An Experimental Reasearchon Piers Made with Waste Plastic Bottles

Prince Arulraj G., Illamathi, Jayashree

ABSTRACT--- This paper deals with "An experimental investigation on piers made with waste plastic bottles". One of the main problems faced by the construction industry is the high cost of the building materials.Materials are the primary requirement for construction. In places where people are below poverty line, the high cost of building materials is becoming one of the most significant problems. Clay bricks are commonly used for the construction of houses. Production of clay bricks results in the liberation of Oxides of Sulphur and Carbon. Even though fly ash bricks avoid the liberation of the greenhouse gases, it is beyond the reach of poor people. On the other hand, urbanization generates waste materials, especially the non-degradable ones. Eco friendly architectural 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. An attempt has been made to build low cost houses using waste plastic bottles along with chicken mesh, providing adequate thermal comfort while being sustainable.The innovative idea reduces the requirement of clay and fly ash bricks at the same time protects the environment from pollution.Strength of bottle blocks were determined for three l/d ratios and the strengths were compared with that of clay brick masonry.It was found that the strength of bottle masonry reinforced with chicken mesh was more that that of the conventional brick masonry.The cost of bottle masonry is also comparable with that of brick masonry.

Keywords—Urbanization, Eco friendly, Plastic bottle, masonry, Brick masonry

INTRODUCTION

Due to urbanization, increase in population and demand for houses, the demand for natural building materials has increased. Brick is one of the building materials which is widely used by the construction industry. Clay bricks are commonly used for the construction of houses, especially in rural areas. Production of clay bricks results in the liberation of oxides of Sulphur and Carbon. Even though fly ash bricks do not liberate the greenhouse gases, it is costlier than clay bricks. Hence, there is a need to find an alternative material for clay and fly ash bricks.

The present study aims of using waste, plastic bottles for making functionally efficient, structurally adequate and cost effective sustainable masonry work.

Millions of bottles of soft drinks are sold worldwide every year. Soft drinks are stored in convenient plastic bottles. The plastic bottles become useless after use.

The majority of plastic bottles are made from Polyethylene Terephthalate (PET) plastic, produced from crude oil. Not only the oil extraction releases greenhouse gases and harm habitats, but the plastic production also liberates toxins into the environment. In India, an average of 1.5 million plastic bottles are used for packaging of water and soft drinks every day. Only a small proportion of the plastic wastes are recycled and the remaining bottles upheave drastically and their disposal results in adverse effects on the environment.Since the production of clay bricks results in liberation of harmful gases there is a need to find an alternative material for clay bricks. Bottle bricks are an alternative to clay bricks and an effective method of disposal of plastic bottle waste. Hence an attempt has been made to study the strength of masonry piers made with plastic bottles.

LITERATURE REVIEW

The first plastic bottles house was constructed in the village of Yelwa in Nigeria by Andreas Froese. Froese used the plastic bottles instead of bricks, bound the bottles together with string and applied the plaster [1].

MojtabaandAzin [2] reported that use of plastic bottles in buildingsand can reduce the emission of harmful gases in manufacturing of clay bricks. Generally, the bottle houses are bioclimatic in design, which means that when it is cold outside is warm inside and when it is warm outside it is cold inside. Constructing a house with plastic bottles for the walls and columns may have a reduction of 45% in the final cost.

PratimaandAkash [3] reported that plastic bottle walls have been less costly as compared 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 do not biodegrade. This has resulted in plastic pollution problems in landfills, water ways and on the roadside.This problem continues to grow along with the growth of the plastic bottle industries.

PuttarajandShanmukha [4] reported that efficient usage of waste plastic in plastic-soil bricks has resulted in effective usage of plastic waste and thereby solving the problem of the safe disposal of plastics. It minimizes the wide spread littering.

Shilpiand Monika. [5] reportedthat by utilizing PET bottles as construction materials, thermal comfort can be achieved in low cost housing.In the low income group of people who cannot afford to buy and operate heating and cooling systems,this can give relief to the poor people and provide cheap and best houses for living.

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Prince Arulraj G., Professor & Dean, Karunya Institute of Technology and Sciences, Coimbatore, T. N, India.

Illamathi,Former students of SNS College of Technology, Coimbatore.T. N, India.

Jayashree, Former students of SNS College of Technology, Coimbatore.T. N, India.

