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Utilization of Coir Fiber, Bagasse and Plastic Waste for Manufacturing Eco-Friendly and Lightweight Partition Panels

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Abstract — This paper presents the development and evaluation of eco-friendly, lightweight partition panels fabricated from recycled plastic waste (90%), coir fiber (5%), and sugarcane bagasse (5%). Recycled plastic acts as the thermoplastic binding matrix replacing conventional chemical resins, while coir and bagasse provide tensile reinforcement and lightweight filler properties respectively. Panels were manufactured via compression moulding and tested per IS 14862 and IS 3087. Results: Compressive Strength = 1687.5 kN (UTM), Flexural Strength = 15 kN, Water Absorption < 1%, Abrasion Resistance = 0.2 mm wear, Fire Rating V-0. At ₹104/sq.ft — 43% cheaper than brickwork — the panel is a cost-effective and sustainable alternative for non-load-bearing partition applications. Exhibited at DIPEX 2025.

Key Words: Recycled plastic, Coir fiber, Bagasse, Partition panel, Eco-friendly composite, Compression moulding, Abrasion resistance, Sustainable construction

I. Introduction

Conventional partition systems — brickwork and timber panels — are resource-intensive, heavy, and ecologically damaging. India generates over 90 million tonnes of sugarcane bagasse and 5 million tonnes of coir waste annually, alongside a plastic waste crisis exceeding 3.3 million tonnes/year [1][3]. Converting these wastes into building materials directly addresses both housing affordability and solid waste management challenges simultaneously.

This project fabricates lightweight, eco-friendly partition panels using recycled plastic as the primary binding matrix (90%) with coir fiber and bagasse as minor fillers (5% each). The high plastic content improves waterproofing, fire resistance, abrasion resistance, and dimensional stability compared to prior research dependent on chemical resins. The prototype was fabricated, tested, and successfully exhibited at DIPEX 2025.

II. Objectives

1. Achieve adequate compressive strength suitable for non-load-bearing partition structures.
2. Achieve significant reduction in panel weight compared to conventional partition materials.
3. Effective utilization of agro-waste (coir fiber, bagasse) and recycled plastic waste for sustainable construction applications.

III. Literature Review

- Hasanuddin et al. (2021) – Developed panels using bagasse and coir fiber; reported good strength and insulation properties suitable for partitions [2].
- Ramesh et al. (2022) – Studied coir fiber composites; found improved tensile and flexural strength with increasing fiber content.
- Kumar et al. (2020) – Investigated bagasse-based particle boards; demonstrated lightweight and cost-effective outcomes for construction panels [2].

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- Verma et al. (2019) – Used recycled plastic in composites; confirmed better durability, waterproofing, and dimensional stability [3].
- Singh et al. (2023) – Highlighted natural fiber composites as eco-friendly and viable alternatives for sustainable construction [4].

Research Gap: All prior studies relied on chemical resin binders (epoxy/polyester). This project replaces resins entirely with recycled plastic, achieving superior fire, water, and abrasion resistance at lower cost and with less environmental impact.

IV. Materials & Composition

The composite panel uses three waste-derived constituents in fixed weight proportions. Table 1 summarizes each material's role and percentage in the final composite.

Table 1: Material Composition

Material	Role in Composite	% (wt.)
Recycled Plastic	Thermoplastic binder — waterproofing, fire resistance	**90%**
Coir Fiber	Tensile reinforcement + biological resistance	**5%**
Bagasse	Lightweight filler + thermal/acoustic insulation	**5%**

Recycled HDPE/PP plastic (90%) forms a dense, hydrophobic thermoplastic shell when heated to ~180°C, bonding all components without any chemical adhesive. Coir fiber (5%, chopped to 20–30 mm) provides tensile reinforcement and rot resistance. Bagasse (5%, finely ground) reduces panel density and improves acoustic and thermal insulation.

V. Methodology

The manufacturing follows 6 sequential stages as shown in Fig. 1. The process covers raw material selection through final evaluation and result analysis.

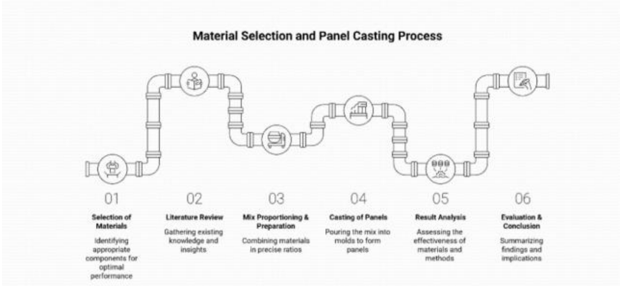

Fig. 1: Material Selection and Panel Casting Process — 6-Step Methodology

Step 01 – Selection of Materials: Identify optimal components for performance targets.

