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PERFORMANCE OF STRENGTH ASPECT OF BASALT FIBER REINFORCED CONCRETE

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Abstract: The objective of this paper is to investigate compressive and tensile strength of basalt fiber reinforced concrete with plain M20 grade concrete cubes and cylinders. Experimental and analytical studies are conducted on basalt fiber reinforced concrete with optimum fiber content, which was obtained by varying the fiber dosages from 0%, 0.50%, 1.0% and 1.5% of total volume of concrete. The experimental test resulted in a considerable increase of compressive strength and split tensile strength of specimen at 7 and 28 days with addition of basalt fibers.

The analytical work was done for experimental work done for experimental specimen by using a commercially available software ANSYS. And was obtained the hand to hand results in experimental work.

Keywords: Compressive strength, Basalt fiber, Split tensile strength, Fiber reinforced concrete

I. INTRODUCTION

During the past few decades, the concrete construction field has seen a growing interest in the advantages that fibre reinforcement has to offer. Between the different types of fibres available, basalt fibre is considered a promising new material to use. It has extremely good strength characteristics and thermal resistance, high resistance to an alkaline environment, and is cheap product, making it an excellent material to reinforce concrete. The rapid increase in the use of fibres in concrete is attributed to its positive effect on the mechanical properties of the cementations composites. It is proven that the addition of fibres to concrete has a significant impact on improving the mechanical properties of fresh and hardened concrete, such as compressive strength, tensile strength, flexural strength, and workability

Basalt is originated from volcanic magma and flood volcanoes. It is a very hot fluid or semi-fluid material which is located under the earth crust. It is solidified in the open air. It will be brown or dark in colour when it is formed from volcanic lava after solidification.It acts as a

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surfacing and filling material in roads. Also used as floor tiles in the construction and as the lining material for transporting the hot fluids in pipes.

II OBJECTIVE OF THE WORK

The main aim of the project is to develop basalt fiber reinforced concrete in which basalt fiber is used as an additive to the cement. Based on the available literature survey the objectives derived are as follows.

- The properties of the basalt fiber reinforced concrete is thoroughly investigating by conducting the experimental work for various specimen.
- Analytically investigate the properties of basalt fiber reinforced concrete for the same experimental specimen.
- Comparing the experimental results with analytical results within the elastic limit.

III. EXPERIMENTAL WORK

3.1 Materials Used

In this the various materials used for the study, their properties, test conducted and results are discussed. This section also explains the mix proportions used for the study.

3.1.1 Coarse Aggregate: Coarse aggregate is a material that will pass the 3-inch screen and will be retained on the No.4 sieve (4.75mm). As per IS 383-1970, coarse aggregate used is graded.

3.1.2 Fine Aggregate: The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. As per IS 383-1970, fine aggregate confirming to zone 3.Locally available clean river sand was sieve analysed and tests for specific gravity were carried out.

3.1.3 Basalt fibers: Basalt fiber is made from a single material, crushed basalt from a carefully chosen quarry source. Melting of Basalt rock at about 1400 degree Celsius is done next extrusion of molten rock through small nozzle to produce continuous filaments of basalt fibers are done. The filament diameter obtained will be between 9-13 micro meters.

3.1.4 Water: Portable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. The pH value shall not be less than 6

Table 1: Properties of Basalt fiber based on literature survey

Properties	value
Tensile strength	4.84 Gpa
Elastic modulus	89 Gpa

Elongation at break	3.1 %
Density	2.7 g/cc

Table 2: Laboratory results of Physical properties of various material used.

CEMENT		
Tests conducted	**Results obtained**	**Requirements as per IS 383 1970**
Specific gravity	2.69	3.15 maximum
Fineness (%)	5	10 maximum
Normal consistency (%)	29	-
FINE AGGREGATE		
Specific gravity	2.69	2.75maximum
Water absorption (%)	0.3	2 maximum
Water content (%)	1.4	-
Sieve analysis	sand falls under zone III as perIS 383 – 1970	
COURSE AGGREGATE		
Specific gravity	2.74	2.85 maximum
Water absorption (%)	0.09	0.6 maximum
Water content (%)	0.03	-

3.2 MIX PROPORTIONING

Based on the literature review M20 grade mix is selected. Then the amount of all the ingredients like cement, fine aggregate, coarse aggregate, water content are calculated. The Concrete specimens were cured in the tank for 7, 28 days.

