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An Experimental Investigation on Properties of Slurry Infiltrated Fibrous Concrete under Elevated Temperature

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Abstract: Slurry infiltrated fibrous concrete (SIFCON) is generally another sort elite fiber fortified concrete in which formwork molds are completely filled with filaments and the subsequent fiber arrange is infiltrated by cement based slurry. Penetration is normally accomplished by gravity stream. Utilizing steel strands in concrete not just creates concrete execution against fire and decreases spalling, yet in addition increments auxiliary obstruction by considering pliable conduct of filaments. This investigation centers chiefly around conduct of SIFCON for different fiber volume parts when presented to raised temperatures. The properties of concrete changes when concrete structures presented to outrageous temperature presentations. To anticipate the reaction of structure after introduction to high temperature, it is fundamental that the quality properties of SIFCON concrete exposed to raised temperatures be obviously perceived. Along these lines it is focused on to contemplate another kind of material, named SIFCON and to decide tentatively the quality attributes of SIFCON with 8, 10 and 12% fiber volume portions with and without exposed to raised temperatures. The outcomes acquired when exposed to temperatures are contemplated and contrasted and estimations of qualities of Conventional SIFCON concrete.
Keywords: SIFCON, Temperature, Slurry infiltrated fibrous concrete

I. INTRODUCTION

Slurry infiltrated fiber concrete (SIFCON) is a moderately new exceptional sort of superior (steel) fiber-reinforced concrete. SIFCON is made by supplanting short discrete fibbers in the molds to its full limit or to the ideal volume division, in this way shaping a system. The fiber arrange is then infiltrated by a fine fluid concrete based slurry or mortar. The fibbers can be sprinkled by hand or by utilizing fiber-dispending units for enormous areas. Vibration is forced if vital during putting the fibbers and pouring the slurry. The steel fiber substance can be as much as 30 % by volume. In traditional fiber reinforced concrete (FRC), where fibbers are combined with different elements of concrete, this rate is constrained to just around 2 % for down to earth workability reasons. In view of its high fiber content, SIFCON has novel and predominant mechanical properties in the zones of both quality and malleability. The primary contrasts among FRC and SIFCON, notwithstanding the unmistakable distinction in fiber volume division, lie without coarse total in SIFCON which, whenever utilized, will block the invasion of the slurry through the thick fiber arrange. Moreover, SIFCON contains generally high concrete and water substance when contrasted with traditional concrete. 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 use of SIFCON matrix in reinforced concrete flexural members leads to crack widths 10 times smaller than those obtained using plain concrete. The use of SIFCON matrix in conventional reinforced concrete beams will eliminate the need for stirrup reinforcement. The use of SIFCON matrix in only the compression zone of a flexural member leads to improve ductility and energy absorption. In columns, the use of SIFCON matrix will eliminate the need for ties. From the behavioural viewpoint, the fibres in SIFCON are subjected to frictional and mechanical interlock in addition to the usual bond with matrix. In SIFCON, the cement matrix plays the role of transferring forces between fibres by shear and also as a bearing to keep the fibres interlock. The primary constituent materials of SIFCON are steel fibres/ glass fibre, polypropylene fibres and cement based slurry. The slurry can contain cement and sand or cement and other additives. The presence of steel fibres helps in reducing the crack width and causes lesser damage to the structure. There is immense development in the construction industry. A variety of mass structures are constructed every day through the world. These structures become prey if there is any cyclone or earthquake.

