STUDY ON STRENGTH PROPERTIES OF SIFCON

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Abstract - *Concrete is a composite material which has wider application in construction industry because of strength and durability. The construction of long span bridge, high rise building, offshore structures, and other mega structures requires materials, with increasingly improved properties, particular strength, stiffness, toughness, ductility, durability. In the cause instances, simultaneous improvement in a combination of properties is needed. Such material often called "High Performance Materials" and "Advanced Materials" and they are basically different from other conventional materials. The aim of present investigation is to study a Slurry Infiltrated Fiber Reinforced Concrete (SIFCON), properties. SIFCON possesses the high strength as well as large ductility because of its high tensile strength. In this experiment cement, sand, fly ash is kept in constant value. The steel fiber are added in various proportions, i.e. 6%, 8%, 10%, 12% to arrive the optimum percentage.*

Key Words: SIFCON, Cement, Steel fiber, Tensile strength, Ductility, Stiffness.

1. INTRODUCTION

Slurry-infiltrated fibrous concrete (SIFCON) [2] can be considered as a special type of fiber concrete with high fiber content. The matrix usually consists of cement slurry or flowing mortar. SIFCON has excellent potential for application in where High ductility and resistance to impact are needed. SIFCON is different from normal FRC. The fiber content of FRC generally varies from 1to3 percent by volume, but the Fiber content of SIFCON varies between 5 and 20 percent. The production of SIFCON [2] far different from FRC(Fiber Reinforced Concrete). Unlike FRC, for which the fibers are added to the wet or dry concrete mix, SIFCON is prepared by infiltrating cement slurry in to abed of fibers preplaced and packed tightly in the moulds.

SIFCON has been used successfully for refractory applications, pavement overlays, and structures subjected to blast and dynamic loading. Because of its highly ductile behavior and far superior impact resistance, the composite has excellent potential for structural applications in which accidental or abnormal loads such as blasts are encountered during service [2].

Slurry infiltrated fiber concrete (SIFCON) is a relatively new special type of high performance (steel) fiber-reinforced concrete (HPFRC). SIFCON is made by pre placing short discrete fibers in the molds to its full capacity or to the desired volume fraction [1].

1.1 SIFCON Definition

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.

1.2 Unit Weight of SIFCON

The unit weight of SIFCON is typically higher than concrete and normal FRC because of the relatively heavy weight of the high fiber content. For a slurry unit weight of 1920 kg/m^{3}the addition of steel fibers results in an increase in density varying from 2160 to 3130 kg/m^{3}for steel volume fraction ranging from 5 to 20 volume percent. The unit weight increase is almost linearly proportional to the fiber content [1].

2. SIFCON DESIGN PRINCIPLES

A high strength SIFCON mix can easily be designed and obtained with virtually any type of steel fibers available today, if slurry is also of high strength like conventional concrete, the strength of slurry is a function of water-cement ratio, because the slurry mixes used in SIFCON usually contain significant percentages of fly ash (or) silica fume (or) both. The term "water-cement plus admixtures" is used when designing slurry mix. In addition, the ratio of "admixtures to cement" is also an important parameter in design of SIFCON higher volume percentages of fibers need lower viscosity slurry to infiltrate the fibers thoroughly. Generally, higher the slurry strength greater is SIFCON strength.

2.1 Factors Affecting SIFCON Efficiency

The following factors affect the strength of SIFCON and the ultimate strength, ductility and energy absorption are all affected by fiber alignment.

i. Slurry strength
ii. Fiber volume
iii. Fiber alignment
iv. Fiber type

2.2 Advantages of SIFCON

i. SIFCON possess excellent durability, energy absorption capacity, impact and abrasion resistance and toughness.

ii. Modulus of elasticity (E) values for SIFCON specimens is more compared with plain concrete.

iii. SIFCON exhibits high ductility.

3. MATERIALS USED

The making of SIFCON considering many materials like cement, sand, fly ash, steel fiber, high range water reducing admixture called CONPLAST SP- 430. In this project Class f fly ash used [3].

3.1 Cement

In general, cement is a binder, a substance that sets and hardens independently, and can bind other materials together. OPC 53 grade cement used, the properties of cement as given in Table 2

Table -1: Properties of cement

Characteristics	Properties
Initial setting time	31 min
Final setting time	570 min
Standard consistency	33%
Specific gravity	3.15
Fineness of cement	4.8%

3.2 Sand

The fine aggregate used was natural river sand passing through600 μ and retain 300 μ sieves. Table 2 gives the following properties of fine aggregate.

Table-2: Properties of sand

Characteristics	Properties
Specific gravity	2.65
Fineness modulus	2.8
Water absorption	0.25%
Bulk density – dense	1750kg/m^3

3.3 Water, Superplasticizer and Fly ash

i. Portable water is used for making mortar. The pH value of water lies between 6 to 8.

ii. ConplastSP430 used and it is based on Sulphonated Napthalene Polymers and supplied as a brown liquid. It has been give to high water reductions up to 25%.Conplast SP 430 have specific gravity about 1.2 -1.225 at 300 ^{0}C.

iii. Fly ash from thermal power plant passing through 300 μ sieve used. It has specific gravity 2.31 with whitish grey to grey with slight black. The fineness of fly ash is 3200cm^2/gm.

3.4 Steel Fiber

A large variety of steel fibers have been investigated for use in SIFCON. The stainless straight steel fibers are used. Table 3 gives the properties of steel fiber.

