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STUDY OF MECHANICAL PROPERTIES AND DURABILITY OF SIFCON

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ABSTRACT

Slurry infiltrated fibrous concrete a special type of concrete possessing high strength, large ductility and excellent potential for structural applications when accidental loads are encountered. The matrix usually consist of cement slurry with different types of steel fibers. There is use of hooked end type of fibers and it has been recognized that the addition of small, closely spaced and uniformly dispersed steel fibers to concrete would act as crack arrested and would substantially improve its static, dynamic, mechanical properties and durability. In this project the main concept is to study the mechanical properties and durability of SIFCON with partial replacement of cement by fly ash(5%,7.5% and 10%) and two different steel fiber volumes (2% and 3%).

Key words: ***steel fiber reinforcement, fly ash mechanical properties, durability.***

I. INTRODUCTION

SIFCON is unique construction material possessing high strength as well as large ductility and far excellent potential for structural applications when accidental loads are encountered during services. The matrix in SIFCON has no coarse aggregates however it may contain fine (or) coarse sand and additives such as fly ash, micro silica and latex emulsions. 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.Slurry-infiltrated fibrous concrete (SIFCON) is a relatively new material that can be considered as a special type of fibers-reinforced concrete (FRC). In two aspects namely fibers content and the method of production of SIFCON is different from normal FRC. The fibers content of FRC generally varies from 1 to 3 percent by volume but the fiber content of SIFCON varies between 5 and 20 percent.

Slurry-infiltrated fibrous concrete (SIFCON) possesses excellent mechanical properties coupled with greater energy absorption characteristics. In SIFCON, the matrix is made of flowing cement mortar slurry as opposed to aggregate concrete in normal fiber-reinforced concrete. The casting process is also different for SIFCON. In most cases, SIFCON is fabricated by infiltrating a bed of pre-placed fibers with cement slurry. There are four main design factors that should be considered in a SIFCON product these are slurry strength, fiber volume, fiber alignment and type of fiber. The fiber volume depends on the fiber type and the vibration effort needed for proper compaction. Smaller or shorter fibers may pack denser than longer fibers and higher fiber volumes can be achieved with careful and sufficient vibration.

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1.1 Objective

- To determine the compressive strength of SIFCON as a replacement of cement with fly ash.
- To determine the flexural strength of SIFCON as a replacement of cement with fly ash.
- To determine the Split tensile strength of SIFCON as a replacement of cement with fly ash.
- To determine the impact strength of SIFCON as a replacement of cement with fly ash.
- To determine the abrasion strength of SIFCON as a replacement of cement with fly ash.
- To study the influence of Magnesium sulphate chemical attack on SIFCON specimen and to determine its compressive strength after the chemical attack under 28 days chemical water curing.

II. LITERATURE SURVEY

In literature survey of last years different research has been carried out to develop the high performance fiberreinforced in different country under different climatic conditions, assumptions, and materials, etc. 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 fibres in cement matrix could be increased, one could get a material with very high strength properties which he christened as SIFCON. He presented the basic properties of SIFCON such as load-deflection curve, ultimate compressive and flexural strengths, impact and abrasion resistance.

Sundarsana Rao and Ramana tested the SIFCON slab elements under flexure and compared the results with FRC and PCC slabs and concluded that SIFCON slabs exhibit superior performance in flexure when compared to FRC and PCC slabs. He investigated the response of SIFCON two way slabs under impact loading and concluded that the SIFCON slabs with 12% fibre volume fraction exhibit excellent performance in strength and energy-absorption characteristics. He presented the behaviour of SIFCON two way slabs in punching shear and show that the SIFCON slabs with 12% fibre volume fraction exhibits excellent performance in punching shear among other slabs. However, literature review reveals that a very little work has been carried out on SIFCON to determine the durability characteristics.

III. METHODOLOGY

3.1 Mechanical properties

3.1.1 Compression test

Compression test is the most common test conducted on hardened concrete partly because it is an easy test to perform the partly because most of the desirable characteristics properties of concrete are qualitatively related to this compressive strength. The mortar of cement and sand is prepared in the proportion as 1:3.

The water is added to mortar in the ratio with cement as 0.4.

The mortar placed in moulds having forms of cubes with side as 70.6 mm or 76 mm.

The mortar, after being placed in moulds, is compacted in vibrating machine for 2 minutes.

The moulds are placed in a damp cabin for 24 hrs.

The specimens are removed from the moulds and they are submerged in clean water for curing.

The cubes are then tested in compression testing machine at the end of 7 days, 28 days and 56 days.

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3.1.2 Flexure test

The determination of flexural tensile test is essential to estimate the load at which the concrete numbers may crack. As it is difficult to determine the tensile strength of concrete by conducting the direct tension test, it is computed by the flexural testing. The flexural tension strength at the failure is called modulus of rupture. The knowledge of modulus of rupture is useful in pavement of slabs, Air field runways, finding deflections and crack widths as flexural tension is critical in this test. This test is done for the specimens on the age of 7 days, 28 days, & 56 days. The modulus of rupture is determined by testing standard test specimen (prism) of size 100 mm x 500 mm over a span of 400 mm, under symmetrical two point loading according to IS : 516 – 1959.

3.1.3 Impact test

The test was conducted on 110 mm diameter and 40 mm length cylinders. At 28 days impact energy test was conducted and tested. Drop weight type impact test machine was used. The machine was of combination of aggregate impact value test machine and drop weight type test approved by standards of ACI 544 - 1987. The drop hammer for this test weighs 3.5 kg, and it is dropped from a height of 380 mm every time. These specimens were tested at 28 days age, and number of blows required to cause the first visible crack and ultimate failure was recorded. First crack is defined as the first visible crack. Ultimate failure is reached when the cracks have opened sufficiently.

