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Recycling Plastic Bottle Structure

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Abstract – *When the bottles are filled with soil or sand they work as bricks and form a framework for walls or pillars in which plaster made of clay or a cement mixture fills the space between all bottles. This paper intends to investigate the application of plastic bottles as one of the urban wastage in buildings construction and that how it can lead to sustainable development. This paper also includes different factors such as time of execution, cost, load capacity, flexibility, reducing waste and energy efficiency; plastic bottles may be more effective compared to some conventional building materials such as brick and concrete block. Authors made effort towards waste plastic bottle used as construction material. Considering some limitation in properties of plastic bottles, authors tested bottle required properties, filler material.*

Key Words**: plastic bottle, soil , cement , nylon rope , water**

1. INTRODUCTION

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 homes and are considered as the barrier for users to obtain the basic needs of the life.

Plastic is one of the most disposable materials in the modern world. It makes up much of the street side litter in urban and rural areas. It is rapidly filling up landfills as choking water bodies. Plastic bottles make up approx. 11% of the content landfills, causing serious environmental consequences.

Due to the consequences some of the plastic facts are as follow:

More than 20000 plastic bottles are needed to obtain one tone of plastic.
It is estimated that 100 million tons of plastic are produced each year.
The average Indian throws away 36 kg of plastics each year.
Some plastic waste sacks are made from 64% recycled plastic.
Plastics packaging totals 42% of total consumption and every year little of this is recycled.

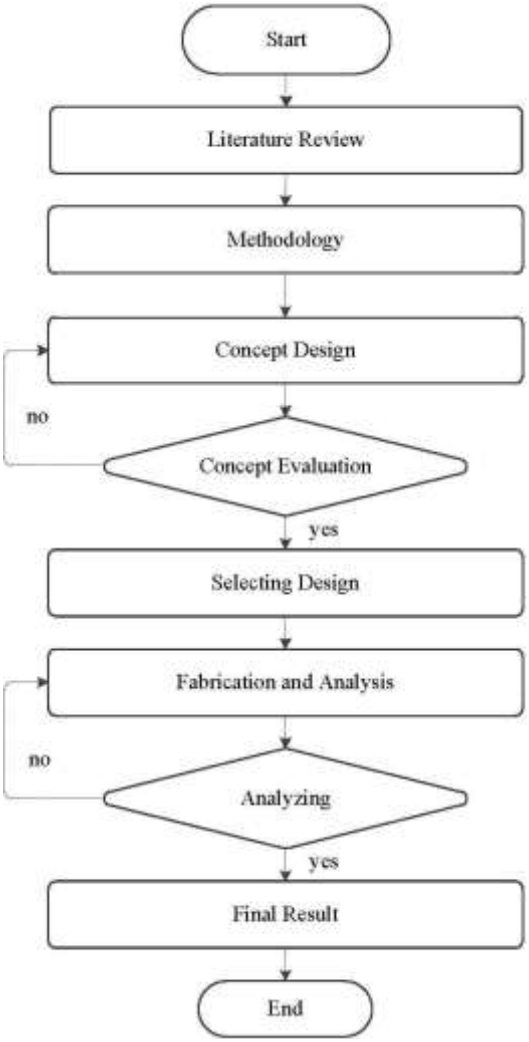
The objective of this project is to investigate the key and positive characteristics of this product and the benefits obtained by using it in building. It also intends to compare the characteristics of some construction materials such as brick, ceramic and concrete block with bottle

1.1 Objective

- Design project which works on plastic bottle bricks
- To evaluate the possibility of recycling waste PET bottles.
- To test and compare the compressive strength of brick bottle with brick.
- Easy to controlling
- Easy to conveyance
- System must be compact
- cost should be low

1.2 Methodology

The methodology is a process for implementation and developing the project. The goal and the successfulness of the project is depends on how the plans is conduct to achieve the result. Methodology is to describe the each step to accomplish the sequence of the flow work from the beginning until the result is obtained and success. All the results obtain were evaluated and improved till the best result came out and to be taken. This implementation would be and getting the worst result where try and error is happens here. Where any ideal decision may reconsider and repeating to satisfy the best result.



1.3 Working principle

Construction of the wall is easy and normal process. The walls can be filled with almost anything (waste, sand, etc.) and then plastered overtop. By collecting plastic bottles and plastic waste to be used as a wall infill improves the surrounding environment and provides inexpensive building materials. Placing bottles right side up within a frame is known as a vertical bottle wall, while lying the bottles on their side is considered a bottle wall.

