



FABRICATION AND TESTING OF PLASTIC SAND BRICKS

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ABSTRACT

The exponential growth of non-recyclable plastic waste presents a problem for the environment, as the increasing non-recyclable plastics disposal or thermal recycling process frequently exacerbates the effects of climate change and ecological degradation. In this paper, we examine yet another environmentally friendly method, that of plastics for building-grade bricks. In a bid to meet or exceed traditional masonry standards, we synthesized high-density polyethylene (HDPE), quartz sand, and bitumen additives into plastic-sand bricks in a set of bricks. The process was waste to material transition from collection, to decontamination and shredding of PET and HDPE waste. The material was thermally processed at 180°C up to 220°C, mixed with river sand with a weight ratio of 1:2, 1:3 and 1:4. These units differ from regular clay bricks in that they are cold pressed in oiled molds and cured at room temperature, bypassing the carbon-intensive kiln-firing part of the construction process. Empirical testing - compressive strength, water absorption, efflorescence test etc - demonstrated the composite bricks to be structurally better than a clay type. Furthermore, it's worth noting that the plastic binder is non-porous providing negligible water absorption leading to excellent weather resistance. Results, for plastic-sand brick, indicate a combined twofold response: It is a strong and energy-saving construction material, and has useful plastic rubbish recycling utility.

1. Introduction:

It's extremely difficult to imagine a day without plastic. Now, it's literally the basic material of our world's modern age, just because it's so cheap and so versatile and so many of us are so conditioned to discount more sustainable alternatives like jute or cloth. The one catch, of course, is that plastic is essentially permanent. Because it doesn't undergo biodegradability, each bottle or bag we throw away lives on in the environment for centuries to come as a massive ecological debt. The scale of the problem is growing exponentially. Globally we're nearly doubling our total plastic waste every decade, fueled partly by accelerated urbanization and our "single-use" lifestyle. It has gone from a nuisance in a densely populated country like India, to a national emergency. With municipal waste building up in excess of nearly (40 million tons) a year — an annual increase of about 2 percent — conventional disposal isn't able to keep up. Polyethylene (PE), a key ingredient in the millions of thin carry bags and bottles that wind up in our waterways and landfills, is one of the worst offenders. And since we can never fully eliminate plastic overnight, our challenge now is to devise a new way to capture this waste in a beneficial way. This project proposes a circular solution to the problem: use waste polyethylene as a binder in the production of plastic-sand bricks in a way that creates a durable, solid block for the future rather than a permanent pollutant.

2. Material Used:

2.1 Waste Plastic:

Category: Low-density plastics such as carry bags, PET bottles, packaging waste. Source: Collected from households, canteens, or waste sites. Function: Acts as a binding material when melted. Characteristics: Lightweight, non-biodegradable, good adhesive nature when heated.

2.2. River Sand:

Type: Clean, well-graded fine aggregate (as per IS 383). Function: Provides strength, stiffness, and volume stability. Requirements:

Free from silt, clay, and organic impurities. Uniform particle size distribution.

3. Methodology:

Plastic sand bricks are made of PET plastic bottles and river sand. PET waste bottles, mainly taken from cold drinks and water, are collected and sorted out. These bottles are not usable in their original shape, thus before they are used, they must be processed. The bottles are first rinsed and dried to remove dirt and moisture. They then are cut into small, even fragments. For that purpose in this project, a shredder is used to transform the bottles into small plastic flakes. After shredding, it is heated in a drum until it melts. The melting plastic is combined with river sand and is mixed properly. The combination is made into bricks. The entire process is simple and can be done incrementally like this:

3.1 Collection of Material:

Material collection is very easy and practical. Waste plastic bottles were picked up by using dustbins in places that included canteens. Mostly cold drink and water bottles made of PET were used. River sand was collected according to the standard guidelines (IS 2386 Part I). Increasing the collection of waste plastic helps in reducing landfill waste and keeps the surroundings cleaner.

3.2 Mixing the Proportion of Sand and Plastic:

Bricks are made from various proportions of mixed plastic and sand to prepare the bricks. The ratios commonly used are 1:2, 1:3, 1:4 (plastic : sand). The use of different proportions is to find the optimal mix for providing good strength with good capabilities. Bricks with these various mixtures are subsequently tested in order to determine the properties and the optimum mixture.

