Waste Plastic Bottles Used In Construction

[1]Adnya Manjarekar
[1]Assistant Professor
[1]Sanjay Ghodawat University, Kolhapur,maharashtra

Abstract - **At the present time, the possibility of utilizing the renewable resources such as solar, wind, geothermal has been provided for us more than before, and development of this science is making progress. But those energies can be chosen as one of the renewable and alternative energies instead of fossil fuels which are cheap as possible and have fewer environmental impacts. Since no attention to economic issues lead to that the use of these energies be just for groups dedicated to specific segments of society. While many renewable energy projects are large-scale, renewable technologies are also suited to rural and remote areas, where energy is often crucial in human development. With 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 The objective of this paper is to investigate the using of plastic bottles as municipal wastes in the buildings, 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 and concrete block with bottle wall**

keywords - **plastic bottles, compressive strength, PET, fly ash, mud brick, etc**

I.INTRODUCTION

Plastic bottles are increasingly becoming a menace to the environment due to the chemicals used in the manufacture, improper use and disposal. In the past, the glass was common in packing some foods such as milk and etc. They could be returned to the factory for using again for the same purpose. But now by changing the human's disposal culture, glass bottles have been replaced by plastic bottles, as they have increasingly become one of the substances of destruction of the landfills because they decompose in a long time. Two alternative solutions against the plastic bottle disposal are recycling and reusing process. Recycling needs additional energy to treat the materials for producing something usable. Moreover, the recycling process produces wastewater and air pollutants. So the best solution is reusing for which no additional energy is required and does not contribute to pollution. Indeed, when we reuse junk, we are helping to save the obtained energy which would otherwise be wasted. It is focused on not only the financial aspect but also the environmental aspect 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. 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 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 First, the thriving problem with plastic bottle environmental issues and Second, the application of PET bottles in construction as masonry without any structural behavior data. This can provide a good amount of confidence in safety and durability design of structures built with PET bottles. As a response to the PET environmental concerns such individual and firm such as Michael Reynolds (known as The garbage warrior), Echo-Tech (founded by Andrea Froese), and BUVAD (Butakoola Village Association for Development, a Ugandan Community based organization), took the innovative initiative of using PET bottles as masonry. Unfortunately, none of them has done any investigation concerning the strength and structural behavior of the PET bottles as masonry. Furthermore, not all soils suitable for construction. First the type of soil used to fill the bottles may have an influence on the strength of the PET bottle masonry in the same frame of reference with earthen material. For example, Adam et. al. clearly draw attention to the fact that the compressive strength of compressed stabilized earth building blocks depends on the soil type, the compaction pressure used to form the block, and the type and amount of stabilizer. Second, the types of soil for optimum combination of cement stabilized mortar and the ratio of the mix of this cement-soil combination is difficult to determine and predict.

II. NEED OF WASTE PLASTIC BOTTLES USED IN CONSTRUCTION

-Waste Management: To build a small house one can use as many as 10,000 used bottles which are readily available. Waste that would otherwise be deposited in a landfill can now help solve other social problems of housing, schools and clinics. If the communities want to get rid of other plastic waste the bottles can be filled prior to construction.

- Provide Structures: Since in many parts of the world homeless people are considered outside normal society. it give structure and area for living to the needy one.

- Durability: The plastic bottles are known for their durability and can last as long as 300years.

- Cost effective: The use of recycle material make it more affordable than conventional building methods and will increase the accessibility to suitable housing. It is a well-insulated and cheaper solution. It also cut the cost of transportation of building material. For a region where money tends to be scarce, the houses are estimated to cost 1/3 of a house made of concrete and bricks

III. OBJECTIVES & METHODOLOGY

1. To study proposed method of construction.
2. To test the bottle mud brick for compression strength.
3. Study about cost comparison between conventional material and bottle mud brick
4. To use the waste plastic bottles.

