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Reuse of Non-Degradable Waste Plastic Bottle for Construction

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***Abstract*:- One of the main disadvantages of' constructing world house is high cost of the building. High cost of primary requirements for constructing the houses in places where people are under poverty line, is forming one of the most significant problems of people. On the other hand, urbanization growth will increase waste especially non-renewable ones. A suitable approach for this situation is using some part of urban waste as required materials for building construction and also providing comfortable situation and suitable thermal for building residents. Plastic bottles are considered as an urban junk with sustainability characteristic which can be used as a material instead of some conventional material such as brick in building construction. This work intends to investigate the application of plastic bottles as one of the urban wastages in buildings 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 points of vien s and some positive points which this material have x'ersus others. At the end, it is concluded that in different factors such as time of execution, cost. load capacity, flexibility, reducing waste and energy efficiency, plastic bottles can be more effective compared to some conventional building materials such as brick, concrete and ceramic block.**

Keyword: Reuse, Non-Degradable, Plastic Bottle Waste, Sustainable Development, Sieve Analysis, Compressive Strength

1.INTRODUCTION: -

India is a developing country and population of the country is very huge. India got second place in population in the world. Population is directly affecting the other parameters like consumption of energy and utilization of daily using materials. Now a day's consumption of energy increased and due to the utilization of high energy we are facing problem like scarcity of energy. So, it is necessary to use alternative method for energy and material. Increase in population directly affects civil field. As the population increases number of buildings also increases. Considering high population increase in India it is difficult to provide basic needs for the people. One of the main basic needs is shelters. Due to high rate of use, there is scarcity of materials. With growing concerns over the growing pollution, there has been an exhaustive search made for means of alternative energy. This has included tapping most of the renewable resources of the earth and using growing technological awareness to create less pollution.

According to ENSO Bottles, in the 1960's plastic bottle production has been negligible but over the years there was an alarming increase in bottles produced and sold but the rate of recycling is still very low (Figureure1). 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. The use of this material has been considered not only for exterior walls but also for the ceiling of the building. The objective of this paper 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. One can use solar bomb (bottle filled with bleaching powder solution) will be fitted on the roof for light source

