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# Experimental Study on Fiber Reinforced Self Compacting Concrete

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***Abstract: Originally developed in Japan, SCC technology was made possible by the much earlier developed of super plasticizers for concrete. SCC has now been taken up with enthusiasm across Europe, for both site and precast concrete work. The use of Self Compacting Concrete is spreading worldwide because of its very attractive properties in the fresh state as well as after hardening. To qualify SCC mixes slump flow, V funnel, L Box, U box tests were conducted and fresh properties obtained are checked against the specifications given by EFNARC Guidelines. Compressive strength tests were conducted to know the strength properties of the mixes at the age of 7 and 28 days of curing. The use of SCC will lead to more industrialized production, reduce the technical cost of in situ cast concrete constructions, improve the quality, durability and reliability of concrete structures and eliminate some the potentials for human error. It will replace manual compaction of fresh concrete with modern semi-automatic placing technology and in that way improve health and safety on and around the construction site.***
***Keywords: Self Compacting Concrete, Glass Fiber, Steel Fiber, Compressive Strength, Spilt tensile Strength***

## I. INTRODUCTION

Self-compacting concrete (SCC) has been described as "the most revolutionary development in concrete construction for several decades". Originally developed to offset a growing shortage of skilled labour, it has proved beneficial economically because of a number of factors, including:-

1) Faster construction
2) Reduction in site manpower
3) Better surface finishes
4) Easier placing, Improved durability
5) Greater freedom in design
6) Thinner concrete sections
7) safer working environment.

Originally developed in Japan, SCC technology was made possible by the much earlier development of super plasticisers for concrete. SCC has now been taken up with enthusiasm across Europe, for both site and precast concrete work. It was developed to overcome Deficiency of skill manpower and problem of placing and compacting congested civil engineering structures. Subsequently it has been observed that SCC not only reduces the requirements of man power, both skill and unskilled, but also results in more durable concrete

### A. *Problem Summary*

Self-Compacting Concrete is nowadays a highly used concrete in the field of construction where there are many complications for compaction. The utilization of SCC is not only for perplexed joints but it is withal utilized for an architectural purport. The mundane concrete is composed of sand cement and aggregates, but now the engineers have done much to ameliorate the strength and other factors in the concrete design, and then they came across to the compaction factor than the used admixtures in concrete to make it compacting. And then the factor was solved utilizing the super plasticiser's admixture. But then came the properties, strength plays the main role in concrete than any other factors. So the main reason to be consummated was strength in SCC. The concrete was self-compacted but to increment in strength utilizing same design was the main quandary. Then we came across the solutions to utilize admixtures in the SCC. The admixtures used were construction fibers. For outer strength i.e. resistance for cracking we used glass fiber and for inner strength, we used steel fibers. So the properties to fulfil our requirements were solved using fibers i.e. strength.

Second thing comes fluidity, which is necessary for SCC so if we admixtures we can also make concrete fluid and by adding another admixture i.e. fiber we can also achieve desirable strength in SCC.

## II. LITERATURE REVIEW

Shahana Sheril P.T.[1]analysed that Self-compacting concrete is a relatively invention in concrete and the addition of fibers to it shows improved strength properties. Several studies have been done on self-compacting concrete with fiber addition. The SCC and GFRSCC mixtures had a cement replacement of 25% fly ash and the addition of glass fiber at 0.05%, 0.10%, 0.15% and 0.2% on total volume of mix. For testing its properties in the fresh state, slum−flow test, L−box, and V−funnel were used. Compression (strength of 7 and 28 days), flexural and split tensile strength tests were carried out. The SCC developed split tensile Strengths ranging from 3.7MPa to 4.75 MPa for M20 grade and from 4.53 MPa to 4.8 MPa for M30 grade. GFRSCC with 0.1% glass fiber showed the substantial increase in the flexural strength than the other specimens.

Thomas Paul, Habung Bida, Bini kiron, Shuhad A K [2] investigated that the use of steel fibers in self-compacting concrete to enhance the physical and mechanical properties of self-compacting concrete. The objective of the study was to determine and compare the differences in properties of Normal concrete, SCC containing without steel fibers and SCC with steel fibers at different proportions. This experimental investigation was carried out to study the compressive strength, flexural strength, Split tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0%, 0.4%, 0.8% and 1.2% volume fraction of end hooked steel fibers. Steel fiber of aspect ratio 75 was used. The result data obtained has been analysed and compared with a specimen having 0% steel fiber. The workability of SCC significantly reduced as the fiber dosage rate increases. The research paper proposes that due to these properties of steel fiber reinforced self-compacting concrete; it can be used at places where compaction is not possible and for the design of curvilinear forms.

