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Application of Plastic Bottle Brick In Green Building Construction

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ABSTRACT--*In building construction brick is one of the major ingredients in the material used for construction. In the process of brick making, it has to be burn in kiln which introduced to evolve the CO_2 gas in major quantity. This CO_2 gas pollutes the environment. So the solution on this disadvantage of the burnt clay bricks is replacing the bricks with another material i.e. bricks made from waste plastic bottles. Today we need cost effective and environment friendly material which not pollute the environment. Therefore We can use the waste plastic bottles for making an affordable house. This project report consist of use of plastic waste bottle in construction as a brick which the bottles are filled with mixture of sand and soil with proportion of 40%-60% in three layers and tamp each layer with tamping rod by 25 blows and use as a brick in construction. Therefore, there were two types of experiments were used to evaluate the properties plastic bottle filled with sand and soil which are Compression test, temperature test in indoor and outdoor and humidity. The compression test conducts on 1000 ml, 600ml and 300 ml bottle. As a result all the bottles are achieving the strength over the permissible limit required for burn clay brick. The comparison of indoor and outdoor wall temperature, air Humidity between the plastic bottle green house and normal brick house has indicate that plastic bottle has recorded highest reading for outdoor wall temperature with 36°C and indoor temperature is 27°C . From these result it can be concluded that plastic bottle house have a potential to us this material in construction. As per the study on PET plastic bottle and its lifespan and various ratios of mixes use for construction is to be carried out.*

Keywords: *PET Plastic Bottle Bricks, Eco Friendly, Compressive Strength, Temperature, Low Cost Material.*

I. INTRODUCTION

Today urbanization is very rapid in its way. The urbanization delivering modernization for human life but changing the environmental aspects. At present environment around us is completely filled with toxic plastic waste posing serious problem to nature. The generation of particular amount of PET tends to recycling of only 1-2% of that amount. Plastic bottle are considered as non-renewable sources. It has insolubility about 300 years perhaps if it is used in walls with soil and sand it can play as sustainable material. So it is very necessary to take a creative action toward the concept of bottles in place of conventional bricks in construction. The objective of this paper is to introduce characteristics of this product and respective benefits in building construction. The detailed comparison of characteristics with convectional brick, mortar and cost of brick with bottle brick. Today the technology developed in great scale that the utilization of renewable resources is made possible which protect environment. Also technology permits bottles in construction. By using the bottle brick the carbon emission happen during baking of an ordinary Indian standard bricks can be reduced. Using recycled materials such as bottles to create building projects is a great way to reduce costs on a build, educate the local community about recycling and also benefits the environment.

Plastic bottles are increasingly becoming a menace to the environment due to the chemicals used in the manufacture, improper use and disposal. As noted by Plastics Industry (2011) reusing plastic bottles may seem safe, but a chemical found in reusable plastic bottles, known as Biphenyl is suspected of posing a health risk to human beings. As only regional products are used the houses are cheap and can be afforded even by poor families. Additionally the method has so far proven to be earthquake resistant and allows short construction periods. It also mentions some ways for self-standing and insulating them in thermal and sound points of views and some positive points which this material have versus others.

Plastics are produced from the oil that is considered as non-renewable resource. Because plastic has the insolubility about 300 years in the nature, it is considered as a sustainable waste and environmental pollutant. So reusing or recycling of it can be effectual in mitigation of environmental impacts relating to it. It has been proven that the use of plastic bottles as innovative materials for building can be a proper solution for replacement of conventional materials. The use of this material has been considered not only for exterior walls but also for the ceiling of the building.

II. MATERIALS

A) PET Plastic

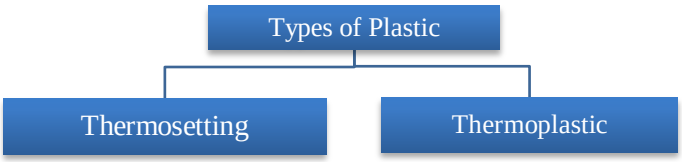


Figure 1: - Types of Plastic

Full form of PET and molecular formula is $C_{10}H_8O_4$ Structure Composition is Polyester of Terephthalate acid and ethylene glycol. PET is used for high impact resistant container for packaging of soda, edible oils and Peanut butter. Used for cereal box liners, Microwave food trays. Used in medicine for plastic vessels and for Implantation. Plastic is heat resistant and chemically stable. PET is resistant to acid, base, some solvents, oils, fats. Following are properties of plastic bottle: - translucent, Flexible over a wide temperature, Heat resistance, chemically stable, Do not absorb moisture**,** Transparent.

