International Journal of Innovative Research in Engineering
Volume 4, Issue 3(May-June 2023), PP: 555-561.
www.theijire.com ***ISSN No: 2582-8746***

Experimental Study on Usage of Waste Plastic for Manufacturing of Bricks

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How to cite this paper:
P. P. Vispute[1], Aditya V. Tile[2], Manoj B. Pathare[3], Gaurav S. Dhakane[4], Rohan S. Patil[5], "Experimental Study on Usage of Waste Plastic for Manufacturing of Bricks", IJIRE-V4I03-555-561.

Abstract: *Globally, 8,300 million tons of virgin plastics had been manufactured as of 2017. Only approximately 9% of material is recycled, and only about 12% is burned, leaving 79% to end up in landfills or the environment. According to "2018 Down to Earth" research, India consumes approximately 16.5 million tons. Additionally, the industry association FICCI reports that 43% of the plastics used in India are single-use plastics and are utilized in packaging. As a result, over 80% of India's entire plastic production is wasted. Some of it either gets burned, which pollutes the air, goes to landfills, or clogs sewers. Animals who consume plastic bags, etc. suffocate. Plastics found in fields inhibit germination and stop moisture from penetrating the soil. Numerous studies and researches have been conducted to find solutions to the mounting issue of disposing of plastic garbage. Some countries have improved technologies to use recycled waste plastic, but in India the plastic waste disposal is a big problem. The current account of potential use of plastic waste in the construction industry is lacking in the literature. This report presents a use of waste plastic in bricks in varying proportions. The report reflects that the reuse of plastic waste is very less as compared to generation of plastic waste. While every industry is trying to minimize the use of plastic, some industries have come forward to research more into waste plastic use in their products for sustainable development. Using plastic to build roads is one potential solution that has gained traction in recent years. In addition to increasing environmental sustainability, highways made of plastic are shown to be more reliable and economical. The report presented is bound to highlight the impending problem of plastic waste for the researchers to come forward with innovative solutions of minimizing and recycling with practical feasibility. The results showed that the production of bricks by using plastic waste could be used as an alternative to soil brick. Production of plastic bricks could reduce the huge quantities of plastic waste in the environment which ultimately saves our soil and aquatic environment and improves the physical environment. This type of plastic usage leads to attaining an eco-friendly environment. In addition, this alternative use of plastic material helps to produce green building materials in the construction sector. The use of plastic with cement in brick reduces the use of soil from the agriculture field as well as reduces pressure on the environment to attain sustainable development.*

Key Word: *Waste Plastic, Fly Ash, Bricks, Compressive Strength, etc.*

I.INTRODUCTION

Plastic is one of the daily increasing useful as well as a hazardous material. At the time of need, plastic is found to be very useful but after its use, it is simply thrown away, creating all kinds of hazards. Plastic is non-biodegradable that remains as a hazardous material for more than centuries. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. They are non-biodegradable and also researchers have found that the plastic materials can remain on earth for 4500 years without degradation In India approximately 40 million tons of the municipal solid waste is generated annually, with evaluated increasing at a rate of 1.5 to 2% every year. Hence, these waste plastics are to be effectively utilized. Waste in its various forms is increasing in landfills. Due to disastrous effects plastic has on human life, environmentalists are persistently working to get a solution to the problem of plastic disposal. They are focusing on day to day human practices which can help to reduce the disposal problem. One of the techniques employed is the 5 R's which is considered to be a base of waste management and should be strictly followed in order to promote ecological balance through conscious human behavior and choices.