IV.PREPRATION OF BOTTLE MUD BRICK WALL

- Binding Mixture: A typical mortar mix is 3:1 mason sand to a pozzalan (fly ash) cement mix. Other mixtures could be made from mortar and clay. Bottle walls are extremely versatile and could be bonded with anything.
- The construction involves the use of glass bottles (jars, glass jugs, and other glass containers) as masonry units and sand, cement, mortar or concrete. Firstly, bottles must be collected and sorted. About 14,000 bottles of uniform size are needed to make a two-bedroom bottle-home.
- Although bottle walls can be constructed in many different ways, they are typically made on a foundation and rebar can be set to add stability to the structure. Bottle walls range one bottle to two bottles thick. Primitive mixture, such as concrete or clay can be used as mortar to bind the bottles. It is thickly spread on the previous layer of bottles followed by the next layer which is pressed into it.
- Two bottles can be cut and taped together to create a window-type effect. This taped bottles act as an opening allowing a light passageway. This also traps air and creates a small amount of insulation. Filling glass with liquid that will be subjected to freezing and thawing is not a good idea, but is useful if the glass is protected from temperature.
- Another technique is the plastic bottles are filled and tightly packed with the sieved sand. Once filled, the bottle becomes a "brick" that can be used as a basis to build a solid structure.

V. TESTING OF BOTTLE MUD BRICK

The comparison of tests were conducted on sea water and distilled water as shown below. In pH test, distilled water reading was 7.48 whose range is in between 6.5 to 7.5 which is in desirable limits. Then, In Alkalinity test, reading of distilled water was 64mg/lit whose desirable limit is 200mg/lit. After that, In Chloride Content test reading for distilled water was 44.02mg/lit whose permissible limit is 250mg/lit. In Hardness test, reading of distilled water was 176 mg/lit whose desirable limit is 300mg/lit. At last, Dissolved Oxygen test was carried out in which, reading of distilled water was 8.89mg/lit whose desirable limit is in the range of 8- 11mg/lit .

A. Compressive Test

The two methods for determining the compressive strength of masonries were adopted. The unit testing **(**single bottle test**)** method was carried on 2 PETE bottle units, using a bending testing machine 600KN capacity, While the bottles wall testing method **(**Bottles wall test**)** was carried on 8 PETE bottle cube specimens, using one hydraulic jack, individual capacity 600kN, stroke 150mm, a manual operated high pressure pump. A pair of iron plate support was used to accommodate the testing process at top and bottom

Phase1:Single Bottle Test Method

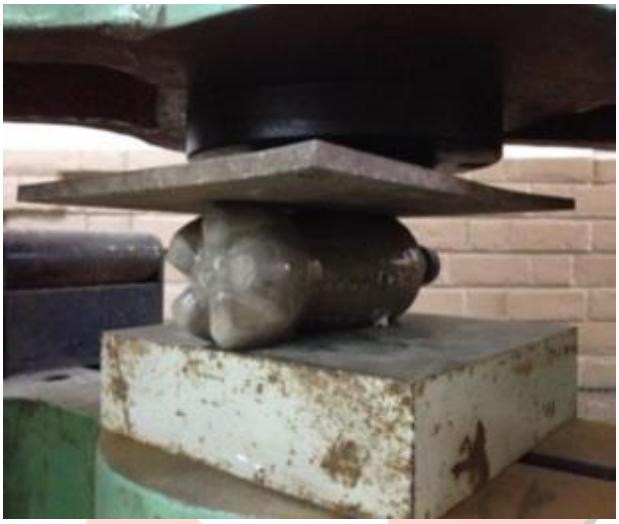

Fig. a.1 -Single bottle under testing machine

First, clean the bearing surface of the plate to remove any loose grit. Put the PETE bottle specimen in the testing machine relatively to its longitudinal axis, at the centre coinciding with the axis of the machine Make a final coinciding with the axis of the machine.

Make a final check of the correct positioning, and then apply the load up to failure. Consider the first crack that appears on the PETE bottle specimen as the failure point. Stop the machine and record the cross section area of the PETE bottle in contact with the platen using a vernier calliper. Record the maximum loads at failure as well as the rate of loading (N).