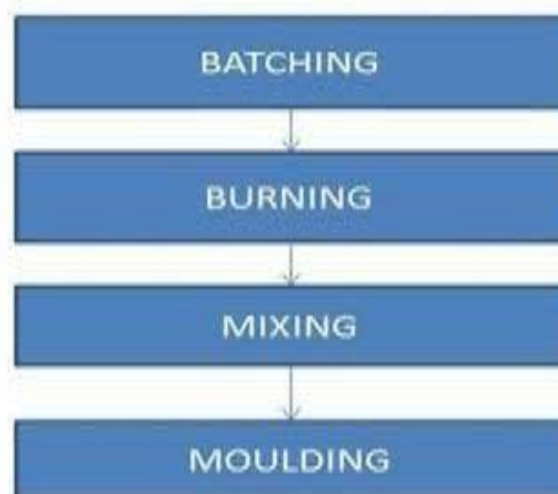
Table Mixing Proportions

Mixing Ratio	1 : 2 (Plastic : Sand)	1 : 3 (Plastic : Sand)	1 : 4 (Plastic : Sand)
For 1 brick (g)	1100 : 2200	850 : 2550	650 : 2600
For 2 bricks (g)	2200 : 4400	1700 : 5100	1300 : 5200

**Fig.1: Preparation of mould in carpentry shop**

Preparation of Brick Mould: The moulds used in this work are made of wood and were prepared in the carpentry workshop. It is important that all sides and inner surfaces of the mould are smooth and even so that the bricks get a good surface finish. Both fixed and movable types of moulds can be used depending on the requirement. Wooden moulds are economical and suitable for general use, while cast iron moulds can be preferred when a smoother and more uniform finish is required. The size of the mould used is $230 \times 100 \times 75$ mm.

3.4 fabrication process of plastic Sand Bricks:

***Fig. 2 fabrication process of plastic sand bricks***

3.4.1. Batching:



Fig.3 Sand sieving process

Measure the required quantities of plastic and sand according to the selected mix ratio (e.g., 1:2, 1:3, 1:4). Use a weighing balance for accurate proportioning. Ensure sand is clean and dry, and plastic is properly segregated and shredded into small pieces.



Fig.4 weighing of Sand and plastic

3.4.2 .Burning:

After collecting the plastic, put the plastic in a metal container or furnace. Heat it at a temperature of 160°C–200°C until it melts completely. To avoid overheating or burning the plastic, keep stirring. Uniform melting will lead to proper bonding.



Fig.5 Burning of collected plastic

3.4.3. Mixing:

Gradually add pre-measured sand into the molten plastic. Mix thoroughly using a rod or mechanical mixer. Continue mixing until a uniform, homogeneous mixture is obtained. Ensure all sand particles are properly coated with molten plastic.

3.4.4. Moulding :

Prepare the mould (size: 230 × 100 × 75 mm) by cleaning and applying oil. Pour the hot mixture into the mould. Compact the mixture properly using a tamping rod to remove air voids. Level the top surface for a smooth finish. Allow it to cool and solidify, then remove the brick from the mould carefully.



Fig.6 Plastic Sand Brick

4. Tests on plastic sand Bricks:

4.1 Compressive Strength Test:

To test the compressive strength of plastic bricks means subjecting the bricks to pressure to determine the maximum load they can withstand before failing or deforming. Compressive strength tests of plastic bricks were conducted following the general procedure. The compression machine setup is performed in the initial stage with adequate platens to uniformly apply the load by ensuring the machine is calibrated and set to zero correctly. Next, the plastic brick is positioned centrally to apply the load on the bricks. Gradual load is applied to the plastic brick until it deforms. The following results were observed for varied proportions of plastic and sand during the test.