Incineration, in fact, may not be possible due to the production of noxious or toxic fumes. Plastic can remain under the ground for 500 years, which leads to the contamination of soil and thus pollutes the environment. According to the report of Central Pollution Control Board (CPCB), it is seen that the packaging and polyvinyl chloride (PVC) pipe industry grows at 16-18% per year. Table 1.1 provides the total plastics waste consumption in India during last decade.
Plastic or synthetic organic polymers have become an integral part of day-to-day life. Plastic waste management has always been a difficult task for India due to its non-biodegradable nature. With population of about 135 crore which is 17.4% of worlds total population and with a GDP of 7.55 in 2018 India being a developing country has 32% of the total

area as urban and 68% as rural area. Thus, due to fast development and large manufacturing industries, India generates 9.46 million tons of waste plastic annually in which the single use plastic that is mostly used for packaging accounts for 43% of the total waste generation and the uncollected plastic waste holds up to 40%. However, India has already started a mission to eliminate the use of single use plastic by 2022, but the accumulated million tons of waste that is already polluting the environment and shows no sign of degradation up till 1000 years is still a concern for the country. The reuse and recycling of plastic waste is the only option for the organizations to handle such a large amount of accumulated waste. Talking on global scale, the world processes 300 million metric tons of plastic annually. Since 1950, 8.3 billion tons of total amount of plastic has been produced out of which 60 % of the waste was disposed in either landfills or natural environment. Thus mismanagement of plastic waste disposal and processing can lead to hazardous effects on people and all living beings on the earth, either marine or on land. Out 5.6 million tons 0.60 tons of plastic waste is sent to seas. Due to which seas adjacent to Mumbai, Kerala and Andaman and Nicobar are the most polluted in the world. The plastic disposal which is sent to ocean affects water species as they directly ingest or gets entangled in the loads of waste. In India Also the chemical in the plastic affects landfills creating environmental pollution and rivers, oceans creating water pollution. According to FICCI with a global average of 28 the per capita consumption of plastic is approximately 11 as compared to 109 in US, 65 in Europe, 38 in China and 32 in Brazil.

Figure 1: Plastic Waste

Recycling of Plastic Waste in India

India generates around 3.4 million tonnes (MT) of plastic waste, a report said on Wednesday noting that only 30 per cent of it is recycled. Over a five-year period, the plastic consumption in the country has risen at a compounded annual growth rate (CAGR) of 9.7 per cent to 14 MT in the financial year 2016-17 to 20 million tonnes in 2019-20, Marico Innovation Foundation said in a report released in the national capital. India's plastic waste output also doubled between the said period, the report titled 'Plastics, The Potential and Possibilities' said. According to the report, which has been prepared in association with the Indian Institute of Science (IISc) and Praxis Global Alliance, Maharashtra, Gujarat and Tamil Nadu together contribute 38 per cent to the total plastic waste that is generated in India.

"The plastic consumption in India has grown at a significant pace over the past five years, and so has its waste output. India produces 3.4 million tonnes of plastic waste in a year, only 30 per cent of it is recycled," it said. While the rest of the plastic waste is sent to landfills or aquatic dumps, the report noted and suggested ways to deal with the challenge as the entire plastic value chain from production to waste disposal severely impacts the local ecologies it surrounds. This impact is wide ranging, and affects communities and ecosystems. Apart from imposing a ban on single-use plastic, the government has been working on creating a statutory framework for including the use of biodegradable plastics as an alternative material. However, there are other effective policy interventions that can be used to create a sustained impact. "Landfill and incineration taxes must be levied in India to encourage recycling rather than dumping. Authorise a 'pay-as-you-throw' system, which requires citizens to pay a variable rate per kilogram for a bag of mixed garbage," it suggested. There is a need to regulate the entire life cycle of plastic bags, from manufacturing or imports to disposal, besides specific incentives to the bioplastics industry like corporate income tax exemptions, infrastructure development support and installation cost reduction.

Figure 2: Beaches Polluted with Plastic Waste

Figure 3: Streets Polluted with Plastic Waste

Problem Statement

Plastics especially Single-use plastics, such as plastic bags, straws, and packaging etc, are a significant contributor to the plastic waste crisis. The disposal of plastic waste is a complex problem that requires innovative and sustainable solutions. The challenge is to enhance circularity and develop a solution that can effectively manage single-use plastic waste and promote a circular economy for plastic. The solution should address the challenges of plastic waste collection, segregation, and recycling, and should also take into account the potential environmental and social impact of plastic

recycling and disposal methods. The solution should be scalable, affordable, and accessible to all segments of the population, including low-income households. The solution should consider fostering collaboration between the needs and concerns of all stakeholders, including government, producers, consumers, recyclers, and regulators. The solution should also promote behavior change among consumers and producers to redesigning and rethinking of single-use plastic and encourage the use of sustainable alternatives. The solution shall not reiterate what has already been covered under the Plastic Waste Management Rules.

