Experimental Study on Manufacturing of Bricks Using Waste Plastic as Partial Replacement of Conventional Materials

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Abstract- India currently generates nearly sixty million tons of plastic waste each year. This creates serious challenges for environmental sustainability. When plastic waste is not disposed of properly, it pollutes soil and water resources. It also negatively impacts living organisms, leading to long-term ecological imbalances. One promising way to tackle this issue is by using waste plastic as a construction material in brick production, which offers both environmental and economic advantages. In this study, waste plastic was mixed with sand, quarry dust, and mineral aggregates to make plastic-based bricks. These bricks were produced through controlled heating and molding processes with minimal cement content. The final bricks are suitable for masonry units and non-load-bearing construction applications. Adding plastic waste significantly impacted properties like water absorption, density, and durability, while also lowering permeability compared to traditional bricks.

Keywords: Waste Plastic, Plastic Bricks, Land filling, Incineration.

I. INTRODUCTION

Zinc-Nowadays, the need for construction materials is increasing because of population growth and continuous development of buildings and roads. Among all materials, bricks are commonly used due to their easy availability and long service life. Traditional clay bricks have been used for many years, but their manufacturing process requires large amounts of natural clay and high heat in brick kilns. This causes damage to agricultural land and increases air pollution. At the same time, plastic waste is becoming a serious problem, as it is thrown away daily and does not decompose easily. Plastic waste can be seen in open areas, drainage systems, and water bodies. Due to poor disposal methods, managing plastic waste has become difficult. Therefore, there is a strong need to find better ways to reuse plastic waste in construction materials. Because plastic is inexpensive, lightweight, and manageable, it is utilized extensively in daily life. However, the majority of plastic products are disposed of improperly after use.

Because plastic doesn't decompose naturally, it stays in the environment for a long time and poses a major threat to soil, water, and living things. Reusing plastic trash in the production of bricks can reduce this problem.

The use of waste plastic in brick manufacturing is gaining attention as a practical solution to both environmental and construction-related problems. Instead of dumping plastic waste in open areas or landfills, it can be collected, cleaned, and processed for use in brick production. In this method, plastic waste is mixed with basic raw materials such as sand or soil and then heated or molded to form bricks. The plastic acts as a binding material, helping the particles stick together without the need for high-temperature firing like traditional clay bricks. This reduces energy use and lowers air pollution. Bricks made with plastic waste are generally lighter in weight and show lower water absorption compared to conventional bricks. These properties make them suitable for non-load-bearing walls and paving applications. Moreover, using plastic waste in bricks helps reduce the use of natural clay, protecting fertile land, and supporting better waste management practices. This approach offers a simple and effective way to reuse plastic in construction.

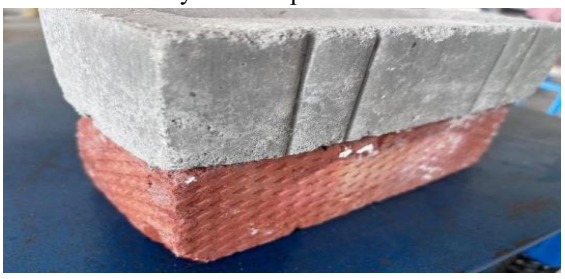


Fig no.1 Plastic bricks Sample (plastic and clay)

II. PLASTIC WASTE

Plastic waste is a common problem seen in daily life due to its heavy use and careless disposal. Every day, plastic items such as bags, bottles, and wrappers are thrown away from homes, shops, and streets. Since plastic does not break down naturally, it stays in the environment for many years. This causes pollution in land and water and creates problems for animals and birds. Plastic waste also blocks drains and affects cleanliness. Using plastic waste in brick manufacturing is a useful way to reduce waste and make better use of unwanted materials.

III. MICRO DEBRIS

Micro debris refers to very small pieces of plastic that are usually less than 5 mm in size. These tiny plastic particles are formed when larger plastic items break into smaller pieces due to sunlight, heat, and physical damage over time. Micro debris can also come from plastic pellets used in industries and from cleaning or cosmetic products. Because of their small size, they easily mix with soil and water and are carried into rivers and oceans. These particles are difficult to collect and can enter the food chain, causing harm to both animals and humans.

