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EXPERIMENTAL STUDY ON BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE USING CALCIUM SILICATE

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Abstract-The need and to cater the demands of the construction industry, extensive and elaborate research work is being carried out in the area of Concrete TechnologyResearch work have been pursued to develop new variants in concrete like compositeconcrete, special concrete. In this Mechanical &Flexural behavior of Reinforced concrete using steel fiber cum calcium silicate has been analysed using different ratio of steel fibres . It is a non-combustible material which makes fire safe and able to withstand high temperature as well as impact resistance. In order to improve the performance of concrete.

Key words : Steel fibre,concrete,compressive strength,calcium silicate

I.INTRODUCTION

Globalisation paves the way for rapid development in terms of modernisation which results the consumption of natural resources in an exorbitant manner. The results of these developments were ecological imbalances which in turn force the world for to develop new strategies in terms of renewable energy utilisation. The frequent cases of fire occurrences in buildings have always been of great concern to the society for the risks itposes to both human lives and property. Fires can occur at any time in a building and the safety of occupants and the ability of structures to maintain its integrity are very important to the people. Building codes and regulations specify detailed measures for the safety of structural members in the event of a fire. Common structural materials are concrete, steel, bricks, timber, fibre reinforced plastic (FRP) composites. Each of these materials resist fire differently and scientist are working tirelessly to improve their fire rating. Fire resistance can be defined as the ability of structural elements to withstand fire or to give protection from it (IBC, 2006). This includes the ability to confine a fire or for a structure to continue to perform its structural functions after fire incidence or both. Fire Resistance Rating (or fire rating), is defined as the duration of time that an assembly (roof, floor, beam, wall, or column) can endure a "standard fire" as defined inASTM E 119 (ASTM, 2000).

II. STEEL FIBER

The use of Steel Fiber Reinforced Concrete (SFRC) has received much attention in concrete industry as more research is being performed and more is being understoodabout its material properties and behavior. Steel fiber reinforced concrete（SFRC） has the ability of excellent tensile strength, flexural strength, shock resistance, fatigue resistance, ductility and crack arrest. Therefore, it has been appliedabroad in various professional fields of construction, irrigation works and architecture. When steel fibers are added to high strength concrete, the increase in fiber volumetric ratio results in an increase in thecompressive strength of the concrete and a considerable amount of increase in the tensile strength of the fiber reinforced specimens is observed in split cylinder tests.

PROPERTIES OF STEEL FIBER

Flexural Strength: Flexural bending strength can beincreased of up to 3 times more compared to conventionalconcrete.
Fatigue Resistance: Almost 1 1/2 times increase infatigue strengthImpact Resistance: Greater resistance to damage incase of a heavy impact.Permeability: The material is less porousAbrasion Resistance: More effective compositionagainst abrasion and spalling.Shrinkage: Shrinkage cracks can be eliminated.Corrosion: Corrosion may affect the material but itwill be limited in certain areas

III CALCIUM SILICATE POWDER

Calcium silicate (often referred to by its shortened trade name Cal-Sil orCalsil) is the chemical compound Ca 2 SiO 4 ,also known as calcium orthosilicate and sometimes formulated 2CaO.SiO 2 . It is one of a group of compounds obtained by reacting calcium oxide and silica in various ratios.Calcium silicate is a white free- flowing powder derived from limestone and diatomaceous earth. It has a low bulk density and high physical water absorption. It is used in roads, insulation, bricks , roof tiles, table salt and occurs in cements, where it is known as belite (or in cement chemist notation C 2 S).It is used as an anti-caking agent in food preparation and an antacid . It is approved by the United Nations' FAO and WHO bodies as a safe food additive in a large variety of products.

Calcium silicate is commonly used as a safe alternative to asbestos for high temperature insulation materials. Industrial grade piping and equipment insulation is often fabricated from calcium silicate. Its fabrication is a routine part of the curriculum for insulation apprentices . Calcium silicate competes in these realms against rockwool as well as proprietary. insulation solids, such as perlite mixture and vermiculite bonded withsodium silicate. Although it is popularly considered an asbestos substitute, early uses of calcium silicate for insulation still made use of asbestos fibers.

