Useful Application of Plastic Waste in Composite Brick Manufacturing

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ABSTRACT

Plastic can be said as a waste, when it is not properly managed and hence imposes the negative environmental effects. All types of non-bio-degradable and unused plastic waste, when cannot be recycled is sent to landfills. Landfills are becoming a big environmental issue and hence expensive with lot of restrictive procedures, forcing the companies to look for alternatives to dispose or reuse plastics. At the same time, reduced availability of conventional binding materials such as clay tested in terms quantity and quality pose a frantic threat for the builders. The proposed research is an experimental development and validation of the use of PET plastics to act as filler materials for brick manufacturing. Samples of bricks were manufactured for studying few design parameters and were tested for the common brick evaluation standards as prescribed by BIS proving that PET plastics can be used as filler materials.

***Keywords:* Composite, Environment, Plastics, Recycle, conventional**

1. INTRODUCTION

Plastic waste involves the accumulation of plastic products in the environment that adversely affects wildlife, habitat or humans [1]. But plastic is a relatively cheap, durable and versatile material and its products have brought benefits to society in terms of economics and quality of life [2]. Because of its demand and use, plastic waste generation has also continued to grow. However, at the global scenario, although its production and utility is being met according to the demand, the proper disposal of plastics is not addressed satisfactorily. Most of the plastics that are carelessly disposed to the environment get directly or indirectly consumed by the animals and has thus entered the food chain [3]. Since these plastics are non-biodegradable and hence not digestible, they can block the intestines leading to health hazards to animal life. Not many plastics can be recycled [4]. Also, recycling not only incurs costs but also emits harmful toxins to the air [5]. The other option is to refill the plastics. However, plastics have become a menace in the landfill areas making it expensive even for landfill [6].

Generally, bricks are made using top soil from agricultural fields and quarries, approximately half an acre land about 2000m^2X 0.05m top soil is required for the making of about 1,00,000 bricks Essentially, bricks are produced by mixing ground clay with, forming the clay into the desired shape, and drying and heating. The manufacturing process has seven general phases which include mining and storage of raw materials, preparing raw materials, preparing different grain sized particle, forming the brick, drying, heating and cooling, de-hacking and storing finished products.

The objective of this research was to develop a solution for the use of plastic waste in composite brick manufacturing. This is achieved by experimenting samples of bricks made of different grain sizes of Polyethylene Terephthalate (PET) plastic waste that replace the weight of natural soil in order to achieve the strength of bricks. The optimum mixing proportion is then determined for the maximum compressive strength of the brick. The typical tests that are done for bricks either in the lab or in the field are commonly compressive strength test, water absorption test, efflorescence test, above one metre impact drop test, ringing sound test and hardness test. These tests were performed according to the BIS standards for the proposed composite bricks and their properties were studied.

2. EXPERIMENTAL SAMPLE PREPERATION

The sample composite bricks were studied for the varied sizes of the PET as shown in the figure 1 below. After once finished with preparing different grain sized plastic material we move on to the proportionality of mixing this plastic grain in the manufacturing of brick.

Figure1: Different grain sizes of PET considered in the composite brick samples.

The materials used to manufacture bricks are clay, fly ash, plastic grains, and water. This all material mixed in the proportion and mould in the still mould. After that left to dry for one day. The dried bricks are sent to Kundapur brick factory for heating in the kiln.

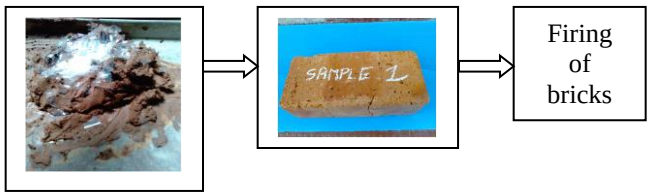

Figure 2: Process of composite brick sample preparation

3. COMPRESSIVE STRENGTH TEST 1 - FOR OPTIMAL GRAIN SIZE

The four samples that were prepared as discussed in section two were tested for compressive strength in the Double column Universal testing machine as shown in the figure 3. From the test, it was found that the brick sample of 4 mm plastic grain size had the highest compressive strength. Thus this grain size was considered for the next compressive strength test.

Figure 3: Testing of the composite bricks in Universal Testing machine

4. COMPRESSIVE STRENGTH TEST 2 - FOR OPTIMAL PLASTIC PROPORTION

Five new samples of plastic composite bricks were manufactured similar to the procedure mentioned in the section 2, but for the same grain size of 4 mm. However, in this experiment, the proportion of the PET plastic to the coarse aggregate percentage weight was kept as 5%, 10%, 15%, 20% and 25% for the five samples respectively. It was found that the sample 4 consisting of 20% PET percentage by weight had the maximum compressive strength of 7.2 N/mm^2.

