

# “USE OF WASTE PLASTIC BOTTLE AS CONVENTIONAL CONSTRUCTION MATERIAL”

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**Abstract** - Today it is necessary to minimize the use of plastic for conservation of environment biodiversity. Simultaneously to control the increasing demand of the construction of house we are using plastic bottles in building walls as it is studied in research papers. All the studied of properties are counted in our project. We are going to take the tests on bottles to check the strength of bottle as a brick in construction of the wall and then compare then results. We are also comparing the cost of brick wall construction with plastic bottle wall construction to find out which is economically in today's world.

Laterite quarry waste is abundantly available and disposal of waste plastics (PET, PP, etc) is the biggest challenge. Only one in six plastic bottles are properly recycled. On other hand high cost of primary requirement for constructing the homes in places on where people are under poverty line is forming one among most vital problems of individuals. A suitable approach for this situation is using some part of urban rubbish or waste as required materials for building construction.

Plastic bottle is taken into account as urban junk .but with sustainability characteristic it are often used as construction material rather than some conventional material like brick up building construction. The project intends to investigate the application of plastic bottles which is one of the urban waste in building 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 point of view and a few positive points which this material have versus others.

**Key Words:** Plastic bottle, Environment, Construction, waste

## 1. INTRODUCTION

Global warming refers to what's believed to be a trend where earth's temperature is increasing. This is believed to be primarily thanks to the emission of artificial pollutants that cause more of the sun's energy to be trapped within the atmosphere. These pollutants are mentioned as-so called greenhouse gases. Most of the pollutant also occur naturally in the environment in some form or another and while man-made emissions are often relatively small compared to those

naturally occurring, they may affecting the natural balance in the environment. While it's estimated that it might take a few years for there to be catastrophic consequences to the rise in green-house gas emissions, it might be too late to reverse the trend if something isn't done now.

Eco-house also referred to as Green building, is that the creative buildings and supportive infrastructure that reduce the utilization of resources, create healthier living environments for people, and minimize negative impacts on local, regional, and global ecosystems Green building also has been studied at United State it shows that the annual impacts of building construction including 35% of carbon dioxide production which is a major contributor to global warming.

Strength of bottle bricks has been doubted by the public since they are made from plastic bottles. However, this doubt is solved because bottle bricks are stronger than common bricks and that they are bullet proof. In a small village in Nigeria, an answer has been applied to not only provide shelter during a poverty stricken country, but find a use for refuse. Packing sand into plastic bottles may be a technique that started nine years ago in India, South and Central America. Named "bottle brick" technology, the compacted sand inside the bottles is nearly 20 times stronger than bricks. Adding to the appeal of the simple technology, the houses are ideal for the hot Nigerian climate because the bottle bricks buffer the house from the intense heat. Also, during a place known for violence, the homes are completely bullet proof.

Compressive Strength are often defined because the maximum compressive stress that a cloth is capable of withstanding without fracture. Structure of wall play a crucial role in supporting the load applied from roof. According to Public Work Department (PWD) Standard Specification for Building Works (2008), the minimum permissible average compressive strength shall be (5.2N/mm<sup>2</sup>) for bricks and (2.8 N/mm<sup>2</sup>) for hollow blocks per 10 samples taken randomly from the Contractor's stock pile of 1000. Thermal comfort is taken into account to be a principal requirement that's usually demanded of by occupants of accommodation units. A compatible indoor climate design is really a modification of the external

environmental system and is meant to supply comfort for occupants.

### 1.1 Problem Definition

Due to increasing population day by day increases the use of plastic bottles. Daily there is almost 26000 tones plastic waste collected in India. State wise collection is about 10 to 15%, it is necessary to find out how to recycle this plastic waste or how it can be reused so than it will decrease the global warming also. Same way by our point of view it is necessary to fulfill the increasing demand of the houses. We found that cost of construction is also increasing day by day as per community. There are many options of plastic bottles in civil construction such as use in roads, cladding of walls, construction of wall etc. To solve these problems we are thinking to make use of these plastic bottles in construction which will also fulfill the green-house demand and also poverty. We have found that plastic bottle is a good option to use it in wall construction.

The problem of users is losing the power and ability of design and building their own homes by themselves. Two factors that prevent aboriginal people from building their homes are high cost building materials and labor and also maybe long transportation. One of the solutions for this problem can be Solve In following Manner.

