International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

Study the Performance of Concrete by Adding Fibre

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Abstract - *In this modern age, Civil Engineering construction have their own and durability requirements, every structure has its own intended purpose, modification in traditional cement concrete has become mandatory. It has been found that different types of fibres added in specific percentage to concrete improves the mechanical properties, durability & serviceability of the structure. It is now established that one of the important properties of Fibre Reinforcement Concrete is its superior resistance to cracking and crack propagation. Fiber-Reinforcement concrete is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibres include steel fibers, glass fibers, synthetic fibres and natural fibers-each of which lend varying properties to the concrete. In addition the character of fiber-reinforcement concrete changes with varying concretes, fibres material, geometries, distribution, orientation, and densities. The weak matrix is concrete, when reinforced with fibres, uniformlly distributed across its entire mass, gets strengthened enormously thereby rendering the matrix to behave as a composite material with properties significantly different from conventional concrete. Basalt fibre is a relative newcomer to fibre reinforced polymers and structural composites. It has a similar chemical composition as glass fibre but has better strength characteristic.*

Key Words: **Basalt Fibres, Reinforcement, Beams, Columns**

1. INTRODUCTION

The use of fibres has a long history going back at least 3500 years. In more recent times, different types of fibres such as asbestos, cellulose, steel, polypropylene and glass have been used to reinforce cement products.

Introduction of fibres in concrete can help to improve the rheology, plastic cracking characteristics, the tensile or flexural strength, the impact strength & toughness & to control cracking & the mode of failure by means of post cracking ductility & to improve durability.

Basalt is a volcanic igneous rock which performs well in terms of strength, temperature range, and durability. Basalt fibres are obtained from basalt rocks through melting process. The basalt rocks can be so finely divided into small particles that it becomes possible to produce into a form of fibres.

In addition, the BFs do not contain any other additives, which make additional advantage in cost. It is known that the BFs have better tensile strength than the E-glass fibres, greater failure strain than the carbon fibres as well as good resistance to chemical attack, impact load & fire with poisonous fumes.

1.1 Factor influencing FRC

Fiber reinforcement concrete improves various aspects in the concrete mix only if it is added properly in sufficient quantity and considering the factors relating to the concrete, fiber, steel, mix etc. Factors which influence the fiber reinforced concrete are relative fiber matrix stiffness, volume of fibers, aspect ratio of fibers, size of coarse aggregate, orientation of fibers, workability of concrete and fiber matrix interfacial bond. Out of these parameters which are considered in the study are as follows:

a. Volume of fibres

b. Aspect ratio of the fibres

1.1.1 Volume of fibres

The strength of the composite largely depends on the quantity of fibres used in it. Use of higher percentage of fibre is likely to cause segregation and harshness of concrete and mortar.

1.1.2 Aspect ratio of the fibres

Another important factor which influences the properties and behavior of composite is the aspect ratio of fibre. It has been reported that up to aspect ratio of 75, increase in the aspect ratio increase the ultimate strength of the concrete linearly. Beyond 75, relative strength and toughness is reduced.

1.2 What is Basalt fibre.

- Basalt fibre is made from crushed lava rocks with specific chemical compositions mined from chosen quarries.
- Unlike glass fibre, no other materials are added and the basalt rock is simply cleaned & then melted down to around 1,450°C.
- The molten rock is then extruded through small orifices at different speeds to produce continuous filaments of basalt fibre.

Fig:1. Raw Basalt Fibres

2. Basalt fibre properties

- Basalt fibre is a relative newcomer to fibre reinforced polymers &structural composites.
- It has a similar chemical composition as glass fibre but has better strength characteristics, and unlike most glass fibres is highly resistant to alkaline ,acidic & salt attack making it a good candidate for concrete, bridge & shoreline structures.