Andreas Froese [1] reported 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 can be built. The compressive strength and fracture behaviour of each wall were measured and compared. He reported that 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.

MATERIALS USED AND THEIR PROPERTIES

USED PET BOTTLES WITH CAPS

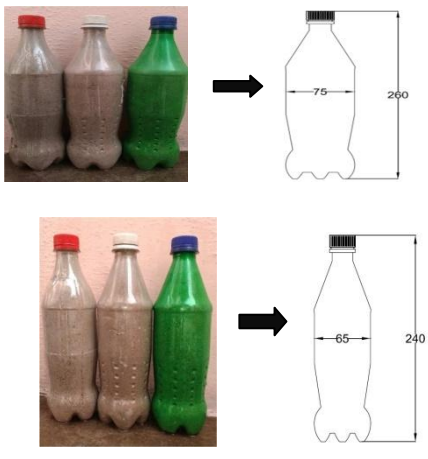
The full form of PET is Polyethylene Terephthalate and the molecular formula is $(C_{10}H_8O_4)_n$. The structural composition of PET is Polyester of Terepthalic acid and Ethylene Glycol.

PET is used for making high impact resistant container for packaging of soda, edible oils and peanut butter. It is used for cereal box liners, microwave food trays and for plastic vessels. Plastic is heat resistant and chemically stable. PET is resistant to acid, base, some solvents, oils and fats. The density of PET is 1.389/cm^3 and the melting point is 260 °C.

EFFECT OF SLENDERNESS RATIO ON STRENGTH OF THE MASONRY

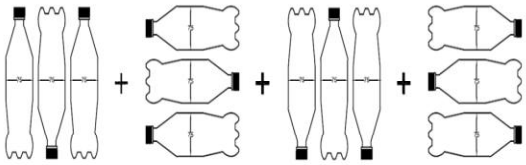
For finding the effect of Slenderness Ratio on the strength of masonry, three piers of different Slenderness Ratios were made.

Two bottles of volume 750ml & 600ml having same shape and made of same material were used for making bottle masonry. The bottles used and their dimensions are shown the Fig.1.



Here the 750ml Bottles are designated as Type **"A"** and the 600ml Bottles are designated as Type **"B"**.

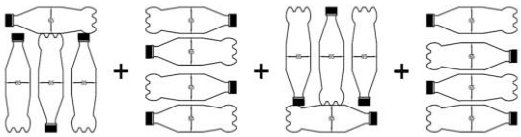
Fig.2 shows the alternative courses of the bottle masonry made with Type A bottles.



Layer 1 Layer 2 Layer 3Layer 4

Fig.2Bottle brick masonry of cross sectional size 13" x 14" made with Type A bottles

Fig.3 shows the alternative courses of the bottle masonry made with Type B bottles.



Layer 1 Layer 2 Layer 3 Layer 4

Fig.3. Bottle brick masonry of cross sectional size 13" x 14" made with Type B bottles

RESULTS & DISCUSSIONS

Crusher dust which was obtained from a local stone crushing plant was used to fill the bottles.In fact any waste product or expansive clay could be used for filling the bottles. A thin layer of mortar was laidover a flat surface.The first layer of bottles was arranged over the mortar.Then the 2nd layer was kept over the first layer after filling gap with 1:6 cement mortar.This process was continued till the required height is reached.In order to give additional strength, chicken mesh was wound over the brick pier and the surface was finished with mortar.

After the fabrication of the bottle masonry piers, the brick masonry piers of same sizes were fabricated. The piers of different slenderness ratios were cured for 28days and their 28th day compressive strengths were found for the strength comparison.

Fig.4 shows the variation of the compressive strength of the bottle brick piers made of Type A bottles with respect to Slenderness Ratio.

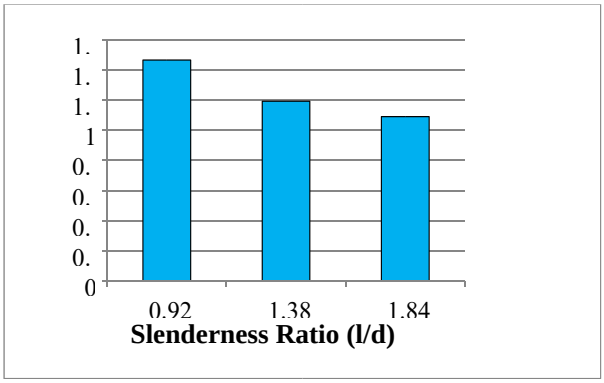


Fig.4. Strength Comparison of piers of different Slenderness Ratios made with Type 'A' bottles

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From the above Fig.ures, it can be seen that as the **Slenderness Ratio increases**, the **Compressive Strength decreases**.