IV. MACRO DEBRIS

Macro debris refers to plastic waste that is large in size, usually more than 20 mm. Common examples include plastic bags, bottles, containers, and food wrappers. This type of plastic waste is often seen in open land, drains, rivers, and coastal areas. Macro debris causes serious problems for animals and marine life, as they may get trapped or injured by it. Discarded fishing nets are a major form of macro debris and continue to trap fish even after being thrown away. Proper collection and reuse of macro plastic waste can reduce these problems.

5. Thesis Organization

Chapter 1 gives the introduction to the project: the problem identified with the objective, proposed outline of the project and scope of the project on dealing with the stated problem.

Chapter 2 gives a summary of the literature review and the final conclusions drawn from them.

Chapter 3 gives the procedures of the tests done on materials used in the bricks manufacturing.

Chapter 4 gives the description of the mix design,

Chapter 5 gives the results and their analysis. From these results we have plotted the graphs and analyzed the results

Chapter 6 gives the summary, final conclusions on the course of the project, and the future scope of work that can be further carried out.

VI. PROPERTIES OF BRICKS (AS PER IS NORMS)

Table 1 shows Properties of bricks as per IS norms.

PROPERTY	TEST STANDARDS (IS)	AS PER STANDARDS (IS)
Dimensional Tolerance	IS 1077	±3 mm
Compressive Strength	IS 3495 (Part 1)	≥ 3.5 MPa (Class 3.5 minimum)
Water Absorption	iS 3495 (Part 2)	≤ 20%
Efflorescence	IS 3495 (Part 3)	Nil to Slight
Abrasion resistance	IS 1237	≤ 3% weight loss
Hardness test	IS 3495 (Part 4)	No visible scratch
Thermal stability	------	Not specified

VII. MATERIALS USED

The following are the materials used in our Brick Manufacturing. They are as follows:
Plastic carry covers like shopping bags, pouches, and thin wrappers are widely used in daily life for holding and moving goods. These covers are made from light plastic sheets and are easy to use and handle. People use them for groceries, food items, chemicals, printed materials, and waste collection. Because they are low in cost, they are often thrown away after a single use. When not disposed of properly, they create problems such as blocked drains, dirty surroundings, and danger to animals. Many areas are now trying to limit their use. Collecting and using these waste plastic covers in brick manufacturing helps reduce pollution and turns unwanted waste into a useful building material.

Fig (2) shows shredded Plastic

7.1. Raw Materials

In this process, the main raw material used is waste plastic, which includes items like carry bags, wrappers, PET bottles, and LDPE or HDPE plastics. These plastics are cleaned, dried, and shredded before use. Sand is added as a filler to give strength and shape, usually clean river sand or manufactured sand. Sometimes, a small amount of soil or clay is included to improve bonding and make the mixture easier to work with. Fly ash can also be used partially in place of sand to reduce cost and give a smoother surface. Stone dust or quarry dust helps increase strength and reduce voids in the final product. Pigments may be added to give color and improve appearance. Water is used for cleaning raw materials and controlling temperature, while release of oil or grease is applied to molds to prevent sticking during shaping.

Table no.2 Shows Synopsis of the Raw Materials

S.NO	RAW MATERIAL	PURPOSE / ROLE	NOTES / OPTIONAL USE
1	Waste Plastic	Main binding material; provides shape and cohesion	Types: carry bags, PET bottles, wrappers, LDPE, HDPE. Must be cleaned, dried, and shredded.
2	Sand	Filler material; adds strength and durability	River sand or manufactured sand preferred.
3	Soil / Clay	Improves bonding and workability	Optional; small percentage only.
4	Fly Ash	Reduces sand usage; improves surface finish	Optional; eco-friendly and reduces cost.
5	Stone Dust / Quarry Dust	Enhances strength; reduces voids	Commonly used in paving bricks.
6	Pigments	Adds color and aesthetic appeal	Optional; used in exposed or decorative bricks.
7	Water	Cleaning and cooling during production	Small quantity; ensures smooth processing.
8	Release Oil / Grease	Prevents bricks from sticking to molds	Applied on molds before pressing.