Fig: 2. Raw Basalt Fibre & Scale

3. Fibre production process:

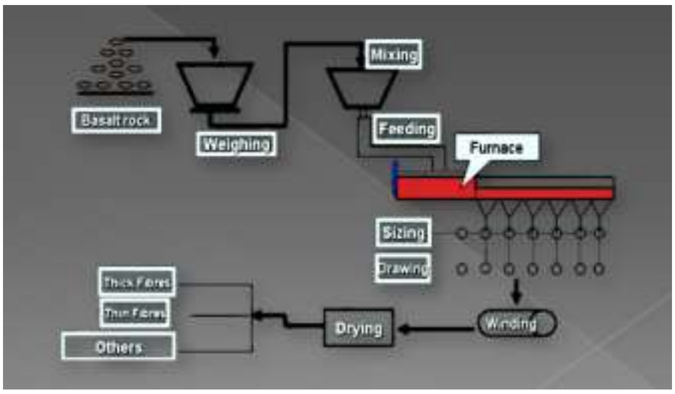

Fig: 3. Production Process

3. Methodology

-Mixing Calculations

a) Volume = 1m3

b) Vol. of cements = (Malls of cements/31 of rosary)×(1/1000)

= (400/3.15)×(1/100)

= 0.126 m3 – (DP) 1.95 X 10 -4 = 1253.103

c) Vol. of Water = (Mass of bloter /Sp gr. Of wave)×(1/1000)

=(180/1)×(1/100)

= 0.18 m3

d) Vol. Of all in = a – (b+c)

= 1 - (0.306)

= 0.694 M3

This Volume is reduced by 1.5 Kg/M3 (Avg. Bf to be cylinder)

density of Bf = 2650 Kg/M3

2650 Kg ---------- / M3

1.5 Kg -------------0.00567 M3

Volume of all in agg. = 6.694

1. Vol. of All agg. = 6.694 M3

Vol. of C.A = 0.68.697 = 0.916 & F.A Vol.= 0.4 X 0.4694 =0.275 M3

Vol. d. C.A = 0.416m3 mask of C.A = d X vol. of CA X Sp.gr.

= C.A. X 100

= 0.6 X 3.03 X 100

= 743.96 = 744 Kg

4. MIX DESIGN

Table -1: Proportion Table

Cement	Water	F.A.	C.A.	W.C.Ratio	Volume of conc. For members
400	180	744	1262	0.45	For 1m3
24.3	10.94	45.19	76.67	0.45	0.06075m3 for 18 cubes
37.8	17.01	70.31	119.26	0.45	0.0945m3 for 6 beams
12.8	5.76	23.81	40.38	0.45	(0.032m3 for 6 cylinders
Mix proportions 1:1.86:3.16					

5. List of Materials

- **River Sand**
- **Aggregate**
- **Cement**
- **Water**
- **Basalt fibre**
- **Cube ,cylinder ,beam moulds**
- **Weighing machine**
- **Tapping rod**
- **Steel**
- **Basalt fibre reinforced bars**

6. Experimental program

- Specimen preparation

This section illustrates the procedure of casting and testing which has been carried out for complete project work. It includes batching, mixing of concrete, placing of concrete in moulds, de-moulding, curing and testing.

Fig: 4. Material Specimen

6.1 Batching

- In the present work, all the ingredients of concrete were weighing batched. River sand, coarse aggregate, Basalt fibre and extra water are measured with digital weighing balance.
- **Figure** shows the digital balance used throughout the experimental work.

Fig: 5. Weighing machine

6.2 Mixing of concrete

- Place the concrete bag in the mixing trough or wheelbarrow and cut along the width of the bag. Stand upwind and lift both ends gradually to empty it into the trough.

Fig: 6. Mixing of Concrete

- Scoop an indentation in the centre of the powdered mix using your hoe and pour in two-thirds of the water specified in the instructions. Use the hoe to push and pull the mix until the water has been absorbed. Gradually add the remaining amount of water -- but no more -- and continue mixing the concrete until it's at an even consistency.

- Instead of adding more water to dry pockets, work the corners and sides of the trough into the mix to soak up excess moisture in the middle. Keep mixing until the concrete reaches the consistency of peanut butter and the dry pockets are gone. To test the mixture, grab a fistful of concrete in your gloved hand and give it a squeeze. The ball of concrete should retain its shape and not drip out between your fingers.

Fig: 7 Mixing

6.3 Placing of concrete

- To place concrete in proper way certain care must be taken to make certain preparations before placing. Inner surfaces of all beams are clean thoroughly. Oil is applied to all the inner surfaces of beam moulds to get smooth surface. The fresh concrete is placed in moulds by trowel.

