Performance of Sifcon with Mineral Admixture

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***Abstract*— There are various types of concrete has been emerged to increase the strength. Among the various types SIFCON concrete plays a vital role. SIFCON is a ductile layer of high performance fibre concrete with significantly large amount of fibres, hence it can also be used to reduce the wear and tear. Silica fume under elevated temperatures. In this research SIFCON specimens are subjected to temperature range of 200°C,400°C and 600°C. The fibre volume fraction adopted is to be 10% in volume of SIFCON. The alignment of fibre is to be random along one direction and the type of fibre used is Hooked end steel fibre. Slurry Infiltrated Fibrous Concrete (SIFCON) is a high-strength, high performance material containing a relatively high volume percentage of steel fiber as compared to SFRC. It is also sometimes termed as 'high-volume fibrous concrete'SIFCON composites has high strength when compared to the conventional concrete and fibre reinforced concrete. Developments during the last two decades have shown a marked increase in the number of structures involving the long time heating of concrete. High temperature resistance is one of the most important parameters which affects the durability and service life of materials.**

I. INTRODUCTION

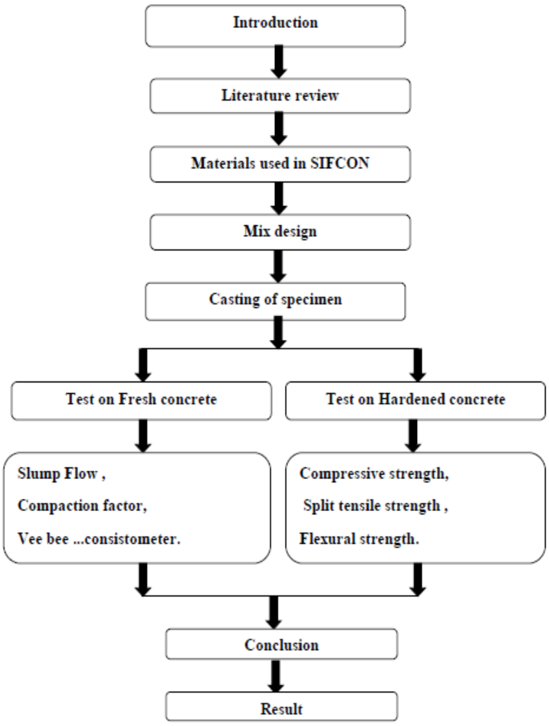
Slurry Infiltrated Fibrous Concrete (SIFCON) is a high-strength, high performance material containing a relatively high volume percentage of steel fiber as compared to SFRC. It is also sometimes termed as 'high-volume fibrous concrete'. The concept of Slurry Infiltrated Fibre Concrete (SIFCON) was introduced by Lankard from the New Mexico Engineering Research Institute (NMERI) in 1983.The percentage of steel fibres in a cement matrix could be increased substantially. While comparing with Fibres Reinforced Concrete the SIFCON has relatively high percentage of fibre. In Fibre Reinforced Concrete there is 1% to 3% of fibre adopted in its volume, whereas in SIFCON there should be 5% to 20% of fibre adopted in its volume. The process of making SIFCON is also different, because of its high steel fibre content. While in SFRC, the steel fibres are mixed intimately with the wet or dry mix of concrete, prior to the mix being poured into the forms, SIFCON is made by infiltrating a low-viscosity cement slurry into a bed of steel fibres 'pre-packed' in forms/moulds.

The matrix in SIFCON has no coarse aggregates, but a high cementitious content. A cement-rich flowable mortar is the binder in SIFCON production. The usage of very high amounts of cement not only affects the production costs, but also has negative effects on the heat of hydration and may cause shrinkage problems. Replacing cement with mineral admixtures seems to be a feasible solution to these problems. Furthermore, incorporation of mineral admixtures may positively affect the durability of SIFCON products. However, it may contain fine or coarse sand and additives such as fly ash, micro silica. The matrix fineness must be designed so as to properly penetrate (infiltrate) the fibre network placed in the moulds, since otherwise, large pores may form leading to a substantial reduction in properties.
There are three important aspects considered in the preparation of SIFCON. They are as follows:
(1) Fibre orientation.
(2) Fibre geometry.
(3) Matrix composition.

Fibre orientation describes the alignment of fibres in the Prepacked moulds in the manner of parallel or perpendicular depends upon the loading axis. In order to attain the highest strength the fibre alignment is the important factor. The maximal fibre volume depends on the fibre geometry and the vibration, effort needed for proper compaction. The shorter fibres may pack denser than the longer ones and the higher fibre volumes can merely be achieved with careful and sufficient vibration. Fibre alignment affects the behaviour of a SIFCON product greatly. Fibres can be aligned parallel to the stress direction which will be taken place within the composite or can be placed randomly. The ultimate strength, residual strength, ductility, and energy absorption properties are all can be affected by the fibre alignment fibre geometry includes the type of fibre used in preparation of SIFCON. Generally Hooked end steel fibres, crimped fibres and straight fibres are used. Among these Hooked end steel fibres are widely used. The fibre lengths vary from 30mm to 60mm (1.2 to 2.4 in.). The aspect ratios range from 60 to100. Crimped and straight fibres have also been used for some applications. Matrix composition determines the use of plain mortar or along with the replacement of cement with the mineral admixture to improve its performance and workability.

