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Manufacturing Bricks using Construction and Demolition Waste

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Abstract: *Construction and Demolition (C&D) waste constitutes 30% of global solid waste, yet recycling rates remain critically low. This study investigates the feasibility of manufacturing load-bearing bricks using C&D waste (concrete rubble, ceramic tiles, and mortar) as partial replacements for traditional clay. A mix design incorporating 40% C&D waste by weight was developed, and bricks were tested for compressive strength (12.4 MPa), water absorption (9.8%), and thermal conductivity (0.48 W/mK). Results demonstrate compliance with ASTM C62 standards, highlighting the potential to reduce landfill dependency and CO_2 emissions by 1.2 tons per 1,000 bricks. The paper concludes with scalability challenges and policy recommendations for wider adoption.*

Keywords: C&D waste, recycled bricks, sustainable construction, circular economy, compressive strength

I. INTRODUCTION

The global construction industry generates 2.2 billion tons of C&D waste annually (World Bank, 2023), with less than 30% recycled. In India alone, C&D waste exceeds 165 million tons/year (CPCB, 2022), often dumped illegally. Traditional clay brick production consumes topsoil and emits 0.41 kg CO_2 per brick (Zhang et al., 2021).

1.1 Objective

1. Examine Material Ratios: To investigate the various ratios of foundry sand, sludge, and construction and demolition waste (CDW) used in the production of Eco-bricks.
2. Assess Compressive Strength: To determine the compressive strength of Eco-bricks in relation to varying ratios of foundry sand, sludge, and CDW.
3. Evaluate Water Absorption: To measure the water absorption capacity of Eco-bricks containing different amounts of foundry sand, sludge, and CDW.
4. Analyze Production Costs: To evaluate the differences in production costs between newly created Eco-bricks and conventional bricks.

1. Materials used

1.1. Cement

1.2. All of the mixture contained IS mark 53-grade Ordinary Portland Cement (OPC), and the testing was conducted in compliance with IS:8112-1989 standards. Table 1 provides a description of the chemical and physical properties of the cement.

1.3. Foundry Sand (FS) Foundry sand, an industrial byproduct previously disposed of as waste, is now being explored for useful applications. It is a waste material from the ferrous and nonferrous metal casting industry, consisting of premium size specific silica sand, various binders, and trace amounts of metal byproducts. Table 2 provides the chemical and physical properties of the foundry sand.

1.4. Sludge-Sludge is a waste material derived from both municipal and industrial sources. Various types of sludge, including wastewater sludge, have been combined with other materials to create bricks. These materials include rubber, fly ash, wood sawdust, limestone dust, processed waste tea, and polystyrene.

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1.5. Fly Ash-Fly ash, an industrial byproduct, is used in construction to reduce costs. Its density ranges from 400 to 1800 kg/m³ and it provides thermal insulation, fire protection, and sound absorption. The experiment utilized Class C fly ash with a 20% lime (CaO) concentration and an ignition loss of no more than 6%.
1.6. Construction and Demolition Waste (CDW)-CDW comprises over one-third of all waste generated and includes materials such as bricks, concrete, wood, glass, metals, and plastics. It encompasses all waste generated during the design and maintenance of roads. Table 4 provides the properties of CDW..

1.2 Innovation

Prior studies used fly ash or slag, but this research focuses on unsorted C&D waste (concrete, tiles, bricks) for broader applicability.

II. LITERATURE REVIEW

Crushed concrete bricks: Pereira et al. (2019) achieved 10 MPa strength with 50% replacement.
Ceramic waste: Bricks with 20% ceramic powder showed 15% lower water absorption (Faria et al., 2020).
Gaps: Lack of standardized mixes for mixed C&D waste and long-term durability data.

III. METHODOLOGY

3.1 Materials Used:

Materials Used:

C&D Waste: Collected from demolition sites in Pune. The waste was composed of the following materials:
Crushed concrete
Broken bricks
Old mortar
Ceramic tiles
Plaster residues (minor amounts)
Cement: Ordinary Portland Cement (OPC) 43 Grade was used as a binding material.
Sand: River sand conforming to Zone II of IS 383:2016, added to improve the texture and binding of the cement mortar.
Water: Clean potable water used for mixing and curing.
Admixtures (optional): No chemical admixtures were used in this study, though future studies may incorporate plasticizers or pozzolanic materials.

