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An Experimental Study on the Behaviour of Self Compacting Concrete with Glass Fibres.

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ABSTRACT

The Self Compacting Concrete is one of the newest inventions in the building sector. Fibres can be added to SCC to improve its characteristics. When compared to traditional concrete, SCC has many benefits, including improved flowability, workability, and pumpability. In the case of conjested reinforcement SCC is advantageous as it does not require any vibration. SCC placement is also more expedient and labor-savingin contrast to conventional methods, SCC provides a better surface finish and also improves the mechanical properties, and durability of concrete.

This work aims to conduct a comparative evaluation of the characteristics of M40 grade SCC and glass fibre reinforced self-compacting concrete (GFRSCC) mixes in both the fresh and hardened states. Fly ash has replaced 25% of the SCC and GFRSCC combinations, and the quantity of glass fibres has been altered by 0.5%, 1.0%, and 1.5% overall.

KEYWORDS-Glass Fibre Reinforced Concrete, glass fibres, workability, flexural strength and compressive strength

I. INTRODUCTION

An effort has been made to combine the benefits of SCC and glass fibre reinforced concrete (GFRC) to create glass fibre reinforced self-compacting concrete (GFRSCC). It seeks to explore the mechanical properties of both SCC and GFRSCC by adding glass fibres to the slurry in varying percentages using fly ash as the mineral additive. The analysis of the various mixes' compressive, flexural, and split tensile strengths is the main goal of the study. It doesn't require vibration to compact SCC because it can fill dense reinforcement and flow against its own weight. Although concrete has a high compressive strength and stiffness, it is renowned for being brittle and weak in tension. The concrete's flexural and tensile strength can be increased by adding fibres, which will also help to inhibit crack propagation and solve this problem.Glass fibre Reinforced Self-Compacting Concrete (GFRSCC) is a relatively new idea, despite the fact that SCC has been in use for many years.

II. LITREATURE REVIEW

Chandramouli et al[1] (2010) An experimental study looked at the effects of introducing alkali-resistant glass fibres on the compressive, split tensile, and flexural strength of concrete with M20, M30, M40, and M50 grades.The major goal of the study was to evaluate the mechanical properties of concrete reinforced with polyester polymer and glass fibre. As seen by the results, the polymer concrete's rupture modulus was around 20 MPa and contained 20% polyester resin and roughly 79% fine silica aggregate. However, when about 1.5% of chopped glass fibres (by weight) being added to the substance, the fracture toughness rose by about 55% while the rupture modulus rose by about 20%.

Shazim Ali Memon[2] et al (2010) The study's goal was to determine whether rice husk ash (RHA) could be used in a cost-effective way to raise the fines content of self-compacting concrete.The properties of freshly mixed, self-compacting concrete containing different concentrations of RHA were compared to those of concrete that contained commercially available viscosity-modifying admixtures, Various superplasticizer concentrations were used for the comparison.while maintaining constant concentrations of cement, water, coarse aggregate, and fine aggregate.On the basis of the cost analysis, the cost of the specific self-compacting concrete mix's ingredients was 42.47% less than the cost of the conventional concrete.

Ahmadi[3] et al (2007) The study looked into how SCC and conventional concrete mixtures that contained rice-husk ash (RHA) from the rice paddy milling sector performed mechanically.Two distinct water/cementitious material ratios (0.40 and 0.35) and 10% and 20% as two replacement percentages for cement with RHA, were used for both self-compacting and normal concrete samples. In comparison to regular concrete, the mixes of SCC showed greater compressive strength, flexural strength and a lower elastic modulus. After 60 days, replacing cement by RHA by 20% of volume of cement improved the concrete propertiesinturn reducing the cost and usage. The study found that RHA had a favourable effect on the mechanical characteristics of the concrete.

