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Green Innovation: Converting Waste Plastics Into Durable Building Bricks

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Abstract : *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's simply thrown away, creating all kinds of hazards. Plastic is not bio degradable, so it will continue to be hazardous for more than centuries. The idea of this paper is to find a use for this waste plastic scrap into something beautiful. The mixing of plastic with sand to create a new type of brick was put into thought. Since it is uneconomical to approach a local brick manufacturer for lending the machine, we will be designing and fabricating a brick manufacturing machine in the nearby engineering workshop. The machine is to be designed so as to fulfill our need for manufacturing brick in small quantity. The plastic scrap to be used will be leftover pieces of bottles, cans etc. So, as a trial the plastic is to be chopped into small pieces and heat will be supplied from below. Into the molten plastic paste, M- sand is to be added in suitable proportions.*

Keywords: Compressive test, Efflorescence test, M-sand, Plastic, Water absorption test.

I. INTRODUCTION

Plastic is one of the most widely used materials because of its low cost, durability, and versatility. However, its non-biodegradable nature has made plastic waste a major environmental concern worldwide [1]. Plastic products are commonly used as low-cost alternatives to traditional materials, such as polyethylene bags replacing jute bags, which has significantly increased plastic consumption [2]. Since plastic can persist in the environment for several centuries, the accumulation of plastic waste has become a serious challenge. Rapid population growth, urbanization, industrialization, and changing lifestyles have further accelerated plastic waste generation [3].

India generates nearly 40 million tonnes of municipal solid waste (MSW) annually, with waste generation increasing by approximately 1.5–2% every year. Effective plastic waste management has therefore become an urgent necessity to reduce environmental pollution and support sustainable development [4]. Recycling and reusing plastic waste in construction materials is considered one of the most promising solutions because it minimizes landfill disposal while conserving natural resources [5].

Recent studies have demonstrated that waste plastic can be successfully converted into construction materials such as paving blocks, railway sleepers, concrete blocks, and plastic-sand bricks by combining recycled plastic with materials such as sand, fly ash, or stone powder [6]. Experimental investigations have shown that bricks manufactured using recycled low-density polyethylene (LDPE) can achieve compressive strengths up to 13.69 MPa, while LDPE–fly ash composite bricks exhibit strengths between 10.42 MPa and 11.48 MPa, exceeding the compressive strength of conventional clay bricks (3–5 MPa) [7].

The present work focuses on developing eco-friendly plastic-sand bricks as an effective solution for plastic waste management. By utilizing waste plastic as a binding material with river sand, the proposed bricks reduce environmental pollution, lower production costs, and decrease dependence on clay extraction. Compared with conventional clay bricks, plastic-sand bricks exhibit lower water absorption, improved surface finish, and adequate mechanical strength for construction applications, making them a sustainable alternative for the building industry [8].

II. PROBLEM STATEMENT

The rapid increase in plastic waste has become a major environmental challenge due to the non-biodegradable nature of plastics and their widespread use in daily life. Conventional disposal methods, such as landfilling and open burning, contribute to land pollution, water contamination, greenhouse gas emissions, and ecosystem degradation. At the same time, the construction industry heavily depends on natural resources such as clay and river sand for manufacturing conventional bricks, leading to resource depletion, soil erosion, and increased carbon emissions. Although several studies have explored the use of recycled plastic in construction materials, there is still a need to develop a cost-effective, durable, and environmentally sustainable brick with improved mechanical properties and low water absorption. Therefore, an effective method for converting waste plastic into high-performance construction bricks is required to reduce plastic pollution, conserve natural resources, and promote sustainable construction practices.

III. OBJECTIVES

- To develop an efficient way for effectively utilization of the waste plastic in construction works.
- Cost comparison between plastic bricks and conventional burnt bricks and fly ash bricks.
- To compare the strength of bricks casted from waste plastic with burnt bricks and fly ash bricks
- To minimize the consumption of natural resources such as clay for the manufacturing of bricks/tiles.
- To reduce and reuse generation of waste plastic on the land and water to avoid land and water degradation and Consequent pollution hazard.

IV. LITERATURE SURVEY

Paper 1: Manufacturing and Experimental Investigation of Bricks with Plastic and Sand

Authors: Aiswaria K., Khansa Abdulla, E. B. Akhil, Haritha Lakshmi V. G., and Jerin Jimmy (2018)

This study investigated the production of eco-friendly bricks using recycled PET plastic and M-sand. The waste plastic was melted and mixed with sand in different proportions before being cast into brick moulds. Various tests, including compressive strength and water absorption, were performed to evaluate the brick quality. The results showed that plastic-sand bricks possessed higher compressive strength, lower water absorption, and better durability than conventional clay bricks. However, the study did not investigate the long-term durability or thermal insulation properties of the developed bricks.

Paper 2: Construction Structures Using Eco-Bricks

Authors: Nitin Goyal and Manisha (2016)

The authors focused on the utilization of waste plastic to manufacture eco-bricks for sustainable construction. Their research demonstrated that eco-bricks reduce plastic waste disposal while providing a lightweight and cost-effective alternative to conventional building materials. The study concluded that plastic-based bricks could significantly contribute to environmental conservation..

