Basalt Fiber Reinforced Self Compacting Concrete

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Abstract - *A The growth of Self Compacting Concrete is revolutionary landmark in the history of construction industry resulting in predominant usage of SCC worldwide nowadays. It has many advantages over normal concrete in terms of enhancement in productivity, reduction in labor and overall cost, excellent finished product with excellent mechanical response and durability. Incorporation of fibers further enhances its properties specially related to post crack behavior of SCC. Hence the aim of the present work is to make a comparative study of mechanical properties of self-consolidating concrete, reinforced with basalt fibers. The basic properties of fresh SCC and mechanical properties were studied.*

Key Words: Self Compacting Concrete, Basalt Fiber, Fiber Reinforced Concrete, Modified Nan Su Method, M35 Concrete.

1. INTRODUCTION

Self-compacting concrete was originally developed in Japan and Europe. It is a concrete that is able to flow and fill every part of the corner of the formwork, even in the presence of dense reinforcement, purely by means of own weight and without the need of for any vibration or other type of compaction[1].The growth of Self Compacting Concrete by Prof. H.Okamura in 1986 has caused a significant impact on the construction industry by overcoming some of the difficulties related to freshly prepared concrete. The SCC in fresh form reports numerous difficulties related to the skill of workers, density of reinforcement, type and configuration of a structural section, pump-ability, segregation resistance and, mostly compaction.

There is an innovative change in the Concrete technology in the recent past with the accessibility of various grades of cements and mineral admixtures. However there is a remarkable development, some complications quiet remained. These problems can be considered as drawbacks for this cementatious material, when it is compared to materials like steel.[2] Concrete, which is a „quasi-fragile material having negligible tensile strength. Several studies have shown that fiber reinforced composites are more efficient than other types of composites. The main purpose of the fiber is to control cracking and to increase the fracture toughness of the brittle matrix through bridging action during both micro and macro cracking of the matrix.

1.1 Basalt Fiber

Basalt is a natural material that is found in volcanic rocks originated from frozen lava, with a melting temperature comprised between 1500° and 1700 °C .Its state is strongly influenced by the temperature rate of quenching process that leads to more or less complete crystallization. Another feature of the basalt fibers is their good compatibility with the matrix materials even if there are some research focused on the surface treatment of these fibers in order to modify their surface morphology and improve their wettability with the matrix material.

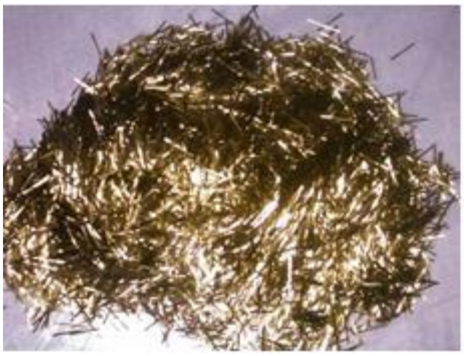

Fig -1: Basalt Fiber

1.2 Objectives of the Study

1. To compare the properties of basalt fiber reinforced self compacting concrete with conventional self compacting concrete.
2. To compare the properties of basalt fiber reinforced self compacting concrete with conventional self compacting concrete.

1.3 Scope of the Study

1. The study is limited to M35 grade SCC made with partial replacement of cement by flyash.
2. Basalt Rock fibers of size 12mm only are used.
3. Percentage of the basalt fibers to be used are 0.1%,0.15%,0.2%,0.25% and 0.3% only.
4. Fresh properties of SCC checked are flow ability, viscosity and passing ability.
5. Hardened properties of SCC checked are compressive strength, split tensile strength, flexural strength, modulus of elasticity and shear strength test.
6. Superplasticizer used was Master Glenium Sky 8233 by BASF Pvt. Ltd.

2. MIX DESIGN

Mix design has been done by the modified Nan-Su Method as well as Trial and error method to satisfy the flow properties.

Table -1: Mix Design for M35 grade SCC

Materials	Weight(kg/m^3)
Cement	400.00
Fine aggregate	800.08
Coarse aggregate	713.56
Water	218.70
Fly ash	249.87
Super plasticizer	3.00

2.1Mix Designation

The following mix designations are used to identify the various mixes to show the rheological and mechanical properties.

Table -1: Mix Designation

Designation	Percentage of Fiber in Concrete
PSC	Plain self-compacting concrete
BFC-1	0.1% Basalt fiber reinforced SCC
BFC-1.5	0.15%Basalt fiber reinforced SCC
BFC-2	0.20%Basalt fiber reinforced SCC
BFC-2.5	0.25%Basalt fiber reinforced SCC
BFC-3	0.30%Basalt fiber reinforced SCC

3. RESULTS AND DISCUSSIONS

3.1 Results of Fresh Properties

Table 2 shows the various flow properties obtained for all the mixes.