- It is ensured that the representative volume is filled evenly in all the moulds to avoid segregation, accumulation of aggregate etc. Concrete cubes of size 150 mm are casted in three layers. Each layer is well compacted by tamping rod of diameter 16 mm. Beam moulds are filled in 5 layers to ensure that no honey combing is occurred in specimen.

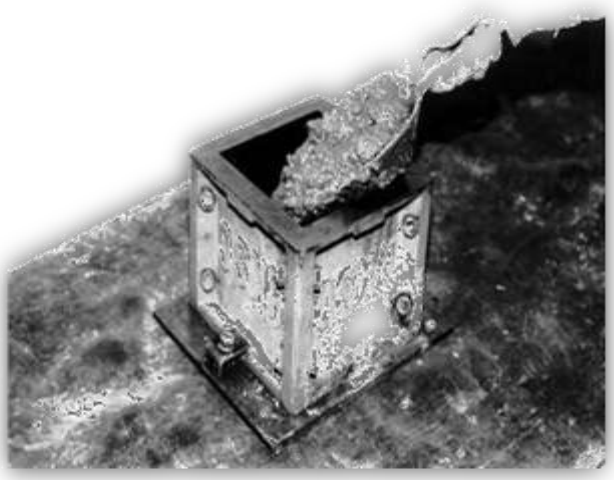

Fig: 8. Placing Of Concrete (a)

Fig: 9. Placing Of Concrete (b)

6.4 Compaction of concrete

- During the manufacture of concrete a considerable quality of air is entrapped. If the entrapped air is not removed, concrete may be porous, non-homogeneous and of reduced strength.

- The process of removal of entrapped air and uniform placement of concrete to form homogeneous dense mass is termed as compaction. Compaction is done by using steel rod of diameter 16 mm uniformly after filling the moulds in layers.

Fig: 10. Compaction of Concrete

6.5 De-moulding of specimens

- Concrete placed in beams and cubes are allowed to settle for 24 hrs. After 24 hrs, de-moulding of beam specimens is done.
- Care should be taken that, during removal of specimens from mould there should not be any damage to the corners of specimen.

Fig: 11. De-moulding (a)

Fig: 12. De-moulding (b)

6.6 Curing

- A newly placed and finished concrete should be cured and protected from drying, extreme changes in temperature, and damage.
- The curing should begin immediately after finishing.

Fig.13 Curing

7. REFERENCES

- A. K. Sachan and C. V. Kameswara Rao (1990), Behaviour of fiber reinforced concrete deep beams, Journal of Cement and Concrete Composites, Vol. 12
- A. Meridaa and F. Kharchib (2015), Pozzolan concrete durability on sulphate attack, Journal of Procedia Engineering, Vol. 114
- A. Sivakumar and M. Santhanam (2007), Mechanical properties of high strength concrete reinforced with metallic and non-metallic fibers, Journal of Cement and Concrete Composites, Vol. 29
- A. S. Sayyad and S. V. Patankar (2013), Effect of stirrups orientation on flexural response of RC deep beams, Journal of American Journal of Civil Engineering and Architecture, Vol. 1

8. Results & Conclusion

8.1 Cube compressive strength:

Compressive strength of cubes are determined at 28 days of normal temperature curing of geopolymer concrete by compression testing machine (CTM) of capacity 2000 kN or by universal testing machine (UTM) of capacity 1000 kN.

Table: 2. Column Testing Results

TYPE OF CYLINDER	BREAKING LOAD
B.F -2	127KN
B.F -2	129.9KN
B.F -2	92.9KN
C -1	128KN
C -2	119.1KN
C -3	117.9KN

TABLE: 3. DEFLECTION TESTING OF BEAM (normal bars)

