

Reuse of Plastic Bottles As A Construction Material

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Abstract- Disposal of non bio-degradable substance has become an issue of major concern now a day. A mound of plastic garbage has been created on earth surface. Laterite quarry waste is abundantly available and disposal of waste plastics (PET, PP, etc.) is the biggest challenge. Only one in six plastic bottles are properly recycled. On other hand high cost of primary requirement for constructing the houses in places on where people are under poverty line is forming one of most significant problems of people. A suitable approach for this situation is using some part of urban rubbish or waste as required materials for building construction. Plastic bottle is considered as urban junk. but with sustainability characteristic it can be used as construction material instead of some conventional material such as brick in building construction. The paper intends to investigate the application of plastic bottles which is one of the urban waste in building construction and that how it can lead to sustainable development. It also mentions some ways for self-standing and insulating them in thermal and sound point of view and some positive points which this material have versus others.

Keywords- Plastic Bottle, Sustainable Material, Construction material, Innovative wall

I. INTRODUCTION

Nowadays, human apply all of its potentiality to consume more. The result of this high consumption is nothing unless reducing the initial resources and increasing the landfill. In recent times, human from the one hand is always seeking broader sources with lower price and from the other hand is following the way to get the rid of the wastes. The waste today can be produced wherever humans footprints be existed, and remind him that they have not chosen the appropriate method for exploitation of the nature 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. Since no attention to economic issues lead to that the use of these energies be just for groups dedicated to specific segments of society. Whilst many renewable energy projects are large-scale, renewable technologies are also suited to rural and remote areas, where energy is often crucial in human development. 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 house and are considered as the barrier for users to obtain the basic needs of the life The problem of users is losing the power and ability of design and building their own homes by themselves. Two factors that prevent aboriginal people from building their homes are high cost building materials and labor and also maybe long transportation. One of the solutions for this problem can be Solve In following Manner.

II. LITERATURE SURVEY

Nowadays, large amount of plastic bottles are wasted and disposed every day. People are thrown away them without considering that what those plastic bottles can have impact on the humans and/or environment. 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

The first bottles house was built using 10000 glass beer bottles by Wiliam F. peck in 1902 in Tonopha, Navada . 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 indecomposable characteristic, and etc. The first 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 . Anyway beside the Eco-Tec, various other institutions and groups have initiated the concept of reusing the plastic bottles for building construction.

Puttaraj et al. ^[1] examined that efficient 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. 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.⁴

Pratima et al. ^[2] studied that plastic bottles wall have been less costly as compare to bricks and also they provide greater strength than bricks. The PET bottles that are not recycled end up in landfills or as litter, and they take approximately 1000 years to biodegrade. This has resulted in plastic pollution problems in landfills, water ways and on the roadside, and this problem continues to grow along with the plastic bottle industry

Arulmalar et al. ^[3] studied that the initial perception on the use of PET bottles in construction is changing day by day. A paradigm which emerged as PET bottle bricks in the construction of load bearing walls with steel trusses and prefabricated metal sheet is at present witnessing flat roofs with nylon 6 replacing steel reinforcement and intuitive vault construction.⁶ Even though research on the effective use PET in developing new material as an option, solutions exploring the application of PET bottles as structural members, foundation, retaining walls and secondary elements like street furniture, road dividers, pavements and other landscape elements is to be looked in to. The Governing bodies shall formulate policies to propagate this eco centric approach via appropriate practices, research investigations on the properties of the materials and construction techniques.

Vikram Pakrashi et al. ^[4] examined Eco-brick is a viable resource for construction purposes with a number of possible applications. The bricks are relatively easily manufactured with controlled weight and packing. Eco bricks have relatively good compressive strength, with values matching that of basic concrete cubes. The weight of Eco-brick was observed to hold a nearly relationship with load at failure and with specific strength. Eco-bricks have a relatively good specific strength. They are lightweight but strong for the weight they bear.