Table -2: Fresh Property Results

Designation	Slump Flow (mm)	L-Box Value(H_2/H_1)	T_{500} Flow (sec)	V-Funnel Flow(sec)
PSC	730	0.96	2.6	5
BFC-1	690	0.89	2.9	8
BFC-1.5	645	0.85	3.1	9
BFC-2	615	0.81	3.8	10
BFC-2.5	570	0.68	5.2	11
BFC-3	535	0.59	6	13

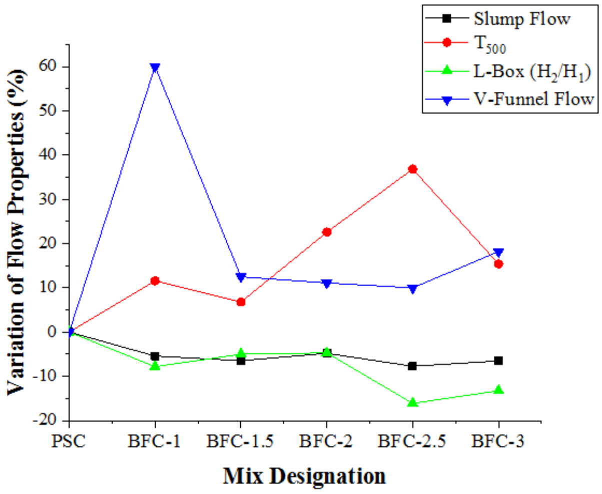

Chart -1: Variation of Flow properties.

Chart-1 indicate reduction of workability owing to inclusion of basalt fibers. The reason for this phenomenon is that a network structure may form due to the distributed fiber in the concrete, which restrains mixture from segregation and flow.

3.2 Results of Hardened Properties

Table -3: Cube Compressive Strength Results

Designation	7th Day Compressive Strength (MPa)	28th Day Compressive Strength (MPa)	56th Day Compressive Strength (MPa)
PSC	23.18	38.45	46.75
BFC-1	21.11	35.67	42.55
BFC-1.5	24.22	47.45	53.12
BFC-2	27.77	54.99	59.62
BFC-2.5	35.48	59.4	64.8
BFC-3	25.185	36.89	45.96

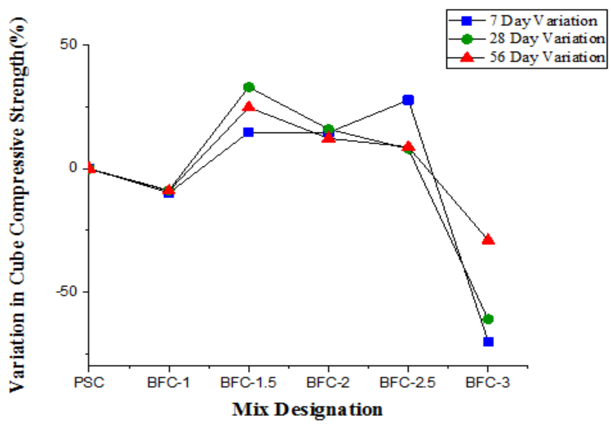

Chart -2: Variation of Cube Compressive Strength

Table -4: Split Tensile Strength Results

Designation	7th Day Split Tensile Strength (MPa)	28th Day Split Tensile Strength (MPa)	56th Day Split Tensile Strength (MPa)
PSC	2.4	4.1	4.9
BFC-1	2.25	3.81	4.51
BFC-1.5	2.8	4.55	5.67
BFC-2	3.25	5.45	6.9
BFC-2.5	3.4	4.34	6.1
BFC-3	3.18	3.89	4.35

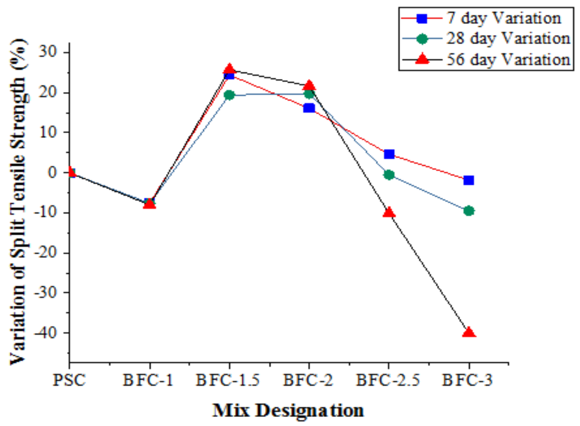

Chart -3: Variation of Split Tensile Strength

Table -5: Flexural Strength Results

Designation	7th Day Flexural Strength(MPa)	28th Day Flexural Strength (MPa)	56th Day Flexural Strength (MPa)
PSC	4.38	8.37	10.45
BFC-1	3.84	7.84	8.51
BFC-1.5	6.54	10.9	12.5
BFC-2	8.23	12.58	14.68
BFC-2.5	9.1	12.92	13.95
BFC-3	6.43	9.54	10.4