7.2. Fine Aggregate

Fine aggregate is small sand used in making bricks and other building materials. It can come from rivers or crushed stones. Fine aggregate helps fill the empty spaces between bigger materials. This makes the mixture strong and stable. It also helps the materials stick together and makes the surface smooth. Using fine aggregate makes the final product durable and long-lasting. It is an important material because it gives strength, shape, and firmness to the product. Without fine aggregate, the mixture would be weak and full of gaps.

7.3. Black Clay

Black clay is added in small amounts to the mixture to improve binding and workability. It is soft and sticky when wet, helping sand, stone dust, and plastics stick together. This clay ensures the mixture forms a strong, smooth, and durable product after shaping and drying.

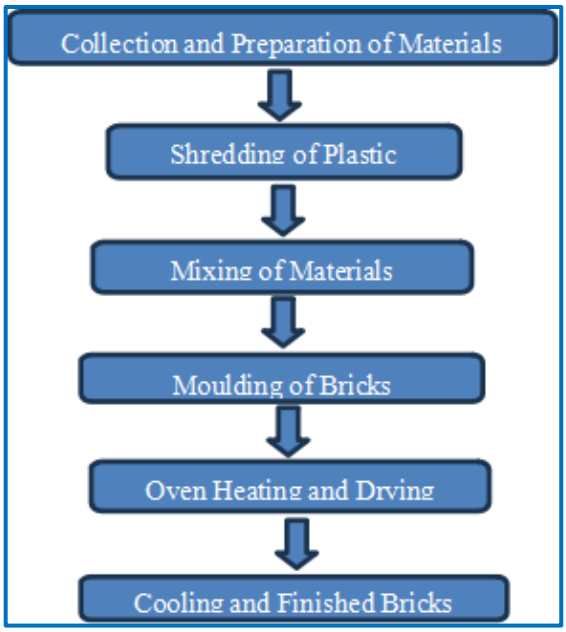
7.4. Formation of Black Clay:

Many theories are proposed for the formation of black clay; some of them are widely accepted. We will see some of the theories in detail: 1) The igneous rock decomposition theory. 2) The surface weathering theory. 3) The organic accumulation theory.

Fig.no.3 Shows Formation of BlackClay

7.5. The igneous emanation theory:

Hot gases from deep within the Earth, along with superheated steam, fluorine compounds, carbon dioxide, and boron, help break down parts of feldspar. This process slowly forms clay deep below the surface. Clay discovered in places like China provide evidence that supports this idea.



Flow Chart Shows Process of Making Clay Bricks

8.1. Methodology Chart

i) Collection and preparation of Materials.

Waste PET plastic and conventional brick materials are collected and prepared.

i) Shredding of Plastic

The plastic waste is cleaned and cut into small grains.

ii) Mixing of Materials

The plastic grains are mixed uniformly with the wet brick mix.

iii) Moulding of Bricks

The prepared mix is placed into moulds and compacted properly.

iv) Oven Heating and Drying

The moulded bricks are heated in an oven, where plastic melts and fills the pores.

v) Cooling and Finished Bricks

The bricks are cooled at room temperature and ready for testing.

IX. MIX DESIGN

To make strong bricks using silica-rich clay and waste plastic, different mix ratios were prepared and tested with a compressive testing machine. The ratios used were 1:2, 1:3, 1:4, 1:5, and 1:6, where the first number is waste plastic, and the second is silica-rich clay or sand. These ratios help find the best mix for strength, durability, and lighter bricks.

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Fig 4 Shows Mix Ratio of Plastic & Fly Ash with Cement

Fig 5 Shows Moulding of Brick

To check the performance and quality of plastic bricks, different tests are carried out. Some of these tests are done in the laboratory under controlled conditions, while others are checked directly at the construction site to observe their behavior in real situations.

X. COMPRESSIVE TEST

The compression test is carried out to check the strength of bricks made using plastic and sand. For this test, five brick samples are taken to the laboratory. Each brick is

placed carefully in a compression testing machine. Load is applied slowly and evenly until the brick breaks. The load at which the brick fails is recorded. The same procedure is followed for all five samples. After testing, the average value of the recorded loads is calculated. This average value represents the compressive strength of the bricks. Bricks prepared with different plastic and sand ratios are tested and compared to identify the mix with better strength.

