Experimental Study on Slurry Infiltrated Fibrous Concrete

[1]M.F.Mohamed Sameer, PG Student, Dept. of Civil Engineering, B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai, India, sameerbinfaruk@gmail.com

[2]A.Manivannan, Assistant Professor, Dept. of Civil Engineering, B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai, India, manivannancivil@crescent.education

Abstract **Slurry infiltrated fibre concrete (SIFCON) is a building construction material that can be considered as a subset of high-performance fibre reinforced concrete (HPFRC) a high fibre content. The use of steel fibre has enhanced concrete mechanical properties such as material toughness in tension and durability. Steel fibres are frequently used in plastic shrinkage cracking and drying shrink cracking in concrete. The use of silica fume had a major impact on industries, allowing them to routinely and commercially produce silica fume modified concrete which is flowable and yet cohesive, resulting in high early and later age strength and also resistance to aggressive environments. The matrix is often made consisting of cement slurry or flowing mortar. There is the use of a crimped type of fibres, and it has been realised that the addition of small, steel fibres added to concrete would act as crack igniters, enhancing its mechanical properties and durability. This experimental study attempts to test concrete compressive strength after 7, 4, and 28 days of curing. Silica fume was used at various proportions of 0%, 5%, 10%, 15%, and 20%, and steel fibre has been used in 0.5 % ,1.0 %, 1.5 % and 2.0 %. In this Study of Compressive Strength of concrete is the replacement of cement concrete in different proportions from additional steel fibre 1% & replaced of Silica fume 20% replacement of cement concrete.**

Keywords- SIFCON, steel fibre, silica fume, compressive strength test

I. INTRODUCTION

Slurry infiltrated fibrous concrete (SIFCON) is high-strength, porous concrete. high-performance concrete with a relatively high percentage of fibre material as compared to conventional reinforced concrete. It is also known as high-volume fibrous concrete HVFC. Fibre has been used as a construction material for centuries. In the last three decades, the use of fibre in ready-mixed concrete, precast concrete, and The use of concrete has increased popularity. Steel, plastic, glass, and natural fibres (such as wood cellulose and bamboo) can be round, flat, and crimped or deformed, with lengths ranging from 6 mm to 150 mm (0.25 in. to 6 in.) Such as thicknesses ranging from 0.005 mm to 0.75 mm (0.0002in. to 0.03 in.). Fibre-reinforced concrete has been used successfully For its satisfactory and outstanding performance in the industry and construction field, is used in a wide range of engineering applications. The majority of engineers and researchers, however, are puzzled as to why and how the fibre works so well The majority of studies conducted over the last four decades to identify the use of fibre reinforced concrete has focused on the mechanical properties of fibre-reinforced concrete and the fibre themselves.

A. Role Of steel fibres

Steel fibre reinforcing in concrete results in long-lasting concrete with high flexural and fatigue flexural strength, as well as improved abrasion, spalling, and impact resistance. Steel fibres can provide cost savings, as well as reduced material volume, energy efficiency, and reduced capital costs. Fibre-reinforced concrete is an ideal buy for enhancing the toughness and durability of concrete and mortar. Concrete fibre helps to reduce shrinkage cracks, improve strength, increase energy absorption, and protect from dangerous spalling at high temperatures.

B. Role Of silica fume

Silica fume is an extremely pozzolanic by-product of the ferrosilicon industry used to improve the mechanical and durability properties of concrete It can be used as a standalone ingredient in concrete or combination with ordinary portland cement, and also silica fume. The role of silica in cement is to provide strength to the material. It undergoes a chemical reaction with calcium to form dicalcium silicate (C_2S) and tricalcium silicate (C_3S). Silica if Present in excess form adds strength to the cement but simultaneously reduces the strength to cement.

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C. Objective

The Objective of the study is identified as under.

- To conduct a feasibility study of producing SIFCON concrete with locally available silica fume, and steel fibres.
- To determine the compressive strength of modified concrete.

