



Research Article

WASTE WATER BOTTLE USED AS A BRICK FOR CONSTRUCTION

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ABSTRACT

Disposal of non bio-degradable substance has become an issue of major concern now a days. Mounds of plastic garbage has been created on earth surface. 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 houses in places on where people are under poverty line is forming one of most significant problems of people. A suitable approach for this situation is using some part of urban rubbish or waste as required materials for building construction. Plastic bottle is considered as urban junk. but with sustainability characteristic it can be used as construction material instead of some conventional material such as brick in building construction. The paper 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 some positive points which this material have versus others.

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INTRODUCTION

Nowadays, human apply all of its potentiality to consume more. The result of this high consumption is nothing unless reducing the initial resources and increasing the landfill. In recent times, human from the one hand is always seeking broader sources with lower price and from the other hand is following the way to get the rid of the wastes. The waste today can be produced wherever humans footprints be existed, and remind him that they have not chosen the appropriate method for exploitation of the nature. 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. Whilst 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 house and are considered as the barrier for users to obtain the basic needs of the life.

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
- Using the method of regenerating through proper education to people.

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. Plastics are produced from the oil that is considered as non-renewable resource. Because plastic

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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 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.

Plastic have many good characteristics which include versatility, light-ness, hardness, and resistant to chemicals, water and impact. 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 approximately 11% of the content landfills, causing serious environmental consequences. Due to the consequences some of the plastic facts are as follow:

- More than 20,000 plastic bottles are needed to obtain one ton of plastic.
- It is estimated that 100 million tons of plastic are produced each year.
- The average European 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. 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.

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.

Plastic Bottles Brick

Plastic bottle brick is made by using waste PET empty bottles which is filled with locally available soil with proper compaction to avoid voids in the bottles.

In this paper plastic bottles are used as a fundamental element, so we have gone through every property of the PETE bottles so as to ensure a stable structure.

Properties of PETE bottle

Polyethylene Terephthalate Ethylene (PETE) bottles is thermoplastic materials. This type of plastic are polymers and with or without cross linking and branching, and they soften on the application of heat, with or without pressure and require cooling to be set to a shape. Following are properties of plastic bottle:

1. Wax like in appearance, translucent, odorless and one of the lightest plastics.
2. Flexible over a wide temperature.
3. Heat resistance.
4. Chemically stable.
5. Do not absorb moisture.
6. Transparent.

Cement

Cement is the important binding material. In these paper it is use to bind the plastic bottles to make the masonry wall more durable so that the quality of cement is check by following properties.

Properties of Cement

Fineness

Fineness or particle size of Portland cement affects Hydration rate and thus the rate of strength gain. The smaller particle size, and the greater the surface area-to- volume ratio so that the more area available for water- cement interaction per unit volume. The effects of greater fineness on strength are generally seen during the first seven days.

Soundness

Soundness is defined as the volume stability of the cement paste. Cement paste strength is typically defined in three ways: compressive, tensile and flexural. These strengths can be affected by a number of items including: water cement ratio, cement-fine aggregate ratio, type and grading of fine aggregate, curing conditions, size and shape of specimen, loading conditions and age.

Setting Time

The initial setting time is defined as the length of time between the penetration of the paste and the time when the needle penetrates 25mm into the cement paste.

Nylon Rope

Nylon rope has a very high tensile strength so that it is use as the main binder for PETE bottles masonry
Properties of Nylon rope

Nylon rope is gotten from coal, Petroleum, air and water. It is a polyamide thermoplastic produced by series on condensation reaction between an amine and organic acids. the properties of nylon as follow:

1. Good abrasion resistance.
2. Tough and strong but flexible too.
3. High impact strength.
4. Absorb water which causes reduction in strength and impact properties
5. Resistant to most of the solvents and chemicals
6. High softening temperatures and thus molding becomes difficult.

Water

Water is in a similar way like cement, an active component in mortar. For cement-sand mortar, without water no hydration can be attained, hence no strength can be achieved. Water is responsible for the workability of a fresh mortar. 20% of the overall weight of the cement and soil was used to determine the quantity of water to be used in the mix. A slump test and a flow test were conducted to evaluate the consistency of the fresh mortar.