In this experimental study on manufacturing of bricks using waste plastic as partial replacement of conventional materials, the compressive strength results of the specimens tested at 3, 7, and 14 days are discussed. Three trials were conducted to understand how the strength of the brick's changes with curing time. The results clearly show that compressive strength increases as the curing period increases in all trials. This happens because, with time, the materials inside the brick bind more firmly, and the plastic gets better integrated with the base materials.

S. No	Trials	3 Days (N/mm²)	7 Days (N/mm²)	14 Days (N/mm²)
1	Trial 1	10	12	13
2	Trial 2	11	13	14
3	Trial 3	12	14	15

Fig 6 Compression Test Conducted for Clay Plastic Bricks

10.1 WATER ABSORPTION TEST

The difference between the dry weight and wet weight gives the amount of water absorbed by the brick. The percentage of water absorption is calculated from this difference. Lower water absorption indicates better quality bricks. Good quality bricks should not absorb more than 20% of their dry weight. The measured water absorption of the test brick was found to be 8.5%. As per IS 3495 (Part 2):1992, the result obtained is within the permissible limit and hence the brick is considered satisfactory. The casted specimen was subjected to a water absorption test to study the water absorption characteristics of the block. After the drying period was completed, the specimen was weighed and then immersed in a water tank for a period of 24 hours. After immersion, the specimen was removed from the water, surface moisture was wiped off, and the specimen was weighed again. The difference between dry weight and wet weight was used to calculate the percentage of water absorption.

S. No	Trial	Dry Weight (kg)	Wet Weight (kg)	Water Absorption (%)
1	Trial 1	2.80	2.95	5.36
2	Trial 2	2.75	2.90	5.45
3	Trial 3	2.70	2.85	5.56

10.2 FIRE RESISTANCE TEST

Plastics usually catch fire easily. But in plastic–sand bricks, sand helps to reduce the effect of heat. During the test, the bricks did not show any major damage up to a temperature of 180°C. After this level, small cracks were seen on the surface. When the temperature increased further, the bricks slowly started to weaken and lose their strength.

Specimens	Temperature (°C)	Remarks
Specimen I	50	No change
	100	No change
	180	Melts
Specimen II	50	No change
	100	No change
	180	Melts
Specimen III	50	No change
	100	No change
	180	Melts

S. No	TYPE OF BRICKS
1.	Waste Plastic Brick
2.	Normal Red Sand Brick

10.3 HARDNESS TEST

In this test, the surface of the brick is scratched using a steel rod or any hard object. If it is difficult to make a scratch on the surface, the brick is considered hard. This result indicates that the brick has good quality and sufficient surface strength.

XI.CONCLUSION

This experimental study shows that waste plastic can be effectively used as a partial replacement of conventional materials in the manufacturing of bricks. The use of recycled plastic not only helps in managing plastic waste but also provides useful construction material. During the study, bricks were prepared by mixing waste plastic with fine aggregate and quarry dust in suitable proportions. The results indicate that using around 20% waste plastic gives satisfactory performance without causing major changes in the properties of the bricks.

The compressive strength of plastic bricks was found to be slightly lower than that of conventional bricks, but it is still adequate for non-load-bearing applications. These bricks are lighter in weight, which makes handling and transportation easier. The water absorption values were lower compared to traditional bricks, showing better resistance to moisture. In addition, the bricks demonstrated good heat resistance, with no major changes in shape or size at moderate temperatures.

From an economic point of view, the production cost of plastic bricks is lower than conventional bricks due to the use of waste materials. This method also reduces the need for landfilling and incineration of plastic waste, which are harmful to the environment. The use of waste plastic in brick manufacturing is therefore an eco-friendly and sustainable solution.

Although plastic bricks may not be suitable for heavy load or high-traffic areas, they can be effectively used in gardens, pedestrian pathways, compound walls, and other light- duty applications. Overall, this study proves that manufacturing bricks using waste plastic is a practical, economical, and environmentally responsible approach that contributes to sustainable construction and reduced plastic pollution.

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