

# Waste Plastic Bottles Offering Innovative Material with Sustainable Application in Safe Guard Tree

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**ABSTRACT:** Due to growth of population and industrial sector rapidly there is increase in plastic pollution. On the weight basis about 5.6 million tonnes of plastic waste is generated in India per year (year 2014) When travelling comes there is need of food & water. Generally water is carried in PET bottles (Polyethylene Terephthalate) which when used are thrown away in environment. It is estimated that 1 out of 5 bottles are sent to recycle bin, rest of which is thrown away which creates pollution. We in our project are reusing waste PET bottles by innovative method in which it acts as a multipurpose safe guard tree which includes its safety and self sustainability. As far as self sustainability concern, it will be able to collect the rain water & store it near its root zone, which will ultimately increase the ground water table near the root zone of a particular tree. It's easy to plant a tree but it is very difficult to grow it up. So our objective is to provide safety & side by side help it to become self sustainable.

**KEYWORDS:** Polyethylene Terephthalate, Innovative safe guard tree construction, brick-mud cocks, root zone, self sustainable.

## I. INTRODUCTION

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. When the society gets affected, then it will be uneconomical for the nation to create sustainable 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.

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 But now by changing the human's disposal culture, glass bottles have been replaced by plastic bottles, as they have increasingly become one of the substances of destruction of the landfills because they decompose in a long time.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.

## II. LITERATURE SURVEY

Mojtaba et.al, The author intends to investigate in this paper that the application of plastic bottles as one of the urban wastage in building construction & that how it can lead to sustainable development. It also mentions some ways for self standing and insulating them in thermal & sound points of views & some positive points which this material

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Vol. 6, Issue 5, May 2017

have versus others. At the end it 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 conventional building materials such as brick, concrete and ceramic blocks etc.

Miss Idalia et.al, The author concluded that bio-degradation is the natural break-down of organic substances. Plastic does not bio-degrade. Nature does not know how to break down plastic because of what plastic is made of photo-degradation is the break-up of materials by the sun. In large periods of time, plastics break down into very small pieces of plastic that float around. Each year, tons of plastics and other litter are tossed into rivers, left on beaches, or dumped overboard from recreational and commercial vessels. Litter not only looks bad, but can put people and wildlife in danger. Plastic particles are now being found in the stomachs of birds in the antarctic and sub-antarctic. This is a signal that our plastic pollution is increasing because these areas were considered to be untouched by pollution. Fish and marine mammals wounded by plastic rings or ropes may develop infections in their open wounds. Turtles that get trapped in plastic rings eventually grow around them, causing their bodies to be deformed and their organs to not develop properly. Plastic pollution blocks the sunlight that is essential for the survival of corals.

Swaptikchowdhury et.al, The author says that recycled PET fibres were considered as reinforcement for concrete as a means for studying and analyzing thereby improving its performance. Also the ecological benefit of successfully using a waste material give added benefit and had been a prime motivation for the work. So from the study it was concluded that PET aggregate concrete have less compression strength, flexural rigidity and tensile strength which can be attributed to the decreased bonding tendency of PET bottles with cement matrix. But as the density of PET fiber is lower than the conventional aggregate, it is very useful in producing light weight construction entities.

Aditya Sing Rawat et.al, The author concluded that no curing time is required if waste PET bottles are used as building material as compared to bricks which require 28 days curing time also while backing of bricks there is a major issue of carbon emission which is negligible in using PET bottles. PET bottles generally have a durability of over 300 years which is more as compared to standard bricks. Cost of construction in case of brick bottle is more economical than standard bricks. Weight of unit bottle bricks was found to be less than that of a standard brick. Compressive strength of the bottle brick is also nearly equal than that of standard brick. Thus we can conclude that using the concept of brick bottles is cost effective, energy efficient and commercially feasible.

Arumalar Ramaraj et.al, The author found that the initial perception on the use of PET bottles in construction is changing day by day. A paradigm which emerged as PET bottle bricks in the construction of load bearing walls with steel trusses and prefabricated metal sheet is at present witnessing flat roofs with nylon 6 replacing steel reinforcement and intuitive vault construction. Apart from this ingenious bonds and columns using PET bottles gives a new direction to think about beams, foundation and simple trusses. With a holistic approach, designing face of PET bottles with interlocking property is innovative. Even though research on the effective use PET in developing new material as an option, solutions exploring the applications of PET bottles as structural members, foundation, retaining walls and secondary elements like steel furniture, kerbs, road, dividers, pavements and other landscape elements is to be looked into.

Dr. Pratima Patel et.al, The author concluded that 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 CO<sub>2</sub> 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.

