ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 9, Issue 6, June 2022

Manufacturing of Brick by Waste Plastic

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Abstract*— Nowadays due to development and urbanization, plastic becomes a part of our daily life. The only flaw is it is non-biodegradable and it takes thousands of years to breakdown or to decompose. This study elaborates the work done by the writer to use plastic as a construction material to replace the clay brick as well as to find a way to effectively utilize the waste plastic. Plastic waste has recyclable characteristics that may be used to recycle it and create a new product that has lesser environmental effect. One way to recycle plastic trash is to make plastic bricks by combining plastic with sand at a particular temperature and using them to replace regular clay bricks. Various authors conducted a comparison study with masonry bricks made of other materials using various testing methods such as scratch testing, water absorption test, porosity testing, soundness testing, scratch testing, efflorescence testing, and concluded that more research in this field could improve the durability, strength, and quality of these masonry plastic bricks. We observe that these plastic bricks are light weighted which absorbs very less amount of water or near to minimal water absorption which enhances its property and the strength is also much better than clay bricks, nearly double of a clay brick. These plastic bricks can hold two time the weight of concrete of same size if compressed thoroughly.

I. INTRODUCTION

Plastic are a wide range of synthetic or semi-synthetic materials that use polymer as a main ingredient, plastic can be made into different shapes when they are heated in a close environment [1]. Plastic has few advantages, some of them are weather resistant, impact resistant, durable, versatile, light weighted, etc. Plastic is a pliable substance which makes it easier to moulded into solid things. According to Central Pollution Control Board (CPCB) report 2018-19, 3.3 million metric tonnes of plastic waste was generated in India in 2018-19 [2]. This roughly translated to 9,200 tonnes a day, and in 2019-20, 3.4 million metric tons of plastic waste was generated annually. The total municipal solid waste generation is 55 to 65 million tonnes, plastic waste is approximately 5-6 percent of the total solid waste generated in the county [3]. The everyday generation of plastic is 25,000 tonnes and 40 percent of it remains uncollected. A survey was done of 250 sites which are in 15 cities, the waste generated is of 53 percent of multilayer plastic. According to a report of plastic waste management released by the ministry of housing and urban affairs, the global average of plastic per capita consumption is 28 kg and India has a per capita plastic consumption of 11 kg [4]. Now from the prospective of plastic waste available in the world, from 1950 to 2015: 8.3 billion metric tons produced globally and 80 percent which is 6.3 billion metric tons accounted as waste, from which 79 percent dumped in landfills, oceans and water bodies. Globally the per capita consumption averages 28 kg. There are several merits and demerits of plastic which are, plastic is cheap, strong and hygienic, but difficult to recycle. It takes thousands of years to decompose which leads to soil and water contamination as well as posses hazards for land, water, wildlife. Presence of plastic in water or food leads to health issues, as we have seen recently that a person has a small particle or piece of plastic in his lungs.

We use clay for bricks but the clay is not infinite, it is a limited resource so we don't have to totally depend upon it, the plastic brick is a good replacement of clay brick as it has all the properties which are found in clay brick, even in most of the tests the plastic bricks perform much more better than clay brick and it is economical too.

8 million tonnes of plastic finding its way into oceans every year. Only 9 percent of all plastic waste ever produced has been recycled, while 79 percent end up in land fills, dumps or the natural environment. India generates 15 million tonnes of plastic per year but only one fourth means 3.75 million of this is recycled due to lack of functioning [5]. For clay brick, depending on the kind of kiln and fuel used for the firing, a brick kiln releases roughly 70–282 g of carbon dioxide, 0.001–0.29 g of black carbon, 0.29–5.78 g of carbon monoxide (CO), and 0.15–1.56 g of particulate matter per kilogram of brick burnt [6]. In India, common burned clay brick is primarily used for structural walls, however in order to save building costs and time, an alternative to these bricks is required. Plastic looked to be an economical and effective raw material due to mass manufacturing, non-recyclable property and its economic revolution.

With the growing concern about adopting eco-friendly, cost-effective, and light-weight construction materials in building materials, we can help meet our material needs without sacrificing the environment. Furthermore, moving construction materials manufacturing from concrete to PET will only help to reduce the Greenhouse effect, since cement production accounts for 5–8% of anthropogenic CO2 emissions [7]. In recent study, direct incorporation

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International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

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of polyethylene terephthalate (PET) bottles in shredded form, and PET in aggregate form by substituting natural coarse aggregate has been used to replace and add. The majority of replacements were done using a volume calculation, which revealed a loss in compressive strength as the increase in plastic fibre amount [8].

