International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Structural Property Analysis in Basalt Fiber Reinforced Concrete

Gokila G
Department of Civil Engineering
K.S.R. College of Engineering (Autonomous)
Tiruchengode, Namakkal, Tamilnadu

Dineshkumar G
Department of Civil Engineering
K.S.R. College of Engineering (Autonomus)
Tiruchengode, Namakkal, Tamilnadu

ABSTRACT

This research article exhibit the knowledge of natural basalt fiber, it is a new coming material to the construction industry. Basalt is a nonmetallic, high performance material made from naturally available igneous rock. Under high temperature basalt fiber and other products formed from igneous rock. Basalt fiber incorporated concrete has more beneficial characteristics like higher strength, good temperature resistance and light weight. In forthcoming days it is very essential for construction domain. This fiber is useful in many civil engineering applications include construction of Commercial, industrial building, pavements (flexible & rigid) and highway bridges. This article deals about the strength characteristics of basalt incorporated concrete with conventional concrete to reveal the compressive strength of cubes & Flexural strength of beams. This research article provides more positive features about the basalt as a construction material in the booming infrastructure industry.

Keywords

Basalt fiber, Igneous Rock, Temperature Resistance, Compressive strength, Flexural Strength

1. INTRODUCTION

Construction engineers & industry is continuously searching for a new material to produce good strength product with a reasonable cost[9], which is more beneficial to the practicing engineers and researchers. Today a tremendous development is perceived in the construction industry due to the usage of composite material. An engineer should keep the following factors in the mind when selecting a material for construction purpose or manufacturing a new product: Environmental impact, Sustainability, Corrosion Risk, Energy conservation. Basalt is a byproduct of igneous rock at a very high temperature of 14000C to 16000C [2].Many basalt products are manufactured from igneous rock, few are basalt chopped fiber, filament, roving, grid and thread.

Figure 1. Basalt Fiber

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

The igneous rocks are formed from the volcanic magma and volcanoes, a hot fluid or semi fluid state material below the earth's crust, change its state from liquid or semi liquid to solid in the atmosphere and form a rock[3]. This kind of rock is called basalt rock. Basalt is general name recommended for a different types of volcanic rock, which are light grey, dark grey, purple and black. The molten rock magma is extruded into the sharp nozzle to form the filament of continuous basalt fiber. In this manufacturing process does not contain any other additives other than the raw material of basalt rock[8]. Due to these reason it does not produce any toxic reaction with atmospheric air and water. And also it does not produce any reaction when it contact with chemicals. So it may not damage environmental.

Basalt fiber has good thermal and hardness properties. It have been effectively used for slab and foundation concrete [4].The availability of various length of the fibers are shown in table 1.

Table 1 Length of Fiber

Chopped Length(mm)	Water Content(%)	Sizing (%)	Sizing & Application
Less than 3	<0.10	<0.40	For brakes pads and lining
4.5	<0.10	<0.40	For Thermoplastic
6	<0.10	<0.40	For Nylon
12	<0.10	<0.40	For Rubber Reinforcement
18	<0.10	50.40	For Asphalt Reinforcement
25	<0.10	<0.40	For Cement Reinforcement
30	<0.10	<0.40	For Composites
50-60	<0.10	<0.40	For Non-Woven Mat, Veil & Blended with other fiber
90	<0.10	<0.35	Blended With Other Fiber

2. PROPERTIES OF BASALT

2.1 Physical Properties

Fiber Density: The basalt fiber Density lies between 2.6-2.75 g/cm3.Coefficient of friction: The frictional coefficient is between 0.40 to 0.50[5].

2.2 Chemical Composition of Basalt Rock

Basalt is highly stable in alkaline matter. But in combination with water; basalt fiber has lost its weight, acidity and alkalinity. Have good resistance to Ultraviolet rays, fungal and biological contamination [8]. This kind of igneous rock fiber has relatively lesser absorption of humidity. And it is more compatible with the phenolic resins.

