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Study of Recycled Plastic Bottles in Sustainable Construction

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ABSTRACT

Plastic waste has become one of the major environmental challenges due to its non-biodegradable nature and rapid accumulation in urban areas. At the same time, the demand for construction materials is continuously increasing with the growth of population and housing needs. Reusing waste plastic bottles in construction can provide a sustainable solution to reduce environmental pollution while conserving conventional building materials. This study investigates the feasibility of using waste plastic bottles as an alternative material in wall construction. The research focuses on evaluating the strength and performance of plastic bottles when used in masonry units and comparing their behaviour with traditional brick walls. Experimental tests are conducted to analyse the structural capacity of bottle walls and to determine their suitability for building applications. In addition, an economic comparison between brick wall construction and plastic bottle wall construction is carried out to assess cost effectiveness. The study also highlights the environmental benefits of recycling plastic waste in construction, including reduction of landfill waste and promotion of sustainable development. The findings suggest that plastic bottle walls can serve as an eco-friendly and economical alternative for low-cost construction.

Keywords: Plastic bottle construction, Sustainable building materials, Waste recycling, Low-cost housing, Environmental sustainability.

1. INTRODUCTION

The rapid growth of population and urbanization has significantly increased the demand for construction materials and infrastructure development. Conventional building materials such as bricks, cement, and aggregates require large quantities of natural resources and energy for their production. At the same time, the accumulation of plastic waste has become a serious environmental issue across the world. Plastic materials are widely used in daily life due to their durability, light weight, and low cost; however, their non-biodegradable nature creates major disposal problems.In recent years, researchers and engineers have been exploring innovative methods to reuse plastic waste in construction activities. One such approach is the utilization of waste plastic bottles as building components in wall construction. Plastic bottles can be filled with materials such as sand or soil and arranged similarly to bricks to form masonry units. This method not only helps in reducing plastic waste but also minimizes the consumption of conventional construction materials.The reuse of plastic bottles in construction offers several potential benefits. It can reduce environmental pollution, lower construction costs, and promote sustainable development. In addition, bottle walls may provide advantages such as improved thermal insulation, sound insulation, and lightweight construction compared to traditional brick masonry.This study focuses on investigating the feasibility of using plastic bottles in wall construction. The project includes examining the strength and behavior of bottle walls,conducting relevant tests, and comparing their performance and cost with conventional brick wall construction. The findings of this research aim to demonstrate the potential of plastic bottle construction as an eco-friendly and economical alternative for sustainable building practices.

1.1 problem definition

Due to increasing population day by day increases the use of plastic bottles. Daily there is almost 26000 tones plastic waste collected in India. State wise collection is about 10 to 15%, it is necessary to find out how to recycle this plastic waste or how it can be reused so than it will decrease the global warming also. Same way by our point of view it is necessary to fulfill the increasing demand of the houses. We found that cost of construction is also increasing day by day as per community. There are many options of plastic bottles in civil construction such as use in roads, cladding of walls, construction of wall etc. To solve these problems we are thinking to make use of these plastic bottles in construction which will also fulfill the green-house demand and also poverty. We have found that plastic bottle is a good option to use it in wall construction. 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.

- Use of affordable recycled materials in buildings
- Use of the method of regenerating through proper

1.2 Scope of Project

In this project, an effort has been made to review and analyse various research studies related to the use of plastic bottles in construction. A case study of an existing project, where plastic bottles were used for the construction of a bungalow, has also been examined. The compressive strength of bottle units is considered and compared with that of conventional bricks to evaluate their suitability as a building material. As part of the experimental work, a small prototype model of a bottle wall will be constructed to study its behaviour and feasibility. The use of plastic bottles is considered not only for wall construction but also for possible applications in ceilings and other building components. This study investigates the key characteristics and advantages of plastic bottle construction and compares it with conventional materials such as brick, ceramic blocks, and concrete blocks. The current study does not consider soil interaction effects. Based on the available studies, plastic bottle construction is mainly suitable for buildings up to two floors, as there are currently no specific standards or guidelines in Indian Standard (IS) codes for plastic bottle masonry. Future research may focus on structural analysis for multi-storey buildings, load calculations for structural elements such as columns, and the development of standardized construction practices. Government and regulatory bodies should also encourage further research and promote eco-friendly construction methods through appropriate policies and guidelines.