Table-3: Properties of Steel fiber

Diameter	0.33 mm
Length	25 mm
Youngs Modulus	2.1 N/mm^2
Aspect ratio (L/D)	75
Unit weight	7850 kg/m^3

Fig-1: Steel Fiber

4. MIX PROPORTION AND TEST SPECIMEN CASTING

In general, proportions of cement and sand generally used for making SIFCON are 1:1, Fly ash equal to 50%by weight of cement is used in mix. w/c is 0.45 and super plasticizers varies from 2% to 5% of weight of cement used. The percentage of fibers by volume can be where from 6% to12% used. Sand is taken in to passing through 600 μ and retains 300 μ. Table 4 and 5 shows the mix proportion of SIFCON and M30 grade concrete.

Table -4: Mix proportion of SIFCON

Mix No	Cement	FA	Fly ash	w/c	SP %	Steel fiber volume %
M1	1	1	0.5	0.45	2	6
M2	1	1	0.5	0.45	2	8
M3	1	1	0.5	0.45	2	10
M4	1	1	0.5	0.45	2	12

Table-5: M30 Grade Concrete Mix

Cement	FA	CA	w/c
1	1.54	2.62	0.45

4.1 Preparation and of the Mould

The compressive strength, porosity and permeability of the concrete were determined by cubes of size 150mmx150mmx150mm, 150mmx300mm cylinder and 400x100x100mm prism. So the mould of such size prepared with water tight and oil applied to ease of demoulding before casting of concrete.

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.

4.2 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.

4.3 Curing

After demoulding of specimen, the cubes are placed inside the water tank conveniently for curing take place with identification mark.

5. TEST and RESULT

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.

5.1 Compression Test for Cubes

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/mm^2)

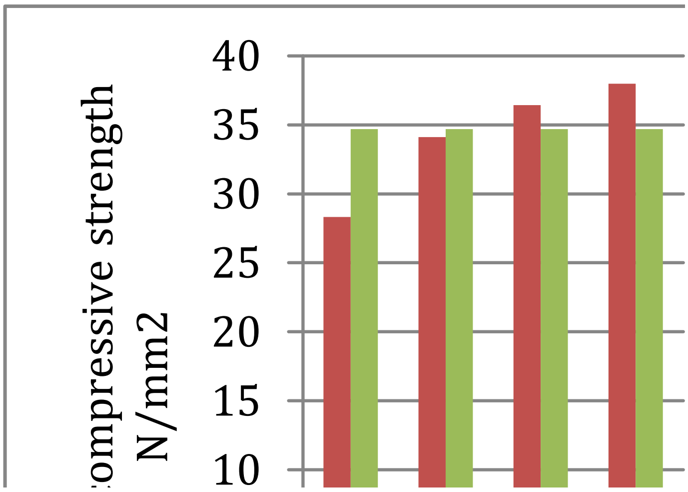

Fig -2: Compressive strength

5.2 Split Tensile Strength

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and load is applied until failure of cylinder, along the vertical diameter.

The figure 3 gives the spilt tensile strength of SIFCON and M 30 concrete.

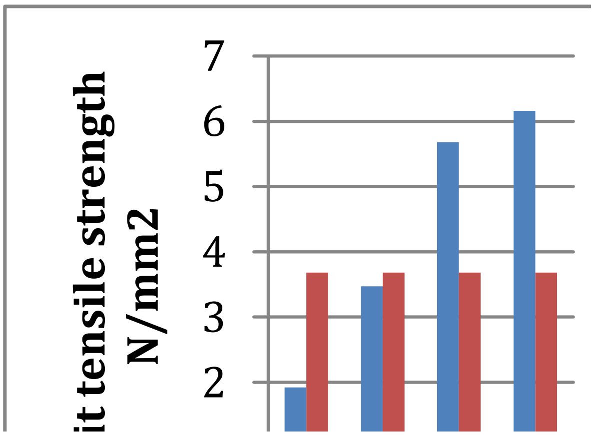

Fig- 3: Split tensile strength

5.3 Flexural Strength Test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measure by loading 6 x 6- inch (150 x 150-mm) concrete beams with a span length at least three times depth. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPA) [5].

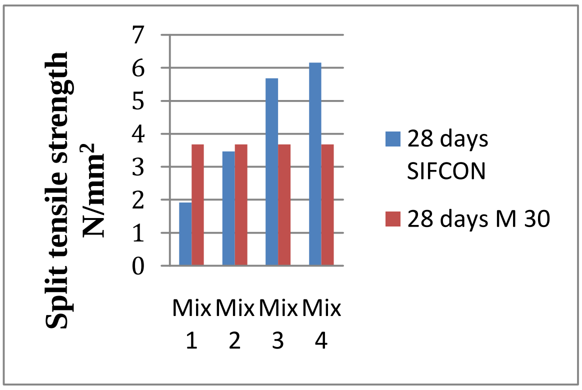

Fig-4: Flexural strength of Specimen

6. CONCLUSIONS

Compressive strength of SIFCON mixes increases with increasing the percentage volume of fiber. It can be observed that the 28 day compressive strength of SIFCON-12 is considerably higher to other SIFCON mixes. Hence, it can be concluded that addition of locally available low tensile steel fibers also contribute to compressive strength of the mix.

The tensile strength of SIFCON is higher than M30 grade concrete.

The test results are comparing with that of the Conventional Concrete subjected to similar loading condition.

It is observed from the results of the present investigation, there is an increase in the compression, tension and flexural strength with an increase in the volume of steel fibers fraction.

12% addition of steel fibers increases the strength about 36.2% when compared to conventional concrete.

In comparing both concrete values SIFCON make high strength and flexural behavior is good and the mix 4 is found to be optimum.

Here coarse aggregate is not used in SIFCON and cost of material is lesser.

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.

In this paper straight stainless steel fiber used, but some research scholars are widely used crimped type mild steel fiber. It also gives high strength, high ductility resistant and gives interlock between slurry.

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