An Experimental Study on Mechanical properties of Basalt Fiber Reinforced Self-Compacting Concrete

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Abstract: Concrete is the most widely usable material in the world due to its mould ability and fluid behavior at early ages. The construction industry consumes millions of tons of concrete every year in India and other countries. Compaction is done using vibratory applications to achieve workability, required strength and durability in concrete. If compaction is not done in concrete, voids present will affect the performance and long term durability in structures. Self compacting concrete (SCC) can be a solution to this problem. SCC is a flowable, yet stable concrete that can spread readily into place and fill the formwork without any compaction and without undergoing any significant separation. Fibers were added in concrete to improve some of the properties of the concrete. In this study, the Basalt fibers are used in M30 mix of SCC. Two different lengths of basalt fiber i.e. 10 mm and 20 mm were added in three different percentages (percentage is calculated in percentage with respect to weight of cement in the matrix) i.e. 1%, 2% and 3%. 4% of workability (Slump flow value) is decreased at 3% of fiber added. The optimum percent of basalt fiber to be added to SCC is suggested as 2%. When the 2% of basalt fibers were added the flexural strength and spilt tensile strength is increased by 63.5% and 34% respectively.

***IndexTerms* - Self-Compacting Concrete, Basalt fiber, Mould ability, flowable, Compaction, Slump Flow.**

I. INTRODUCTION

Self-compacting concrete was developed in Japan in 1980s by Prof. Dr. Hajime Okamura. It is a concrete that is able to flow and fill every part of the corner of the formwork, even in the presence of solid reinforcement, purely by means of own weight and without requirement for any vibration or other type of compaction.

The objective of present research is to test SCC of grade M30 (mix design is adopted from Jena, 2015) and to study the effect of inclusion of chopped basalt fiber on fresh properties and hardened properties of SCC. Fresh properties include flow ability and hardened properties to be considered are compressive strength, splitting tensile strength, flexural strength tests.

As there are many types of fibers which can be used in SCC and other concrete such as glass fibers, nylon fibers, polypropylene fibers, bio-degradable fibers etc. But we have chosen basalt fibers for our mix design and testing procedures due to its non-biodegradability, found in various length, durability, strength performance and long life.

Basalt is an igneous rock, which is solidified volcanic lava. Basalt fiber is a high performance, metallic fiber made from basalt rock melted at high temperature. Basalt fiber reinforced concrete offers more characteristics such lightweight, good fire resistance and strength. In future it is very useful for construction industry. Many applications of basalt fiber reinforced cement concrete are industrial, highway and bridges etc.

Table 1: properties of Basalt Fibers

Sr. No.	Properties of Material	Basalt Fiber
1	Length (mm)	10 mm and 20 mm
2	Thickness (mm)	0.07
3	Tensile Strength (MPa)	4100-4800
4	Elongation to Break (%)	3.1 – 3.2
5	Abrasion Resistance	Good
6	Water Absorption (%)	0.01 – 0.02

7	Specific Gravity	2.65
8	Melting Point (^{0}C)	1450

Fig.1: Basalt Fiber

II. Experimental Programme

2.1 Preparation of SCC Specimens:

The different percentages of basalt fiber (1%, 2% and 3%) were added and basalt fiber reinforced self-compacting concrete (BFSCC) prepared (using 10 mm and 20 mm length). After adding fiber to SCC mixes, again the same methods were followed for the determination of properties in the fresh state and hardened state for all these fiber reinforced SCC.

- All the materials are placed & mixed well manually.
- The sample is taken out and poured in to the moulds.
- The moulds are soaked in water & allowed for curing for 28 days.

2.2 Adopted Mix Proportions of SCC

Table 2 Mix Proportion of M30 SCC

Cement (Kg/m^3)	Basalt Fibers (Kg/m^3)	Water (in Litres)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Super Plasticizers (Kg/m^3)
450.33	45.03	189.13	963.36	642.24	5.553
1	0.10	0.42	2.14	1.42	0.012

2.3 Testing method:

2.3.1 Slump Flow

1. Slump flow test is used to find the filling ability of the SCC.
2. The SCC sample is poured in to the slump cone then the slump flow diameter is measured.
3. The higher the slump flow value, the greater its ability to fill formwork under its own weight.
4. Value of slump flow should range between 500 mm to 800 mm.