Aim of the Study

Every minute, the equivalent of one garbage truck of plastic is dumped into the ocean. This marine litter and plastic pollution endangers aquatic life, threatens human health and results in myriad hidden costs for the economy. Plastic waste is becoming extremely threatening to the environment due to their high quantities generated which pose serious harm to both the environment and its inhabitants. A major victim of this menace is the marine environment. Plastic wastes generated on land find their way to water bodies where they cause detrimental effects such as flooding and poisoning of the animals in the marine ecosystem. The plastics in the marine environment, which are ingested in fish, are also deleterious to human health if such fish are consumed. In order to find an effective way to manage these wastes and improve the sustainability of our environment, this study, therefore, explores various approaches to recycling plastic wastes into new products.

Objectives of the Study

The reported work has aimed at the development and verification of a systematic methodology for process planning and optimization for most efficient method. The objectives of this study are as follows:

1. To develop an efficient way and to effectively utilize the waste plastics.
2. To reduce the consumption of natural resources such as clay for the manufacturing of bricks.
3. To minimize and reuse generation of waste plastic on the land and water to avoid land and water degradation and consequent pollution hazard.
4. To produce cost-effective materials which a common person can afford easily.
5. To aware the construction industry about the benefit of plastic bricks and provide technical results to use it.

II.METHODOLOGY

Brick

A brick is a type of construction material used to build walls, pavements and other elements in masonry construction. Properly, the term brick denotes a unit primarily composed of clay, but is now also used informally to denote units made of other materials or other chemically cured construction blocks. Bricks can be joined using mortar, adhesives or by interlocking. Bricks are usually produced at brickworks in numerous classes, types, materials, and sizes which vary with region, and are produced in bulk quantities.

Block is a similar term referring to a rectangular building unit composed of clay or concrete, but is usually larger than a brick. Lightweight bricks (also called lightweight blocks) are made from expanded clay aggregate. Fired bricks are one of the longest-lasting and strongest building materials, sometimes referred to as artificial stone, and have been used since circa 4000 BC. Air-dried bricks, also known as mud-bricks, have a history older than fired bricks, and have an additional ingredient of a mechanical binder such as straw. Bricks are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure.

Figure 4: Bricks

Manufacturing of Plastic Bricks

1. **Collection of Plastic Material: -** The plastic material should be collected from the factories waste, hospital waste, industrial waste, food packages and plastic bottles this will come under the LDPE plastic type.

2. **Batching of Plastic: -** Measurement of materials for making brick is called batching. After collection of materials we separate the types of plastic and remove any other waste presented in the collected material and check that any water content in sample collected ten proceed for burning.

3. **Burning of Waste Plastic: -** After completion batching the plastic waste were taken for burning in which the plastic bags are drop one by one into the container and allowed to melt. These would be done in closed vessel because to prevent the toxic gases released into atmosphere. These will be at the temperature of 90-110 degrees centigrade.

4. **Mixing: -** Mixing of materials is essential for the production of uniform and strength for brick. The mixing has to be ensure that the mass becomes homogeneous, uniform in color and consistency. Generally, there are two types of mixing,

Hand mixing and mechanical mixing. In this paper proportion is added into it. then these plastic liquids thoroughly mixed by using trowel before it hardens. The mixture has very short setting bags are turned to molten state; the river sand is added to it. The sand added is mixed time. Hence mixing process should not consume more time.

5. Moulding: - After completion of proper mixing we place mix into required mould. In these projects we use the normal brick sizes (19x9x9 cm). After 2 days remove the brick from the mould and then done curing.

6. Curing: - The test specimens after moulding were allowed to dry for a period of 24 hours. The specimens were kept in curing tank and allowed to cure for a period of 28 days.