Jayanta Chakraborty, Sulagno Banerjee [3] studied that It has been widely accepted that in the concrete industry the conventional concrete mixes also suffer from plastic shrinkage during the setting period and even can often lead to cracking. This paper discusses in detail a comprehensive review on various aspects of Glass and Steel Fiber Reinforced Self Compacting Concrete in regards to behaviour, applications and performance. Glass fiber reduces the possibility of cracks and improves the surface integrity as well as its homogeneity by the reduction in bleeding. Workability of self-compacting concrete decreases with increase in steel fiber volume fraction. Glass fibers increase the strength of concrete, without causing any problems. The addition of steel and glass fibers increases the Compressive strength to a great extent. The addition of steel and glass fibers improves the durability and the fracture parameters of concrete.

K.C.Denesh[4] analysed the fresh and hardened properties of SCC (M30&M40) with various steel fiber proportions.he found that hardened properties of M40 with 1% steel fiber gives better result. Use of fly ash improve setting characteristics but do not achieve required flow properties.

Mohammed Karem Abd[5]concluded that adding of glass fiber would reduce value of slump flow,T50cm, and time flow of V-funnel test. Also he found that compressive, splitting strength and modulus of rupture increase with increase in volume of fibers.

## III. OBJECTIVES OF PRESENT STUDY

The main aim of SCC was to fulfil the workability factor that is fluidity of concrete without segregation. As it is used in main structural members like beam and slab then another factor comes is strength. To increase the strength of the concrete admixtures are used.Presently in today's condition, it is not only needed for compaction but also in some super solid structures, the SCC is used. The SCC is also used for architectural purposes. In today’s developing infrastructure the shape and size of various buildings are unique where compaction is not easy or it is complicated than in that places or projects SCC are essential. For elevation purpose, the concrete's desirable colour is white so to fulfil that requirement use of pigment is done in SCC and is used in elevation also where compaction and painting is complicated. It is also designed for the lighting of the weight of concrete for elevation purposes. The next thing is strength factor; this experiment is done for mainly strength purposes in the SCC and to get desirable strength without compaction. To achieve the desirable strength of SCC using fibers. To achieve the fluidity using admixtures in SCC without segregation of materials.

Fig 1 Glass fiber


Fig 2 Steel fiber

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## IV. MATERIALS/TOOLS

1) *Cement:* The cement used in the present study is 43 Grade Portland Pozzolana Cement, and the strength targeted was greater Than 30MPa.
2) *Sand:* The sand used was river sand with the specific gravity of 2.61, and an absorption capacity of 0.03%
3) *Fine Aggregate:* The coarse aggregates, obtained from a local source, had a specific gravity of 2.64 for 20 mm down Aggregates and 2.67 for 10 mm down aggregates.
4) *Steel Fibers:* Cross section of the steel fibers used was circular with a diameter of 1mm; the fibers were straight without any anchorage at the edges. They were obtained by cutting the locally available binding wire with length 50mm and hence maintaining an aspect ratio of 50 throughout the work.
5) *Glass Fibers:* The Cem-FIL Anti – Crack glass fibers were used. The glass fibers used are of Cem-FIL Anti-Crack HD with modulus of elasticity 72 GPA, Filament diameter 14 microns, specific gravity 2.68, and length 12 mm.
6) *Water:* Potable water conforming to IS 3025–1986 part 22 & 23 and IS: 456–2000 was used in the investigations.
7) *Admixtures:* Super plasticizer by MYK SCHOMBLUE high- performance Construction chemical Conforming to IS: 9103–1999 was used in the present investigations

### A. *Tools/Test ON SCC*

Table:1 Tools/Test on Scc

| TEST TO BE CARRIED OUT | PROPERTOES TO BE DETERMINED |
|---|---|
| Slump test | Passing ability |
| V-funnel test | Passing ability |
| J-ring test | Passing ability |
| L-box | Filling ability |
| U-box | Filling ability |
| Fill box | Filling ability |

### B. *Properties of Glass Fibres*

The design of glass-fiber-reinforced concrete panels uses knowledge of its basic properties under tensile, compressive, bending and shears forces, coupled with estimates of behavior under secondary loading effects such as creep, thermal response and moisture movement.