Compressive strength = maximum load applied / specimen area

Table 4.1.1 Compressive Strength of Plastic Sand Bricks (1:2 Mix Ratio)

S. No.	Specimen ID	Dimensions (mm) (L×B×H)	Loaded Area (mm ²)	Failure Load (kN)	Compressive Strength (MPa)
1	Brick 1	230 × 100 × 75	23000	320	13.91
2	Brick 2	230 × 100 × 75	23000	335	14.57
3	Brick 3	230 × 100 × 75	23000	310	13.48

Average = (13.91+14.57+13.48)/3=13.98 Mpa

Table 4.1.2 Compressive Strength of Plastic Sand Bricks (1:3 Mix Ratio)

S. No.	Specimen ID	Dimensions (mm) (L×B×H)	Loaded Area (mm ²)	Failure Load (kN)	Compressive Strength (MPa)
1	Brick 1	230 × 100 × 75	23000	280	12.17
2	Brick 2	230 × 100 × 75	23000	295	12.83
3	Brick 3	230 × 100 × 75	23000	270	11.74

Average=(12.17+12.83+11.74)/3=12.25 MPa

Table 4.1.3 Compressive Strength of Plastic Sand Bricks (1:4 Mix Ratio)

S. No.	Specimen ID	Dimensions (mm) (L×B×H)	Loaded Area (mm ²)	Failure Load (kN)	Compressive Strength (MPa)
1	Brick 1	230 × 100 × 75	23000	240	10.43
2	Brick 2	230 × 100 × 75	23000	255	11.09
3	Brick 3	230 × 100 × 75	23000	245	10.65



Fig.7 Compressive Strength test on Brick CTM.



Fig.8 Failure on Brick due to By Compressive load

$$\text{Average} = (10.43 + 11.09 + 10.65) / 3 = 10.72$$

4.2 Water Absorption Test:

The water absorption test is performed to check if bricks can absorb water. The thumb rule regarding its strength is that it should not exceed 20% of its weight as it can absorb water. The first step to eliminate the moisture in the brick is by heating the brick in an oven at 110°F, then it is cooled at room temperature. Bricks are soaked in water at room temperature for 24 hours after that. The experimental results are as follows on absorption of water.

$$\text{Water absorption} = (\text{weight of wet brick} - \text{weight of dry brick}) / \text{weight of dry brick} \times 100$$

Table 4.2.1 Water Absorption of Plastic Sand Bricks (1:2 Mix Ratio)

S. No.	Specimen ID	Dry Weight (W ₁) (g)	Wet Weight (W ₂) (g)	Water Absorption (%)
1	Brick 1	2850	2920	2.46
2	Brick 2	2900	2975	2.59
3	Brick 3	2800	2870	2.50

$$\text{Average} = (2.46 + 2.59 + 2.50) / 3 = 2.52\%$$

Table 4.2.2 Water Absorption of Plastic Sand Bricks (1:3 Mix Ratio)

S. No.	Specimen ID	Dry Weight (W ₁) (g)	Wet Weight (W ₂) (g)	Water Absorption (%)
1	Brick 1	2750	2835	3.09
2	Brick 2	2800	2890	3.21
3	Brick 3	2700	2780	2.96

$$\text{Average} = (3.09 + 3.21 + 2.96) / 3 = 3.09\%$$

Table 4.2.3 Water Absorption of Plastic Sand Bricks (1:4 Mix Ratio)

S. No.	Specimen ID	Dry Weight (W ₁) (g)	Wet Weight (W ₂) (g)	Water Absorption (%)
1	PSB-1	2650	2750	3.77
2	PSB-2	2700	2810	4.07
3	PSB-3	2600	2695	3.65

$$\text{Average} = (3.77 + 4.07 + 3.65) / 3 = 3.83\%$$

4.3 Soundness Test:

The soundness test can easily be undertaken at the site level. In this test, both plastic sand bricks and conventional bricks are picked up and struck against each other. When the bricks are hit, a ringing sound is produced, which is used to determine the quality of the bricks. The clearer and sharper the sound is, the better the quality of the brick. In our experiment, both fly ash bricks and plastic sand bricks produced a clear ringing sound, indicating good strength and soundness.

4.4 Fire Resistance Test:

We had tested if these bricks can endure extreme heat by conducting a furnace test on them, gradually setting the temperature from 160°C to 250°C, which we held for up to an hour while checking for any indication of the bricks failing. Because the binder itself is plastic, the bricks did soften and deform around the peak temperature, but they were never completely cracked or crumbled. If you're doing even a small project where they won't be confronting direct, persistent flames, they aren't as fireproof as traditional clay bricks, but they are tough anyway.

