© 2017 IJSRST | Volume 3 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

An Experimental Study on Strength Properties of Hybrid Fiber Reinforced Self Compacting Concrete

Sachin S*[1], Raghavendra D[2]
*[1]PG Student, Department of Civil Engineering, EPCET, Bengaluru, Karnataka, India
[2]Assistant Professor, Department of Civil Engineering, DBIT, Bengaluru, Karnataka, India

ABSTRACT

In early days normal concrete is difficult to place and compaction is required, after using the self-compacting concrete gained popularity due to its higher workability and flowability which reduces compaction. In this study focuses on strength properties of hybrid fiber reinforced self-compacting concrete (combination of crimped steel fiber and polypropylene fiber), combination of these fibers have been tried which effects strength and other properties in different ways. Total fiber content of 0.5%(with steel fiber dosage of 0.3% and polypropylene fiber dosage of 0.2%) was kept constant which results in increasing compressive strength and improvement in flexural and tensile strength which results durability aspects such as shrinkage, bleeding, segregation and the corresponding properties of normal concrete were studied. The age at loading of concrete 7 and 28 days curing for cubes, cylinders and prism. To achieve better work ability and flow ability Super plasticizer of Master Glenium Sky 8630 of 1% for normal concrete and 1.5% for hybrid concrete. Cement has partially replaced by 30% of fly ash, 30% of GGBFS and 10% of micro cement. Workability was reduced when polypropylene fiber used. Addition of increasing super plasticizer dosage from 1% to 1.5% gives work ability and flowability. The study is done for a M40 grade of concrete was designed by using Nan su with w/c of 0.40. Some of the tests conducted on slump flow, L and U box and V funnel to determine the parameters for self compactability of mixtures.

Keywords: SCC, Compressive strength, Tensile strength, Flexural strength, Hybrid Fibers, Fresh and Hardened state of SCC.

I. INTRODUCTION

Self-compacting concrete (SCC) is a type of concrete which is able to flow and compact under its own weight which doesn't require any mechanical vibration and enough cohesive which is exceedingly flowable to be handled without segregation or bleeding.

SCC requires main following aspects such as:

A) Addition of water reducing agents such as superplasticizers is added to mix to attain high flowability and workability characteristics.
B) The aggregate mixture is added to attain desired cohesive mix with compactness, the aggregate content may be of round shape and equal in size in order to get increase in locking tendancy of concrete.

II. HISTORY

Nan Su et al proposes design mix method on Self compacting concrete in 2001.Mainly it derives from using necessary quantities of aggregates that are evaluated and cement paste is poured into aggregates so that concrete that attain flowability, compactability and other important properties of SCC. To ensure these actions of SCC in terms of test conducted on compressive strength and the results obtained will indicate that this methodology gives lucratively high quality of SCC.

In early 1983, there was a problem in Japan with the durability of concrete structures. For the development of construction, skilled labors are required for placing and compacting concrete to obtain durable structures. The availability of skilled labors was less at the time of its development in Europe and Japan (Okamura et al., 2003). Decrease in these skilled or experienced workers results in decrease in quality of work in the construction industry. However, when SCC was developed many other additional benefits was developed, irrespective with the skill of worker in construction. Self-Consolidating concrete and high performance concrete are the developments made with reference of SCC in which the concrete can pour easily under its own weight in all directions. There will be no reduction within the uniformity of concrete and there will be no loss of coarse aggregates from the concrete while placing and flow. This type of concrete was proposed by Okamura in 1986. Professor Ozowa of Japan (Ozowa et al., 1989) introduced the "Self Compacting Concrete (SCC)" and then developed at the University of Tokyo and later it was developed by Ouchi and Okamura (Ouchi and Okamura, 2003). SCC was different from normal concrete that was characterized by its flowability under its self-weight or no compaction required with of absence of segregation and bleeding carried out in the development of SCC referred to as Japanese Method.

III. MATERIALS USED

3.1 cement: Ordinary Portland cement of mortar compressive strength at 28 days curing period of 53MPa, has been used in the present study and specific gravity was 3.15.

3.2 Fine aggregate: Local river sand has been used. The specific gravity, fineness modulus and bulk density of sand were 2.63, 2.73 and 1.356g/cc used respectively.

3.3 Coarse aggregate: Crushed aggregate of maximum size of 12.5mm. The specific gravity, fineness modulus and bulk density of sand were 2.65, 6.36 and 1.33g/cc used respectively.