Paper 3: Fabrication of Plastic Brick Manufacturing Machine and Brick Analysis

Authors: Gopu Mohan C., Jikku Mathew, Jithin X. Ninan Kurian, and John Thomas Moolayil (2016)

This research presented the design and fabrication of a plastic brick manufacturing machine capable of converting waste plastic into construction bricks. Mechanical testing indicated that the produced bricks had satisfactory compressive strength and could be manufactured at a relatively low cost. Although the machine proved effective for brick production, the study mainly concentrated on machine development and did not optimize the material composition for maximum brick strength and durability.

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Paper 4: Manufacturing Bricks from Sand and Waste Plastics

Authors: Loukham Gerion Singh, Pongsumbam Boss Singh, and Suresh Thokchom (2017)

This study proposed the use of waste plastic and river sand for manufacturing construction bricks. Different plastic-to-sand ratios were tested to evaluate their compressive strength and water absorption characteristics. The experimental results showed that plastic-sand bricks offered good mechanical strength, low water absorption, and an environmentally friendly alternative to conventional clay bricks. However, the research did not examine long-term field performance, thermal properties, or large-scale industrial implementation.

IV. WORKING OF SYSTEM

A. Collection and Preparation of Raw Materials

The Email/URL Input module acts as the entry point of the phishing detection system. It collects suspicious emails and website URLs from users, browser extensions, email servers, or security gateways. The module validates the input data, checks its format, and securely transfers it for further analysis.

Fig 1: Block Diagram

B. Mixing and Melting Process

The shredded plastic is heated in a metal drum at a controlled temperature of approximately **180–200°C** until it reaches a molten state. Once the plastic is completely melted, pre-measured quantities of river sand and thermocol are gradually added according to the selected mix proportion. Continuous stirring is performed to obtain a homogeneous mixture

C. Brick Moulding and Cooling

The prepared plastic-sand mixture is immediately poured into a standard brick mould coated with a thin layer of oil to facilitate easy removal. The mixture is compacted using a tamping rod to eliminate air voids and achieve proper density..

D. Performance Testing

The manufactured bricks are tested according to standard testing procedures to evaluate their engineering properties. The tests include compressive strength, water absorption, efflorescence, hardness, soundness, impact resistance, and shape and dimensional accuracy.

E. Result Analysis and Sustainable Application

The experimental results are analyzed by comparing the performance of different brick compositions. Among the tested samples, the brick containing 25% recycled plastic, 70% river sand, and 5% thermocol demonstrated the highest compressive strength of 4.55 N/mm² while maintaining low water absorption and good durability.

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V. SYSTEM DESIGN

A. Hardness Test

A good brick should resist scratches against sharp-edged things. So for this test a sharp tool or finger nail will be used to make a scratch on the brick. If there is impression of scratch on the brick then it is called to be a hard brick.

Fig 2: Hardness Test

B. Material Processing Module

After preparation, the plastic waste is shredded into small pieces to facilitate uniform melting. The shredded plastic is heated in a metal drum at a controlled temperature of **180–200°C** until it becomes molten. River sand and thermocol are then added in predetermined proportions.

Fig 3: Material Processing Module

C. Compression Test

the cubical brick specimen will be placed in the compression strength testing machine. After placing it we will apply the load on the brick without any impact. The load will be increased at a rate of 140 kg/cm2 min continuously till the specimen's resistance to increasing load breaks down and it cannot withstand any greater load further.

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Fig 4: Compression Test

D. Shape And Size Test

In this test, a brick is closely inspected. The brick should be of specified size and its shape should be truly rectangular with proper edges. For this purpose, 9 bricks of standard size (200 mm x 100 mm x 100 mm) are to be selected at random and they will be stacked lengthwise, along the width and along the height.

Fig 5: Shape And Size Test

E. Soundness Test

Soundness test of bricks presents the nature of brick against sudden collision. In this test two bricks are chosen randomly and struck with one another for finding out soundness of the brick. The sound produced after striking the bricks with each other should be clear bell ringing sound and bricks should not break, then it is said to be a good brick.

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Fig 6: Soundness Test

VI. RESULTS

Test Results Of Compression Test

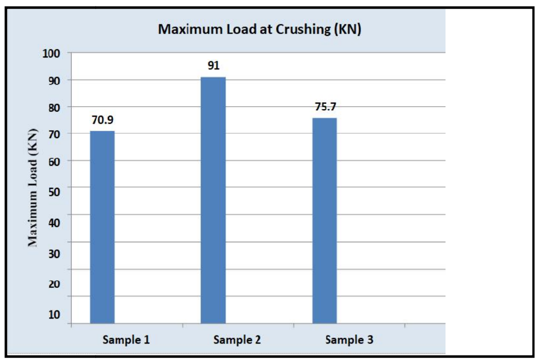

Fig 7: Graph 1

Following graph shows the maximum crushing load of each composition. The crushing load of composition 1 is 70.93, the crushing load of composition 2 is 91, and the crushing load of composition 3 is 75.7. The crushing strength of the brick is increasing up to the 2nd composition after that it is decreasing thus proving 2nd composition having the optimum content of plastic as a brick constituent. It shows that if we use 25% of plastic and 70% of sand then the crushing load of the brick will be maximum

Compressive Strength of Sample

The following graph shows the compressive strength of each composition increasing up to the 2nd composition having plastic content 25% after that decreasing, indicating it to be the optimum content for the plastic sand brick as it has the maximum compressive strength amongst the three samples.