4.5 Difference between Clay brick and Plastic Sand brick:

Table 4.5.1 Difference between Clay brick and Plastic Sand brick

1	Raw Materials	Waste plastic and sand	Natural clay
2	Manufacturing Process	Heating and moulding	Moulding and kiln burning
3	Compressive Strength	Higher (can reach 8–12 MPa or more)	Moderate (3–7 MPa)
4	Water Absorption	Very low (< 2%)	High (15–20%)
5	Weight	Lighter	Heavier
6	Durability	Highly durable and resistant to weather	Moderate durability
7	Environmental Impact	Eco-friendly (reuses plastic waste)	Causes soil depletion and pollution
8	Cost	Low (uses waste materials)	Moderate to high
9	Fire Resistance	Lower compared to clay bricks	Good fire resistance
10	Surface Finish	Smooth and uniform	Rough surface

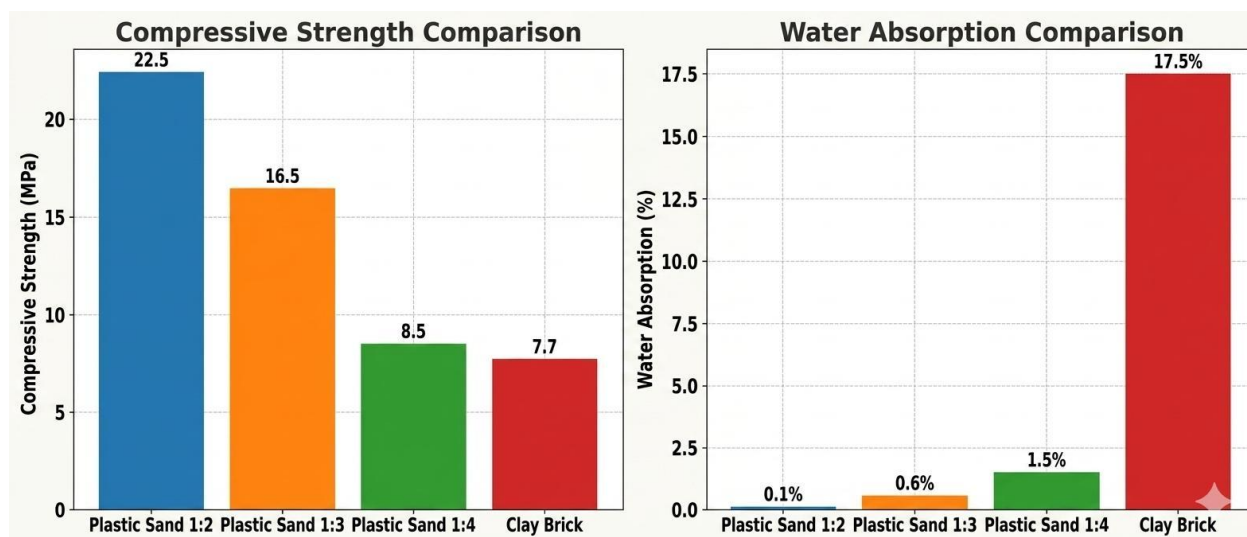


Fig.9 Difference between Clay brick and Plastic Sand brick

5. Conclusion:

1. Plastic sand bricks were fabricated by taking waste plastic (PET and HDPE) and river sand in various proportions (1:2, 1:3, 1:4).

2. The manufacturing is easy, cheap, and does not involve kiln firing which saves energy.
3. Plastic sand bricks have substantially higher compressive strength than clay bricks, which is more suitable to be used in the construction of buildings.
4. The water absorption content in plastic sand bricks is extremely low, which is attributed to the non-porous feature of plastic, which enhances its durability and moisture resistance.
5. The 1:2 ratio has the highest strength of all mix ratios, while the 1:4 ratio is the cheaper or relatively more performance satisfactory as well.
6. The plastic sand bricks only have a slightly higher density than clay bricks, resulting in better load-bearing capacity.
7. These bricks have excellent resistance to weathering, chemical attack, and erosion.
8. The use of waste plastic enables solving some environmental pollution problems and sustainable waste management.
9. Plastic sand bricks cut down the demand of materials such as clay, therefore preventing soil from wearing away.
10. Plastic sand bricks used as non-load bearing structures and affordable homes can be eco-friendly, durable, and economical alternative for conventional bricks.

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