EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF SIFCON

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***Abstract*: There are many new type of concrete that are being introduced to increase the strength of the concrete. In such case SIFCON, Slurry Infiltrated Fibre Reinforced Concrete is also new type of concrete. This SIFCON is a new method to increase the strength of concrete. In this study, the mechanical properties of SIFCON members are evaluated and they are compared with conventional concrete of grade M40. The cement based slurry used in this study is a composition of cement, fly ash, silica fume, Ground Granulated Blast Furnace Slag. From the results obtained it was found that SIFCON members are much better than conventional concrete. The stress strain curve for conventional concrete and SIFCON specimens were also plotted. Thus this study shows that SIFCON can be used as an effective alternative in special concreting purposes or where the concrete or conventional SFRC cannot perform as expected/required or in situations where such high strength is required.**

***Keywords*: SIFCON, Mechanical Properties, fly ash, silica fume, Ground Granulated Blast Furnace Slag, steel fibre.**

I. INTRODUCTION

SIFCON is a new method to increase the strength of concrete. SIFCON is incorporated by using some amount of steel fibre in mould to form very dense network of fibre. The network is then infiltrated with cement based slurry or mortar. As the fibre concentration is increased along with fibre aspect ratio(length/diameter), it becomes difficult to mix and place these materials. In practice it has been found that the amount of fibre must be kept fewer than 2% volume and aspect ratio must be kept under 100. This situation places bounds on their improvements in the engineering properties of concrete (flexural strength, flexural toughness index, impact resistance and fatigue resistance) that can be gained through the use of steel fibres. In 1978, Lankard began an investigation to incorporate larger amounts of steel fibres in steel fibre reinforced cement based composites. The result of this investigation led to the development of

new cement composite called "Slurry Infiltrated Fibre Concrete (SIFCON)" in which steel fibres up to 20% by volume could be used. Yazici et al., studied the effect of incorporating high volume of class C fly ash on mechanical properties of the SIFCON and concluded that by increase in the fibre volume remarkably increases flexural strength and toughness of SIFCON. Sharma H.K et al. studied the structural optimization and performance of SIFCON plates with an optimum fibre volume fraction of 8%. Sundarsana Rao et al. tested the SIFCON slab elements under flexure and compared the results with FRC and PCC slabs and concluded that SIFCON slabs exhibit superior performance in flexure when compared to FRC and PCC slabs. However, literature review reveals that a very little work has been carried out on SIFCON without sand. The main aim of this project is to study the mechanical properties of SIFCON by using cementitious materials like fly ash, silica fume, GGBS. Moreover, the usage of very high amounts of cement not only affects the economy of construction, but also has negative effects on the heat of hydration and may cause shrinkage problems. The use of supplementary cementitious materials seems to feasible solution to overcome these problems.

II. EXPERIMENTAL PROGRAM

The experimental work was carried out by casting cubes of size 150 x 150 x 150mm to find the compressive strength and prism of size 100mm x 100mm x 500mm to find the flexural strength and cylinder of 100mm diameter and 200mm height were casted to obtain the stress strain curve. The SIFCON specimens (say F1,F2,F3,F4,F5) and without fibre (only slurry, say S1,S2,S3,S4,S5) were casted and compared with the conventional concrete (say C) of grade M40 to study the compressive strength and flexural strength. The edges of the mould were sealed with plaster of paris to prevent the leakage of slurry. The fibre is dispersed in a random manner to the volume fraction.Compaction by table vibrator was used to ensure complete penetration of the slurry into the fibre pack. Twenty four hours after casting, the cubes were demoulded and cured in water for 7 and 28 days.

A. Materials Used

The materials used for Conventional Concrete was, cement, fine aggregate, coarse aggregate and water. The materials used for preparing SIFCON was cement, Mineral admixtures that includes Fly Ash, GGBS and Silica fume, steel fibre, plasticizer and water.