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A. Importance Of The Structures Subjected To Temperature

Concrete is widely used as a primary structural material in construction due to numerous advantages, such as strength, durability, ease of fabrication, and non combustibility properties, it possesses over other construction materials. Concrete structural members when used in buildings have to satisfy appropriate fire safety requirements specified in building codes. This is because fire represents one of the most severe environmental conditions to which structures may be subjected; therefore, provision of appropriate fire safety measures for structural members is an important aspect of building design. Fire safety measures to structural members are measured in terms of fire resistance which is the duration during which a structural member exhibits resistance with respect to structural integrity, stability, and temperature transmission. Concrete generally provides the best fire resistance properties of any building material This excellent fire resistance is due to concrete's constituent materials (i.e., cement and aggregates) which, when chemically combined, form a material that is essentially inert and has low thermal conductivity, high heat capacity, and slower strength degradation with temperature. Clearly, the generic information available on properties of concrete at room temperature is seldom applicable in fire resistance design. It is imperative, therefore, that the fire safety practitioner knows how to extend, based on a priori considerations, the utility of the scanty property data that can be gathered from the technical literature. Also, knowledge of unique characteristics, such as fire induced spalling in concrete, is critical to determine the fire performance of concrete structural members.

B. Need of the Project

Concrete through not is obstinate material, is incombustible and has great heat proof properties. Concrete is a material regularly utilized in the development of elevated structures and particular reason. Concrete if there should be an occurrence of sudden fire, the concrete properties are changed after fire. Consequently, it is critical to comprehend the adjustment in the properties of concrete because of outrageous temperature exposures. As it is utilized for unique reason, the danger of presenting it to high temperature additionally increments. To have the option to foresee the reaction of structure after presentation to high temperature, it is basic that the quality properties of concrete exposed to raised temperatures be plainly comprehended. High temperature can cause the advancement of breaks. These splits like some other breaks 6 engendering may in the long run cause loss of basic respectability and shorting of administration life. Thus in the current examination, an investigation has been done on SIFCON concrete examples to contemplate the its quality attributes when presented to raised temperatures.

C. Objectives of the Project

1) To study the strength characteristics of SIFCON without subjected to elevated temperatures for various percentages of fibre volume fractions at 7days and 28 days of curing.
2) To study the residual strengths of SIFCON for 8%, 10% and 12% of steel fibre fractions at 28 days for 2 hours of exposure.
3) To compare the results of strengths of SIFCON among different fibre fractions before and after heating

II. METHODOLOGY

30 concrete cubes of size 150x150x150mm and 30 cylinders of size 150mm diameter and 300mm height and 30 prisms of size 500 x 100 x 100mm have been cast. After the casting the specimens kept in portable water tank for 28days for curing. After curing, the specimens were removed from the tank and allow for drying at room temperature. Some specimens were tested in room temperatures, and remaining specimens are exposed to elevated temperatures by using electric oven. After heating as per the prescribed temperature and exposure times, the specimens have to be tested. The test program consisted of carrying out compressive test, split tensile strength test and modules of rupture strength test at different temperatures and 2hrs of exposure time.

A. Preparation and Casting of test Specimens

The first step in preparing SIFCON is placing the fibres into the moulds, up to the required volume fraction. No vibration was imposed during fibre placing for the specimens with a Vf of 8 % to insure filling the moulds without large voids, while a light vibration was applied in the case of Vf of 12 %, and the vibration was relatively intense in the case of the maximum Vf (12 %) to ensure filling the mould with the required quality of fibres. The vibration was externally applied using a vibrating table. The weight of steel fibre to be put in the mould depends on the required volume fraction, the dimensions of the mould, and, of course, on the specific gravity of the steel itself. After being filled with steel fibres up to the required volume fraction, the moulds were filled with the slurry or mortar matrix which has to be flow able enough to ensure complete infiltration through the dense beds of fibres in the mould. Usually, vibration during matrix placing was necessary to avoid honeycombing or voids.

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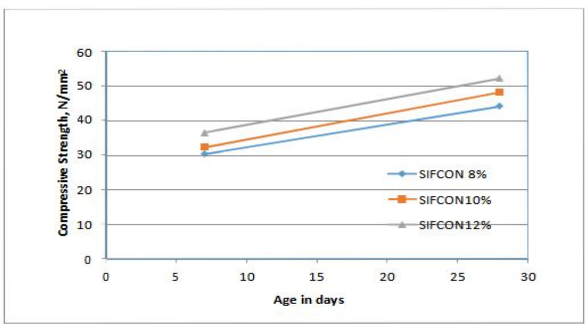
One of the important aspects in the fabrication of SIFCON is fibre orientation. As might be expected, when steel fibres are placed onto a substrate or into a mould, a preferred fibre orientation occurs. The orientation is essentially two–dimensional, perpendicular to the gravity vector. The orientation effect is more exaggerated with some fibres than with others. In general, there is a trend toward a three-dimensional fibre orientation that accompanies reduction in fibre diameter and aspect ratio.