### C. *Properties of Steel Fibers*

1) Increasing the initial first crack strength.
2) Large numbers of fibres intercepting the micro-cracks and preventing propagation by controlling tensile strength.
3) Unlike rebar and welded wire fabric, fibres are dispersed throughout the slab to Reinforce isotopically, so there is no weak plane for a crack to follow.
4) Significantly reduced risk of cracking.
5) Reduced spalling joint edges.
6) Stronger joints., High impact resistance

## V. DESIGN METHODOLOGY

### A. *Mix Design*

As per requirement of mixed design, all data are collected through various tests of materials and mix design can be calculated. Following is the mixed design of concrete as per IS10262:2010.

### B. *Design Stipulation*

Table:2 Design stipulation

| | | |
|---|---|---|
| 1 | Grade designation | M30 |
| 2 | Maximum nominal size of aggregate | 10mm (angular) |
| 3 | Degree of Workability | 0.90 compacting factor |
| 4 | The degree of quality control | Good |
| 5 | Type of exposure | Moderate |

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*1) Test Data For Materials*

Table:3 Test data for materials

| | | |
|---|---|---|
| 1 | Cement used | PPC grade IS:269-1989 |
| 2 | The specific gravity of cement | 3.15 |
| 3 | A specific gravity of Coarse aggregate | 2.80 |
| 4 | A specific gravity of Fine Aggregate | 2.70 |

*2) Solution*

*a) Step-1:* Target mean strength of concrete
fck = fck + t x s
fck = 30 N/mm2
t = 1.65 (for proportion of low results 1in20 IS: 1343-1980)
s = 4.00 (Standard deviation (as per table-1 IS: 10262-2009)
fck = 30 + 1.65 x 4 = 36.6 N/mm2 (MPa) get avg. compressive strength at 28day
fck = characteristics compressive strength at 28days
fck = fck + t x s
30+1.65*4 =36.6 N/mm2

*b) Step-2:* Selection of water cement ratio
From table-5.4 IS: 456-2000 maximum water-cement ratio (see note under 4.1) = 0.50
Based on experience adopt water-cement ratio as 0.55 as the cement is grade 53 Grade
Hence, OK

*c) Step-3:* Selection of water and sand content
From table 9.7, for 20mm nominal maximum size aggregate and sand conforming to grading zone-II, water content per cubic meter of concrete = 186 kg and sand content as the percentage of total aggregate by absolute volume = 35%. i.e.
Water = 176 kg/m3 of concrete
Sand = 35% of total aggregate by absolute volume.
For change in values in water-cement ratio, compacting factor and sand belonging to Zone-I, the following adjustment is required.

Table:4 water and sand content

| Sr no | Change in condition | Water content% | Percentage sand in total aggregate |
|---|---|---|---|
| 1) | For decrease in water-cement ratio (0.60-0.44) that is 0.16 ∴ (0.16/0.05)*1 = 3.2 | 0 | -3.2 |
| 2) | For increase in compacting factor (0.9-0.8) = 0.1 ∴(0.1/0.1)*3 = 3.0 | +3 | 0 |
| 3) | For sand conforming to zone-I of Table 4 of IS: 383-1970. | 0 | +1.5 |
| | Total | +3 | -1.7 |
| ∴Required water content = 176+ 7.3 = 181.3 lit/$m^3$ | | | |

Required sand content as percentage of total aggregate by absolute volume
P = 40-3.5 = 36.5%

*d) Step-4:* Calculation of cement content
Water cement ratio = 0.55
Water = 181.3 liter = 182 kg
W/c = 0.55

182/c = 0.55
c = 402.8 kg/m3
= 403 kg/m3
From table-5 IS: 456 minimum cement content for moderate exposure condition = 300 kg/m3
Hence, 403 kg/m3 > 300 kg/m3 OK…

*e) Step- 5:* Determination of CA and FA content
Consider volume of concrete = 1m3
But, entrapped air in wet concrete = 2%
Absolute volume of fresh concrete V = 1 m3
V = (W + C/SC + 1/p * fa/Sfa) * 1/1000...... For fine aggregate
1 = (182 + 403/3.15 + 1/0.365 * fa/2.70) * 1/1000
1 = 331.269 + [1.053 fa] 1/1000
fa = 899.4 kg
Similarly, .Ca = 967.6 kg/m3 .mass of C.A.