5. WATER ABSORPTION AND OTHER BRICK TESTS

The water absorption test was conducted on a new sample manufactured as per section 2 with the 4 mm PET plastic grain size in the proportion of 15% by weight to the weight of the full brick. The initial weight of the brick was 2.46 kg and the final weight of the brick was 2.67 kg. The water absorption percentage was calculated to be 8.53%.

The same brick was later dried and tested for efflorescence. This was done by dipping the brick in water for 24 hours and then removed to dry in the atmosphere. Approximately, around 2546 mm^2 = 3% of the brick's surface was covered by white patches which are highly acceptable as per the standards.
Impact drop test was performed by dropping the sample brick at a height slightly above 1.5 m high. As the plastic grains are well bonded with soil, the sample brick considered was able to clear the impact drop test.

6. RESULTS & DISCUSSIONS

The results of the compressive strength 1 test for varied grain sizes are shown in the figure 4. From the compression test result it is clearly shows that the value of compressive strength is maximum for the plastic grain size with 0.5 to 0.75cm followed by 20% replacement of clay by plastic and it showed in the maximum load on compression is 97kN.

According to Bureau of Indian Standards 1077:1992 commonly burnt clay building bricks average compressive strength for first class brick should not less than 10N/mm^2 or 100kgf/cm^2.

Our experiment results justifies that this bricks are reaching the BIS limits. Therefore we can use this bricks and replace the first class bricks since it is economical and ecofriendly product.
The results of the compressive strength test 2 for varied plastic proportion by weight is as shown in the figure 5.
The compressive strength of the sample bricks of proportions of 5%, 10%, 15%, 20% and 25% plastic waste were 5.15, 5.35, 5.68, 5.25 and 5.2 N/mm^2 respectively. The maximum load was recorded as 72 kN, 75 kN, 82 kN, 97 kN and 93 kN respectively.

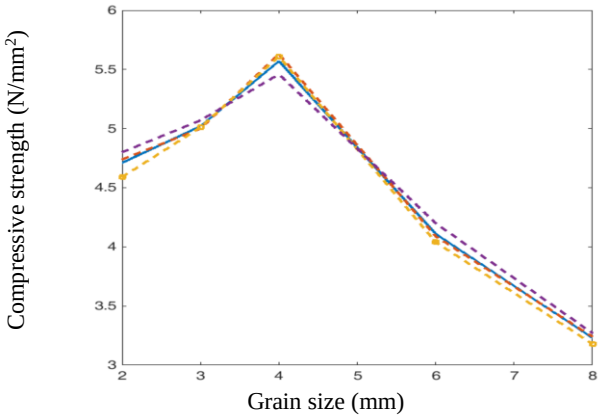

Figure 4: Experimentally observed effect of grain size of the PET in the compressive strength of the composite brick.

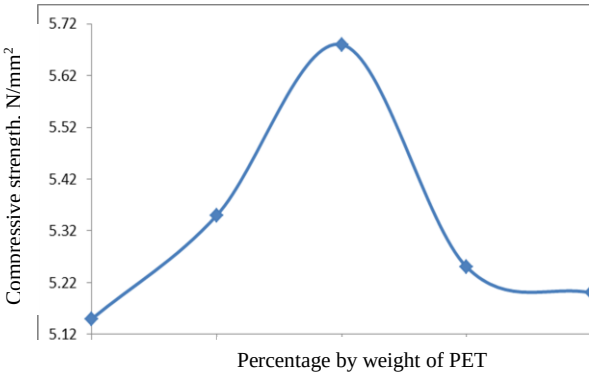

Figure 5: Experimentally observed effect of plastic proportion by weight of the PET in the compressive strength of the composite brick.

The water absorption percentage was about 8.53% which is significantly less than the 20% set by the Indian Standards 1077:1992. The efflorescence test confirmed 3% of the surface to have alkaline deposition not affecting much of the brick structure.

7. CONCLUSION

The percentage of different grain sizes of plastic waste is replaced by the weight of natural soil in order to achieve the strength of bricks. This results in reducing the harmful effects of the waste plastics in the environment. We also developed a solution for reduction of the disposal of plastic waste by replacing 20% plastic waste in order have maximum load at crushing of 97 kN.

ACKNOWLEDGMENT

We are thankful to Mr Vaishak N L, Assistant Professor, and Mr. Sudeep Shetty for extending their support to do this project. We would like to extend our gratitude to Sahyadri project support scheme -SPSS, an Undergraduate project grant for doing this project.

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