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Recycling All Mix Plastic Waste for Reuse Precast Cement Concretes Applications.

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Founder of Mantrom Plastic Industry

Abstract- This invention addresses the environmental challenges raised by the material of plastic waste at dump yards, which means plastic waste products of Polypropylene, Polyesters, Ethylene Vinyl Acetate, Polyamides, Polyvinyl Chloride, Polyvinylidene Chloride, Polystyrene, Acrylonitrile Butadiene Styrene, Ethylene Vinyl Alcohol, Polymethyl pentene and Polyvinyl Acetate. Recycling All Mix Plastic Waste for Reuse for Precast Cement Concrete Applications, this all mix plastic waste by introducing a novel approach - All Mix Plastic Waste Products (AMPWP). The manufacturing process avoided use of sand, water and cement, only used molten all mix plastic waste as the products material. The AMPWP enhanced sustainability providing an eco-friendly alternative for dump yard plastic waste. AMPWP useful for road, garden, drainage system, construction applications and contributing to millions of tons plastic waste reduction.

Index Terms- Mixed plastic waste, Unsegregated recycling, Plastic-based precast units, Sustainable construction, Waste valorization.

I. INTRODUCTION

Background of the invention- Indian cities are among the largest generators of municipal solid waste globally, producing millions of tons of plastic waste annually. Despite established collection systems, only about 60% of the collected plastic waste is recycled, while the remaining 40% remains unaccounted for, often ending up in landfills, open dumping sites, or being incinerated. A significant fraction of this waste consists of plastic packaging materials, including multilayer snack packets (Chips and Kurkure), spice sachets, plastic films, carry bags, bottles, containers, foams, and various flexible and rigid packaging forms. The exact quantity of such heterogeneous plastic waste remains uncertain due to its dispersed and unsegregated nature.
Plastic packaging waste represents one of the fastest-growing and most problematic waste streams due to its complex composition and low recyclability. Conventional waste management practices such as landfilling, open burning, or use as low-grade fillers are environmentally hazardous and economically inefficient. These methods contribute to soil, air, and water pollution while failing to recover material value.

Existing recycling technologies are primarily polymer-specific and require extensive pre-processing steps, including sorting, washing, shredding, drying, and granulation. For instance, polymers such as LDPE, HDPE, and PET are processed separately to produce uniform granules for reuse. However, segregation of mixed plastic waste is labor-intensive, time-consuming, and economically unviable, especially for low-value, contaminated, and multilayer plastic waste streams. As a result, a large portion of mixed plastic waste remains unrecycled.

A fundamental limitation in recycling mixed plastics arises from the inherent incompatibility of different polymer types, which possess varying molecular structures, melting temperatures, and rheological properties. These differences prevent effective blending during conventional thermal processing, leading to poor mechanical performance in recycled products. Additionally, traditional recycling processes require significant water and energy inputs, further increasing environmental and operational burdens.

To address these challenges, the present work proposes a novel approach for the direct utilization of unsegregated mixed plastic waste through advanced thermomechanical processing and densification techniques. The developed methodology eliminates the need for sorting and water-intensive washing, enabling the conversion of heterogeneous plastic waste into value-added precast structural products.

This approach offers a sustainable, scalable, and resource-efficient solution for plastic waste management while contributing to circular economy principles and infrastructure development.

II. MANUFACTURING PROCESS

The developed manufacturing methodology enables the direct conversion of unsegregated mixed plastic waste into structural precast products through an integrated thermomechanical processing route. The process eliminates the need for conventional preprocessing steps such as washing and segregation, thereby reducing water consumption and operational complexity.

Initially, the collected plastic waste undergoes a dry mechanical cleaning process to remove adhered contaminants. The semi-clean material is subsequently subjected to thermomechanical densification, where controlled mechanical shear and frictional heating facilitate size reduction and increase bulk density, improving material handling and feed consistency.