1.3 Objectives

1) To reduce pollution due to plastic bottles.
2) To reduce the cost of construction as compared to brick wall construction.
3) To give Aesthetic look for house.
4) To build green construction by saving energy and resources.
5) To reduce the CO2 emission by using small amount of cement.

1.4 Literature Survey

1.4.1 International Journal of Engineering and Technical Research (IJETR): (Reuse of Plastic Bottles as a Construction Material) Published: September 2019

PETE bottles, plastic rope, soil, Portland cement, and water are the main material components to produce the PETE bottles masonry. Unfortunately there is no research that has ever been undertaken to determine structural behavior of PETE bottles as masonry and that could have been an appropriate source of reference for a literature review in guiding this research. The few attempts that have been performed in building structure with PETE bottles were made by means of trial and error according to Froese (Personal communication, 2008).

1.4.2 International Journal of Advanced Research in Science and Engineering (IJARSE): (Literature Review on Use of Plastic Bottles for construction of Water Tank as a Sustainable Material.) Published: March 2018

This paper proposes the use of waste plastic PET bottles as construction entity to standardized bricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are major explanation for 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 are often concluded that advantage of the utilization of PET bottles include both improved ductility as compared with raw blocks and inhibition of crack propagation after its initial formation.

1.4.3 International Journal of Current Trends in Engineering & Research (IJCTER): (A WALL STRUCTURE FOR GREEN HOUSE ARPN Journal of Engineering and Applied Sciences) Published: May 2016

Wall structure plays important roles in supporting the superstructures, separates spaces in buildings into sections and delineates an area in outdoors . Most of the development of house in Malaysia use bricks and mortar which consists of cement, aggregates and water because the materials to create the structure of wall. However, materials such as cement and bricks manufacturing process will contribute to a high emission of carbon dioxide (CO2) which may lead to global warming. Therefore, objective of this paper is to seek out an alternate solution to scale back this hazardous environmental problem. The alternative way that can solve the problem is by replacing the use of bricks in building construction by plastic bottles filled with sand as we called it plastic bottle green house. Reuse of those non-biodegradable plastic bottles not only can solve the environmental problem, but it also can reduce the pollution. The main concern of this project is that the strength of bottle bricks. Therefore, there were two types of experiments were used to evaluate the properties of bricks and plastic bottle filled with sand which are compression test and temperature test in indoor and outdoor of wall structure.

The compression test is prepared for 1.5L bottle brick, 250ml bottle brick and common clay brick. As results, the strength of 1.5L and 250ml bottle bricks are 3 and 4 times respectively stronger compare to common clay brick. The comparison of indoor and outdoor wall temperature, air humidity and wind velocity between the plastic green house and normal brick house has indicate that plastic bottle has recorded highest reading for outdoor wall temperature with 36°C and lowest reading on outdoor humidity and outdoor wind velocity with 78% and 0.8 m/s respectively. From these result it can be concluded that plastic bottle greenhouse have a potential as awall construction material and further study on its other properties such as its lifespan and ratio between water, cement and sand usage as a mortar should be carried out..

1.4.4 International Journal of Engineering Technology Science and Research (IJETSR): (Construction of houses using plastic bottles) Published: April 2017

This paper intends to research the appliance of plastic bottles together of the urban wastage in buildings construction which how it can cause sustainable development. This paper also includes various factors like time of execution, cost, load capacity, flexibility, reducing waste and energy efficiency; plastic bottles could also be simpler compared to some conventional building materials like brick and concrete block. Authors made effort towards waste plastic bottle used as construction material.