Andreas Froese et al. ^[5] concluded that when the bottles are filled with soil or sand they work as bricks and form a framework for walls or pillars. Different types of walls varying in size and orientation of the bottles are built. The compression strength and fracture behaviour of each wall are measured and compared. PET bottle walls can bear up to 4.3 N/mm² when the bottles are filled with sand which is the

weakest filling material. The bottles bear one third of the load while the plaster bears two thirds. Plaster made of clay or a cement mixture fills the space between all bottles while a roof made of wood or corrugated metal completes the house. 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.

Yahaya Ahmade et al. ^[6] said that the structure has the added advantage of being fire proof, bullet proof and earthquake resistant, with the interior maintaining a constant temperature of 18 degrees C (64 degrees F) which is good for tropical climate. **Seltzer et al.**, ^[7] revealed that the first example of known structures built with bottles is 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. These buildings were primarily made out of glass bottles used as masonry units and they were bound using mortar made out of adobe, sand, cement, clay and plaster.

Job Bwire & Arithea Nakiwala et al. ^[8] suggested that, baked bricks, tiles, concrete and rocks, among other construction materials, have been essentials in construction. But did you know that a house constructed using plastic bottles can save you more and be just as strong as or even stronger than brick homes? Water bottle housing is an innovation aimed at providing low cost housing, while contributing to environment management.

Mojtaba et al. ^[9] Concluded that 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 CO₂ emission in manufacturing the cement by reducing the percentage of cement used. 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 when it is warm it is cold inside. Constructing a house by plastic bottles used for the walls, joist ceiling and concrete column offers us 45% diminution in the final cost. Separation of various components of cost shows that the use of local manpower in making bottle panels can lead to cost reduction up to 75% compared to building the walls using the brick and concrete block.

Shilpi et al. ^[10] concluded that by utilizing PET bottles in construction recycled materials, thermal comfort can be achieved in very low cost housing, benefit in residents for those who cannot afford to buy and operate heating and cooling systems. Plastic is non-biodegradable, toxic, highly

resistant to heat and electricity (best insulator) and not recyclable in true sense, plastic PET bottles use in bottle brick technique. This gives relief for the poor people of India to provide cheap and best houses for living [3-5].

III. NECESSITY AND OBJECTIVES

Nowadays, human apply all of its potentiality to consume more. The result of this high consumption is nothing unless reducing the initial resources and increasing the landfill. In recent times, human from the one hand is always seeking broader sources with lower price and from the other hand is following the necessity to get the rid of the wastes.

A. Necessity

- Now a day plastic bottles waste increases rapidly and in our society no any efficient techniques available to dispose it.
- So if we make use of plastic bottles as construction material then we have solution to dispose plastic bottles and we can conserve natural resources.
- Recourses conservation: To conserve the non-renewable resources such as fuel , mineral and etc to ensure sufficient supply for present and future generations.
- Built development : To integrate environmental considerations in to planning and development to respect the natural environment.
- Environmental quality: To prevent or reduce processes such as land filling which can lead to environment degradation and develop the culture of reusing and recycling process.
- Social equality: To impede development that increase the gap between the rich and the poor, and to encourage for reach to the social equality.

B. Objectives

- We are the part of the environment & we has responsibility towards society and environment.
- We want to do such type of project which help to make our environment more sustainable.
- We want to minimize plastic bottles waste from environment and society.
- This plastic bottles construction is economical for poor peoples.
- Plastic is non-degradable waste in environment therefore only reuse of plastic is the best way to dispose effectively.
- To make green structure to conserve natural for future need

IV. METHODOLOGY

4.1 Construction Process:

Collection and cleaning of waste plastic bottle The gathering phase is the simplest, requiring the homeowner to calculate the number of bottles they will require and to then collect the bottles and necessary equipment.

4.2 Prepare:

The prepare phase then requires the homeowner to fill the collected bottles with sand and prepare the ground upon which the construction will take place.