- Use of affordable recycled materials in buildings
- Use of the method of regenerating through proper education to people.

### 1.2 Scope of Project

Aim of our project is to make society aware about use of plastic bottles in wall construction as Conventional construction material. We have tried our best to compare different research papers for the testimony. We have made a case study of the project one paper in which bottles are used for the construction of bungalow. Here by consideration of compression strength of the brick is taken and compared it with the normal brick. We are going to make a small prototype of the wall with bottle construction.

The use of this material has been considered not only for exterior walls but also for the ceiling of the building. This project 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, ceramic and concrete block with bottle panel.

Here soil interaction is not taken in to account. House of 2 floor can be made of plastic bottles above that it is not as there is not a proper study of plastic brick bottle in any IS codes.

Further study will include the study of the building above 2 floors. Many more innovation and standardization is possible in this project. The study of load calculation for columns is more challenging in the project. The Governing bodies shall formulate policies to propagate this eco centric approach via appropriate practices, research investigations on the properties of the materials and construction techniques.

### Objectives

- 1) To reduce pollution due to plastic bottles.
- 2) To reduce the cost of construction as compared to brick wall construction.
- 3) To give Aesthetic look for house.
- 4) To build green construction by saving energy and resources.
- 5) To reduce the CO<sub>2</sub> emission by using small amount of cement.

## 2. LITERATURE SURVEY

### 2.1 International Journal of Engineering and Technical Research (IJETR): (Reuse of Plastic Bottles as a Construction Material) Published: September 2019

PETE bottles, plastic rope, soil, Portland cement, and water are the main material components to produce the PETE bottles masonry. Unfortunately there is no research that has ever been undertaken to determine structural behavior of PETE bottles as masonry and that could have been an appropriate source of reference for a literature review in guiding this research. The few attempts that have been performed in building structure with PETE bottles were made by means of trial and error according to Froese( Personal communication, 2008).

### 2.2 International Journal of Advanced Research in Science and Engineering (IJARSE): (Literature Review on Use of Plastic Bottles for construction of Water Tank as a Sustainable Material.) Published: March 2018

This paper proposes the use of waste plastic PET bottles as construction entity to standardized bricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are major explanation for solid waste disposal. Polyethylene terephthalate is commonly used for carbonated beverage and water bottles. This is an environmental issue as waste plastic bottles are difficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding cost effective materials for increasing the strength of structures. This project deals with the possibility of using waste PET bottles as a partial replacement. It are often concluded that advantage of the utilization of PET bottles include both improved ductility as compared with raw blocks and inhibition of crack propagation after its initial formation.

**2.3 International Journal of Current Trends in Engineering & Research (IJCTER): (A WALL STRUCTURE FOR GREEN HOUSE ARPN Journal of Engineering and Applied Sciences) Published: May 2016**

Wall structure plays important roles in supporting the superstructures, separates spaces in buildings into sections and delineates an area in outdoors. Most of the development of house in Malaysia use bricks and mortar which consists of cement, aggregates and water because the materials to create the structure of wall. However, materials such as cement and bricks manufacturing process will contribute to a high emission of carbon dioxide (CO<sub>2</sub>) which may lead to global warming. Therefore, objective of this paper is to seek out an alternate solution to scale back this hazardous environmental problem. The alternative way that can solve the problem is by replacing the use of bricks in building construction by plastic bottles filled with sand as we called it plastic bottle green house. Reuse of those non-biodegradable plastic bottles not only can solve the environmental problem, but it also can reduce the pollution. The main concern of this project is that the strength of bottle bricks. Therefore, there were two types of experiments were used to evaluate the properties of bricks and plastic bottle filled with sand which are compression test and temperature test in indoor and outdoor of wall structure. The compression test is prepared for 1.5L bottle brick, 250ml bottle brick and common clay brick. As results, the strength of 1.5L and 250ml bottle bricks is 3 and 4 times respectively stronger compare to common clay brick. The comparison of indoor and outdoor wall temperature, air humidity and wind velocity between the plastic green house and normal brick house has indicate that plastic bottle has recorded highest reading for outdoor wall temperature with 36°C and lowest reading on outdoor humidity and outdoor wind velocity with 78% and 0.8 m/s respectively. From these result it can be concluded that plastic bottle greenhouse have a potential as a wall construction material and further study on its other properties such as its lifespan and ratio between water, cement and sand usage as a mortar should be carried out.