The densified material is then processed through a controlled thermal extrusion system, where heterogeneous polymer fractions are softened and transformed into a semi-homogeneous molten mass under optimized thermal and shear conditions. The processing parameters are maintained within a suitable range to ensure effective melting while minimizing thermal degradation.

The resulting molten composite is transferred into pre-designed molds and subjected to high-pressure compression molding, enabling effective compaction and structural consolidation. Controlled cooling under pressure ensures dimensional stability and mechanical integrity of the final product.

The developed process results in the formation of dense, structurally stable plastic-based precast units suitable for various infrastructure applications.

III. EXPERIMENTAL TESTING AND MECHANICAL CHARACTERIZATION

3.1 Compressive Strength Evaluation

The mechanical performance of the developed plastic-based blocks was systematically evaluated through compressive strength testing to quantify their load-bearing capacity and structural applicability in civil infrastructure systems. The primary objective of this investigation was to assess the suitability of the material for applications such as pedestrian pavements, landscaping structures, and low-traffic load-bearing surfaces.

The compressive strength tests were conducted at the Central Institute of Petrochemicals Engineering and Technology (CIPET) and Soil Globe Consulting Services, utilizing calibrated hydraulic compression testing machines with controlled loading conditions. All experiments were performed in accordance with standard testing protocols applicable to precast structural materials to ensure accuracy, repeatability, and reliability of the results.

The test specimens comprised square-shaped plastic-based grass blocks with nominal dimensions of 400 mm × 400 mm (CIPET) and 150 mm × 150 mm (Soil Globe Consulting Services), fabricated using the developed thermomechanical processing technique fabricated using the developed thermomechanical processing route, including densification, extrusion, and high-pressure molding. Prior to testing, each specimen was subjected to a detailed visual and dimensional inspection to ensure the absence of macroscopic defects such as cracks, voids, or surface inconsistencies that could influence the test outcome.

During testing, the specimens were centrally aligned between the compression platens to ensure uniform stress distribution. A monotonically increasing compressive load was applied at a controlled rate until the onset of failure or substantial plastic deformation. The peak load sustained by each specimen was recorded, and the compressive strength was determined based on the effective loaded area.

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CIPET : (CSTS) Aurangabad

CONTINUATION SHEET

Issued to:

MANTROM PLASTIC
Plot No. 24, Gut No. 42/43, Karodi,
Aurangabad – 431136

ULR No - TC822725000000432F
Test Report No. : 32830 A
Dated : 17.04.2025
Your Ref : Letter
Dated : 16.04.2025
Page No. 2 of 2

TC-8227

PART-C
Test Results

S. No.	Name of the test Clause No. (if any)	Test Method	Unit	Test Value Obtained	Specified Requirements
1.	Compressive Strength	IS 13360 Pt-5 / Sec-8	N/mm²	10.37	–

PART – D
Remarks: Nil

NOTE :
01 This Test Report is issued only for the samples submitted to CIPET.
02 The results stated above related only to the items tested.
03 The quality of the subsequent production lot has to be ensured by the purchaser.
04 The report full or part shall not be reproduced, published, advertised and used for any legal action without written approval from the laboratory.
05 Tested sample will be disposed-off after 90 days from the date of test.
06 Details of tests subcontracted: Nil
07 Results apply for the sample as received.
08 Conformity statement: It is based on the limiting values of the product specification without considering measurement of uncertainty – Not Applicable.

End of the Report

Reviewed by / Authorized Signatory
M.V. Kranthi Kumar
Sr. Tech. Asst.

Authorized Signatory
Kirankumar V. Kali
Technical Officer

Fig. 1. Certified compressive strength test report of plastic-based grass block (CIPET).