II. LITERATURE REVIEW

Bulent Baradan, HalitYazici (2006) In this study, the effect of incorporating a considerable volume of Class C fly ash (FA) on the mechanical properties of autoclaved SIFCON (slurry infiltrated fibre concrete) is investigated. In SIFCON compositions, Cement was replaced with up to 60% FA, and three different steel fibre volumes (2, 6, and 10%) were used. The test results were compared to the control mix (0% FA and 0 % fibre). Almost every FA replacement had a positive effect on mechanical properties. Moreover, by an increase in fibre flexural strength, volume, and toughness were significantly increased. At 10% fibre content, this tendency was more pronounced. Flexural strength of 55 MPa could be achieved with % FA replacement at this fibre volume ratio.

Ghada D. Abdel-Hameed, HamedM.Salem (2009) An experimental study has been carried out to investigate the shear characteristic of slurry infiltrated fibre concrete (SIFCON) beams. Slurry-infiltrated fibre concrete shear behaviour (SIFCON) beams were investigated in experimental analysis. Thirteen specimens were tested, with different steel fibre volumes of fractions (Vf), shear span-depth ratios, fibre forms, and beam sizes. Four-point loading was used to test the beams. The findings showed that as Vf increased or the shear span-depth ratio decreased, the nominal shear stress at diagonal ultimate shear strength and cracking increased. Hooked-end fibre was found to have the greatest shear strength of SIFCON beams as compared to plain and corrugated fibre. SIFCON beams had a smaller size effect than conventional ordinary concrete (RC) beams. A structural equation was developed using a simplified analytical model to quantify the SIFCON's power and also fibre reinforced concrete (FRC) beams. The proposed equation and the experimental results derived were found to have a high level of agreement.

Farnam. Y, Moosavi.M(2010) Slurry infiltrated fibre concrete (SIFCON) is a new construction material that is comparable with high-performance fibre reinforced concrete (HPFRC) with higher fibre content. The new research looks at high strength concrete's triaxial compressive strength (HSC), HPFRC, and SIFCON were investigated. High-strength concrete (HSC), elevated fibre reinforced concrete (HPFRC), and SIFCON all had their triaxial compressive actions investigated. Laboratory Experiments were conducted on four different types of 75150 mm cylindrical specimens made from different steel fibre volumes (0, 2, 5, and 10 per cent). According to triaxial conditions, both experiments were performed at four separate confining pressure ranges (0, 5, 15, and 21.5 MPa). As an effect, stress-strain curves for HSC, HPFRC, SIFCON samples were also collected obtained, or the governing patterns in failure and failure criteria were addressed. Growing fibre volume increases peak tension, energy absorption, durability, and Poisson's ratio, while Peak stress, energy absorption, and so on or peak pressure all increase as confining pressures increase and toughness, according to the results. Concrete may also begin to behave like a plastic material as a part of this.

Kuldeep Dagar (2012) The cement slurry (without fibres) used in the making of SIFCON generally develops a one-day strength of 25 to 35 MPa and a 28-day strength of 50 to 70 MPa. SIFCON's corresponding values compressive properties of composites extend from Depending on the percentage of steel fibres incorporated in the matrix, the compressive strength range from 40 to 80 MPa and from 90 to 160 MPa. SIFCON has a very ductile structure. When compressed. The observed values range from 25 to 75 MPa, with an average of 40 MPa. SIFCON has excellent ductility under both Loading that is monotonic and has a high amplitude. Loading is monotonic and has a high amplitude. SIFCON specimens were 30.5, 28.1, 33.3, and 31.8 MPa for fibre lengths of 30, 40, 50, and 60 mm, indicating that the fibre length does not seem to affect the strength. The average shear strength of SIFCON can be taken as about 30 MPa as compared to just about 5 MPa for plain concrete.

Aniyan Thomas (2014) An experimental study was conducted to investigate the strength and conduct of SIFCON with various kinds of fibres. An experiment was conducted to investigate the strength and conduct of SIFCON with different kinds of fibres. Polypropylene and steel fibre was the different fibres used in this experiment. The separate fibre volumes that were considered were 4%, 5%, and 6%, respectively. Flexural, compression, and Split tensile tests were performed. In the flexural test, a beam specimen measuring A dimensions The specimen's activity under load was studied to use 100 x 100 x 500 mm measurements. The compression test of a 150 x 150 x 150 cube specimen was taken into consideration. The compressive strength and split tensile of specimens with different volumes and types of fibres were tested to use a 150 x 300 mm cylinder specimen. Hooked end steel fibres with a diameter of 1 mm and an aspect ratio of 50 were used in this study. The product used was polypropylene fibre with a length of 50.8mm. According to the results, among the 4%, 5%, and 6% of steel and polypropylene fibre tested, 5 per cent had the best compression, stress, and flexural strength. As compared to the 5 per cent volume of fibre, Bothfibres' results showed a decrease in strength. Polypropylene fibres could be used to reduce the specimen's crack width and density.

