

A Review on: Use of Waste Plastic Bottle as a Construction Material

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Abstract: One of the main disadvantages in constructing houses is the high cost of the building. On the other hand, substantial quantities of plastic consumption have led to an exponential increase of plastic derived waste. In this paper we implemented strategies and systems based on Eco-friendly environment that could still be built at very low costs, with plastic waste materials, providing adequate thermal comfort while being sustainable. Eco-friendly constructive principles are being incorporated into more buildings every day in the world but they are still out of reach of many people due to lack of knowledge and awareness. To overcome from this, a systematic method is employed which makes use of plastic extrude for reutilizing waste plastic into suitable construction materials. Several trials with different combinations were conducted to efficiently convert waste plastic into bricks. In the end, it concluded that in different factors such as time of execution, load capacity, flexibility, reducing plastic waste, cost, and energy efficiency, waste plastic can be more effective compared to some regular construction materials such as brick, concrete, and ceramic blocks.

Keywords: Waste Plastic, construction material, environment, Eco friendly.

I. Introduction:

In recent times, a human, on the one hand, is always seeking broader sources with lower prices and on the other hand, is following the way to get rid of the plastic wastes. This paper introduces the improvement and low-cost housing in India. The generation of plastic waste is one of the fastest industrial-wise. It is estimated that the rate of expansion is doubled every year. This wastes produced today will remain in the environment for hundreds and perhaps thousands of years. As landfill areas are rapidly diminished the cost of solid waste disposal is highly grow. One solution to this crisis lies in recycling wastes into the useful process. So this plastic waste is used in the construction process. In India, about 43 million tons of solid waste is produced annually. This increasing at a rate of 1.5 to 2% every year. Plastics constitute 30% of total waste produced most of which is from discarded plastic bottles. The plastic waste cannot be disposed of off by dumping or burning, as they produce uncontrolled fire or contaminate the soil and vegetation.

Compared to other materials such as metal, plastic bottles have lower cost, higher strength-to-weight ratio more durable, resistant to collapse, easy to work and shape, and have low density. However, waste plastics are generally a risk to the overall atmosphere.



Fig.1: Collection of waste plastic bottles

1.1 Objective

The objectives of this research are:-

- To reduce the overexploitation of limited natural resources.
- To use plastic waste which is generated by human use.
- To make construction economical if possible.
- To know applications of plastic waste in the construction industry.
- To reduce the pressure on naturally available materials by replacing them with recycled plastic bottle.

II. Literature review:

Mojtaba et al. [1] Concluded that using 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 CO₂ excretion in manufacturing the cement by reducing the % of cement used.

Shilpi et al. [2] concluded that by utilizing PET bottles in construction recycled materials, thermal comfort can be achieved in very low-cost housing this gives relief for the poor people of India to provide cheap and best houses for a living [3-5].

Puttaraj et al. [6] examined that effective usage of waste plastic in plastic-soil bricks has resulted in effective usage of plastic waste and thereby can solve the problem of safe disposal of plastics also avoids its widespread littering and the utilization of quarry waste has reduced to some extent the problem of its disposal. [4].

Vikram Pakrashi et al. [7] examined Eco-brick as a viable resource for construction purposes with several possible applications. The weight of Eco-brick was observed to hold a near relationship with load at failure and with specific strength. Eco-bricks have a relatively good a specific strength.

Andreas Froese et al. [8] concluded that when the plastic bottles are filled with soil or sand they work as bricks and form a framework for walls. Different types of walls varying in size and orientation of the bottles are built. PET bottle walls can bear up to 4.3 N/mm² when the bottles are filled with sand or soil which is the weakest filling material. Moreover, the method has so far proven to be earthquake resistant and allows short construction periods.

Seltzer et al. [8] revealed that the first example of known structures built with bottles are the William F. Peck's Bottle House located in Nevada (USA). It was built around 1902, and it required 10,000 beer bottles to be built.

Job Bwire & Arithea Nakiwala et al. [9] suggested that, baked bricks, tiles, concrete and rocks, among other construction materials have been essentials in construction. Water bottle housing is an innovation aimed at providing low cost housing, while contributing to an environment management [14-18]

III. Basic construction material and their properties:

This construction requires some of the basic materials which ensure a stable, eco friendly structure and also results in cheap construction as compared to a brick walls.

Basic construction materials:

1)Soil 2)plastic bottle 3)Cement

4) Nylon rope 5)Water

1) SOIL

Soil is the basic element in any construction project so before using it in our project we have to study the basic properties of the soil and go through different tests, to check whether the soil sample selected is suitable for the given project.