1) Cement

Ordinary Portland cement of 53grade conforming to IS: 12269 were used. The specific gravity of cement was found to be 3. 15.

2) Fine aggregate

Locally available river sand passing through 4.75 mm sieve was used. The specific gravity was found as 2. 71.

3) Supplementary cementitious materials

Silica fume conforming to ASTM C 1240 and ground granulated blast furnace slag conforming to ASTM C 989 and flyash conforming to ASTM C 618 was used. The specific gravity of silica fume, GGBS and flyash was found to be 2. 2, 2. 9 and 2.45 respectively.

4) Coarse aggregate

Coarse aggregate of 20 mm maximum size and typical particle shapes "average and cubic" was used as the coarse aggregate sample.

5) Water

Fresh water available from local sources was used for mixing and curing of specimens.

6) Super plasticizer

To improve the workability of SIFCON, Cera Hyper Plast XR-W40, a high –range water reducing agent has been used.

7) Fibre

- Fibre type : crimped steel fibre
- Section type : Round
- Length : 35mm
- Diameter : 0.65mm
- Aspect ratio : 54
- Tensile strength : 1100 Mpa
- Density : 7.91g/cc

B. Mix proportions

Fibre content of 8% by volume was adopted for SIFCON. Water cement ratio of 0.4 and super plastisizer about 2% was adopted. The slurry consisted of cement, silica fume, fly ash and GGBS. The cement, silica fume, fly ash ratio is 1:0.15:0.5 by weight and GGBS varied from 0.2 to 0.6.The mix ratio adopted for conventional concrete of grade M40 is 1:1.62:2.98 with w/c ratio of 0.4. The following table shows the mix proportion of and SIFCON.

TABLE 1
MIX PROPORTION FOR SIFCON

Specimens	Materials used				Fibre	W/C	SP
	Cement	Silica fume	Fly ash	GBBS			
F1	1	0.15	0.5	0.2	8%	0.4	2%
F2	1	0.15	0.5	0.3	8%	0.4	2%
F3	1	0.15	0.5	0.4	8%	0.4	2%
F4	1	0.15	0.5	0.5	8%	0.4	2%
F5	1	0.15	0.5	0.6	8%	0.4	2%
S1	1	0.15	0.5	0.2	-	0.4	-
S2	1	0.15	0.5	0.3	-	0.4	-
S3	1	0.15	0.5	0.4	-	0.4	-
S4	1	0.15	0.5	0.5	-	0.4	-
S5	1	0.15	0.5	0.6	-	0.4	-

III. TEST RESULTS AND DISCUSSION

C. Compressive Strength

The compressive strength of the specimens was tested with the universal testing machine of capacity 1000kN. The following graph shows the comparison of average compressive strength of the SIFCON specimens, SIFCON specimens

without fibre and conventional concrete at 7 and 28 days respectively.

