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Development and Performance Evaluation of Biochar-Based Sustainable Concrete

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Abstract: *Concrete is one of the most widely used construction materials in the world; however, the production of cement contributes significantly to carbon dioxide emissions and environmental degradation. The growing demand for sustainable construction materials has encouraged researchers to explore eco-friendly alternatives that can improve concrete performance while reducing environmental impact. This project focuses on the study and application of biochar as a partial replacement material in concrete to develop a sustainable construction material commonly referred to as biocrete, Biochar is a carbon-rich material produced through the pyrolysis of biomass under limited oxygen conditions. Due to its porous structure, high surface area, and carbon sequestration capability, biochar has the potential to enhance certain mechanical and durability properties of concrete while reducing the overall carbon footprint. In this study, biochar is incorporated in small percentages as a partial replacement of cement by weight to evaluate its effect on concrete performance.The methodology involves production or procurement of biochar, preparation of concrete mix proportions, casting of standard concrete cubes, curing under controlled conditions, and testing for compressive strength and other relevant properties. Comparative analysis is carried out between conventional concrete and biochar-modified concrete specimens to assess strength characteristics, workability, and sustainability benefits.The expected outcome of this project is to demonstrate that the controlled use of biochar in concrete can contribute to improved environmental sustainability through carbon storage while maintaining acceptable strength performance. The study highlights the potential application of biochar concrete in sustainable construction practices and promotes the development of low-carbon building materials for future infrastructure.*

Keywords: *Biochar, Biocrete, Sustainable Concrete, Eco-friendly Construction Materials, Pyrolysis, Compressive Strength, Concrete Durability, Green Construction, Biomass Utilization, Sustainable Infrastructure*

I. INTRODUCTION

A literature survey is carried out to understand previous research work related to biochar and its application in concrete. The review helps in identifying the research gap, defining the problem statement, and selecting appropriate methodology for the project. Various studies have investigated sustainable construction materials aimed at reducing carbon emissions and improving environmental performance of concrete. Recent research focuses on incorporating carbon-rich and waste-derived materials into cement-based composites to enhance sustainability while maintaining structural properties.

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II. PROBLEM STATEMENT

Conventional concrete production causes high CO2 emissions due to heavy cement use. At the same time, large amounts of agricultural biomass in India are burned, causing pollution. Therefore, using biochar from biomass as a partial replacement for cement can be a sustainable solution for eco-friendly concrete.

III. METHODOLOGY

The study evaluates the performance of biochar as a partial replacement of cement in concrete through a systematic experimental procedure. It involves selection of materials such as cement, fine and coarse aggregates, water, and biochar, which is prepared by drying, crushing, and sieving biomass. Concrete mixes are prepared with small percentages of biochar and compared with conventional concrete. Cube specimens (150×150×150 mm) are cast, properly compacted, and cured for 7 and 28 days. The hardened specimens are then tested for compressive strength using a Compression Testing Machine (CTM). Finally, the results are analyzed to assess the strength and feasibility of biochar concrete.

.IV. CONCLUSION

This project shows that biochar can be used as a partial replacement for cement to produce sustainable concrete. It improves internal curing due to its porous nature, though it slightly reduces workability. The compressive strength remains acceptable at controlled levels. Overall, biochar helps reduce environmental impact and supports the development of eco-friendly, low-carbon construction materials.

V. ACKNOWLEDGMENT

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