Table 2 Chemical Composition of Fiber

Basalt rock-Chemical Composition	Percentage
SiO_2	52.8
Fe_2O_3	10.3
MgO	4.63
CaO	8.59
Al_2O_3	17.5
TiO_2	1.38
K_2O	1.46
Na_2O	3.34
Cr_2O_3	0.06
P_2O_5	0.28
MnO	0.16

2.3 Thermal Properties

The basalt fiber has high melting point value of 14500C with a temperature range of 2500C-9850C and also low heat conductivity of 0.030w/mk-0.038 w/mk.It has ideal application in both insulation protection and fire protection application. It is more economical than other types of fiber like Armand, glass, carbon and other types of jute fiber. Basalt provides triple the times better thermal efficiency than asbestos without any hazards. It is the best replacement material for asbestos. It is a inflammable and detonation proof material. After elucidation smaller than 4200 fiber of basalt rock loss their early strength.[6]

2.4 Mechanical Properties

The separation stress to density ratio of basalt exceeds the value of steel greatly. These fibers are non-hygroscopic and non-capillary [10]; produce good resistance to water absorption capacity. Basalt has available in smaller size that is less than 3mm.Thatswhy it develop greater strength with constituent materials.

Table 3 Mechanical properties of Basalt Fiber

Fiber type	Tensile Yield Strength ksi (MPa)	Specific Gravity	Strain at Break	Elastic Modulus ksi (Gpa)
Basalt	400-695 (2800-4800)	2.7	0.0315	12500-13000 (86-90)

3. OBJECTIVES OF THE STUDY

- To understand the various design aspects of BF (Basalt fiber) reinforced concrete.
- Identify the uses of BFRC in Civil Engineering applications.
- Conduct the laboratory test for find out the strength (Compressive, Flexural and Tensile strength) of fiber reinforced concrete.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

4. EXPERIMENTATION

This article reveals an experimental program that is completed to evaluate the characteristic's performance of basalt fiber incorporated concrete beams. The basalt fibers were purchased from Arrow technologies private limited, Chennai. The principal objective of this research was to calculate the strength of this fiber in concrete. And to relate experimentally the moment carrying capacity of BFRC beams and maximum moment carrying capacity based on IS 516:1959[7] test methods to determine concrete strength. Various chemical test are conducted for basalt fiber to examine the stability and strength effect on the physical properties of the soil.

Table 4 Flexural strength of BFRC in 14 days

Sl. No.	Specimen Number	% of Basalt Fiber	Flexural Strength in N/mm^2 (14 Days)	Average Strength in N/mm^2
1	1	0.5 %	4.20	4.46
2	2	0.5 %	4.32	
3	3	0.5 %	4.85	
4	1	1%	5.40	5.42
5	2	1%	5.25	
6	3	1%	5.62	

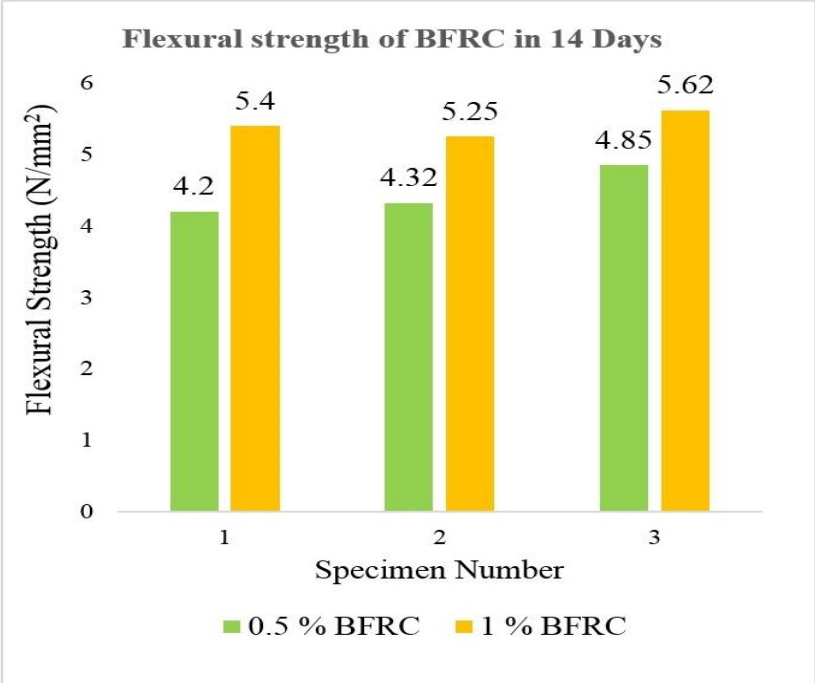


Figure 2. Flexural Strength of BFRC in 14 Days

0.5% and 1% Basalt fibre incorporated concrete Flexural strength at 14days are given in table 4 and graphically represented in Figure 2.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Table 5 Flexural strength of BFRC in 28 days