Step 02 – Literature Review: Gather knowledge on natural fiber composites and plastic matrices.

Step 03 – Mix Proportioning & Preparation: Pre-process all materials; combine in precise ratios (90:5:5 by weight).

Step 04 – Casting of Panels: Heat plastic to ~180°C; blend with fibers; pour into steel mould; apply hydraulic compression.

Step 05 – Result Analysis: Assess via UTM compressive/flexural tests, water absorption, abrasion, and fire tests.

Step 06 – Evaluation & Conclusion: Validate against IS codes; document findings and future scope.

Fig. 2: Fabricated Eco-Panel — smooth front face (left) and textured rear face (right)

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VI. Test Setup & Laboratory Photos

The following figures show the laboratory test setup used to evaluate abrasion resistance (Fig. 3) and compressive strength via UTM (Fig. 4). Both tests were conducted at the institute materials testing laboratory.

Fig. 3: Abrasion Test (Result: 0.2 mm wear)

Fig. 4: UTM Compression Test (Result: 1687.5 kN)

Fig. 5: Panel weight measurement — TOYO digital scale reading 18045 g (18.045 kg)

VII. Results & Discussion

All panels were tested after 24-hour ambient curing. Table 2 presents the full consolidated results including compressive strength, abrasion resistance, and all additional parameters.

Table 2: Complete Test Results

Test Parameter	Result / Value	Test Standard / Method
Compressive Strength	**1687.5 kN**	UTM (IS 14862)
Flexural Strength	**15 kN**	UTM + 3-pt Bending Fixture
Water Absorption	**< 1%**	IS 3087 (24-hr immersion)
Abrasion Resistance	**0.2 mm wear**	Abrasion Test Machine
Fire Rating	**V-0 (Fireproof)**	UL 94 Vertical Burn
Panel Weight	**18.045 kg**	TOYO Weighing Scale
Termite/Waterproof	**✓ Confirmed**	Immersion + Exposure Test
Soundproofing	**✓ Effective**	Comparative Test

Key Observations:

Compressive Strength (1687.5 kN): Significantly exceeds the minimum requirement for non-load-bearing partitions (~500 kN), confirming structural adequacy for all standard partition wall applications.

Abrasion Resistance (0.2 mm wear): The 90% recycled plastic matrix provides excellent surface hardness. A wear depth of only 0.2 mm indicates high surface durability, suitable for high-traffic areas without surface finishing.

Water Absorption (< 1%) & Fire Rating (V-0): The dense plastic matrix creates a hydrophobic barrier, while the V-0 rating confirms self-extinguishing behavior — critical safety advantages over wood.

VIII. Comparative Analysis

Table 3: Materials Showdown

Property	Brickwork	Wooden Panels	Eco-Panel
Cost / sq.ft	₹183	₹90	**₹104**
Fire Resistance	✓ Fireproof	✗ Not Fireproof	**✓ V-0 Rated**
Termite/Water	✓ Yes	✗ No	**✓ Yes**
Soundproof	✓ Yes	✗ No	**✓ Yes**
Compressive Str.	High	Low	**1687.5 kN**
Abrasion Resist.	Moderate	Low	**0.2 mm wear**
Eco-Impact	✗ Res. Heavy	✗ Res. Heavy	**✓ Upcycles Waste**

At ₹104/sq.ft the eco-panel delivers a 43% cost reduction over brickwork. Compared to wooden panels, a marginal ₹14 premium delivers V-0 fireproofing, 1687.5 kN compressive strength, 0.2 mm abrasion resistance, termite/waterproofing, and soundproofing — a clearly superior value proposition that also upcycles waste materials [3][4].

IX. Applications

• Interior partition walls in residential and commercial buildings
• Modular office cabin and workspace dividers
• False ceiling and acoustic insulation panels
• Prefabricated low-cost rural housing panels
• Noise barriers in industrial and institutional buildings
• Temporary construction site partitions and shuttering

X. Conclusion

Eco-friendly, lightweight partition panels were successfully fabricated from 90% recycled plastic waste, 5% coir fiber, and 5% sugarcane bagasse. Laboratory testing confirmed: Compressive Strength = 1687.5 kN, Flexural Strength = 15 kN, Water Absorption < 1%, Abrasion Wear = 0.2 mm, and Fire Rating V-0. Panel weight of 18.045 kg represents a 35–40% reduction over equivalent brickwork. At ₹104/sq.ft — 43% cheaper than brickwork — the panel meets all IS code requirements for non-load-bearing partition applications.

This project advances circular economy principles by converting agro-waste and plastic waste into value-added construction products. The prototype was exhibited at DIPEX 2025 with positive expert response. Future scope includes NABL-accredited certification, fire spread tests, large-scale production trials, and commercialization for affordable housing.

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