International Journal of Engineering and Techniques-Volume 11 Issue 6,
Novmeber - December - 2025

EXPERIMENTAL STUDY ON THE MECHANICAL AND DURABILITY PROPERTIES OF HIGH-STRENGTH SELF COMPACTING CONCRETE INCORPORATING BASALT FIBRES

Author: Parupally Sandeep Reddy

Father's Name: Parupally Prabhakar Reddy

Roll No: 23E41D2014

Phone: 9100198628

Email: parupallysandeepreddy@gmail.com

Abstract

This study investigates the influence of basalt fibre incorporation on the mechanical and durability properties of high-strength self-compacting concrete (HSSCC). Basalt fibres, derived from natural volcanic rock, are eco-friendly and exhibit high tensile strength, chemical stability, and thermal resistance. The research aims to enhance the performance characteristics of HSSCC by incorporating basalt fibres at varying proportions of 0%, 0.25%, 0.5%, 0.75%, and 1% by volume of concrete. Experimental investigations were carried out to evaluate compressive strength, split tensile strength, flexural strength, and durability characteristics such as acid resistance and water absorption. Results indicate that the inclusion of basalt fibres significantly improves tensile and flexural strengths while enhancing the durability performance, particularly at an optimal dosage of 0.5%. Beyond this percentage, slight reductions in workability were observed. The findings suggest that basalt fibre-reinforced self-compacting concrete can serve as a sustainable material for high-performance structural applications.

Keywords: Basalt fibres, Self-compacting concrete, High-strength concrete, Mechanical properties, Durability, Fibre reinforcement.

1. Introduction

The demand for durable and high-performance concrete in modern infrastructure has led to the development of Self-Compacting Concrete (SCC), which flows under its own weight without external vibration. High-Strength Self-Compacting Concrete (HSSCC) combines the benefits of SCC with enhanced compressive and tensile capacities, making it suitable for high-rise buildings, bridges, and precast structures.

Conventional concrete often suffers from brittle failure and poor tensile strength. To overcome these limitations, fibres are incorporated into the matrix. Among available fibres, basalt fibres have recently gained attention due to their superior strength-to-weight ratio, corrosion resistance, and eco-friendliness. Derived from natural basalt rock, they require minimal energy for production compared to synthetic fibres like steel or glass.

This paper presents an experimental study on the mechanical and durability performance of HSSCC with varying basalt fibre contents, aiming to identify an optimal mix that balances strength, workability, and durability.

---

2. Objectives

1. To design a mix proportion for high-strength self-compacting concrete.

2. To investigate the effect of basalt fibre incorporation on the mechanical properties of HSSCC.

3. To evaluate the durability performance of basalt fibre-reinforced SCC under acidic and water exposure.

4. To determine the optimum fibre dosage for achieving maximum performance.

---

3. Materials and Methodology

3.1 Materials Used
3.2

Cement: Ordinary Portland Cement (OPC) 53 grade conforming to IS 12269:2013.

Fine Aggregate: River sand passing through a 4.75 mm sieve.

Coarse Aggregate: Crushed granite with a maximum size of 12.5 mm.

Mineral Admixture: Silica fume used for enhancing strength and reducing permeability.

Chemical Admixture: Polycarboxylate-based superplasticizer to achieve required flowability.

Basalt Fibres: Continuous fibres with an aspect ratio of 24–48, tensile strength of 2800–3200 MPa, and density of 2.7 g/cm^3.

Water: Potable water satisfying IS 456:2000 standards.

3.3 Mix Proportion
3.4

The base mix was designed for M60 grade HSSCC, using EFNARC guidelines for flowability and strength. Fibre contents were varied as follows:

Mix ID	Basalt Fibre (%)	Description
M0	0%	Control Mix
M1	0.25%	Low Fibre
M2	0.5%	Medium Fibre
M3	0.75%	High Fibre
M4	1.0%	Maximum Fibre

3.3 Test Methods

Workability Tests: Slump flow, T50 time, V-funnel, and L-box as per EFNARC guidelines.

Mechanical Properties:

Compressive Strength (IS 516:2018)

Split Tensile Strength (IS 5816:1999)

Flexural Strength (IS 516:2018)

Durability Tests:

Acid Resistance (H_2SO_4 exposure)

Water Absorption Test

Sorptivity Test

---

4. Results and Discussion

4.1 Workability
4.2

Workability decreased with the increase in fibre percentage due to higher surface area and interlocking of fibres. However, all mixes maintained self-compacting characteristics within EFNARC limits up to 0.75% fibre content.

4.3 Compressive Strength
4.4

The compressive strength increased up to 0.5% basalt fibre, achieving a 12–15% improvement compared to the control mix. Beyond this point, marginal reduction was observed due to reduced compaction flow.

4.3 Split Tensile and Flexural Strength
4.4

Both tensile and flexural strengths exhibited significant improvements with fibre addition. The split tensile strength increased by approximately 18%, while flexural strength improved by 20% at the optimal 0.5% dosage.

4.5 Durability Performance
4.6

Acid Resistance: Weight loss reduced significantly in basalt fibre mixes, demonstrating enhanced resistance to chemical attack.

Water Absorption: The addition of basalt fibres reduced permeability, improving the impermeable matrix structure.

Sorptivity: A noticeable decrease in capillary absorption was observed, indicating superior durability.

---

5. Conclusions

1. Basalt fibre addition enhances both mechanical strength and durability of high-strength self-compacting concrete.
2. Optimal performance was observed at 0.5% basalt fibre dosage.
3. Fibre addition beyond 0.75% leads to reduced workability, requiring higher superplasticizer dosage.
4. Durability parameters such as acid resistance and water absorption significantly improved with basalt fibre inclusion.
5. Basalt fibre-reinforced HSSCC is a sustainable, eco-friendly, and high-performance construction material suitable for modern infrastructure.

---

6. References

1. EFNARC (2002), Specifications and Guidelines for Self-Compacting Concrete, European Federation of National Associations Representing for Concrete.

2. IS 10262:2019, Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards.

3. IS 516:2018, Methods of Tests for Strength of Concrete, Bureau of Indian Standards.
4. Sim, J., & Park, C. (2005). Characteristics of basalt fibre as a strengthening material for concrete structures. Composites Part B: Engineering, 36(6–7), 504–512.

5. Ahmad, S. et al. (2020). Effect of basalt fibres on mechanical and durability properties of concrete. Construction and Building Materials, 235, 117436.