4.3 Construct:

1. Lay, 2cm (3/4 inch) of cement onto the foundations of which the wall is being built.
2. Place plastic bottles on top of this cement with a 1cm (1/3 inch) space between bottles.
3. Pour cement on top of these bottles being careful to fill in all gaps, ensuring that the cement is 2cm (3/4 inch) above the top of the bottles.
4. Place the next layer of plastic bottles in between the bottles below, as shown in Figure 7 (over).
5. Pour cement on top of these bottles being careful to fill in all gaps, ensuring that the cement is 2cm (3/4 inch) above the top of the bottles.
6. Repeat steps 1-5 until the wall is at the desired height.
7. Once the wall is built and dried completely render the sides to achieve the desired outward aesthetic look.

V. DETAILS OF DESIGN , WORKING , AND PROCRSSES

5.1- Planning And Designing

5.1.1 Planning

We were decided to make a small wall using plastic bottles. We has to draft a plan with respect to cost, time, material, labours, execution of work etc,. Whole work is divided in two parts as report and model. Then assign work to group members to execute work with quality. We decided time for whole work and as per it we collected the material on one place and started to make the masonry wall.

5.1.2 Designing

Measurement of total quantities of item of work
 Comparison between Brick Masonry Wall and Bottle Masonry Wall Here, we consider 10 sq. meter Masonry works for calculation of quantities.

Table 5.1 Design of wall made by plastic bottles.

Sr No.	Type Of Structure	Particular	Dimension
1	Masonry Wall	Shape	Rectangular cube
		height	487 mm
		Thickness	150 mm
		Length	609 mm
		Weight	6.5 kg

5.2 Designing

Measurement of total quantities of item of work.
 Here, we consider 10 sq. meter Masonry works for calculation of quantities.

Table 5.2.1 : Cost Estimation of Brick Wall Masonry

Sr No.	Material	Quantity	Rate	Per	Amount(Rs)
1	Brick	1150 nos.	5	1 nos.	5750
2	Cement	5.45	300	1 bag	1635
3	Sand	0.237	250	1 m ³	59.25
				Total	7444.25

Table 5.2.2 : Material Quantity rate pre amount

Sr no.	Material	Quantity	Rate	Per	Amount (Rs)
1	Plastic bottle	1572nos.	0.5	1 no.	786
2	Cement	5.45	300	1 bag	1635
3	Sand	0.237	250	1 m ³	59.25
4	Soil	1.99	100	1 m ³	199
5	Labour work	4	300	1 person	1200
				Total	3879.25

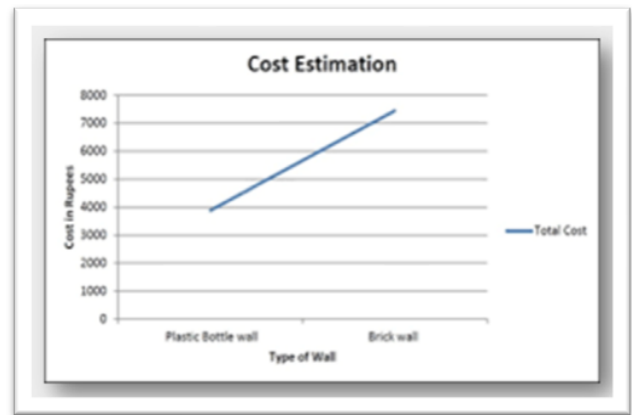


Fig 5.2.1 Cost Estimation of Plastic Bottle Wall Masonry

All the costing of the project was done as per the availability of the material. As we have all the material and no money required for this project

5.3 Collection of Required Raw Material

We collected plastic bottles from different hotel nearby, soil is locally available which is taken from hill near to the college campus. Other material such as wooden ply, rods is taken waste which thrown by peoples. Tools and instruments were taken from the college concrete technology lab.