B. S. Putte gowda[4] et al (2005)(SCC) was created as a remedy for Japan's lack of competent labour. SCC can flow and solidify on its own, unlike regular concrete, which needs to be manually compacted.Fines are a major part of SCC about 20-25% of total volume. These powdered fines, also referred to as pozzolana or fly ash, are made up of OPC. Additionally, SCC contains 160–200 kg/cum of water, the same amount of water as regular concrete, but only about 25% of the volume is made up of coarse aggregate.In order to maintain its fluidity and flow for a sufficient amount of time without suffering substantial slump loss, SCC often needs a super-plasticizer.In order to ensure a stable and cohesive mixture, viscosity modifying agents are also added. This allows SCC to tolerate fluctuations in moisture content, unintentional surplus water, changes in ambient temperature, humidity, and other variables found on construction sites.

III. EXPERIMENTAL PROGRAMME

MATERIAL PROPERTIES

3.1 CEMENT

Table 1. Properties of Cement

Sl.no	Properties	Obtained value	Requirements as per IS:12269
1	Colour	Grey	-----
2	Fineness	1.5%	Not more than 10%
3	Specific gravity	3.14	-----
4	Standard consistency	28%	-----
5	Setting time Initial final	47 min 135min	Not less than 30min Not less than 600min
6	Compressive strength 3-days 7-days 28-days	29N/mm^2 38N/mm^2 47N/mm^2	Not less than 26N/mm^2 Not less than 34N/mm^2 Not less than 45N/mm^2
7	Soundness	10mm	Not more than 10mm

3.2 FINE AGGREGATES

Specific gravity - 2.59
Fineness modulus - 2.9

3.3 COARSE AGGREGATE

Fineness Modulus=6.5
Water Absorption=0.3%
Specific-Gravity-of-coarse aggregate =2.64

3.4 MINERAL ADMIXTURE

Specific gravity = 2.25
Specific surface area = 325m^2/Kg
Grade of fly-ash = E

3.5 CHEMICAL ADMIXTURE

Master Glenium® SKY-8233

Aspect	Light brown liquid
Relative density	1.08 ± 0.01 at 25°C
pH	>6
Chloride ion content	<0.2%

Table 2. Physical properties of-super-plasticizer

3.6 GLASS FIBRES

Table 3. Physical properties of glass fibres

PROPERTIES	**VALUES**
Name	CEM-FIL ANTI CRAK HD
Modulus of elasticity	72 GPa
Tensile strength	1700 MPa
Filament diameter	14 Micron
Specific gravity	2.68
Density	26 kN/m^3
Length	12mm
Aspect ratio	857.1
No. of fibre per kg	212 million fibres

3.7 MIX PROPORTION USED

Table 4. Materials required for 1m^3 of concrete

MATERIAL	**QUANTITY**
Powder (kg)	402.00
Cement (kg)	321.60
Fly ash %	25
Fly ash (kg)	80.40
Fine aggregate (kg)	787.92
Coarse aggregate (kg)	643.20
Super plasticizer content (Lit)	1.407
Water content (Lit)	225.00

6 cubes(150x150x150)mm and 6 beams(500x100x100)mm were tested for compression and flexure.

IV. DISCUSSION OF RESULTS

4.1 FRESH CONCRETE-Following are the test results obtained during experiment on self-compacting concrete in final trial of mix at 0% of glass fibre.This shows that SCC is successfully obtained, because the values satisfy the EFNARC criteria.

Table 5. Properties-of-fresh concrete

SL NO.	TEST	PROPERTY	OBTAINED VALUE	EFNARC CRITERIA
1	Slump-flow test	Filling-ability	710 mm	650 – 800
2	T_{500} slump flow test	Filling ability	2.32 sec	2 – 8 sec
3	V-funnel-test	Filling-ability	9.23 sec	8 – 12 sec
4	V- funnel-test at $T_{5(min)}$	Segregation resistance	11.45 sec	+3 sec

Fig.1(a). Flow before adding glass fibre

Fig.1(b). Flow after adding glass fibre

There was a significant reduction in workability when glass fibre was added to the matrix at 0.5%, 1.0%, and 1.5% of the volume of mix. Concrete was unable to flow under its own weight. Figure 1 illustrates the difference in slump between the controlled SCC and after adding 0.5% by volume of glass fibre.

