana Rao , "determination of mechanical properties of slurry infiltrated concrete (SIFCON) ," in *International Journal For Technological Research In Engineering Volume 2, Issue 7, March-2015 ISSN (Online): 2347 - 4718*

[9] Niveditha.A, S.Manivel, "effects of partial replacement of cement by metakaolin in SIFCON ," *Volume-4, Issue-2, April-2014, ISSN No.: 2250-0758 International Journal of Engineering and Management Research*

[10] Jayashree.S.M, R. Rakul Bharatwaj, Helen Santhi.M, "dynamic response of a space framed structure subjected to blast load," *international journal of civil and structural engineering Volume 4, No 1, 2013*

[11]. H Sudarsana Rao and N V Ramana, " behavior of SIFCON simply supported beam in flexure" Indian journal of engineering and material sciences, vol.12 October 2005 pp.427-433.

[12] M. Sonebi, L. Svermova and P. J. M. Bartos, "statistical modelling of cement slurries for self-compacting SIFCON containing silica fume" *Materials' and Structures 38 (January-February 2005) 79-86*

[13] K. Marchand, P. Nash, P. Cox, "tests and analysis of the localized response of slurry infiltrated fiber concrete (SIFCON) and conventional reinforced concrete (crc) subjected to blast and fragment loading," *HAL Id: jpa-00227770 https://hal.archives-ouvertes.fr/jpa-00227770 Submitted on 1 Jan 1988*