Fig.2 Slump Flow Test

2.3.2 Compressive Strength Test:

For each mix, six numbers of cubes of (150×150×150) mm were cast (3 with 10 mm Basalt fiber and 3 with 20 mm Basalt fiber) to determine the compressive strength, after the required curing period of the specimen. So in total Twenty four numbers cubes were casted to calculate the compressive strength. After 28 days curing, the cubes were tested in Compressive testing machine.

2.2.3 Split Tensile Strength Test

For each mix six numbers of cylinders of (150×300) mm were cast (3 with 10 mm Basalt fiber and 3 with 20 mm Basalt fiber) to determine the split tensile strength, after the required curing period of the sample. So in total twenty four numbers of cylinders were casted to determine the split tensile strength after 28days.

2.3.3 Flexural Strength Test

The flexural strength test was carried out on a prism specimen of dimension 100mm×100mm×700mm as per IS specification. For each mix, six numbers of prisms were casted (3 with 10 mm Basalt fiber and 3 with 20 mm Basalt fiber). So in total twenty four numbers prisms were cast to measure the flexural strength after 28-days.

Fig. 3, 4, 5: Compressive Strength test, Split Tensile test, Flexural Strength test

III. Experimental Results

3.1 Slump Flow Test

Table 3 Slump Flow value of BFSCC

Sr. No.	Fiber Content	Slump Flow (mm)	
		10 mm	20 mm
1	Plain SCC	646 mm	
2	SCC + 1%	635 mm	633 mm
3	SCC + 2%	629 mm	628 mm

4	SCC + 3%	620 mm	619 mm

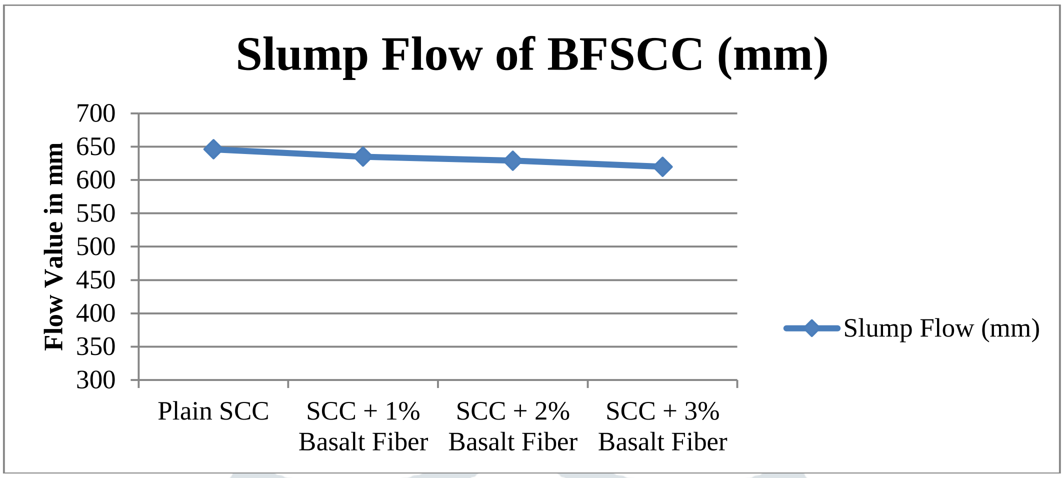

Fig. 6 Slump Flow of BFSCC

3.2 Compressive Strength Test

Table 4 Compressive Strength test result of BFSCC

Sr. No.	Fiber Content	Avg. Compressive Strength at 28 days (MPa)	
		10 mm	20 mm
1	Plain SCC	31.5	
2	SCC + 1% Basalt Fiber	31.9	31.8
3	SCC + 2% Basalt Fiber	32.2	32.1
4	SCC + 3% Basalt Fiber	32.1	32.1