Table 3: Design mix proportion of cubes and cylinders

Specimen	Water cement ratio	Cement (kg)	Sand (kg)	Coarse aggregate (kg)	Basalt fiber (kg)
A	0.45	21.576	42.95	54.69	-
B	0.45	21.576	42.95	54.69	0.108
C	0.45	21.576	42.95	54.69	0.2153
D	0.45	21.576	42.95	54.69	0.323

VI. EXPERIMENTAL TEST RESULTS AND DISCUSSIONS

4.1 Compressive Strength Test: The compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Compressive strength were measured at 7,28 day of testing. The test results are shown in the following table 4.

4.2 Splitting Tensile Strength Test: The split tensile strength values of ordinary concrete and basalt fiber concrete mixes are observed at 7 and 28 day of testing. The test results are presented in the table 4 below.

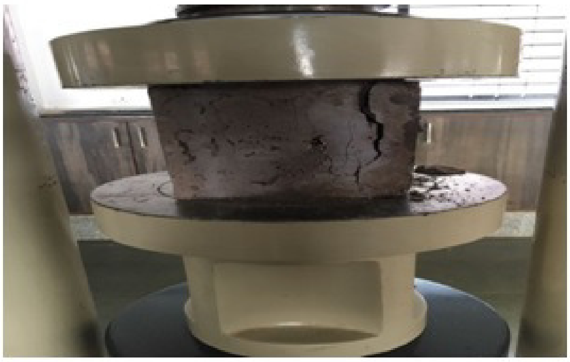


Figure 1: Compressive strength test

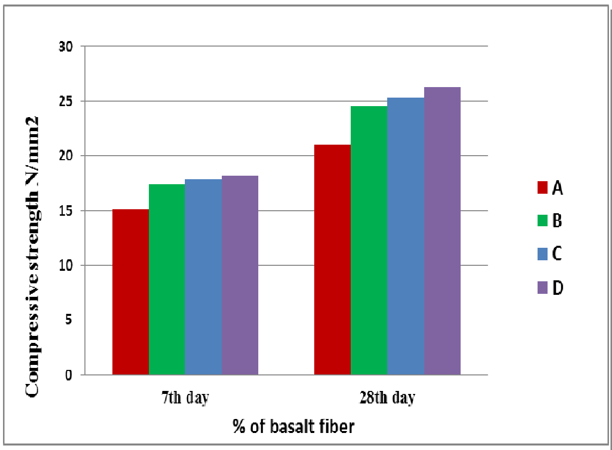
Figure 2: Tensile strength test

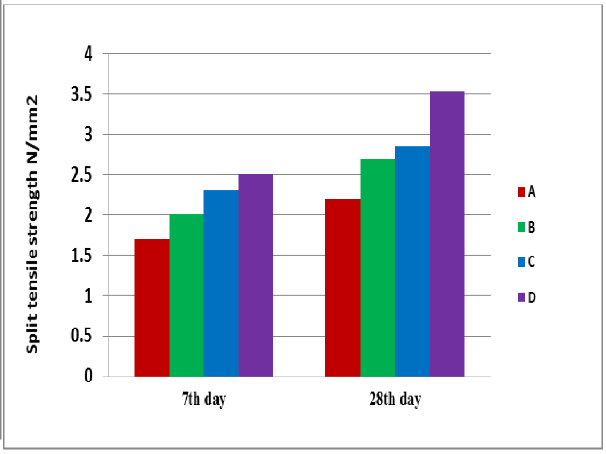
Table 4: Compressive strength and split tensile strength of basalt fiber specimens at 7days

