Experimental and Numerical Investigation on Self-Compacting Concrete with Addition of Glass Fibre

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***Abstract*- Self-Compacting Concrete (SCC) has gained significant attention in the construction industry due to its ability to flow and compact under its own weight, ensuring complete filling of formwork without the need for mechanical consolidation. This research focuses on enhancing the properties of SCC by incorporating fly ash and glass fiber.**

The study begins with a comprehensive literature review to understand the individual contributions of fly ash and glass fiber to concrete properties. Fly ash, a byproduct of coal combustion, is known for its pozzolanic characteristics, contributing to improved durability and reduced environmental impact. On the other hand, glass fibers, with their high tensile strength and enhance the mechanical properties of concrete.

The experimental program involves the formulation of SCC mixes with varying percentages of fly ash and glass fiber. The key properties investigated include workability, compressive strength and split tensile strength. The fresh properties of SCC are evaluated using slump flow, U-box test, L-box test and V-funnel tests, while the mechanical properties are assessed through standard testing procedures.

The results of the experiments are analyzed to determine the optimal combination of fly ash and glass fiber for achieving enhanced performance in SCC. The findings of this research contribute to the understanding of the synergistic effects of fly ash and glass fiber in self-compacting concrete, providing valuable insights for the construction industry to develop sustainable and durable concrete structures.

Key Words: Self Compacting Concrete, Glass Fiber, M25 Grade of Concrete, Mechanical Properties.

1. INTRODUCTION

Self-Compacting Concrete (SCC) is defined as concrete that has an ability to flow under its own weight, to fill the required space or formwork completely and to produce a dense and adequately homogenous material without a need for vibrating compaction. Self-compacting concrete is made up of the same basic ingredients as regular concrete: cement, water, and aggregates such as sand and gravel. However, unlike traditional concrete, it tends to have a higher proportion of fine aggregates and a greater amount of water-reducing agents. Some self-compacting concrete mixtures include admixtures like super plasticizer and viscosity modifiers to reduce bleeding and segregation. When concrete segregates, it loses strength and results in honeycombed areas throughout the surface. However, a well-designed self-compacting concrete will not segregate thanks to its plasticity and stability.

2. OBJECTIVE

- To study and analyse the behaviour of Self compacting concrete experimentally.
- To analyse the strength of SCC which is prepared by using flyash (25%) and glass fibre (0.25%, 0.5%, 0.75%, 1%, 1.25% and 1.5%) and testing both fresh and hardened SCC.
- To compare the mechanical property of the SCC concrete with Normal SCC.

3. MATERIALS USED

A.CEMENT

Ordinary Portland cement 53 grade cement is used. Its characteristics are given below.

TABLE 1: TEST VALUES OF OPC 53 GRADE CEMENT

CHARACTERISTICS	VALUES
CONSISTENCY	32%
FINENESS (BY SIEVE METHOD)	4%(Residue)
INITIAL SETTING TIME	33min
FINAL SETTING TIME	410min
SPECIFIC GRAVITY	3.15

B. AGGREGATES

Fine aggregate m-sand is used. Coarse aggregate 20mm size is used.

TABLE 2: TEST VALUES OF FINE AGGREGATE

CHARACTERISTICS	VALUES
SPECIFIC GRAVITY	2.507
FINENESS MODULUS	2.44
WATER ABSORPTION	1.5%
BULK DENSITY	1632.9kg/m3
GRADING ZONE	II

TABLE 3: TEST VALUES OF COARSE AGGREGATE

CHARACTERISTICS	VALUES
SPECIFIC GRAVITY	2.665
IMPACT VALUE	12.5%
CRUSHING VALUE	19.6%
WATER ABSORPTION	0.5%
BULK DENSITY	1558.5kg/m3
FINENESS MODULUS	7.54

C.WATER

The quality of water used is potable water standard which is available is the laboratory for mixing and curing which is used for reinforced concrete structures.

D.MINERAL ADMIXTURE

FLYASH

Class F fly ash obtained from thermal power plant is used for the process.

TABLE 4: TEST VALUES OF CLASS F FLYASH

CHARACTERISTICS	VALUES
CONSISTENCY	43%
FINENESS	8% (Residue)
SPECIFIC GRAVITY	2.3

E.MINERAL ADMIXTURE

Poly carboxylic ether is used. Dosage of super plasticizer is 1% of cementations material.

