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Plastic Waste Pavement Blocks and Papercrete Bricks: A Sustainable Construction Approach

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Abstract

Rapid urbanization has significantly increased the generation of paper and plastic waste, creating environmental challenges while the construction industry continues to consume large quantities of natural resources. This study investigates the feasibility of producing sustainable construction materials using waste paper and recycled plastic in the form of **Papercrete Bricks** and **Plastic Waste Pavement Blocks**. Papercrete Bricks were prepared using a mix proportion of **1:5:4 (cement:sand:paper pulp)**, while Plastic Waste Pavement Blocks were manufactured using **1:1.2:1.2 (cement:sand:plastic waste)**. Laboratory investigations were conducted according to relevant Indian Standard specifications to evaluate workability, compressive strength, density, and water absorption.

The results showed that Papercrete Bricks achieved a **28-day compressive strength of 3.8 MPa**, density of **870 kg/m³**, and water absorption of **18%**, making them suitable for lightweight, non-load-bearing construction. Plastic Waste Pavement Blocks attained a compressive strength of **6.3 MPa**, density of **1130 kg/m³**, and water absorption of only **7%**, demonstrating suitability for footpaths, pedestrian walkways, and landscape applications. The study concludes that both materials offer an effective approach for waste utilization, environmental protection, and sustainable construction.

Keywords— Papercrete, Plastic Waste, Pavement Block, Sustainable Construction, Recycling, Green Building Materials.

I. INTRODUCTION

The construction industry is one of the largest consumers of natural resources and contributes significantly to environmental degradation through the extraction of raw materials and the production of cement. Simultaneously, the disposal of municipal solid waste, particularly paper and plastic, has become a major environmental concern due to increasing urbanization and industrialization. Landfilling and open burning of these wastes result in pollution, greenhouse gas emissions, and inefficient resource utilization.

The concept of sustainable construction encourages the reuse of waste materials as alternative building resources. Paper waste can be converted into paper pulp and combined with cement and sand to produce **Papercrete Bricks**, a lightweight construction material with good thermal insulation properties. Similarly, recycled plastic waste can be incorporated into cement-based mixtures to manufacture durable **Plastic Waste Pavement Blocks**, reducing plastic pollution while improving water resistance and durability.

Although several researchers have investigated these materials individually, comparative studies evaluating both materials under similar laboratory conditions remain limited. This research compares their engineering properties and identifies suitable applications based on experimental testing.

Objectives

The objectives of this study are:

- To manufacture Papercrete Bricks using recycled paper waste.
- To manufacture Plastic Waste Pavement Blocks using recycled plastic waste.
- To evaluate compressive strength, density, workability, and water absorption.
- To compare their engineering performance and practical applications.
- To assess their contribution towards sustainable construction and waste management.

II. MATERIALS AND METHODOLOGY

A. Materials

The following materials were used:

- Ordinary Portland Cement (OPC 43 Grade)
- River Sand conforming to IS 383
- Waste Paper Pulp
- Shredded LDPE and PP Plastic Waste
- Potable Water

Waste paper was collected from offices and households, soaked in water for 24 hours, and converted into pulp. Plastic waste was cleaned, dried, and shredded to particles smaller than 4 mm before use.

B. Mix Proportions

The optimized mix proportions adopted in the study are presented in Table I.

Table I. Mix Proportions

Material	Cement	Sand	Paper Pulp	Plastic Waste
Papercrete Brick	1	5	4	–
Plastic Pavement Block	1	1.2	–	1.2

C. Specimen Preparation

The materials were mixed thoroughly to obtain a homogeneous mix and cast into standard moulds. Papercrete Bricks were cured by water immersion for 28 days, whereas Plastic Waste Pavement Blocks were cured under ambient conditions with periodic water sprinkling. Three specimens were prepared for each test to obtain average values.

D. Experimental Testing

The following laboratory tests were carried out in accordance with Indian Standard specifications:

- Slump Test (IS 1199)
- Compressive Strength Test (IS 516)
- Density Test
- Water Absorption Test (IS 3495 Part II)

The test programme was designed to compare the engineering performance of both materials under identical conditions.

