Experimental Investigation on Enhancing Properties of Concrete Using Ternary Blends and Basalt Fibers

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Abstract—Conventional concrete is brittle, has low tensile strength, and is prone to micro-cracking. This study investigates High Performance Concrete (HPC) by incorporating a ternary blend of cement, Class F Fly Ash, and Undensified Micro-Silica combined with 0.5% Basalt Fibers. The research aims to increase compressive strength while reducing cement consumption by 15%. Experimental results show that the hybrid concrete achieved a compressive strength of 45.40 MPa, marking a 21.06% increase over the control mix. The addition of fibers also resulted in controlled cracking and improved ductility

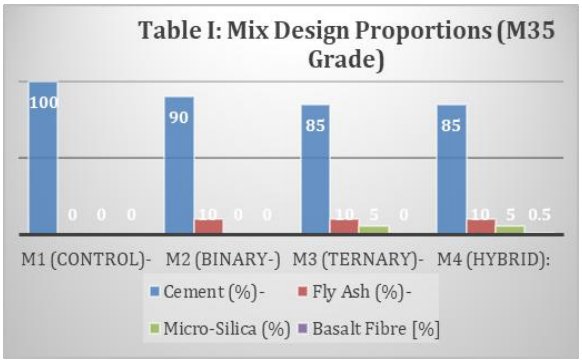
Index - Terms—Basalt Fibers, Compressive Strength, High Performance Concrete, Micro-Silica, Ternary Blend

I. INTRODUCTION

Concrete is the most widely used construction material due to its strength, durability, and versatility. However, conventional concrete has certain limitations such as brittleness and susceptibility to cracking. To overcome these, researchers are focusing on High Performance Concrete (HPC) by incorporating supplementary cementitious materials and fiber reinforcement. In this project, a ternary blend of cement, fly ash, and micro-silica combined with basalt fibers is used to enhance the mechanical properties and durability of concrete. The aim is to increase compressive strength while reducing cement consumption.

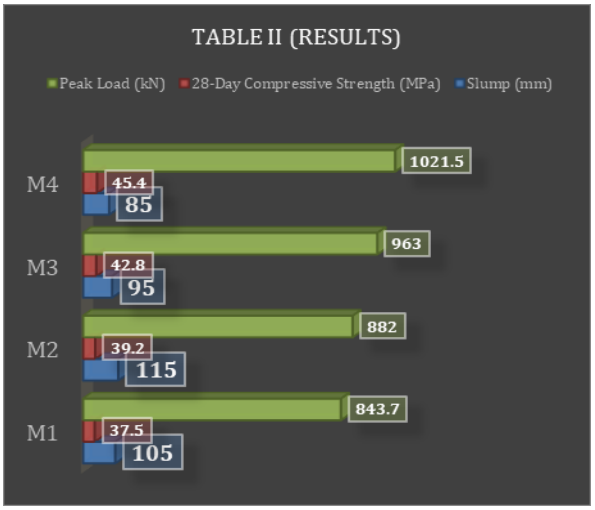
II. EXPERIMENTAL PROGRAM

The experimental phase involved the preparation of concrete specimens using M35 grade design parameters. Standard cube specimens of size 150 x 150 x 150 mm were cast for testing the compressive strength. The raw materials were provided to IR Solutions Laboratory, where professional testing was conducted to ensure high precision in data collection. Key materials included OPC 43 Grade cement, Class F Fly Ash, Undensified Micro-Silica, and 12 mm Basalt Fibers. A Polycarboxylate Ether (PCE) based superplasticizer was used to maintain workability at a water-cement ratio of 0.40.



III. MATH

The peak load recorded during testing for the optimized M4 mix was 1021.5 kN.



IV. UNITS

Use SI (MKS) as primary units. Compressive strength is measured in Megapascals (MPa), and loads are measured in Kilo-Newtons (kN).

V. CONCLUSION

The experimental investigation shows that ternary blended concrete reinforced with basalt fibers significantly improves the performance of concrete. Key conclusions are:

- Hybrid concrete achieved 45.40 MPa compressive strength.
- Cement replacement with 10% Fly Ash and 5% Micro-Silica improved microstructure and durability.
- Basalt fibers enhanced ductility and reduced brittle failure.
- Cement usage was reduced by 15%, contributing to environmental sustainability

ACKNOWLEDGMENT

The authors thank Prof. Prashant Kapure for his guidance throughout this study. We also acknowledge IR Solutions Laboratory for performing the professional testing and providing the Universal Testing Machine (UTM) facility required for gathering experimental results.

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