Study on Self Compacting Concrete using hybrid steel fibers and GGBS

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ABSTRACT

In this paper, an attempt is being made to prepare self compacting concrete (SCC) with GGBS and hybrid steel fibers. The aim of this study is to prepare M40 SCC with GGBS and hybrid steel fiber and compare its strength behavior with conventional concrete. Ordinary cement is done by using IS 10262 2009 and SCC is done by using Modified Nan Su method. For this purpose the concrete is replaced by 10%, 20% and 30% of GGBS with addition of 1%, 1.5% and 2% of hybrid steel fibers respectively. Cubes of size 150x150x150mm are prepared for determining the compressive strength of SCC while cylindrical specimens of 150x300mm are used for split tensile strength determination were as prism of size 100x100x500mm are prepared for determining flexural strength of SCC.

KEY WORDS

Aspect ratio, Ground granulated blast slag, Hybrid steel fibers, Self compacting concrete, Compressive strength, Split tensile strength and Flexural strength.

1. INTRODUCTION

The term SCC is not new in the present era. With the growing population and reduction in skilled labor the need for a concrete such as SCC is quite natural.

Self compacting concrete generally refers to a concrete which can flow under its own weight due to this reason it is widely used to fill congested reinforcements.

In the modern era were everything needs to be carried out a rapid rate SCC is the best concrete available which can flow under its own weight and doesn't requires any kind of compaction. In order to fill congested reinforcements were it is very difficult for the concrete to flow SCC with its efficient passing and filling ability is the most preferred concrete.

SCC is used in almost all type of construction work be it in the precast industry for the construction of bridge deck, panels, tunnels, pavement, flyovers, dams, reservoirs, tall structures highways etc.

Hybrid fibres are a combination of various types of fibers used together to achieve desired strength in concrete.

Fibres in general increases the strength of concrete. But the type and amount of fibres to be used are of paramount importance.

Hybrid fibres normally refers to a combination in which one type of fibre is mixed with another different kind of fibre for instance a combination of steel fibre and polypropylene may be termed as a hybrid fibre. The fibers help to transfer the loads at the internal micro cracks.

2. LITERATURE REVIEW

Osman Gencel et al [1] studied SCC with steel fibres. The fibre amounts were 15, 30, 45 and 60 kg/m3, in comparison to CVC the strength in compression was increased by 3% and reduced by 3.3%, 1.9 % and 0.9 %, respectively were as tensile strength of frc was found to be increase by 19%, 23 %, 13.9% and 20.9% and the flexural strength of SCC increased by 13.1%, 24.2%, 40.6% and 51.7% respectively.

In 2010 Abhishek kumar singh, et al [2] studied the effect of a mixture of steel fibres with ppf on behavior of SCC and concluded that the a hybrid mix containing polypropylene and steel fibres impart more strength to SCC mix than the normal.

The experimental study carried out by **Dr. Mrs. S. A. Bhalchandra and Pawase Amiat Bajirao [3] (2012**) on SCC reveals that by addition of different content of steel fibers. The results showed that with the addition of fibers of steel there is an increase of strength in tension and the maximum fiber content for increasing the strength was found to be 1.75%. When the results were compared for SFRSCC and normal Self Compacting Concrete (SCC) the increase in compressive strength was found to be 25.75% and flexural strength as 19.47%.

In 2016 B.Fathima Juliet mary and M.Renganathan [4] conducted a study on mechanical behavior of SCC with hybrid steel fibres (stainless steel and polypropylene) and concluded that maximum strength is achieved at 1% addition of hybrid fibres.

In 2004 Balasubramanian and Krishnamoorthy [5] studied the properties of SCC such as durability by conducting test such as chloride diffusion and water absorption with improved with GGBS. The water absorption and chloride diffusion values were lower in the case of slag based concrete mixtures with 7 percent cement replacement material level.

3. EXPERIMENTAL PROGRAMMES

In this experimental study, cement, aggregates, water, GGBS and hybrid steel fibers are used.

Cement

Ordinary Portland Cement (OPC) of 53 grade with specific gravity of 3.15 was used in this experiment.

Sand

Locally available sand of specific gravity 2.6 passing through 4.75 mm IS sieve was used.

Coarse aggregate

Coarse aggregate of specific gravity 2.73 passing through 10 mm sieve and retaining on 4.75mm sieve was used.

Water

Potable water free from impurities was used.

Hybrid steel fibers

Two types of fibers of different aspect ratios were used. One was a straight shaped fiber and the other was a co regulated shape.

GGBS

Ground granulated blast slag of white color is obtained from the blast furnace, was used in this experiment.

