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Utilization of Recycled Plastic Waste and Sugarcane Bagasse Ash for Eco-Friendly Paver Block

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ABSTRACT

The research work is based on the use of plastic waste and sugarcane bagasse ash to make eco-friendly paver blocks. The main purpose of this work is to use waste materials effectively and reduce the environmental problems caused by plastic and agricultural waste. In the present study, recycled plastic granules were used as a binding material, while sand and sugarcane bagasse ash were used as filler materials. The mix proportions were prepared by the percentage-by-weight method in three different combinations. After weighing, the materials were mixed thoroughly to achieve a uniform blend. The mixed material was then heated to between 150 and 250 degrees Celsius so that the plastic melted and bound the sand and ash particles together. The hot mixture was poured into moulds measuring 200 mm × 100 mm × 60 mm and cooled to room temperature. After cooling, the blocks were removed from the moulds and tested for compressive strength. From the test results, it was observed that the mix containing 60% plastic, 25% sand, and 15% sugarcane bagasse ash had the highest compressive strength of about 20.16 N/mm^2. This study shows that waste plastic and agro-waste ash can be used to produce paver blocks for low-traffic areas, such as footpaths and parking areas. This method helps in waste utilization and eco-friendly construction.

1. INTRODUCTION

Plastic waste is a problem for our environment because it does not break down easily and keeps piling up day by day. When it is not properly disposed of, it pollutes land and water, harming the environment and human health. At the same time, sugar industries produce a large amount of agricultural waste, such as sugarcane bagasse ash, and disposing of it is also a problem. Most of these waste materials are not used properly and end up causing environmental issues.

Paver blocks are widely used in construction for footpaths, parking areas, and walkways. They are usually made from cement, sand, and aggregates. Manufacturing cement requires a lot of energy and pollutes the environment, so it is important to find

materials that can replace cement and improve the environmental impact of construction. In this study, recycled plastic granules were used as a binder in place of cement, while sugarcane bagasse ash and sand were used as filler materials. When the plastic is heated, it sticks the sand and ash particles together, and when it cools, it forms a solid paver block. In this way, waste materials can be turned into useful construction materials such as paver blocks.

The main goal of this study is to produce eco-friendly paver blocks using recycled plastic granules, sand, and sugarcane bagasse ash, and to assess their strength at various mixing ratios.

2. EXPERIMENTAL PROCEDURE

A. Properties of Materials

Recycled Plastic Granules: Recycled plastic granules were collected from a plastic recycling industry. Plastic acts as a binding material when heated and holds the sand and SCBA particles together.

Table 1: Properties of Recycled Plastic (LDPE)

Sr. No.	Property	Value
1.	Melting Point	150–250°C
2.	Density	0.91–0.94 g/cm^3
3.	Tensile Strength	0.20–0.40 N/mm^2
4.	Thermal Expansion	100–200 × 10^{-6} /°C



Figure 2: Recycled Plastic Granules

Sand: Locally available river sand was used as fine aggregate in this study. Sand helps in filling voids and improving the strength and density of paver blocks. The tests conducted on sand include sieve analysis and specific gravity test as per Indian Standard specifications.

Table 2: Properties of Sand

Sr. No.	Property	Value
1.	Specific Gravity	2.60
2.	Fineness Modulus	2.70
3.	Grading Zone	Zone II
4.	Water Absorption	1.5%
5.	Nature	Medium graded sand



Figure 2: Fine Aggregate (Sand)

Sugarcane Bagasse Ash (SCBA): Sugarcane bagasse ash was collected from a sugar industry. The ash was dried and sieved before use. Sugarcane bagasse ash acts as a filler material and helps to improve the bonding between plastic and sand particles.

Table 3: Properties of SCBA

Sr. No.	Property	Value
1.	Specific Gravity	2.10
2.	Fineness Modulus	2.20
3.	Color	Grey
4.	Nature	Fine powder

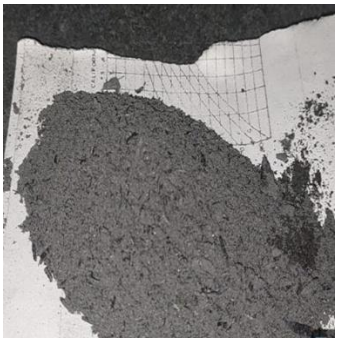


Figure 3: Sugarcane Bagasse Ash

B. Mix Proportions

Paver blocks were prepared using three different mix proportions by weight.

Table 4: Mix Proportion Used in the Study

Sr. No.	Mix Type	Plastic (%)	Sand (%)	SCBA (%)
1.	Mix 1	70	20	10
2.	Mix 2	60	25	15
3.	Mix 3	50	30	20

Three paver blocks were cast for each mix proportion

C. Preparation of Test Specimen

Recycled plastic granules, sand, and sugarcane bagasse ash were first weighed according to the required mix proportions. All the materials were then mixed properly in a dry mixer to obtain a uniform dry mixture. After proper mixing, the prepared mix was placed in a crucible and heated in a muffle furnace at a temperature range of 150°C to 250°C until the plastic melted completely and coated the other materials. The hot mixture was then carefully taken out from the furnace and

poured into moulds of size 200 mm × 100 mm × 60 mm. Proper compaction was carried out to remove air voids and to achieve good bonding between the materials. The moulds were kept at room temperature for 24 hours to allow cooling and hardening of the blocks. After 24 hours, the paver blocks were carefully removed from the moulds and kept ready for further testing.