Soil Globe Consulting Services
Cube Testing

Company Name	Mantrom Plastic Industries
Site Address	Plot no-24, Gut no 42/43, Karodi, Waluj, Aurangabad, Maharashtra.
Cube Details	Plastic Casted Cube
Date of Casting	-
Job No	SGC/JN/23-24/99_A
Report Number	SGC/RN/23-24/99_A

Sr. No.	Date of Testing	Cube No.	Size in cm³	Area in mm²	Weight of Cube in kg	Thickness (cm)	Load Applied in kN	Strength in N/mm²	Strength of cube
1	26-Mar-2024	1	1237.5	150 x 150	1.166	5.50	245.00	10.89	10.00
2		2	2025.0	150 x 150	1.940	9.00	192.20	8.54	
3		3	2137.5	150 x 150	2.020	9.50	237.90	10.57	

Is code 2185 part 4 : 2008 cl 5.2 Solid Concrete Block — Grade C - minimum average compressive strength 4 and 5 N/mm2-(Only Refrance value)

Approved By
Er. Ankush Bhuse (ME)
Technical Manager
Soil Globe Consulting Services
Mob: 8329984408 / 9595958958
Email: soilglobeconsulting@gmail.com

Fig. 2. Certified compressive strength test report of plastic-based block (Soil Globe Consulting Services).

3.2 Results

The experimental investigation revealed that the developed plastic-based blocks exhibited an average compressive strength of: 10.37 N/mm² (Fig. 1)

This result indicates a significant load-bearing capability, demonstrating that the material possesses adequate mechanical strength for utilization in non-structural and semi-structural applications, including pedestrian pathways, landscape elements, drainage components, and low-load pavement systems.

3.3 Discussion

The observed compressive strength is primarily attributed to the synergistic effect of thermomechanical processing, densification, and high-pressure consolidation. The densification stage facilitates a substantial increase in bulk density and minimizes internal porosity, thereby enhancing load transfer efficiency within the material matrix. The extrusion process promotes partial homogenization of heterogeneous polymer constituents through intensive shear-induced mixing, resulting in improved phase distribution.

Furthermore, the application of elevated compressive stresses during molding significantly enhances interfacial adhesion between dissimilar polymer phases, leading to improved structural cohesion and mechanical integrity. The reduction in void content and improved polymer chain entanglement contribute to the overall strength development of the composite material.

In comparison with conventional low-grade concrete and paver blocks, the obtained compressive strength falls within a comparable range for light-load applications. Additionally, the developed material offers distinct advantages, including negligible water absorption, reduced density, corrosion resistance, and the capability to directly utilize unsegregated mixed plastic waste without extensive preprocessing.

The experimental findings were validated through certified test reports issued by CIPET and Soil Globe Consulting Services, thereby confirming the reliability, consistency, and reproducibility of the measured mechanical properties.

IV. PERFORMANCE EVALUATION OF MIXED PLASTIC WASTE-BASED UNITS

The present study introduces a novel approach for the utilization of 100% unsegregated mixed plastic waste in the manufacturing of precast structural units without the requirement of preliminary washing or sorting. Unlike conventional practices, where plastic waste is incorporated in limited proportions (typically 5–15%) as a partial replacement of sand or aggregates in cement-based composites, the proposed methodology employs mixed plastic waste as the **sole** material matrix, thereby eliminating the dependence on natural resources such as sand, cement, and water. The developed process enables the production of a wide range of precast products, including bricks, roadside blocks, divider plates, garden blocks, compound panels, grass blocks, drainage gutters, roadside information boards, benches, stools, and plant containers**.** These products are manufactured using an integrated thermomechanical processing route followed by high-pressure molding, resulting in structurally stable and dimensionally consistent units.

Mechanical performance, particularly compressive strength, is a critical parameter governing the applicability of construction materials. In this study, compressive strength tests were conducted on cube specimens of mixed plastic waste-based material at varying thicknesses, corresponding to typical precast concrete product dimensions. The experimental results demonstrated satisfactory performance, indicating that the developed material meets the requirements for practical applications.

