Comparison Of Production And Properties Of Polymer Sand Bricks With Conventional Clay Bricks By Altering Polymer Sand Ratio

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Abstract- *Bricks, essential in construction, are evolving to meet economic and environmental demands. Incorporating waste plastics into brick production offers a sustainable solution, reducing plastic pollution and minimizing landfilling and incineration.*

This study explores producing plastic sand bricks using polyethylene waste, detailing the process from raw material preparation to molding and curing. It also compares their properties with traditional sand bricks.

Four samples with varying plastic-to-sand ratios were tested for compressive strength, water absorption, efflorescence, and fire resistance. Results showed plastic sand bricks have high hardness, durability, low water absorption, and no efflorescence.

Additionally, these bricks demonstrated improved tensile strength and reduced weight, enhancing their construction suitability. The findings suggest plastic sand bricks as a viable, eco-friendly alternative, addressing plastic waste while providing durable building materials and supporting a circular economy.

Keywords- plastic bricks, polyethylene, polypropylene, sand bricks, plastic waste.

I. INTRODUCTION

Brief Introduction

Plastics, composed of synthetic organic polymers, are extensively used in products such as construction materials, food packaging, clothing, medical supplies, water bottles, and electronic devices. Over the past six decades, plastics have become indispensable due to their versatility, diverse chemical compositions, and wide range of applications. Initially perceived as harmless, their persistent disposal has led to significant environmental concerns. Plastic waste pollution, particularly in aquatic ecosystems, poses severe threats as plastics degrade slowly, impacting wildlife and proving difficult to remove.

Single-use plastics, including packaging and sheeting, are often discarded after use but persist in the environment due to their durability. Although research on plastic pollution is ongoing, existing findings raise serious concerns. Petroleum-based plastics are prevalent in homes and offices, and once their utility ends, they are often disposed of in landfills alongside municipal solid waste. These plastics contain harmful chemicals like phthalates, bisphenol A (BPA), brominated flame retardants, polyfluorinated compounds, and antimony trioxide, which can leach into the environment and pose health risks.

Furthermore, e-waste plastics have become a major global concern due to inadequate waste management systems. Reports from countries like China, Nigeria, and India highlight the leakage of hazardous plastic compounds from e-waste into the environment, exacerbating public health and environmental hazards.

Bricks In Construction:

The most often utilized material in the construction business is concrete bricks. One of the drawbacks of red clay bricks is that they emit greenhouse gases when they burn. Paihte P. L. et al. combined building waste with plastic bottle trash to conduct an experimental investigation on material-filled waste plastic bottles. With a similar compressive strength, it is the ideal substitute for red bricks. The compressive strength of plastic bottles made from finer aggregates (less than 425 μm) was higher. The manufacturing of plastic waste is growing at an alarming rate. Between 1960 and 2010, the percentage of plastic garbage in solid waste in the United States increased from 0.5% to 12.5%. 75% of the plastic that has ever been created worldwide has reportedly ended up as trash, with 100 million tons, or one-third, of that amount contributing to pollution on land or in the ocean. If significant action is not taken, an additional 100 million tons are predicted by 2030. Finding alternate methods for reusing waste plastics is therefore urgently needed. Traditional civil engineering materials like steel and concrete need a lot of energy to produce and produce pollutants.

Introduction to the Research Topic:

In essence, the current study is an experimental exploration of the mechanical and constructional features of a novel class of polymer-bricks that are packed with sand particles and molten plastic. An essential metric for characterizing the mechanical properties of particulate-filled polymer composite systems is the material's effective compressive strength, efflorescence production tendency, water absorption, and fire resistance. The thermal conductivity of these materials is influenced by a number of intricate aspects.

A one-dimensional conduction model is suggested in light of the thesis to estimate the material's compressive strength, efflorescence formation propensity, water absorption, and fire resistance capabilities of particulate-filled polymer composites with varying filler concentrations. An experimental analysis of a collection of polymer-particulate composites confirms the correlation. It is investigated how adding more reinforcement to the sand aggregate affects the material's compressive strength, efflorescence formation propensity, water absorption, and fire resistance of the polymer-brick particles.

Research Topic:

The work focuses on experimentally examining the mechanical and constructional properties of polymer sand bricks. Important mechanical and constructional aspects of polysand bricks are examined, including their compressive strength, propensity for efflorescence development, water absorption, and fire resistance. The weight percentages of the liquid polymer and sand particles are changed to 15:85, 25:75, and 35:65. Mechanical properties are investigated and specimens are manufactured in accordance with ASTM guidelines. The poly sand brick is ready with a particular interlocking design. Have a strong interlocking ability.

