

Experimental Study On Strengthening of RC Beam with Basalt Chopped Strands Fiber

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Abstract: The aim of this paper is to study the properties of basalt chopped strands fiber. To study the flexural behaviour of basalt chopped strands fiber reinforced concrete beam. To study its load-deformation characteristics and load carrying capacity, failure mode across cross section of the basalt strands chopped concrete beam. To study the parameters, which affect the behavior and increase in ultimate strength of the flexural strength of basalt fiber strands chopped fiber and effective technique in using the same. The various length of basalt chopped fiber in different volume of ratio to find. Major application of the basalt chopped fiber concrete for strengthening the beam. The beam is of 150mm x 175mm cross section through the longitudinal length of 1200mm long simply supported beam designed for flexure failure. To reduce the weight and cost of the reinforced concrete structures by adding the concrete.

Keywords: Basalt chopped fibers, reinforced concrete beam strengthening.

1. Introduction

Basalt is a type of igneous rock formed by the rapid cooling of lava at the surface of a planet. It is the most common rock in the Earth's crust. Basalt rock characteristics vary from the source of lava, cooling rate, and historical exposure to the elements. High quality fibers are made from basalt deposits with uniform chemical makeup.

Basalt is fine-grained, extrusive, igneous rock composed of plagioclase, feldspar, pyroxene and magnetite, with or without olivine and containing not more than 53 Weight percentages of SiO₂ and less than 5 weight percentages of total alkalis. Many types of basalt contain phenocrysts of olivine, clinopyroxene (augite) and plagioclase feldspar. Basalt is divided into two main types, alkali basalt and tholeiites. They have a similar concentration of SiO₂, but alkali basalts have higher content of Na₂O and K₂O than tholeiites. The production of basalt fibers is similar to the production of glass fibers. Basalt is quarried, crushed and washed and then melted at 1500° C.

A. Advantages of Basalt Fiber

- It is similar to carbon fiber and glass fiber, having better physico-mechanical properties than fiber glass, but being significantly cheaper than carbon fiber.
- It does not undergo any toxic reaction with water and does not release toxic chemicals during manufacturing and don't pollute the air also.

- Higher mechanical properties and chemical resistance in both acid & alkali environment better than E glass.
- It is highly resistant to alkaline, acidic and salt attack making it a good candidate for concrete, bridge and shoreline structures.
- It is Environmental friendly and purely natural fiber.
- Easy recycling of Basalt Fiber Reinforced Plastics (BFRP) in comparison with (GFRP).
- Production cost of basalt-fibers is very low compared to other types of fibers.

2. Literature Review

Huobao Rong Zhang, Xiangdong Song, Yang (2008) [1], The experimental program consists of casting and testing of RC beam of size 200mmx350mmx2100mm with concrete mix design for M-25 grade concrete. This paper works on thirds point static loading tests until failure, study and performance of different steel reinforcement ratio of basalt chopped strands fiber reinforced concrete beam simply supported beam. Basalt chopped strands fiber reinforced concrete beam load-deflection curve is approximately a straight line, but still performed better with ductility and crack width can be controlled at 2.5 mm or less.

Tan Zhifang (2009) [2], The experimental program consists of casting and testing of RC beam of size 100mm x 150mm x 700mm with concrete mix design for M-20 grade concrete. By Increasing Basalt chopped strands fiber length of 12mm, 14mm and 16mm ratios of reinforcement beams crack control effect is more obvious. The 16mm basalt chopped strands fiber with volume rate of 0.3% gives high resistance to crack and give high tensile strength. This results in a crack resistance, and enhanced toughening effect and other mechanical properties of concrete on strength basis.

Ding Bin Yujiang, Tao Ouyang, Lijun Jiang Jie (2010) [3], The experimental program consists of casting and testing of RC beam of size 150mmx250mmx2000mm with concrete mix design for M-30 grade concrete. In continuous beams, the basalt chopped strands fiber is added to 0.5%. The length of 12mm basalt chopped strands fiber is used here which significantly improves the strength of the beam. By using this fiber, the corrosion-resistant properties as well as in strengthening cost has obvious advantages. The results show that the basalt

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chopped strands fiber reinforcement beams yield load, ultimate load was significantly improved and showed good ductility and stability.

Fan Feilin, Bai Erlei, Liu Junzhong (2010) [4], The experimental program consists of casting and testing of RC beam of size 150mmx200mmx2100mm with concrete mix design for M-20 grade concrete. In this paper, the dynamic mechanical property of basalt strands chopped fiber reinforced concrete beam (BFRC) is discussed, a dynamic test on basalt strands chopped fiber with four kinds of volume content (0.1%, 0.2% and 0.3%) of fiber was carried out using 15mm-length of basalt chopped fiber. Dynamic stress-strain curves and testing data have been analyzed. The strain rate sensitivity of impact-compression strength is stronger and the dynamic compression strength and toughness are higher relatively when the fiber volume content is 0.1% and there is approximate linear function relation between the dynamic strength increasing factor in the concrete.

