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AN EXPERIMENTAL INVESTIGATION ON BRICKS USING PLASTIC WASTE

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Abstract – *The present study focuses on exploring the feasibility and potential benefits of incorporating waste plastic into brick production as the disposal of plastic waste has become a significant environmental concern in today's date. The study elaborates the work done on bricks made using the plastic waste composite along with cement, sand, and water. The small pieces of recycled waste plastic composite taken from leftover pieces of bottles, cans etc. After thorough mixing of sand, cement, water and plastic waste, mixture is poured into rectangular mold with standard brick dimensions. After 24 hours, bricks were removed from mold and kept for 3 days curing. Local brick testing methods were conducted such as free fall of the brick and scratch test. Compressive strength test and water absorption test also conducted on bricks samples. The test results concluded that the Plastic Composite Brick is efficient than the normal cement brick. The bricks produced are light in weight, have smooth surface and fine edges, and have high crushing strength and very low water absorption.*

Key Words: Plastic Bricks, Cement Bricks, Compressive Strength, Water Absorption, Waste Plastic.

1.INTRODUCTION

The way plastic waste is disposed of has emerged to be a major environmental concern in the modern world. Plastic waste accumulates in landfills, seas, and other natural areas, harming ecosystems, and public health. It is now essential to find efficient ways to handle and reuse this waste. Utilizing waste plastic in the brick-making process is one promising approach that provides an extended solution to waste management and building requirements. The purpose of this research is to investigate the viability and possible advantages of using waste plastic in the manufacturing of bricks. The process of making cement bricks normally uses a lot of cement and sand, which has negative environmental effects of its own, like sand erosion.

This study aims to mitigate the plastic waste problem and reduce these negative effects by replacing a portion of cement with waste plastic. There are various benefits to using waste plastic in the production of bricks. First of all, it offers a workable way to get rid of plastic waste that would otherwise pollute the environment or land in a landfill. We divert plastic from harming ecosystems by making bricks out of it, and we also provide a useful resource for building. Furthermore, adding plastic to bricks can improve their insulating qualities, lowering the cost of heating and cooling buildings and increasing energy efficiency. Furthermore, it has been demonstrated that bricks treated with plastic may be more resilient to weathering and durable, extending the life of buildings.

This study comprises a thorough investigation of numerous aspects associated with the use of leftover plastic in brick manufacturing. It involves assessing the mechanical characteristics, durability, and environmental effects of bricks modified with plastic to those made with regular cement. In addition, the initiative intends to create streamlined production procedures that maximize the use of leftover waste plastic while ensuring the bricks' quality and structural integrity. To sum up, using waste plastic in the production of bricks offers a viable way to solve issues related to construction and the environment. We can turn plastic waste into a useful resource for sustainable development by utilizing creative solutions. This project aims to promote effective plastic waste management while advancing environmentally friendly construction techniques.

2. LITERATURE REVIEW

In-depth literature review was completed to find the work done on application of plastic waste in the manufacturing of bricks. This extensive literature survey also helps to find out the research gaps associated with the bricks manufacturing industry and increasing demand of bricks for the development of different infrastructural activities. Following research papers investigated some gaps in the brick manufacturing using plastic waste.

Shetty S. et al. (2014) investigated that, Plastic sand bricks give us hope and a way to work on innovative things related to the plastic and to try to invent some new civil engineering materials which shows some remarkable changes in future industry and 5 changes the thoughts of the researchers, users and industries. Such as, in going for plastic sand wall

up framed structures as a partition wall, plastic sand benches within the parks, plastic sand tracks for running and jogging in place of concrete.

Velmurugan V. et al. (2019) worked on the comparative study between clay bricks, plastic sand bricks and plastic fly ash bricks. This project reuses the plastic waste and protects the environment from plastic pollutants. This project is done with different mixing ratios of sand and plastic. All the bricks with different ratio are tested and 6 finally came up with the best ratio to construct brick and that is 70% of sand and 30% of plastic. Comparing all the bricks it is better to use the brick made with plastic and fly ash as both are obtained from waste. These produce harm separately thus this waste materials are often combined to make an ecofriendly product.

Tapkire G. et al (2014) worked on analysis of replacement of conventional aggregates with recycled plastic aggregates in concrete. The concrete consists of cement, sand, Aggregate and water. Out of which the aggregate percentage is 60 to 70 % in concrete and from the observation, it is computed to use the 20% Recycled plastic aggregate in concrete which does not affect the properties of concrete.