Sl no	Specimen	Slump in mm	Age			
			7 days			
			Compressive Strength in MPa	Percentage of strength increased w.r.t zero % fiber	Split Tensile Strength in MPa	Percentage of strength increased w.r.t zero % fiber
1	A(zero % fiber)	98	15.10	-	1.7	-
2	B (0.5 %)	85	17.40	15.23	2.0	17.64
3	C (1%)	77	17.83	18.08	2.3	35.29
4	D (1.5%)	68	18.22	20.66	2.5	47.05

Table 5: Compressive strength and split tensile strength of basalt fiber specimens at 28days

Sl no	Specimen	Slump in mm	Age			
			28 days			
			Compressive Strength in MPa	Percentage of strength increased w.r.t zero % fiber	Split Tensile Strength in MPa	Percentage of strength increased w.r.t zero % fiber
1	A(zero % fiber)	98	21.05	-	2.20	-
2	B (0.5 %)	85	24.50	16.38	2.70	22.72
3	C (1%)	77	25.30	20.19	2.85	29.54
4	D (1.5%)	68	26.23	24.60	3.53	60.45





Graph1: Compressive strength of various specimen

Graph 2: Split tensile strength of various specimen

By referring above **Graph 1** as the percentage of basalt increases in a concrete the compressive strength of the concrete also increasesupto 24.60% w.r.t Zero percent basalt fiber.

By referring above **Graph 2** as the percentage of basalt increases in a concrete tensile strength of the concrete also increasesupto60.45% w.r.t Zero percent basalt fiber.

V. ANALYTICAL WORK

5.1 Introduction:

In this chapter the details of analytical model was developed for the same experimental specimens to study the behaviour of basalt fiber reinforced concrete is provided. This model has been developed by using commercially available software ANSYS.

5.2 Linear Analysis Procedure:

Linear analysis is extremely used in structural dynamic studies of existing equipment or to evaluate the dynamic characteristics of machines and structures prior to fabrication. ANSYS model is typically much more detailed than an experimental model. Linear analysis in ANSYS was carried out on M20-1.5% concrete cubes and cylinders by finding elastic modulus at 28 days.

5.3 Concrete Material Properties

Table 6: Concrete Properties Prior To Initial Yield Surface

Specimen	Modulus Of Elasticity (Mpa)	Poisson's Ratio (μ)
A(zero % fiber)	22360.68	0.2
B (0.5 %)	24748.74	0.2
C (1%)	25149.55	0.2
D (1.5%)	25607.62	0.2

5.4 Compressive Strength

To study the compressive strength of experimental specimen, the finite model was prepared of size 150x150x150mm in ANSYS.

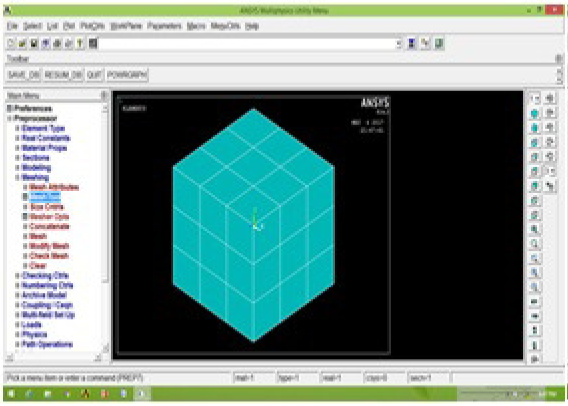


Figure 3: Meshing of the typical specimen

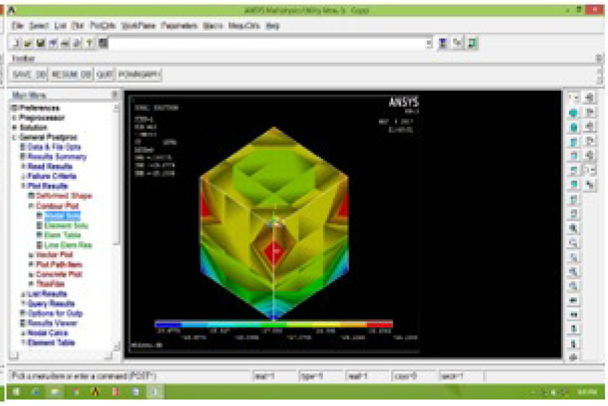


Figure 4: Results of the typical specimen

Table 7: Compressive strength of basalt fiber specimens at 28days

Sl no.	Specimen	Ultimate load kN	Compressive Strength, MPa	Percentage of strength increased w.r.t zero % fiber
1	A (zero % fiber)	473	21.10	-
2	B (0.5 %)	553	24.76	17.34
3	C (1%)	570	25.05	18.72
4	D (1.5%)	590	26.30	24.64