Background: The first bottle house was constructed in 1902 by William F. Peck in Tonopah, Nevada. The house was built with 10,000 bottles of beer, which were 90% alcohol and 10% opium. The Peck house was demolished in the early 1980's. The use of empty vessels in construction dates back to ancient Rome, which had structures with amphorae embedded in concrete. This was not done for aesthetic reasons, but to lighten the load of upper levels of structures empty, and to reduce concrete usage. The first plastic bottle construction project in Africa was pioneered in Uganda by Butakoola Village Association for Development (BUVAD) in 2010 in Cayuga district. The idea followed a BUVAD community survey in 2009 that revealed that many farmers in Kayunga were experiencing low crop yields due to poor soil fertility, which was a result of the presence of waste plastics, such as bottles and polythene bags, in the soil.

Hanging Garden

The garden made with plastic bottles over wall & bottles hang with ropes which is used to grown vegetables crops.

Chapter 2

Necessity's of Reuse of Plastic Waste Bottles

Now a day plastic bottles waste increase rapidly and in our society no any efficient techniques available to dispose it. So if we make use of plastic bottles as construction material then we have solution to dispose plastic bottles and we can conserve natural resources.

Resource conservation: To conserve the non renewable resources such as fuel mineral and etc to ensure sufficient supply for present and future generations.

Built development: to integrate environmental considerations into planning and development to respect the natural environment.

Environmental Quality: To prevent or reduce processes such as land filling which can lead to environment degradation and develop the culture of reusing and recycling process.

Social Equity: To impede development that increase the gap between the rich and the poor and to encourage for reach to the social equality.

Objectives

We are the part of the environment & we has responsibility towards society and environment. We want to do such type of project which help to make our environment more sustainable.

Our Aims

- We want to minimize plastic bottles waste from environment and society
- This plastic bottles house and toilets economical for poor peoples

- Plastic is non-degradable waste in environment therefore only reuse of plastic is the best way to dispose effectively.
- To make green structure to conserve natural resources for future need.

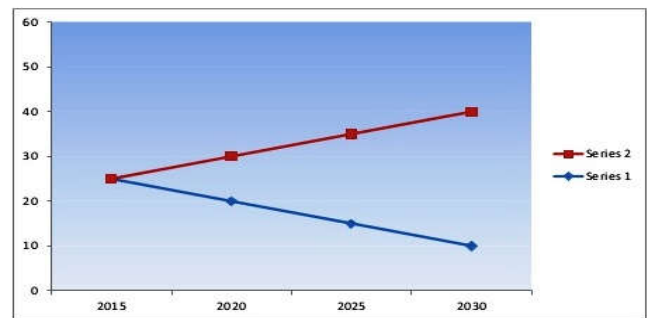
Chapter 3

Previous study

Now a days, large amount of plastic bottles are wasted and disposed every day. People are thrown away them without considering that what those plastic bottles can have impact on the humans and/or environment. We observed that in our environment in 100 sq. m area is minimum 10-25 a bottle occurs. This plastic bottles creates many problems in our society such it makes crowding areas dirty then block the drains which promote to flood situations.

We studied, generally in small hotels and restaurants 50-60 waste water bottles generated daily. Plastic bottles take hundreds of years to biodegrade in landfills. Every year are dumped into waterways and landfills causing pollution, erosion, and irrigation blockage and health problems. Using these bottles as bricks for construction may be termed as cradle-to-cradle approach for designing. According to trade Invest Nigeria each plastic bottles takes on average 450 years to biodegrade and once filled with sand creates a sustainable, eco-friendly and bullet-proof building block that can be used in variety of architectural designs. According to research findings from a recent environmental impact assessment conducted by REPRISED as quoted by an organization called Recycling of used plastic limited (RECOUP)

Graph analysis



Chapter 4

Literature Review

The first bottles house was built using 10000 glass bottles by William F. peck in 1902 in Tonopah, Nevada After that the newer innovative concept has been using plastic bottle instead of glass bottles in constructing the houses. This innovative idea took to account for some reasons such as providing a cost-efficient construction method for pauperized third-world countries. Reusing the plastic bottles due to their not indecomposable characteristics and etc. the first plastic bottle house in Africa was constructed in the village of Yelwa in Nigeria by Andreas Forese. Forese used the plastic bottles instead of bricks bound the bottles together with string and at the end applied the plaster.

However now a days, the concept has spread to countries all over the world. Various kinds of homes have been built from

plastic bottles such as ecological house constructed using 8000 bottles in Honduras; an Eco-tech home in Bolivia constructed using PET and wine bottle; a house of waste plastic bottle in Serbia by Tomislav Radovanic; Taiwan's plastic bottle building; ecological bottle house built using 1200 PET plastic bottles for the walls near the Iquazu Falls. Misiones, Argentina and etc.

