



To Investigate And Optimize Concrete Properties Using Recycled Aggregate, Fishnet Fiber And Corn Cob Ash

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Abstract: The growing emphasis on environmental protection and sustainable construction has increased interest in using waste-derived materials in concrete. This research investigates the combined use of Recycled Aggregates (RA), Fishnet Fibers (FN), and Corn Cob Ash (CCA) as partial replacements for traditional concrete components to develop a more sustainable M45 grade mix. The study examines how these alternative materials influence mechanical properties, economic viability, and overall environmental impact.

Recycled aggregates obtained from demolished structures were introduced as a substitute for natural coarse aggregates to reduce dependency on virgin resources. Corn cob ash, an agricultural residue with pozzolanic characteristics, was used to partially replace cement, while processed waste fishnets were incorporated as fibers to enhance tensile behavior and minimize cracking.

Multiple proportions of RA, CCA, and FN were evaluated through compressive strength, split tensile strength, flexural strength, and workability tests, supported by cost and environmental assessments. Findings indicate that the combination of 10% RA, 5% CCA, and 0.5% FN delivered the most balanced performance, retaining adequate strength while lowering both material cost and carbon emissions.

Overall, the research demonstrated that integrating recycled aggregates, waste fibers, and agricultural ash can produce a durable and eco-efficient concrete mix, contributing to more sustainable construction practices.

Index Terms - Concrete, Recycled Aggregate, Fishnet Fiber, Corn Cob Ash, Sustainable Construction.

I. INTRODUCTION

Concrete remains the primary material used in global construction due to its strength and versatility, yet its production significantly impacts the environment. The extraction of natural aggregates and the high carbon emissions from cement manufacture contribute heavily to resource depletion and pollution. With cement identified as a major source of CO₂ emissions, the shift toward sustainable construction materials has become essential. This study focuses on incorporating waste-based alternatives to reduce the ecological burden associated with conventional concrete.

II. LITERATURE REVIEW

Poon et al. (2004) conducted an extensive study on the properties of concrete incorporating recycled aggregates. They found that concrete made with recycled aggregates exhibited lower compressive strength compared to concrete made with natural aggregates. The reduced strength was attributed to the higher porosity and impurities present in the recycled aggregates. However, the study also suggested that the reduction in strength could be mitigated by using a lower water-cement ratio and optimizing the mix design. Poon's research provided valuable insights into the challenges of using recycled aggregates in concrete and highlighted the potential for improving concrete performance through careful material selection and mix design optimization.

Zhang et al. (2016) conducted a study on the effects of synthetic fibers, including fishnet fibers, on the mechanical properties of concrete. They found that the inclusion of fishnet fibers significantly improved the tensile strength and flexural strength of concrete. The fibers helped in bridging micro-cracks that developed under stress, preventing further crack propagation. **Zhang et al. (2016)** concluded that fishnet fibers could be particularly beneficial for improving the post-crack behavior of concrete, offering increased durability and toughness.

Kumar et al. (2018) investigated the use of corn cob ash as a partial replacement for cement in concrete. Their research showed that up to 10% replacement of cement with corn cob ash did not significantly affect the workability or strength of the concrete, while higher replacement levels (15% and 20%) led to a gradual decline in performance. However, they found that the use of corn cob ash enhanced the microstructure of concrete by filling voids and reducing pore size, which contributed to improved durability. The study emphasized that the use of CCA could reduce the environmental impact of concrete production by lowering the carbon footprint associated with cement manufacturing.

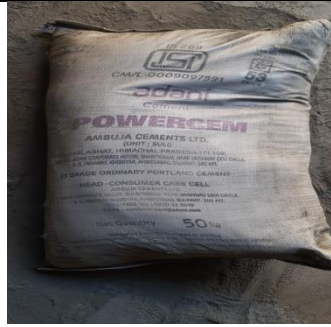
III. OBJECTIVES

1. To evaluate the effect of recycled aggregates, fishnet fibers, and corn cob ash on the mechanical performance of concrete.
2. To develop an optimized M45 concrete mix using RA, FN, and CCA.
3. To evaluate the workability of concrete incorporating these materials.
4. To determine the compressive strength of concrete containing RA, FN, and CCA.
5. To assess the flexural strength of the modified concrete mixes.
6. To measure the tensile strength improvements achieved through the use of RA, FN, and CCA.
7. To conduct a cost analysis comparing conventional and modified concrete mixes.
8. To examine the environmental advantages of incorporating these waste-derived materials in concrete production.