3.4 GGBFS: GGGBFS has been used as a 30% partial replacement of cement.

3.5 Fly ash: Class F fly ash has been used as a 30% partial replacement of cement.

3.6 Microcement (Alcofine): The product obtained from granulation of high content of glass in form of slag has been used as a 10% partial replacement of cement and has specific gravity of 2.9.

3.7 Superplasticizers: MasterGlenium Sky 8630 is used. Optimum dosage is confirmed by various trail mixes.

3.8 Water: Potable water is used for mixing of concrete and curing.

IV. FRESH STATE PROPERTIES OF SCC

The SCC should reach the some important functions at plastic stage that are different from conventional concrete or vibrated fresh concrete.

A) Filling Ability: SCC should fill up to entire formwork and enclosing of reinforcement and other places with maintaining homogeneity in horizontal as well as vertical directions of formwork is essential.

B) Passing ability: SCC should pass through congested formwork with closely spaced reinforcement area without obstructing caused by interlocking of particles of aggregates.

C) Resistance to segregation and bleeding: SCC should maintain uniformity throughout mixing, transportation and at the time of casting on site. The stability refers to the resistance to bleeding, segregation and surface settlement of concrete after casting on site.

V. METHODOLOGY

NAN SU mix design method is considered to be very simple mix design method and therefore it is used for designing SCC mix of M40 grade in this experimental work. This method was used to prepare trial mixes for M40 grade SCC to calculate strength properties by replacing cement by Fly ash, GGBFS and Microcement with addition of hybrid fibers (combination of steel and polypropylene fibers) with W/C of 0.4 and keeping all parameters like fine aggregate and coarse aggregate were constant. Each mix was tested to achieve workability property, then cubes, cylinders and prisms are casted for conducting tests on compressive strength, split tensile strength and flexural strength tests respectively.

Data's obtained from experimental mix design

- Packing factor(PF)= 1.1
- Specific gravity of cement(Gc)= 3.15
- Specific gravity of FA(Gfa)= 2.63
- Specific gravity of CA(Gca)= 2.65
- Specific gravity of Fly ash (Gf)= 2.11
- Specific gravity of water(Gw)= 1.0
- Bulk density of FA(Wfa)= 1456Kg/m3
- Bulk density of CA(Wca)= 1346Kg/m3
- The volume ratio of fine to total aggregate= 0.54
- Air content (Va) = 1%.

Mix Proportions for 1m3

- Cement: 562.893kg/m3
- Fine Aggregate(FA): 865.327 kg/m3
- Coarse Aggregate(CA): 681.379 kg/m3
- Water: 225.677ltr/m3
- Superplasticizers
- 5.62lL(1%)for Plain SCC
- 8.43L (1.5%) for Hybrid SCC.

VI. TESTS RESULTS OF FRESH STATE OF SCC

Based on EFNARC guidelines some of the tests conducted on fresh properties of concrete such as slump flow, L-box, U-box and V-funnel were conducted to evaluate the fresh properties of concrete. EFNARC specifications for SCC workability on fresh state are given below in the table 1 and results obtained for Plain SCC and hybrid SCC of
Mix1=(100%cement),
Mix2=(70%cement+30%GGBFS),
Mix3=(70%cement+30%Flyash
Mix4= (90%cement+10%microcement).

CONCRETE PROPERTIES	MIX 1	MIX 2	MIX 3	MIX 4	EFNARC GUIDELINES
Slump test (mm)	723	685	693	710	650 - 800
V funnel (sec)	8	10	9	11	6 – 12
U box test (mm)	14	12	13	15	0 – 30
L box test	0.85	0.93	0.92	0.84	0.8 – 1

Table 1: Plain SCC (Without Fibers)

CONCRETE PROPERTIES	MIX 1	MIX 2	MIX 3	MIX 4	EFNARC GUIDELINES
Slump test (mm)	724	688	697	710	650 - 800
V funnel (sec)	7	10	9	10	6 – 12
U box test (mm)	14	12	11	12	0 – 30
L box test	0.82	0.93	0.91	0.83	0.8 – 1

Table 2: Hybrid SCC

VII. TESTS RESULTS OF HARDENED STATE OF SCC

This chapter represents the experimental results of Cubes, cylinders and prism at age of curing period of 7 and 28 days for plain and hybrid SCC.