Sl. No.	Specimen Number	% of Basalt Fiber	Flexural Strength in N/mm^2 (28 Days)	Average Strength in N/mm^2
1	1	0.5 %	5.10	5.00
2	2	0.5 %	4.90	
3	3	0.5 %	5.02	
4	1	1%	6.20	6.19
5	2	1%	6.43	
6	3	1%	5.95	

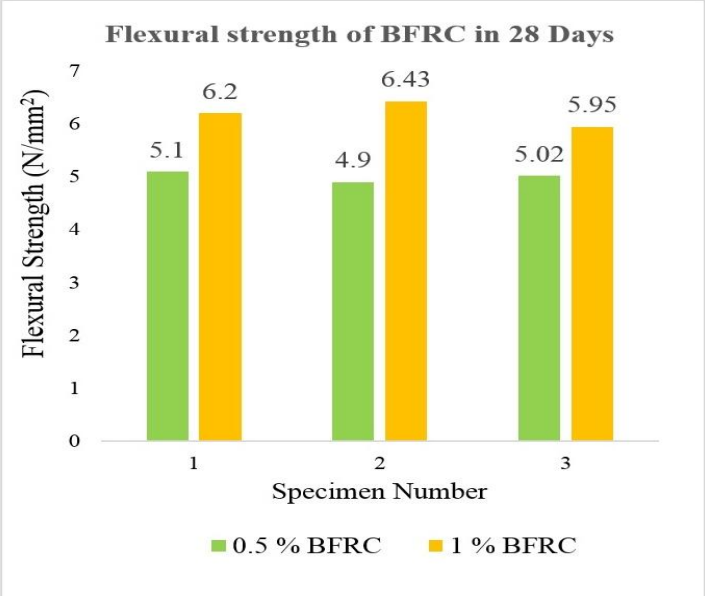


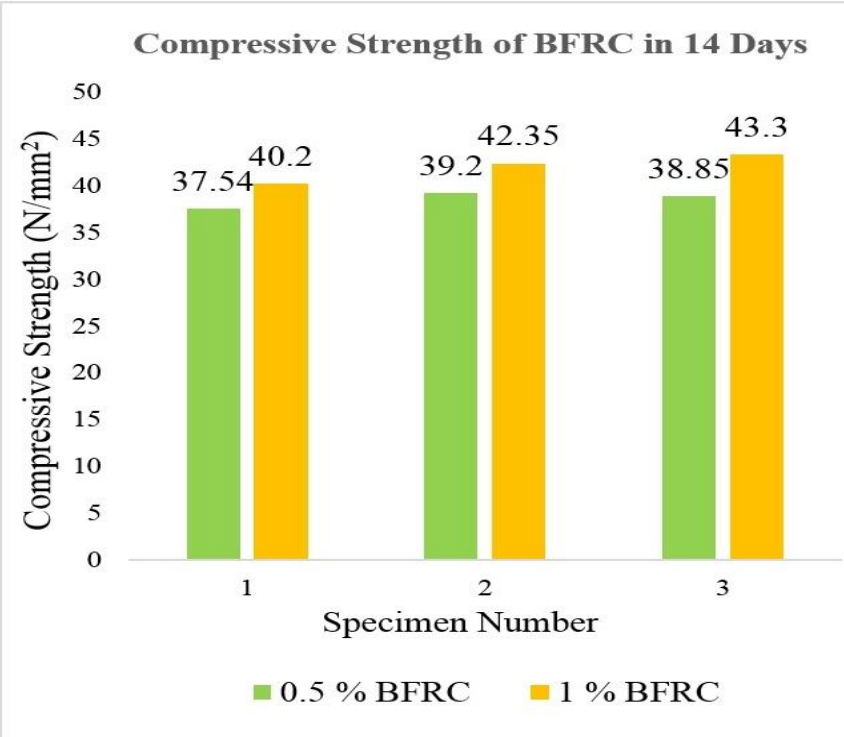
Figure 3. Flexural Strength of BFRC in 28 Days

0.5% and 1% Basalt fiber incorporated concrete Flexural strength at 28 days are given in table 5 and the graphical representations are shown in Figure 3.

