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# Lightweight Concrete Production and Performance Monitoring System

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**ABSTRACT:** Rapid urbanization and infrastructure growth have resulted in excessive consumption of natural aggregates and increased construction waste, leading to severe environmental concerns. Lightweight concrete (LWC) presents a sustainable alternative by reducing dead load, material consumption, and carbon footprint. This project presents the development and performance analysis of lightweight concrete using waste-derived materials such as crushed coconut shell (as partial fine aggregate replacement) and crushed mosaic tile waste (as partial coarse aggregate replacement). The system integrates experimental testing with structured monitoring of material properties and strength development, aligned with modern smart construction practices. The proposed methodology demonstrates that waste-based lightweight concrete can achieve acceptable mechanical performance while significantly improving sustainability and resource efficiency. The study highlights the potential application of such materials in structural and non-structural elements, contributing toward eco-friendly construction practices.

**KEYWORDS:** Lightweight Concrete, Coconut Shell Aggregate, Mosaic Tile Waste, Sustainable Construction, Waste Utilization

## I. INTRODUCTION

The construction industry is one of the largest consumers of natural resources, particularly sand and coarse aggregates. Excessive extraction has caused environmental degradation such as riverbed erosion and depletion of natural reserves. Simultaneously, agricultural waste like coconut shells and construction debris such as mosaic tiles pose major disposal challenges. Lightweight concrete (LWC) offers a promising solution by reducing structural dead load, improving thermal performance, and minimizing environmental impact.

Lightweight concrete incorporates lightweight aggregates that reduce density while maintaining adequate strength. Reduced self-weight results in economical structural design, lower transportation costs, and improved seismic performance. This project focuses on utilizing powdered coconut shell (PCS) as a fine aggregate replacement and crushed mosaic tile waste (CMTW) as a coarse aggregate replacement to develop an eco-friendly lightweight concrete mix.

## II. LITERATURE SURVEY

Extensive research has been carried out on lightweight concrete using natural and artificial aggregates. Studies indicate that coconut shell aggregates significantly reduce concrete density while maintaining moderate compressive strength. Ceramic and mosaic tile waste has shown potential as a durable coarse aggregate substitute with acceptable bonding characteristics.

Previous researchers have highlighted that optimal replacement percentages are crucial to balance strength and density. Internal curing effects from porous aggregates improve hydration and durability. However, limited studies exist on combined use of agricultural and construction waste aggregates, particularly with long-term performance considerations.

### III. METHODOLOGY

The project methodology involves material selection, mix design, specimen casting, curing, and testing.

#### A. Materials Used

- Cement: OPC 53 Grade with Fly Ash
- Fine Aggregate: Crushed Coconut Shell (PCS)
- Coarse Aggregate: Crushed Mosaic Tile Waste (CMTW)
- Water: Potable water as per IS 456:2000

#### B. Mix Design

Mix design is carried out as per IS 10262:2019, targeting reduced density while achieving adequate compressive strength. Trial mixes are conducted to determine optimal replacement percentages and workability.

#### C. Casting and Curing

Concrete specimens are cast into standard moulds and compacted carefully to avoid segregation. Specimens are cured using curing compounds for up to 28–90 days to ensure proper hydration.

#### D. Testing

Tests conducted include compressive strength, tensile strength, water absorption, density, slump cone test, rebound hammer test, and ultrasonic pulse velocity test.

### IV. RESULTS AND DISCUSSION

The results indicate a significant reduction in concrete density compared to conventional concrete. Compressive strength values demonstrate that partial replacement of aggregates yields optimal performance. Coconut shell contributes to weight reduction, while mosaic tile waste enhances mechanical strength at lower replacement levels.

Water absorption values are slightly higher than conventional concrete but remain within permissible limits for lightweight applications. The combined use of waste materials shows promising results for sustainable construction.

### V. CONCLUSION

This study successfully demonstrates the feasibility of producing lightweight concrete using coconut shell and mosaic tile waste. The developed mix achieves reduced density, acceptable strength, and improved sustainability. The approach addresses environmental concerns related to waste disposal and natural resource depletion. Future work may focus on durability studies, large-scale implementation, and integration with smart monitoring systems for real-time performance tracking.

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