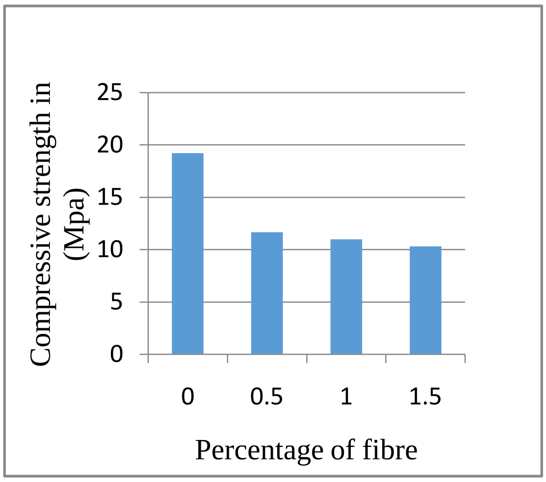
4.2 HARDENED CONCRETE PROPERTIES

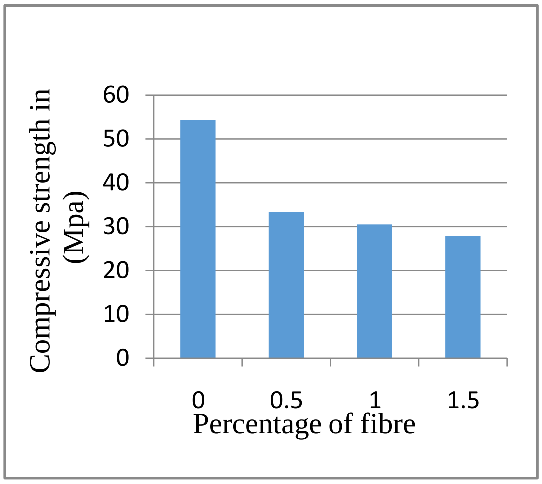
Following are the 7-days and 28-days compression and flexure strength results obtained in for different percentage of glass fibre.

Table 6. 7and 28day compressive-and-flexural strength

SL NO.	% OF GF (MPa)	7 DAY CS (MPa)	7 DAY FS (MPa)	28 DAY CS (MPa)	28 DAY FS (MPa)
1	0.0	19.23	3.09	54.36	5.15
2	0.5	11.66	1.96	33.31	3.27
3	1.0	10.99	2.32	30.52	3.87
4	1.5	10.31	2.88	27.86	4.80

