Feasibility Study of Coconut Shell as Partial Replacement for Coarse Aggregate in Concrete

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***Abstract*—This research examines the potential of coconut shells as sustainable partial replacements for conventional coarse aggregates in concrete mixtures. Through systematic experimentation with replacement ratios of 0%, 10%, 20%, and 30%, the study evaluates key mechanical properties including compressive strength, workability, and density. Findings suggest that a 10% replacement ratio maintains structural integrity while offering environmental benefits, making it suitable for non-load-bearing applications. The investigation contributes to sustainable construction practices by valorising agricultural waste.**

***IndexTerms*—Sustainable concrete, Agricultural Waste, Coconut Shell Aggregate, Compressive Strength, Lightweight Concrete.**

I. INTRODUCTION

The construction industry's dependence on natural aggregates has led to significant environmental concerns, including resource depletion and ecological disruption. With concrete production reaching unprecedented levels globally, the incorporation of alternative materials has become imperative. Coconut shells, typically discarded as agricultural waste in tropical regions, present a promising solution due to their abundance and material properties. This study systematically evaluates the mechanical performance of concrete incorporating coconut shell aggregates at varying replacement ratios, addressing both technical feasibility and environmental sustainability.

II. LITERATURE REVIEW

Previous investigations into alternative aggregates have demonstrated varying degrees of success with materials such as crushed ceramics, recycled plastics, and agricultural byproducts. Notably, research by Gunasekaran et al. (2011) established coconut shells' viability as lightweight aggregates, achieving 70-80% of conventional concrete's compressive strength at 20% replacement. Subsequent studies by Olanipekun (2006) highlighted improved thermal insulation properties but noted challenges in water absorption. This literature gap regarding optimal replacement ratios and long-term durability motivates the current investigation.

III. MATERIALS AND METHODOLOGY

A. Materials

- Cement: OPC 53 grade confirming to IS 12269
- Fine aggregate: Natural River sand (Zone II)
- Coarse aggregate: 10mm crushed stone (control) and processed coconut shells
- Water: Potable water meeting IS 456 requirements

B. Sample PreparationCoconut shells underwent thorough cleaning, sun-drying for 72 hours, and mechanical crushing to achieve consistent 10-12mm particle sizes. The replacement process maintained consistent gradation curves across all mixtures.

C. Experimental DesignFour mix designs with 0%, 10%, 20%, and 30% coconut shell replacement were prepared maintaining a constant 0.5 water-cement ratio. Testing protocols included:

1. Fresh concrete: Slump test (IS 1199)
2. Hardened concrete:
   - Compressive strength (IS 516) at 7/28 days
   - Density measurement (ASTM C138)
   - Water absorption (ASTM C642)

IV. RESULTS AND DISCUSSIONA.

Workability The control mix (0%) exhibited a slump of 85mm, decreasing to 65mm (10%), 50mm (20%), and 40mm (30%) respectively. This reduction correlates with the angular morphology and surface roughness of coconut shell particles.

B. Compressive Strength28-day results showed:

- 0%: 28.5 N/mm²
- 10%: 24.2 N/mm² (85% of control)
- 20%: 19.8 N/mm² (69.5%)
- 30%: 17.1 N/mm² (60%)

C. Density Dry density decreased linearly from 2400 kg/m³ (0%) to 2080 kg/m³ (30%), confirming the material's lightweight potential.

V. CONCLUSION

The experimental results demonstrate that coconut shells can effectively replace up to 10% of conventional coarse aggregates without significant strength compromise. While higher replacements reduce mechanical properties, they may be suitable for non-structural applications like partition walls or garden paving. This approach aligns with circular economy principles by valorizing agricultural waste.

VI. RECOMMENDATIONS

Future research should investigate:

1. Chemical treatments to improve shell-cement bonding
2. Long-term durability under environmental exposure
3. Life cycle assessment comparing environmental impacts
4. Economic analysis of large-scale implementation

REFERENCES

[1] Gunasekaran K., et al. (2011). "Coconut shell as partial replacement for coarse aggregate." Construction and Building Materials, 25(4), 1918-1923.

[2] IS 456:2000. Indian Standard for Plain and Reinforced Concrete.

[3] Olanipekun E.A. (2006). "Comparative analysis of coconut and palm kernel shells as aggregates." Journal of Materials in Civil Engineering, 18(2), 235-240.