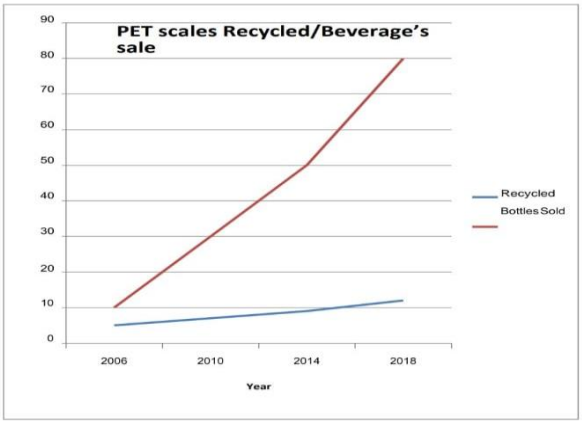

Figure 1 PET Bottle Sales/ Recycled

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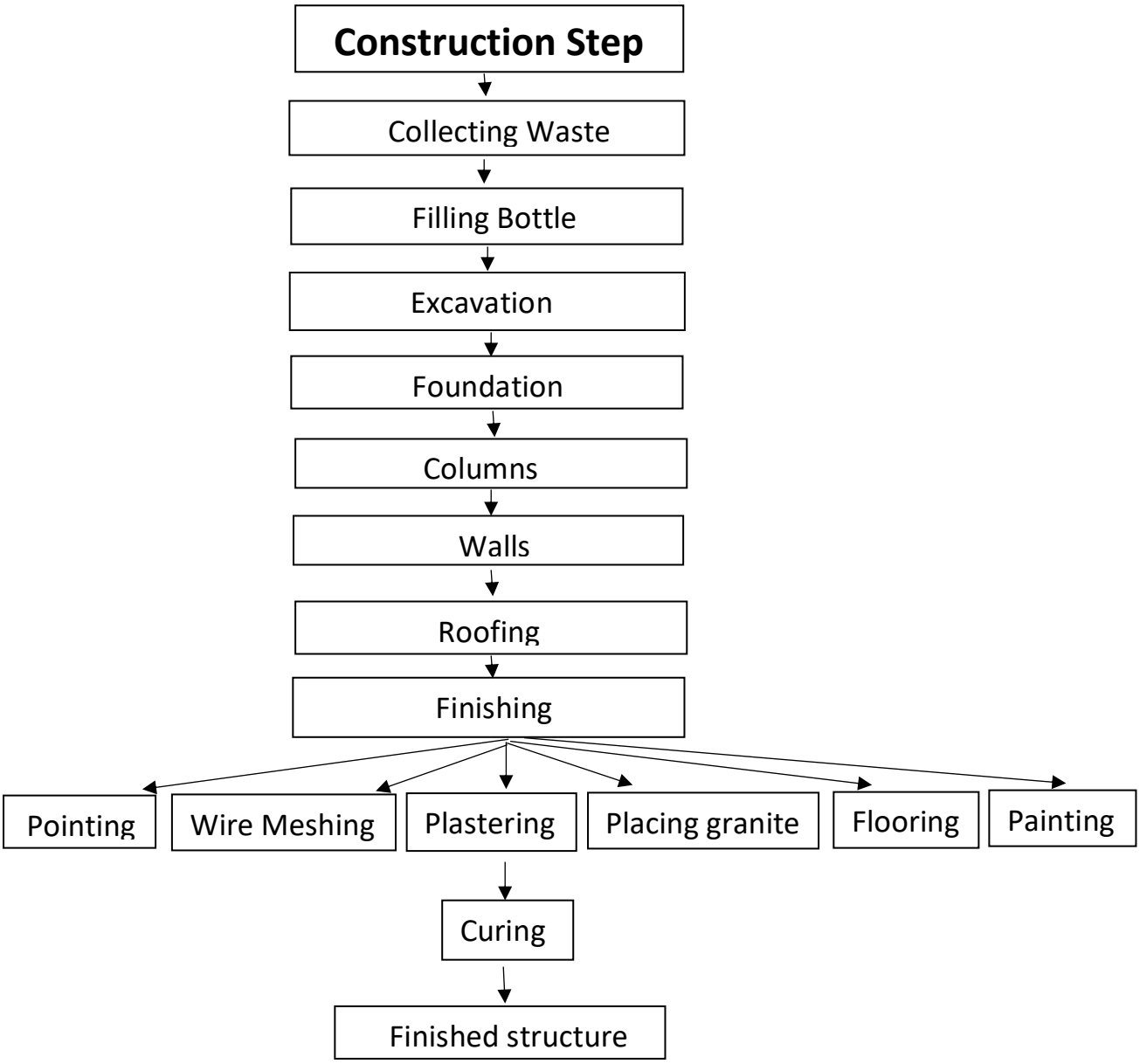
2. METHODOLOGY: -

Basic Construction Materials and Properties: -

1. Soil
2. Cement
3. Nylon rope
4. Plastic Bottle
5. Sand
6. Water Construction

Steps: -

Construction Steps of plastic bottle security (shelter)



3.TESTING: -

1. Sieve Analysis: -

Procedure of Sand Sieve Analysis Test: -

1. The following is the test procedure for sieve analysis test of sand.
2. Take the required amount of aggregate sample (for a sand (fine aggregate) minimum of 0.5kg sample is required.
3. Arrange the required no of sieves as per the contract or job requirement in a descending manner. (i.e., keep the sieve having the largest size opening at the top and the smallest size opening at the bottom).