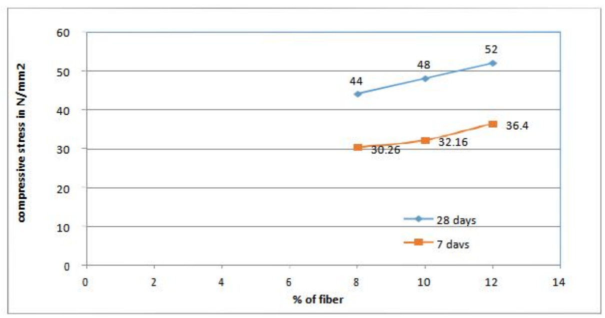
Fig: Preparation and casting of test specimens

III. RESULTS AND DISCUSSIONS

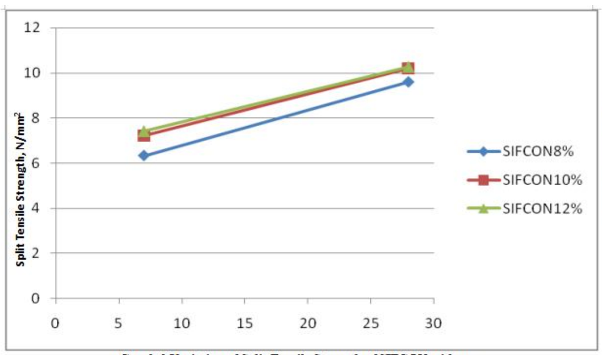
Series of tests were conducted on concrete specimens to obtain the strength characteristics of SIFCON concrete for application in civil engineering field. From the experimental investigation the values obtained have been represented graphically to show the behaviour of SIFCON concrete with various fibre volume fractions with and without being subjected to elevated temperature



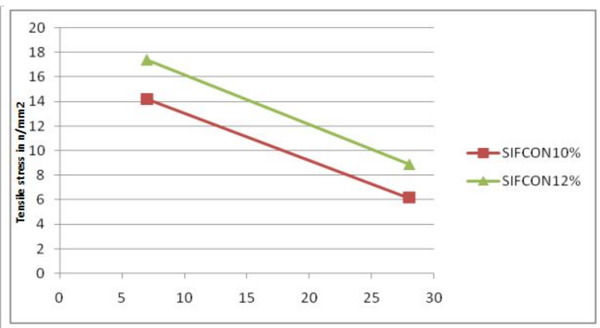
Graph 1 Variation of Compressive Strength of SIFCON with age



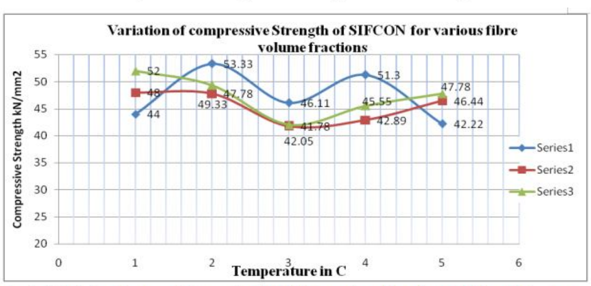
Graph 2 Variation of Compressive Strength of SIFCON with % of fibre volume fraction at 7 & 28 days