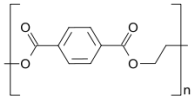
Polyethylene Terephthalate	
Properties	
Chemical formula	$(C_{10}H_8O_4)_n$
Density	1.38 g/cm^3 (20 °C),
Melting point	> 250 °C, 260 °C
Boiling point	> 350 °C(decomposes)
Solubility in water	Practically insoluble
Tensile strength (σ_t)	55–75 MPa

Figure 2:- Proprities Of PET Plastic

B) Nylon Rope

Nylon rop**e** has a very high strength property so it is use as a binder for PET bottle brick. It is a polymide thermoplastic product by series of condensation reaction between an amine and organic acids. The nylone rope has an property of abrasion resistence, tough and strong, and flexible. For the binding of bottle brick 2mm diameter of nylon rope are most suitable.

Figure 3: - Nylon Rope

2. BACKGROUND:-

The large amount of waste plastic bottle are every in the world which are polluting the environment and impacting on human life. The first bottles house was built using 10,000 glass beer bottles by Wiliam F. peck in 1902 in Tonopha,

Nevada. After that the newer innovative concept has been using plastic bottle instead of glass bottles in constructing the houses. This innovative idea took to account for some reasons such as providing a cost-efficient construction method for pauperized third-world countries, reusing the plastic bottles due to their not in decomposable characteristic etc. (**fig 4)**

Figure4: - Glass Beer Bottles By Wiliam F. Peck in 1902 In Tonopha

In 1905, At the age of 76, Mr. Tom Kelly started the first bottle structure in Rhyolite, Nevada. He used over 30,000 beer bottles that were held together with adobe. Being that Rhyolite was a Gold Rush town, he had no trouble collecting the beer bottles from the local saloons. He completed the house in less than 6 months but he never actually lived in the home. Instead he raffled off tickets to win the home. About 20 year later, the Gold Rush had settled down and the town was close to deserted. Paramount Studios found the house and repaired it for one of their movies. The home still stands to this day and volunteers care of it. **(fig.5)**

Figure 5:- Mr. Tom Kelly in Nevada, House constructed by beer bottle

Andreas Froese, the founder of Eco-Tec Environmental Solution, in searching for finding an inventive solution to junk, established the innovation of building plastic bottle houses. Plastic bottles house in Africa was constructed in the village of Yelwa in Nigeria by Andreas Forese. Forese used the plastic bottles instead of bricks, bound the bottles together with string and at the end applied the plaster. **(fig.6)**

Figure 6:- Eco-Tec Africa – solving Nigeria's housing problem

The Eco-Tec, various other institutions and groups have initiated the concept of reusing the plastic bottles for building construction. However nowadays, the concept has spread to countries all over the world. Various kinds of homes have been built from plastic bottles such as ecological house constructed using 8000 bottles in Honduras; an Eco-Tec home in Bolivia constructed using the PET and wine bottle. A house of waste plastic bottles built in Serbia by Tomislav Radovanic 'Taiwan's plastic bottle building. Ecological bottle house built using 1200 PET plastic bottles for the walls near the lquazu Falls, Misiones, Argentina. **(fig.7)**

Figure 7:- Eco-Tech Home In Bolivia by Wine Bottle

III. ADVANTAGES AND DISADVANTAGES

The technical characteristic of PET plastic bottle brick has both advantages and disadvantages depending on their requirement. Application and the context, some of the main advantages are reported by Shilpi Saxena (2013), Mojtaba Valinejad Shoubi (2013), Dr. Pratima A. Patel (2016) are

A) Advantages

- It contributes to reducing environmental pollution especially in cities, villages, rivers, lake and seas.
- Recycling of plastic without burning helps to reduce the CO_2 emission and best solution is reusing as brick which no additional energy is required and does not contribute to pollution.
- Plastic bottle brick walls are lighter than the walls built by brick and block. That makes these buildings to show a good response against earthquake.
- Flexibility of plastic is a characteristic which makes the building's performance higher against the unexpected load.
- The plastic bottle is free from dampness due to the impervious material.