F. GLASS FIBER:

The glass fibre used shall be CEM FIL anti crack high - Quality Alkali – Resistant glass fibre which is designed to reinforce cementations and other alkaline matrix.

TABLE 5: PROPERTIES OF GLASS FIBER

PROPERTIES	VALUES
LENGTH	12mm
FILAMENT DIAMETER	14microns
SPECIFIC GRAVITY	2.68
MODULUS OF ELASTICITY	72GPA

4. MIX PROPORTION FOR M25 GRADE CONCRETE

INGREDIENTS	QUANTITY
CEMENT	300kg/m^3
FLYASH	167.5 kg/m^3
FINE AGGREGATE	895.1 kg/m^3
COARSE AGGREGATE	604.6 kg/m^3
WATER	200 litres/m^3
SUPER PLASTICIZER	3.7 litres/m^3

TABLE 6: MIX PROPORTION FOR SCC

MIX	FLYASH	GLASS FIBER
SCC	0	0
SCC1	25%	0.25%
SCC2	25%	0.50%
SCC3	25%	0.75%
SCC4	25%	1%
SCC5	25%	1.25%
SCC6	25%	1.50%

5. EXPERIMENTAL INVESTIGATION

A.FRESH PROPERTIES OF SCC

Several test methods have been developed and together with visual inspection are often utilized to verify the performance of fresh SCC.

5.1.1 SLUMP FLOW TEST:

The procedure of the test done by the following steps, firstly make sure about the smooth of the cone and the plate or surface then put the cone to the downside and fill it with concrete without tamping. Then remove the cone in the vertical side to allow the concrete flow as a form of a circle. Calculate the diameter of the concrete in the vertical direction by taking the measured average of two diameters, the average number will be the slump flow in mm.

5.1.2 V-FUNNEL TEST:

The test procedure done by the following steps, fill the funnel with 12 liters of concrete without being compacted with closing the door of the funnel. Bucket must be ready and placed under the funnel door, then open the door and calculate the period of the discharge. Flow time indicates flow ability and if there is segregation in the concrete, the time of flow will increase.

5.1.3 L-BOX TEST:

The test assesses the flow of the concrete and also the extent to which it is subjected to blocking by reinforcement. The L-Box test to BS EN 12350-10 is used to assess the passing ability of self-compacting concrete to flow through tight obstructions without segregation or blocking

5.1.4 U-BOX TEST:

The test can be done by the following steps, place the

machine of test on the ground and fill it with 20 litres of concrete and leave it for 1 minute. After that open the gate of the machine test and leave the concrete flowing to another box. Then calculate the height of the concrete from different two positions and measure their mean.

TABLE 7: FRESH CONCRETE TEST RESULTS

MIX	Slump flow (650 to 800 mm)	V-funnel (6 -12 sec)	L-box test [(h2/h1) = 0.8 to 1]	U-Box H2-H1 =30mm (max)
SCC	740	8	0.9	29
SCC-0.25% GF	720	8	0.88	27.4
SCC-0.50% GF	705	9	0.86	25
SCC-0.75% GF	660	9	0.84	23
SCC-1% GF	620	10	0.8	24
SCC-1.25% GF	598	11	0.7	21
SCC-1.50% GF	578	12	0.68	19

B.HARDENED PROPERTIES OF SCC

Test on Hardened Concrete is performed to check and control the quality of the concrete works used in the structure. In addition to quality control, various test on hardened concrete also plays an important role in determining different physical properties such as strength and elastic properties of concrete.

A. COMPRESSIVE STRENGTH TEST

By using 100*100*100mm cube specimen, compressive strength of SCC is tested. The test was conducted in a compression testing machine of sufficient capacity and capable of applying the load at the rate as specified in IS: 456-2000. Tests were conducted at recognized ages of the test specimens, i.e., 7 and 28 days, fc =P/A Where, P = maximum load applied in Newton, A = cross- sectional area calculated from the mean dimensions of the section in mm^2

TABLE 8: COMPRESSION TEST RESULTS

MIX	COMPRESSIVE STRENGTH (N/mm^2) (7 days)	COMPRESSIVE STRENGTH (N/mm^2) (28days)
SCC	16.73	25.73
SCC-0.25% GF	17.06	26.25
SCC-0.50% GF	17.74	27.29
SCC-0.75% GF	18.09	27.83
SCC-1% GF	19.24	29.60
SCC-1.25% GF	18.37	28.26
SCC-1.50% GF	17.63	27.13

B .SPLIT TENSILE STRENGTH TEST

The cylindrical specimens having diameter 150mm. and length 300 mm. were prepared for the test. Compression machine, of sufficient capacity for the tests and capable of applying the load at the rate specified in IS: 5816-1999 was used. Tests were made at the recognized ages of the test specimens i.e. 7 and 28 days. The splitting tensile strength fck, of the specimen was calculated using the formula: fck =2P/ (πLD) Where, P = maximum load applied in Newton; L = length of the specimen (in mm) D = cross sectional dimension of the specimen.