IV. MATERIALS USED

a. CEMENT

Ordinary Portland Cement (OPC) of 53 grade was used as the primary binding material for producing M45 grade concrete. This cement type is widely preferred in structural applications due to its high early strength and consistent performance. The cement was sourced from a certified local manufacturer to ensure quality compliance with IS 12269:2013. Before use, the cement was checked for fineness, standard consistency, initial and final setting times, and soundness to verify its suitability for high-strength concrete production.



b. COARSE AGGREGATE

The coarse aggregates used in this study were sourced from a local quarry. Crushed angular aggregates of 20 mm nominal size were selected, as they provide better interlocking and enhance the mechanical strength of concrete. The aggregates were tested for specific gravity, water absorption, impact value, and crushing value as per IS 2386. Only aggregates meeting the standard requirements were used to ensure uniformity and reliability in the experimental results.



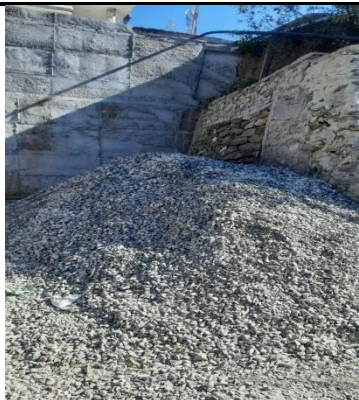
c. FINE AGGREGATE

Fine aggregate consisting of clean natural river sand or manufactured sand (M-sand) was collected from a local supplier. The sand conforms to Zone II grading as per IS 383:2016, making it suitable for high-strength concrete. Prior to mixing, the fine aggregate was analyzed for specific gravity, silt content, moisture content, and particle size distribution. Proper grading of fine aggregate ensures adequate workability and reduces the risk of segregation.



d. RECYCLED AGGREGATE

Recycled Aggregate (RA) was obtained from crushed concrete debris sourced from demolition materials. The material was processed through crushing, screening, and washing to remove impurities such as dust, mortar fragments, and organic matter. RA typically displays higher water absorption and lower density due to attached old mortar; hence, these properties were tested in accordance with IS 2386. The use of RA reduces the extraction of natural aggregates and supports sustainable construction. In this study, RA served as a partial replacement for conventional coarse aggregates.



e. FISHNET FIBER

Fishnet fibers used in the study originated from discarded nylon fishing nets, which were manually cleaned, cut, and processed into uniform short fibers. These fibers possess high tensile strength, flexibility, and resistance to environmental degradation. Their inclusion in concrete helps improve post-cracking behavior, tensile strength, and ductility. Utilizing waste fishnets not only enhances concrete performance but also provides a sustainable solution for managing marine plastic waste.



f. CORN COB ASH

Corn Cob Ash (CCA) was prepared by burning dried corn cobs under controlled conditions to ensure complete combustion. The resulting ash was sieved through the 90-micron sieve to obtain a fine pozzolanic material. Chemical analysis confirmed the presence of silica, alumina, and iron oxides, which contribute to long-term strength development through pozzolanic reactions. CCA acts as a supplementary cementitious material, reducing cement consumption and lowering the carbon footprint associated with concrete production.



