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IMPLEMENTATION OF ROLE OF CIRCULAR ECONOMY PRINCIPLES IN SUSTAINABLE CONSTRUCTION PRACTICES

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Abstract: The construction sector is a major contributor to global waste, necessitating the adoption of sustainable and circular solutions. This study examines the implementation of circular economy (CE) principles in construction practices, with the aim of reducing environmental impact through innovative waste management and material reuse strategies. Key objectives include analyzing construction waste generation and current management practices in light of CE concepts, as well as identifying behavioral and contextual factors influencing on-site waste handling. A core focus of the research is the utilization of PET (polyethylene terephthalate) bottles and locally available waste soil in the fabrication of alternative masonry units. These units are evaluated for their structural and economic feasibility in comparison to conventional brickwork. A detailed cost analysis is carried out for both traditional masonry walls and PET bottle–based walls, assessing material costs, labor, and long-term viability. The study ultimately assesses the practicality and benefits of CE-inspired construction, offering insights into sustainable building methods that promote resource efficiency, waste minimization, and environmental stewardship.

IndexTerms **- Circular Economy, Sustainable Construction, Construction Waste Management, PET Bottles, Waste Soil, Cost Analysis.**

I. INTRODUCTION

The construction industry is a significant driver of economic growth, yet it is also one of the largest contributors to global environmental degradation. With increasing urbanization and infrastructure development, the sector generates vast quantities of construction and demolition waste, placing immense pressure on landfills and natural resources. Traditional linear construction models characterized by a "take-make-dispose" approach are no longer sustainable in the face of escalating resource scarcity and environmental concerns.

In response, the concept of the circular economy (CE) has gained prominence as a strategic framework for transforming waste into resources, extending material life cycles, and enhancing sustainability across industries. Applied to the construction sector, circular economy principles encourage waste minimization, material reuse, recycling, and innovative design approaches that reduce environmental impact. Implementing CE in construction involves rethinking not just materials, but also design, supply chains, and stakeholder behavior.

This study explores the practical application of circular economy principles in sustainable construction, with a particular focus on waste reduction, behavioral influences, and innovative use of recycled materials. It investigates the potential of incorporating PET (polyethylene terephthalate) bottles and waste soil in the development of alternative masonry units, offering a solution to both plastic waste and construction material demand. Additionally, the study performs a comparative cost analysis of traditional masonry walls and PET bottle–based walls to evaluate economic viability.

By examining construction waste generation and management, assessing contextual and behavioral factors, and exploring alternative building materials, this research aims to determine the feasibility and effectiveness of CE-inspired construction practices. The findings aim to contribute to a growing body of knowledge that supports the transition toward a more sustainable and resource-efficient construction industry.

1.1 Soil From Excavation And Demolition

Soil from excavation and demolition refers to the material that is removed from the ground during construction activities like excavation (digging) and demolition (breaking down or dismantling structures). This soil can come in a variety of forms and contain different types of materials based on the site and the purpose of the work being done.

Fig 1 Soil from Excavation

- **Topsoil:** The uppermost layer of soil, often removed before excavation to preserve it for landscaping or other uses.
- **Subsoil:** Located beneath the topsoil, often removed in larger quantities during excavation.
- **Contaminated Soil:** Soil that has been affected by hazardous materials such as oil, chemicals, or other pollutants from demolition activities.
- **Mixed Soil:** Soil mixed with debris from demolished buildings, such as concrete, bricks, wood, and other construction materials

II. NEED OF THE STUDY.

The rapid pace of urbanization and infrastructure development has led to a significant increase in construction and demolition waste, placing considerable stress on the environment and waste management systems. Traditional construction practices are resource-intensive and follow a linear model that is no longer sustainable in the face of growing environmental concerns, material scarcity, and climate change.

There is a pressing need to adopt circular economy (CE) principles in the construction sector to promote sustainability through the efficient use of materials, reduction of waste, and reuse of resources. By shifting towards circular approaches, the industry can reduce its environmental footprint, conserve natural resources, and create innovative, cost-effective building solutions.
Furthermore, the large volume of plastic waste, particularly PET bottles, and abundant waste soil generated from excavation and other activities presents an opportunity for reuse in construction. These materials, often considered pollutants, can be transformed into valuable resources for alternative masonry units, reducing reliance on conventional bricks and cement-based blocks.

III. USE OF WASTE PLASTIC BOTTLE

Plastic has become one of the most widely used yet highly disposable materials in the modern world. Among the various plastic products, plastic bottles, especially those made from PET (polyethylene terephthalate), pose a significant threat to the environment due to the chemicals involved in their production, improper disposal practices, and resistance to degradation. These bottles often end up in landfills, polluting the soil, choking water bodies, and contributing to a range of environmental issues.