The compressive strength of composition 1 is 2.705, compressive strength of composition 2 is 3.47, and the compressive strength of composition 3 is 2.88. It shows that if we use 25% of plastic and 70% of sand than the compressive strength of brick will be maximum

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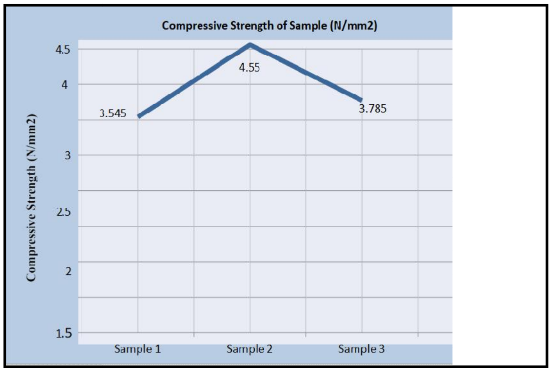

Fig 8:Graph2

Test Results of Water Absorption Test

The following graph shows the average dry weight and average wet weight of each composition.

The average dry weight of composition 1is 2.800, average dry weight of composition 2 is 2.800 and the average dry weight of composition 3 is 2.822.

The average wet weight of composition 1 is 2.801, average wet weight of composition 2 is 2.802, and the average wet weight of composition 3 is 2.814. Hence it shows that composition 1 absorbs less water than other 2 compositions i.e. if we use 15% of plastic than water absorption is lesser. Water absorption of the brick increases with the increase in plastic percentage in the brick

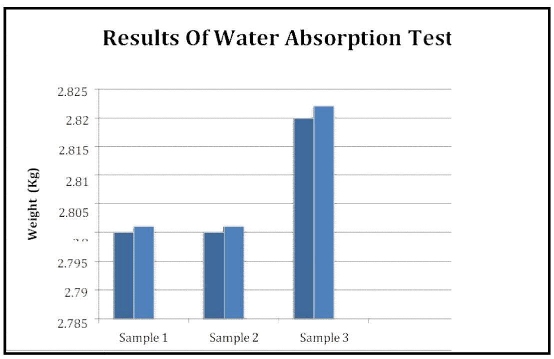

Fig 9:Graph 3

Following graph shows the plastic percentage verses water absorbed by each composition of brick.

If 15 percent of plastic content is there in the composition then the water absorption is lowest

i.e. 0.03.

If we use 25 percent of plastic content in the brick then water absorption is 0.4, if we use 35 percent of plastic in the brick then the water absorption is 0.1 i.e. highest

It shows that if we increase plastic percentage in mixture the water absorption also increases

i.e. water absorption is directly proportional to the plastic content in the brick.

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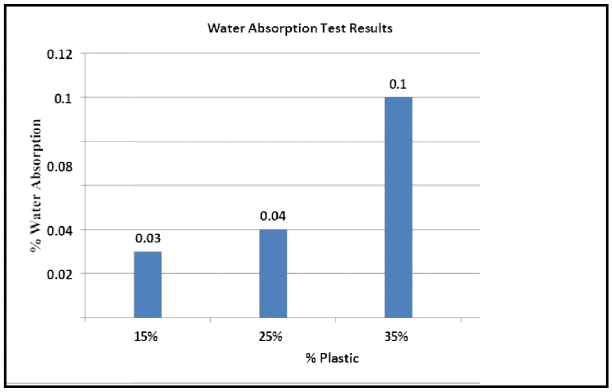

Fig 10: Graph 4

VIII. FUTURE SCOPE

The proposed plastic-sand brick technology provides significant opportunities for future research and practical applications in sustainable construction. Further investigations can focus on optimizing the ratio of different types of waste plastics and sand to achieve enhanced mechanical strength, durability, and thermal performance. Advanced testing methods such as long-term weather resistance, fire resistance, impact strength, and structural behavior analysis can be conducted to evaluate the suitability of plastic-sand bricks for large-scale construction applications.

Future work can also explore the integration of additional waste materials such as fly ash, industrial waste, glass powder, and natural fibers to improve the properties of recycled bricks and develop more sustainable composite materials

CONCLUSION

The increasing generation of plastic waste has created a significant environmental challenge due to its non-biodegradable nature and improper disposal practices. The utilization of waste plastic in construction materials provides an effective approach for reducing plastic pollution while promoting sustainable development. In this research work, the development of plastic-sand bricks using recycled waste plastic as a binding material demonstrates a promising alternative to conventional clay bricks.

The proposed plastic-sand bricks help in reducing dependence on natural resources such as clay and minimize the environmental impacts associated with traditional brick manufacturing. These bricks offer advantages such as low water absorption, improved durability, effective waste utilization, and potential cost reduction.

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