II. MATERIAL USED

2.1 Plastic

Plastics are made up of synthetic or semi-synthetic materials with a polymer as the primary chemical component. Plastic is created mostly as a result of plastic products such as plastic bottles, one-time-use plastics, multi-layer plastics, and other similar items, which clog our environment and have a significant impact on human and wildlife habitat on the planet. Due to its low density, when plastic garbage is exposed to sun radiation, it releases two particularly dangerous greenhouse gases known as methane and ethylene.

Generally, there are seven types of plastics available on our earth name as, PET - Polyethylene Terephthalate, HDP - High Density Polyethylene, LDP - Low Density Polythene, PVC - Polyvinyl Chloride, PS – Polystyrene, PP – Polypropylene, and other remaining plastics.

2.2 Sand

Sand is a granular substance made up of small rock and mineral particles that have been coarsely split. Its size distinguishes it from gravel and silt, being finer than gravel and coarser than silt.

III. METHODOLOGY ADOPTED

There are various methods which are used by several authors, some of them just use low density plastic, by cutting it in small pieces and mix it with the mixture of cement sand and aggregate. Some of them burn plastic and then mix it with iron chips, bitumen, rice husk and several other materials.

Here we melt plastic and then mix sand with it. The types of plastic which we are using are Low density Polyethylene (LDPE), Polystyrene (PS), High density polyethylene (HDPE), Polyphenylene ether (PPE). For making this plastic brick, these four types of plastic got collected and we have to clean it with the help of water to remove impurities and after washing, put it to dry naturally. We cannot use there plastic in the form in which it is available, we have to shred it or cut it into small piece. If we directly put these plastic in its shape then it takes time to melt, so we reduce it's surface area so that it can easily melt. Plastic and sand are mixed in the various proportions as 1:1, 1:2, 1:3, by weight.

Then the plastic is melted in a container when got fully dry. After melting we will mix sand into it and then mix it thoroughly, after proper mixing we will put the mixture into the brick mould. Then we will put it into water after 3-4 minutes and after 10 to 15 minutes we will try to remove brick from that mould.

3.1 Material collection

Plastic:-

Plastic bottles, food packages, polybags, bottle caps, tupperware, and other items that fall under the plastic type can be collected from the canteen's garbage as well as from households, local dumping locations, and hospitals.

Sand:-

Sand can be purchased by the nearby local supplier.

3.2 Batching Of Material

Batching is the process of weighing and measuring materials. Check that there is no water content in the plastic garbage once it has been collected, and if there is, dry it in the sunlight. A brick will be made from medium sand. By sieving, we may obtain medium sand, which is suitable for the production of plastic bricks.

3.3 Proportion of plastic and sand

In order to make plastic brick, different ratio of sand and plastic must be taken, the ratios are 1:1, 1:2, 1:3 by weight.

3.4 Development of brick mould

In most cases, the moulds used in the production of bricks are wooden moulds that may be easily bought from a carpentry shop. But here we are using metallic mould so that we can easily compact the plastic and sand mixture filled into it without any wear and tear in the mould. To produce excellent quality bricks with good sharp edges and smooth surfaces, the whole surface of the mould should be smooth which metallic mould have better as compared to wooden mould. The size of mould would be 19 cm × 9 cm × 9 cm.

3.5 Procedure for casting of brick

3.5.1 Melting

To begin, set up the container, as well as the firewood, stove, heater or extruder. If a heater is to be used, the container must first be adequately heated to remove the moisture. After that, place the little cut pieces of plastic (chips) in the container and melt them. Remember, all the plastic which will be used should be fully in dried condition, no moisture should be present in the plastic so that it can be easily get melted without releasing excessive smoke.

3.5.2 Mixing

The sand is incorporated into the container while the temperature of the melted plastic remains about 180°C to 220°C. The molten plastic and sand are constantly stirred

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

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to ensure that they are properly blended and bound.

3.5.3 Moulding

Apply the oil on the inside surface of the mould to make it easier to remove the bricks. If no oil is used the plastic and sand combination has solidified, the brick will be difficult to remove. As a result, appropriate oiling is required prior to pouring the mixture into the mould. The prepared mixture is poured into the metallic mould and tamped down with a rod to ensure adequate compaction and filling.