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III. MATERIAL PROPERTIES

This section presents the details of the various tests conducted on the materials used in concrete.

A. Cement

B. Fine aggregate

C. Coarse aggregate

A. *CEMENT* The cement used for this study was ordinary Portland cement of 53 grade (OPC 53). All properties of the cement were determined by referring to IS 12269 – 1987

B. *FINE AGGREGATE* The results of 7-day and 28-day tests on fibrous concrete were compared to the results of conventional concrete and concrete which did not match steel fibre. The greater the surface area with relation to the volume ratio of a particle, the more surface area is available for water-cement interaction per unit volume. Sieving is used to evaluate fineness. Using the standard IS sieve, sieve 100 g of cement (90 microns). The sample is sieved continuously for 15 minutes after air set lumps are broken with fingers. Mechanical sieving devices can be used, and the debris The remaining residue on the sieve can then be weighed. The weight for ordinary cement shall not exceed 10%.

C. *COARSE AGGREGATE* The coarse aggregate of 20 mm size graded confirming to IS: 383 – 1970 is used. The properties of coarse aggregate, A specific gravity and fineness modulus are calculated. The coarse aggregate of 20 mm size graded confirming to IS: 383 – 1970 is used.

PHYSICAL PROPERTIES

A. Sieve Analysis

B. Specific Gravity

A. SIEVE ANALYSIS The modulus of coarse aggregate fineness is an index number that represents the coarse aggregate's average particle size. It is measured by sieve analysis using standard sieves. The aggregate retained after sieving through a 4.75 mm screen is referred to as coarse aggregate.

TABLE 1 Sieve Analysis of Fine Aggregate

S.no	Sieve size	Weight of retained on the sieve	Cumulative mass retained	Cumulative % of Passing %	% of passing
1	4.75 mm	1.2	0.12	0.12	99.88
2	2.36 mm	72.2	73.4	7.34	92.66
3	1.18mm	553.6	627	62.7	37.3
4	600 μ	180.8	807.8	80.78	19.22
5	300 μ	98.2	906	90.6	9.4
6	150 μ	49	955	95.5	4.5
7	Pan	45	1000	100	0

TABLE 2 Sieve Analysis of Coarse Aggregate

S.no	Sieve size	Weight of retained on the sieve	%Weight retained (%)	%weight passing (%)	Cumulative % retained (%)
1	40 mm	0	0	0	100
2	25 mm	25.5	1	1.275	98.75
3.	20 mm	615	31.3	32.025	67.975
4	12.5 mm	1310	65.5	97.525	2.475
5	10 mm	39	1.95	99.475	0.525
6	6.3 mm	10.5	0.9	100	0

B. Specific Gravity test

TABLE 3 Specific Gravity Test

Description	Specific Gravity
Cement	3.15
Fine Aggregates	2.5
Coarse Aggregates 20mm	2.7
Silica fume	2.24

IV. RESULT & DISCUSSION

The mechanical properties such as compression strength were conducted on the casted specimens.

A. Compressive Strength Test

TABLE 4 Strength of Conventional Concrete

Days	Compressive Strength (MPa)
7 Days	30.2
14 Days	34.87
28 Days	39.4

A. Compressive Strength Test The tests on concrete under compression are conducted on the concrete cube of size 100x100x100mm prepared following IS 516-1959 at 7,14 and 28 days using a compression testing machine.