2. METHODOLOGY

The increasing demand for housing and shelter has led to a rapid rise in the consumption of conventional construction materials. At the same time, the accumulation of plastic waste has become a serious environmental problem. Large quantities of plastic bottles are discarded every day, creating challenges in waste management and environmental protection. Therefore, it is necessary to explore innovative ways to reuse plastic waste in useful applications. This project proposes the use of plastic bottles as an alternative material for wall construction, which can help address both environmental and economic concerns. By utilizing waste plastic bottles in building construction, it is possible to reduce plastic pollution and minimize the use of conventional materials such as bricks. This approach can contribute to sustainable and eco-friendly construction practices. Various low-cost materials and techniques are used in modern construction to reduce overall building expenses. In this project, a comparative study will be conducted between conventional brick wall construction and plastic bottle wall construction in terms of cost and feasibility. The use of plastic bottles in construction can support green building concepts by promoting recycling, conserving natural resources, reducing waste, and minimizing environmental pollution. Since cost is a critical factor in construction, the study aims to explore practical methods of incorporating plastic bottles into building structures. Initially, different techniques and methods of using plastic bottles in construction will be examined, followed by an analysis of their economic and environmental benefits. This research attempts to identify a cost-effective and sustainable solution for future construction practices.

2.1 Plastic bottle sand brick

Fig.1: Fill Plastic bottle with sand

Fig .2: Fixing of bottles with wooden

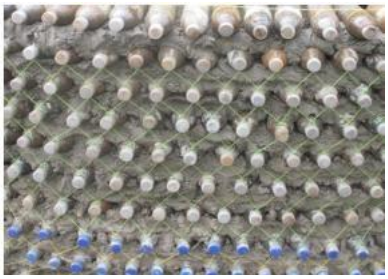

Fig -3: Plastic bottle wall 2.2Benefits of plastic bottle over masonry wall

Eco-house also known as Green building, is the creative buildings and supportive infrastructure that reduce the use of resources, create healthier living environments for people, and minimize negative impacts on local, regional, and global ecosystems. Strength of bottle bricks has been doubted by the general public since they're

made up of plastic bottles. Packing sand into plastic bottles is a technique that started nine years ago in India, South and Central America. Named “bottle brick” technology, the compacted sand inside the bottles is nearly 20 times stronger than bricks. Adding to the appeal of the simple technology, the houses are ideal for the hot Nigerian climate because the bottle bricks buffer the house from the intense heat. Also, during a place known for violence, the homes are completely bullet proof. Structure of wall play a crucial role in supporting the load applied from roof. According to Public Work Department (PWD) Standard Specification for Building Works (2008), the minimum permissible average compressive strength shall be 5.2N/mm2 for bricks and a couple of .8 N/mm2 for hollow blocks per 10 samples taken at random from the Contractor’s stock pile of 1000 or part thereof (JKR , 2005). Thermal comfort is taken into account to be a principal requirement that's usually demanded of by occupants of accommodation units. A compatible indoor climate design is really a modification of the external environmental system and is meant to supply comfort for occupants. There is a reciprocal relationship between climate and man in both indoor and outdoor areas. One of the many objectives of designing buildings is to make sure the thermal comfort to occupants. This is because most people generally spend 85 90% of their time indoors and thus providing a comfortable and healthy environment is imperative.

The most important benefits of those alternative innovative materials compared to standard materials like brick can include

A. Good construction ability: The walls built by these bottles are lighter than the walls built by brick and block, which makes these buildings to point out an honest response against earthquake. Due to the compaction of filling materials in each bottle, resistance of every bottle against the load is 20 times higher compared to brick. And these compressed filling materials, makes the plastic bottle to be prevented from passing the shot that makes the building as a bulletproof shelter.

B. Low cost: Constructing a house by plastic bottles used for the walls, joist ceiling and concrete column offers us 45% diminution within the final cost. Separation of varied components of cost shows that the utilization of local manpower in making bottle walls can cause cost reduction up to 75% compared to putting together the walls using the brick and concrete block. It must be noted that the subtle manpower can cause reducing the development time and therefore the relative costs also become lower.

C. Non-brittle characteristic: Using the non-brittle materials can reduce construction waste. Unlike brick, plastic bottle is non-brittle. So thanks to the frangibility property, the share of manufacturing construction waste in brick is quite plastic bottles.