By referring above table 7 as the percentage of basalt increases in a concrete the compressive strength of the concrete also increases upto 24.64% w.r.t Zero percent basalt fiber

5.5 Tensile Strength

To study the tensile strength of experimental specimen, the finite model of cylinder was prepared of height 300 and diameter 150mm in ANSYS.

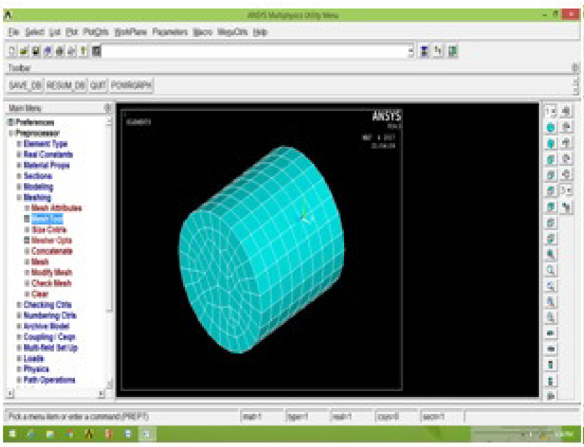


Figure 5: Meshing of the typical specimen

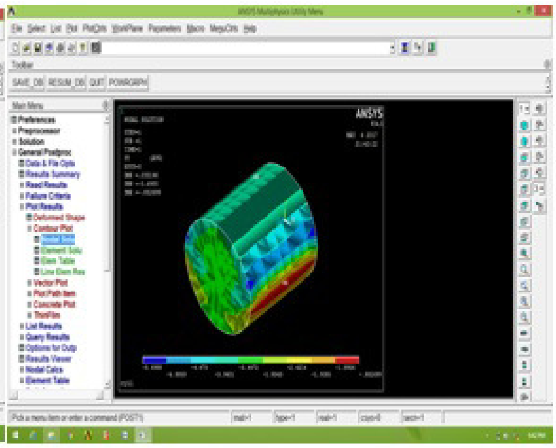


Figure 6: Results of the typical specimen

Table 8: Split tensile strength of basalt fiber specimens at 28days

Sl no.	Specimen	Ultimate load kN	Split tensile strength MPa	Percentage of strength increased w.r.t zero % fiber
1	A (zero % fiber)	156	2.30	-
2	B (0.5 %)	191	2.56	11.3
3	C (1%)	202	3.23	40.4
4	D (1.5%)	231	3.66	59.13

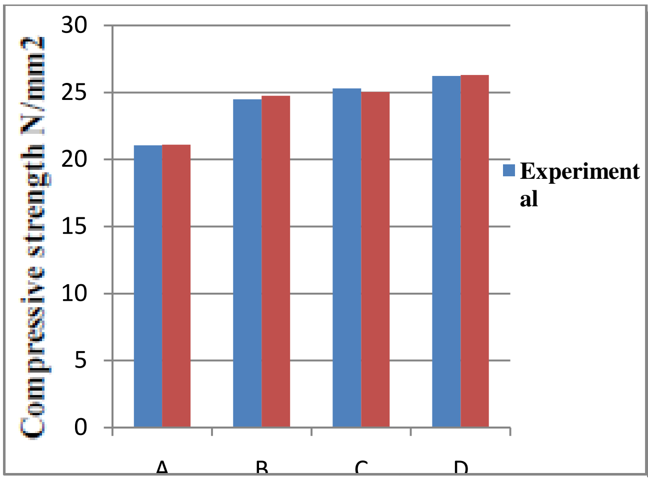
By referring above table 8as the percentage of basalt increases in a concrete tensile strength of the concrete also increases upto 59.13% w.r.t Zero percent basalt fiber.