IV. DURABILITY TEST

4.1 Sulphate attack

The most aggressive environmental agent that affects the long term durability of field concrete structure are the chlorides(marine environment deicing salt) and the sulphates(soil, ground water, sea water). Sulphates are found in the form of sodium sulphate (Na2SO4), potassium sulphate (K2SO4), magnesium sulphate (MgSO4) and calcium sulphate (CaSO4), and these salts are highly soluble. When sulphates are present above a certain thresh hold level (>1000ppm), they are known to be detrimental to the concrete. Well-known researchers in the area of durability of concrete reported that the US Bureau of reclenation warned that the concentration of soluble sulphates>0.1% in the soil(150 mg/lit SO4 in water) endanger concrete and more than 0.5% soluble sulphate in soil(over 2000mg/lit SO4 in water) may have a serious effect.

4.2 Ultrasonic pulse velocity test

In this test method, the ultrasonic pulse is produced by the transducer which is held in contact with one surface of the concrete member under a test. After traversing a known path length (L) in the concrete, the pulse of vibrations is converted into an electrical signal by second transducer held in contact with the other surfaces of the concrete member and an electronic timing circuit enables the transit time (T) of the pulse to be measured. The pulse velocity (V) is given by $V=L / T$

The quality of concrete is term of uniformity, incidence or absence of internal flaws, cracks and segregation, etc. indicative of the level of workmanship employed, can thus be assessed using the guidelines given in the table below which have been evolved for characterizing the quality of concrete in structures in terms of the ultrasonic pulse velocity.

4.3 Velocity Criterion for Concrete Quality Grading

Sr.no.	Pulse velocity by cross probing(km/sec)	Concrete quality grading
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3.0	Doubtful

V. ABRASION TEST

The abrasion test was carried out on 70 x 70 x 40 mm test specimens in accordance with IS 1237- 1980 and using a standard abrasion testing machine. The specimens were first dried to open atmosphere under sunlight for 24 hr. Each specimen was then clamped on top of the disk in the machine and was loaded at its centre by a weight of 300 N. Gun powder was used as the abrasive agent. After completing 22 revolutions, the rotation of the disk was stopped. The dust resulting from the abrasion of the specimen and the spill over of the Gun powder was removed. New powder in quantities specimen was turned about its vertical axis through an angle of 90 degrees, and the test was continued until 220 revolutions were completed. The surface was cleaned, and the specimen was weighed

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VII. CONCLUSION

By adopting suitable percentage of steel hooked end fibers with partial replacement of cement by fly ash in different volumes, the mechanical properties as well as the durability of control concrete can be enhanced .

REFERENCES

[1]. Yashar SHAFAEI., “Influence of Hooked-End Steel Fibers on Some Engineering Properties of SIFCON”, thesis for the degree of Master of Science in Civil Engineering, Eastern Mediterranean University, April 2012 ,Gazimağusa, North Cyprus.

ISSN: 2454-9665

[2]. Job Thomas and Ananth Ramaswamy, "Mechanical Properties of Steel Fiber-Reinforced Concrete, JOURNAL OF MATERIALS IN CIVIL ENGINEERING © ASCE / MAY 2007 / 391.

[3]. V. S. Parameswaran, T. S, Krishnamoorthy, K. Balasubramanian, and Santhi Gangadar, "Studies on Slurry-Infiltrated Fibrous Concrete (SIFCON), Transportation Research Record 1382.

[4]. Halit YazNcN , Hu¨seyin Yig˘iter, Serdar AydNn, Bu¨ lent Baradan, "Autoclaved SIFCON with high volume Class C fly ash binder phase" Cement and Concrete Research 36 (2006) 481 – 486.

[5]. L Svermova., P J M Bartos., "Development of insitu SIFCON for connections in precast concrete and seismic resistant structures", 27th Conference on OUR WORLD IN CONCRETE & STRUCTURES: 29 - 30 August 2002, Singapore.

[6]. D. Elavarsi, K Saravanaraja Mohan, "Behavior of Fly Ash Based Slurry Infiltrated Fibrous Concrete", Asian Journal of Applied Sciences, 2013 ISSN 1996-3343

[7]. Surendra P. Shah, James I. Daniel, "Measurement of properties of Fiber Reinforced Concrete", ACI Committee 544.

[8]. Antonie E. Naaman and Joseph R. Homrich, "Tensile Stress- Strain Properties of SIFCON", ACI Materials Journal, V. 86, No.3, May- June 1989.

[9]. I.S. 269-1976, Specifications of Ordinary Portland Cement and Low heat Cement.

[10]. I.S. 650- 1966, Specification for standard sand for testing of cement.

[11]. I.S. 2386 (Part-1) - 1963, Methods of test of aggregate for concrete, part 1 particle size and shape.

[12]. I.S. 2386- (Part3 and Part 4) 1963, Methods of test of aggregate part 4 Mechanical Properties.

[13]. I.S. 2386- (Part 4) 1963, Methods of test of aggregate for concrete.

[14]. I.S. 5816-1999, Method of test for splitting tensile strength of concrete cylinders.

[15]. I.S. 516: 1959, Methods of test for strength of concrete.

[16]. I.S. 456-2000, Code of practice for plain and reinforced cement concrete for general building construction