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Full Length Research Paper

Evaluation of Brick Tile Production from Plastic Waste

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ABSTRACT: Plastic garbage is non-biodegradable, and incorrect disposal of spent plastic causes pollution and damage of the surrounding environment. This research involves the utilization of plastic waste in the construction of brick tiles in order to reduce the threat of environmental pollution caused by the continual disposal of plastic trash in developing countries. The brick tiles were made by combining sharp sand with molten plastics in various ratios of 1:1, 1:2, 1:3, and 1:4, with a sand-cement mixture serving as the control. The study's findings revealed that the optimum value was obtained at the plastic sand mixing ratio of (1:3), with compressive strength, weight, density, and load failure of 8.46KN/mm^2, 3.02kg, 1799.23kg/m^3, and 84.6KN, respectively, which is greater than the value of the conventional type (control), with compressive strength, weight, density, and load failure of 6.29KN/mm2, 2.74kg, 1543.68kg/m^3, and 62.93KN, respectively. When compared to the traditional type (control) with a water absorption ratio of 3.61 percent, the plastic sand combination was found to have the least and best water absorption ratio at a mixing ratio of 1:3 (2.97%). When compared to the control, the optimal compressive strength, weight, density, and load failure of the manufactured plastic sand brick tiles are within the specified standard.

Keywords: Pollution, quartz, compressive strength, thermal conductivity, thermoplastic, thermoset

INTRODUCTION

Pollution has been considered as a metaphor of inefficient resource utilization (FAO, 2016). As we all know, the globe has been in a constant battle to preserve the environment while still fostering human progress, particularly in terms of enhancing their well-being. Environmental sustainability has been a hot topic at a number of international conferences and gatherings.

Municipal solid garbage, agricultural waste, building and demolition debris, medical waste, and other types of waste are generated by households and industries. Plastic consumption has increased as the world population and urbanization have continued to rise, particularly in low-income nations. Plastic use has surged from 5 million tons in the 1950s to nearly 100 million tons now.

Plastics account for about 3-7 percent of municipal garbage (Noel et al., 2015). As waste generation increases, solutions to reduce, reuse, recycle, and transform it should be adopted and implemented. Reusing materials are a recent trend in waste management (Kehinde et al., 2020). Plastics are divided into two types: thermoplastics and thermoset plastics. The melting point of thermoplastics is low. When heated, the plastic softens and melts, allowing it to be recycled or turned into different end products.

Thermosetting plastics, on the other hand, can sustain greater temperatures without losing stiffness; as a result, thermosetting materials cannot be remolded or recycled with heat (Osaruwense et al., 2020). Plastic garbage is frequently burned in the open air in most parts of Nigeria as a waste management practice, which has negative consequences for air, soil, and water quality (Shinde et al., 2018).

Bricks and tiles created from plastic waste outperformed standard bricks composed of sand, cement, and clay in terms of water absorption, compression strength, breakability, and so on. The conversion of plastic trash into

bricks are a significant sustainable material management practice that will not only create jobs but also maintain the environment safe for future generations (Mohan et al., 2018). As a result, the purpose of this research is to assess the manufacturing of brick tiles from plastic trash.

MATERIALS AND METHOD

River sand

Sand is a granular material that occurs naturally and is made up of mineral particles and finely split material. Sand composition varies depending on local rock conditions and sources, although silicon dioxide (SiO2) in the form of quartz is the predominant ingredient of sand in inland continental settings and non-tropical coastal locations. The second most prevalent sand is calcium carbonate, such as aragonite, which was largely formed during the last half billion years by diverse forms of life such as coral and shellfish. Sand is increasingly employed in all aspects of building (Dines et al., 2016).

Waste plastics

When heated in the proper setting, plastics can be formed into various shapes. They arrive in various forms, such as cups, furniture, basins, plastic bags, food and drinking containers, and they end up as waste. Such garbage accumulation in our immediate surroundings can have major effects for human, plant, and animal life. As a result, proper disposal or utilization of these wastes in regenerated forms is critical.

This can be accomplished through the plastic waste management procedure. Plastic waste management can be accomplished by recycling. They are a big polluter of the environment if they are not recycled since they do not breakdown easily, are toxic, and do not enable water to soak into the soil (Dines et al., 2016).