LOAD (KN)	Deflection readings on strain gauge in mm					
	Controlled Beam 1		Controlled Beam 2		Controlled Beam 3	
	Left	Right	Left	Right	Left	Right
5	1.1	1.0	1.0	1.0	1.1	1.1
10	1.3	1.3	1.1	1.3	1.2	1.4
15	1.6	1.6	1.4	1.9	1.52	1.53
20	1.7	1.7	1.51	2.2	1.61	1.78
25	1.9	1.9	1.7	2.53	1.8	1.87
30	2.1	2.2	1.89	2.67	1.97	2
35	2.2	2.2	1.97	2.98	2.09	2.11
40	2.4	2.4	2.03	3.02	2.2	2.34
45	2.5	2.5	2.22	3.3	2.45	2.51
50	2.7	2.73	2.5	3.72	2.61	2.69
55	2.9	2.9	2.81	3.88	2.8	2.8
60	3.1	3.19	3	3.91	2.98	2.99
65	3.4	3.37	3.12	4.13	3.11	3.07
70	3.75	3.6	3.4	4.36	3.39	3.21
75	4.01	3.98	3.6	4.43	3.50	3.43
80	4.37	4	3.79	4.6	3.7	3.70
85	4.5	4.4	3.9	4.81	3.92	3.94
90	4.8	4.78	4.07	4.89	4.3	4.3
95	4.97	4.93	4.5	4.96	4.7	4.6
100	5	5	5	5	5	5

LOAD IN(KN)	Basalt fibers cylinders 1.	2.	3.	Normal cylinders 1.	2.	3.
30	-	-	-	-	-	-
60	-	-	Slight deformed	-	-	-
90	Slight deformed	-	Diagonal cracks	-	Slight deformed	Slight deformed
92.9	-	-	Breaked	Slight deformed	-	Diagonal cracks
117.9	-	Slight deformed		-	Diagonal cracks	Breaked
119.1	-	-		-	Breaked	
120	Diagonal cracks	Diagonal cracks		Diagonal cracks		
127	Breaked	-		-		
128		-		Breaked		
129.9		Breaked				
150						

TABLE: 4. CYLINDER TESTING

8.2 Concrete cube test result

Sr.No.	B.F. %	Specimen No.	Area	Compressive strength
1	0	1	150mm CUBE	42.85
2	0	1		32.08
3	0	1		42.3
4	0.5	2		43.35
5	0.5	2		41.74
6	0.5	2		41.71
7	1	3		17.71
8	1	3		20.41
9	1	3		19.57
10	1.5	4		11.62
11	1.5	4		11.50
12	1.5	4		13.04
13	2	5		12.21
14	2	5		16.48
15	2	5		12.18
16	2.5	6		10.16
17	2.5	6		10.45
18	2.5	6		10.27

Table: 5. Test Results

9. Conclusions

- ❖ The addition of Basalt fibers did not affect the compressive strength of the HPFRC. The variation in the average cube and cylinder strengths of HPFRC containing Basalt fibers was found to be in the range of ±4% compared to the average compressive strength of the control specimens.

- ❖ The addition of Basalt fibers improved the strain capacity of the HPFRC. The average increase in the compressive strains was found to be 4.76%, 9.99%, and 12.20% when Basalt fibers were added as 1%, 2%, and 3% by volume in the concrete mixes, respectively.

- ❖ For each of the three mixes of HPFRC, the tensile splitting strength was found to be significantly increased with the increasing volume of Basalt fibers. With respect to the control specimen (without fibers), the average increase in the tensile splitting strength of all mixes of concrete with 1%, 2%, and 3% was found to be 1.64%, 5.27%, and 23.95% higher. This shows that 3% Basalt fiber volume is the maximum fiber volume. Use of mineral admixtures (particularly silica fume) together with the basalt fibers significantly enhanced the tensile splitting characteristics of HPFRC in comparison to those concretes in which no mineral admixture or metakaolin was added.

- ❖ Similar to the results of tensile splitting strength, the addition of Basalt fibers considerably increased the flexural strength of the HPFRC. The use of 1%, 2%, and 3% Basalt fibers increased the flexural strength of the concrete as 18.15%, 36.12%, and

27.17% higher than that of the concrete without fibers. Individually, the use of mineral admixtures, particularly metakaolin together with the Basalt fibers, significantly enhanced the flexural strength of HPFRC in comparison to the plain concrete in which no mineral admixture was added.

9.1 Statement:

Hence the report occurred is positive as per the results.

The required amount of result has been occurred.

It proves that adding basalt at a certain percentage is very useful and gains higher strength too.

Addition of basalt fiber should be done only upto 0.5% and not above that.

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