Figure 4: Dry Mixing of Materials



Figure 5: Mixed Material Placed in Crucible



Figure 6: Heating in Muffle Furnace



Figure 7: Casting in Mould



Figure 8: Prepared Paver Block

D. Testing of Specimen

The compressive strength test was carried out on the paver block specimens using a Compression Testing Machine (CTM). The size of the specimen was 200 mm × 100 mm × 60 mm. The specimen was placed properly on the CTM machine and load was applied slowly and continuously until the block failed. The maximum load at failure was recorded for each specimen. This test was conducted as per IS 15658:2006 standard. Three specimens were tested for each mix proportion and the average compressive strength was calculated. The compressive strength was obtained by dividing the ultimate load by the loaded area of the specimen. The test results were used to find the strength of the paver blocks and to check whether the blocks satisfy the standard requirements.



Figure 9: Experimental Setup for Compression Test



Figure 10: CTM Machine with Control Panel

3. RESULTS

Table 5: Compressive Strength Test Results for Mix A

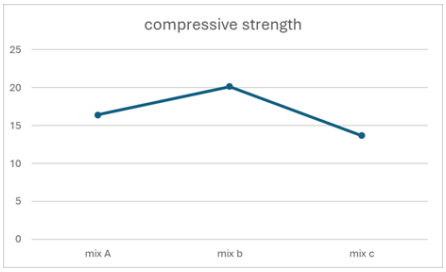
Sr. No.	Specimen No.	Weight (kg)	Load (kN)	Compressive Strength (N/mm^2)	Average Strength (N/mm^2)
1.	S1	1.825	150	12.5	
2.	S2	1.660	350	17.5	16.43
3.	S3	1.900	386	19.3	

Table 6: Compressive Strength Test Results for Mix B

Sr. No.	Specimen No.	Weight (kg)	Load (kN)	Compressive Strength (N/mm^2)	Average Strength (N/mm^2)
1.	S1	1.283	350	17.5	
2.	S2	1.215	409	20.5	20.16
3.	S3	1.568	450	22.5	

Table 7: Compressive Strength Test Results for Mix C

Sr. No.	Specimen No.	Weight (kg)	Load (kN)	Compressive Strength (N/mm^2)	Average Strength (N/mm^2)
1.	S1	1.843	150	12.5	
2.	S2	1.549	160	8.0	13.66
3.	S3	1.469	410	20.5	



Graph 1: Compressive Strength vs. Mix Type

A. Discussion of Results

1. The results show that the strength of paver blocks depends on the proportion of plastic, sand, and bagasse ash used in the mix.
2. Mix B had the highest strength; the average strength of Mix B was 20.16 N/mm^2. This means Mix B has good bonding and the materials are well balanced.
3. Mix A also had good strength (16.43 N/mm^2), but it is not as strong as Mix B, so Mix A is suitable for places that do not carry a lot of load.
4. Mix C had a strength of 13.66 N/mm^2 because Mix C contains a large amount of bagasse ash, which makes the particles stick together less effectively.
5. It is observed that adding plastic to the paver blocks improves bonding, but adding too much ash makes the paver blocks weaker.
6. As per IS 15658:2006, Mix A and Mix B are suitable for areas that carry traffic, while Mix C is suitable only for areas with very little load, such as footpaths and gardens.

CONCLUSION

1. In this study, eco-friendly paver blocks were made using waste plastic and sugarcane bagasse ash. These waste materials usually cause disposal problems, but this study found a useful way to reuse them for construction work.
2. Plastic was used as a binding material in place of cement. When heated and mixed with sand and bagasse ash, it bound the materials together, and after cooling, it formed a solid paver block.
3. The test results showed that the strength of paver blocks mainly depends on the mix of plastic, sand, and bagasse ash. The mix proportion must be optimized to achieve good strength.
4. The compressive strength test results were: Mix B – 20.16 N/mm^2 (suitable for traffic areas); Mix A – 16.43 N/mm^2 (suitable for footpaths and pedestrian areas); Mix C – 13.66 N/mm^2 (suitable only for low-load areas).
5. These paver blocks are economical because waste plastic and bagasse ash are low-cost materials, so the overall cost of paver blocks can be reduced compared to conventional concrete paver blocks.
6. The plastic paver blocks also showed resistance to water and heat, which means they are durable and suitable for practical use.
7. Overall, this study shows that waste plastic and sugarcane bagasse ash can be effectively used to produce eco-friendly, economical, and durable paver blocks for footpaths, gardens, walkways, and other light-traffic areas, offering a sustainable alternative to traditional paver blocks.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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