### *C. Mix Proportion [M30]*

Table: 5 Mix proportion

| Water | Cement | Sand | Grit | Glass Fiber% | Steel Fiber% | Admixture kg/m3 |
|---|---|---|---|---|---|---|
| 210 lit. | 382 kg | 635.07 kg | 1104.85 kg | 0.03 | 0.50 | 3.62 |
| 0.70 | 1.28 | 2.14 | 3.72 | - | - | - |

Cube Size= .15*.15*.15= 3.375*10-3
Total Quality for 1 cube= .7 + 1.28 + 2.14 + 3.72 = 7.84 kg
Now,

1) In SCC, required steel fibers are 0.5 % of total weight of concrete.
2) In SCC, a Glass fiber is 0.03% of total weight of concrete.
3) In SCC, Admixtures is 1% of weight of cement

### *D. Mix Proportion [M30]*

Table: 6 Mix proportion

| Water | Cement | Sand | Grit | Glass Fiber% | Steel Fiber% | Admixture kg/m3 |
|---|---|---|---|---|---|---|
| 182 lit. | 403 kg | 899.4 kg | 967.6 kg | 0.05 | 1 | 5.24 |
| 0.61 | 1.36 | 3.03 | 3.26 | - | - | - |

Cube Size= .15*.15*.15= 3.375*10-3
Total Quality for 1 cube= .7 + 1.36 + 3.03 + 3.26 = 8.35 kg
Now,

1) In SCC required steel fibers are 1 % of total weight of cement.
2) In SCC, Glass fibers are 0.05 % of total weight of cement.
3) In SCC, Admixtures is 1.2 % of weight of cement.

## VI. TEST REPORT

### *A. Slump Flow Test*

| Water | Cement | Sand | Grit | Slump flow test (mm) | Glass Fiber% | Steel Fiber% | Admixture kg/m3 |
|---|---|---|---|---|---|---|---|
| 210 lit. | 382 kg | 635.07 kg | 1104.85 kg | 300 mm | 0.03 | 0.50 | 3.62 |
| 182 lit. | 403 kg | 899.4 kg | 967.6 kg | 670 mm | 0.05 | 1 | 5.24 |

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*B. Flow Test*

*1)* L-box test

| Test | Flow time | Initial/start Thk(cm) | End/last Thk(cm) |
|---|---|---|---|
| L-box test | 39 | 5.5 | 2.5 |
| L-box test | 32 | 5.7 | 2.7 |

*2) U-box test*

| Test | Flow time | Initial/start Thk(cm) | End/last Thk(cm) |
|---|---|---|---|
| L-box test | 39 | 5.5 | 2.5 |
| L-box test | 32 | 5.7 | 2.7 |

*C. Compressive Strength Test*

After 7-days (1st mix proportion)

| grade | Weight in kg | Density gm/cc | Observed load,KN | Compressive strength N/mm$^2$ |
|---|---|---|---|---|
| M-30 | 8.512 | 2.522 | 605.0 | 26.89 |
| | 8.469 | 2.509 | 611.5 | 27.18 |
| | 8.532 | 2.528 | 603.0 | 26.8 |
| | Average | | | 26.96 |
| After 7-days(2nd mix proportion) | | | | |
| M-30 | 8.623 | 2.554 | 605.0 | 22.77 |
| | 8.658 | 2.563 | 611.5 | 23.65 |
| | 8.693 | 2.572 | 603 | 24.02 |
| | Average | | | 23.48 |

Flexural Strength Test

| Sr no | Identification mark | Weight in kg | Failure load kg | Flexural strength Kg/cm$^2$ | Flexural strength (N/mm$^2$) |
|---|---|---|---|---|---|
| 1 | Beam-1 | 39.8 | 1550 | 32.15 | 3.21 |
| 2 | Beam-2 | 39.51 | 1600 | 33.19 | 3.32 |
| 3 | Beam-3 | 39.66 | 1525 | 31.63 | 3.16 |
| | | | | Average | 3.23 |

## VII. CONCLUSIONS

*A.* Glass fiber reduces the possibility of cracks and improves the surface integrity as well as its homogeneity by the reduction in bleeding.

*B.* Glass fibers increase the strength of concrete, without causing any problems.