**2.4 International Journal of Engineering Technology Science and Research (IJETSR): (Construction of houses using plastic bottles) Published: April 2017**

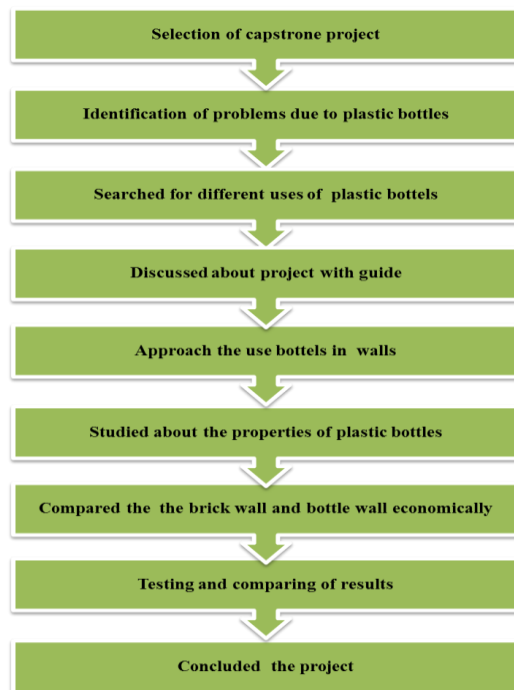
This paper intends to research the appliance of plastic bottles together of the urban wastage in buildings construction which how it can cause sustainable development. This paper also includes various factors like time of execution, cost, load capacity, flexibility, reducing waste and energy efficiency; plastic bottles could also be simpler compared to some conventional building materials like brick and concrete block. Authors made effort towards waste plastic bottle used as construction material.

**3. METHODOLOGY**

To solve the increasing demand of the shelter and also to save environment from plastic bottles we are suggesting society an option which can also be beneficial economically other than brick. There are many materials used for low costing

construction. We are going to compare brick wall construction and bottle wall construction in costing. 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.

As we have revealed that cost is an important factor in construction, we came across with the different solutions to reduce pollution and to decrease the cost of construction. Firstly we will study the methods with which we can make use of plastic in the construction.



**Chart -1: PRACTICAL METHODOLOGY FOR PROJECT**

**Plastic bottle sand brick**

Eco-house also known as Green building, is the creative buildings and supportive infrastructure that reduce the use of resources, create healthier living environments for people, and minimize negative impacts on local, regional, and global ecosystems. Strength of bottle bricks has been doubted by the general public since they're made up of plastic bottles. Packing sand into plastic bottles is a technique that started nine years ago in India, South and Central America. Named "bottle brick" technology, the compacted sand inside the bottles is nearly 20 times stronger than bricks. Adding to the appeal of the simple technology, the houses are ideal for the hot Nigerian climate because the bottle bricks buffer the house from the intense heat. Also, during a place known for violence, the homes are completely bullet proof. Structure of wall play a crucial role in supporting the load applied from roof. According to Public Work Department (PWD) Standard Specification for Building Works (2008), the minimum permissible average compressive strength shall be

5.2N/mm<sup>2</sup> for bricks and a couple of .8 N/mm<sup>2</sup> for hollow blocks per 10 samples taken at random from the Contractor's stock pile of 1000 or part thereof (JKR, 2005). Thermal comfort is taken into account to be a principal requirement that's usually demanded of by occupants of accommodation units. A compatible indoor climate design is really a modification of the external environmental system and is meant to supply comfort for occupants. There is a reciprocal relationship between climate and man in both indoor and outdoor areas. One of the many objectives of designing buildings is to make sure the thermal comfort to occupants. This is because most people generally spend 85-90% of their time indoors and thus providing a comfortable and healthy environment is imperative.



Fig -1: Filled plastic bottles with sand



Fig -2: Fixing of bottles with wooden



Fig -3: Plastic bottle wall

### Benefits of plastic bottle over masonry wall

The most important benefits of those alternative innovative materials compared to standard materials like brick can include

#### A. Good construction ability:

The walls built by these bottles are lighter than the walls built by brick and block, which makes these buildings to point out an honest response against earthquake. Due to the compaction of filling materials in each bottle, resistance of every bottle against the load is 20 times higher compared to brick. And these compressed filling materials, makes the plastic bottle to be prevented from passing the shot that makes the building as a bulletproof shelter.