D. Absorbs abrupt shock loads: Flexibility is a characteristic which makes the buildings performance higher against the unexpected load. Since the plastic bottles aren't fragile, they will be flexible and tolerates sudden loads without failure. This characteristic also can increase the buildings bearing capacity against the earthquake

E. Green Construction: 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. Above mentioned are the different uses of plastic in construction field. In our case study we have studied about the main factors which affect conditions of construction. Keeping in mind rather than the pollution there are even better option to deal with such as cost estimation of the any product which will come in market. So keeping this point in mind we have even searched for more options in which what can be the option in place of clay bricks. Than we have revealed about the different types of brick used in construction. Bricks such as Fly ash bricks, Sand lime brick, Smart bricks, etc. but these bricks are bit costlier than bottle sand brick. We are going to use Bottle sand brick method and change the filler materials to give them more strength.

2.2 Details of Design, Working and Processes

In our project we are going to show which brick in comparison of clay brick is the cheapest cost and also strength. We are going to change the filler materials in the bottle. As we have studied pervious papers about this project the filler material were only sand or soil or cement mortar. The proportion of sand, soil, and fly-ash in a proper proportion so that it will save sand and it will also gain strength. For assurance we are going to take tests on all the bottles. We are going to test with filler material Sand, soil and fly-ash. Also, we are going to prepare cube of bottles and take tests on it. After filling the material in the bottles, we will take compressive strength of the bottle mentioned above. And going to introduce society with a best brick product which will satisfy all the conditions mentioned in our case study. Here by we are considering load bearing structure.

2.2.1 Procedure of Preparing Plastic Bottle Bricks

- Collection of PET bottles of different sizes from different sources such as hotels, canteens, open areas solid waste management plant etc. and to decide uniform size for us for the construction of the plastic bottles.
- Bottle sized with 25 cm is preferable because normally wall thickness in construction is assumed 23cm commonly. So, we are using 25 cm heighted bottle in our construction with 7 cm diameter.
- Then collect filler materials to fill the bottles e.g. sand, soil and fly-ash and tamping rod to make material fill properly without living air voids as shown in fig.5.1 Filling of materials in bottle.
- First of all, we had filled bottle with saturated sand and soil in each bottles separately. After filling a thick paste

of mortar was placed on the cap of the bottle so that filler material should not come out due to excessive compressive load on each bottle. Measured the bottles with filler material so that it will be easy to take proportion of other bottles

- Bottle filled with sand was of 130 gm weight and the bottle filled with soil was having 800 gm weight.
- Then after that taking these weights, we got an idea how to proportionate the remaining filler materials.
- After taking filling all four bottles, we took compressive test on each bottle to know which bottle resist more compressive forces.
- Noted down all thee reading and prepared results and conclusion for the project.

2.2.2Procedure to organize cube

- Wooden cube (25.5×25.5×25.5) cm was prepared.
- The wooden cube was painted black to form the surface smooth and dried it within the airA layer of diesel was applied within the mould in order that the cube can easily detach from the surface after drying.
- 4. The cement mortar ratio for the cube was kept as 1:3 (OPC).
- A layer of 2cm was laid on surface of the mould and 25 blows got with the assistance of the tampering rod.
- Three 500 ml bottles were laid on the surface of the mould
- Another layer of the mortar was placed on the bottles covering them completely.
- 15 blows of tampering rods got this point .
- Another layer of three bottles was placed on the mortar layer.
- within the same manner nine bottles were inserted within the mould the ultimate layer of the mortar was finished properly to achieve smoother surface
- The mould was left in outdoors to dry for 48 hours.
- On the third day the cube was taken out from the mould and was kept in curing tank for 28 days.
- On the 28th day the cube was taken out from the curing tank.
- it had been then dried in outdoors .
- Then the cube was placed within the digital compression testing machine between both the plates and therefore the results were recorded.
- The load at which the cube breaks out was the utmost loading bearing capacity of that cube.

2.2.3 Procedure of construction wall

- Lay, 2cm (3/4 inch) of cement onto the Foundations of which the wall is being built on the ground .
- Place plastic bottles on top of this cement with a 1cm (1/3 inch) space between bottles.
- Pour cement on top of those bottles being careful to fill altogether gaps, ensuring that the cement is 2cm (3/4 inch) above the highest of the bottle
- Place subsequent layer of plastic bottles in between the bottles below. (Fig.5.6 Construct wall sample)
- Pour cement on top of those bottles being careful to fill altogether gaps, ensuring that the cement is 2cm (3/4 inch) above the highest of the bottles.
- Repeat steps 1-5 until the wall is at the specified height. .