From the observation it is possible to use the plastic in concrete mix up to 20% weight of coarse aggregate. Looking into above aspect they concluded that plastic can be in cement concrete mix increase the % in plastic to decrease the strength of concrete. By using the plastic in concrete mix to reduces the load of cube up 15%.

Singhal A.et al. (2018) presented a review on utilization of plastic waste in manufacturing of plastic sand bricks. They concluded that, Waste plastic, which is available everywhere, may be put to an effective use in brick/tiles making. Plastic sand bricks/tiles also help to reduce the environmental pollution, thus making the environment clean and healthy. Plastic sand bricks/tiles minimize the usage of clay in making of bricks/tiles. Plastic sand bricks/tiles give an alternate option of bricks/tiles to the purchasers on water absorption of plastic sand brick is verry less nearly zero percent. Compressive strength of plastic sand brick found to be 5.6 N/mm2 and, the compressive load of 96 KN. They also concluded 7 that the plastic sand bricks are useful for the construction industry when compared with Fly Ash bricks and 3rd class clay bricks.

Kzumar A. et al. (2020) studied that the manufacturing of bricks using plastic waste. Based on the results obtained, they concluded that, Plastic bricks can a very good alternative of traditional earthen bricks. Plastic bricks are often used for partition walls and exterior walls; however, they need to not be utilized in load bearing walls. Cost of manufacturing per unit plastic brick is significantly lower than traditional earthen bricks, hence they are cheaper alternative. Plastic bricks are water-resistant, hence are often utilized in underwater structures.

Daftardar A. et al. (2017) performed an experimental study over use of waste plastic as a construction material. This work was able to achieve its main aim of reducing the plastic waste throughout the globe. It makes use of extruder machine which is harmless to the environment and efficiently utilizes waste plastic to form a product i.e., brick, which is of higher strength, higher water absorption capacity, lower Weight, etc. Then conventional bricks. It's of multiple uses as by increasing the size of the mould, the brick can be utilized as building blocks as well.

Saiprasad M Ket al. (2019) studied the feasibility of plastic-soil brick as a construction material. An experimental study was conducted including various tests on bricks to check its strength and durability. Since test results found it was concluded that the project helps to convert effectively waste plastic into useful building materials like bricks and floor interlocks which can effectively reduce the pollution and further decreases the problem of waste plastic in society. The value of the recycled product is significantly less than the cost of producing.

From the extensive literature survey, it is revealed that it is possible to use the plastic in concrete and bonding admixture in concrete and increase the half of plastic in concrete. The use of Recycled plastic aggregate in concrete is the best option for the disposal of plastic & ultimately reduces the plastic pollution in the Environment. Therefore, the objectives of the present study are as follows:

I. To develop an efficient way for effective utilization of the waste plastic in construction works.

II. Cost comparison between plastic waste composite bricks and conventional bricks.

III. To compare the strength of bricks casted from waste plastic composite with normal cement bricks.

IV. To minimize the consumption of natural resources such as sand for the manufacturing of bricks.

V. To reduce and reuse generation of waste plastic on the land and water to avoid land and water degradation and Consequent pollution hazard.

3.METHODOLOGY

3.1 SELECTION OF WASTE PLASTIC TYPES:

Different types of waste plastic, such as bottles, plastic containers, and plastic bags, will be collected from recycling centers or waste management facilities. The collected waste plastic will be sorted, cleaned, and shredded into uniform sizes to facilitate incorporation into brick manufacturing.

3.2 FORMULATION OF BRICK COMPOSITIONS:

Various mix designs will be developed by substituting a percentage of clay with shredded waste plastic. The proportions of waste plastic to clay will be optimized to ensure the desired properties of the plastic-modified bricks, including strength, durability, and thermal insulation.

Experimental Procedures for Brick Manufacturing:

a. Mixing: The Fly ash, cement, sand and shredded waste plastic will be mixed thoroughly using a concrete mixer or a pug mill to achieve homogeneity.

b. Molding: The homogeneous mixture will be placed in brick molds of standard dimensions, compacted, and leveled to form brick shapes.

Fig -1: Brick Molds used for casting of plastic bricks.

c. Curing: The molded bricks will undergo curing under controlled conditions of temperature and humidity to promote hydration and development of strength.

d. Concrete mixer or pug mill: A concrete mixer or pug mill will be used for mixing the clay and shredded waste plastic to ensure uniform distribution of materials and achieve homogeneity in the brick composition.

