# Study of Mechanical Properties of SIFCON Material

**M.N.Bajad , Ashwini Pradeep Pawar**
[#]*Department of civil engineering, Savitribai Phule Pune University*
*Sinhgad College of Engg,Pune,Maharashtra,India*
*mnbajad@sinhgad.edu*
*ashwinipawar4495@gmail.com*

***Abstract*— Slurry Infiltrated Fiber Reinforced Concrete (SIFCON) is one of the superior material and can be reflected as special type of high performance fiber reinforced concrete (HPFRC) .SIFCON has different types of mechanical properties such as ductility, compressive, tensile, shear and especially flexural strengths. But according to outcomes ductility fails in CY system, Triaxial compression fails in stress curve pattern achieved by cubes under confining pressure level. This paper aims the study of various properties of SIFCON .From study of results, SIFCON is used in CY system.**

***Keywords*— SIFCON, Compression Yielding, Triaxial shear, Ductility.**

## I. INTRODUCTION

Now-a-days many types of High Performance Fiber Reinforced Cement (HPFRC) complexes have been developed. These materials have high strength, ductility and toughness which make them ideal materials for structural repair and retrofit. Among several types of HPFRC composites, Slurry Infiltrated Fiber Concrete (SIFCON) is a type of concrete in which formwork moulds are filled to capacity with fibers and then the resulting fiber network is intruded by a cement-based slurry. Infiltration is usually accomplished by gravity flow aided by a light vibration or pressure grouting. Concrete is a brittle material. Traditional concrete structures depend on largely on the deformation and yielding of their tensile reinforcement to satisfy their ductility demand. However, the prevalent application of high-strength steel reinforcement in concrete structures has a substantial drawback from the ductility point of view.

Flexural members generally tackled the problem of ductility, for that recently the pioneering structural concept of compression yielding has been introduced .The concept behind CY is simple.

The concrete in the compression zone of a plastic hinge is substituted by strong and more ductile material or mechanism to ensure that rotation of that hinge is obtained through compression yielding or deformation on the compression side, rather than through the yielding of the reinforcement on tension side. Simply supported beams are adequate to explain the conceptual structural configuration that allows CY .The only difference between a structural system with CY and normal RC beam lies in the plastic zone , in which a special ductile compression material or mechanism is used to supplant the concrete on the compression zone. High strength concrete (HSC), HPFRC and SIFCON were studied under triaxial compression behaviour. Some researches were employed on four types of cylindrical specimens with different steel fibres volumes. All tests were done under four different confining pressure levels according to triaxial conditions. Also, stress-strain behaviour were achieved by plotting graphs and prevalent failure patterns and failure criterions of HSC, HPFRC and SIFCON samples were studied According to the results peak stress increased due to increase in fiber volume, energy absorption, toughness and Poisson's ratio while increasing confining pressures increases peak stress, energy absorption and toughness. Also, this aids concrete to behave as a plastic material.

For the moderately new material SIFCON, determination of the behaviour in shear is vital because it may possess planes of weakness along which shear failures may develop. Due to its anisotropic nature, SIFCON has knowingly different strengths in different directions. The material is somewhat equivalent to a fiber composite material where the fiber distribution is a combination of alignment in parallel planes and random distribution. This arrangement shows some inter laminar strength above that provided by the strength of the matrix, but one would still expect inter laminar shear stress to be a apprehension with SIFCON .Simultaneously, it is important to study the shear strength of SIFCON and how that strength relates to compressive strength of the material and to the strength of the constituent parts.

### *A. Necessity*

Even though slurry infiltrated fibre concrete (SIFCON) has very good ductile nature, it is still impotent to satisfy the excessive ductility demand of Compression Yielding Structural system. Therefore this research needs to be investigated.

### *B. Aim*

This study emphases on studying the mechanical properties of SIFCON material for Compression yielding structural system

### *C. Objectives*

The aim of this research was attained through the following objectives:

- To Study the physical and mechanical properties of SIFCON

 

- To study and improve the vital role of mechanical properties especially Ductility , and its application in various field

### D. Research Significance

Significance is as follows:

- Slurry Infiltrated Fiber Concrete (SIFCON) composites has much more outstanding strength, Ductility, and crack/spall resistant properties.
- SIFCON has better mechanical properties such as compressive, tensile, shear and especially flexural strengths with outstanding toughness values.
- The mechanical properties of SIFCON are primarily depend on fiber and slurry properties such as compressive strength and modulus of elasticity of slurry. Volume, fiber type, alignment, Therefore this research is very imperative.

### E. Limitations

Because of distinctive properties of SIFCON it doesn't have much more restrictions. SIFCON is limited wide applications only because of Homogeneity and quality control of fiber distribution in addition to high placement cost linked with manual addition of fiber.

### F. Scope Of Study

Superior toughness property of SIFCON shows the latent usage area in industrial floors, strengthening and retrofitting works, seismic resistant structures, and explosion resistant structures.

## II.EFFECT OF COMPRESSION ON SIFCON BLOCK

We have already known that CY block require ideal yield plateau of compressive resistance hence this paper is examine the various mechanical properties of SIFCON block.

The SIFCON blocks can be tested with an MTS compression testing machine.

### A. Factors influencing the mechanical performance of SIFCON blocks are as follows:

- Fiber alignment- We know fibre alignment have substantial effect on ductility of concrete. By line up the fibers perpendicular, rather than parallel, to the loading direction, a higher degree of ductility can be obtained.
- Confinement- Confinement can advance the strength and ductility of concrete. Therefore, the ductility of SIFCON blocks can be improved by properly designed transverse reinforcement.
- Perforation-Ductility of compressive material can be improved by implanting holes or providing voids in steel or other material. The perforation method is also supposed to be effective for SIFCON blocks.
- Reinforcing holes in SIFCON blocks- A steel tube can be inserted into the internal side of a hole in SIFCON blocks to reinforce it, hence reducing the speedy strength decrement of block.
- Longitudinal reinforcement- Longitudinal reinforcement is necessary to clutch the stirrups. The longitudinal bar is therefore one of the factors prompting the ductility of SIFCON blocks.