Table 6 Compressive Strength of BFRC in 14 days

Sl. No.	Specimen Number	Type of concrete	Compressive Strength in N/mm^2 (14 Days)	Average Strength in N/mm^2
1	1	0.5 %	37.54	38.53
2	2	0.5 %	39.20	
3	3	0.5 %	38.85	
4	1	1%	40.20	41.95
5	2	1%	42.35	
6	3	1%	43.30	

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017



Compressive strength of 0.5% and 1% Basalt fiber incorporated concrete at 14 days are shown in table 6 and figure 4.

Table 7 Compressive Strength of BFRC in 28 days

Sl. No.	Specimen Number	Type of concrete	Compressive Strength in N/mm^2 (28 Days)	Average Strength in N/mm^2
1	1	0.5 %	41.30	41.59
2	2	0.5 %	42.55	
3	3	0.5 %	40.93	
4	1	1%	45.26	45.38
5	2	1%	46.30	
6	3	1%	44.60	

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

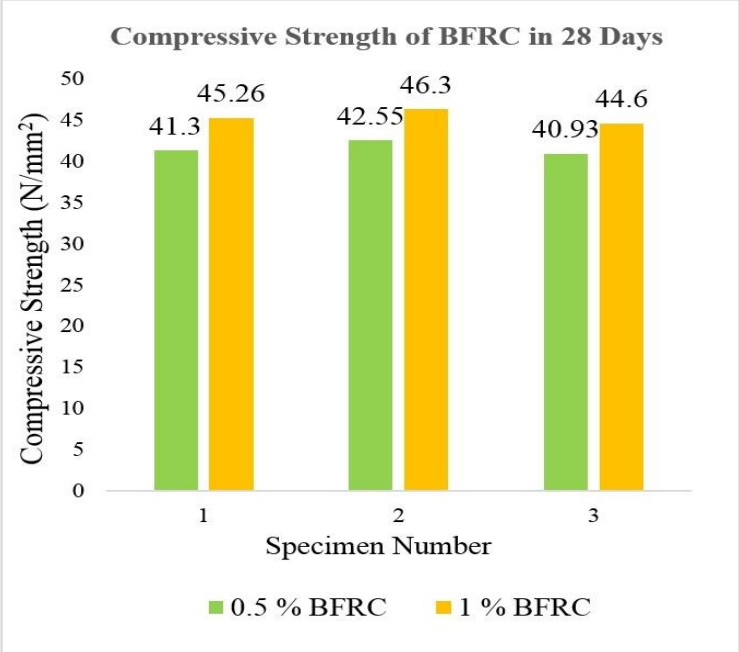


Figure 5. Compressive Strength of BFRC in 28 Days

Compressive strength of Basalt fiber incorporated concrete at 0.5% and 1% at 28days are shown in table 7 and graphically represented in figure 5.

Table 8 Compressive Strength of 0.5 % BFRC immersed in chemicals

Sl. No.	Specimen Number	Name of the Chemical	Compressive Strength in N/mm^2 (28 Days)	Average Strength in N/mm^2
1	1	Na2SO4	40.52	41.72
2	2	HCL	43.50	
3	3	NaOH	41.15	

Table 9 Compressive Strength of 1 % BFRC immersed in chemicals

Sl. No.	Specimen Number	Name of the Chemical	Compressive Strength in N/mm^2 (28 Days)	Average Strength in N/mm^2
1	1	Na2SO4	45.50	45.21
2	2	HCL	46.20	
3	3	NaOH	43.93	