For validation, the obtained results were compared with the specifications outlined in IS 2185 (Part 1): 2005 – Concrete Masonry Units**.** According to this standard:

- For hollow load-bearing units, the minimum average compressive strength ranges from 3.5 to 15 N/mm², with individual unit strength ranging from 2.8 to 12 N/mm²**.**
- For solid load-bearing units, the minimum average compressive strength ranges from 4 to 5 N/mm², with individual unit strength ranging from 3.2 to 4 N/mm²**.**

The developed mixed plastic waste-based units exhibited an average compressive strength of 10.37 N/mm².

This value falls well within the range specified for load-bearing masonry units and is comparable to conventional precast cement concrete products used in light to moderate load applications. The satisfactory mechanical performance can be attributed to effective densification, reduced porosity, and improved interfacial bonding achieved through thermomechanical processing and high-pressure compression molding. The results were further validated through certified laboratory testing, confirming the reliability and structural adequacy of the developed material. The findings demonstrate that 100% mixed plastic waste can be successfully transformed into high-performance precast construction units, offering a sustainable and resource-efficient alternative to conventional materials while addressing the challenges associated with plastic waste management.

V. APPLICATIONS OF DEVELOPED PRODUCTS

The developed mixed plastic waste-based material demonstrates significant potential for a wide range of civil and infrastructure applications due to its adequate mechanical strength, durability, and resistance to environmental degradation.

The precast products manufactured using the proposed methodology can be effectively utilized in:

- Road infrastructure: grass blocks, roadside blocks, divider plates, and low-traffic pavement systems
- Drainage systems: roadside gutters and water management structures
- Landscaping applications: garden blocks, planters, and compound walls
- Public utility structures: benches, stools, and roadside information boards
- Modular construction elements: interlocking blocks and prefabricated panels

The inherent properties of the material, including low water absorption, corrosion resistance, and lightweight characteristics, make it particularly suitable for outdoor and moisture-prone environments. Furthermore, the ability to process 100% unsegregated plastic waste without water-intensive operations provides a significant advantage for large-scale implementation in municipal waste management systems. A notable advantage of this technology is its large-scale waste utilization potential. It is estimated that approximately 150 tons of mixed plastic waste can be utilized in the construction of a 1 km long and 3 m wide road section using plastic-based grass blocks. This highlights the capability of the proposed system to significantly reduce plastic waste accumulation while contributing to sustainable infrastructure development.

VI. ADVANTAGES OF THE DEVELOPED TECHNOLOGY

The proposed manufacturing methodology offers several technical, environmental, and economic advantages over conventional plastic recycling and construction material production processes:

- 100% utilization of mixed plastic waste without segregation.
- Elimination of water usage, reducing environmental impact.
- No requirement of cement or natural aggregates, conserving natural resources.
- Reduced processing cost due to simplified operations.
- Scalable and industry-compatible process.
- High durability and resistance to environmental degradation.
- Reduction in landfill burden and open burning of plastic waste.

This approach aligns with the principles of circular economy and sustainable material engineering, enabling effective waste valorization.

VII. CONCLUSION

The present study successfully demonstrates an innovative and sustainable approach for the direct utilization of unsegregated mixed plastic waste in the production of precast structural units. The developed manufacturing process eliminates the need for conventional preprocessing steps such as sorting and washing, thereby reducing water consumption, energy usage, and operational complexity. The experimental evaluation confirmed that the developed plastic-based blocks exhibit an average compressive strength of 10.37 N/mm², which is comparable to conventional low-grade concrete materials and satisfies the requirements specified under IS 2185 (Part 1): 2005 for load-bearing applications. The results highlight that mixed plastic waste can be effectively transformed into structurally reliable and durable construction materials through thermomechanical processing and high-pressure molding. In addition to mechanical performance, the developed products offer advantages such as corrosion resistance, low water absorption, and environmental sustainability. This work provides a scalable, cost-effective, and eco-friendly solution for plastic waste management while contributing to sustainable infrastructure development and circular economy practices.

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