III. RESULTS AND DISCUSSION

The experimental results obtained after 28 days of curing are summarized in Table II.

Table II. Experimental Results

Property	Papercrete Brick	Plastic Pavement Block
Slump (mm)	35–40	20–25
7-Day Strength (MPa)	2.5	4.5
28-Day Strength (MPa)	3.8	6.3
Density (kg/m³)	870	1130
Water Absorption (%)	18	7

Papercrete Bricks exhibited lower density because of the presence of paper fibres, resulting in lightweight construction with improved thermal insulation. However, their higher water absorption limits their application to non-load-bearing elements.

Plastic Waste Pavement Blocks showed higher compressive strength and significantly lower water absorption. The hydrophobic nature of plastic particles reduced permeability and improved durability, making these blocks suitable for outdoor applications such as footpaths, cycle tracks, and pedestrian pavements.

The results confirm that recycled waste materials can be effectively utilized in sustainable construction while maintaining acceptable engineering performance.

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IV. COMPARISON WITH CONVENTIONAL MATERIALS

To evaluate the performance of the developed materials, the experimental results were compared with conventional clay bricks and concrete pavement blocks. Table III summarizes the comparison.

Table III. Comparison of Conventional and Proposed Materials

Property	Conventional Brick	Papercrete Brick	Plastic Pavement Block
Density (kg/m³)	1800	870	1130
Compressive Strength (MPa)	7–10	3.8	6.3
Water Absorption (%)	15–20	18	7
Thermal Insulation	Moderate	Excellent	Moderate
Weight	Heavy	Very Light	Medium
Waste Utilization	No	Yes	Yes
Sustainability	Moderate	High	High

The comparison indicates that although conventional clay bricks provide higher compressive strength, Papercrete Bricks offer significant advantages in terms of lightweight construction and thermal insulation. Plastic Waste Pavement Blocks demonstrated improved water resistance and adequate compressive strength for pedestrian paving applications. Both proposed materials contribute to sustainable construction by utilizing waste resources that would otherwise be disposed of in landfills.

V. SUSTAINABILITY ASSESSMENT

The construction industry is increasingly adopting sustainable materials to reduce environmental impacts. The utilization of waste paper and recycled plastic in this study contributes to environmental protection through:

- Reduction of municipal solid waste disposed in landfills.
- Conservation of natural aggregates and clay resources.
- Promotion of recycling and circular economy principles.
- Reduction in environmental pollution caused by plastic waste.
- Production of eco-friendly construction materials using locally available waste.

In addition to environmental benefits, the proposed materials reduce dependence on virgin raw materials and encourage resource-efficient construction practices.

VI. ENGINEERING APPLICATIONS

Based on the experimental findings, the following practical applications are recommended:

Papercrete Bricks

- Partition walls
- Lightweight non-load-bearing walls
- Temporary buildings
- Thermal insulation panels
- Low-cost housing

Plastic Waste Pavement Blocks

- Footpaths
- Garden walkways
- Cycle tracks
- Pedestrian pavements
- Parking areas
- Landscape paving

These applications make effective use of recycled waste while meeting the required engineering performance for non-structural and paving works.

VII. CONCLUSION

This study evaluated the feasibility of manufacturing **Papercrete Bricks** and **Plastic Waste Pavement Blocks** using recycled paper and plastic waste. Experimental investigations showed that Papercrete Bricks achieved a **28-day compressive strength of 3.8 MPa**, density of **870 kg/m^3**, and water absorption of **18%**, making them suitable for lightweight, non-load-bearing applications.

Plastic Waste Pavement Blocks achieved a **compressive strength of 6.3 MPa**, density of **1130 kg/m^3**, and **7% water absorption**, demonstrating better durability and suitability for pedestrian pavements and landscape applications.

The results confirm that both materials provide an environmentally sustainable solution for utilizing waste paper and plastic while reducing landfill disposal and conserving natural resources. The study supports the adoption of recycled waste materials in sustainable construction and highlights their potential for practical civil engineering applications.

Future research should focus on long-term durability, abrasion resistance, fire performance, and life-cycle assessment to further establish the suitability of these materials for large-scale implementation.

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