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4. Sieve Arrangement – At Top 10mm,4.75mm,2.36mm,1.18mm,600µ,300µ,150µ at Bottom and Last Pan)
5. Place the sieve set on the mechanical shaker and shake vigorously for at least 2 minutes.
6. Then measure the weight of aggregate retained on each sieve and express it as the percentage of passing.
7. Now compare these values with the recommendation values to know whether it falls within the range or not. If not come within the desired gradation, then take the necessary action to make sand well graded.

IS Sieves	Weight Retained	% Retained	Cumul % Retained	% Passing	Limit	Remark
10 mm	0	0.00	0.00	100.00	100	
4.75 mm	78	7.80	7.80	92.20	90-100	
2.36 mm	102	10.20	18.00	82.00	75-100	FM 2.88
1.18 mm	154	15.40	33.40	66.60	55-90	ZONE 11
600 µ	184	18.40	51.80	48.20	35-59	
300 µ	278	27.80	79.60	20.40	8-30	
150 µ	175	17.50	97.10	2.90	0-10	
Pan	29.00	2.90	100.00	0.00		
	1000.00					

Table: -1 Sieve Analysis

2. Compression Test on Bottles: -
Procedure of compression test on bottle: -
1. First, clean the bearing surface of the plate to remove any loose grit.

2. Put the PETE bottle specimen in the testing machine relatively to its longitudinal axis, at the centre coinciding with the axis of the machine.
3. Make a final check of the correct positioning and then apply the load up to failure.

4. A test was conducted in the compression machine to compare the compressive. 5. Strength of bottle. Bottle filled with sand.
6. Place the specimen with flat face horizontal.

7. Consider the first cracks that appearance on the PET bottle specimen as the failure point.

8. Note maximum load at failure.

Trial No.	Length In Mm	Width In Mm	Height In Mm	A=LxW In Mm2	Peak Load In KN	Compressive Strength =Px1000/A In N/Mm2	Average Compressive Strength In N/Mm2
1.	250.8	70.3	69.1	17631.2	130.4	7.4	
2.	250.6	69.8	69.6	17491.9	133.5	7.6	
3.	249.7	70.5	69.9	17603.9	120.6	6.9	7.1
4.	249.5	70.1	69.5	17490	114.7	6.6	
5.	250.2	70.3	69.3	17589.1	118.8	6.8	
6.	250.3	70.2	70.1	17571.1	109.5	6.2	
7.	249.8	70.0	69.9	17486	112.6	6.4	
8.	249.7	70.3	69.7	17553.9	108.8	6.2	6.4
9.	250.0	70.1	70.2	17525	118.7	6.8	
10.	250.1	69.4	70.0	17356.9	111.3	6.4	

Table: - 2 Compressive Strength of Bottle

3. Compression Test on Bricks: -
Procedure of Compressive Strength Test on Brick: -

1. Firstly, we remove asymmetry observed the bed faces to provide two smooth lateral faces by grinding. Immerse the bricks in water at room temperature for 24 hours. Remove the specimen and drain out any unused moisture at room

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temperature.

2. Fill the frog and all voids in the bed faces level with cement mortar (1 cement, 1 clean coarse sand of grade 3 mm and down). Store it under the damp jute bags for 24 hours.
3. Place the specimen with flat face horizontal and mortar filled face facing upwards between plates of the testing machine.
4. Apply load axially till failure occurs and note maximum load at failure.

Trial No.	Length In mm	Width In mm	Height In mm	A=LxW In mm2	Peak Load In KN	Compressive Strength =Px1000/A In N/MM2	Average Compressive Strength In N/MM2
1.	218.0	148.0	88.0	32264	95.6	3.0	
2.	218.0	147.0	88.0	32046	99	3.1	
3.	217.0	146.0	87.9	31682	71.2	2.2	2.6
4.	224.9	148.9	92.0	33485.4	62.6	1.9	
5.	223.2	146.5	92.3	32687.6	93	2.8	
6.	220.8	149.7	88.1	33062.6	95.6	2.9	
7.	214.9	148.3	86.5	31863.2	87.3	2.7	
8.	224.9	147.8	89.5	33242.5	72.6	2.2	2.5
9.	216.7	146.0	87.0	31629.5	80.1	2.5	
10.	223.6	151.5	85.6	33870.9	72.9	2.2	

Table 3-Compressive Strength of Brick

5. RESULT: -

Compression test is conducted on 1L pet bottle with sand as well as clay brick to determine and compare the compressive strength between them. From this compression test, the maximum stress that can be achieved by 1L plastic bottle is 7.1 and 6.4 N/mm2 Respectively, the maximum stress for clay brick is 2.6 and 2.5 N/mm2.