IV MATERIALS USED AND TESTS

TESTS FOR CEMENT

The ordinary Portland cement confirming to IS 4031 was used for the preparation of specimens. OPC 53 grade was used.

- Specific gravity of cement G = 3.134
- Percentage of fineness = 3.6%
- Consistency of the given sample of cement, P = 32%
- Final Setting Time of Cement = 10 hours
- Initial Setting time 30 minutes

TESTS ON FINE AGGREGATE

It confirming to zone II of IS 383-1970.Sand is used in the work which has the particle was less than 4.75mm.

- Fineness modulus = 4.83
- Bulk density of fine aggregate in loose state = 1620.64 kg/m^3
- Bulk density of fine aggregate in rodded state = 1782.46 kg/m^3

TESTS FOR COARSE AGGREGATE

The coarse aggregate particles passing through 20mm and retained on 12.5 mm I.S Sieve used as the natural aggregate which met the grading requirement of IS383-1970.

- Specific gravity of coarse aggregate = 2.6
- Water absorption = 0.56%
- Coarse aggregate Impact Value = 15%
- Fineness modulus = 8.4
- Bulk density of coarse aggregate in loose state = 1553.46 kg/m^3
- Bulk density of coarse aggregate in rodded state = 1693.15 kg/m^3

V. PREPARATION OF CONCRETE CUBES, CYLINDERS AND PRISMS

The coarse aggregate, fine aggregates, cement and water is used to make cement concrete. The damping rod is used for compacting during casting. The concrete cubes of size 150 x 150 mm x150 mm , cylinder of size 150 mm x 300 mm and prism of size 100 x 100 mm x 500 mm are casted and are placed in water for curing for 28 days.

VI .EXPERIMENTAL INVESTIGATION ON STRENGTHPROPERTIES

1. COMPRESSIVE STRENGTH TEST

The load applied to opposite side of the cubes as cast.The maximum load was applied to the specimen until the failure recorded.

Compressive strength = Ultimate load / Contact

area of the cube

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Fig1. Compressive strength test

TYPE OF CONCRETE	COMPRESSIVE STRENGTH (N/mm^2)	
	7^{th} day	**28^{th} day**
Control	20.8	31.11
CSF-1	21.8	32.66
CSF-2	21.11	30.8
CSF-3	17.3	28
CSF-4	15.3	24.44

Table 1. Compressive strength test results

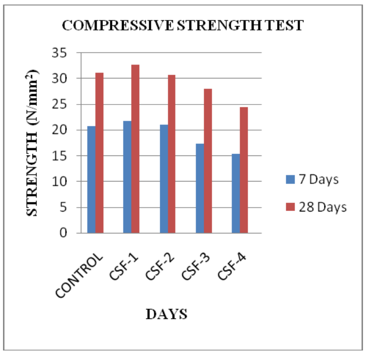


Fig.2. Graph showing variations in Compressive strength test

2.SPLIT TENSILE STRENGTH TEST

The wet cylinder specimen is placed on the strip horizontally with its axis perpendicular to the loading direction. The second steel rod is then placed lengthwise on the cylindrical centrally. The maximum load is applied to the specimen is noted ad the splitting tensile strength is calculated as follows.

Split Tensile strength = 2P/ (ΠLD)

Where,P = the compressive load o the cylinder

L = Length of the cylinder in mm

D = Diameter of the cylinder in mm

Fig3. Split Tensile Test

Table 2. Split Tensile Strength Test results

TYPE OF CONCRETE	SPLIT TENSILE STRENGTH (N/mm^2)	
	7^{th} day	**28^{th} day**
Control	1.55	2.33
CSF-1	1.69	2.829
CSF-2	1.84	2.47
CSF-3	1.25	1.414
CSF-4	0.51	0.707