- After analyzing our previous study and literature we knowing how to construct plastic house and which things is required to construct it.
- We also knew availability of material and how to collect them from source of generation.
- After this study we were getting information regarding properties of plastic, soil etc.
- Requirement of workers for this work is approximately examine.
- We were getting help to done approximate estimate of propose of work.

Chapter

Project Study

Planning and Designing

Planning: We were decided to make a toilet and hanging garden by using plastic bottles. We have to be draft a plant with respect to cost, time, material, laboures, execution of work etc. Whole work is divided in two main part one is toilet construction and other is hanging garden. Then assign work tp group members to execute work with quality. We decided time for whole work is about five days, two days, for material collection two day for masonry work and last one day is for finishing work.

Designing

Design of toilet and hanging garden as follows

Sr No.	Type of Structure	Particulars	Dimensions
1.	Toilet	Shape	Circular
		Inner diameter	1m
		Outer diameter	1.27m
		Height	1.45m
2.	Hanging Garden	Thickness of wall	0.27m
		Wall size	4x4 sq.m
		Number of walls	2

Estimation and Delegation of Work

Estiamtion

Measurement of total quantities of items of works

Bottle Calculation

Toilet internal diameter = 1m
 Outer diameter = 1.27m
 Height of toilet = 1.45m

$$\text{Volume} = \frac{\pi}{4} \times (D^2 - d^2) \times (H)$$

$$= \frac{\pi}{4} \times (1.27^2 - 1^2) \times (1.45)$$

$$= 0.6979 \text{ cum}$$

Bottle volume with mortar thickness
 Diameter of bottle = 0.07m
 Length = 0.27m

$$\text{Volume of bottle} = \frac{\pi}{4} \times D^2 \times L$$

$$= \frac{\pi}{4} \times (0.07^2 \times 0.27)$$

$$= 0.001093 \text{ cum}$$

Deduction for Door

$$\text{Volume} = h \times l \times t$$

$$= 1.3 \times 0.6 \times 0.07$$

$$= 0.0546 \text{ cum}$$

Deduction for Window

$$\text{Volume} = h_1 \times l_1 \times t$$

$$= 0.20 \times 0.30 \times 0.07$$

$$= 0.0042 \text{ cum}$$

$$\text{Total} = 0.0588 \text{ cum}$$

$$\text{Final volume} = 0.6979 - 0.0588$$

$$= 0.6391 \text{ cum}$$

$$\text{No of bottle} = \text{final volume} / \text{volume of bottle}$$

$$= 0.6391 / 0.001039$$

$$= 615 \text{ bottles}$$

Bottles for panel of roof

$$\text{Panel volume} = 1 \times 0.73 \times 0.07$$

$$= 0.0511 \text{ cum}$$

$$\text{No. of bottles} = 0.0511 / 0.001039$$

$$= 50 \text{ bottles for each panel}$$

$$= 3 \times 3 \times 50$$

$$= 150 \text{ bottles}$$

For hanging garden approximately 50 bottles required

Total bottles required is

$$= 615 + 150 + 50$$

$$= 815 \text{ bottles}$$

Soil Calculation

$$\text{Soil} = \text{volume of bottle} \times \text{no. of bottles filled by soil}$$

$$= 1 \times 615$$

$$= 615 \text{ Kg}$$

No. of Steel Bars

6mm ø – 4mm required of 1.5 m length

Other Materials

500m long metal rope
 40 bricks for piers
 40 card sheets
 Crops seeds

Costing

Bottles

$$= \text{no. of bottles} \times \text{rate per bottle}$$

$$= 815 \times 0.50$$

$$= \text{Rs. } 407.50$$

Rods

$$= \text{no. of rods} \times \text{rate per rod}$$

$$= 4 \times 60$$

$$= \text{Rs. } 240$$

Bricks

$$= \text{no. of bricks} \times \text{rate per brick}$$

$$= 40 \times 6$$

$$= \text{Rs. } 240$$

Other Materials

Soil is taken from local hilly area without any cost. Card sheets taken from college waste paper submission. Seeds are purchase at Rs. 40.

Transportation and T&P

For collection of raw material Rs.200 required. For tools and plants Rs. 150 required

Laboures

We have to work self physically, but minimum 4 laboures required per day.