In one of the previous case study of reuse of pet bottle for construction they conducted compression test on pet bottle with sand and clay brick from this test the maximum stress that had been achieved by plastic bottle is 6.0 N/mm2 and clay brick is found to be 4 N/mm2. In both test similarly they also found that the plastic bottles have high compressive strength than brick and it can be used as building material in place of brick in construction

6. DISCUSSION: -

1. Cost Analysis: -The cost of PET bottle green house will always be less than traditional brick house. As the bottles to be used for construction are available in abundance and are free of cost. On the other hand, a single traditional brick will cost nearly Rs.10/-. Rest of the building materials used in the construction of both the traditional house and green house are nearly same and will have a very less effect on the cost difference.

2. Thermal Strength: -In order to determine and compare the indoor temperature of both standard brick house and plastic bottle eco-house, we have measured a series of data related to factors affecting thermal comfort of a building e.g., air temperature, air humidity, and air velocity. According to the test results, the plastic bottle green house has not achieved the thermal comfort zone as its temperature range is 30℃ to 34℃. Same goes to the normal brick house which range from 29℃ to 34℃. Both of them share similar range of temperature. This could be caused by poor ventilation within the eco-house prototype as it only consists a small ventilation gap near the roof.

3. Structural Wall Stability: -A study was conducted on a wall of 3m height and 300mm thickness. The wall was constructed with air filled bottles and tested for structural stability. The results indicated that the wall resist almost 50% less load as compared to individual block, may be due to mortar interlocking.

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4. Energy Saving: -When the plastic bottle house project was initiated in august 2015, cooler interior temperature were expected since air in the bottles is an insulator. We never expected such a temperature difference between conventional concrete block walls and plastic bottle walls. Nevertheless, the temperature difference between the outside and inside wall of a plastic bottle homes extremely energy saving.

5. Environmental Impact: -Environmental Friendliness: The use of plastic waste bottles in construction also contributes to environmental friendliness and energy savings of buildings. It is reported that building with walls constructed of plastic bottles maintains room temperatures and contribute to energy saving and cost of providing artificial thermal control system. Making substantive deductions from the empirical and experiential findings herein, it is evident the menace and complications associated with waste plastic in our natural environment. To this effect, researchers have sought for diverse ways to recycle waste plastic to benefit mankind and the environment. This has led to the exploitation of waste plastic in areas such as the construction and architecture industry. Further to that, evidence from the review has shown that the plastic bottles as a potential construction material or unit, has come to stay. Most imperatively, additional studies on how to fuse the plastic bottles into the diverse form of design construction methods are therefore required to maximise its potentials. It is therefore of paramount interest to investigate into the feasibility of the

The use of plastic waste bottles in construction contributes to environmental friendliness and energy savings since buildings with walls constructed of plastic bottles maintains room temperatures and contribute to energy saving and the cost of providing an artificial thermal control system.

6. Cost Savings: -In Ghana and most developing countries, plastic waste bottles are cheaper to acquire than most conventional construction materials such as sand and crushed rocks. In addition, concrete or brick containing any amount of plastic bottle is noted to reduce the total quantities of conventional materials required, thereby reducing the cost as well.

7. Life of plastic bottle: -Average human can consume 15 or more products packed in PET single use plastic a month. If you were born after 1978, and live until 80 years old, you will leave behind a minimum of 14,400 plastic packaging on this planet. This plastic take hundreds of years to break down into tiny pieces of plastic, never to completely disappear. Most of the waste is consumed by fish and birds, which has shortened their lifespan greatly.