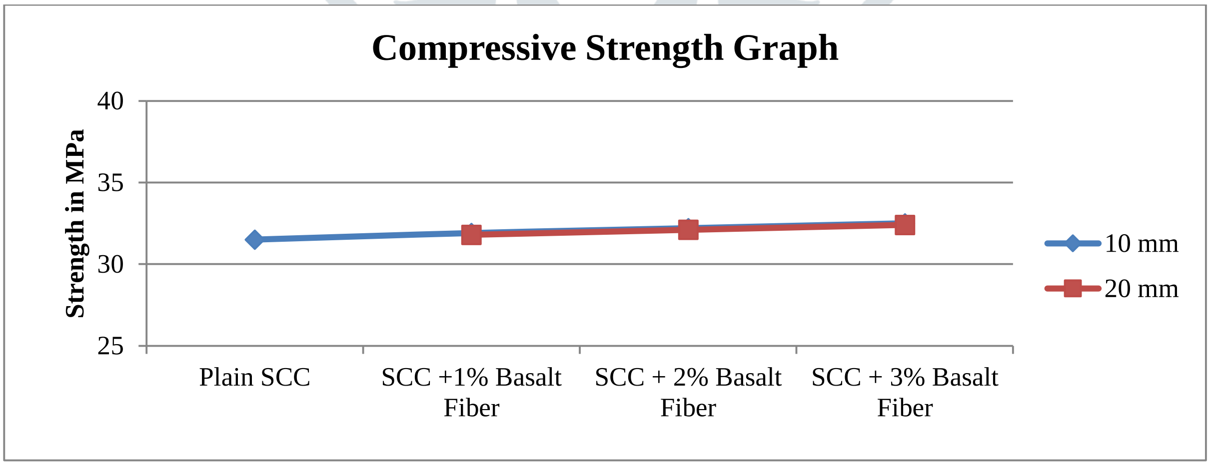

Fig.7 Compressive Strength test results

3.3 Split Tensile Strength Test

Table 5 Split Tensile Strength results of BFSCC

Sr. No.	Fiber Content	Avg. Split Tensile Strength at 28 days (MPa)	
		10 mm	20 mm

1	**Plain SCC**	**4.1**	
2	**SCC + 1% Basalt Fiber**	**4.8**	**4.7**
3	**SCC + 2% Basalt Fiber**	**5.6**	**5.5**
4	**SCC + 3% Basalt Fiber**	**5.3**	**5.2**