Fig.5 shows the variation of the compressive strength of the bottle brick piers made of Type B bottles with respect to Slenderness Ratio.

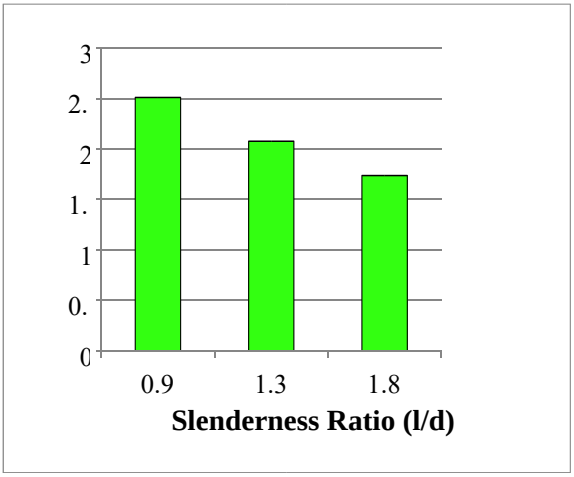

Fig.5. Strength Comparison of piers of different Slenderness Ratios made with Type 'B' bottles

From the above Figures, it can be seen that as the **Slenderness Ratio increases**, the **Compressive Strength decreases**.

EFFECT OF SIZE OF THE BOTTLES ON STRENGTH OF THE MASONRY

In order to determine the effect of the size of the bottles on the strength of the bottle masonry, two piers having same cross sectional area and slenderness ratios made of two different bottles were compared. Fig.6 shows the comparison of the compressive strengths of the bottle brick piers made with type 'A' and type 'B' bottles.

Fig.6. Comparison of Strengths of Bottle Masonry Piers with type 'A' and type 'B' bottles

The piers made up of bottle "B" showed higher strengths than the piers made up of bottle "A".Strength of bottle masonry piers with "B" type bottles was found to be **2.65%** higher than that of the bottle masonry piers with "A" type bottles. Even though the increase in the strength of the piers made with B type bottles is insignificant, one can conclude that small size bottles bricks results in higher strength.

COMPARISON OF SPECIFIC WEIGHTS OF BRICK AND BOTTLE MASONRY

The weights of bottle masonry piers and the brick masonry piers of cross-sectional size 13"x14" and height 12" werefound and their Specific Weights were calculated.

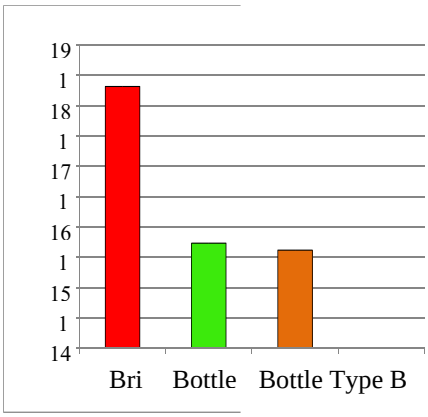

Fig.6. Comparison of Specific Weights of Bricks and Bottle Bricks

From Fig. 6, it can be seen that the specific weights of bottle masonry are less than that of the brick masonry. Specific Weights of the Bottle masonry are approximately **15%** less than that of the Equivalent Brick masonry.Thus, the **use of bottle bricks** in the masonry **results in a lighter structure compared to conventional brick masonry**.

STRENGTH COMPARISON OF BOTTLE MASONRY PIERS WITH BRICK MASONRY PIERS

In order to determine whether the bottle masonry piers are structurally better than the brick masonry piers, the compressive strengths of the bottle masonry piers are compared with that of the brick masonry piers.

Fig.6 shows the comparison of the Compressive Strengths of bottle masonry piers made with Type 'A' bottles and brick masonry piers of same cross-sectional area 13"x14".

It can be clearly seenthat the **strength of the bottle masonry piers with type 'A' bottles is higher than that of the brick masonry piers.**

The Strength of bottle masonry piers made with Type 'A' bottles was found to be approximately **31%** higher than that of the same sized brick masonry piers at a slenderness ratio of 0.923.