Fig 2 Plastic Bottle As brick

Simultaneously, the growing global population continues to increase the demand for housing and land for construction. For economically disadvantaged communities, the rising cost of conventional construction materials makes home ownership an increasingly distant goal. This scenario necessitates the exploration of alternative, low-cost, and sustainable building materials.

One such alternative is the use of waste plastic bottles as construction units. While unconventional, research and practical applications have shown that mud-filled or sand-filled plastic bottles can serve as effective substitutes for traditional bricks. These bottles, when tightly packed and arranged in a framework, can form structurally sound walls or pillars. The gaps between bottles are filled using clay or a cement-based plaster, and the structure can be completed with roofing materials such as wood or corrugated metal sheets. Since these buildings primarily use locally available and recycled materials, they are significantly more affordable and environmentally friendly.

IV. RESEARCH METHODOLOGY

The methodology adopted for this study is structured to comprehensively assess the feasibility of implementing circular economy (CE) principles in sustainable construction, with a focus on utilizing plastic bottles and waste soil as alternative building materials. The following steps outline the sequential process undertaken during the research:

4.1 Study of Circular Economy

A thorough literature review was conducted to understand the concept, principles, and global applications of the circular economy in the construction sector. Emphasis was placed on waste reduction, material reuse, and resource optimization strategies relevant to building practices. The review also explored case studies, best practices, and innovations in circular construction.

4.2 Selection of Study Area

A suitable construction site was identified based on criteria such as accessibility, ongoing or planned construction activities, and potential for incorporating circular methods. The chosen site allows for observation and analysis of real-world construction waste generation and management practices.

4.2 Study of Wastage on the Site

On-site data collection was carried out to quantify the types and volumes of construction waste generated. Special attention was given to plastic waste, particularly PET bottles, and excavated waste soil—both considered for reuse in masonry construction. The behavior, awareness, and practices of workers and stakeholders regarding waste management were also observed and recorded.

4.3 Implementation of Circular Economy

Based on the analysis, an alternative construction technique using plastic bottles filled with excavated soil was implemented on a small-scale model or selected portion of the building. Various patterns of bottle masonry were tested and compared with traditional brickwork in terms of ease of construction, time, and structural integration.

4.4 Cost-Benefit Analysis

A detailed comparison between brick masonry and plastic bottle masonry was performed. Parameters such as material cost, labor cost, total construction cost, load implications, and durability were analyzed. This step evaluated both the economic viability and environmental benefits of using waste-based construction materials.

V. RESULTS AND DISCUSSION

5.1 Problem Statement

This study aims to estimate and compare the material requirements and structural implications of using conventional brick masonry versus plastic bottle walls filled with excavated waste soil in a G+1 reinforced concrete (RC) frame building, with each floor having a height of 3 meters. The physical and mechanical properties of the frame structure are defined in accordance with standard construction practices. The primary focus is to calculate the total quantity of wall materials required for both types of construction and subsequently determine the total wall loads imparted on the structural frame. This comparison will help assess the feasibility and potential structural impact of integrating plastic bottle masonry as a sustainable alternative to traditional brickwork.

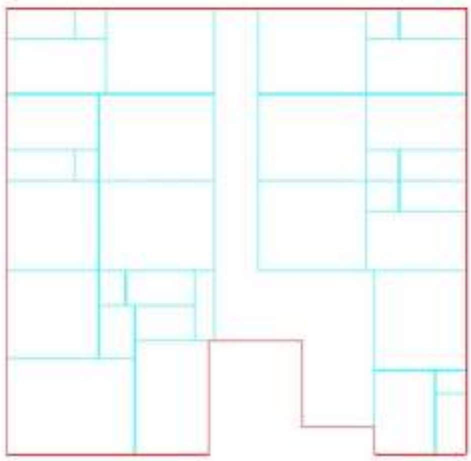


Fig 3 Total Brickwork Area

Above fig shows the total brickwork area cover in the plan , the red area indicate the wall having thickness of 150 mm (outer wall) and Cyan area indicates the wall having thickness of 125mm (inner wall)

5.2 Rate analysis of brick masonry

Rate analysis of brick masonry used of reference book IS Code 1200 part 3(IS Code 1200 part 3 used for measurement), IS Code 2212, and CPWD Part 1