Table.1: Properties of Soil

Properties	Result
Specific Gravity	2.65
Optimum moisture content	10.2 %
Maximum dry density	2.021g/cc
Cohesion	5800 kPa

2) PLASTIC BOTTLE

In this paper, plastic bottles are used as a fundamental element, so we have gone through every property of the PETE bottles to ensure a stable structure.

Table.2: Properties of plastic bottle

Property	Result
Chemical Formula	$(C_{10}H_8O_4)_n$
Density	$1.38g/cm^3(20^\circ C)$
Melting Point	$>250^\circ C, 260^\circ C$
Boiling Point	$>350^\circ C$ (decomposes)

3) CEMENT

Cement is an important binding material. In this paper is used to bind the plastic bottles to make the masonry wall more durable so that the quality of cement is check by following properties.

Table.3: Properties of cement

Property	Result
Consistency	35 %
Initial setting time	30 Minutes
Final setting time	600 Minutes
Fineness	8.16 %
Specific Gravity	3.43

4) NYLON ROPE

Nylon rope has a very high tensile strength so that it is used as the main binder for PETE bottles masonry

Properties of Nylon rope:

Nylon rope is gotten from coal, Petroleum, air, and water, the properties of nylon as follow:

- 1) Good abrasion resistance.
- 2) Tough and strong but flexible too.
- 3) High impact strength.
- 4) Absorb water which causes a reduction in strength and impact properties

5) WATER

Water is similarly way to cement, an active component in mortar. The quality of water use as a direct impact on the strength of the mortar and cement in the construction work. 20% of the overall weight of the cement and soil was used to determine the quantity of water to be used in the mix.

IV. Methodology:



Fig.2: Construction of house using waste plastic bottle

4.1 EXPERIMENTAL WORKS:

4.1.1 Preparation of Eco-Bricks

Waste plastic bottles were collected and it is filled with soil. It is compacted well without any voids by tamping each layer with 25 blows and Eco-Bricks are ready.



Fig.3: Eco-Bricks

4.1.2 Eco-Brick

It is made up of plastic bottle filled up with soil.

4.1.3 Conventional Brick

A hard block of baked clay is used to build buildings, houses, pavements and other elements in construction is known as conventional brick which size is 19×9×9.

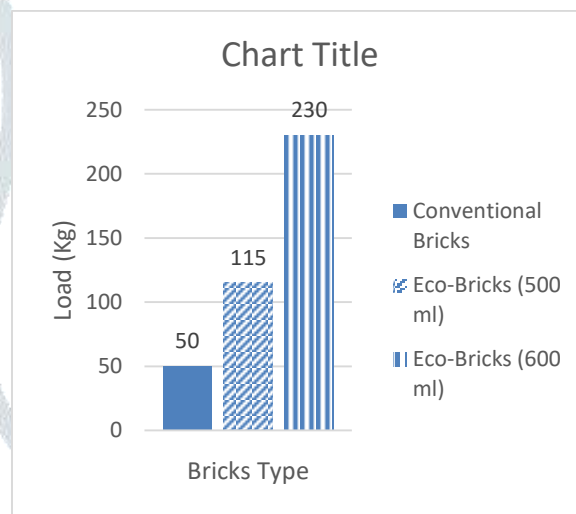
4.2 Test for Eco-Brick:

The Eco-Brick were tested under Compression Testing Machine and the load carried by each is tabulated in table 4.

Table.4: Load Undertaken by an Eco-Brick

S.No	Brick Type	Weight(kg)	Load(Kn)
1.	Conventional brick	3.576	50
2.	Eco-Brick (500 ml)	1.586	115
3.	Eco-Brick (600 ml)	1.897	230

4.2.1 Chart-1 Load Carried Out by an Eco-Brick



V. Benefits of waste plastic in construction:

- The total waste generated is reduced.
- The source of building material is local. No additional cost for the same.
- The natural resources are preserved.
- The carbon footprint is reduced.
- The plastic bottle is expensive.
- The technology used is short and easy to execute.

VI. Conclusions:

This work can achieve its main aim of reducing plastic waste. Plastic bottles can be used as a part of green construction by saving energy and resources, recycling materials, minimizing the emission, having significant stipulated savings and increasing workplace production.

Use of inventive materials with sustainable application such as plastic bottles can have substantial benefits including finding the best reduction in energy consumption and hence reducing atmospheric degradation.

Moreover, there would be fewer thermal conduction in plastic masonry construction compared to conventional masonry hence it would reduce the heat inside the building and less external resources would be needed for cooling purposes.

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