### B. Modes of Failure of SIFCON Material

Localized compression failure

- Shear failure for specimen without hole.
- Shear failure for specimen with hole.
- Uniform compression failure.

## III. DUCTILE BEHAVIOUR OF SIFCON

The CY structural scheme comprises a ductile material to substitute concrete in the compression side of a plastic hinge. Basically there are two methods to achieve CY in a plastic.

- Deposing the concrete with ductile material.
- By using ductile material in compression zone.

Numerous engineering materials such as cementitious, metallic, plastic, elastomeric, polymeric, rubber cement composite materials, etc have been measured for the first type of method. Till today, however, no single material has been obtained to fulfill the necessary requirements, i.e., satisfactory elasticity and stiffness at the service load and a large degree of plasticity, without major strength deviation at the factored load. CY materials requests too much ductility which is a major difficulty. Theoretical study has revealed that this ductility demand is often an order of magnitude higher than that on beam member .Perforated mild steel block is one of the outstanding mechanism solution for the second type of method, namely a P-Block. A mild steel P-block allows a nearly elastic perfectly plastic compressive response to be obtained, which leads to nearly elastic perfectly plastic flexural response in the simply supported beam with almost uncontrolled ductility. Although, study has shown ideal mechanical characteristics of mild steel P-blocks the mechanism also has disadvantages: (1)Due to its deprived resistance to corrosion it agonizes a problem of durability; (2) it has low capacity of fire resistance; and (3) the material is different from the surrounding concrete , which produces additional difficulty in the connection .To determine this problem further efforts testified herein have been made.`

## IV.DISCUSSION ON STUDY

### A. Effect of longitudinal reinforcement –

The stirrups offers significant confinement to the concrete .As the breadth B is greater than the thickness, t, the confinement pressure in the thickness direction manages the compressive resistance of the block.

### B. Effect of perforation-

The void ratio, $v$, is nothing but the total volume of holes over that of the complete block

$$v = n_h . m_{h.}\ \pi . d^2 \frac{100\%}{4. L. B}$$

### *C. Strength of SIFCON block*

Theoretical study has proved that the yield plateau must be nearly flat to satisfy the ductility demand of CY beams. Therefore, a flat yield plateau is the aim for the design of the SIFCON blocks. For the set of results with 0.94% of the stirrup ratio, linear progression gives the following equation

$$\frac{f_y}{f_0} = -1.06v + 0.65$$

and

$$\frac{f_{cu}}{f_0} = -10.55v + 1.51$$

## V. EFFECT OF TRIAXIAL COMPRESSION

According to study, it has been recognized that there is no comprehensive studies have been showed on triaxial behavior of SIFCON block.

### *A. Mohr – coulomb failure criterion*

Mohr – coulomb failure criterion is one of the pressure reliant failure criteria that the pure shear be contingent linearly on the hydrostatic stress. This model is the most applied classical model for clarifying of failure envelope and is still used extensively due to its ease. Mohr-coulomb can be described as

$$\frac{\sigma_1}{f_c} = 1 + k(\frac{\sigma_3}{f_c})$$

### *B. Energy absorption capacity (Toughness)*

According to study SIFCON under triaxial loading quantified totally different behaviour rather than normal FRC. Therefore this study benefits to calculate the toughness of SIFCON by a analogous way corresponding to ASTM C1018.

## VI. CONCLUSIONS

Even if the SIFCON has much more ductile nature than normal concrete, its material ductility is unsatisfactory for use as a CY material. To lessen the strength degradation after the peak reply, the longitudinal reinforcement used to fix the stirrups should be as small as possible. Ductility can also be increased by quarantine in the form of steel stirrups. Mohr – coulomb failure criterion displays that adding steel fibers has significant effect on associated coefficient. Both confining pressure and fiber content have good effect on toughness of HSC upto 78 times.

Triaxial mechanical properties meaningfully depends upon two parameters including the steel fiber volume and confining pressure. Perforation in the form of holes is highly operative in increasing the ductility of SIFCON block when it is combined with stirrups. Such perforation can control the strength of SIFCON block.

## ACKNOWLEDGEMENT

The author appreciatively acknowledge to the guide M. N. Bajad for the full support and guidance during study of review paper, whose valuable guidance and persistent inspiration lead me towards the successful accomplishment of review paper.

## REFERENCES

[1] Y. Farnam, M. Moosav, M. Shekarchi , S.K. Babanajad A. Bagherzadeh Construction Materials Institute, School of Civil Engineering, College of Engineering, University of Tehran, Tehran, Iran. Construction and Building Materials 24 (2010) 2454–2465

[2] Yu-Fei Wu*, Jia-Fei Jiang, Kang Liu Dept. of Building and Construction, City University of Hong Kong, Hong Kong. Construction and Building Materials 24 (2010) 2454–2465

[3] ) B. Abdollahi a, M. Bakhshi b,⇑, Z. Mirzaee c, M. Shekarchi a, M. Motavalli d College of Civil Engineering, University of Tehran, Tehran, Iran Construction and Building Materials 24 (2010) 2454–2465.

[4] Metin Ipek a,⇑, Mecbure Aksu b, Kemalettin Yilmaz c, Mucteba Uysal c. Construction and Building Materials 36 (2012) 765–778.

 