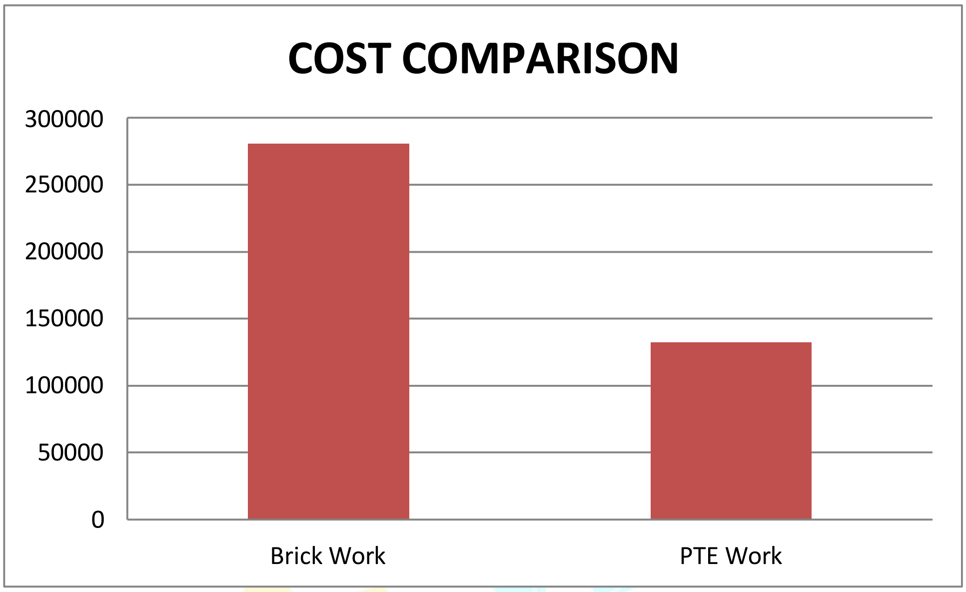
Table 1 Rate analysis of brick masonry

Sr No.	Description	Qty	Unit	Rate	Cost
A.	**Material**				
1	Bricks (Size of brick = 190 mm x 90 mm x 90 mm)	33269	No	4	133076
	Wastage of brick 5% Extra	5%			6654
2	Cement	85	Bag	370	31450
	Wastage of cement 2% Extra	2%			629
3	Sand	6.27	Brass	7000	43890
	Wastage of sand 2% Extra	2%			877.8
B.	**Labor Charges**				
1	Mate	15	No	350	5250
2	Mason	25	No	700	17500
3	Helper	15	No	500	7500
4	Coolie	10	No	350	3500
C.	**Total Cost**				250327
	Scaffolding 1% Extra	1%			2503
	Add for Water Charge @ 1% on Items Market	1%			2503
	Add for Contractor's Profit @10% on Items Marked	10%			25033
Total Cost of 66.54 Cu.m.					280366

5.3 Rate Analysis PTE Bottles

Table 2 Rate Analysis PTE Bottles

Sr No.	Description	Qty	Unit	Rate	Cost
A.	**Material**				
1	PTE Bottle	2554	No	2	76620
2	Cement	92	Bag	370	34040
	Wastage of cement 2% Extra	2%			680.8
3	Sand	6.77	Brass	7000	47390
	Wastage of sand 2% Extra	2%			947.8
B.	**Labor Charges**				
1	Mate	15	No	350	5250
2	Mason	15	No	700	10500
3	Helper	20	No	500	10000
4	Coolie	15	No	350	5250
		65			
C.	**Total Cost**				119167
	Add for Water Charge @ 1% on Items Market	1%			1192
	Add for Contractor's Profit @10% on Items Marked	10%			11917
Total Cost of 66.54 Cu.m.					132275



Graph 1 Cost Comparison

Above graph shows the cost comparison of brick work and PET work, its conclude that PET work are economical financially its differ aprox 1.48L rs per floor.

VI. CONCLUSION

For the study we study G+1 storey structure of a building located in Punavale, Pune with 3 m floor to floor height and calculate Quantity and loads of Brick masonry and Plastic Bottle masonry of R.C.C Buildings. Find the cost feasibility and seismic effect of the structure. The final conclusion are conclude that the PET bottles are economical than brick masonry in financially and stability too. The conclusion are conclude from the following points

- 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.
- 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. Plastic bottles wall have been less costly as compare to bricks and also they provide greater strength than bricks.
- Plastic bottles are considered as a kind of indecomposable junk which can have substantial dangerous impact on environment. On the other hand using the non-renewable resource cannot lead to sustainable development and causes to the resource depletion which can bring a destructive concern for the future generation. It has been demonstrated that the plastic bottles can be used in some parts of building construction such as walls, roof and etc
- The cost comparison of brick work and PET work, its conclude that PET work are economical financially its differ aprox 1.48L rs per floor.

VII. ACKNOWLEDGMENT

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