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Experimental Study on Eco-Bricks

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Abstract. PET plastic bottles are a major contributor to plastic in all big cities, in this Research, we assess Eco-Bricks (a possible solution to plastic disposal) from an experimental point of view. This Research paper aims to assess the feasibility of using PET bottles as Eco Bricks, in-wall module material. This study suggests using Eco-blocks that are filled with single-use plastic waste as a posed solution for plastic disposal, with the liberty of reoccupying the filler material when advanced recycling choices become available. Using single-use plastic as filler material, this research presents an experimental characterization of density, thermal shrinkage, and compressive strength test, Because the suggested Eco-bricks' density and elastic modulus are very close to those of EPS used in smaller structures, we believe, these bricks can be a better alternative to such construction materials. In the first experiment density of such Eco-Bricks was figured out using Archimedes Principle, further, we determine the thermal shrinkage of this newly posed construction material, Thermal Shrinkage helps us in gauging the performance of such bricks at higher temperatures, Lastly, the Compressive Strength Test was performed on Eco Bricks.

Keywords. PET bottles, Eco-Bricks, Thermal Shrinkage, Compressive Strength, Archimedes Principle

1. Introduction

Over the past 70 years as huge has 8.3 billion metric tons of plastic has been produced, and in a usual cycle only 9 percent of produced plastic is recycled and 12 percent is incinerated, and the leftover 79 percent of produced plastic ends up in landfills or as waste, and in the biosphere plastic does not decompose, and thus contaminates the Earth or our water bodies. Plastic in no way can be absorbed or consumed in ecological system and hence its presence disturbs the natural fabric of the current earthly ecosystem. Eco-bricks pose a great potential solution for storage and effective application of waste single-use plastic. They are cheap, simple, and effective materials. They are strong and are immune to rot and water damage. They can act as insulators and are Earthquake resistant as well. Eco bricks are an Eco friendly and sustainable substitute for construction materials, they are PET bottles filled usually with inorganic waste, which are now a very cheap construction material, with two-fold benefits[1]. Eco bricks provide us a groundbreaking and cheaper alternative to building materials, with an edge of providing storage solutions for the inorganic non-biodegradable waste we generate for human consumption[2]. In this project we will be performing a critical analysis on the feasibility and benefits of using eco-bricks in real-life structures, we'd be performing experiments

to figure out their Density, Thermal Shrinkage, and Strength[3]. On account of the lengthy timespan PET containers and different inorganic materials take to decompose, these bricks can be an innovative container for such substances[4]. Also, the usage of Eco-brick as development material relies profoundly upon the materials used to fabricate them[5]. There is restricted information accessible about the mechanical and physical properties of Eco-bricks up till now[6]. Two reasons that make the possible further usage of such bricks are namely, the fact that they provide a storage option for otherwise non-decomposing materials , and secondly, these options can be economically viable for smaller structures[7]. This work proposes a strength-based experimental review, which assures the usage of such bricks in small structures[8]. The Author proposes that Eco-bricks loaded up with the help of a single inorganic waste material could work productively as a development material while providing a storage space for the inorganic material that in the long run could be recuperated when alternate approaches of reusing or recycling become available and accessible[9]. This Study brings an experimental emphasis on a material that can enhance our waste disposal techniques. It gives us an idea about the strength and temperature endurance of such eco-bricks.

Dry and clean waste created from 20 families, appropriated around the urban areas of Delhi, was gathered for three weeks for this exploration work[10]. The most gathered material was: Plastic Wrappers etc[11]. This material was further utilized as single sort fillers to make Eco-bricks. Eco-bricks manufacturing - First and foremost plastic so collected from households was thoroughly washed and cleaned, and then it was dried outside in sunlight for a day[12]. After drying the plastic material it was tightly packed into uniform Eco-blocks, the blocks so obtained are further used for experimentation as Eco Bricks[13]. Single type of waste material was used to fill each bottle, lastly all bottles were sealed with a cap[14]. Bottles were stored in a dark space to avoid photodegradation before testing[15].