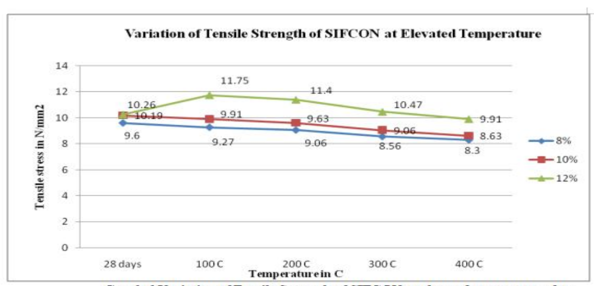
Graph 3 Variation of Split Tensile Strength of SIFCON with age



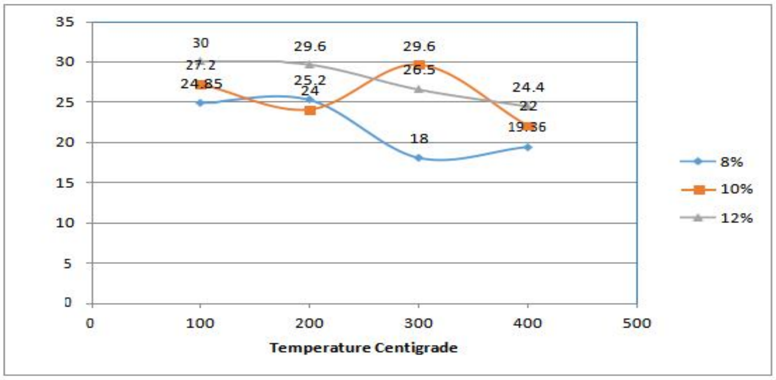
Graph 4 Variation of Split tensile strength of SIFCON for different fibre volume fractions with % of fibre fraction



Graph 5 Variation of compressive Strength of SIFCON for various fibre volume fractions subjected to elevated temperatures.



Graph 6 Variation of Tensile Strength of SIFCON at elevated temperature for various fibre volume fractions with elevated temperature



Graph 7 Variation of Modulus of Rupture Strength of SIFCON for various fibre volume fractions with elevated temperatures.

IV. CONCLUSIONS

The following conclusions are drawn from the investigations

A. From the experimental study, it can be said that strength properties of SIFCON significantly increased as the percentage fibre volume fraction increases.
B. Amongst 8, 10 and 12 % of fibre volume fractions, 12% fibre fraction showed the maximum values in Compression and Tension. This is due to the higher volume fraction of fibres present in the specimen. Because the slurry strength, fibre volume, fibre alignment and fibre type greatly influence the strength of SIFCON specimens.
C. The increase in Compressive Strength of SIFCON with 10% of fibre fraction is 6.27% at 7 days and 9.09% at 28days when compared to SIFCON with 8% of fibre fraction. Similarly SIFCON with 12% of fibre fraction is 20.30% at 7 days and 18.18% at 28days when compared to SIFCON with 8% of fibre fraction.
D. The increase in Split Tensile Strength of SIFCON with 10% of fibre fraction is- 14.21% at 7 days and 6.15% at 28days when compared to SIFCON with 8% of fibre fraction. Similarly SIFCON with 12% of fibre fraction is 17.40% at 7 days and 8.87% at 28days when compared to SIFCON with 8% of fibre fraction.
E. The residual strength of concrete decreases as the exposure temperature increases for 2hours of exposure condition.
F. The strengths of SIFCON concrete with and without being subjected to elevated temperatures for 28 days have reached the target mean strength.
G. The value of Compressive Strength of SIFCON with 8% of fibre fraction was found to increase when they are exposed to 100^0C at both 7 days and 28 days for 2 hr duration. The increase in strength is 21.20% for 100^0 C. Further decrease in compressive strength is observed by 4.80% at 200^0C, increase in compressive strength is by 16.59% at 300^0C and decrease in compressive strength is observed by 4.05% at 400^0C respectively. Whereas for 10% and 12% fibre fraction, the decrease in strength is observed up to 200^0C and further increase in strength is observed as the elevated temperature increases beyond 200^0C.