Total cost of construction = $407.50+240+240+40+200+150$
= Rs. 1280

Total Cost=Rs.1280

Collection of Required Raw Mayterial

We collected plastics bottles from different hotels nearby college such as Shelter inn, Jata Shankar etc. Soil is locally available red soil is taken from hill near college campus. Other material such as card sheets, bamboos is taken waste which thrown by people.

Tools and plants are crow bar, buckets, trowel, tray etc. this are taken from village people.

Execution of work

Toilet Construction

Layout

As per design we mark a circle on ground with lime.

Bottle Filling With Soil

All bottles fill with red soil properly and to fill bottle steel rod use, it help to avoid voids will chances of creation in bottle.

Masonry Work

All plastic bottles are arranged as a English Bond with minimum mortar.

Finishing Work

Door, Window, roofing work is done in this work.

Hanging Garden

With the help of bottle card sheet background are prepared on wall. Then set the base for hanging bottles by using ropes wood planks etc. After that seeds of crops are sown in bottle with soil and water.

Overview After Completion of Execution Work of Project

Time required for whole work is two days with total four workers. Cost of whole construction is Rs.1800.

We face Following Problems During Execution of work

- ❖ When we going to prepared mortar that time mud becomes early dried so water requirement is increases.
- ❖ While collecting PET bottles transportation from hotels to college is too difficulties for us.



Fig. 5.4.3

Advantages

Economical

Empty plastic bottles has low purchasing value as compared to bricks so therefore it can be reduces about 80% cost of construction.

Simple and easy construction

With the help of plastic bottles construction could be become easy there are no requirement of skilled labour and mason.

Minimized Waste From Environment

If we make an reuse of waste plastic bottles in civil construction then percentage of waste in environment automatically decreases.

High Durability

When plastic bottles filled with soil then it gives 45 N/mm^2 compressive strength which 900% greater than standard brick. Plastic is non-degradable material remains as it is in the environment.

Curing Does Not Required

Plastic bottles have 0% water absorption capacity and plastic is does not required water for curing or any other curing method to increase strength.

Green Construction

Plastic bottle is considered as a sustainable material which can help in achieving the SD.

Using the plastic bottle can follow the objectives of SD. It can abstain from the resource depletion, assist in protecting the environment: prevent or reduce the environmental degradation process such as land filling through reusing process and it can assist to obtain social equity by avoiding the gap between rich and poor people in the society.

Non-Brittle Characteristic

Using the non-brittle materials can reduce construction waste. Unlike brick, plastic bottle is non-brittle. So due to the

frangibility property, the percentage of producing construction waste in brick is more than plastic bottles.

Absorbs Abrupt Shock Loads

Flexibility is a characteristic which make the building's performance higher against the unexpected load. Since the plastic bottles are not fragile, they can be flexible and tolerates sudden loads without failure. This characteristic can also increase the building's bearing capacity against the earthquake.

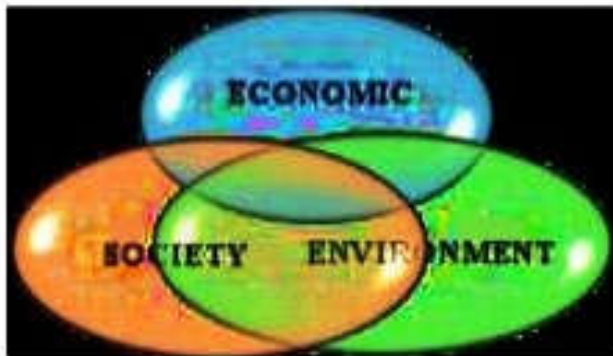


Fig. 5.5.1

Disadvantages

Material availability

In hilly or remote area which not well developed there are very less chances of a getting material for construction such as plastic bottles soil etc.

Applicable Only For Load Bearing Structure

For multi-storied building it is not fully applicable but we can be use in a partition wall for construction.

Properties of Plastic Bottles

- ❖ Plastic bottles are remains as it is in environment for 300 years.
- ❖ Plastic bottles are bullets proof.
- ❖ Plastic bottles are light in weight.
- ❖ Non-absorptive material.
- ❖ Chemical and insects proof.

Chapter 6

Testing

Compressive test

Compressive test of plastic bottle filled with soil is conducted on CTM machine. Compressive strength of plastic bottle is 45 N/mm²

Water Absorption Test

Water absorption test of plastic bottle is zero.