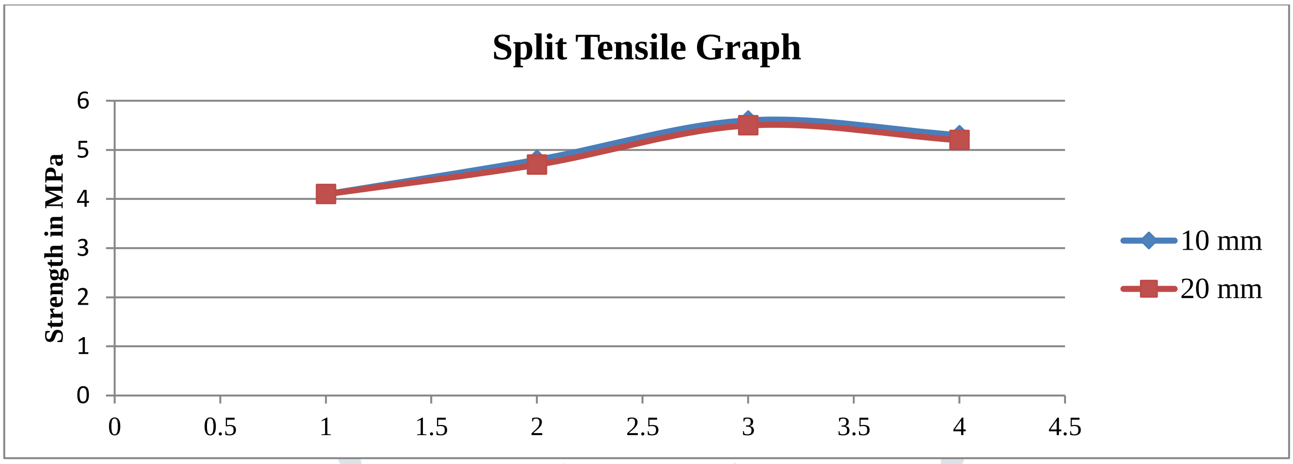

Fig.8 Split Tensile graph

3.4 Flexural Strength Test

Table 6 Flexural Strength results of BFSCC

Sr. No.	**Fiber Content**	**Avg. Flexural Strength at 28 days (MPa)**	
		10 mm	**20 mm**
1	**Plain SCC**	**7.4**	
2	**SCC + 1% Basalt Fiber**	**10.7**	**10.5**
3	**SCC + 2% Basalt Fiber**	**11.9**	**12.1**
4	**SCC + 3% Basalt Fiber**	**11.4**	**11.3**

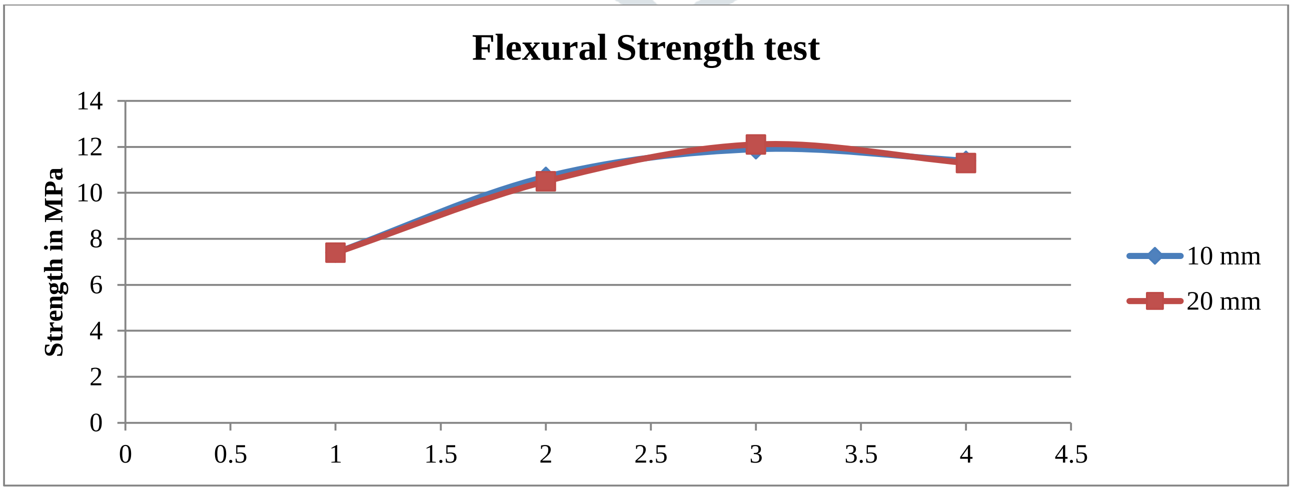

Fig.9: Flexural Strength graph

IV. CONCLUSIONS

An experimental study was performed to study the effect of addition of Basalt fiber in different percentages by weight of cement in M30 grade Self Compacting concrete. This study was intended to find the effective ways to utilize the Basalt fiber as addition by weight of cement in SCC. Analysis of the results of the effect of using Basalt fiber as addition by weight of cement on the strength of concrete leads to the following conclusions-