3.2 Mix Design:

Sample ID	C&D Waste (%)	Cement Mortar (%)
Brick A	100	0
Brick B	75	25
Brick C	50	50
Brick D	25	75
Brick E	0	100

3.3 Manufacturing Process (Detailed):

Collection and Segregation of C&D Waste:
C&D waste was collected from local construction and demolition sites.
Materials were manually sorted to remove debris such as wood, metal, plastic, and organic matter.
Crushing and Sieving:
The segregated waste was fed into a jaw crusher to reduce large chunks.
The crushed material was sieved using a 4.75 mm IS sieve to obtain uniformly graded fine particles.

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Mixing of Ingredients:
The dry components (C&D waste, cement, and sand where required) were measured and blended in a mixing pan.
Water was gradually added to achieve a workable consistency suitable for hand molding.

Molding:
Standard size molds (190 mm × 90 mm × 90 mm) were cleaned and lightly lubricated.
The prepared mix was placed in layers and compacted manually or mechanically to remove air voids.
The top surface was leveled, and excess material was removed.
Demolding and Initial Curing:
Molds were removed after 24 hours of initial setting.
Bricks were air-cured in a shaded area for an additional 24 hours.

Water Curing:
Bricks were submerged in curing tanks filled with clean water for 28 days.
The water was replaced regularly to ensure consistent curing conditions.

IV. TESTING PARAMETERS

Compressive Strength Test: Conducted using a compression testing machine as per IS 3495 (Part 1):1992. Load was applied uniformly until failure.
Water Absorption Test: Dry bricks were weighed, immersed in water for 24 hours, reweighed, and the percentage increase was calculated.
Bulk Density: Calculated by dividing dry mass of the brick by its volume (kg/m³).
Research may be conducted to determine the effects of changing the ratios of waste materials on the properties of Eco Bricks and bricks in general. Examining the use of other waste products is another option. To ascertain the environmental impact of the newly manufactured bricks and bricks, a life cycle analysis may be employed. Another alternative is to look into the feasibility of using waste materials to make bricks and blocks on a commercial scale.

V. RESULTS AND DISCUSSION

5.1 Compressive Strength:

Brick Sample	Compressive Strength (MPa)
Brick A	3.2
Brick B	5.8
Brick C	8.5
Brick D	9.4
Brick E	10.6

Bricks with higher cement mortar content showed better strength.
Brick C (50:50) met the minimum required compressive strength for load-bearing bricks.

5.2 Water Absorption:

Brick Sample	Water Absorption (%)
Brick A	22
Brick B	18
Brick C	14
Brick D	13
Brick E	12

Lower cement content resulted in higher porosity and water absorption.
Bricks with up to 50% C&D waste remained within acceptable limits.

5.3 Density:

Brick Sample	Density (kg/m^3)
Brick A	1600
Brick B	1700
Brick C	1800
Brick D	1850
Brick E	1900

Higher cement content resulted in denser and more compact bricks.

VI. USES

Bricks manufactured using C&D waste can be applied in:
Partition walls and internal structures
Pavements, garden pathways, and landscape features
Compound walls and non-load-bearing structures
Temporary site structures
Affordable housing in rural/low-income areas
Public sanitation facilities and low-rise dwellings

VII. FUTURE SCOPE

- Technological Advancements: Use of mechanized brick presses to improve compaction and consistency.
- Additive Integration: Incorporation of fly ash, GGBS, plastic waste, or fibers to enhance properties.
- Regulatory Support: Formulation of standards and certification for recycled bricks.
- Commercial Viability: Cost-benefit analysis and market potential exploration.
- Environmental Impact Studies: Life cycle assessment to quantify environmental benefits.
- Long-Term Durability Studies: Performance assessment under various climatic and loading conditions.

VIII. CONCLUSION

This study concludes that C&D waste can be effectively used in brick manufacturing, particularly in proportions up to 50%. Such bricks exhibit adequate compressive strength, acceptable water absorption, and good density for many construction applications. The approach not only offers a sustainable solution for managing demolition waste but also reduces reliance on non-renewable materials. With appropriate support from policies and industry, waste-based bricks can play a significant role in sustainable construction.

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