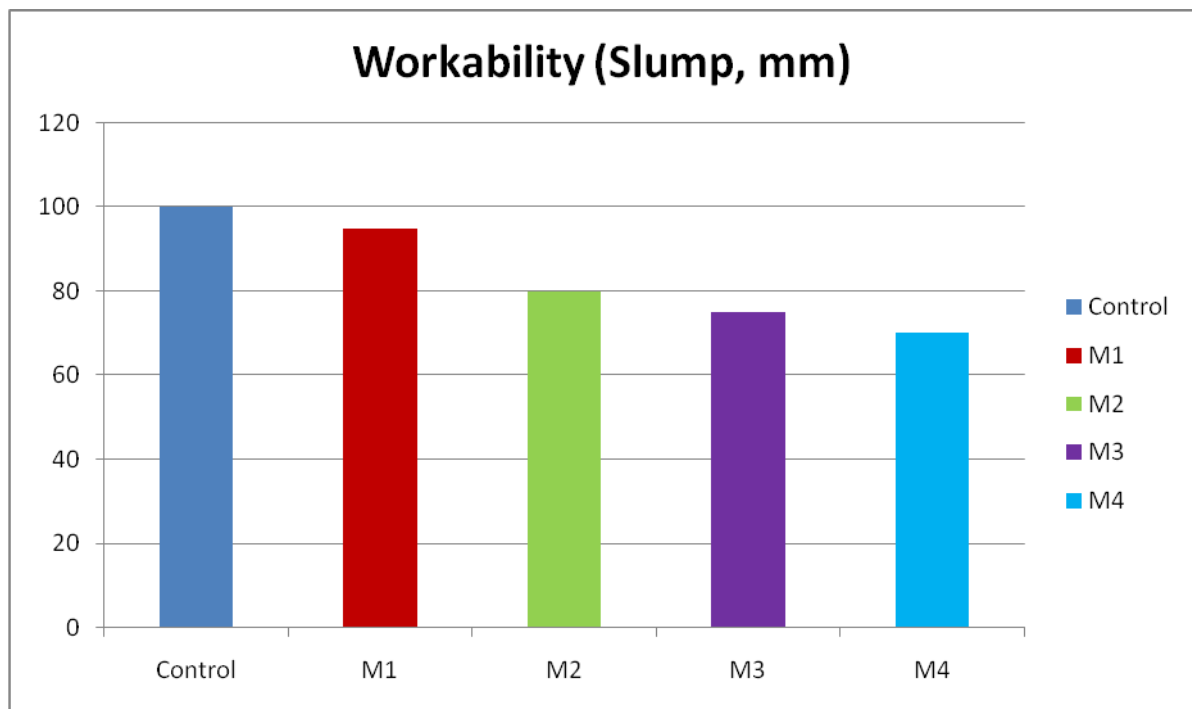
V. Mix Proportions

The experiment included five mixes: control (M0) without any replacement, M1 with 10% RA, 5% CCA and 0.5% FN, M2 with 20% RA, 10% CCA and 1% FN, M3 with 30% RA, 15% CCA and 1.5% FN & M4 with 40% RA, 20% CCA and 2% FN.