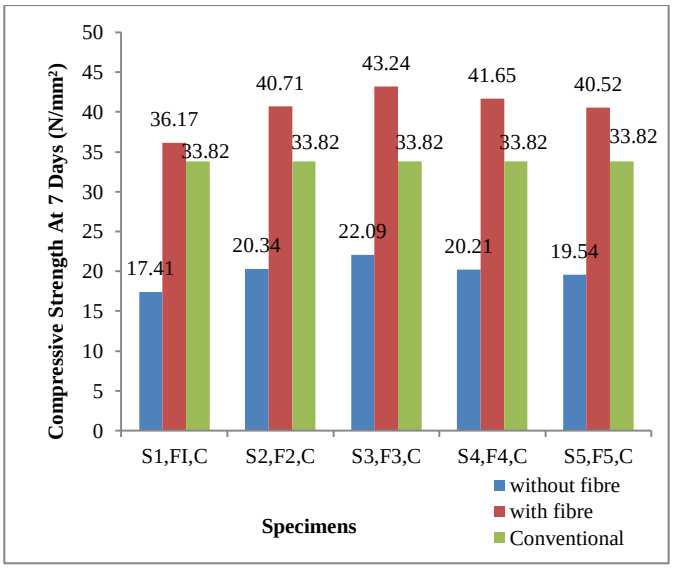

Fig.1 Comparison of compressive strength of the specimens at 7 days

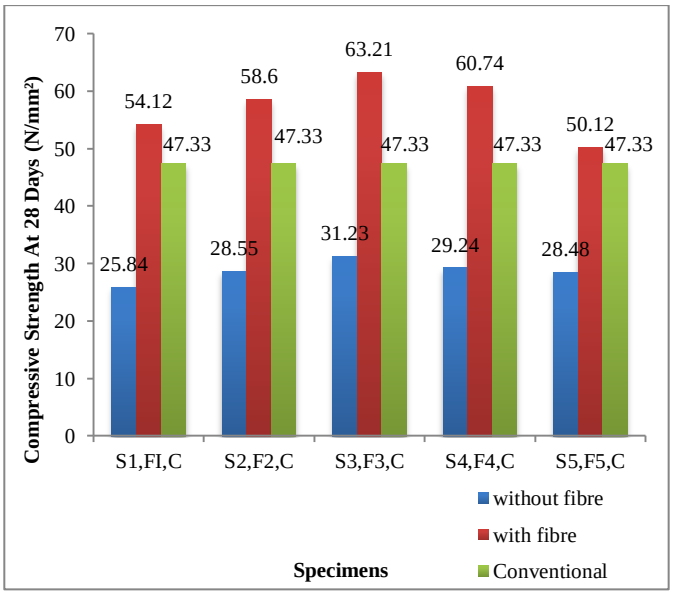

Fig.2 Comparison of compressive strength of the specimens at 28 days

D. Flexural strength

The flexural strength of the specimens was found at 28 days. The following graph shows the comparison of the average flexural strength of SIFCON specimen, SIFCON specimen without fibre and conventional concrete.

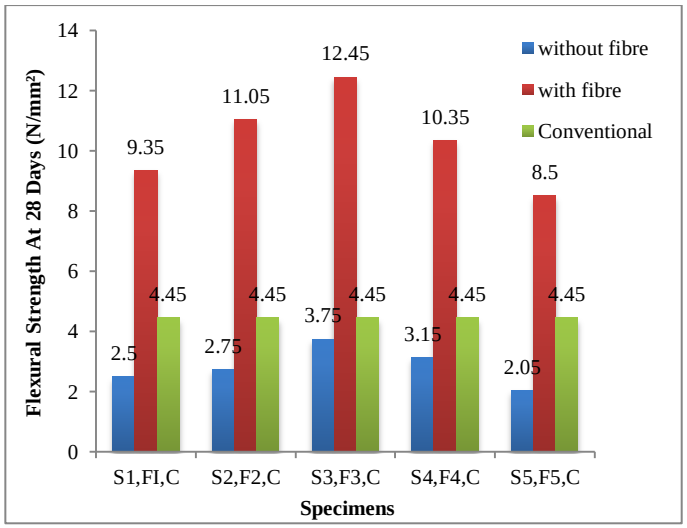

Fig.3 Comparison of flexural strength of the specimens at 28 days.

E. Stress strain curve for cylinder

The stress strain curve is obtained for SIFCON cylinders at 28 days by using compressometer in Universal testing machine having a capacity of 1000kN. The stress strain curve for conventional concrete also tested at 28 days and plotted in the following graph.