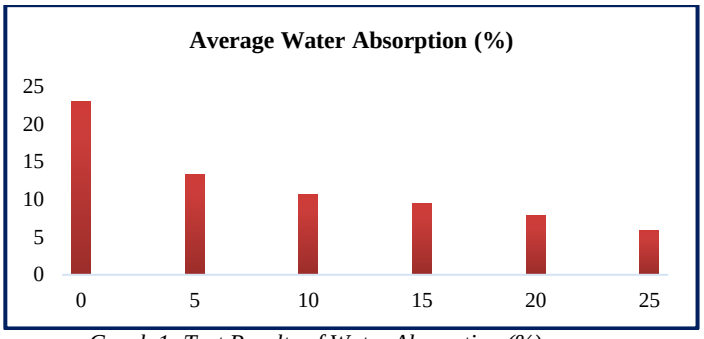
III.RESULT AND ANALYSIS

Absorption Test on Bricks

Water absorption test on bricks are conducted to determine durability property of bricks such as degree of burning, quality and behavior of bricks in weathering. A brick with water absorption of less than 7% provides better resistance to damage by freezing. The degree of compactness of bricks can be obtained by water absorption test, as water is absorbed by pores in bricks. The water absorption by bricks increase with increase in pores. So, the bricks, which have water absorption less than 3 percent can be called as vitrified. This test provides the percentage of water absorption of bricks and procedure of the same is discussed below.

Table 1: Test Results of Water Absorption

Sr. No.	Plastic Waste (%)	Water Absorption (%)			Average Water Absorption (%)
		Model 1	Model 2	Model 3	
1	0	22	23	24	23
2	5	14	13	13	13.33
3	10	11	10	11	10.66
4	15	9.5	9	10	9.5
5	20	8.5	9	6	7.83
6	25	6.5	6.2	5.5	5.9



Graph 1: Test Results of Water Absorption (%)

Crushing Strength or Compressive Strength

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine. Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Thus, it is important to know the compressive strength of bricks to check for its suitability for construction.

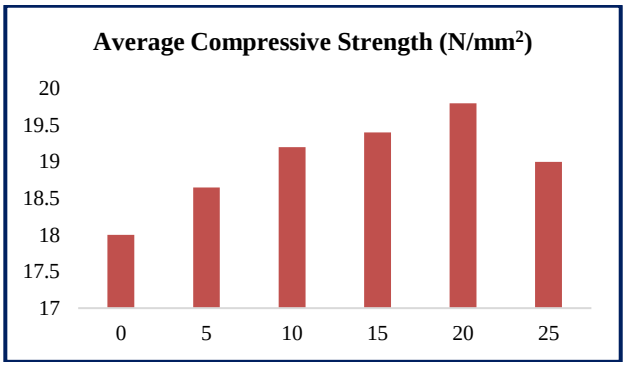
Figure 5: Compressive Strength Test on Brick using Compression Testing Machine

$$compressive\ Strength\ of\ Bricks\ = \frac{Maximum\ Load\ at\ Failure\ (N)}{Average\ area\ of\ bed\ face\ (mm^2)}$$

Table 2: Test Results of Compressive Strength

Sr. No.	Plastic Waste (%)	Compressive Strength (N/mm^2)			Average Compressive Strength (N/mm^2)
		Model 1	Model 2	Model 3	
1	0	17.50	18	18.50	18

2	5	18.90	18.40	18.65	18.65
3	10	19.45	19.25	18.90	19.20
4	15	18.90	19.30	20	19.40
5	20	20.30	19.50	19.60	19.80
6	25	19.05	18.85	19.15	19



Graph 2: Test Results of Water Absorption (%)

Hardness Test on Bricks

The hardness of the brick depends on the soil that is used in its composition. The hardness of a clay brick would be different as compared with the brick that is made with a mixture of clay with some other material. Only hard brick is expected to have good compressive strength, resistance against water percolation and thereby the frost action. The hard bricks are also called hard burnt bricks. One method of testing whether the brick is hard or not is to tap the brick with a hammer and listen to the sound produced. If the sound is dull ringing sound that the brick is said to be sound and hard but if it gives dull thud sound it is said to be soft useless brick. The Hardness Test of Brick can be judged with the help of the scratch of the fingernail. Try to scratch the figure on the brick, if no scratch is left on the surface of the brick, it is considered to be having sufficient hardness.