Mix proportion for M40

By using IS 13262 2009 the ratio of 1 :1.59 :2.96 with W/C 0.38 was used.

Casting and curing of specimen

In order to determine the strength parameters of SCC different tests are carried out using different moulds .The details of which are mentioned below

i) Cubes of size (0.15x0.15x0.15)m for compression test.
ii) Cylindrical specimens of size (0.15x0.30)m for determining tensile strength
iii) In order to determine strength of concrete in flexure prisms of size (0.1x0.1x0.5)m were used

The casting of specimens was done in a clean environment. The moulds are demoulded after 24 hours and kept in curing tank for 28 days.

4. EXPERIMENTAL METHODOLOGY

4.1 Compressive strength test

In this test, the specimens of 150 X 150 X 150 mm were cast for M40 grade concrete. The percentage of fibers added were 0, 1, 1.5 and 2% by weight of cement with the addition of GGBS 0, 10, 20 and 30% respectively. After 24 hours the specimens were shifted to curing tank to cure for 7 and 28 days. After the curing period the cubes were tested in UTM. The compressive strength is noted. In each category 3 cubes were tested and their average value is reported.

4.2 Split tensile strength test

In this test, the cylindrical specimens of 300mm height and 150mm diameter were cast. The percentage of fibers added were 0, 1, 1.5 and 2% by weight of cement with the addition of GGBS 0, 10, 20 and 30% respectively. After 24 hours the specimens were shifted to curing tank to cure for 28 days. After the curing period the specimens were tested in UTM. In each category 3 cylinders were tested and their average value is reported.

4.3 Flexural strength test

In this test, the beam specimens of dimensions 500 X 100 X 100mm were cast. The percentage of fibers added were 0, 1, 1.5 and 2% by weight of cement with the addition of GGBS 0, 10, 20 and 30% respectively. After 24 hours the specimens were shifted to curing tank to cure for 28 days. These specimens were tested under 2 point loads. In each category 3 beams were tested and their average value is reported.

5. EXPERIMENT RESULTS

5.1 Compressive strength

Fig 1 Compressive strength test

Table 1
7 day compressive strength for SCC and cement replaced by GGBFS and steel fibers

Mix ID	Strength in compression (N/mm2)
0% GGBS + 0% Hybrid steel fibers(CVC)	26.85
0% GGBS + 0% Hybrid steel fibers(SCC)	27.98
10% GGBS + 1% Hybrid steel fibers(M1)	28.56
20% GGBS + 1.5% Hybrid steel fibers(M2)	30.737
30% GGBS + 2% Hybrid steel fibers(M3)	27.54

Fig 2 Graph

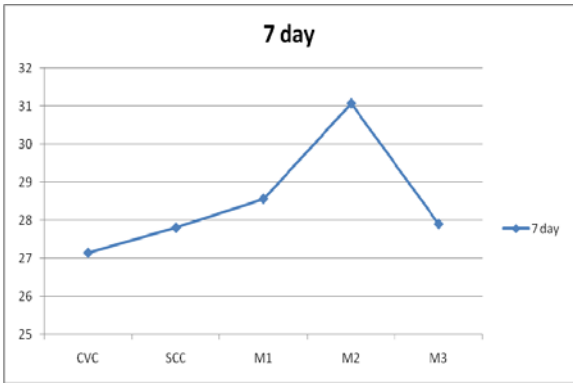
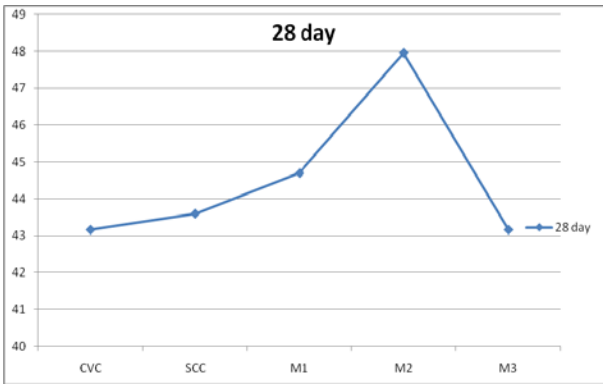


Table 2
28 day compressive strength for CVCM40, SCC and cement replaced by GGBFS and steel fibers

Mix ID	Strength in compression (N/mm2)
0% GGBS + 0% Hybrid steel fibers(CVC)	43.055
0% GGBS + 0% Hybrid steel fibers(SCC)	43.854
10% GGBS + 1% Hybrid steel fibers(M1)	44.875
20% GGBS + 1.5% Hybrid steel fibers(M2)	47.96
30% GGBS + 2% Hybrid steel fibers(M3)	43.127