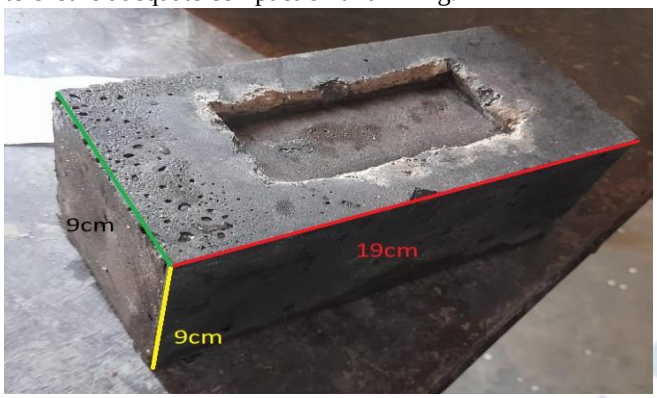

Fig. 1 – Plastic brick

IV. EXPERIMENT ON PLASTIC BRICK

The bricks should be examined before being used to ensure that they are suitable for the job. The following tests are commonly used to evaluate bricks : -

4.1 Compressive strength test

The compressive strength test of brick may be determined by placing them in a compression testing machine. After that, load is given to these plastic bricks. This will raise the load by 140 kg/cm2 each minute until the brick cracks and can no longer carry any more weight. Note the value of the failure load, and then multiply the highest load at failure by the area of the bricks to get the compressive strength of the bricks.

$$\text{COMPRESSIVE STRENGTH} = \frac{\text{Maximum Load at Failure}}{\text{Average Area of Bed Surface}}$$

Fig. 2 (A) and **Fig. 2 (B)**– Filling sand in frog

Fig. 3 – Compressive strength testing of plastic brick

OBSERVATION 1:

Plastic : Sand = 1:1

S.No.	SAMPLE	AREA(A) MM ^{2}	FAILURE LOAD (P) KN	P/A (N/MM ^{2})
1	Brick 1	17100	240	14.03
2	Brick 2	17100	235	13.74
3	Brick 3	17100	245	14.32

$$\text{Average} = \frac{14.03 + 13.74 + 14.32}{3} = 14.03\ \text{N/mm2}$$

OBSERVATION 2:

Plastic : Sand = 1:1.5

S.No.	SAMPLE	AREA(A) MM ^{2}	FAILURE LOAD (P) KN	P/A (N/MM ^{2})
1	Brick 1	17100	275	16.08
2	Brick 2	17100	280	16.37
3	Brick 3	17100	290	16.95

$$\text{Average} = \frac{16.08 + 16.37 + 16.95}{3} = 16.47\text{N/mm2}$$

ISSN (Online) 2456-1290

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Vol 9, Issue 6, June 2022

OBSERVATION 3:

Plastic: Sand = 1:3

S.No.	SAMPLE	AREA(A) MM ^{2}	FAILURE LOAD (P) KN	P/A (N/MM ^{2})
1	BRICK1	17100	155	9.064
2	BRICK 2	17100	140	8.187
3	BRICK3	17100	150	8.771

$$\text{AVERAGE} = \frac{9.064 + 8.187 + 8.771}{3} = 8.64\text{N/mm2}$$

RESULTS:

S.No.	OBSERVATION	COMPRESSIVE STRENGTH (N/MM^2)
1	Sample 1 (1:1)	14.03
2	Sample 2 (1:1.5)	16.47
3	Sample 3 (3:1)	8.64

Sample 2, ratio (1:1.5) has the highest compressive strength of the brick.

4.2 Water Absorption Test

Before use the bricks, they should be checked for their ability to absorb water, which should not exceed 20% of their weight. The ability of a brick to absorb water affects its strength. First, the moisture in the brick should be entirely eliminated in an oven at 105° to 115°F until it reaches a consistent weight, then it should be cooled and weighed. Let's call it W1. The bricks are then soaked in clean water at 27°2° for 24 hours at room temperature. After taking the bricks from the water, a moist towel was used to clean them off the surface before weighing them. Let's call it W2. The brick's water absorption capacity is calculated as follows:

$$W = \frac{w1-w2}{w1} \times 100$$

W_1 = Weight of brick in dry condition

W_2 = Weight of brick in wet condition

Fig. 4 – Submerging plastic bricks into water for 24 hours

Fig. 5 – Take out bricks from water after 24 hours

S.No.	SAMPLE	DRY WEIGTH(w1) in KG	WET WEIGTH(w2) in KG	W%
1.	Brick 1	1.926	1.947	1.090
2.	Brick 2	2.250	2.255	0.23
3.	Brick 3	2.666	2.698	1.200
			Average value	0.840

Result:-

Water absorption of the given brick is 0.840 which is < 1%.