Table 3: Test Results of Hardness on Bricks

Sr. No.	Plastic Waste (%)	Hardness
1	0	No Scratch – Good Quality Brick
2	5	No Scratch – Good Quality Brick
3	10	No Scratch – Good Quality Brick
4	15	No Scratch – Good Quality Brick
5	20	No Scratch – Good Quality Brick
6	25	Scratch – Bad Quality Brick

Soundness Test on Bricks

A soundness brick test is conducted by striking two bricks together. The striking of brick should emit a ringing sound. It can be tested by the fall of brick. A good quality brick should not break, when made to fall flat on hard ground, from a height of about 1 m.

Table 4: Test Results of Soundness on Bricks

Sr. No.	Plastic Waste (%)	Soundness
1	0	No ringing bell sound and not break
2	5	No ringing bell sound and not break
3	10	No ringing bell sound and not break
4	15	No ringing bell sound and not break
5	20	No ringing bell sound and not break
6	25	Ringing bell sound and brick get breaked

Efflorescence Test on Bricks

As bricks are made with natural clay that has many soluble salts in it with diversified chemical characteristics. These salts are crystalized later on when the bricks are saturated and water is dried from the surface. This phenomenon is termed as efflorescence. This white powdery scum on the bricks is a stubborn and persistent trouble that has plagued the brick industry with complete detrimental effects on aesthetics of the structures. This problem is more persistent in substructure of the building i.e. areas below DPCs where the wall bricks are more liable to get saturated with water. Although the production of this flowery white powder is apparently not detrimental to the structural integrity of the brick wall. But in some cases if the salts are present in large concentrations in clay bricks, the saturation and crystallization of salts would result in spalling of the surface layer of bricks. The efflorescence in bricks can be evaluated by using a laboratory test. The brick, obtained from representative sample of the lot, is placed in a water dish such that it gets immersed up to depth of 25 mm. The assembly is left in a warm room so that water can be absorbed in the brick and is then

evaporated upon drying. At the end the surface of the brick is visually inspected for high, moderate or low level of efflorescence.

Figure 6: Efflorescence on Bricks

Table 5: Test Results of Efflorescence Test on Bricks

Sr. No.	Plastic Waste (%)	Efflorescence
1	0	Nil
2	5	Nil
3	10	Nil
4	15	Nil
5	20	Nil
6	25	Moderate

IV.CONCLUSION

1) The results showed that the production of bricks by using plastic waste could be used as an alternative to soil brick. Production of plastic bricks could reduce the huge quantities of plastic waste in the environment which ultimately saves our soil and aquatic environment and improves the physical environment. This type of plastic usage leads to attaining an eco-friendly environment.
2) In addition, this alternative use of plastic material helps to produce green building materials in the construction sector. The use of plastic with cement in brick reduces the use of soil from the agriculture field as well as reduces pressure on the environment to attain sustainable development.
3) The present results showed that compressive strength of the brick specimens tested in this study is reduced by increasing the percentage of plastic waste. However, the reduction is more significant at higher percentages than at a lower percentage. In all cases, compressive strength remained higher than the usual values in most standards.
4) The water absorption is decreased linearly with an increase in the percentage of plastic waste.
5) It can be corroborated that up to 20 % plastic waste, bricks performed very well in all aspects, including strength, water absorption (related to durability). However, 20 % of plastic waste can be selected as an optimum plastic waste percentage to achieve better results and falls under A-class and severe weather resistance criteria.
6) Bricks with plastic waste are lightweight and exhibit volume stability. They also reduce the depletion of natural soil. In this case, plastic waste usage in bricks is a useful approach toward a circular economy. It results in better and lightweight brick production that has higher volume stability. Awareness-building activities as well as social willingness are needed to encourage the use of plastic bricks as green construction materials.

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