#### B. Low cost:

Constructing a house by plastic bottles used for the walls, joist ceiling and concrete column offers us 45% diminution within the final cost. Separation of varied components of cost shows that the utilization of local manpower in making bottle walls can cause cost reduction up to 75% compared to putting together the walls using the brick and concrete block. It must be noted that the subtle manpower can cause reducing the development time and therefore the relative costs also become lower.

#### C. Non-brittle characteristic:

Using the non-brittle materials can reduce construction waste. Unlike brick, plastic bottle is non-brittle. So thanks to the frangibility property, the share of manufacturing construction waste in brick is quite plastic bottles.

#### D. Absorbs abrupt shock loads:

Flexibility is a characteristic which makes the buildings performance higher against the unexpected load. Since the plastic bottles aren't fragile, they will be flexible and tolerates sudden loads without failure. This characteristic also can increase the buildings bearing capacity against the earthquake

#### E. Green 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.

Above mentioned are the different uses of plastic in construction field. In our case study we have studied about

the main factors which affect conditions of construction. Keeping in mind rather than the pollution there are even better option to deal with such as cost estimation of the any product which will come in market. So keeping this point in mind we have even searched for more options in which what can be the option in place of clay bricks. Than we have revealed about the different types of brick used in construction. Bricks such as Fly ash bricks, Sand lime brick, Smart bricks, etc. but these bricks are bit costlier than bottle sand brick. We are going to use Bottle sand brick method and change the filler materials to give them more strength.

#### 4. DETAILS OF DESIGN, WORKING AND PROCESSES

In our project we are going to show which brick in comparison of clay brick is the cheapest cost and also strength. We are going to change the filler materials in the bottle. As we have studied pervious papers about this project the filler material were only sand or soil or cement mortar. The proportion of sand, soil, and fly-ash in a proper proportion so that it will save sand and it will also gain strength. For assurance we are going to take tests on all the bottles. We are going to test with filler material Sand, soil and fly-ash. Also we are going to prepare cube of bottles and take tests on it.

After filling the material in the bottles we will take compressive strength of the bottle mentioned above. And going to introduce society with a best brick product which will satisfy all the conditions mentioned in our case study. Here by we are considering load bearing structure.

#### PROCEDURE OF PREPARING PLASTIC BOTTLE BRICKS

1. Collection of PET bottles of different sizes from different sources such as hotels, canteens, open areas solid waste management plant etc. and to decide uniform size for us for the construction of the plastic bottles.
2. Bottle sized with 25 cm is preferable because normally wall thickness in construction is assumed 23cm commonly. So we are using 25 cm heighted bottle in our construction with 7 cm diameter.
3. Than collect filler materials to fill the bottles e.g. sand, soil and fly-ash and tamping rod to make material fill properly without living air voids as shown in fig.5.1 Filling of materials in bottle.
4. First of all we had filled bottle with saturated sand and soil in each bottles separately. After filling a thick paste of mortar was placed on the cap of the bottle so that filler material should not come out due to excessive compressive load on each bottle.
5. Measured the bottles with filler material so that it will be easy to take proportion of other bottles
6. Bottle filled with sand was of 130 gm weight and the bottle filled with soil was having 800 gm weight.
7. Then after that taking these weights we got an idea how to proportionate the remaining filler materials.
8. After taking filling all four bottles we took compressive test on each bottle to know which bottle resist more compressive forces.

9. Noted down all thee reading and prepared results and conclusion for the project.

#### PROCEDURE to organize CUBE

1. Wooden cube (25.5×25.5×25.5) cm was prepared.
2. The wooden cube was painted black to form the surface smooth and dried it within the air
3. A layer of diesel was applied within the mould in order that the cube can easily detach from the surface after drying.
4. The cement mortar ratio for the cube was kept as 1:3 (OPC).
5. A layer of 2cm was laid on surface of the mould and 25 blows got with the assistance of the tamping rod.
6. Three 500 ml bottles were laid on the surface of the mould
7. Another layer of the mortar was placed on the bottles covering them completely.
8. 15 blows of tamping rods got this point .
9. Another layer of three bottles was placed on the mortar layer.
10. within the same manner nine bottles were inserted within the mould the ultimate layer of the mortar was finished properly to achieve smoother surface.
11. The mould was left in outdoors to dry for 48 hours.
12. On the third day the cube was taken out from the mould and wa was kept in curing tank for 28 days.
13. On the 28th day the cube was taken out from the curing tank.
14. it had been then dried in outdoors .
15. Then the cube was placed within the digital compression testing machine between both the plates and therefore the results were recorded.
16. The load at which the cube breaks out was the utmost loading bearing capacity of that cube.