When compared to conventional normal SIFCON concrete, the Split Tensile Strength of SIFCON is found to be decreased when the cylinders were exposed to all temperatures for 2hr duration. The decrease in strength is 3.44% at 100^0C, 5.62% at 200^0C, 10.83% at 300^0C and 13.54% at 400^0C respectively

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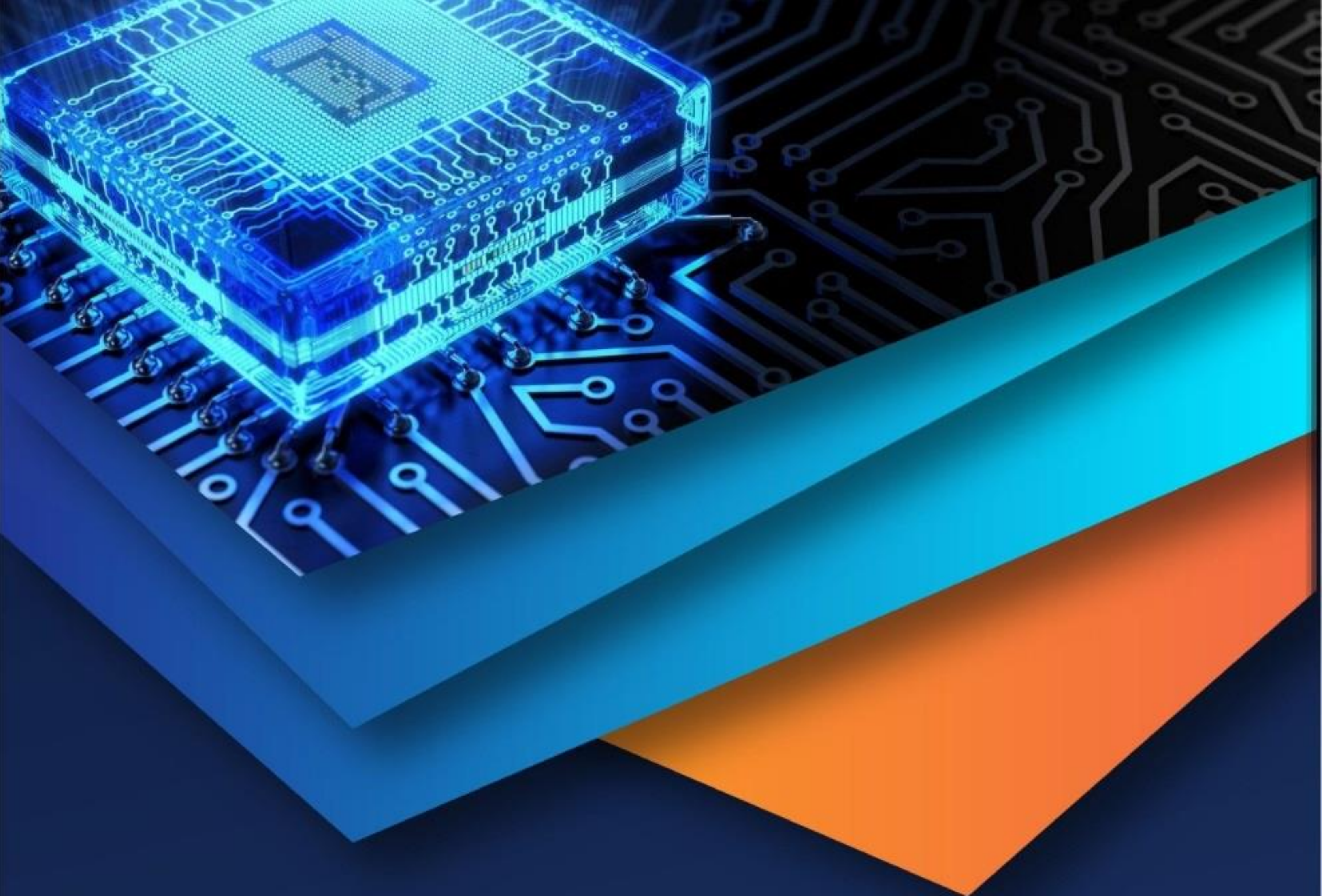

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