II. LITERATURE REVIEW

The literature review conducted for this study is summarized in the current chapter. This literature review's goal is to give background knowledge on the topics surrounding the current study in order to delineate its goals. Thus, this paper covers a number of topics related to polymer sand bricks, with particular emphasis on their fire resistance, water absorption, efflorescence formation propensity, and mechanical constructional compressive strength. A summary of the literature review and the knowledge gap in previous studies are provided at the chapter's conclusion. The goals of the current research project are then described.

On brick production:

Mondal M. K. investigated the characteristics of plastic bricks made from fly ash, sand, regular cement, and a mixture of plastics, polycarbonates, and polystyrene. The produced bricks have a compressive strength of around 17 MPa and excellent heat resistance. Low density polyethylene (LDPE) sand blocks with a compressive strength of up to 27 Mpa were examined by Cheeseman C. et al. The size of the sand particles had an inverse relationship with the density and compressive strength. After failure, 30% of the load is retained by LDPE-bonded sand brick. The compressive load on three different types of bricks—polypropylene and rubber, LDPE and rubber, and clay bricks—was compared by Shiri N. d. et al. The largest compressive load, up to 17 tons, is offered by polypropylene and rubber composite plastic sand bricks among these three varieties.

Pakrashi et al. tested the bricks made from leftover Polyethylene Terephthalates (PET) bottles using compression, sound insulation, and light transmission. Manufactured Eco bricks were shown to have a number of benefits, including a high sound reduction index, a lower risk of damage from lifting heavy objects, non-brittleness, light weight, and lower transportation costs [8]. Wahid et al. investigated the impact of the ratio of waste plastic to sand in the production of plastic sand bricks. Compressive strength falls when the ratio of plastic to sand increases because of the weakening of the cement-plastic adhesive. These bricks are appropriate for minimal workability applications such as canal linings and partition wall panels.

Kumar et al. conducted characterization tests on the plastic bricks and investigated the process of producing them by adding thermocol, waste plastic, and produced sand in varying amounts [6, 13]. The plastic bricks made from fly ash, sludge lime, gypsum, fine aggregate, and high density polyethylene waste plastic bottles in different ratios were also examined by Kumar et al. The amount of plastic utilized in the samples ranged from 5 to 20%, and it was discovered that as the proportion of plastic increased, the compressive strength decreased as well.

III. KNOWLEDGE GAP IN EARLIER INVESTIGATIONS

Despite the numerous studies that have been published in the past, there is still a significant knowledge gap that necessitates a thorough and organized investigation into the field of sand particle-filled polymer composites. According to a thorough analysis of the published literature, the majority of studies focus on adding conductive fillers to increase the polymer's tensile strength, compression strength, bending strength, and hardness rather than trying to improve its mechanical properties. The literature contains reports on studies conducted on the mechanical behaviour of polymer composites with metal fillers, but very few on composites filled with powdered metal and particulates.

Although a few studies on the mechanical behaviour of metal powder-filled polymer composites have been published, there hasn't been any discussion of the potential synergy that could result from combining the two metals in epoxy to increase changed mechanical properties.

Given the foregoing, the current study aims to examine the mechanical and structural characteristics of polymer matrix composites that contain sand particles.

IV. OBJECTIVES OF THE PRESENT WORK

The main objective of the work as follows:

- The production of materials with varying weight proportions
- The specimens are manufactured in accordance with ASTM standards, and
- Their mechanical and structural qualities are assessed by testing.
- The brick is prepared with interlocking capability.

V. EXPERIMENTAL SETUP

5.1 Raw materials & apparatus

- Plastic waste material i.e. polypropylene pipes and polyethylene bags,
- Soft refine sand(1.18mmsoft),
- Gas cooker, weighing balance, storage drums

5.2 Collection of Plastic Materials:

The plastic material, which falls under the LDPE plastic type, should be gathered from the waste of companies, hospitals, and industries as well as from food packaging and plastic bottles. gathering of waste polyethylene bags and scrap polypropylene pipes from nearby industries

5.3 METHODOLOGY

- CollectionofMaterials.
- Batching.
- Melting.
- Mixing.
- Moulding.
- Curing.

5.3.1 CollectionofPlasticMaterials:

The plastic material, which falls under the LDPE plastic type, should be gathered from the waste of companies, hospitals, and industries as well as from food packaging and plastic bottles. gathering of waste polyethylene bags and scrap polypropylene pipes from nearby industries

5.3.2 Batching of plastic

Batching is the process of measuring the materials used to make bricks. Following material collection, we sort the different kinds of plastic, eliminate any further debris that may have been there, and make sure that there is no water present in the sample before burning it. Waste plastic was washed to get rid of any dust and other impurities, and it was let to dry for a day.

Weighting of sand and plasticSand sieving process

5.3.3 **Burning of waste plastic**

Once batching was finished, the plastic garbage was carried to a burning facility, where plastic bags were dropped into a container one at a time and left to melt. In order to avoid releasing harmful gasses into the atmosphere, these would be carried out in closed vessels. The temperature for these will be between 120 and 150 degrees Celsius. After being cleaned to get rid of all dust and other impurities, waste plastic was left to dry for a day. The heater was filled with a 1:1 ratio of polypropylene and polypropylene waste, and it was heated to 180 degrees Celsius.

