JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 09, ISSUE 04, 2022

EXPERIMENTAL STUDY ON BASALT FIBER REINFORCED CONCRETE

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Abstract

Basalt fiber is a high performance non-metallic fiber made from basalt rock melted at high temperature. Basalt fiber reinforced concrete offers many advantages such as light weight, good fire resistance and strength. In future it is very beneficial for construction industry. Many applications of basalt fiber are residential, industrial, highway and bridgesetc. In this project trial test for concrete with Basalt fiber and without Basalt fiber are conducted to show the difference in compressive strength and split tensile strength by using cubes and concrete cylinders. The different types of proportions have been taken for the casting of concrete cubes and cylinders with different size of basalt chopped fiber used (6mm and 12mm) with proportions of i.e. 0.5%, 1.0%, 1.5%. 2.0%. And the highest strength of BFRC obtained at 1.0% to 1.5%. Various application of BFRC shown in the project, the experimental test result comparison with other type presented, indicate the tremendous potential of BFRC as analternative construction material.

Key words: Concrete, Strength Properties, Fibers, Durability

1. Introduction:

One of the most important primary necessities for any human is shelter. In India, most of the construction activities are made with concrete, as is easily available and the moldings can be done even by unskilled labor. Thus, concrete is becoming a very important materials for every human. In view of the extensive eco-friendly property of glass fibers, it is planned to investigate the efficacy for possible use in concrete. Recently, composite materials are replacing the conventional concrete new material for use in concrete are being developed so that we can improve the tensile properties of concrete as well as, which can be helpful

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in overcoming the need for providing more steel for a given load.

2. Literature Review:

Pas-chal Chimeremeze Chiadighikaobi (2021 June). The review on the effect ofbasalt fiber on concrete and in structural construction and increases mechanical properties. Nayan Rathod, Mukund Gonbare (2015 may). It is observed from the experimental results that the compressive strength and split tensile strength of concrete increases withaddition of 1.5% of Basalt Fiber. Tamil Selvi et al (2013). The test shows that the steel fiber reinforced concrete improvescompressive strength and split tensile strength. Deshmukh et al (2012). It is observed from the experimental results that the compressive strength of concrete, flexural strength of concrete and splitting tensile strength of concreteincrease with addition of 0.1% percentage of glass fiber. Indrajit et al (2011). The use of polyester fibres increases compressive strength to the order of 12 to 15 %. Habibur Rahman et al (2011). Test results indicate that externally bonded CFRP laminates can be used effectively to strengthen the reinforced concrete beams. Effect of increase in number of CFRP layers is to increase stiffness and flexural strength. Tara sen et al (2011). The test result indicates significant increase in strength, stiffness and stability in strengthened bamboo fiber specimens when compared to controlled specimens. 8.B.L.P.Swami et al (2010). 1.5% of AR glass fiber gives more strength of compressive,Split tensile and flexural strength. Ductility also increase. Ali Elloze (2010) As compared to plain concrete, an improvement of 25% in compressive strength and an improvement 45% in Split tensile strength have been reported. Flexural Behavior of Concrete Beams Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars by Houssam A. Toutanji and Mohamed Saafi, 5th September 2009. Concrete members reinforced with glass fiber reinforced polymer (GFRP) bars exhibit large deflections and crack widths compared with concrete members reinforced with steel. This paper presents the methods for predicting deflections and crack widths in beams reinforced with GFRP.

3. Materials:

3.1Cement

It can be defined as material having adhesive and cohesive properties which makeit capable of bonding material fragments in to a compact mass. Cement is obtained by burning together in a definite proportion, a mixture of naturally occurring calcareous (Containing calcium Carbonate or lime) and argillaceous (Containing alumina) material to be partial fusion at high temperature about 1450 ^{o} C. The ordinary Portland cement was classified in

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to 3 grades, namely 33 grades, 43 grades, 53 grades depending upon the strength of the cement at 28 days when testedas per IS 4031 – 1988. If 28 days strength is not less than 53 N/mm^2, it is called 53 grade of cement. It is proposed to study the properties of high strength concrete of grade M20. Adopting 53 grade of cement for the study.

3.2Fine Aggregate

Natural river sand with fraction passing through 4.75 mm sieve andretained on 60 micron sieve is used and will be tested as per IS 2386. The finenessmodulus of sand is 3.12 with specific gravity around 2.61.

3.3Coarse Aggregate

Coarse aggregate of size 20mm has been selected for the study. The physical properties will be tested as per IS 2386 (Part 1)-1963. The fineness modulus of sand is 5.94 with specific gravity around 2.72.

3.4 Water

Portable tap water available in the laboratory with pH value of 7.0 and conforming to the requirements of IS 456-2000 is used for making concreteand curing the specimen.