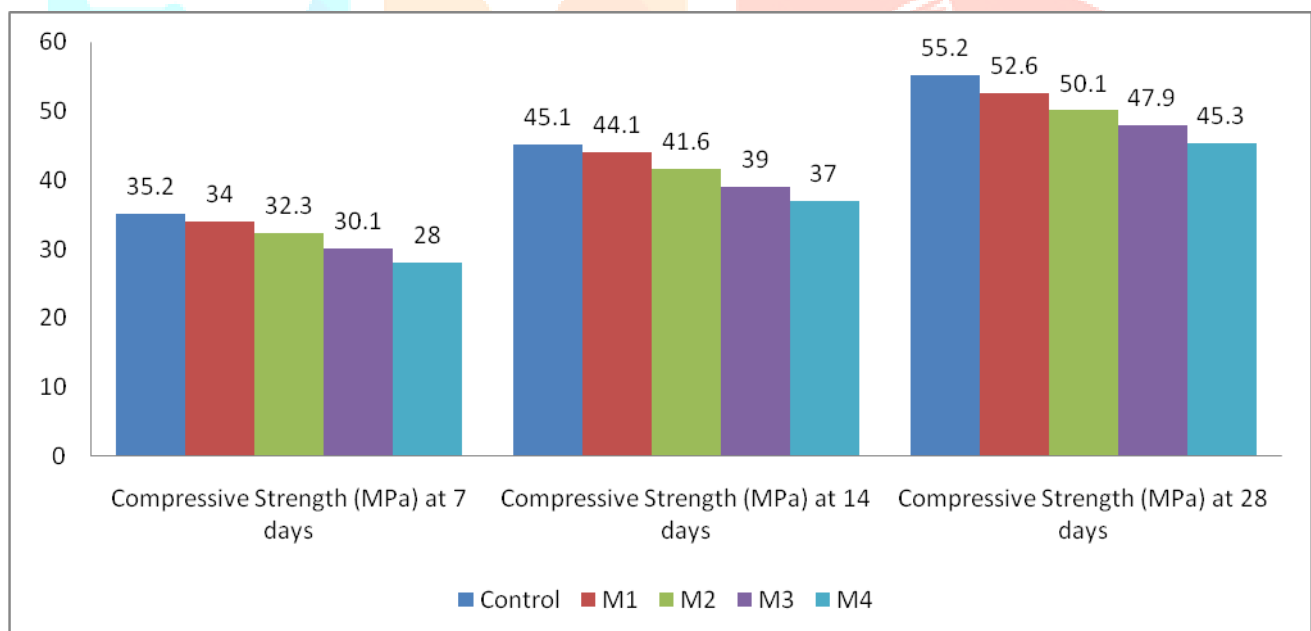
VI. Testing Procedure

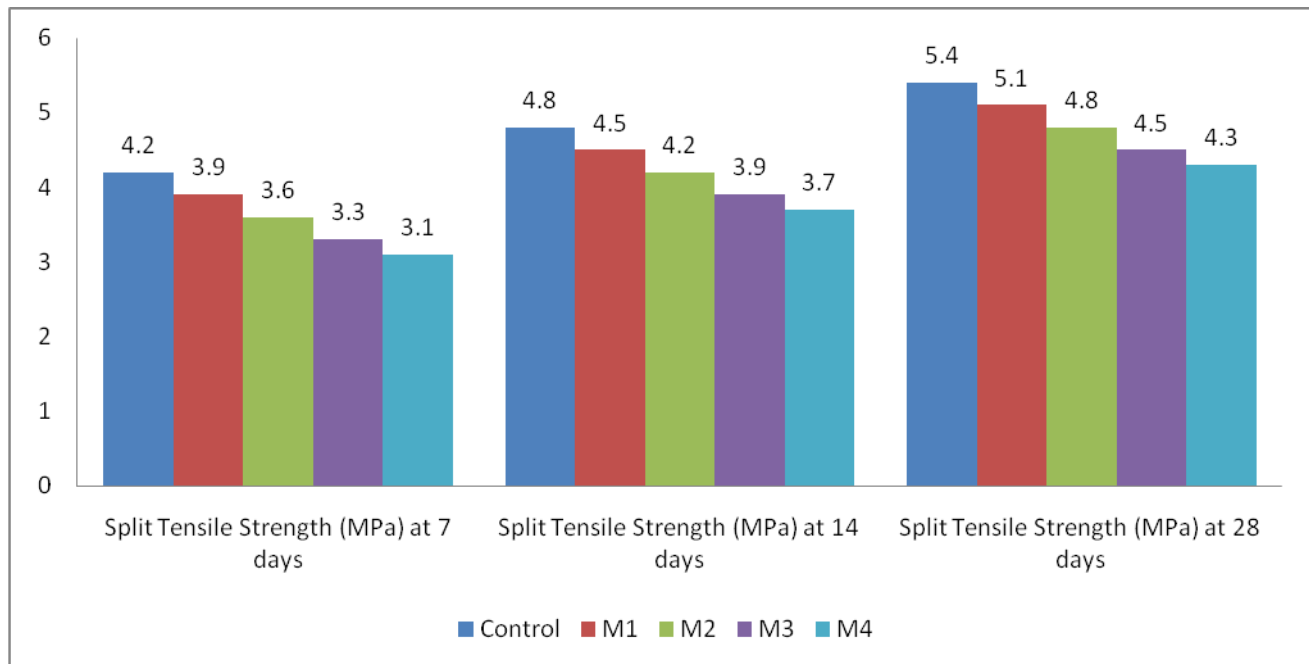
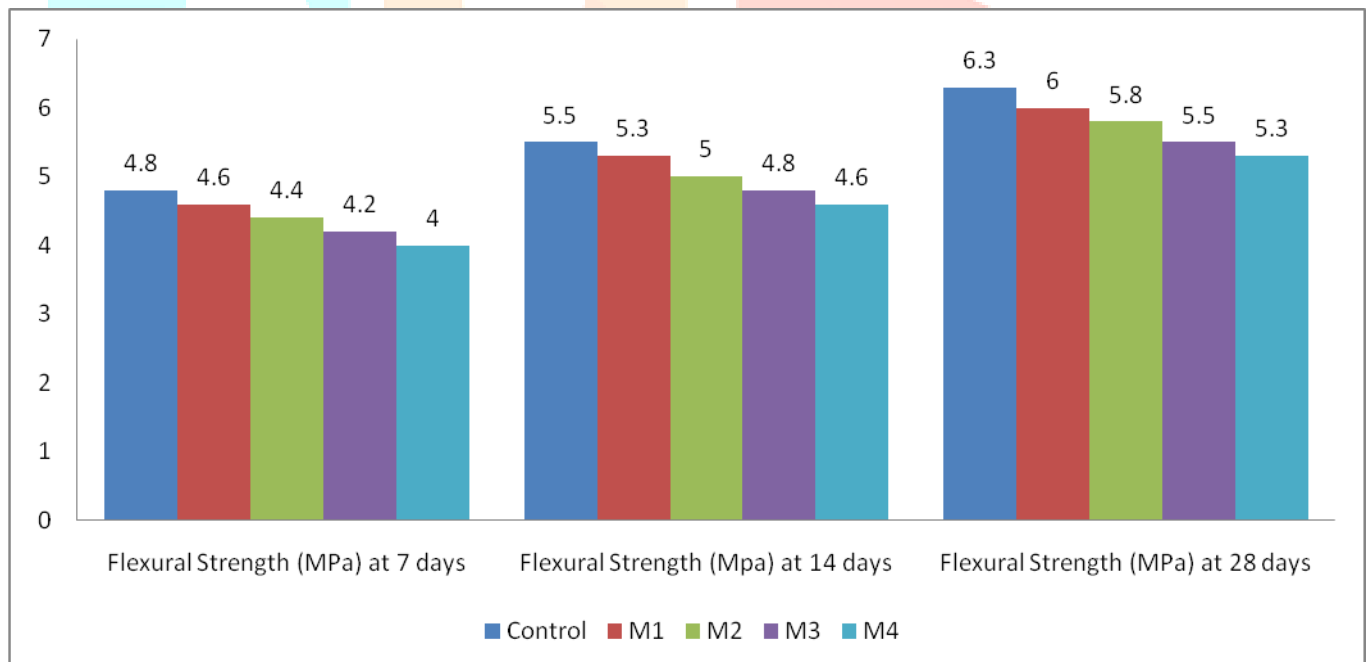
Tests conducted include slump test for workability, compressive strength, split tensile strength, and flexural strength at 7, 14, and 28 days. Standard IS procedures were followed for all tests.