#### PROCEDURE OF CONSTRUCTION WALL

1. Lay, 2cm (3/4 inch) of cement onto the foundations of which the wall is being built on the ground .
2. Place plastic bottles on top of this cement with a 1cm (1/3 inch) space between bottles.
3. Pour cement on top of those bottles being careful to fill altogether gaps, ensuring that the cement is 2cm (3/4 inch) above the highest of the bottle
4. Place subsequent layer of plastic bottles in between the bottles below. (Fig.5.6 Construct wall sample)
5. Pour cement on top of those bottles being careful to fill altogether gaps, ensuring that the cement is 2cm (3/4 inch) above the highest of the bottles.
6. Repeat steps 1-5 until the wall is at the specified height.

#### 5. RESULT AND APPLICATION

##### EXPERIMENTALLY WORK: CHECK DENSITY OF MATERIAL:

Density calculation for sand

- a. Determination of mass of sand in the cone
  1. mass of sand + cylinder before pouring (M1) =7900gm
  2. mean mass of sand in cone (M2) =405 gm

- b. Determination of bulk density of sand
- 3. Volume of calibrating container (v) = 1178.10cm<sup>3</sup>
- 4. mean mass of sand+ cylinder after pouring =5650gm
- 5. mass of sand filling calibrating container M'=m1-m3-m2 =1845gm
- 6. Bulk density of sand(M'/V) =1.56 gm/cm<sup>3</sup>

Density calculation for soil

- a. Determination of mass of soil in the cone
- 1. mass of soil + cylinder before pouring (M1) =5880gm
- 2. mean mass of soil in cone (M2) =274 gm

- b. Determination of bulk density of soil
- 3. Volume of calibrating container (v) = 1178.10cm<sup>3</sup>
- 4. mean mass of soil+ cylinder after pouring =4356gm
- 5. mass of sand filling calibrating container M'=m1-m3-m2 =1250gm
- 6. Bulk density of soil(M'/V) =1.06 gm/cm<sup>3</sup>

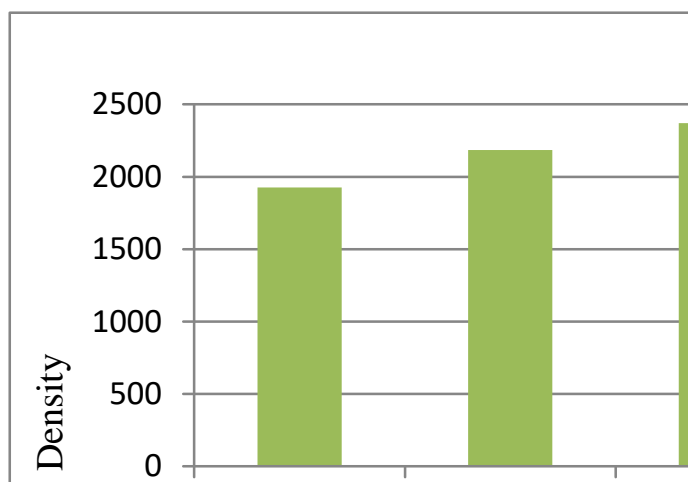
Density calculation for flyash

- a. Determination of mass of flyash in the cone
- 1. mass of flyash + cylinder before pouring (M1) =6800gm
- 2. mean mass of flyash in cone (M2) =315gm

- b. Determination of bulk density of flyash
- 3. Volume of calibrating container (v) = 1178.10cm<sup>3</sup>
- 4. mean mass of flyash + cylinder after pouring =4507gm
- 5. mass of flyash filling calibrating container M'=m1-m3-m2 =1978gm
- 6. Bulk density of flyash (M'/V) =1.67 gm/cm<sup>3</sup>

**Table -1:** Density of Material

Sr.no.	Material block	Weight	Volume(m <sup>3</sup> )	Density (kg/m <sup>3</sup> )
1.	Sand	59	0.027	2185.18
2.	soil	52	0.027	1925.92
3.	Fly ash	64	0.027	2370.37