R. Singaravivelan, Dr.K. L. Muthuramu, N. Sakthieswaren (2010) [5], The experimental program consists of casting and testing of RC beam of size 150mmx200mmx2100mm with concrete mix design for M-20 grade concrete. In this paper they have taken the basalt fiber sheet which wraps the concrete cube and cylinder specimen and it gives 25% increase in the ultimate strength compared to controlled specimens. By having 2 layers of basalt strands fiber cloth which is found to have less brittle failure than normal reinforced concrete. About 28% increase in flexural strength of concrete is obtained by using basalt strands chopped fiber than normal concrete. The crack obtained in normal concrete is much minimized as compared to basalt fiber cloth.

A. Summary of Literature Review

- Flexural strength is maximum when 2% basalt fiber is used.
- The higher flexure strength of basalt fiber reinforced concrete can be obtained by adding 2% basalt fiber and the percentage increase in flexure strength is 78.94%.
- The percentage increase of compressive strength of basalt fiber concrete mix compared with 28 days' compressive strength of Plain Concrete is observed as 14%.
- Basalt fibers were fully active and showed resistance against extensive cracking and the dilation of concrete. With the increasing fiber volume, the resistance against cracking was also increased.
- When 50 mm length basalt fiber at 8 kg/m³ dosage. It showed a 21% increase in flexural strength, 38% increase in compressive strength, and a 14% increase in split tensile strength compared to the plain concrete control specimen.

3. Beam Strengthening

A. Basalt Chopped Strands Fiber

- In this experimentation, Basalt chopped strands fiber is used. The Basalt chopped strands fiber with 500 aspect

ratio, two different length of this fiber were used are 6mm and 12mm partially.



Fig. 1. Basalt chopped strands fiber

B. Reinforcement Details

The beam is provided with 4 numbers of 12mm bars as main reinforcement and 8mm stirrups with 150 mm c/c.



Fig. 2. Reinforcement details

C. Mix design

Concrete for M30 grade were prepared as per I.S.-10262:2009. A mix proportion of 1:1.62:3.32 with 0.40 water cement ratio to get a characteristic strength of M30 was considered for this study.

Table 1
Mix design

Cement	394 kg/m ³
Fine Aggregate	636 kg/m ³
Coarse Aggregate	1310 kg/m ³
Water	157.67 liters
Basalt chopped strands fiber	0.2% by volume of concrete

- At 3% fiber volume compressive strength reduced probably due to the presence of voids caused by the use of higher fiber volume of Basalt fiber, voids can be reduced some admixtures like plasticizer and superplasticizer.
- By wrapping the basalt chopped fiber in concrete cube and cylinder specimen in which 25% increase in the flexural strength compared to controlled specimens.

D. Flexure Strength

The flexural test of beam specimen is checked after 28 days with 4 beam specimens (2 normal mix beam and 0.2% basalt chopped strands fiber mix).



Fig. 3. Flexure strength

4. Results and Discussion

A. Graph Representation of Test Results for Normal Mix



Fig. 4. Specimen 1: Normal mix



Fig. 5. Specimen 2: Normal mix

B. Graph Representation of Test Results for Normal Mix

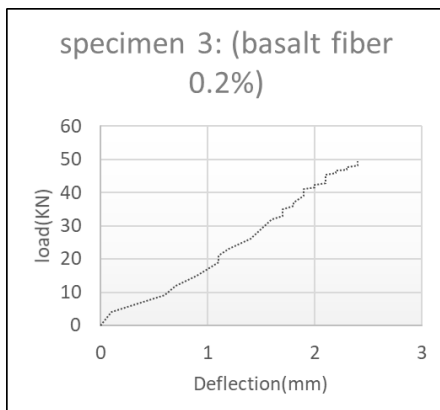


Fig. 6. Specimen 3: Basalt fiber 0.2%

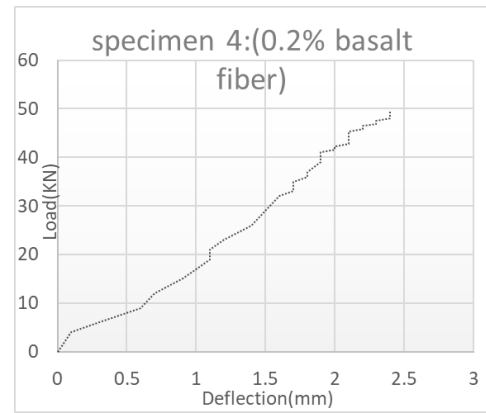


Fig. 7. Specimen 4: 0.2% basalt fiber

5. Conclusion

- From the analysis the flexural behavior of beam with different length of 0.2% percentages of basalt fiber is studied compared with normal mix concrete.
- About 20% increase in compressive strength than the design strength, when 0.2% of basalt chopped fibers are introduced in the concrete.
- The basalt fiber with 6mm and 12mm length strands when added partially, it gives better results in performance of concrete than normal mix concrete beam.

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