1. Build structural frame
2. Collect and fill bottles
3. Align bottles in wall cavity
4. Overlay frame with steel wires or mesh to hold bottles together for better structural
5. Stuff loose plastic around bottle gaps
6. Plaster wall for clean finish

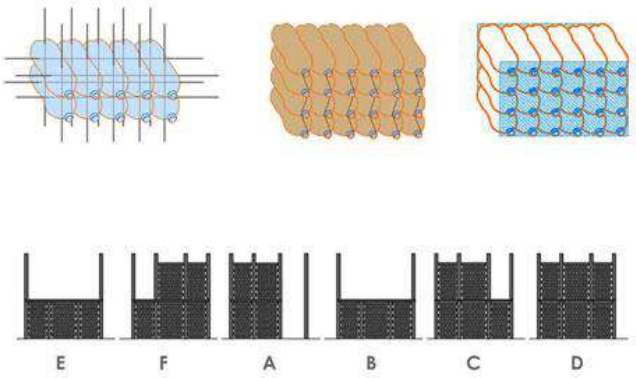


Fig 1: over view

2. Project Material

This construction require 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:

- Soil
- Plastic bottles
- Cement
- Nylon rope
- Water

2.1 Strength and cost calculations

Compressive strength is that test for each bottle was determined on universal testing machine and the average value is considered for analysis. Weight of empty polyethylene terephthalate bottles and completely filled of polyethylene terephthalate bottles were noted and amount of soil used was calculated for the same.

Fig 2: Weighing Balance to weight pet bottle before testing

After compressive strength testing done on about 8 bottles an average calculation for concluding a result is done. The

Data obtained as per universal testing machine is tabulated in table.

Table 1 Experiment testing Data

Load (Kg)	Area (mm 2)	Compressive Strength (MPa)	Average
13000	14202.5	8.98	
13000	14205	8.977	
13001	14201.9	8.98	
13000	14201.6	8.97	8.99
13002	14202.5	9.11	
13011	14202.1	8.98	
13005	14201.9	8.98	
13023	14202.8	8.98	

Sample Calculation of first reading:
Load in kg = 13000 kg
Load in N. = 13000×9.81
= 127530 N Area
= 14202.5 mm^2
Compressive strength of bottle =127530/14202.5
= 8.98Mpa
(brick is having strength 10 Mpa)
Similarly all calculations were done.

Summary from Compressive test:

Weight of a unit bottle brick was found to be less than that of a standard brick. Compressive strength of the bottle brick is also nearly equal than that of a standard brick. Thus we can conclude that using the concept of brick bottles is cost effective, energy efficient and commercially feasible.

Fig 3: Test applied on a waste PET bottles filled with soil and sealed tightly

2.2 Comparison between the walls by Plastic Bottles wall and Brick Wall

For construction Time and speed of Execution for 5 persons team-one working day for plastic wall is 15% faster and for brick wall 120 m^2. Material and equipment cost for plastic bottle wall is less as compared to brick wall. Transportation cost for plastic bottle wall construction is less than brick wall. Plastic bottle wall construction require less manpower as compare to brick wall and require high cost. Strength and load capacity for plastic bottle wall construction is 20 times more than brick wall construction.

1. Time and speed of execution works done by five person team per day plastic bottle wall 15% faster compare to brick wall.

2. Material and equipment cost the plastic bottle wall saving in cement, water, grinder and fitting compare to brick wall more weight and more material use

3. Transportation cost on plastic bottle wall lighter and higher volume, easy and cheap displacement compare to brick wall grater weight and less volume, hard and costly displacement.

4. Strength and load capacity of plastic bottle 20 time more than brick wall.

5. Cleanness and beauty of work plastic bottle wall very clean execution no construction waste compare to brick wall high volume construction waste.

6. In plastic bottle wall high flexibility compare to brick wall.

7. Exaction cost plastic bottle wall less manpower use compare to brick wall.

8. Material wastage in plastic bottle wall less compare to brick wall.

3. Cost comparison between brick masonry wall and bottle masonry wall

Here, we consider 10 m^2 Masonry works for calculation of quantities

3.1.1 Brick Masonry wall

- Number of bricks

Actual size of brick =19 cm x9 cm x 9cm

Normal size of brick (with mortar joint) = 20 cm x10 cm x 10 cm

Volume of brick masonry = Area x thickness of wall

= 10 x 0.23

=2.3

No. of Brick = Volume of brick mason / Volume of 1 brick with mortar

No. of Brick = 2.3 / (0.2 X 0.1 X 0.1)

No. of Brick = 1150 Nos

- *Mortar*

Actual volume of bricks in brick masonry = 1150 × (0.19×0.19×0.19) = 1.76m^3

Volume of wet mortar = 2.3 - 1.76 = 0.531m^3

For frog filling, cut bricks, for bonding, wastage etc increase this quantity by 15%.

