

Experimental Investigation on Strength Properties of Basalt Fiber Reinforced Concrete

Khushbu Kumari, Nitesh Kumar Singh, Raushan Kumar

Department of Civil Engineering,

Sengunthar Engineering College (Autonomous), Tiruchengode, India

khushbuk6543@gmail.com, nitesg87098@gmail.com, raushansynghyadav8@gmail.com

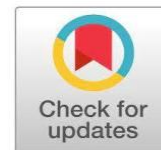
Dr.P.Prabhu 

Associate Professor, Department of Civil Engineering

Sengunthar Engineering College (Autonomous), Tiruchengode, India

drprabhuspalanisamy@gmail.com

<https://orcid.org/0009-0009-7609-4190>



Publication History

Manuscript Reference No: IJRAE/RS/Vol.13/Issue03/AEMR26.MRAE10094

Research Article | Open Access | Double-Blind Peer-Reviewed | Article ID: IJRAE/RS/Vol.13/Issue03/AEMR26.MRAE10094

Received: 22, February 2026, Revised: 01, March 2026, Accepted: 16, March 2026, Published Online: 25, March 2026.

<https://www.ijrae.com/volumes/Vol13/iss-03/15.AEMR26.MRAE10094.pdf>

Article Citation: Khushbu, Nitesh, Raushan, Dr. Prabhu (2026). Experimental Investigation on Strength Properties of Basalt Fiber Reinforced Concrete, IJRAE: International Journal of Innovative Research in Advanced Engineering, Volume 13, Issue 03 of 2026 pages 177-181 **Doi:->** <https://doi.org/10.26562/ijrae.2026.v1303.15>

BibTeX Key: Khushbu@2026Experimental

IJRAE papers should be cited as IJRAE (International Journal of Innovative Research in Advanced Engineering, AM Publications, India 2025, ISSN 2349-2163, <https://doi.org/10.26562/ijrae.2026.v1303.15> The journal's official abbreviation is IJRAE. **Orcid:** <https://orcid.org/0009-0004-9398-7488>

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Abstract: The inherent limitations of ordinary concrete, particularly its low tensile strength, brittleness, and poor crack resistance, restrict its application in various structures. This project presents an experimental investigation into the effect of incorporating Basalt Fibers (BF) on the mechanical and strength properties of concrete, aiming to develop a high-performance material known as Basalt Fiber- Reinforced Concrete (BFRC). The study involves preparing concrete mixes with varying volume fractions (e.g., 0.1%, 0.3%, 0.5%, etc.) and potentially different lengths of chopped basalt fibres, in comparison with a control mix (plain concrete). The experimental program includes testing the hardened properties of BFRC specimens (cubes, cylinders, and prisms) at specified curing ages (typically 7, 14 and 28 days) to evaluate key strength parameters.

Keywords: Basalt Fibers (BF), Workability, Basalt Fiber- Reinforced Concrete (BFRC), Sustainable Construction Materials.

I. INTRODUCTION

Concrete is the most widely used construction material in civil engineering due to its high compressive strength, durability, and ability to be molded into different shapes. However, conventional concrete possesses relatively low tensile strength and limited resistance to cracking. These inherent weaknesses often lead to the development of micro-cracks, which may propagate under loading and reduce the overall structural performance and durability of concrete structures. To overcome these limitations, the use of fiber reinforced concrete (FRC) has gained significant attention in recent years. Fiber reinforced concrete is a composite material consisting of cement, fine aggregate, coarse aggregate, water, and discrete fibers that are uniformly distributed within the concrete matrix. The addition of fibers helps to control crack propagation, improve tensile strength, enhance ductility, and increase impact resistance. Various types of fibers such as steel fibers, glass fibers, polypropylene fibers, and synthetic fibers have been used in concrete to improve its mechanical properties. Among the different types of fibers, basalt fibers have emerged as a promising reinforcing material for concrete due to their excellent mechanical and chemical properties. Basalt fiber is produced from natural volcanic basalt rock through a melting and extrusion process. It exhibits high tensile strength, good thermal stability, corrosion resistance, and excellent durability compared to many traditional fibers. In addition, basalt fibers are environmentally friendly and cost-effective, making them suitable for sustainable construction practices. The incorporation of basalt fibers in concrete can significantly improve the mechanical performance of the material. Basalt fiber reinforced concrete (BFRC) has shown improvements in compressive strength, split tensile strength, and flexural strength, while also reducing shrinkage cracks and improving toughness. These advantages make BFRC suitable for applications such as pavements, bridge decks, industrial floors, and structural members subjected to dynamic loading. The present study focuses on the experimental investigation of strength properties of basalt fiber reinforced concrete using M20 grade concrete. Different percentages of basalt fibers are added to the concrete mix to evaluate their influence on the mechanical properties. Standard laboratory tests such as compressive strength, split tensile strength, and flexural strength are conducted according to relevant Indian Standard codes. The results obtained from the experimental study are compared with conventional concrete to determine the effectiveness of basalt fiber reinforcement.