Weight Measuring Test

Weight of plastic bottle when filled with soil is equal to 1.5 Kg.

Volume of Bottle

Volume of plastic bottle is equal to 1 liter



Fig 6.4

Sr No.	Factors	Considerations	Bottle panel	Ceramic block	Concrete block
1	Time and speed of execution	5 Persons team one working day	15% faster	120 m ²	Less than 100 m ²
2	Material and Equipment cost	Implementation and installation of material and equipment	Saving in cement water grinder and fitting	More weight ,ore material	More weight more materials
3	Transportation Cost	Displacement in the building	Lighter and higher vol. easy and cheap displacement	Greater weight and less volume hard and costly displacement	Greater weight and less volume hard and costly displacement
4	Execution Cost	Using calculations in panel	Less manpower and indigenous	More human resources the higher cost	More human resources the higher cost
5	Strength and Load Capacity		20 times more than brick	Greater wall thickness lower strength	Greater wall thickness lower strength
6	Resistance to Earthquake	Earthquake has a direct relationship with the weight of each structure	Low and integrated weight without falling debris	High weight and loss of material	High weight and loss material
7	Cleanness and Beauty of Work	.....	Very clean execution no construction waste	High volume construction waste	High volume of construction waste
8	Flexibility	.....	High flexibility	Low flexibility	
9	Material Waste	.....	No wastage	High and unusual	High and unusual

Chapter 7

Compression Between Standard brick and Plastic Bottles with soil

Chapter 8

Other Applications & Some Suggestion

Other Application

Plastic bottles can also use for making a small slab culvert which is used over public drains. Chairs, table, sofa, etc. are cab be made by using plastic bottles.

We can also make a small water storage tank by plastic bottles. For poor people who have no money for buy a water filter so for that people we can make water filter help of plastic bottles. Kid's toys, flowerpots, door mat etc. can also made by using plastic bottles.

Chapter 9

9.1 SOME PHOTOGRAPHS



TOILET CONSTRUCTION

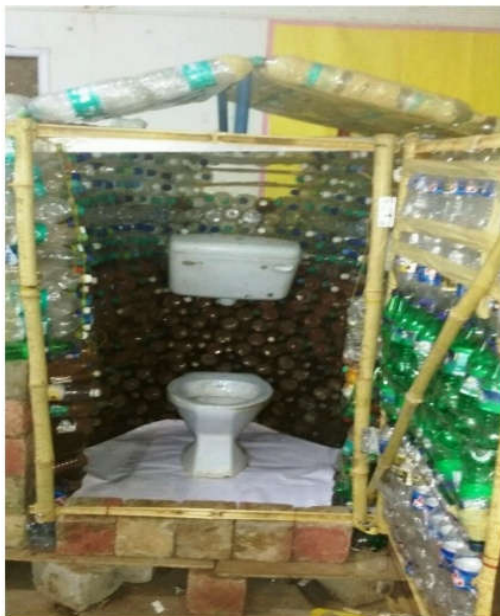


Fig.9.1

May 2011 Samarpan Foundation has constructed a children school in New Delhi, using hundreds of used PET bottles instead of conventional bricks.



Dec 2nd, 2010 proving that there are all kinds of uses for recycled PET plastic, Taiwan-based Er. Arthur Huang processed 1.8 million used plastic bottles into honeycomb-shaped bricks for a boat-shaped exhibition hall called the Eco-ARK. Built for Taipei's flower show, Eco-ARK was constructed for just one-third the cost of a conventional structure. Once locked together, the bricks are extremely strong.



Our Experience

It was very nice experience of project work. We feel like a civil engineer while working project work. We listened that how need to us work actually on site in future.

We knowing that team work, communication between people, how to give presentation, how to take decision in team. Main thing is that we learn if we going to execute any project so that time which things we need to plan. Which things need to do etc. when we execute any concept then this concept how to present in front of others?

This experience definitely helpful to us in future for execution of any work project etc.

Chapter 10

Need for Further study

Now a day's plastic waste in environment is very serious and big problem.

And in future it is increase rapidly so recent no efficient techniques to dispose off.

Reuse is the better way to dispose effectively and it is very economical for poor people.

So, if after more details study on this project it is definitely helps us to keep our society free from plastic bottles waste.

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. 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 CO₂ 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 sq.m Brick masonry wall is Rs. 7444.25 and total cost of 10 sq m Bottle masonry wall is Rs. 3879.25.

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