VI. RESULTS AND DISCUSSION

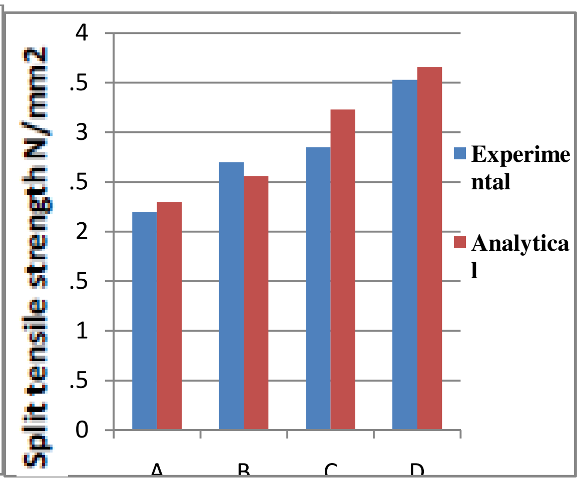
6.1 Compressive Strength and Tensile Strength

➢ **Comparison of experimental results with analytical results at the Age of 28 days:**

The experimental values of compressive strength&tensile strength of specimens are compared with analytical results of specimen. It is shown in the following table and graph.



Graph 3



Graph 4

Table 9: Comparison of experimental results with analytical results at the Age of 28 days:

Sl no	Specimen	Age 28 days			
		Compressive Strength in MPa		Split Tensile Strength in MPa	
		Experimental	Analytical	Experimental	Analytical
		Percentage of strength increased w.r.t zero % fiber	Percentage of strength increased w.r.t zero % fiber	Percentage of strength increased w.r.t zero % fiber	Percentage of strength increased w.r.t zero % fiber
1	A(zero % fiber)	-	-	-	-
2	B (0.5 %)	16.38	17.34	22.72	11.3
3	C (1%)	20.19	18.72	29.54	40.4
4	D (1.5%)	24.60	24.64	60.45	59.13

Graph 3 & 4: Comparison of Compressive strength & Split tensile strength of experimental results with analytical results at the Age of 28 days

By referring the above graph we can observe that the compressive strength & tensile strength obtained from analytical work matches with the results of experimental work.

Based on the analytical results it is able to confirm that the experimental results go hand in hand with the experimental results. Analytical values support the experimental results so that the followed experimental procedure was correct. This gives validation for the project.

6.3 CONCLUSION

Regarding the experiment work conducted the subsequent remarks concerning the performance and characteristic of concrete on addition of basalt fiber to the weight of cement

- Basalt fiber can be effectively used as an additive to the weight of cement in developing BFRC.
- Compression strength and split tensile strength of concrete increases about 24.6% and 60.45% at 28 days with usage of basalt fiber of 1.5 % with respect to weight of cement.
- By observing the above values, it can be concluded that basalt fiber is very much effective in increasing the split tensile strength than the compressive strength.
- Involving this work will lead to development of construction segment and pioneering Building material

REFERENCES

[1] Dr. Patnaik Anil, “Applications of Basalt Fibers Reinforced Polymer (BFRP) Reinforcement for Transportation Infrastructure”, Developing a Research Agenda for Transportation Infrastructure – TRB, November 2009, 1-5.

[2] Dr. Sergey Osnos, “Basalt continuous fiber: development of technologies and equipment from the past to the present”, Basalt Fiber& Composite Materials Technology Development Company, China.

[3] Murray Allan D.,” Basalt Fibers for high-performance composites”, Allied composite Technologies LLC, 1-4.

[4] Saravanan D., “Spinning of rocks – Basalt fibers”, Institute of Engineers (India) Journal, volume 82, February 2006, 39-45.

[5] Sheldon G. L., “Forming fibers from basalt rock”, platinum metal review, 1977, 18-24.

[6] Singha Kunal “A Short Review on Basalt Fiber”, International Journal of Textile Science, volume 1 (4), 2012, 19-28.