Phase 2 : Bottles Wall Test Method

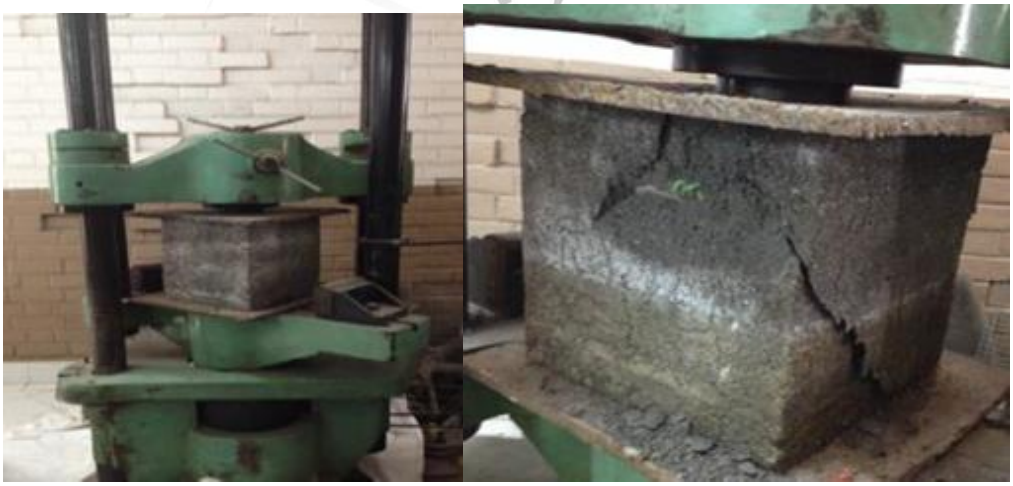

Fig. a.2- Bottles cube before test

Fig. a.3- Bottles cube after test

VI. METHOD OF CONSTRUCTION

4.1 Construction of bottles cube

1. A wooden frame of 30cm x 30cm x 30cm was used for casting cube of plastic bottles and bricks. The inner surface of a wooden frame properly oiled so that casted cube can easily separate from frame work without stick
2. First layer of bottles or bricks are arrange as per design after placing cement mortar (1:3) layer (bottom cover) Attach the bottles to one another by using nylon rope while laying them on the mortar layer to ensure that the bottom of the cube is level.
3. After placing bottles layer space between bottles filled by cement mortar then similarly make another bottle layer as per design of cube.
4 . A wooden frame was removed after 24 hour from completely casted cube. Finally curing of casted cube for 7 & 28 days.

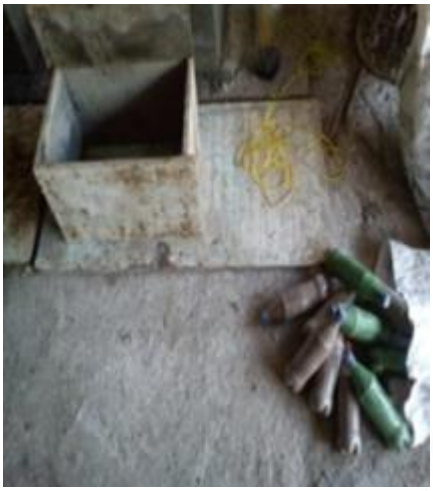

Fig.b.1- Wooden frame work

Fig.b.2- First layer of bottle

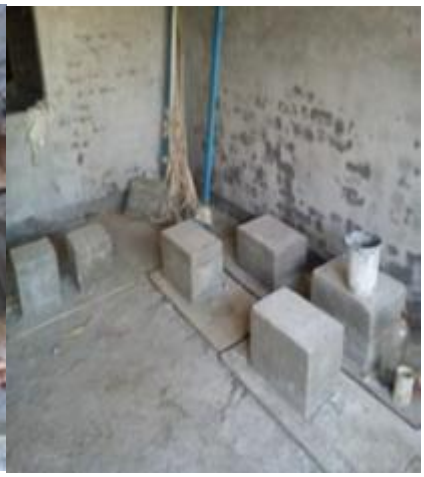

Fig.b.3- Casted cubes

VII. **RESULT AND DISCUSSION**

Laboratory and Field test results are represented as below:

Table 1 Laboratory tasting of soil (filler material)

NO.	TEST.	TYPE OF SAMPLE	VALUE
1	Sieve analysis	SW-SP	Uc= 0.83,Uu= 3.3 d60 = 1 mm, d10 = 0.3 mm
2	Liquid limit WL	CL	42%
3	Plastic limit WP	SM – SP	56%
4	Specific gravity	–	2.65
5	Dry density clay	–	0.103 g/cc
6	Dry density sand	–	1.655 g/cc
7	Permeability	Sandy clay	3.64 x 10-4 cm/sec

- ***Table 2 Result of Compressive test of cube casted with bottle and brick after 7 Days***

SAMPLE TYPE	L cm	B (cm)	H (cm)	Area (m2)	Volume (m3)	Weight (kg)	Density (kg/m3)	Failure load (kN)	Compressive strength(kN/m2)
Bottles are arranged parallel	30	30	30	0.09	0.027	56.70	2100	180	2000
Bottles are arranged alternatively	30	30	30	0.09	0.027	56.60	2096.2	185	2060
Bottles are arranged vertically	30	30	30	0.09	0.027	56.60	1874	165	1800
Cube constructed with Brick	30	30	30	0.09	0.027	51.70	1914.8	175	1940

- ***Table 3 Result of Compressive test of cube casted with bottle and brick after 28 Days***

SAMPLE TYPE	L cm	B Cm	H cm	Area (m2)	Vol (m3)	Weight (kg)	Density (kg/m3)	Failure load (kN)	Compressive strength(kN/m2)
Bottles are arranged parallel	30	30	30	0.09	0.027	58.80	2178	240	2666
Bottles are arranged alternatively	30	30	30	0.09	0.027	61.28	2270	245	2730
Bottles are arranged vertically	30	30	30	0.09	0.027	52.44	195-0	220	2445
Cube constructed with Brick	30	30	30	0.09	0.027	53.36	1980	230	2550

- ***Table 4 Cost analysis of 10 m2 Brick masonry wall***

Sr.	Material	Quantity	Rate (Rs.)	per	Amount (Rs.)
1	Brick	1156 no.	8	1 no.	9248
2	Cement	2 bags	300	1 Bag	600
3	Sand	0.24 m3	250	1 m3	50
				TOTAL	**9898**

- ***Table 5 Cost analysis of 10 m2 Bottle masonry wall***

Sr.	Material	Quantity	Rate (Rs.)	Per	Amount(Rs.)
1	Plastic bottle	2600 no.	0.5	1 No.	1300
2	Cement	7 bags	300	1 bag	2100
3	Sand	0.753 m3	250	1 m3	188
4	Soil	1.56 m3	100	1 m3	156
5	Labor work	4 no.	300	1 person	1200
				TOTAL	**4944**

VIII. CONCLUSION

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. 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
3. Cost compression between bottles wall is roughly half than conventional brick masonry. i.e., Total cost of 10 m2 Brick masonry wall is 9898 Rs. and total cost of 10 m2 Bottle masonry wall is 4944 Rs. (Table 4&5).
4. Here is a procedure to construct the bottle house which is resistant to external loads. Millions of plastic water and beverage bottles are discarded every year into the landfills. Sustainable reuse of bottles is beneficial for construction. Ordinary mortar is used to hold the "eco bricks" in place, as in regular masonry. The bottle construction techniques and their benefits must be spread and educate to local community. They are the group of people who are most benefitted by low-cost construction.
5. 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.
6. 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. It is counted as one of the foundation's green project and has caught the attention of the architecture and construction industry. Generally the bottle houses are bioclimatic in design, which means that when it is cold outside is warm inside and vice versa. 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 behavior in building such as causing to the light weight structure and can also be applied in a project to construct buildings considered temporary.

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