B) Disadvantages

- it takes a hundred of year to decompose
- Hard to dispose property.
- It is made from non-renewable resources of earth.

IV. METHODOLOGY

We had study about the use of plastic bottles in building construction for the poor people and reduced the waste of PET bottles. so we decide to make plastic bottle bricks as per the villagers economic purpose. For the making of plastic bricks we had done research on plastic bottles, soil and sand to collect all the information from net search.

After the collection of all the materials, We made various test with it, such as sieve analysis of the soil, moisture content test etc. the bottle is filled by the mixture of soil and sand with the ratio 60% of soil and 40% of sand. Once the bottle is filled in three layers and each layer tamped with tamping rod in 25 blows. Once the bottle brick is made, the various tests are conducted on it. We made the model by using plastic bottle bricks and various tests are done on it, such as indoor and outdoor temperature and humidity.

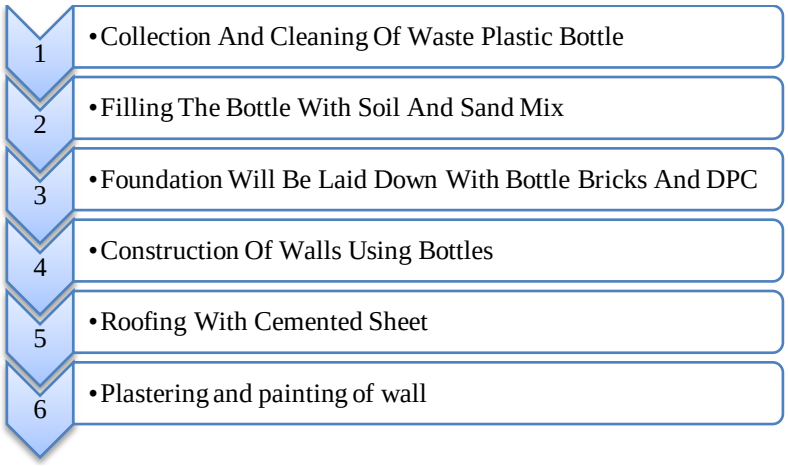


Figure 8: Methodology for Bottle Brick Construction

V. RESULTS

The data obtained from the various tests on the bottle bricks are summarized in Tables. Tables show test conducted on soil, sand and plastic bottle bricks. From the characteristics of the soil and sand and there mix with the various proportion. With the various size of bottles the compressive strength are shows the suitability of the material for the building construction.

A) Results of Compression Test

Each and every result is discussed below which tests are conducted on soils as well as plastic bottle bricks. The data obtained from the tests on bottle brick i.e. compressive strength values are presented in table shown below. From the table it can be noticed that, soil and sand are both provide good strength. As the sand is carry much more strength than soil filling.

Size of bottle	Sand	Soil
300ml	10.8 N/mm^2	8.1 N/mm^2
600ml	9.32 N/mm^2	6.96 N/mm^2
1000ml	8.04 N/mm^2	6.27 N/mm^2

Table 1: Compression Test on Different Sizes of Bottles (N/mm^2)

As 600 ml size of bottle are as similar like normal brick and suitable for brick construction. The sand and soil mix are suitable for building construction where is sand provide the strength and soil maintain the temperature of brick. Thus the compression test done on the various mixes with 5 samples.

600ml size of bottle	**Mix Proportion**			
	50% soil & 50% sand	***55% soil & 45% sand***	***60 soil & 40% sand***	***65 soil & 35% sand***
1	8.92 N/mm^2	7.98 N/mm^2	8.10 N/mm^2	7.12 N/mm^2
2	8.58 N/mm^2	8.12 N/mm^2	7.90 N/mm^2	7.68 N/mm^2
3	8.76 N/mm^2	8.17 N/mm^2	7.97 N/mm^2	7.59 N/mm^2
4	8.31 N/mm^2	8.32 N/mm^2	7.62 N/mm^2	7.61 N/mm^2
5	8.56 N/mm^2	8.19 N/mm^2	7.89 N/mm^2	7.32 N/mm^2

Table 2: Compressive Strength of Different Types Of Mix Used In 600ml Size of Bottle (N/mm^2)

