SLURRY INFILTRATED FIBROUS REINFORCED CONCRETE (SIFCON)

GENERAL

Slurry Infiltrated Fibrous Reinforced Concrete (SIFCON) is a relatively new high performance and advanced material and can be considered as a special type of Steel Fiber Reinforced Concrete (SFRC).The technique of infiltrated layers of steel fibers with Portland cement based materials was first proposed by Haynes (1968).Lankard (1979) modified the method used by Haynes and proved that if percentage of steel fibers in cement matrix could be increased, one could get a material with very high strength properties which he christened as SIFCON.

WHAT IS SIFCON?

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.

COMPOSITION OF SIFCON

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 any where from 4 to 20% even though the current practical ranges from 4 to 12%.

PROCESS OF MAKING SIFCON

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.

DESIGN PRINCIPLES

The design methods for SIFCON members must take into account their application (or) end, the property that needs to be enhanced, minimum proportion, strength as well as its constructability and service life.

In general, 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.

FACTORS AFFECTING THE EFFICENCY OF SIFCON

There are four variables to consider when evaluating a SIFCON specimen. They are:-

(1) Slurry strength
(2) Fiber volume
(3) Fiber alignment
(4) Fiber type

“Cement slurry” greatly affects the behavior of SIFCON specimens because the slurry is the back bone of specimen. The elastic moduli, tensile strength and compressive strength of slurry affect the behavior of composite SIFCON matrix. Fiber pullout strength is lest one variable that depends upon slurry compressive strength.

“Fiber volume” depends upon fiber type and vibration effort. Smaller (or) Shorter fibers will pack denser than longer fibers. Higher fiber volume can be achieved with added vibration time.

“Fiber alignment” greatly affects the behavior of a SIFCON specimen. Fibers can be aligned normal to loading (or) parallel to loading. The ultimate strength, ductility and energy absorption are all affected by fiber alignment.

“Fiber types” are mainly 2 types. They are:-

(1) Steel fibers (2) Glass fibers

Steel fibers come in three main shapes and several sizes and strengths. The shapes are hooked, crimped and deformed with various aspect ratios (l/d). The most popular steel fiber is Dramix fiber (hooked) made by Bekaert Corporation. Glass fibers were generally rod like in shape with various lengths, diameters and strengths.

ADVANTAGES OF SIFCON

(1)SIFCON possess excellent durability, energy absorption capacity, impact and abrasion resistance and toughness.
(2)Modulus of elasticity (E) values for SIFCON specimens is more compared with plain concrete.
(3) SIFCON exhibits high ductility.
(4) The limitation in SFRC that is balling problem of steel fibers with increase in fiber volume is overcomes by SIFCON, because of its fiber alignment.
(5) Deflection for SIFCON will be very less compared to conventional and will act as rigid body.

DISADVANTAGES OF SIFCON

Inspite of unique properties of SIFCON it doesn’t have much limitations. Uniformity and quality control of fiber distribution in addition to high placement cost associated with manual addition of fibers, restricted wide applications of these composites.

USAGE /APPLICATION AREA

SIFCON has properties like ductility, crack resistance, penetration and impact resistance very high compared to other materials like SFRC, concrete it is best suited to applications in following areas:-

(1) Pavement rehabilitation and pre cast concrete products.
(2) Overlays, bridge decks and protective revetments.
(3) Seismic and explosive resistant structures.
(4) Security concrete applications.(safety vaults, strong rooms)
(5) Refractory applications. (soak-pit covers, furnace lintels, saddle piers)
(6) Sea protective works.
(7) Military applications such as anti-missile hangers, under ground shelters.
(8) Aerospace launching platforms.
(9) Repair, rehabilitation and strengthening of structures.
(10) Concrete mega structures like offshore and long span structures, solar towers.

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