1. The incorporation of Basalt fiber in concrete causes gradual decrease in workability.
2. 4% decrease in Slump flow is observed when the fiber content is 2% added.
3. In this experimental study it has been found that the Compressive strength of BFSCC increases gradually up to 2%.
4. The increase of approx 2.2% and 1.90% in Compressive strength is observed for BFSCC (at 2% of fiber addition, 10 mm and 20 mm size respectively) in comparison to unreinforced sample.
5. In this experimental study it has been found that the Flexural strength of BFSCC increases gradually up to 2%.
6. The increase of 60.8% and 63.5% in flexural strength is observed for BFSCC (at 2% of fiber addition, 10 mm and 20 mm size respectively) in comparison to unreinforced sample.
7. In this experimental study it has been found that the Split Tensile strength of BFRC increases gradually up to 2%.
8. The increase of 36.6% and 34% in Split tensile strength is observed for BFRC (at 2% of fiber addition, 10 mm and 20 mm size respectively) in comparison to unreinforced sample.

V. FUTURE SCOPE OF THE PRESENT STUDY

In the present study Self Compacting concrete mix were made by addition of Basalt fiber by weight of cement with different percentages of Basalt fiber 1%, 2%, and 3%. Researcher suggested that further investigations can be done in future on following parameters-

(1) In future, Researchers can be change length and thickness of basalt fiber.
(2) Researchers can also go through on different grades of SCC.
(3) The percentage variations of BFRC can also be plays an important role in strength properties.

REFERENCES

[1] Aggrawal, P. Siddique, R. Aggrawal, Y. And Gupta, S.M. 2008. Self Compacting Concrete- Procedures for mix design. LEJPT journal. Issue 12. PP 15-24.

[2] Chaohua Jiang, Ke Fan, Fei Wu, Da Chen, "Experimental study on the mechanical properties and microstructure of choppedbasalt fiber reinforced concrete", Materials and Design 58 (2014) 187–193.

[3] "Guidelines for Mix design of SCC". 2008. Danish Technological Institute, SCC Consortation.

[4] Jena, Biswajit (2015) A study on mechanical properties and fracture behavior of chopped fiber reinforced self compacting concrete, NIT Rourkela, Odisha.

[5] Kumar, Ashish and Kumar gaurav. 2018. A Mix Design procedure for Self-Compacting Concrete. IRJET journal. Vol.5, Issue 2. PP 65-70.

[6] Krishna Murthy, N. Narsimha Rao, A.V., Ramana Reddy, Vijay Shekhar Reddy. 2012. Mix Design Procedure for Self Compacting Concrete. IOSR journal of Engineering. Vol. 2. Issue 9. PP 33-41.

[7] Ouchi M. And Okamura H. "Mix-Design for Self-Compacting Concrete", Concrete Library of JSCE, No.25, June 1995(ND), pp107-120

[8] Ouchi M. And Okamura H. "Effect of Super plasticizer On Fresh Concrete", Journal of Transportation Board, 1997, pp37-40.

[9] Raghuprasad P. S. "Comparative Study on Different types of Blended Cement with Different Grade O.P.0 Concrete - An Experimental Approach", ICACC-2004. Proceedings of International Conference on Advances in Concrete and Construction. 16-18 December 2004, Hyderabad, Vol.II, pp637- 646.

[10] Ravindra Gettu, Hannah Collie, CamiloBernad, Tomas Garcia and Clotie D Robin "Use of High Strength Self Compacting Concrete in Prefabricated Architectural Elements", International Conference on Recent Trends in Concrete, Technology and Structures INCONTEST 2003 Coimbatore, September 10-12, 2003, PP355-363.

[11] SeshadriSekhar.T, Sravana. P and SrinivasaRao.P, "Some Studies on the Permeability Behavior of Self Compacting Concrete" AKG Journal of Technology, Vol.1, No.2.(2005)

[12] Sood Dr. Hemant,(2009) "Incorporating European standards for testing Self-Compacting Concrete in Indian Conditions". N.I.T.T.T.R. Chandigarh, India.
[13] The European Guidelines for Self—Compacting Concrete (Specification, Production and Use) May 2005
[14] Upadhayay, Hardik., Shah, P., and George E. 2011. Testing and Mix Design method of Self-Compacting Concrete. National Conference on Recent trends in Engg. And Technology.