Experimental investigation

Brick tiles are made from sand and plastic. A trial and variation mixing ratio was used to combine the two. In the manufacture of the brick tiles, the plastic was utilized as a binder. Cement and sand aggregate are combined with water in traditional brick tiles. In this investigation, this approach was used as a control. Although cement is utilized as a binding material, recycled plastic brick tiles just require sand and plastic.

Collection of raw materials and mix design

The plastic waste (PET bottles) was gathered from disposal sites and eateries near Auchi Polytechnic and its surroundings. The plastic materials were sorted and washed with water to remove impurities like grease and dirt before being sun dried. Sharp sand was gathered at a construction site. To avoid pores in the completed product, the sand was oven-dried and sieved to achieve consistent sizes of fewer than 500m. The plastic waste (PET bottles) and sand were separately weighed to determine the plastic-to-sand ratios of 1:1, 1:2, 1:3, and 1:4.

Production of brick tiles

The plastics were placed in a melting barrel and gradually heated to between 1600 and 1700 degrees Celsius until they were entirely melted into a molten state. The sand was added and vigorously stirred until the mixture was homogenous (Shinde et al 2018). Following that, the hot mixture was poured into aluminum molds. To avoid air bubbles, the mixture was crushed with a compactor. To make the removal of the moulded brick tiles easier, the molds were beforehand greased with engine oil. The mixture was set aside for twenty-four hours to cool before being removed. Before conducting qualitative studies on the tiles, they were allowed to cure for 28 days (Plates 1 - 3).

Qualitative tests on the sand plastic tiles

Compression test and load failure

The compression test was performed using a digital Matest Universal Testing Machine, as described by (Thirugnanasambantham et al., 2017). The surface area was estimated after measuring the dimensions of the brick tiles. The samples were loaded continually on a machine until the composite material fractured. As a result, the maximum (failure) load was determined and recorded. The equation below was used to compute the comprehensive strength from the maximum load (Osaruwense et al., 2020).

$$\frac{\text{Maximum load} \times 1000\ (N)}{\text{Surface area } (mm^2)} \qquad \text{(equation 1)}$$

Weight and density of the brick tiles

After manufacture, the weight of the brick tiles was measured using a spring balance. The ratio of mass to volume of the created tiles was used to determine the density of the brick tiles. Other material qualities such as porosity, compressive strength, thermal conductivity, and durability will be influenced by the density of paver tiles. Tiles with a lower density than the manufacturer's

(A)

(B)

(C)

Plate 1 (A): Image of materials needed for the production of brick tiles
Plate 2 (B): Image of melting and mixing of plastic and sand
Plate3 (C): Image of the produced brick tiles

specifications are not permitted. The compressive strength of paving tiles increases as the density increases, and the amount of moisture absorbed into the tile decreases (Yalley and Kwan, 2013).

Water absorption ratio test

A water absorption test was performed on the finished brick tiles. Before immersing the composite in cold water, the weight of the composite was measured with a digital weighing balance (model PM 4800). The composite was removed after 24 hours of immersion and allowed to drain for one minute on a wire mesh. With a damp towel, any apparent water droplets on the surface were wiped, and the weight was reweighed. The amount of water taken in was measured (Lalith et al., 2018; Mohan et al., 2018).

RESULTS AND DISCUSSION

The compressive strength of the produced plastic sand brick tiles and control ranged between 5.45 and 8.46N/mm^2 respectively. The compressive strength of the brick tiles was evaluated to be optimum at a mixing ratio of 1:3 (8.46N/mm^2). This value is high compared to the test

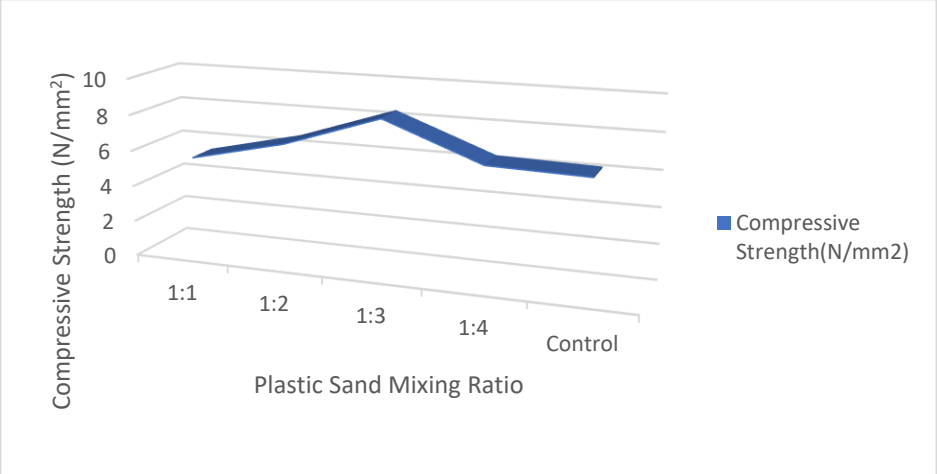

Figure 1: The graph of compressive strength of the respective brick tiles.