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

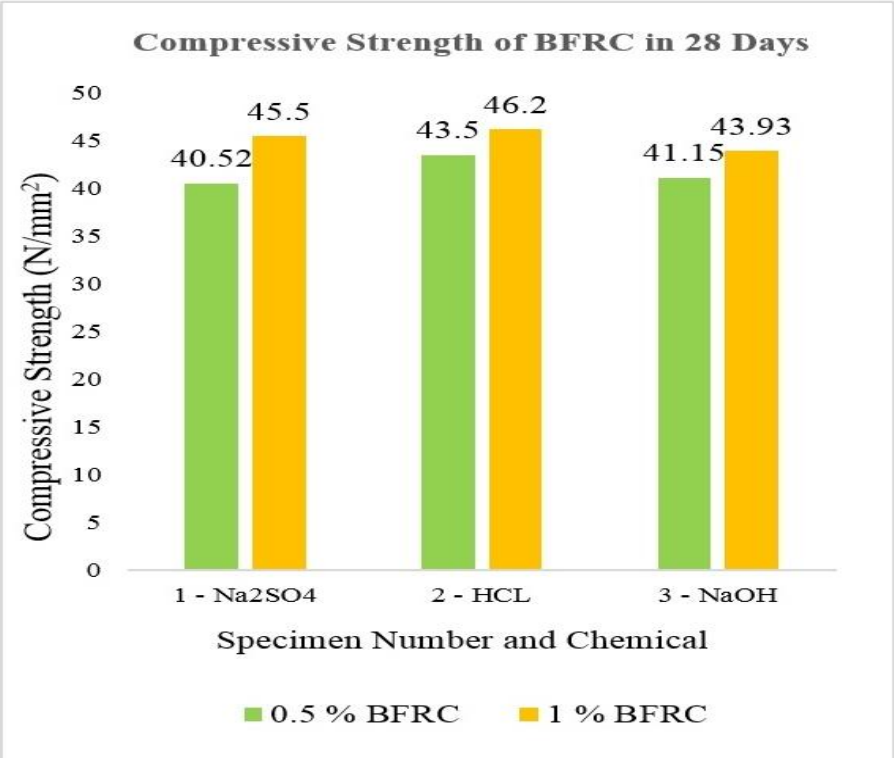


Figure 6. Compressive Strength of BFRC immersed in chemical

Basalt fiber incorporated concrete under various chemical environmental conditions results are shown in table 8,9 and graphically shown in Figure 6.

5. DISCUSSION

- From Table 4, Flexural strength at 14 days produce higher strength when the addition of 1% basalt fiber. And 42% to 50% strength increases is observed.
- As seen from Table 7, the 28 days average compressive strength is maximum when 1% fibers are used. About 82% & 90% increase in compressive strength is produced than the target mean strength when adding the basalt fiber.
- Basalt fiber reinforced specimen immersed in 3 different chemicals does not produce any decreases in strength due to its corrosion resistance behavior.
- The basalt fiber are mixed before mixing the water into the concrete.
- When using the basalt fiber in concrete mix, the mixing time should not exceed 1.5 minutes otherwise segregation takes place.

6. CONCLUSION

From the consideration of the above experimental result, this article concluded that usage of basalt fiber create many beneficial performances in the booming construction industry. The benefits are non-corrosive, higher compressive strength and higher temperature resistance. These are all the basic requirements of a building while choosing new construction materials.

REFERENCES

[1] A G Novitskii, V VSudakov(2004), "An unwoven basalt-fibre ma-terial for the encasing of fibrous insulation : an alternative to glass cloth" Refractories and Industrial Ceramics; vol 45, no 4, pp 234 - 241.

[2] Beller, J. A., Greenfield, H. J., Fayek, M., Shai, I., and Maeir, A. M. 2016,"Provenance and Exchange of Basalt Ground Stone Artefacts of EB III Tell es-Safi/Gath, Israel. Journal of Archaeological Science Reports 9: 226–37.

[3] Czigany, T., Vad, J., &Poloskei, K. (2005), "Basalt fiber as a reinforcement of polymer composites", PeriodicaPolytechnica, Mechanical Engineering, 49(1), 3-14.

[4] E. R. Thorhallsson, A. Gunnarsson and J. Th. Snaebjornsson(2014), "Simulation of experimental research of concrete beams prestressed with BFRP tendons"., Nordic Concrete Research Symposium 2014, Reykjavik. Iceland.

[5] GajananDeshmukh (2007),"Basalt - The Technical Fibre", Man-made Textiles in India; pp258-261.

[6] Ghobarah, A. and El-Amoury, T; (2002), "Seismic rehabilitation of beam–column joint using GFRP sheets", Engineering Structures 24 1397–1407.

[7] L. Michel, E. Ferrier, A. Agbossou, P. Hamelin(2009), "Flexural stiffness modelling of RC slab strengthened by externally bonded FRP", in Composites: Part B 40,pp758–765.

[8] Ramakrishnan, V., &Panchalan, R. (2005),"A new construction Material—Non-corrosive basalt bar reinforced concrete". Special Publication, 229, 253-270.

[9] Sezen, H. (2012), "Repair and Strengthening of Reinforced Concrete Beam-Column Joints with Fiber-Reinforced Polymer Composites", Journal of Composites for Construction, Vol. 16, No 5, pp.499-506.

[10] V.V. Pakharenko, I. Yanchar, V. A. Pakharenko, V. V. Efanova,"Polymer composite materials with fibrous and dis-perse basalt fillers", Fibre Chemistry, Vol. 40, No. 3, 2008.