5.3.4 **Mixing**

In order to produce brick that is both uniform and strong, the components must be mixed. The mass must be mixed to achieve homogeneity, consistency, and uniformity in color. Hand mixing and mechanical mixing are the two main categories of mixing. For this project, hand mixing was used. Until all of the plastic that is needed to make one mix proportion of plastic brick is added. Before it solidifies, these plastic liquids are then properly blended with a trowel. River sand is added to the mixture, which has a very short setting time before the bags melt. It is mixed time when the sand is introduced. Therefore, the mixing process shouldn't take longer.

5.3.5 Moulding

We put the mixture into the appropriate mold once it has been properly mixed. We use standard brick sizes (19x9x9 cm) for these designs. After two days, take the brick out of the mold, and it will have finished curing. determining how to portion plastic sand into a specific ratio in order to create four samples of plastic sand bricks.

High-density polyethylene melts at 180 degrees Celsius, while polypropylene melts at 160 degrees. To add a deep red hue, combine 5 grams of red oxide with the melted mixture. Depending on the required ratios, sand is added. Steel rods were used to adequately mix the mixture before it was poured into the molds. The sides of the molds were greased to make removal easier before the substance was poured into them.

Sample were kept for 24 hours fordrying and removed from the molds. It was kept to cure for 14 days.

5.3.6 Curing

Following molding, the test specimens were let to dry for a full day. For a duration of 28 days, the specimens were housed in a curing tank and permitted to cure. Following curing, the sample bricks underwent compression, water absorption, and efflorescence tests in the lab.
Casting of brick

Figure 2: Manufactured Plastic Bricks Samples

Specimen preparation:

Weight of plastics and bricks: Weight of each plastics and brick samples was measured and given in the Table. As the sand ratio is increases the weight increases. In this process three specimens are made with different weight percentage. Specimens for compression test, effloresces test, water absorption test and fire resistance property. The following table indicates the specimen weight ratios i.e. percentage of sand and percentage of plastic.

SI No	Plastics and Weight %	Size of brick (mm)	Weight of PSB (kg)
1	15-85	(75×120×50)	3.5
2	25-75	(75×120×50)	4.9
3	35-65	(75×120×50)	5.2

Table1: Weight of three samples of Plastics and bricks

VI. RESULTS AND DISCUSSION

Compressive strength:

The first and foremost the important test to be considered is compression test. The brick should posses' high compressional strength. Here the fore specimens with different weight proportions specimens are subjected to compression test. The min average compression strength of bricks is 7.5N/mm2. The sand polymer bricks possess high compression strength then the general bricks. Results show various compression strength of bricks made up of polymer and sand. When the percentage of sand is more compression strength is maximum and decreases with the increasing the percentage of polymer in the sand. The compression strength of the specimen-1 is maximum i.e, 12.43N/mm^2. but the bonding between the sand particle is less due to the less percentage of plastic in brick. The brick percentage of 25:75 should be considered as best by taking the bonding of sand particles under consideration.

Sample no	Plastic-sand ration	Dimensions of sample in mm	Max load Applied (KN)	Compressive Strength (N/mm^2)
1	15-85	40*40	303.0	12.43
2	25-75	40*40	102.8	9.76
3	35-65	40*40	133.2	8.21

Table3: Compressive test results

Effloresces test: Even though efflorescence is thought to be harmless, it is still unacceptable: if there is a noticeable amount of efflorescence on the bricks, it could eventually cause deterioration like breaking and peeling due to increased moisture, which would cause the building to collapse and require reform. Based on this experience, the experiment's results showed no discernible efflorescence deposits.

Nil	0%
Slight	Upto10%
Moderate	10%-50%
Heavy	Morethan50%withoutPowdered flakes
Serious	Morethan50%withPowderedflakes

Alkali presence in the bricks as appeared on the surface

The efflorescence in the brick can be categorized in to the above categories on the basis of area covered by salt/alkalis.

Water absorption test: Since the bricks' water absorption guideline is that they should not absorb more than 12% of their weight in water, the water absorption findings for plastic sand bricks range from 0% to 2.8%. While having 0% water absorption, as in sample 3, is not ideal, a tiny degree of water absorption is necessary in the building industry to avoid future cracks or defects. However, because scrap plastic was utilized instead of concrete, the outcome is satisfactory. The following formula is used to measure the amount of water absorption.

$$W_a=\left(\frac{W2-W1}{W1}\right)\times 100$$

Where, W_a= water absorption percentage,
W2=weight of brick after test and

W1=weight of dry brick sample.