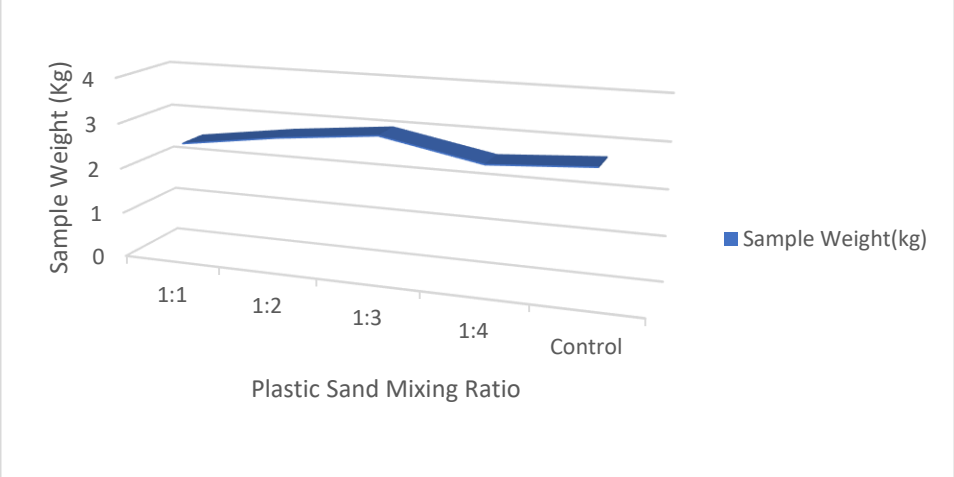

Figure 2: The graph of sample weight of the respective brick tiles.

on the conventional sand-cement brick tiles (control) with an evaluated value of 6.29N/mm^2. This is an indication that the plastic-sand paver is considerably stronger than the sand-cement composite (Figure 1).

The weight of the generated plastic sand brick tiles and the control was 2.50 and 3.02 kilograms, respectively. At a mixing ratio of 1:3, the weight of the brick tiles was determined to be optimal (3.02kg). This number is higher than the 2.74kg value obtained from testing on typical sand-cement brick tiles (control) (Figure 2).

The density of the generated plastic sand brick tiles and the control ranged from 1489.40 to 1799.23 kg/m^3. At a mixing ratio of 1:3 (1799.23kg/m^3), the brick tiles' density was found to be optimal. When compared to the tests on traditional sand-cement brick tiles (control), with an evaluated value of 1543.68kg/m^3, this number is high (Figure 3).

The load at which a brick tile can no longer resist any further load rise, or the load the brick can sustain without breaking, is called load failure (Lalith et al., 2018). The density of a brick has a significant impact on its strength and failure load (Shah et al., 2017). The paver was put between two steel pads of the crushing machine and the load was applied vertically until fracture occurred to ascertain the failure load. The load failure of the manufactured sand plastic brick tiles and the control ranges from 54.5 to 62.93KN.

The load failure of the manufactured brick tiles was found to be optimal at a 1:3 (84.6KN) mixing ratio (Figure 4). This value is higher than the 62.93KN value obtained

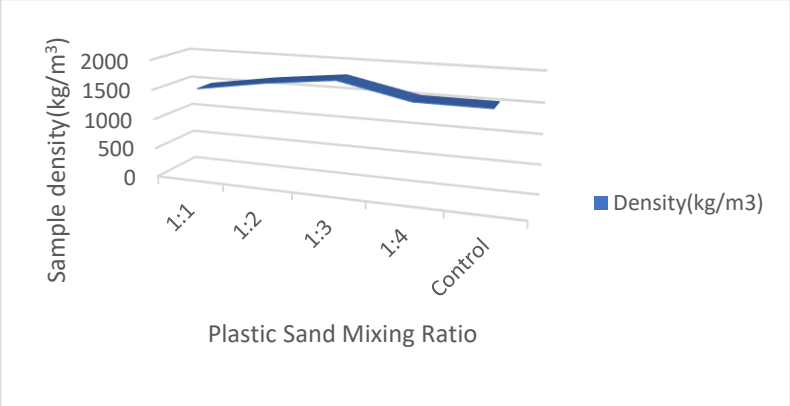

Figure 3: The graph of sample density of the respective brick tiles.