2. Methodology

2.1 Density Determination

Eco-brick densities would be obtained by calculating the mass-to-volume ratio of each sample. A weighing scale was used to figure out the mass. The Archimedes principle was used to compute the volume of Eco-Brick. Eco-bricks were placed in water at 25°C, the chosen container provided satisfactory resolution of water displaced. The amount of water in the container was measured using a measuring tape, and the amount of water so displaced was estimated. After testing, the bottles were dried and stored in the same circumstances.

2.2 Thermal Shrinkage Test

Each sample was marked at three distinct heights: 1) at the cap, 2) in the middle part, and 3) towards the finish. With the use of a Vernier caliper, the diameters of these samples were measured at 25°C at the particular heights stated. Each sample was immersed in water for 48 hours. The temperature of the water was kept at 35°C for the first day and 65°C for the next day.

Then it was chilled for 24 hours at room temperature before the r f was measured.

$$\Delta\varepsilon_r = \frac{r_f - r_i}{r_i}$$

2.3 Compressive Strength Test

A cuboid (270*210*210) was cast with 4 Eco Bricks placed in the vertical position, for the preparation of Mortar, Cement was mixed with Standard Sand in proportions of 1:3 (3.2 kg : 9.6 kg). Water was added to the mortar mix (11.25% of the total weight of the mix) and compressive strength tests of the cubes so formed were performed on the 7th, 14th, and 28th days of casting.

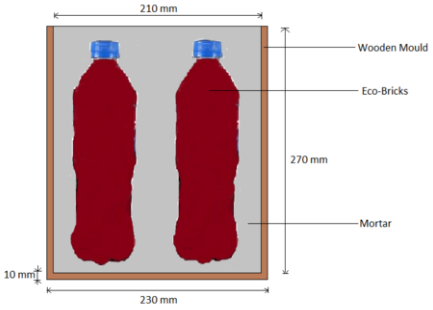

Fig 1. Side view

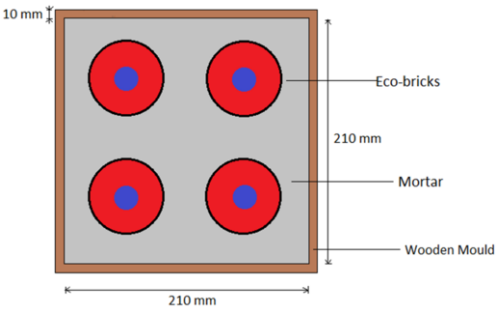

Fig 2. Top view

3. Results and Discussion

Eco bricks are posed as a construction alternative for small scale structures and three experiments are performed to figure out the various characteristics of man-made Eco blocks, the first test so performed is the Density assessment of Eco Bricks using the Archimedes Principle, the calculated Density of one such eco block Came out to be 390.8 kg/m^3. According to the GEA(Global Eco-brick Alliance), the minimum density of an Eco-brick should be 330 kg/m3 for any further usage. So the bricks used for experimentation are as per GEA standards.

Table 1. Thermal Shrinkage Results

Position of mark	r_i (mm)	$r_f - r_i$ (mm)	$\Delta\varepsilon_r$ (μ strain / °C)
25 mm below the cap	50.3	1.5	750
		1.4	695
Middle of eco brick	78.6	3.1	980
		2.9	920
Bottom of eco brick	70.5	2.5	890
		2.3	815

The next test performed was the Thermal Shrinkage test, this test helps us to gauge volumetric changes in an Eco Bricks, due to temperature changes[16].
For gauging these parameters, Radial Thermal Shrinkage was found as shown in table 1. The thermal shrinkage values are very low, which depicts that these bricks would not undergo much radial or volumetric changes in the above mentioned temperature range.