Comparison between the walls by plastic bottle and brick

Sr. No.	Factors	Considerations	Plastic Bottle Wall	Brick Wall
1	Time and Speed of Execution	5-person team in one working day	15% faster execution, covers around 120 m²	Slower execution
2	Material and Equipment Costs	Implementation and installation of materials and equipment	Savings in cement, water, grinding, and fitting costs	Higher material consumption and greater overall weight
3	Transportation Costs	Displacement and movement in the building	Lightweight, higher volume, easy and low-cost transportation	Heavy weight, lower volume efficiency, difficult and costly transportation
4	Execution Cost	Based on panel construction calculations	Requires less manpower and uses indigenous resources	Requires more manpower, leading to higher costs
5	Strength and Load Capacity	Structural performance	Approximately 20 times stronger than brick walls	Greater wall thickness, lower strength, higher weight, and more material loss
6	Resistance to Earthquake	Relationship between structural weight and earthquake impact	Low integrated weight reduces collapse and falling debris	Higher structural weight increases earthquake impact

7	Cleanliness and Beauty of Work	Construction site condition	Clean execution with minimal construction waste	Large amount of construction waste generated
8	Flexibility	Adaptability in construction	Flexible and easy to modify	Less flexible in comparison

3. CONCLUSIONS

The experimental study was conducted to evaluate the suitability of different filler materials used in plastic bottle bricks. From the density tests of the materials such as soil, sand, and fly ash, it was observed that fly ash has a higher density compared to soil and sand. The compressive strength test results also indicated that the bottles filled with fly ash showed higher strength than those filled with soil and sand. From these observations, it can be concluded that as the density of the filler material increases, the compressive strength of the bottle unit also increases. The cost analysis of 1 m^3 of masonry work was also carried out to compare conventional brick masonry with plastic bottle masonry. The results revealed that the cost of bottle brick masonry is approximately 35% lower than that of conventional brick masonry, making it a more economical option for construction, particularly for low-cost housing. Plastic bottles are generally considered non-biodegradable waste that can cause serious environmental problems. At the same time, excessive use of non-renewable construction materials leads to depletion of natural resources. Reusing plastic bottles in construction helps address both issues by reducing plastic waste and conserving natural materials. Plastic bottles can be used in several parts of building construction such as walls, roofs, and partition structures. The reuse of plastic bottles as building materials can significantly reduce the embodied energy of buildings by replacing traditional bricks and lowering cement consumption, which in turn reduces CO_2 emissions associated with cement production. Bottle houses are also considered bioclimatic structures, meaning they can provide better thermal comfort—remaining warmer in cold conditions and cooler in hot conditions. Overall, the use of plastic bottles in construction offers environmental, economic, and energy-saving benefits. The technique uses conventional mortar to bond the "eco-bricks" similar to traditional masonry. Therefore, spreading awareness and educating communities about plastic bottle construction techniques can encourage the adoption of this low-cost and sustainable building method.

4. REFERENCES

[1] International Journal of Engineering and Technical Research (IJETR): "Reuse of Plastic Bottles as a Construction Material" Published: September 2019
[2] International Journal of Current Trends in Engineering & Research (IJCTER): "A WALL STRUCTURE FOR GREEN HOUSE" ARPN Journal of Engineering and Applied Sciences Published: May 2016
[3] International Journal of Engineering Technology Science and Research (IJETSR): "Construction of houses using plastic bottles" Published: April 2017
[4] Aditya Raut-"Application of Waste Plastic Bottle as a Construction Material"(2015)
[5] International Advanced Research Journal in Science, Engineering and Technology AGNI-PANKH 16 Jawaharlal Darda Institute of Engineering and Technology, Yavatmal Vol. 4, Special Issue 3, January 2017 Copyright to IARJSET DOI 10.17148/IARJSET 1 "Waste Plastic Bottle as Construction Material".
[6] Aditya Singh Rawat, R. Kansal- PET Bottles as Sustainable Building Material: "A Step Towards Green Building Construction"(2014) (7) Mojtaba Valinejad Shoubi-"Use of plastic bottle in construction" (2013)
[7] Pratima A. Patel-"Waste plastic bottles offering innovative building materials with sustainable application" (2016)