Fig -2: Manufacturing of bricks with plastic waste.

e. Brick Molds: Standard-sized brick molds made of metal or plastic will be used for shaping the plastic-modified bricks during the molding process. These molds will have dimensions conforming to industry standards for bricks.

f. Curing Chamber: A curing chamber equipped with temperature and humidity controls will be utilized for curing the molded bricks. This chamber provides a controlled environment conducive to the hydration process, promoting the development of strength in the bricks.

3.3 TESTING METHODOLOGIES:

Local Testing Method: Free Fall test and scratch test were conducted on bricks to find out the quality of plastic waste composite bricks.

Mechanical Properties: The compressive strength, and water absorption characteristics of the plastic-modified bricks will be determined according to relevant ASTM or ISO standards.

Testing Equipment: Various testing equipment such as compression testing machines, flexural testing machines, water absorption apparatus, are employed to evaluate the mechanical, and physical properties of the plastic-modified bricks according to standard testing procedures.

4. RESULTS

4.1 Compressive Strength Test

Testing the compressive strength of plastic bricks involves subjecting the bricks to pressure to determine the maximum load they can withstand before failing or deforming. The general procedure was followed for conducting compressive strength tests on plastic bricks. Firstly, the compression machine setup is done with appropriate platens for applying load uniformly by ensuring the machine is calibrated and set to zero correctly. After that, plastic brick is placed centrally to apply the load on bricks. Gradual application of load is given to plastic brick until it deforms. The following results were observed for varied proportions of plastic and sand during the test.

Table -1: Results of compressive strength for the ratio of Plastic: Sand = 1:2

Brick Number	Brick 1	Brick 2	Brick 3
Area (mm^2)	26220	26220	26220
Max. Load on Crushing (KN)	630	647	622
Compressive Strength (N/mm^2)	24.02	24.67	23.72

Average= (24.02 + 24.67 + 23.72) /3 = 24.133 N/mm^2

Table -2: Results of compressive strength for the ratio of Plastic: Sand = 1:2.5

Brick Number	Brick 1	Brick 2	Brick 3
Area (mm^2)	26220	26220	26220
Max. Load on Crushing (KN)	711	695	698
Compressive Strength (N/mm^2)	27.11	26.50	26.62

Average= (27.11+ 26.50 + 26.62) /3 = 26.74 N/mm^2

Table -3: Results of compressive strength for the ratio of Plastic: Sand = 1:3

Brick Number	Brick 1	Brick 2	Brick 3
Area (mm^2)	26220	26220	26220
Max. Load on Crushing (KN)	570	553	567
Compressive Strength (N/mm^2)	21.73	21.09	21.62

Average= (21.73+ 21.09 + 21.62) /3 = 21.48 N/mm^2

From the Table 1, 2 and 3, it can be observed that, highest compressive strength was achieved for the 1:2.5 ratio of Sand: Plastic and the strength was 26.74 N/mm^2. When ratio changed to 1:3, compressive strength was reduced to 21.48 N/mm^2

Fig -3: Compressive strength test on plastic bricks

4.2 Water Absorption Test

To check the ability of bricks to absorb the water, there is need to perform the water absorption test on bricks. The ability to absorb the water should not exceed 20% of their weight is the thumb rule as it affects to its strength. Firstly, the moisture in the brick is eliminated by heating the brick in a oven at a temperature of 110°F the it was cooled at room temperature. Then bricks are soaked in water for 24 hours at room temperature. After that following results were observed for water absorption.

Table -4: Results of water absorption test

Sample	Dry Weight (KG)	Wet Weight (KG)	W (%)
Brick 1	2.526	2.689	6.45
Brick 2	2.387	2.499	4.69
Brick 3	2.791	2.960	6.05
		Average	5.73

Results of water absorption test shows that the plastic composite bricks have lowest water absorption than the normal conventional bricks.

5. CONCLUSIONS

Using plastic waste in bricks offers several potential benefits, depends on various factors such as environmental impact, durability, and economic feasibility. The use of plastic waste in bricks holds promise as a sustainable solution to address both waste management and construction material needs.

The present study investigated that, highest compressive strength was achieved for the 1:2.5 ratio of Sand: Plastic as a partial replacement of sand in bricks and the strength was 26.74 N/mm^2. When ratio changed to 1:3, compressive strength was reduced to 21.48 N/mm^2. The study also investigated that water absorption test shows that the plastic composite bricks have lowest water absorption than the normal conventional bricks.

It is essential to conduct comprehensive research and testing to ensure that plastic-infused bricks meet safety standards, are environmentally responsible throughout their lifecycle, and are economically viable. Collaboration between researchers, policymakers, and industry stakeholders is crucial to realize the potential benefits of this innovative approach while mitigating associated risks.

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