If you live in a plastic bottle house 100 square meters, then your house will be built reusing 14,000 plastic bottle. These up cycled bottle could neutralize the negative effect of your passage on this planet, and move closer to leaving only your “footprint”.

7. CONCLUSION: -

The use of waste PET bottles in construction cannot be overemphasis. The over reliance on plastic due to wider range of applications and as such has higher growth rate than any other material, make it to be more sustainable material. The plastic per its physical and structural properties renders it mostly single use thereby making it become waste in abundance. Per UNEP (2018) report, plastic constitute about 50% of global waste generated. Furthermore, it is noted to last about 300years before decaying. These therefore make it sustainable waste and as such environmental pollutant which required much attention due to its side effects that such as:

1. CO2 emission from heating and burning contributing to global warming;
2. Polluting of cities and water bodies due to its lightweight hence easily carried by air and ran water;
3. Choking of drains causing stagnate water which end up breeding mosquitos.

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, establishment of the appropriate structural behaviour in building such as causing to the light weight structure and can also be applied in a project to construct buildings considered temporary.

Effort to reduce or eliminate these burdens from the plastic waste is to seek sustainable disposal methods of which recycling of the plastic waste into other use is reported to the best option for now. The construction industry has taken keen interest of its much-reported advantages of current state of the plastics waste, which is being lighter in weight, readily available, cheap to obtain, longer lifespan than most building materials, etc., to be a potential construction material. This paper centred on the use of plastic bottles waste in 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.

Cost compression between bottles wall is roughly half than conventional brick masonry. i.e., Total cost of 10 m2 Brick masonry wall is Rs. 14,342.2 and total cost of 10 m2 Bottle masonry wall is Rs. 7011.2

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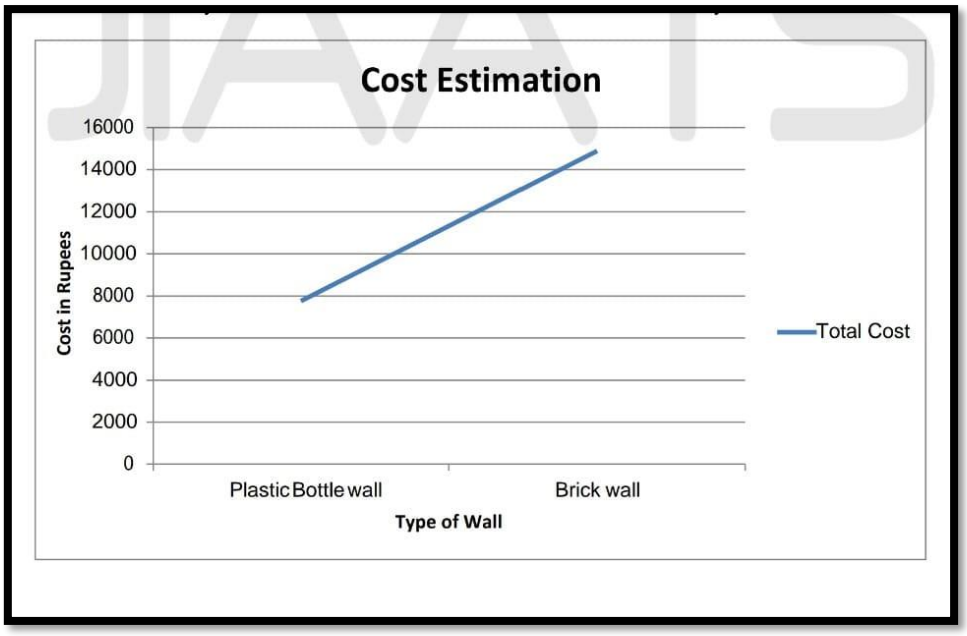

Figure 2 Cost Estimation

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