VII. RESULTS

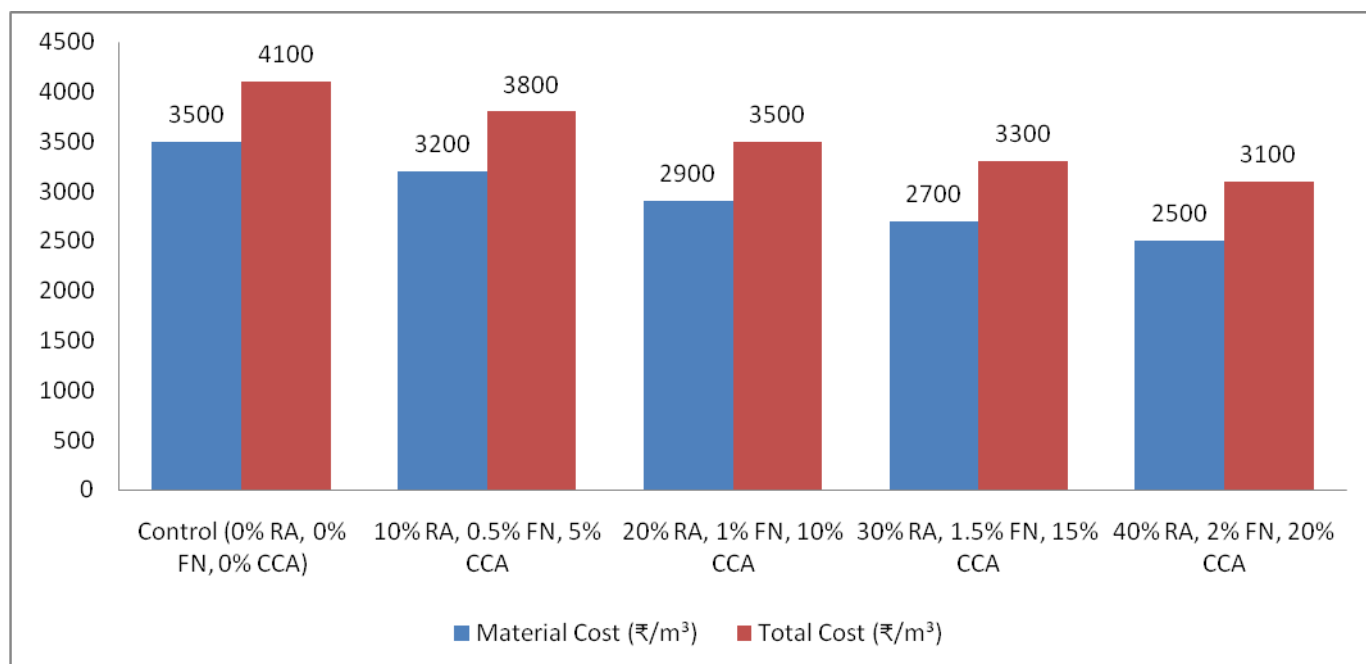


VIII. COMPRESSIVE STRENGTH TEST



IX. SPLIT TENSILE STRENGTH TEST**X. FLEXURE STRENGTH TEST**

XI. COST ANALYSIS



VI. CONCLUSIONS

1. In terms of mix, it was found that cement replaced with 5% CCA, natural aggregates replaced with 10% RA and incorporation of 0.5% FN is optimum.
2. In terms of workability, it was found with the decrease in the cement content, workability also performed in the direct proportion, thus decreasing in the same manner. Among all the mixes, the control mix (M0) exhibited the highest workability due to the absence of recycled aggregates, corn cob ash and fishnet fibres, all of which tend to reduce slump. The workability of optimum mix M1 was found to be 95mm.
3. In terms of compressive strength, it was found that with the increase in the replacement levels the respective mixes gained their compressive strength gradually when tested at 7 days, 14 days and 28 days. The maximum compressive strength for the optimum mix came to be 5.1 Mpa.
4. In terms of split tensile strength, it was found that the tensile strength of mixes increased in a gradual manner when tested at the time duration of 7 days, 14 days and 28 days. The split tensile strength of the optimum mix M1 was found to be 5.1 Mpa.
5. In terms of flexural strength test, the same trend of gradual improvement of strength with time was found when tested at 7 days, 14 days and 28 days of which the optimum mix M0 gained 6 Mpa of flexural strength.
6. The overall cost was found to decrease with the increase in the replacement level when compared with the control mix M0. The material cost and total cost per cubic metre was found to be ₹ 3200 and ₹ 3800.
7. In terms of environmental sustainability, it was found that the increase in replacement levels of natural aggregates with RA, cement with CCA the overall load on fresh supply can be reduced to some extent benefitting the environment.

VII. REFERENCES

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