Fig.7 shows the comparison of the Compressive Strengths of bottle masonry piers made with Type 'B' bottles and brick masonry piers of same cross-sectional area 13"x14".

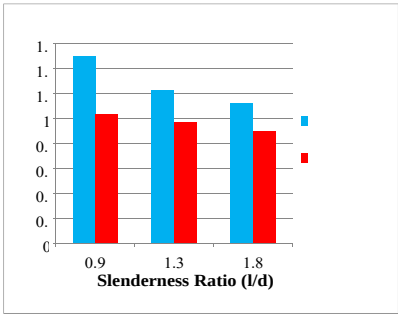

Fig.7. Comparison of Strength of bottle bricks piers made with Type 'B' bottle piers with Identical Brick Masonry pier

The strength of bottle masonry made with type 'B' bottles is found to be 47% higher than that of the brck masonry.

COST COMPARISON OF BRICKS WITH BOTTLE BRICKS

The cost of an individual bricks was compared with that of the cost of individual bottle bricks. Here, the cost of the bottle bricks includes the cost of the empty bottles, the soil filled in it and the labour required for filling the bottles.

Fig.8 shows the comparison of the Cost of Bricks and Bottle Bricks made of Type A and B.

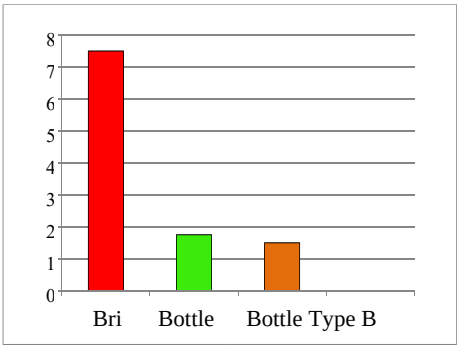

Fig.8. Cost of Individual Units

From the figure, it can be seen that cost of each bottle is much lower than that of each brick.

Table 1: COST OF CONSTRUCTION OF BOTTLE MASONRY PIERS

S.No	Materials	Quantity	Rate		Amount (₹)
			(₹)	per	
1	Plastic bottles	80 Nos.	0.5	No.	40.00
2	Cement	0.4 bag	400	bag	160.00
3	Sand	0.085 m^3	1450	m3	123.25
4	Soil	0.0624 m^3	800	m^3	49.60
5	Labour work (Filling)	0.2 days	300	day	60.00
6	Chicken mesh	10 m	10	m	100.00
7	Labour for masonry work	0.25	500	day	125.00
				Total	**657.85**

Table 2: COST OF CONSTRUCTION OF BRICK MASONRY PIERS

S. No	Material	Quantity	Rate		Amount (₹)
			(₹)	per	
1	Bricks	70 Nos	7.5	No	525.00
2	Cement	0.218 bag	400	bag	87.20
3	Sand	0.0457 m^3	1450	m3	66.27
4	Labour	0.2 day	500	day	100
				Total	**778.47**

The cost of construction of the conventional brick masonry is approximately 18% more than the cost of equivalent bottle masonry. Hence, the use of bottle masonry results in **18% savings** in the total cost of masonry.

The quantity of 1: 6 cement mortar required for the construction of the bottle masonry is approximately **46.16%** more than the quantity of 1: 6 cement mortar required for equivalent brick masonry.If the mortar requirement is brought down, the cost of bottle masonry could be further brought down.

This limitation could be overcome by the use of bottles of square cross-section instead of round cross-section.

CONCLUSIONS

- The **Strength of the Piers**, **is inversely proportional to the size of the bottles.**
- The piers made up of bottles of **"Type B"**had higher strengths than the piers made up of bottles of **"Type A".**
- The Specific Weights of the bottle piers are approximately **15% less** than that of the Equivalent brick piers.
- The Strength of bottle masonry piers was found to be approximately
- **18%** higher than that of the Equivalent brick masonry piers.
- The cost of construction of the conventional brick masonry is approximately 18% more than the cost of equivalent bottle masonry. Hence, the use of bottle masonry results in **18% savings** in the total cost of masonry.
- The quantity of 1: 6 cement mortar required for the construction of the bottle masonry is approximately **46.16%** more than the quantity of 1: 6 cement mortar required for equivalent brick masonry. T**his limitation could be overcome if all the bottles are having square cross-section instead of round cross-section.**

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