F =Glass fibre, CS =Compressive strength, FS = Flexure strength





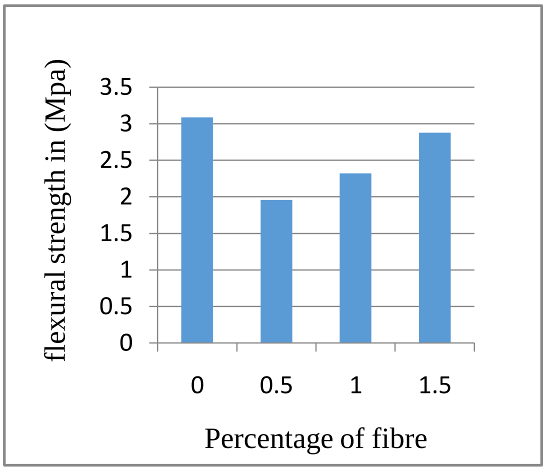


Fig 4. 7-day flexural strength

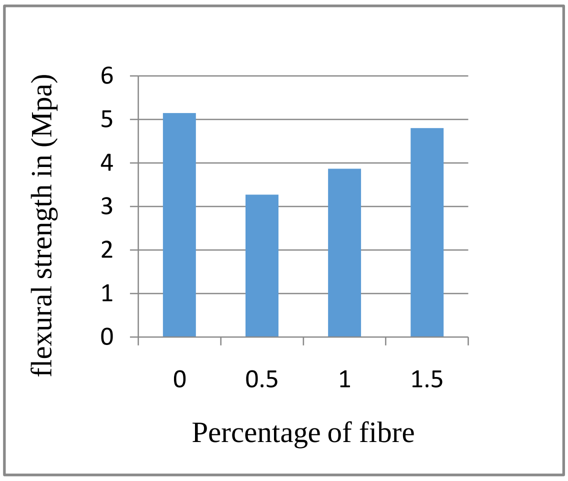


Fig 5. 28-day flexural strength

Concrete that has glass fibres added to it loses compressive strength as compared to the control specimen..Additionally, the compressive strength of concrete gradually declines as the percentage of fibres increases. The flexural strength of the concrete, on the other hand, also decreases when compared to the control, but it increases steadily as the fraction of glass fibres increases.

Fig 6. Cubes after compression **test**

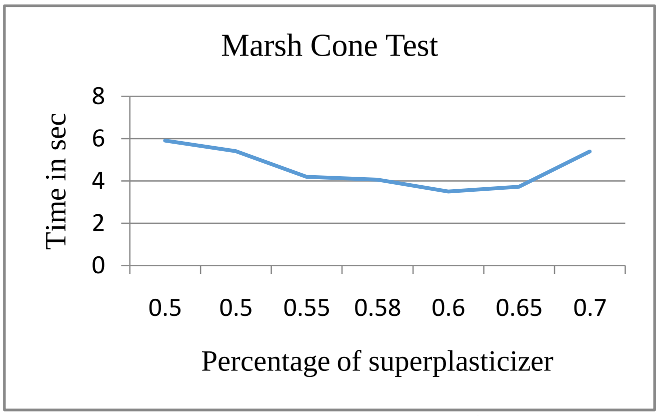
Fig 7. Prism after flexural failure

Fig 8. CS of prism failed under flexure test

The CS of the beam failed the flexure test, as shown in Fig. 8. Increases in glass fibres are observed to increase voids, which results in a decrease in compressive and flexural strength

4.3 MARSH CONE TEST

Fig 9. Marsh cone test value for 25% replacement of fly ash



From the above graph it is clear that, 0.6% super-plasticizer of powder gives the optimum dosage of superplasticizer for cement and fly ash slurry.

V. CONCLUSIONS

5.1 FRESH CONCRETE

- Due to its large surface area, fine diameter (14 microns), and length of 12 mm, which mayhave a great capacity to absorb water, there was a significant loss of workability as a result of the addition of fibres.
- Bleeding results from the overuse of fibre volume, which is greater than 1.5% of the volume of mix.
- The mixture was extremely temperature sensitive. For the same mix, the flow varied in the morning and the afternoon. The flow was reduced by around 20 to 50 mm due to a temperature shift of 2 to 40 C.
- The ideal super-plasticizer dose values The results of the marsh cone test are in no way comparable to the recommended dose for concrete.
- The tilting mixture was discovered to be ineffective for mixing small amounts of self-compacting concrete.

5.2 HARDENED CONCRETE

- The presence of fly ash caused a delay in the concrete's setting time. It was observed that the beam changed its shape after the mould was withdrawn from the concrete 24 hours after casting. The lowest few millimetres of the concrete stuck to the mould, remaining on the bottom surface of the mould, whilst the upper surface of the beam appeared to be hard and retained its position, indicating some degree of strength.
- The concrete mixture has a honeycomb like structure.
- Compressive and flexural strength are both affected negatively by fibre volume.
- There was a rise in flexural strength with the increase of fibre fraction value.

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