The objective of this research is to evaluate the performance of basalt fibre reinforced concrete and to identify the optimum fiber content that provides maximum strength improvement.

II. OBJECTIVE AND SCOPE OF THE PROJECT

The main objective of this study is to experimentally investigate the effect of basalt fibre on the strength properties of concrete. The addition of basalt fibres is expected to improve the mechanical performance and crack resistance of conventional concrete. The specific objectives of the study are as follows: To study the behaviour of basalt fibre reinforced concrete (BFRC) using M20 grade concrete. To determine the compressive strength of concrete containing different percentages of basalt fibres and compare it with conventional concrete. To evaluate the split tensile strength of basalt fibre reinforced concrete. To determine the flexural strength of basalt fibre reinforced concrete beams. To analyse the effect of basalt fibre on the crack resistance and ductility of concrete.

To compare the overall strength performance of basalt fibre reinforced concrete with normal concrete. To determine the optimum percentage of basalt fibre that provides maximum improvement in strength properties. The scope of this project is to study the influence of basalt fibres on the strength characteristics of concrete through experimental investigation. In conventional concrete, cracks develop due to low tensile strength and brittleness. The addition of basalt fibres is expected to improve the mechanical properties and crack resistance of concrete. This study focuses on the preparation of M20 grade concrete with different percentages of basalt fibre added to the concrete mix. The concrete specimens such as cubes, cylinders, and beams are cast and cured under standard laboratory conditions. After curing, various strength tests are conducted to evaluate the performance of basalt fibre reinforced concrete. The scope of the project includes testing and comparing the compressive strength, split tensile strength, and flexural strength of basalt fibre reinforced concrete with conventional concrete. The experimental results are analysed to determine the improvement in strength properties due to the addition of basalt fibres. Furthermore, the study aims to identify the optimum fibre content that provides the best strength performance. The results of this research can help in promoting the use of basalt fibre reinforced concrete in construction applications such as pavements, industrial floors, and structural elements where higher strength and crack resistance are required.

III. MATERIALS AND METHODOLOGY

- **Fine Aggregate:** Locally available river sand passing through 4.75 mm sieve and conforming to Zone II of IS 383 was used as fine aggregate.
- **Coarse Aggregate:** Crushed angular aggregates of 20 mm maximum size were used. The aggregates were clean, hard, and free from dust.
- **Cement:** Ordinary Portland Cement (OPC) of 43 grade conforming to IS 8112 was used for preparing the concrete mix. The cement was fresh and free from lumps.
- **Water:** Potable water free from impurities was used for mixing and curing of concrete as per IS 456 recommendations.
- **Basalt Fiber:** Basalt fibers are produced from volcanic basalt rock and have high tensile strength and good chemical resistance.