TABLE 9: SPLIT TENSILE STRENGTH TEST RESULTS

MIX	SPLIT TENSILE STRENGTH (7 days)	SPLIT TENSILE STRENGTH (28days)
SCC	1.74	2.43
SCC-0.25% GF	1.87	2.88
SCC-0.50% GF	1.98	3.06
SCC-0.75% GF	2.14	3.29
SCC-1% GF	2.41	3.71
SCC-1.25% GF	1.74	2.68
SCC-1.50% GF	1.67	2.57

6. RESULT AND DISCUSSIONS:

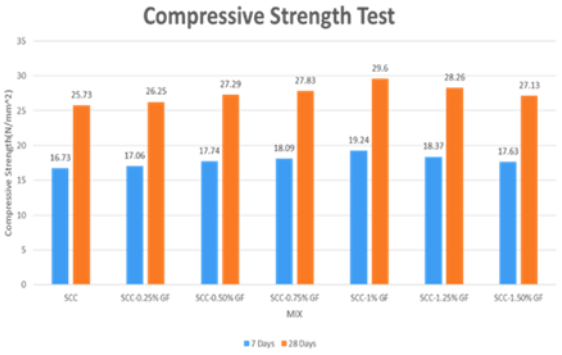


FIG 1: COMPRESSION STRENGTH TEST GRAPH

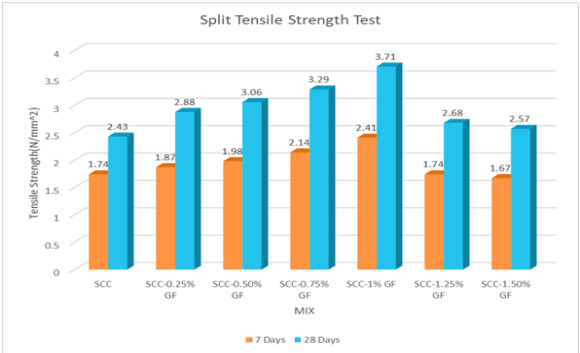
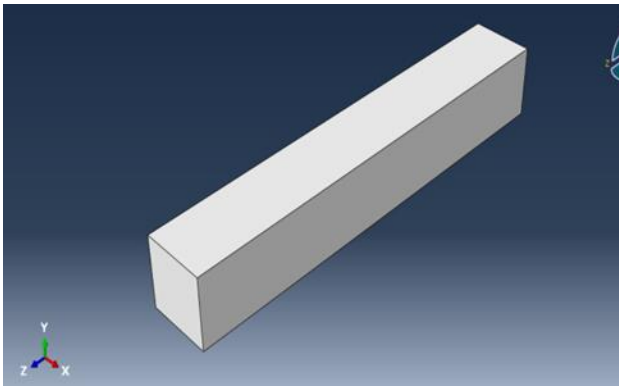


FIG 2: SPLIT TENSILE STRENGTH TEST GRAPH

- The slump flow of SCC-1% GF gives the flow ability compared to the conventional SCC.
- The L-box test of SCC-1% GF gives the passing ability compared to the conventional SCC.
- The addition of Glass Fibre in SCC, the compressive strength increased by 15.04% respectively. The value of compressive strength at 28days is higher in SCC-1% GF compared to the conventional concrete. And found the optimum percentage of glass fibre (1%) is for cubes.
- The addition of Glass Fibre in SCC, split tensile strength increased by 52.67% respectively. The value of split tensile strength at 28days is higher in SCC-1% GF compared to the conventional concrete. And found the optimum percentage of glass fibre (1%) is for cylinders.