CUBE TEST RESULTS:
Average Compressive strength values of cube test result for Plain SCC and Hybrid SCC at age of curing 7 and 28 days:

Mixes	7 days		28 days	
	Plain SCC	Hybrid SCC	Plain SCC	Hybrid SCC
MIX 1	45.11	47.43	54.72	58.67
MIX 2	30.63	39.11	45.66	55.70
MIX 3	31.24	36.85	44.67	52.79
MIX 4	33.593	35.67	42.63	56.889

Table 3: Avg Compressive strength

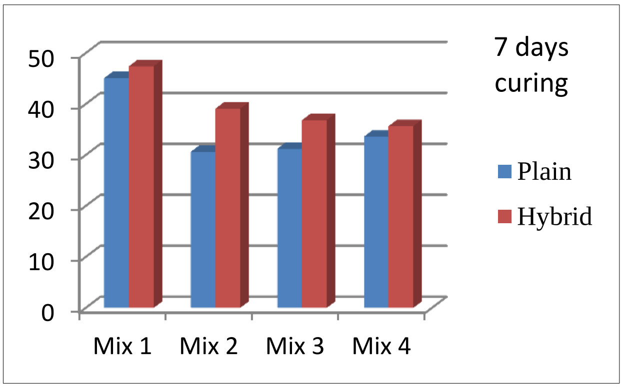

Fig 1: Variation of Compressive strength at 7 days

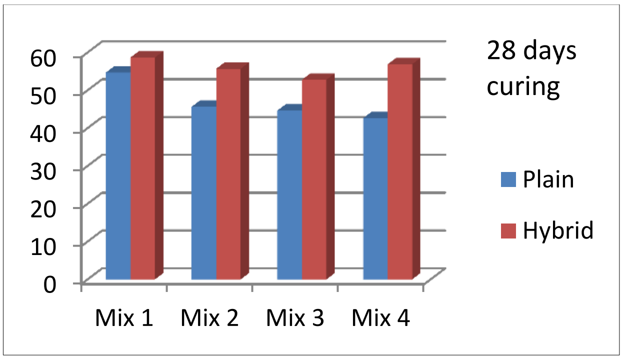

Fig 2: Variation of Compressive strength at 28 days

Split Tensile Results:

Average Split tensile strength values for Plain SCC and Hybrid SCC at age of curing 7 and 28 days:

Mixes	7 days		28 days	
	Plain SCC	Hybrid SCC	Plain SCC	Hybrid SCC
MIX 1	2.794	3.03	3.34	3.806
MIX 2	2.87	2.966	3.54	3.796
MIX 3	2.714	3.155	3.45	3.763
MIX 4	2.55	2.98	3.472	4.031

Table 4: Avg Split tensile strength

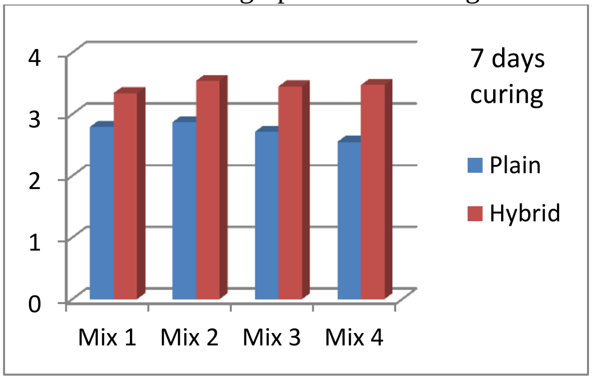

Fig 3: Variation of Tensile strength at 7 days

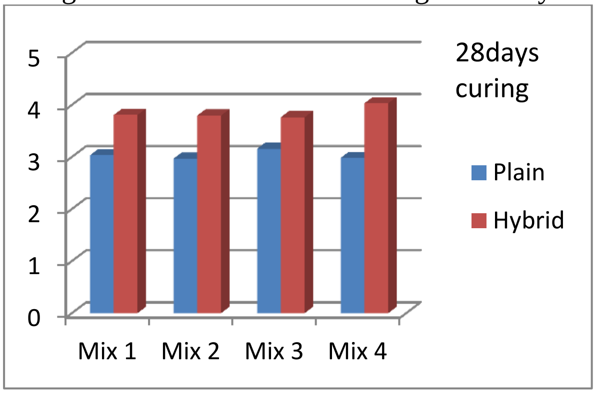

Fig 4: Variation of Tensile strength at 28 days

Flexural strength RESULTS:

Average Flexural strength values for Plain SCC and Hybrid SCC at age of curing 7 and 28 days:

Mixes	7 days		28 days	
	Plain SCC	Hybrid SCC	Plain SCC	Hybrid SCC
MIX 1	7.83	9.85	10.167	11.0
MIX 2	6.0	7.0	10.167	10.667
MIX 3	6.83	7.67	8.167	10.33
MIX 4	7.83	7	9.667	10.667

Table 5: Avg Flexural strength

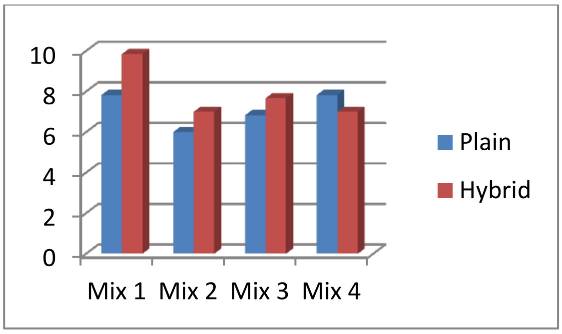

Fig 5: Variation of Flexural strength at 7 days

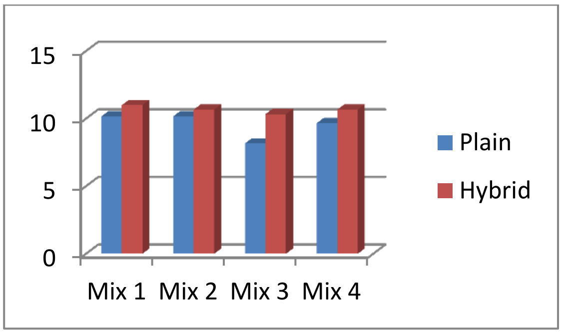

Fig 6: Variation of Flexural strength at 28 days

VIII. CONCLUSION

1. Nan su Mix design method has successfully employed for SCC.
2. All the Mix proportions developed and satisfied the requirements Specified by the guidelines of EFNARC.
3. In this study it is observed that addition of PP fibers can cause workability, so that increase in dosage of superplasticizers gives required workability that fulfills the criteria of EFNARC
4. The compressive strength of Mix 4 at curing age of 7 days shows less strength when cured it for 28 days shows gradually increased in compressive strength.
5. Hybrid fibers shows adverse effect on strength and flow of concrete and workability, thereby reducing flow value and make the mix less workability. Higher dosage of admixture is needed to achieve the same workability condition as controlled mixes.
6. Based on results, it can be concluded that addition of fibers will reduce shrinkage which results in increase in cohesiveness of mix and also helps in increase in strength.

IX. REFERENCES

[1] **Nan su, Kung-chung Hsu**. A simple mix design for self-compacting concrete. Cement and concrete research, pp.1799-1807(2001).

[2] **EFNARC-2005**. European guidelines for self-compacting concrete, specification, production and use.

[3] **EFNARC Guidelines**, "Requirements of Self Compacting Concrete", Published On 2002.

[4] **Okamura, H., Ozawa, K. (1995).** Mix design for self-compacting concrete. Concrete Library of Japanese Society of Civil Engineers, Vol.25, No.6, pp.107-120.

[5] **Khayat, K.H. (1999).** Workability, testing and performance of self-compacting concrete. ACI Material Journal, Vol.96, No.3, pp.346-353.

[6] **Kishor S Sable, Madhuri K Rathi**., 2012 " Effect of Different type of steel fiber and aspect ratio on mechanical properties of Self compacting concrete", International journal of engineering and Innovative technology.

[7] **B. Krishna rao and Professor V Ravindra**, 2001 " steel fibers reinforced self-compacting concrete incorporating class f fly ash", International journal of engineering science and technology.

[8] **Syal Tarun , Goel Sanjay, Bhutani manish,** 2013, "Workability and compressive strength of steel polypropylene hybrid fiber reinforced SCC", International journal for science and emerging technologies with latest trends,6(1):7-13.

[9] **Ding Y, Liu S, Zhang Y and Thomas A** (2009). "The investigation on strength and flexural toughness of fiber cocktail reinforced self-compacting high performance concrete", journal of construction and building material.