4. Concrete Testing

4.1 Test on Fresh Concrete

That property of freshly mixed concrete, plaster, or mortar which determines theease and homogeneity with which it can be mixed, applied, compacted, spread, or finished; place ability. Workability of Fresh Concrete can be found by Slump Test and compaction factor test.

4.2 Tests on Hardened Concrete

4.2.1 Compressive Strength

It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other factor affecting the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of fully compacted concrete is inversely proportional to the water-cement ratio. The Compression Test is a laboratory test to determine the characteristic strength of the concrete but the making of test

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Fig 4.1 Compressive Strength Test Machine

Table 4.1: Compressive strength of M_{20} (28 days strength) with 0% of Basalt fiber (6mm and 12mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	0	26.84	27.14
2.	0	27.88	
3.	0	27.70	

Hence at 0% Basalt fiber (6mm and 12mm) the conventional concrete hasobtained the average target mean strength of M20 grade for 28days is 27.14 **(N/mm^2).**

Table 4.2: Compressive strength of M_{20} (28 days strength) with 0.5% of Basalt fiber(6mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	0.5	29.15	30.49
2.	0.5	30.00	
3.	0..5	32.33	

Hence at 0.5% Basalt fiber(6mm) the concrete has obtained the target mean strength of

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M20 grade for 28days is 30.49**(N/mm^2).** Therefore, the strength of the member increases when compare to conventional concrete.

Table 4.3: Compressive strength of M_{20} (28 days strength) with 0.5% of Basalt fiber (12mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	0.5	27.50	28.14
2.	0.5	28.62	
3.	0..5	28.32	

Hence at 0.5% Basalt fiber (12mm) the concrete has obtained the average target mean strength of M20 grade for 28days is 28.14**(N/mm^2)** as compare with conventional concrete the strength of the member has been increased.

Table 4.4: Compressive strength of M_{20} (28 days strength) with 1% of Basalt fiber(6mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	1	32.28	33.006
2.	1	33.78	
3.	1	32.96	

Hence at 1% Basalt fiber (6mm) the concrete has obtained the average target mean strength of M20 grade for 28days is 33.006**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 0.5% the strength is 30.49 **(N/mm^2)** and for 1% the strength is 33.006**(N/mm^2).**

Table 4.5: Compressive strength of M_{20} (28 days strength) with 1% of Basalt fiber (12mm)

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S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	1	29.66	29.83
2.	1	29.05	
3.	1	30.80	

Hence at 1% Basalt fiber (12mm) the concrete has obtained the target mean strength of M20 grade for 28days 29.83**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e for 0.5% the strength is 28.14(**N/mm^2)** and for 1% the strength is 29.83**(N/mm^2).**

Table 4.6: Compressive strength of M_{20} (28 days strength) with 1.5% of Basalt fiber (6mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	1.5	36.81	37.07
2.	1.5	36.55	
3.	1.5	37.85	

Hence at 1.5% Basalt fiber (6mm) the concrete has obtained the average target mean strength of M20 grade for 28days is 37.07**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 1.0% the strength is 33.006(**N/mm^2)** and for 1.5% the strength is 37.07**(N/mm^2).**

Table 4.7: Compressive strength of M_{20} (28 days strength) with 1.5% of Basalt fiber (12mm)

S.No	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1.	1.5	34.23	

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2.	1.5	35.95	35.22
3.	1.5	35.50	

Hence at 1.5% Basalt fiber (12mm) the concrete has obtained the average target mean strength of M20 grade for 28days is 35.22**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e., for 1.0% the strength is 29.83(**N/mm^2)** and for 1.5% the strength is 35.22**(N/mm^2).**

Table 4.8: Compressive strength of M_{20} (28 days strength) with 2.0% of Basalt fiber (6mm)

S.no	Volume of the fiber %	Compression strength (N/mm^2)	Average (N/mm^2)
1	2	32.00	
2	2	34.34	33.92
3	2	35.83	

Hence at 2% Basalt fiber (6mm) the concrete has obtained the average target mean strength of M20 grade for 28days is 33.92 **(N/mm^2).** When we compare the values of 1.0%,1.5% the strength of the concrete member is increases but for 2% the value got decreases i.e

Table 4.9: Compressive strength of M_{20} (28 days strength) with 2.0% of Basalt fiber (12mm)

s.no	Volume of the fiber %	Compressive strength (N/mm^2)	Average (N/mm^2)
1	2	30.94	
2	2	31.48	31.40
3	2	31.79	

Hence at 2% Basalt fiber (12mm) the concrete has obtained the target mean strength of M20 grade for 28days is 31.40**(N/mm^2).** When we compare the values of 1.0%, 1.5%

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the strength of the concrete member is increases but for 2% the value got decreases i.e

4.2.2 Split Tensile Strength

A method of determining the tensile strength of concrete using a cylinder whichsplits across the vertical diameter.