Sample No	Plastics and ratio	W1(kg)	W2(kg)	W a%
1	15-65	6.1	6.2	1.64
2	25-75	4.9	5	2.04
3	35-85	4.6	4.6	0

Table2:water absorption test results

It has been observed that the polymer sand brick with percentage of 25:75 is considered as a best quality because of its water abortion capability.

Fire Resistance Test:

BIS 3809 1979 serves as the test's standard. In the event of a fire, the sand and plastic mixture may tolerate temperatures that polymers alone typically cannot. Plastic alone is easily vulnerable to high temperatures, if not combustible.

Up to 180 degrees Celsius, the bricks' structural integrity has been found to stand up very well. In order to determine whether the qualities have changed, we will first heat and retain the brick in the furnace at the standard testing temperature before performing the compressive strength test.

VII. CONCLUSION

The newly created plastic sand bricks have a number of features and benefits that will advance global development, such as reducing the amount of plastic waste that accumulates through recycling, which will reduce the need for conventional disposal techniques and protect the environment and living things. Additionally, making plastic sand bricks from readily available materials for use in the construction industry. The steps involved in making plastic sand bricks began with gathering discarded plastic and soft, refined sand as basic materials. The mixture was then heated until it became a liquid. After that, a pre-made mould is used to shape the entire mixture into a fixed-size plastic sand brick sample.

According to the results, plastic sand bricks have new qualities that would be useful in the construction industry. These include zero efflorescence, a range of (zero-slight) water absorption, good fire resistance, and a high compressive strength of up to 12.43 N/mm^2 for plastic sand bricks with a ratio of 25-75. when compared to regular concrete bricks. In conclusion, the new plastic sand bricks product will significantly reduce greenhouse gas emissions, waste plastic removal, the amount of clay and cement used to make bricks, and brick manufacturing costs.

Conversely, this brick has a certain amount of tensile strength that regular clay bricks lack. By giving the structure rigidity, this maintains the structures during earthquakes.

REFERENCES

[1] Abtihal l Zadjali, Walke, S. (2016). Plastic Recycling to Produce Fuel.*International Journal of EmergingTechnologiesandEngineering*, *3*(6), 44–47.

[2] Deepak Shiri, N., VarunKajava, P., V, R. H., LloydPais, N., &Naik, V. M. (2015). Processing of WastePlastics into Building Materials Using a Plastic Extruder and Compression Testing of Plastic Bricks.*JournalofMechanicalEngineeringandAutomation*, *5*(3B),39–42.https://doi.org/10.5923/c.jmea.201502.08.

[3] Mondal, M. K., Bose, B. P., & Bansal, P. (2019). Recycling waste thermoplastic for energy efficient constructionmaterials: An experimental investigation. *Journal of Environmental Management*, *240*(February), 119–125.https://doi.org/10.1016/j.jenvman.2019.03.016.

[4] Karthikeyan, M., Balamurali, K., V, B. K., S, M. P., & Janarthanan, R. (2019). Utilization of Waste Plastic inConcreteUtilizationofWastePlasticinConcrete,(April).

[5] Kognole, R. S., Shipkule, K., &Survase, K. S. | M. P. | L. P. | U. (2019). Utilization of Plastic waste for MakingPlastic Bricks. *International Journal of Trend in Scientific Research and Development*, *Volume-3*(Issue-4),878–880.https://doi.org/10.31142/ijtsrd23938.

[6] Kumar, K. P., & Gomathi, M. (2017). Production of Construction Bricks by Partial Replacement of WastePlastics, *14*(4), 9–12.https://doi.org/10.9790/1684-1404020912.

[7] Kumi-Larbi, A., Yunana, D., Kamsouloum, P., Webster, M., Wilson, D. C., & Cheeseman, C. (2018). Recyclingwaste plastics in developing countries: Use of low-density polyethylene water sachets to form plastic bondedsandblocks.*WasteManagement*,*80*, 112–118.https://doi.org/10.1016/j.wasman.2018.09.003.

[8] S. A Gaikar, R Bhore, S Ambre, Walke. (2015).Stored Potable Water-Evaporation Reduction by Thin FilmSurfaceCoating.Int.J. Inf.Futur.Res.,vol.2,no. 8, pp.2929–2935.

[9] LalzarlianaPaihte, P., Lalngaihawma, A. C., & Saini, G. (2019). Recycled Aggregate filled waste plastic bottlesasareplacementofbricks.*MaterialsToday:Proceedings*,*15*,663–668.https://doi.org/10.1016/j.matpr.2019.04.135.

[10] Dinesh.S, Dinesh.A, Kirubakaran.K, “UTILISATION OF WASTE PLASTIC IN

MANUFACTURING OF BRICKS AND PAVER BLOCKS'' International Journal of Applied Engineering Research, ISSN 0973-4562, Volume 1, 2016.