4.3 Efflorescence test

This test should be carried out by submerging one end of the brick vertically in water. The height of the submerged bricks must be at least 25 mm. The entire setup should be put in a ventilated warm room with a temperature of 20° to 30°. Until all of the water has evaporated After the water has been absorbed, the bricks seem to be dry. After that, a comparable amount of distilled water will be added and allowed to evaporate as previously. After this time has passed, bricks are used to check for efflorescence. On the brick surface, the alkalis produce white areas or dots.

a. Nil: When there is no salt deposition or there are no white areas.
b. Slight: When there is a thin layer of salt on the surface of the bricks, but it does not cover more than 10% of the surface area.
c. Moderate: When salt deposition is heavier but not more than 50% of the surface area of the brick.
d. Heavy: When salt deposition is greater than 50% without flaking or powdering on the surface of the brick.
e. Serious: When salt deposition is greater than 50% on the surface, with flaking or powdering, and tends to grow with repeated soaking of the brick.

ISSN (Online) 2456-1290

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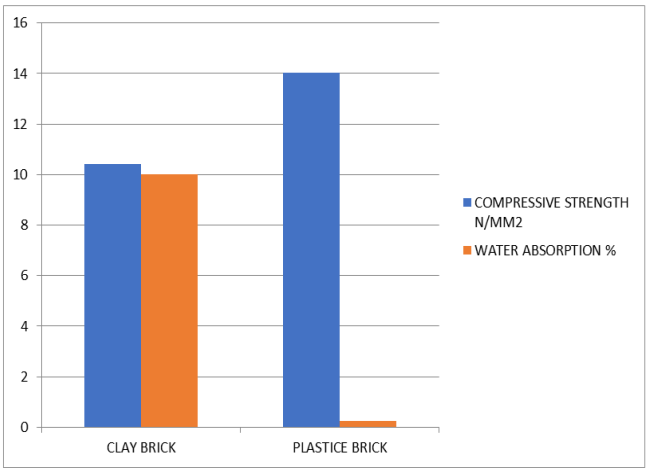
4.4 Hardness test

In hardness test, the scratch is made using a finger nail or a sharp implement on the brick surface. If there are no scratch marks on the brick, it is considered a hard brick.

4.5 Soundness test

For this test, two bricks are struck against each other to see if a clear ringing sound is created. If the brick does not shatter and creates a clear ringing sound, it is sufficiently sound.

V. COMPARISON OF PLASTIC BRICK AND CLAY BRICK



VI. RESULT AND DISCUSSION

- Since plastic is commonly available worldwide, we can find plastic everywhere as a waste and we collect it to make bricks. It is a low-cost building material. The use of plastic in bricks benefits the environment since the best method to dispose of plastic is to reuse/recycle it, and land and other hazardous effects could be stopped or cannot be damaged.
- In compared to native clay bricks, plastic bricks are more cost-effective, have stronger compressive strength, have negligible water absorption, and are lighter in weight.
- Whereas the purpose of these plastic bricks is to dispose of plastic waste from natural environment. Plastic waste in landfills, oceans, etc has also decreased. Plastic has shown to be cost-effective and a tremendous replacement of the clay bricks.
- Plastic is a non-biodegradable and unsustainable substance that has a negative impact on the environment. However, because plastic is a versatile material with varied properties (lasting, strong, and easy to mould), it may be used as a green material and is the greatest answer for minimising pollution.
- These plastic bricks are appropriate for all countries, but especially for those who have difficulty disposing of plastics. Although plastics have the disadvantage of generating pollution, they also offer various positives such as providing superior insulation, low porosity, being inexpensive and readily accessible, and so on. As a result, it's utilised in bricks, which improves its overall quality.

REFERENCES

[1] https://www.coursehero.com/file/143204472/
[2] https://cpcb.nic.in/uploads/plasticwaste/LCA_Report_15.05.2018.pdf
[3] https://www.downtoearth.org.in/blog/waste/draft-plastic-waste-management-rules-2021-addressing-the-bigger-problem-75939
[4] https://www.heraldgoa.in/Edit/Opinions/Plastic-waste-management-/188454
[5] https://theconversation.com/eight-million-tonnes-of-plastic-are-going-into-the-ocean-each-year-37521
[6] Kumar, R., Kumar, M., Kumar, I. and Srivastava, D., 2021. A review on utilization of plastic waste materials in bricks manufacturing process. Materials Today: Proceedings, 46, pp.6775-6780.
[7] https://news.climate.columbia.edu/2012/05/09/emissions-from-the-cement-industry/
[8] Casanova-del-Angel, F. and Vázquez-Ruiz, J., 2022. Manufacturing Light Concrete with PET Aggregate.