Dibya Jivan Pati et.al, The author attempts to highlight the potential of plastic bottle waste used as an alternative material in construction and its low-cost characteristic. Most nonbiodegradable waste like plastic bottle, construction waste, glass and metals together with other municipal waste end-up at landfill thereby increasing the need for more land and unnecessary investment which could otherwise be used for different purposes and alternate way of disposing

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Vol. 6, Issue 5, May 2017

the solid waste. In Indian context, housing shortage and poor solid waste management go together hand in hand. While urban poor households suffer homelessness and inadequate basic amenities, the higher income groups (HIG) contribute to generation of garbage in accordance to their urban lifestyles. An effective and productive planning for utilization of solid waste in construction can help in curbing both the problems together. Most non-biodegradable wastes generated in India are not recycled. While plastic bottles are dumped in landfill, it takes long time to decompose. Utilization of plastic bottles in construction has been proved safe and is evidently stronger and cheaper than conventional brick masonry, therefore should be brought to the forefront on cost effective housing development. Construction and demolition waste (C&D) recycling is tedious and time consuming. Most urban or metro cities seldom take care of these wastes. Use of C&D waste in low-cost housing can reduce the load of landfill and management.

P. Rajkumaret. al, The author studied that economic status i.e., income level has a bearing on the usage and disposal of plastic materials. The low income group stands low in attitude towards disposal and environmental concern. They dispose the plastic waste in the open area in such a way as to cause environmental degradation. The observation points to the need for shaping the attitudes of the low group people towards the proper disposal of plastic wastes and creating environmental concern among them so that environment will remain graded and clean.

SukainaKazmiet. al, The author conclude that bitumen grade of 60/70 guidelines match with the general specifications of MOTC, the same as been adapted in the present work for using in Marshall stability method the study conclusively showed that the waste plastic materials could be incorporated as a binding agent for the construction of roads.

### III. CASE STUDY AND MODELLING

1. In this study we firstly collected waste plastic bottles, cycle rims, waste steel rods of size 42 inches approximate & waste rubber strips from junk yards.
2. Then construction of frame with 4 rims placed one above other at specified distance supporting them with 8 steel rods. Spot welding is done, & ensured that the specified symmetry is achieved & then final welding is done.
3. In this way frame is constructed. Then a series of 5 bottles is interconnected by making hole in bottom part of bottle of diameter such that the mouth of bottle is inserted into that hole & gets interconnected.
4. Adhesive is applied to ensure that there is no leakage between bottles. In this way 27 series are made & arranged around the circumference of the frame. These bottles are held in position with help of 5 to 6 rubber strips & steel wire to hold on the weight of bottles when filled with water at its maximum level.
5. These are then placed at equal distance from each other. Note that that the bottom most layers of bottles is fitted with the brick mud cock which ensures the low rate of seepage through bottles, when water is poured from top most bottle, it directly travels through the bottles & gets percolated in the ground.
6. Its storage capacity, shape, materials used can be modified as per persons needs. Fertilizers also can be introduced through the bottles which may be useful in agricultural sector.

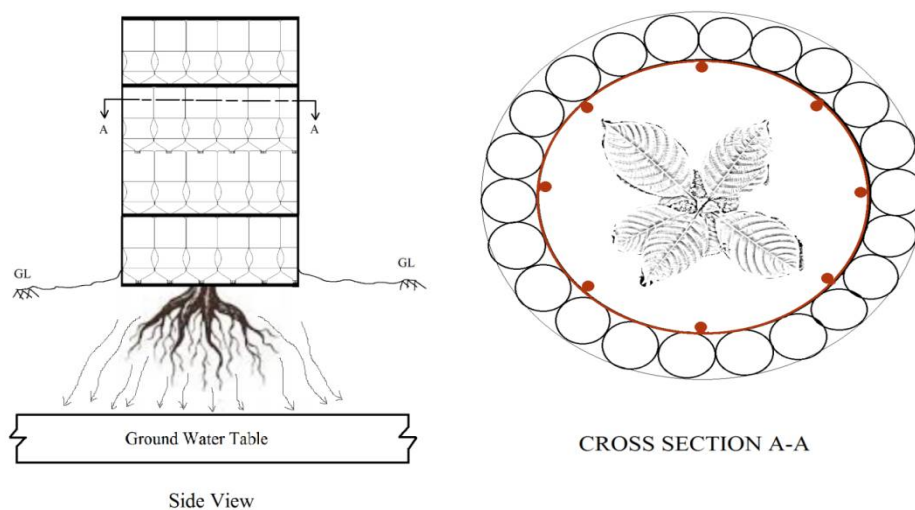


Figure 1: Design of Safe Guard Tree.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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Vol. 6, Issue 5, May 2017

### 1. Design of Safe Guard Tree-

The typical layout of plastic bottled safe guard tree which shows a side view & cross-section through which we can understand the working of safe guard tree. Side view shows the roots of tree which are spread in vertically downward direction in search of water. The cross-section shows the top view of safe guard tree

### 2. Construction of Frame-

Construction of frame is done with cycle rims & steel rods, which forms a proper drum shape where bottles can be attached to the circumference of the frame with help of rubber tube strips & a metal string.