Fig.No.1: Specific Gravity Test



Fig.No.2: Casting of Concrete specimens

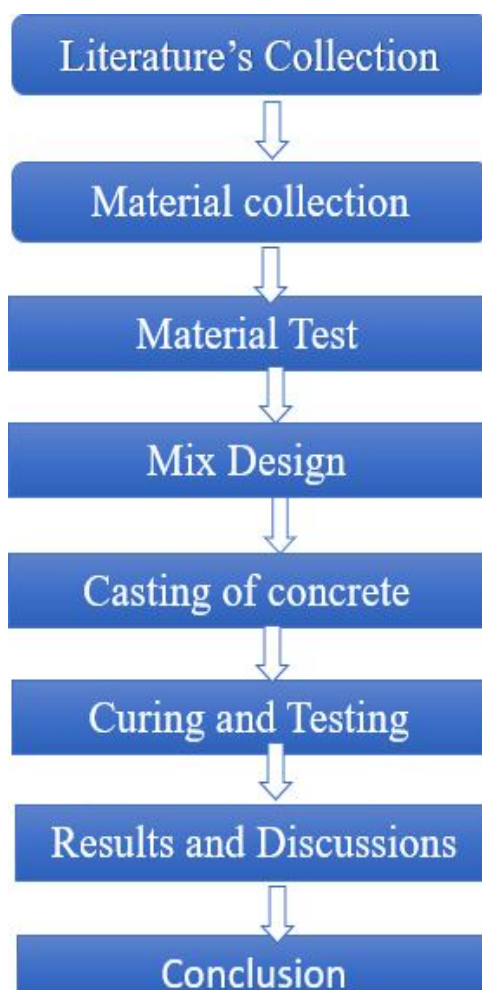


Fig.No.3. Flowchart of methodology
IV. RESULTS AND DISCUSSION

In this experimental study, Basalt Fiber Reinforced Concrete (BFRC) was prepared using M20 grade concrete mix. Different percentages of basalt fibers were added to the concrete mix and the specimens were tested to evaluate the compressive strength, split tensile strength, and flexural strength. Concrete cubes, cylinders, and prisms were cast and tested after 7 days, 14 days and 28 days of curing. The results obtained from the tests indicate that the addition of basalt fibers improves the mechanical properties of concrete compared to conventional concrete. The compressive strength of basalt fiber reinforced concrete was observed to increase slightly with the addition of fibers.

The fibers help in controlling micro-cracks and improving the internal bonding of concrete. The optimum percentage of basalt fiber showed higher compressive strength than the control mix (M20 without fibers). The split tensile strength showed a noticeable improvement with the inclusion of basalt fibers. Fibers act as crack arresters and bridge the cracks formed in concrete, which increases the tensile resistance of the concrete

Table.1: Strength Properties of Basalt Fiber Reinforced Concrete at Different Curing Periods.

Test	7 Days	14 Days	28 Days
Compressive Strength	14.3MPa	18.3MPa	21.0MPa
Split Tensile Strength	1.71MPa	2.13MPa	2.56MPa
Flexural Strength	2.73MPa	3.56MPa	4.39MPa



Fig No.4: Tensile Strength

Similarly, the flexural strength of the concrete beams increased with the addition of basalt fibers. The fibers improved the ductility and load carrying capacity of the concrete specimens. It was also observed that the workability of concrete slightly decreased as the percentage of basalt fiber increased. This is due to the increased surface area and interlocking effect of the fibers in the concrete mix. However, proper mixing and compaction helped in achieving satisfactory workability. Overall, the experimental results indicate that basalt fibers can effectively improve the strength characteristics and crack resistance of M20 grade concrete. Similarly, the split tensile strength of the concrete specimens showed a progressive increase with curing time. The recorded split tensile strength values were 1.71 MPa at 7 days, 2.13 MPa at 14 days, and 2.56 MPa at 28 days. The improvement in tensile strength can be attributed to the bridging action of basalt fibers, which restricts crack propagation and improves the tensile behaviour of concrete. The flexural strength test results also indicate a significant improvement in the bending resistance of the concrete. The flexural strength increased from 2.73 MPa at 7 days to 3.56 MPa at 14 days, and further reached 4.39 MPa at 28 days.

V. CONCLUSION

Based on the experimental investigation on Basalt Fiber Reinforced Concrete using M20 grade concrete, the following conclusions are drawn:

- The addition of basalt fibers improves the compressive strength of concrete compared to conventional M20 concrete.
- Split tensile strength of concrete increases significantly due to the crack bridging effect of basalt fibers.
- Flexural strength also increases with the inclusion of basalt fibers, which enhances the load carrying capacity of concrete beams.
- Basalt fibers help in controlling cracks and improving durability of concrete structures.
- The workability of concrete decreases slightly with the increase in fiber content, but it can be managed by proper mixing.
- Basalt fiber reinforced concrete is more resistant to cracking and provides better structural performance than normal concrete.
- Therefore, basalt fibers can be effectively used in concrete for improving strength and durability in construction applications.

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