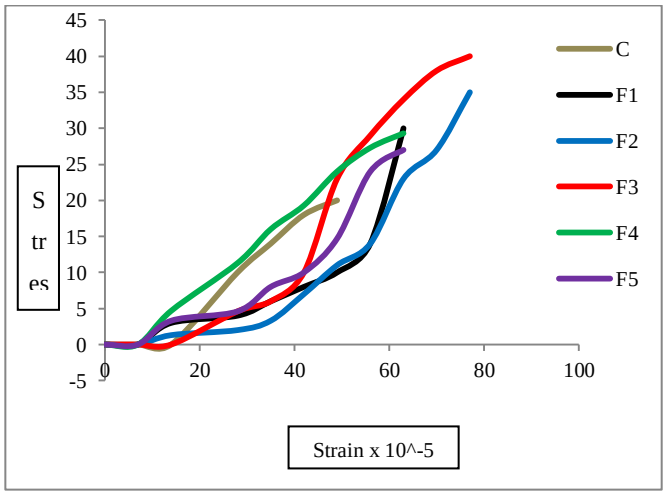

Fig.4 Comparison of Stress Strain Curve of SIFCON with conventional Mix M40

CONCLUSION

From the experimental study of SIFCON, the following conclusion is drawn.

- The compressive strength & Flexural strength of SIFCON specimen with fibre is found to be greater than SIFCON specimen without fibre and conventional concrete.
- The mix F3 (1:0.15:0.5:0.4) was found to be optimum with increase in compressive strength of 33% more than more than conventional concrete.
- The optimum usage of GGBS in SIFCON was inferred as 40%. When the percentage of GGBS is increased more than 40% a significant reduction in strength is noted.
- From the stress strain curve of the SIFCON mix it was found that the SIFCON specimen with fibre shows greater resistance to deflection and obeys Hooke's law.
- The modulus of elasticity of SIFCON mix was found as 9.6 x 10^5 N/mm² which is higher than conventional concrete.
- Hence SIFCON with its improved properties than the conventional concrete can be used as an effective alternative in special concreting purposes or were the conventional concrete does not meet the requirement.

REFERENCES

1] Chang Lin, ObadaKayali, Evgeny.V&David.J, *Integrated Plain And Slurry Infiltrated Fibre Concrete (IP-SIFCON)* Composite Beams,16th International Conference on Composite Structures, Vol-8, pp-16, (2011)

2] HalitYazici, SerdarAydin, GirayAlptuna, *Improvement on SIFCON Performance by Fibre Orientation and High Volume Mineral Admixtures*, Journal of Materials In Civil Engineering, ASME, Vol-22, pp:1093-1101,(2010)

3] Kuldeep Dagar, *Slurry Infiltrated Fibre Concrete (SIFCON)*, International Journal of Applied Engineering and technology, Vol-2(2), pp:99,100, (2012)

4] Lankard D.R.1984. *Properties of slurry infiltrated fibrous concrete (SIFCON*), International journal of applied engineering and tecnology, 29, 44-48.

5] Niveditha.A, Manivel.S, *Effects of Partial Replacement of Cement by Metakaolin in SIFCON*, International Journal of Engineering and Management Research, Vol-4, pp:100-103, (2014).

6] Parameswaran.V.S, krishnamoorthy.T.S, &Balasubramanian, *Studies on Slurry Infiltrated Fibre Concrete*, Transportation Research Record 1382, SERC chennai, (2008),

7] Sharma.H.K&Singh.V.P, *Performance Characteristics SIFCON Plates*7th WSEAS Int. Conf. on Applied Computer & Applied Computational,Vol-8, pp: 6,8, (2008).

8] SudarsanaRao.H, Vaishali.G.Ghorpade, Ramana.N.V, Gnaneswar.k, *Response of SIFCON two way Slabs under Impact Loading*,International Journal of Impact Engineering, Vol-37, pp:452-458.

9] Tamilselvi.P, DevadasManoharan.P, *Study of Behaviour of Concrete Frames with Slab Using SIFCON in Beam Column Joints*, Journal of Engineering and Applied Science, Vol-3(1), pp: 104-108, (2008).

10] Thirugnanam.G.S, Balaji.S, *Cyclic Behaviour of Exterior Beam Column Joint Strengthened with Precast slurry Infiltrated Fibre Concrete Laminates*, International Journal of Applied Engineering Research, Vol-1, pp:49-58, (2010).