Volume of wet mortar = 1.15 × 0.531

= 0.610m^3

Volume of dry mortar reduces by 25% when water is added

Volume of dry mortar =1.25×0.610

= 0.763m^3

- *Material for 1:3 brick work*

Quantity of brick = 2.3m^3

Proportion 1:3

Volume of dry mortar = 0.763m^3

1:3 = 4

C: S

Cement = (1/4) × 0.763 = 0.190m3

No. of bags = 0.190 / 0.035

= 6 bags

For 1 bag of cement

Weight = 50kg

Volume = 0.035m3

Sand = (3/4) ×0.763 = 0.237m3

Table 2 : Cost Estimation of Brick Wall Masonry

Sr. No	Material	Quantity	Rate	Per	Amount(rs.)
1	Brick	1150 nos.	5	1 no.	5750
2	Cement	6	250	1 bag	1500
3	Sand	0.237	250	1 m3	59.25
4	Labour Work	4	300	1 person	1200
				Total	8509.25

3.2.2 Plastic Bottle Masonry wall

- *Number of bottle*

Actual size of bottle = 24cm x 8 cm ϕ Normal size of bottle (with mortar joint) = 24 cm x9 cm ϕ

Volume of bottle masonry = Area x thickness of wall

= 10 ×0.24 =2.4m^3

No. of Bottle = Vol. of bottle masonry / Vol. of 1 bottle with mortar joint

=2.4 / {0 .24×(π/4×0.092)}

=1572

- *Mortar*

Actual volume of bricks in brick masonry = 1150 × (0.19×0.19×0.19)

= 1.76m^3

Volume of wet mortar = 2.3 -1.76

= 0.531m^3

For frog filling, cut bricks, for bonding, wastage etc increase this quantity by 15%

Volume of wet mortar = 1.15 × 0.531
= 0.610m^3

Volume of dry mortar reduces by 25% when water is added
Volume of dry mortar = 1.25 × 0.610
= 0.763m^3

- *Material for 1:3 brick work*

Quantity of brick = 2.3m^3
Proportion 1:3
Volume of dry mortar = 0.763m^3
1:3 = 4
C:S

Cement = (1/4) × 0.763 = 0.190 m^3

For 1 bag of cement
Weight = 50kg
Volume = 0.035m3

No of cement bag required = 0.190 / 0.035
= 5.45 bags

Sand = (3/4) ×0.763 = 0.237m3

Here, consider 1000 ml bottle

Soil= 1990×0.0001=1.99m3

- *No. of Labour*

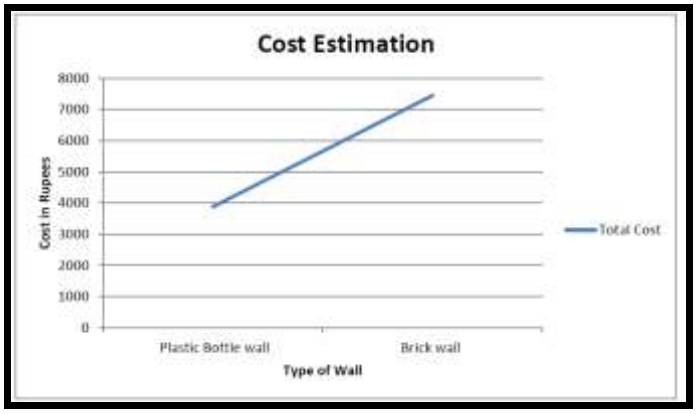
One labour can made 400 bottles per day (filling soil in bottles).

Total no. of bottles = 1572

Numbers of labour needed = (1572/400) = 4 nos.

Table 3: Cost Estimation of Plastic Bottle Wall Masonry

Sr. no	Material	Quantity	Rate	Per	Amount(Rs.)
1	Plastic bottle	1572 nos.	0.5	1 no.	786
2	Cement	6	250	1 bag	1500
3	Sand	0.237	250	1m3	59.25
4	Soil	1.99	100	1m3	199
5	Labour work	4	300	1 person	1200
				Total	3744.25



4. CONCLUSIONS

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 CO_2 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 m^2 Brick masonry wall is Rs. 8509.25 and total cost of 10 m^2 Bottle masonry wall is Rs. 3744.25.

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