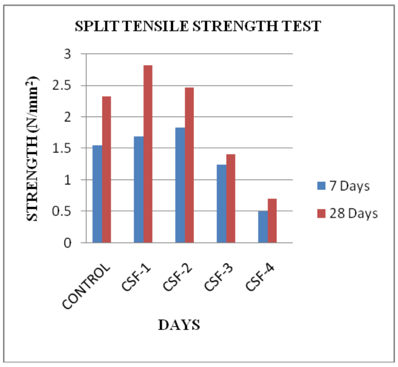


Fig 4. Graph showing variation in split tensile test

3. FLEXURAL STRENGTH TEST

Two additionalloading rollers were placed on top the beam as shown inFigure-1. The load was applied without shock at a rate of200m/s. The flexural strength was then calculated usingthe formula below:

Flexural strength = $3pl/bd^2$

b= breadth of the specimen

TYPE OF CONCRETE	FLEXURAL STRENGTH (N/mm^2)
	28th day
Control	6.787
CSF-1	6.825
CSF-2	6.15
CSF-3	5.625
CSF-4	3.03

Table 3. Flexural strength Test results

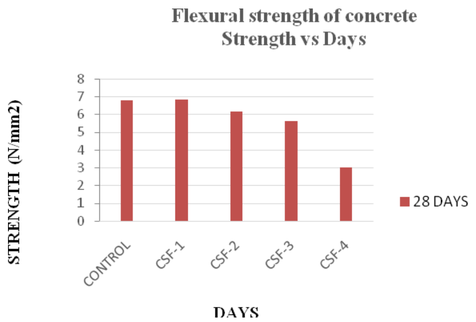
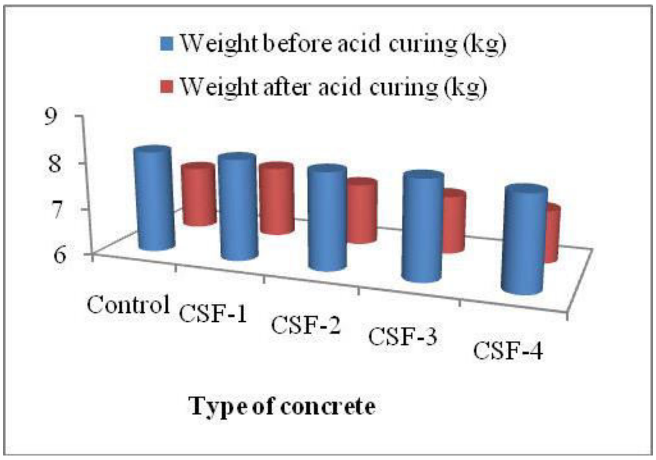


Fig 5. Graph showing variation in Flexural strength Test

4.ACID RESISTANCE

Acid resistance was tested on 150 mm size concrete cube specimens at the age of 28 days of curing. The cubespecimens were weighed and immersed in water diluted with five percent by weight of Hydro Chloric acid for 7, 14, 28days. Then, the specimens were takenout from the acid water and the surfaces of the cubeswere cleaned. Then, the weight and the compressivestrength of the specimens were found out and

Fig 6.Acid attack on Concrete



Type of Concrete	Weight (Kg)			Compressive Strength (N/mm^2)		
	Before curing	After curing	Reduction of weight %	Before curing	After curing	Reduction of strength %
Control	8.188	7.085	13.47	31.11	29.36	5.96
CSF-1	8.176	7.128	12.82	32.66	31.52	3.6
CSF-2	8.08	7.164	11.34	30.8	28.34	8.6
CSF-3	8.115	7.325	10.78	28	25.58	9.4
CSF-4	8.33	7.256	14.83	24.44	22.68	7.76

Table 4. Acid Curing results

CONCLUSION

The following conclusions could be drawn from the present investigation.

The Maximum values of compressive strength ($32.66N/mm^2$),Split tensile strength($2.829 N/mm^2$),Flexural strength($6.825N/mm^2$) after 28 days with addition of 1% steel fiber and 3%calcium silicate in to the mix as compare with normal M30 grade concrete without any additives.

It is observed 6% of calcium silicate added to get good impact resistant of concrete.

Finally the test result indicate that addition of minimum percentage of calcium silicate increasing compressive strength as well as impact resistant

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