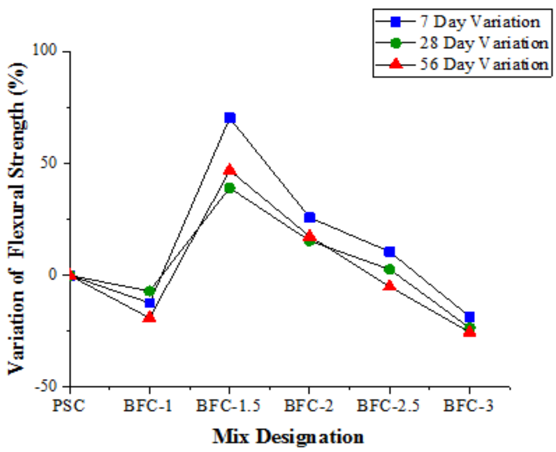

Chart -4: Variation of Flexural Strength

Table -6: Shear Strength Results

Designation	28th Day Shear Strength (MPa)
PSC	3.4
BFC-1	3.45
BFC-1.5	4.2
BFC-2	4.85
BFC-2.5	4.95
BFC-3	4.15

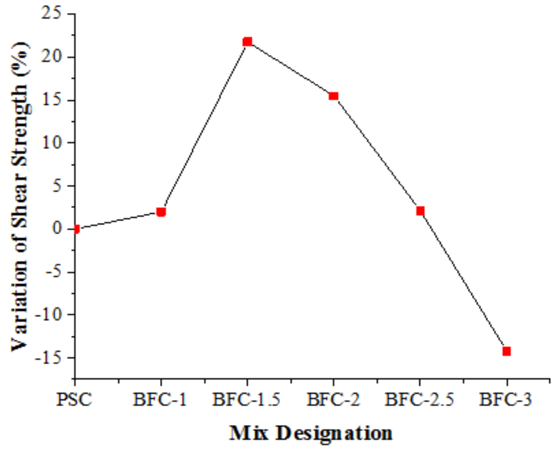

Chart -5: Variation of Shear Strength

Table -7: Modulus of Elasticity Results

Designation	28th Day Modulus of Elasticity (MPa)
PSC	29758
BFC-1	29671
BFC-1.5	30586
BFC-2	31259
BFC-2.5	31350
BFC-3	30196

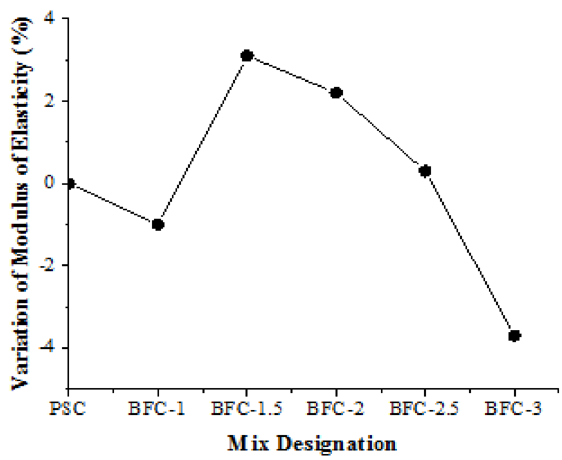

Chart -6: Variation Modulus of Elasticity Results

3.3 Discussions

- Addition of fibers in the SCC has significantly affected the rheological properties of the self compacting concrete in terms of its passing ability, flow ability and viscosity.
- Addition of fibers to self-compacting concrete improve mechanical properties like compressive strength ,split tensile strength, flexural strength, shear strength and modulus of elasticity of the concrete.
- Mix having 0.25% of basalt fiber were observed to increase the compressive strength to maximum.0.25% addition of basalt fiber to SCC was observed to increase at 7 days was increased by 53.1%, 28-days compressive strength increased by 54.5%, and 56-day compressive strength increased by 38.6%.
- Compared with the control mix 7-days flexural strength of basalt fibre self compacting concrete BFC-2.5 at 7 days was increased by 107.7%, 28-days flexural strength increased by 54.36%, and 0.20% of basalt fibre mix BFC-2 showed 56-day flexural strength increase by 40.49%.
- Compared with the control mix7-days Split Tensile strength of basalt fibre self compacting concrete BFC-2.5 at 7 days was increased by 41.7%, and for BFC-2 28-days Split Tensile strength increased by 32.93%, and 56-day Split Tensile strength increased by 40.8%.
- Compared with the control mixthe mix having 0.25% of basalt fiber showed maximum increase in shear strength of 45.58% compared with the control mix.
- Compared with the control mix the mix having 0.25% of basalt fiber showed maximum increase in modulus of elasticity of 5.4% compared with the control mix.

4. CONCLUSION

Basalt FRSCC exhibited better properties in fresh state and hardened state. In terms of the cost it is cheaper than other commonly used fibers such as carbon, polypropelyne etc, hence basalt fiber performance is can be used to improve the characteristics of SCC.

5. FUTURE SCOPE OF WORK

Durability study on the Basalt Fiber Reinforced Concrete has not been done. Further in micro level, SEM analysis can be conducted to visualize the fiber matrix composite and their behavior with hydrated products.

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