**COST COMPARISON**

**Table -2:** Cost analysis of 1 m<sup>3</sup> Clay Brick masonry wall

Sr. no.	Material	Quantity	Rate	Per	Amount(Rs.)
1	Brick	500 no.	6	No.	3000
2	Cement	1.4 bag	275	Bag	385
3	Sand	0.284 cum	2115	cum	600.7
4	Labour work	3nos	100	day	300
Total					4285.7

**Table -2:** Cost analysis of 1 m<sup>3</sup> Plastic Bottle Brick wall

Sr. no.	Material	Quantity	Rate	Per	Amount(Rs.)
1	Plastic brick	27.8	15	No.	417
2	Cement	2.665 bags	275	Bag	732.8
3	Sand	0.555cumec	2115	Cum	1173.8
4	Soil	0.1557m <sup>3</sup>	100	M <sup>3</sup>	45
5	Labour Work	4 no.	100	day	400
Total					2768.6

**COMPARISON BETWEEN THE WALLS BY PLASTIC BOTTLE AND BRICK**

Sr. No	Factors	Considerations	Plastic bottle wall	Brick wall
1.	Time and speed of Execution	5 persons team one working day	15% faster	120 m <sup>2</sup>
2.	Material and equipment costs	Implementation and installation of materials and equipment	Saving in cement, water, grinder and fitting	More weight, more materials
3.	Transportation Costs	Displacement in the building	Lighter and higher volume, easy and cheap displacement	Greater weight and less volume, hard and costly displacement
4.	Execution cost	Using calculations of panel	Less manpower and indigenous	More human resources-the higher cost

Sr. No	Factors	Considerations	Plastic bottle wall	Brick wall
5.	Strength and load Capacity	-	20 times more than brick	Greater wall thickness, lower strength High weight and loss of material
6.	Resistance to Earthquake	Earthquake has a direct relationship with the weight of each structure	Low and Integrated weight without falling debris	-
7	Cleanness and beauty of work	-	Very clean execution, no construction waste	High volume of construction waste
8.	Flexibility	-	Very clean execution, no construction waste	-



Fig -5: Plastic bottle wall construction for swimming pool and steps, garden

**Case Study**

Owner name:-Rajendra Inamadar  
 Location of site:- Gheya village, Sinhagad fort, Pune.  
 Project:- Pet Bottle used in house construction  
 Aim:- To reduce plastic pollution and green building.  
 Type structure: - Load Bearing G+2 story  
 Area:- area of bungalow 750 sq.m  
 Collected bottles from sinhagad fort, total 75000 bottles used for construction of bungalow  
 Filler material used in bottle:- crushed sand mortar  
 Door, windows used are 10 year old  
 Cost of construction about 7 lakhs  
 30% efficient economically as compared to brick walls



Fig -4: Plastic bottle wall constructed bungalow

**5. CONCLUSION AND FUTURE SCOPE**

From the density test of materials soil, sand and fly-ash it is observed that fly-ash has high density than soil and sand. Also compressive strength of fly-ash is more than soil and sand. From these results it is concluded that as the density of material is increases the compressive strength of the material is also increases.

From the cost analysis of 1m3 brick work, it is observed that the cost of bottle brick masonry is 35% less than conventional brick masonry.

Plastic bottles are considered as a sort of indecomposable junk which may 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 are often utilized in some parts of building construction like walls, roof and etc.

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 share of cement used. It is counted together of the foundation’s green project and has caught the eye of the architecture and housing industry. Generally the bottle houses are bioclimatic in design, which suggests that when it’s cold outside is warm inside and the other way around.

Use of innovative materials with sustainable application like plastic bottles can have considerable benefits including finding the simplest optimization in energy consumption of the region, reducing environmental degradation, establishment of the acceptable structural behavior in

building like causing to the sunshine weight structure and may even be applied during a project to construct buildings considered temporary

Here may be a procedure to construct the bottle house which is immune 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 employed to carry the "eco bricks" in situ, as in regular masonry. The bottle construction techniques and their benefits must be spread and educate to area people. They are the group of individuals who are most benefitted by low-cost construction.

### Future Scope

The plastic bricks used for further in construction projects due low cost. Actually in some parts of Maharashtra project has been conducted. But, till yet it's not executed Sindhudurg, so our plan is to conduct project using plastic brick house in here our district.

Further plastic bottle blocks preparation in-situ can also be a challenging one. It can also be developed on large scale so that construction cost will decrease and development of any poor region can be done.

When plastic used for these construction the structures will be more economics and it have enough strength, durability.

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