

PET Bottles as Sustainable Building Material: A Step Towards Green Building Construction

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Abstract: This paper proposes the use of waste plastic PET bottles as construction entity to standardised bricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are major cause of solid waste disposal. Polyethylene terephthalate is commonly used for carbonated beverage and water bottles. This is an environmental issue as waste plastic bottles are difficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding cost effective materials for increasing the strength of structures. This project deals with the possibility of using waste PET bottles as a partial replacement. It can be concluded that benefit of the use of PET bottles include both improved ductility in comparison with raw blocks and inhibition of crack propagation after its initial formation. The solution offered in the paper is one of the answers to long standing menace of waste disposal.

1. INTRODUCTION

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. When the society gets affected, then it will be uneconomical for the nation to create sustainable development [1]. Plastic bottle can assist to obtain a social equity by avoiding the gap between the rich and the poor people in the society. With population growth in today's world, the need to the building has increased and to respond to this demand, the countries tend to use the industrial building materials and decline the use of indigenous and traditional materials. These factors in spite of increasing the energy consumption in the industry section; they can also raise the cost of homes and are considered as the barrier for users to obtain the basic needs of the life. [2]

At the present time, the possibility of utilizing the renewable resources such as solar, wind, geothermal has been provided for us more than before, and development of this science is making progress. But those energies can be chosen as one of the renewable and alternative energies instead of fossil fuels which are cheap as possible and have fewer environmental impacts [3]. 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 Iquazu Falls, Misiones, Argentina; and etc [4]. With a serious housing shortage but no shortage of plastic bottles littering the streets, the Development Association for Renewable Energies an NGO based in Nigeria – decided to build an incredible two-bedroom bungalow entirely out of plastic bottles which is bullet and fireproof, earthquake resistant, and maintains a comfortable interior temperature of 64 degrees Fahrenheit year round [5]. Hundreds of plastic bottles were filled with sand and then linked together at the neck by an intricate network of string. The bottles were then strategically laid and packed down with a combination of mud and cement, creating a building material that is stronger than blocks. Thus in relation to the various experiments conducted till now by various researchers, in this research paper we have tried to explore the relative strength and cost of the bottle brick as compared to the conventional brick

2. OBJECTIVES

- a) To evaluate the possibility of recycling waste PET bottles.
- b) To investigate the mechanical behaviour of the unit.
- c) To test and compare the compressive strength of brick bottle with brick.

3. METHODOLOGY

In this study, the first step taken was collection of waste PET bottles from stores, waste collectors and other possible resources. Once the bottles are collected they have to be filled with local available soil so as to provide them the structural strength. In our experimental work we have taken 60, 100 and PAN mesh size soil which is first screened by a sieve shaker properly so as to remove any unwanted foreign large size particles. Once all the collected bottles are filled with this prepared soil and tamping it in instalment they are tightly capped and sealed. Now to check the structural strength various tests are performed and comparison is made against those for a brick. A comparative economic analysis is also done.

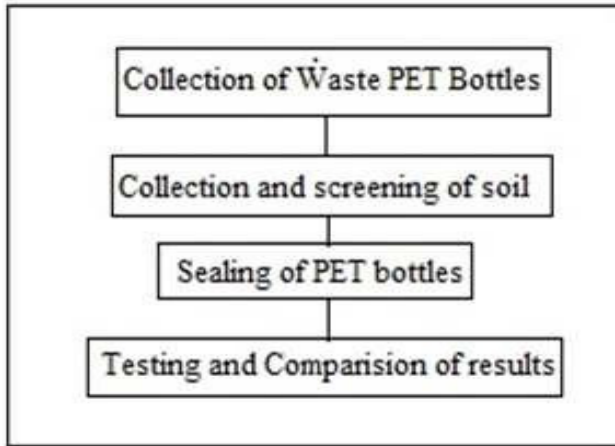


Fig. 1. Process Steps of methodology adopted

4. EXPERIMENTAL TESTING

Compressive strength test for each bottle was determined on universal testing machine and the average value was considered for analysis. Weight of empty PET bottles and completely filled PET bottles were noted and amount of soil used was calculated for the same. Similarly, compressive strength of brick was calculated by taking the average value and the results were compared and analysed.

The formula used is:

$$\text{Compressive strength} = P/A \text{ (N/mm}^2\text{)}$$

Where

P = Load at failure in N.

A = Area subjected to compression in mm^2



Fig. 2. Weighing balance to weigh Sealed PET bottle before testing



Fig. 3. Test applied on a waste PET bottles filled with soil and sealed tightly



Fig. 4. Compressive strength universal testing machine

5. RESULT AND DISCUSSION

After compressive strength testing done on about 8 bottles an average calculation for concluding a result is done. The Data obtained as per universal testing machine is tabulated in table 1.

TABLE 1: EXPERIMENTAL TESTING DATA

Load (Kg)	Area (mm^2)	Compressive Strength (MPa)	Average
13000	14202.5	8.98	
13000	14205	8.977	
13001	14201.9	8.98	
13000	14201.6	8.97	8.99
13002	14202.5	9.11	
13011	14202.1	8.98	
13005	14201.9	8.98	
13023	14202.8	8.98	

Sample Calculation of first reading: Load in kg = 13000 kg
 Load in N. = $13000 \times 9.81 = 127530$ N Area
 = 14202.5 mm^2 Compressive strength
 = $127530/14202.5$
 = 8.98Mpa

5.2. Cost calculation:

Calculation of bottle market price:

Average wt. of 600ml PET bottle = 30gms. Cost of waste plastic bottles in market is Rs.8/kg.
 $\Rightarrow (1000 \div 30) = 33$ nos. of bottles in
 1kg. $\Rightarrow (8 \div 33) = 0.242$ paisa (approx =0.2)

Cost of soil to be filled:

Quantity & Cost of 1 trolley soil = 2.8 m^3 (say = 3m^3) in Rs. 900
 Cost & wt. of 1 m^3 soil Rs. 300 & 1600kg Cost of 1kg soil = $300 \div 1600 = 0.187$ (say=0.190)

• Total cost of bottle brick:

Wt. of empty bottle= 30gms Wt. of bottle with soil= 1430gms
 So, wt. of soil in 1 bottle = 1400gms Cost of soil used in a unit bottle

= $1.4 \times 0.190 = 0.266$ paise Therefore total cost of bottle brick
 cost of empty bottle+ cost of soil = $0.25 + 0.266 = \text{Rs.}0.516$
 (say = 60 paisa)

• Calculation of Profit:

Cost of a unit brick = Rs 5
 Therefore it shows a direct profit of $(5 - 0.60) = \text{Rs.} 4.40$

Thus based upon these observations we can infer that wall made of PET bottle can be use as partition wall or secondary walls and in frame structure as external wall. These are very useful in construction of yarn, warehouses etc.

6. CONCLUSION

From the above experimental observations we can infer that no curing time is required if waste PET bottles are used as building material as compared to bricks which require 28 days curing time. Also while baking of bricks there is a major issue of carbon emission which is negligible in using PET bottles. PET bottles generally have a durability of over 300 years which is more as compared to standard bricks. Cost of construction in case of brick bottle is more economical than standard bricks. Weight of a unit bottle brick was found to be less than that of a standard brick. Compressive strength of the bottle brick is also nearly equal than that of a standard brick. Thus we can conclude that using the concept of brick bottles is cost effective, energy efficient and commercially feasible. Using PET bottles is also Bio-climatic and thus we can say it is a Green construction.

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