Table 2. Compressive Strength Results

Days	Compressive load (kN)	Compressive Stress (N/mm^2)
07	157.2	2.76
14	207.1	3.64
28	240.9	4.25

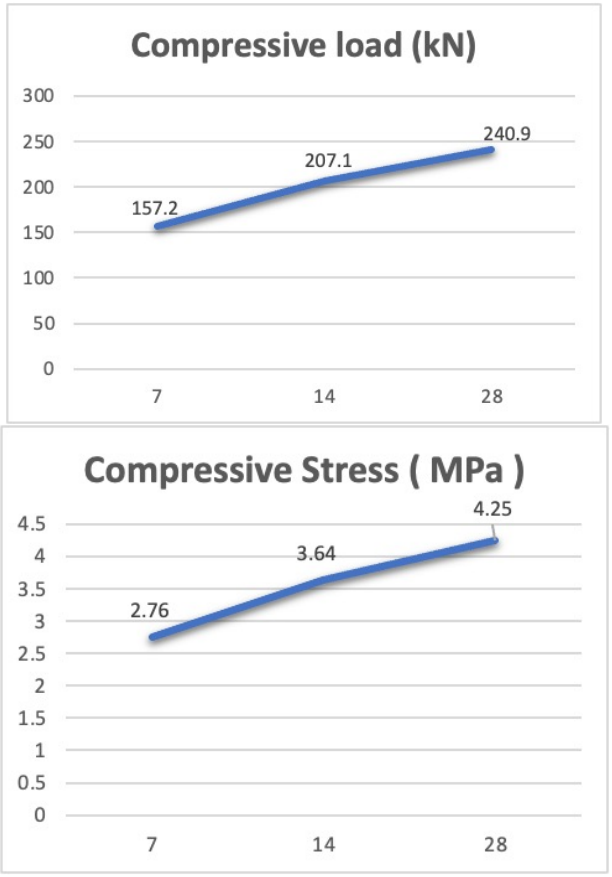

Fig 3. Compressive Load & Compressive Stress against number of days

In the final test, the strength of an Eco-Brick based cube was figured out, to gauge its structural usage abilities. The results of the test are presented in Table 2.

Strength for the 7th,14th, and 28th days are mentioned in Table 2. Fig 3 shows a graph depicting the successive increase in strength and compressive stress over 28 days. Assuming linear growth in strength and stress over time, we can also figure out the intermediary values for these parameters using fig 3. According to the results of Compressive Strength Test, these bricks can be used for small scale structures, as they provide significant strength after 28 days.

Fig 4. Compressive Strength Test being performed on eco-brick based block

4. Conclusion

Eco Bricks provide a storage capsule for non-bio-degradable waste such as single-use plastic, wrappers, metallic wastes, etc. [17] which in turn can be used as construction alternatives for small-scale structures. The materials so stored in such Eco Blocks can be hazardous to the environment around us, and their disposal looms a great threat to life around us[18]. Eco Bricks can provide a unique disposal solution for such materials[19]. Through the course of this research, the Authors have tried to emphasize on figuring out the strengths and limitations of Eco Bricks as a construction alternative.[20] The Use of Eco Bricks in bigger structures requires further testing such as Flammability Testing, and their introduction in formal codes requires rigor research.[21] Current research on Eco-Bricks, suggests and promotes the usage of such blocks for smaller structures.[22] Usage of such bricks in smaller structures can further enhance avenues of research on such eco-friendly solutions[23]. The upside of the research is the ability to alleviate the world from the present ongoing plastic disposal battle.[24] The strength testing of such bricks is limited as of now, but the results seem promising enough to tread the path in search of better solutions.[25]. This research also suggests the development of better biodegradable alternatives which can further de-escalate the current situation and reduce our plastic dependency. Development of better recycling solutions can also be an alternative solution to the problem at hand, but until we are equipped with proper research, educating people about the present disposal crisis and government intervention to reduce the usage of single-use plastic can be pivotal and can further help the cause.

The current disposal methods involve landfilling, which mainly results in the production of Greenhouse Gases such as Methane(CH_4) and Carbon Dioxide(CO_2), Landfills account for around 13% of the methane and around 818 metric tons of CO_2 per annum.

Other than these factors landfills can also result in Groundwater Pollution, Land Pollution, and Air Pollution, whereas Eco Bricks can solve all these problems and are eco-friendly as well as a cost-friendly solution to the problem. Further research on such avenues can strengthen our understanding of the strength-based usage of such bricks. It would also help us to determine, whether we can inculcate such Eco-friendly solutions in IS codes and standardize their usage specifications in a documented form.

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