5.3.1 Construction Materials and Properties.

This construction requires some of the basic materials which ensures a stable, eco-friendly structure and also results in cheap construction as compared to brick wall. Materials uses for Bottle wall masonry construction are:

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, so as to check whether the soil sample selected is suitable for the given project



Fig. 5.3.1 Soil Sample

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 so as to ensure a stable structure. Properties of PETE bottle Polyethylene Terephthalate Ethylene (PETE) bottles is thermoplastic materials. This type of plastic are polymers and with or without cross linking and branching, and they soften on the application of heat, with or without pressure and require cooling to be set to a shape



Fig. 5.3.2 Plastic Bottles

3. Cement:

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

- Fineness:

Fineness or particle size of Portland cement affects Hydration rate and thus the rate of strength gain. The smaller particle size, and the greater the surface area-to-volume ratio so that the more area available for watercement interaction per unit volume. The effects of greater fineness on strength are generally seen during the first seven days.

- Soundness:

Soundness is defined as the volume stability of the cement paste. Cement paste strength is typically defined in three ways: compressive, tensile and flexural. These strengths can be affected by a number of items including: water cement ratio, cement-fine aggregate ratio, type and grading of fine aggregate, curing conditions, size and shape of specimen, loading conditions and age.

- Setting Time:

The initial setting time is defined as the length of time between the penetration of the paste and the time when the needle penetrates 25mm into the cement paste.



Fig. 5.3.3 Cement

4. Nylon Rope:

Nylon rope has a very high tensile strength so that it is use as the main binder for PETE bottles masonry Properties of Nylon rope Nylon rope is gotten from coal, Petroleum, air and water. It is a polyamide thermoplastic produced by series on condensation reaction between an amine and organic acids.



Fig. 5.3.4 Nylon Rope

5. Water:

Water is in a similar way like cement, an active component in mortar. For cement-sand mortar, without water no hydration can be attained, hence no strength can be achieved. Water is responsible for the workability of a fresh mortar. 20% of the overall weight of the cement and soil was used to determine the quantity of water to be used in the mix. A slump test and a flow test were conducted to evaluate the consistency of the fresh mortar.



Fig. 5.3.5 Water

5.4 Execution of Work

5.4.1 Wall Construction

1. Layout

As per design we mark a rectangle on the wooden ply on it with lime.

2. Bottle filling with soil

All the bottles fill with red soil properly and to fill bottle steel roof use, it help to avoid voids will chances of creation in bottle

3. Masonry Work

All plastic bottles are arranged as English bond with minimum mortar.

4. Finishing work:

Plastering is done in this work only in one side to show material as plastic bottles.



Fig. 5.3.6 Execution of work

VII. CONCLUSION

Followings are the conclusions that are drawn from this study

1. Use of innovative materials with sustainable application such as plastic bottles can have considerable benefits including finding the best optimization in energy consumption of the region, reducing environmental degradation
2. Generally the bottle houses are bio-climatic in design, which means that when it is cold outside is warm inside and vice versa.
3. Re-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 emission in manufacturing the cement by reducing the percentage of cement used.
4. Plastic bottles can cause the green construction by saving energy and resources, recycling materials,

minimizing the emission, having significant operational savings and increasing work place productivity.

5. Cost compression between bottles wall is roughly half than conventional brick masonry. i.e., Total cost of 10 sq m Brick masonry wall is Rs. 7444.25 and total cost of 10 sq m Bottle masonry wall is Rs. 3879.25.

VII. FUTURE SCOPE

The present research can be extended to:

1. The test can be carried out different grade of concrete.
2. The use of admixtures in the test can be performed to get improved strength.
3. Experimental study has to be conducted for other varieties of plastic like HDPE, PET, and PP etc.
4. The durability of such as concrete has to be tested for beams and columns with varying proportions of waste plastic at different edges.
5. The use of waste plastic in concrete is relatively a new development in the world of concrete technology and lot of research must go in before this material is actively used in concrete construction.
6. Estimation of types, quantity, and use full component present in the waste plastic material in city and surrounding areas.
7. Methodology for collection and sorting out the useful component of the plastic waste.
8. Working out relative economic of using the modify concrete mixes in road construction work. Considering the improved performance increasing service life of the pavement.
9. Preparation specification and standard for the construction industry
10. Durability studies can be conducted so as to study its properties in the long run.
11. Tensile strength can be studied concrete needs more tensile capacity.

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