### 3. Application of Red Oxide Coating on Frame-

Application of red oxide paint was done in case to avoid rusting of frame in moisture conditions & for good appearance.

### 4. Interconnection between Bottles-

Interconnecting bottles by making hole at bottom of bottle and inserting another bottle into it, in this way a series of 5 bottles were made. Such 27 series were made to ensure the requirement. Side by side the upper portion of upper layer of bottle is cut down horizontally which makes path to enter rainwater as well as through conventional means. By changing the capacity of bottles (500 ml, 1litre, 2 liters etc) or by modifying the numbers of bottles attached to frame, the total water carrying capacity of safe guard tree can be modified.



Figure 1: Construction of Brick-Mud Cocks

### 5. Construction of Brick-Mud Cocks-

By taking raw brick mud such cylindrical shaped cocks were made & let them bake at 950°C for 24 hours. After drying it was then inserted into a last bottle of series & made it water tight by applying adhesive. Here after water is filled in bottles its percolation rate will be decreased due to low porosity of mud cocks.



Figure 2: Actual Photograph showing Mud-Cocks Inserted in Bottles.

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(An ISO 3297: 2007 Certified Organization)

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Vol. 6, Issue 5, May 2017

### 6. Actual Photograph showing Mud-Cocks Inserted in Bottles-

After inserting these mud-cocks the percolation rate was calculated as 1.33 lit/hr which is more than sufficient to water a tree for 8 to 10 days. This atomization helps us to just fill these bottles once in 8 to 10 days.



Figure 3: Actual Photographs of Model

### 7. Actual Photographs of Model-

The last layer of bottles is inserted into ground about 10 to 12 cm to ensure that the water seeps through vertical direction only which in turn results in increase in ground water table.



Figure 4: Bottles Full of Water

### 8. Bottles Full of Water

After proper bonding & drying of adhesives, it is ensured that there is no leakage between the connections. The above photograph shows the bottles full of water & ensures the leak proof connection. This safe guard tree was then tested & results were obtained as given below in conclusion.

# International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 5, May 2017



Figure 5: Implementation in the college campus.

## IV. COSTING & COMPARISON

As far as our project is concerned we have prepared the safe guard tree in order to satisfy the water requirement of the tree & to prevent the excess water flow of f on per day basis. Following table shows the estimate of model.

Table 1: Costing of plastic bottle safe guard tree

Sr. No.	Material	Rate/Unit (Rs)	Total
1	Steel Rods 8mm $\phi$ 42 Inch-8 No. (3.37 Kg)	25/Kg	Rs.85
2	Plastic Bottles- 150 No.	0.50 / Bottle	Rs.75
3	Cycle Rim- 4 No.	20 / Rim	Rs.80
4	Rubber Packing -10 No.	6	Rs.60
5	Adhesive 500gm- 1No.	100	Rs.100
6	Red Oxide Paint, 500 ml – 1 No.	90	Rs.90
Total cost of designed unit			<b>Rs.490=00</b>

Table 2: Cost Comparison (different materials used)

Table 2 shows the cost comparison between different materials that can be used for preparing the model.

Sr. No.	Type of tree guard	Cost Per Unit	Remark
1	M. S. ( Mild Steel)	<b>Rs. 1500</b>	Manufacturing cost is more, more corrosion possible, life span up to 10 years.
2	Brick	<b>Rs. 1200</b>	Manufacturing cost is more and more utilization of other natural resources; load per unit area is more, life span up to 5 years.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 5, May 2017

3	Sun Shade Cloth	<b>Rs. 350</b>	Manufacturing cost is minimum but life span is less than 1 year.
4	Safe guard tree	<b>Rs. 490</b>	Manufacturing cost is less, life span more than 15 years; cost can be reduced by modifications.

Table 3: Comparison (different methods)

Sr. No.	Water Supply System	Cost /Unit (Rs.)	Remark
1	Sprinkler	2500	Operating and maintenance cost is more, water evaporation is maximum, life span is up to 5years but more cost, covers maximum area.
2	Drip	2050	Operating and maintenance cost is more, evaporation is minimum, life span up to 15 years but more cost, covers maximum area.
3	Manual	1000	Requires more no's of labors & other equipments. ( Including Wages and salaries of workers)
4	Safe guard tree	490	Operating and maintenance cost is much more less than conventional systems, life span more than 5 year's.

The costing of Safe Guard Tree is excluding the fabrication & man power cost.

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