SIMCON is made using a non-woven "steel fiber mats" that is infiltrated with concrete slurry. Steel fibers produced directly from molten metal using a chilled wheel concept are interwoven into a 0.5 to 2 inches thick mat. This mat is then rolled and coiled into weights and sizes convenient to a customer's application (normally up to 120 cm wide and weighing around 200 kg).As in conventional SFRC, factors such as aspect ratio and fiber volume have a direct influence on the performance of SIMCON. Higher aspect ratios are desirable to obtain increased flexural strength. Generally, because of the use of mats, SIMCON the aspect ratios of fibers contained in it could well exceed 500. Since the mat is already in a preformed shape, handling problems are significantly minimized resulting in savings in labor cost. Besides this, “balling” of fibers does not become a factor at all in the production of SIMCON.

II.METHODOLOGY



MIX DESIGN

5.1 DESIGN MIX FOR M60 GRADE OF CONCRETE AS PER IS 10262 – 2009

DESIGN STIPULATION:-

Target strength = 60Mpa
Max size of aggregate used = 20 mm
Specific gravity of cement = 3.12
Specific gravity of fine aggregate (F.A) = 2.66
Specific gravity of Coarse aggregate (C.A) = 2.73
Dry Rodded Bulk Density of fine aggregate = 1665 Kg/m3
Dry Rodded Bulk Density of coarse aggregate = 1800Kg/m3

Step-1 Calculation for weight of Coarse Aggregate: From ACI 211.4R Table 4.3.3
Fractional volume of oven dry Rodded C.A for 20mm size aggregate is 0.64m3
Weight of C.A = 0.64*1800
= 1152 Kg/m3

Step-2
Calculation for Quantity of Water: From ACI 211.4R Table 4.3.4 Assuming Slump as 50 to 75mm and for C.A size 20 mm the Mixing water = 160 ml
Void content of FA for this mixing water = 35%
Void content of FA (V) V = {1-(Dry Rodded unit wt / specific gravity of FA*1000)}*100
= [1-(1665/2.6*1000)]*100
= 37.4% 24

Adjustment in mixing water = (V-35)* 4.55 = (37.4% – 35)*4.55 = 2.40 ml Total water required = 160 + (2.40) = 162.40 ml

Step-3 Calculation for weight of cement From ACI 211.4R Table 4.3.5(b) Take W / C ratio = 0.29 Weight of cement = 162.40 / 0.29
= 560.02 kg/m3

Step-4 Calculation for weight of Fine Aggregate:
Cement = 560.02 / 3.12*1000
= 0.1794 Water
= 162.40/ 1*1000
= 0.1624 CA
= 1152 / 2.73*1000
= 0.4219 Entrapped Air
= 2 / 100
= 0.020
Total = $0.7837m^3$
Volume of Fine Aggregate = 1-0.7837
Weight of Fine Aggregate = 0.2163*2.66*1000
= 575.358 kg/m3 25

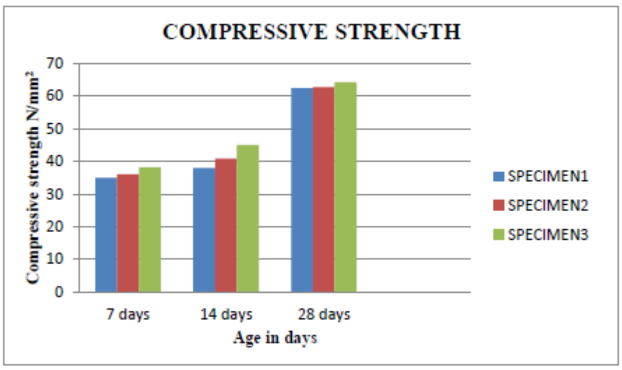
Step-5 Super plasticizer: For 0.8% = (0.8 / 100)*583.53
= 4.668 ml

Step-6 Correction for water: Weight of water (For 0.8%)
=162.40 – 4.668
=157.73kg/m3

Requirement of materials per Cubic meter Cement = 560 Kg/m3 Fine Aggregate = 575.358 Kg/m3 Coarse Aggregate = 1152 Kg/m3 Water = 157.73 Kg/ m3 Super plasticizers = 4.6681 / m3
So the final ratio becomes Cement: Fine agg (kg/m3): Coarse agg (kg/m3): Water (l/m3): Super plasticizer (l/m3)

Materials	Cement content	Fine aggregate	Coarse aggregate	Weight of water content	Super plasticizer
Weight	560 kg/m^3	575.15 kg/m^3	1152 kg/m^3	157.73 kg/m^3	4.668/m^3
Ratio	1	1.02	2.05	0.29	0.8

Sl. No	Name of work	Slump in mm	w/c ratio
1	Concrete for road and mass concrete.	25 to 50	0.7
2	Concrete for R.C.C beams and slabs	50 to 100	0.55
3	Columns and retaining walls	75 to125	0.45
4	Mass concrete in foundation	25 to50	0.70



Sl.No	7th day (N/mm^2)	14th day (N/mm^2)	28th day (N/mm^2)
specimen1	3.8	4.8	7.5
specimen2	4.0	5.2	7.4
specmen3	3.9	5.6	7.

It has been identified from the reviews high volume Class C fly ash mixtures are suitable for autoclave production of high strength SIFCON. Fibre volume is the most important parameter that affects the behaviour of the SIFCON. Furthermore, the mechanical performance can be improved remarkably by autoclave curing compared to normal curing. The mechanical properties achieved in this research indicate that SIFCON compositions incorporating high volumes of FA and steel fibres may be an ideal material for the construction of seismic resistant structures and under the impact and explosion effects. It's been observed that the use of Polypropylene fibre may reduce the explosive spalling of concretes at elevated temperatures. It is recommended that SIFCON composites may be produced with a concrete cover against high temperature oxidation of steel fibres, especially for military structures. Hence SIFCON with its improved properties than the conventional concrete can be used as an effective alternative in special concreting purposes or where the conventional concrete does not meet the requirement.

In phase II have collected literature reviews and studied methodology.

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