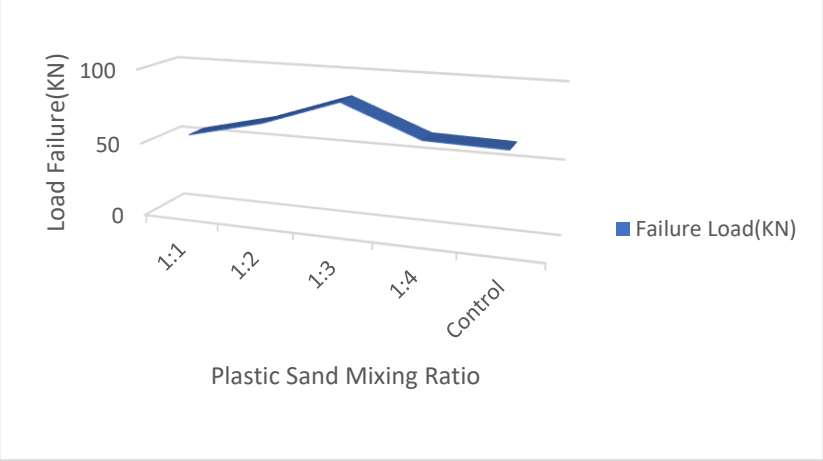

Figure 4: The graph of the load failure limit of the respective brick tiles.

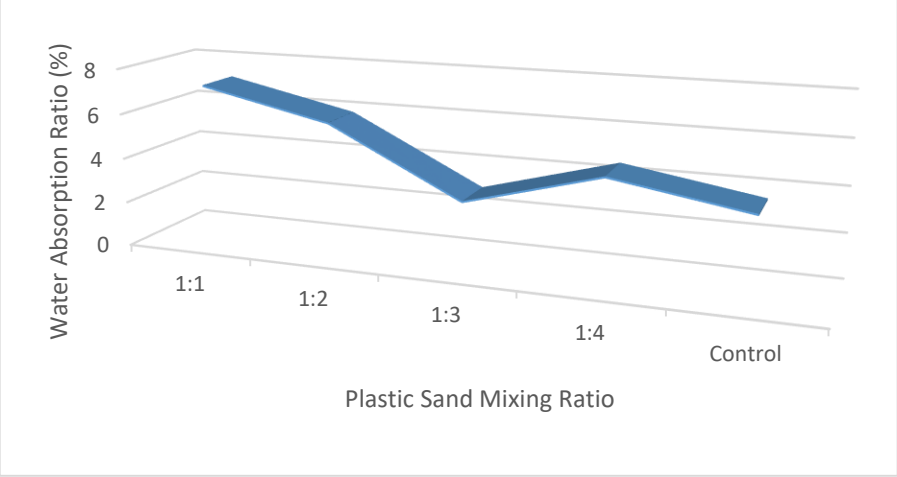

Figure 5: The graph of water absorption ratio of the respective brick tiles.

from a test on typical sand-cement brick tiles (control). This indicates that the plastic-sand paver's estimated optimum value is significantly stronger than the sand-cement composite. The load failure of the created brick tiles was used to determine the compressive strength of a brick.

The water absorption ratio of the individual brick tiles ranges between 2.97 and 7.14 percent, as illustrated in (Figure 5). The water absorption ratio was found to be lowest when using a 1:3 sand plastic mixing ratio and highest when using 1:1. When compared to the control, the water absorption ratio of the 1:3 plastic sand mix is lower (2.97 percent) (3.61%).

Conclusion

Plastic sand bricks have other benefits, such as cost savings, less solid waste, and lower greenhouse gas emissions, among others. This strategy is appropriate for developing and underdeveloped countries that face challenges managing plastic garbage. When compared to traditional sand and cement mixtures, the natural resources used to make plastic-sand bricks and paver blocks are significantly lower. The use of several types of sand could help lower manufacturing costs even more. Further research would increase the quality and durability of the plastic sand bricks and paver blocks manufactured and evaluated in this study due to the multiple benefits.

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