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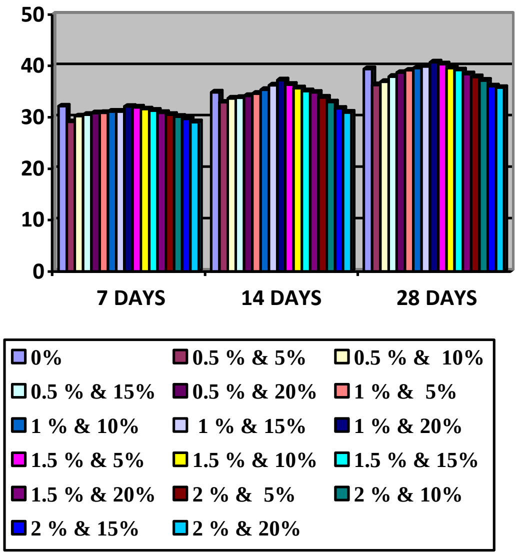
TABLE 5 Compressive Strength of Concrete at 7,14,and 28 Days

S.No	Percentage of steel fibre& silica fume	Compressive Strength @ 7days (N/mm^2)	Compressive Strength @ 14 days (N/mm^2)	Compressive Strength @28 days (N/mm^2)
1	Steel fibre 0.5% & silica fume 5%	29.10	32.9	36.3
2	Steel fibre 0.5% & silica fume 10%	30.23	33.67	36.9
3	Steel fibre 0.5% & silica fume 15%	30.5	33.83	37.93
4	Steel fibre 0.5% & silica fume 20%	30.8	34.17	38.7
5	Steel fibre 1% & silica fume 5%	30.9	34.6	39.13
6	Steel fibre 1% & silica fume 10%	31.13	35.37	39.57
7	Steel fibre 1% & silica fume 15%	31.15	36.23	39.9
8	Steel fibre 1% & silica fume 20%	32.1	37.23	40.73
9	Steel fibre 1.5% & silica fume 5%	31.93	36.37	40.33
10	Steel fibre 1.5% & silica fume 10%	31.6	35.67	39.6
11	Steel fibre 1.5% & silica fume 15%	31.33	35.13	39.2
12	Steel fibre 1.5% & silica fume 20%	30.9	34.83	38.4
13	Steel fibre 2% & 5%	30.5	33.87	37.87
14	Steel fibre 2% & silica fume 10%	30.13	32.97	37.17
15	Steel fibre 2% & silica fume 15%	29.67	31.73	36.03
16	Steel fibre 2% & silica fume 20%	29.07	30.93	35.77

Graph 1 Compressive Strength at 7,14, and 28 Days



The results on the variation of compressive strength of concrete concerning the age of Concrete for different percentage of replacement cement with steel fibre and silica fume and a constant percentage as cementitious material is shown in the graph.

7 DAYS

- The optimum percentage of Replacement cement with steel fibre 1 %, silica fume 20% value 32.1 MPa increase than the Conventional Concrete
- It concluded the attained compressive strength on replacement of concrete in addition of steel fiber 1.5% and silica fume 5% and appreciate the same result when compare conventional concrete

14 DAYS

- The optimum percentage of Replacement cement with steel fibre 1 %, silica fume 20% value 37.23 MPa increase than the Conventional Concrete
- It concluded the attained compressive strength on replacement of concrete in addition of steel fiber 1.5% and silica fume 5% and appreciate the same result when compare conventional concrete

28 DAYS

- The optimum percentage of Replacement cement with steel fibre 1 %, silica fume 20% value 40.73 MPa increase than the Conventional Concrete
- It concluded the attained compressive strength on replacement of concrete in addition of steel fiber 1.5% and silica fume 5% and appreciate the same result when compare conventional concrete

V. CONCLUSION

In this experiment, steel fibre and silica fume are used in SIFCON to significantly increase the compressive strength.

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On comparing the SIFCON's power steel fibre and silica fume performed better than conventional concrete. Almost steel fibre 1% and silica fume 20% of strength showed the optimum compression percentage of specimens. The specimen has a higher volume of fibre. Steel fibre and silica fume increase the strength of the concrete compared to conventional concrete. According to the result after 7, 14, & 28 days, SIFCON with strength 32.10 MPa, 37.23 MPa, & 40.73 MPa exceeds conventional concrete. It is concluded that the compressive strength of concrete is significant and that the results are nearly the same when compared to conventional concrete.

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