7. ANALYSIS OF SCC BEAM IN ABAQUS SOFTWARE

FIG 3: MODEL SCC BEAM PREVIEW



Breadth: 150mm, Depth: 180mm, Length: 1000mm

FIG 4: ASSEMBLING FOR TWO POINT FLEXURAL BENDING TEST

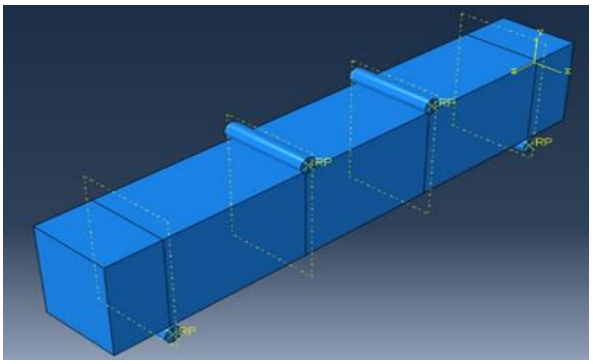


FIG 5: LOADINGS AND ANALYSIS RESULTS OF SCC BEAM

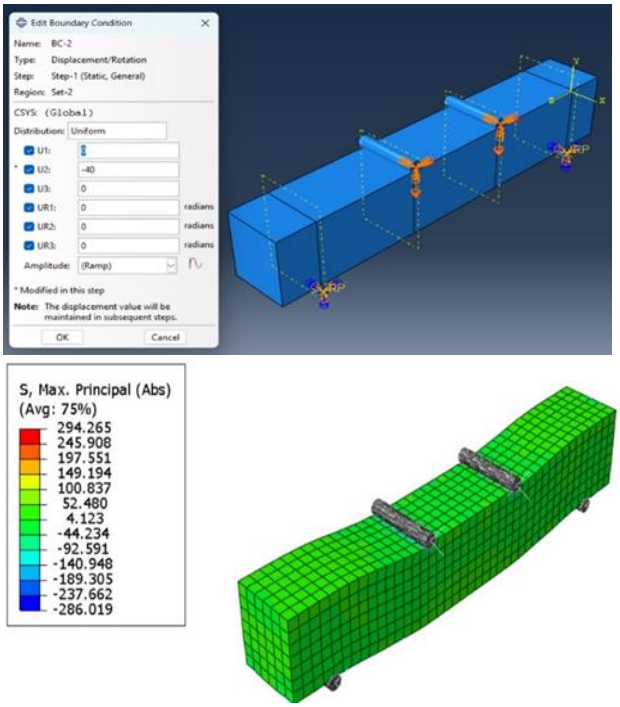


FIG 6: PLASTIC STRAIN OF SCC BEAM

SCC BEAM RESULTS

Maximum Capacity	88.734 kN-m
Flexural Strength	98.5959Mpa
Ultimate Load	332761N

8. CONCLUSION

- The compressive and split tensile strength of SCC with 1% glass fibre was higher when compared to conventional concrete at the age of 7 and 28 days.
- The segregation and bleeding of self-compacting concrete addition of glass fibre were checked using slump flow test, L- box test and V-funnel test are according to the guidelines of EFNARC.
- Using ABAQUS Software the beam size 1000mm x 150mm x 180mm was analysed.

REFERANCE

[1] Okamura, Hajime, and Masahiro Ouchi. "Self-compacting concrete." Journal of advanced concrete technology 1.1 (2003): 5-15.

[2] EFNARC, Specification. "Guidelines for Self-Compacting Concrete, European Federation for Specialist Construction and production (2005)

[3] IS 456. (2000). Plain Concrete and Reinforced.

Bureau of Indian Standards, New Dehli, 1–114.IS
[4] IS10262:2019, Concrete Mix Proportioning - Guidelines
[5] IS383-2016 Coarse and fine aggregate for concrete - specification
[6] IS12269-2013 Ordinary Portland cement 53 grade - specification
[7] Brouwers, H.J.H. and Radix, H.J. "Self-Compacting Concrete: Theoretical and experimental study" 2005.
[8] Garg, Er. Neeraj Kumar "Self Compacted Concrete" 2016, International Journal of Recent Research Aspects.
[9] Shahana Sheril P.T. "Self-Compacting Concrete Using Fly Ash and Glass Fibre" ISSN: 2278-0181 Vol. 2 Issue 9, September – 2013
[10] R Bharathi Murugan et.al "Influence of Glass Fiber on Fresh and Hardened Properties of Self-Compacting Concrete" IOP Conf. Series: Earth and Environmental Science 80 (2017)