Fig 3 Graph

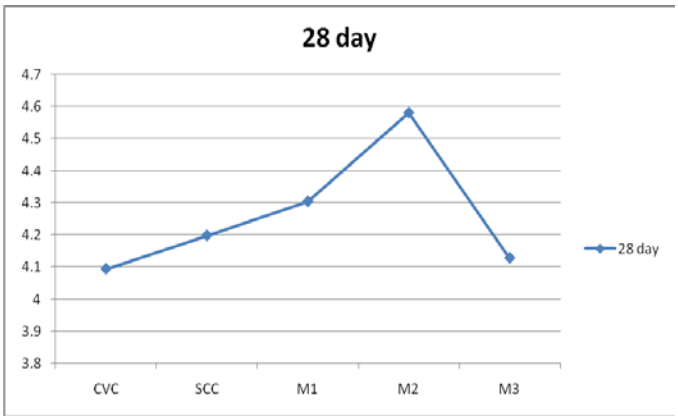


5.2 Split tensile strength

Table 3
28 day split tensile strength for CVCM40, SCC and cement replaced by GGBFS and steel fibers

Mix ID	Tensile strength (N/mm2)
0% GGBS + 0% Hybrid steel fibers(CVC)	4.082
0% GGBS + 0% Hybrid steel fibers(SCC)	4.198
10% GGBS + 1% Hybrid steel fibers(M1)	4.3
20% GGBS + 1.5% Hybrid steel fibers(M2)	4.591
30% GGBS + 2% Hybrid steel fibers(M3)	4.163

Fig 4 Graph

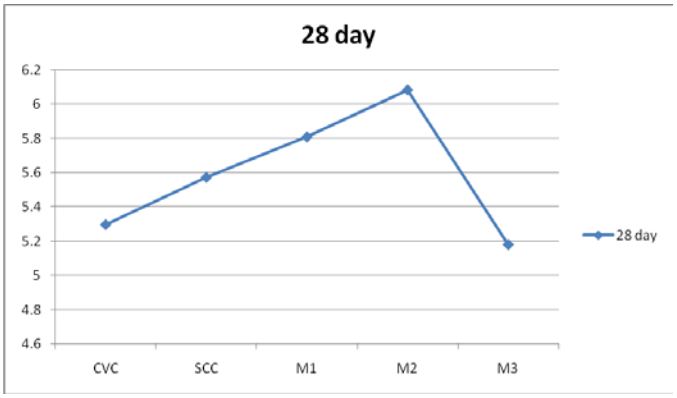


5.3 Flexural strength

Table 4
28 day flexural strength for CVCM40, SCC and cement replaced by GGBFS and steel fibers

Mix ID	Flexural strength in N/mm2
0% GGBS + 0% Hybrid steel fibers(CVC)	5.402
0% GGBS + 0% Hybrid steel fibers(SCC)	5.454
10% GGBS + 1% Hybrid steel fibers(M1)	5.8
20% GGBS + 1.5% Hybrid steel fibers(M2)	6.18
30% GGBS + 2% Hybrid steel fibers(M3)	5.3

Fig 5 Graph



6. CONCLUSIONS

1. Mix design for CVC of M40 is done according to IS code 10262 2009 and a compressive strength of 43.13 N/mm2 is achieved after 28 days.
2. SCC for M40 was planned with GGBS and it had a compressive strength of 44.11 N/mm2 which is 2.27% greater than CVC of M40 grade.
3. Mix M2 containing 20% GGBS and 1.5% of hybrid fibers of steel acquire extreme compressive strength.
4. Mix M2 containing 20% GGBS and 1.5% of hybrid fibers of steel acquire extreme split tensile strength .
5. Mix M2 containing 20% GGBS and 1.5% of hybrid fibers of steel acquire extreme flexural strength.
6. With the addition of GGBS in rates of 10%, 20% and 30%the droop stream increments, by keeping the super plasticizer same content in all the blends an increase in strength parameters of concrete was observed.
7. Mix M2 containing 20% GGBS and 1.5% of hybrid steel fibers acquire extreme compressive strength of 47.96 N/mm2 at 28 days of curing .
8. Mix M2 containing 20% GGBS and 1.5% of hybrid steel fibers acquire extreme split tensile strength of 4.591 N/mm2 at 28 days of curing
9. Mix M2 containing 20% GGBS and with addition of 1.5% of hybrid steel fibers acquire extreme flexural strength of 6.18 N/mm2.
10. Finally it can be concluded that Mix 2 with 1.5% hybrid steel fibers and 20% GGBS was the optimum dosage to be used in the present study.

7. REFERENCES

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