B) Results of Temperature Test

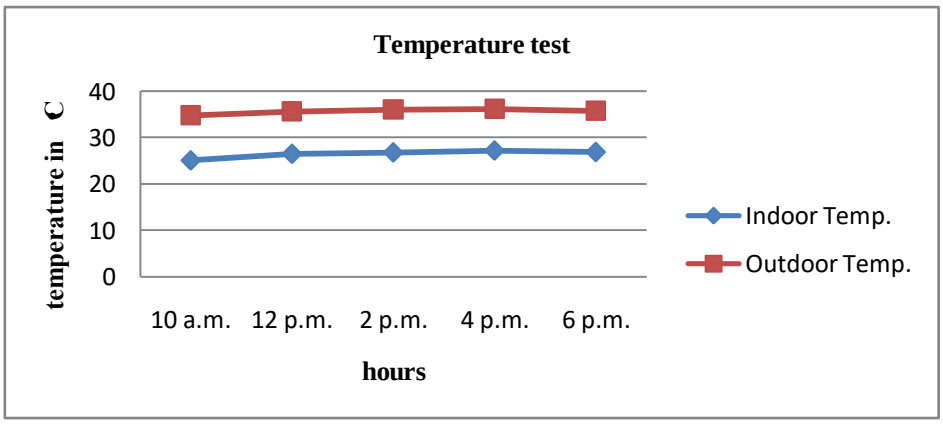


Figure 9: Result of Temperature Test

C) Results of Humidity Test

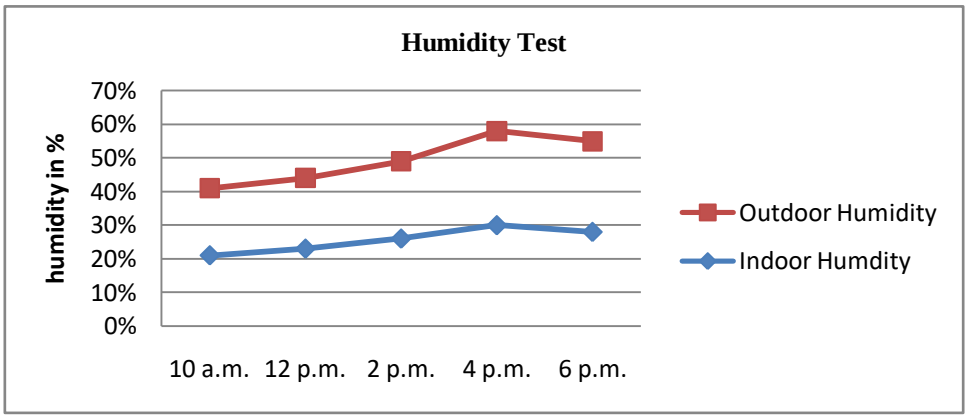


Figure 10: Results of Humidity Test

VI. COST COMPARISON BETWEEN BRICK MASONRY WALL AND BOTTLE MASONRY WALL

Table 3: Estimate for Burnt Clay Brick Structure for 10m²

Sr. no.	Material	Quantity	Rate	Per	Amount (Rs.)
1	Brick	1150 nos.	5	1 no	5750
2	Cement	8.31	300	1 bag	2493
3	Sand	.531	1000	1m³	531
				Total	8774

Table 4: *Estimate for PET Bottle Brick Structure for 10m²*

Sr. no	Material	Quantity	Rate	Per	Amount (Rs.)
1	Plastic bottle	1989	0.4	1 no	795
2	Cement	5.57	300	1 bag	1671
3	Sand	1.01	1000	1 m³	1010
4	Soil	0.714	650	1 m³	496
5	Nylon rope	25	5	Per meter	125
6	Labour work	5	250	1 person	1250
				Total	5347

VII. CONCLUSION

As a conclusion, the application of plastic bottle filled with soil and sand as a wall structure to replace burn clay brick in construction industry is acceptable as the strength is over the minimum permissible strength of standard brisk as per IS code 1077 the plastic bottle have the capacity to replace standard bricks in India. As per the thermal comfort for the bottle it achieve the comfort zone with the range of 26 ºC to 28 ºC.

Reusing the plastic bottles as the building materials can have substantial effects on saving the building embodied energy by using them instead of bricks in walls and reducing the CO_2 emission in manufacturing the clay brick. It is counted as one of the foundation's green project and has caught the attention of the architecture and construction industry. Generally the bottle houses are bioclimatic in design, which means that when it is cold outside is warm inside and vice versa. Use of innovative materials with sustainable application such as plastic bottles can have considerable benefits.

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