*C.* The addition of steel and glass fibers increases the compressive strength to a great extent.

*D.* The addition of steel and glass fibers improves the durability and the fracture parameters of concrete. The slump value decreases as fiber quantity increases. Thus, workability decreases with increase in fiber content.

*E.* Ductility of SCC is found to increase with the increase in the fiber content. Thus, the width of cracks is found to be less in steel fiber reinforced SCC than that compared to plain cement concrete.

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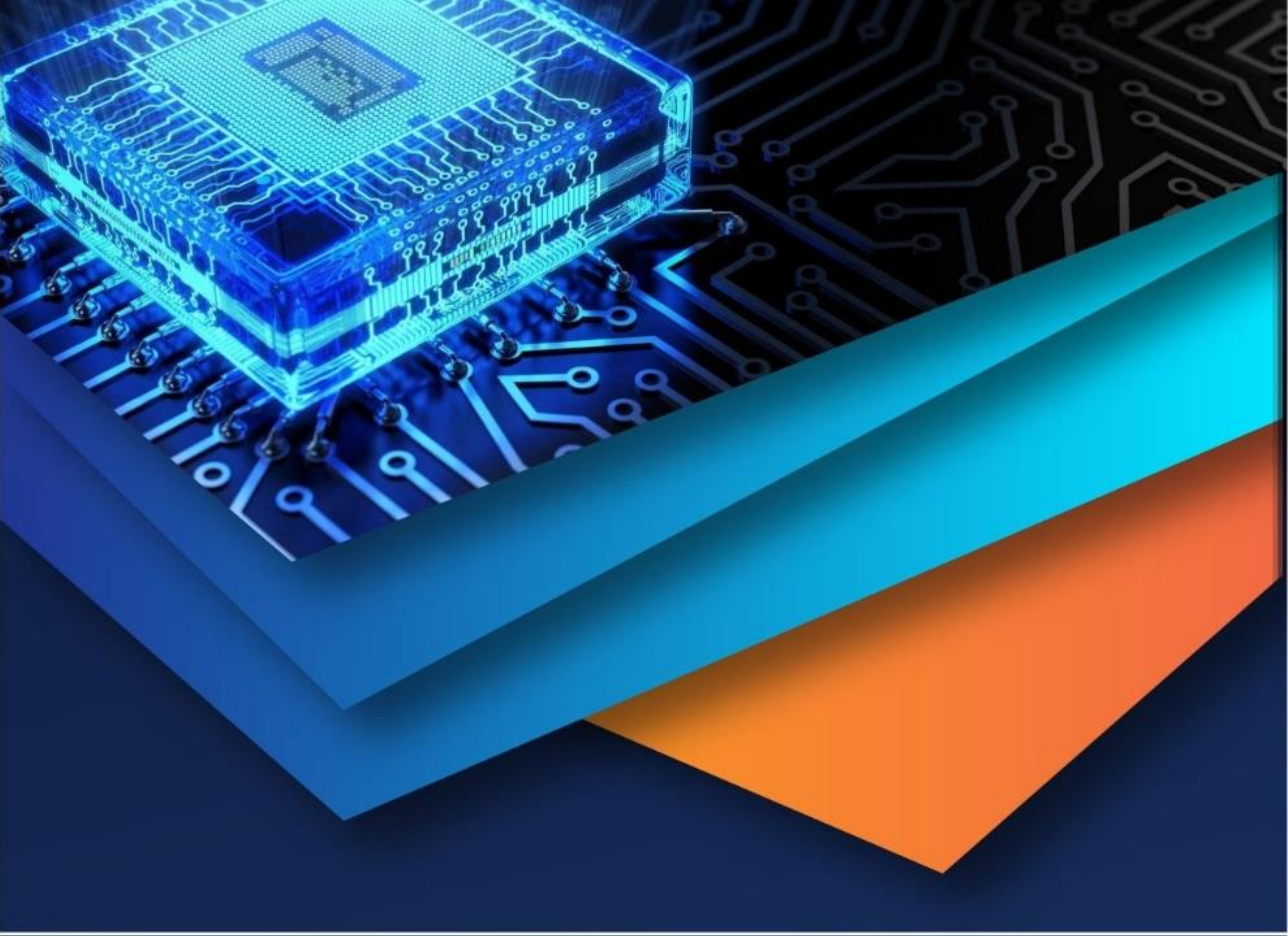


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