The test is conducted in UTM machine as per IS518 (1959)and three specimens on dimensions 300mm length and 150mm diameter is tested as per the following procedure.

Figure 4.2: Split tensile strength testing

Table 8: Split tensile strength of M_{20} (28 days strength) with 0% of Basalt fiber (6mm and 12mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	0	2.65	2.47
2.	0	2.44	
3.	0	2.34	

Hence at 0% Basalt fiber (6mm) the conventional concrete has obtained the average target mean strength of M20 grade for 28days is 2.47 **(N/mm^2).**

Table 8.1: Split tensile strength of M_{20} (28 days strength) with 0.5% of Basalt fiber (6mm)

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S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	0.5	3.58	3.96
2.	0.5	4.05	
3.	0.5	4.25	

Hence the 0.5% Basalt fiber (6mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 3.96**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 0.5% the strength is 3.96(**N/mm^2)** and for 0% the strength is 2.47**(N/mm^2).**

Table 8.2: Split tensile strength of M_{20} (28 days strength) with0.5 % of Basalt fiber (12mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	0.5	2.55	3.48
2.	0.5	3.75	
3.	0.5	4.15	

Hence the 0.5% Basalt fiber (12mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 3.48**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 0.5% the strength is 3.48(**N/mm^2)** and for 0% the strength is 2.47**(N/mm^2).**

Table 8.3: Split tensile strength of M_{20} (28 days strength) with1 % of Basalt fiber (6mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)

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1.	1	3.78	4.22
2.	1	4.15	
3.	1	4.75	

Hence the1 % Basalt fiber (12mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 4.22**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 0.5% the strength is 4.22(**N/mm^2)** and for 0.5% the strength is 3.96**(N/mm^2).**

Table 8.4: Split tensile strength of M_{20} (28 days strength) with1 % of Basalt fiber (12mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	1	3.85	4.18
2.	1	4.05	
3.	1	4.65	

Hence the 1% Basalt fiber (12mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 4.18**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 0.5% the strength is 4.18(**N/mm^2)** and for 0.5% the strength is 3.48**(N/mm^2).**

Table 8.5: Split tensile strength of M_{20} (28 days strength) with1.5 % of Basalt fiber (6mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	1.5	3.95	4.75
2.	1.5	4.98	
3.	1.5	5.33	

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Hence the 1.5% Basalt fiber (6mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 4.75**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 1.5% the strength is 4.75(**N/mm^2)** and for 1% the strength is 4.22**(N/mm^2).**

Table 8.6: Split tensile strength of M_{20} (28 days strength) with1.5 % of Basalt fiber (12mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	1.5	3.85	4.48
2.	1.5	4.65	
3.	1.5	4.95	

Hence the 1.5% Basalt fiber (6mm) of concrete has obtained the average target mean strength of M20 grade for 28days is 4.48**(N/mm^2).** There is a difference in the strength in the member as percentage of the fiber increases i.e. for 1.5% the strength is 4.48(**N/mm^2)** and for 1.0% the strength is 4.18**(N/mm^2).**

Table 8.7: Split tensile strength of M_{20} (28 days strength) with 2.0 % of Basalt fiber (6mm)

S.No	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1.	2.0	3.43	3.70
2.	2.0	3.58	
3.	2.0	3.67	

Hence at 2% Basalt fiber (6mm) the concrete has obtained the target mean strength of M20 grade for 28days is 3.70**(N/mm^2).** When we compare the values of 0.5% 1.0%, 1.5% the strength of the concrete member is increases but for 2% the value got decreases i.e

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Table 8.8: Split tensile strength of M_{20} (28 days strength) with 2.0 % of Basalt fiber(12mm)

s.no	Volume of the fiber %	Split tensile strength (N/mm^2)	Average (N/mm^2)
1	2.0	3.25	
2	2.0	3.55	3.56
3	2.0	3.75	

Hence at 2% Basalt fiber (12mm) the concrete has obtained the target mean strength of M20 grade for 28days is 3.56**(N/mm^2).** When we compare the values of 0.5, 1.0%, 1.5% the strength of the concrete member is increases but for 2% the value got decreases i.e

5. Conclusion

1. Compressive strength of the cubes are increasing after adding of the Basalt fiber up to 1.5% compare to the conventional concrete. And further adding of the fiber lead to decrease the compressive strength of the specimen.
2. Split tensile strength of the cylinder are also increasing after adding of the Basalt Fiber. And further adding of the fiber lead to decrease the split tensile strength of the specimen.
3. Among 6 mm & 12 mm of Basalt fiber, 6mm fiber gives more compressive strength and split tensile strength as compare to the 12mm fibers.

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