

Polyethylene Terephthalate (PET) Bottle Construction

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Abstract: In this paper we are introducing the concept of reuse as a mean to achieve sustainability. It also analyses different factors such as time of execution, cost, load capacity, flexibility, reducing waste and energy efficiency. It is found that polyethylene terephthalate (PET) bottles filled with soil can be more effective compared to some conventional building materials such as brick, concrete and ceramic block. The suitability of this paper was incorporated with the construction of water retaining structure.

Keywords— Reuse, Sustainability, PET bottle

I. INTRODUCTION

As India's population is on the verge of overflowing rate, the consumption of plastic has been increasing day by day. Plastics are unavoidable part of our daily life. Since they can be used for various purposes their disposal becomes a major threat. Being non- biodegradable , it contains toxic substances which pollutes earth air and water. It causes serious damage to environment during manufacture and disposal. They are mainly disposed by burning, recycling and landfilling.

II. SCOPE AND OBJECTIVES OF THE STUDY

Several investigations has been made on the use of plastic waste such as polyethylene terephthalate (PET) bottle, poly vinyl chloride (PVC) pipe, high density polyethylene (HDPE), shredded and recycled plastic waste, polyurethane foam, polypropylene fiber etc. as a source of aggregate, filler or as fiber in the production of concrete. Polyethylene Terephthalate (PET) is one of the most vital and widely used plastics in the world.The production of PET accounts to 6.7 million tons/year and it is due to increasing demands in Idia and China.

This paper investigates the usage of plastic bottles as a unit of construction in the buildings. The characteristics and benefits of these bottles are utilized in building concepts. It also compares the characteristics of certain construction materials like brick, ceramic and concrete block with bottle panel.

III. PET BOTTLES

Full name: Polyethylene terephthalate
Chemical Formula: $C_{10}H_8O_4$

Structural Composition: Polyester of terephthalic acid and ethylene glycol

PET, being a member among family of polyesters, is nowadays being used mainly in the food industry, for packing soft drinks, mineral water, milk, oil and other types of products. Besides the multiple advantages these packages exhibit, there is also series of disadvantages viz. great waste volume generation, and non biodegradability. PET bottles can be successfully used as a clear, strong and impermeable unit of construction. One of the prominent features about plastic is that it is indestructible. This makes it ideal to use for products such as soft drink bottles, beverages and drinking cups. But their disposable is a major environmental threat.

A. Properties

- White or light cream material
- Density 1.33220 gm/cm³
- M.P.-255 to 2650C
- Solubility- Insoluble in water
- Heat resistant and chemically stable to acid, base, some solvents, oils, fats.

IV. BASIC CONSTRUCTION MATERIALS AND THEIR PROPERTIES

This construction require some basic materials which provides a stable, cheap and eco friendly structure as compared to brick wall. Materials used for Bottle wall masonry construction are:

- 1) Soil
- 2) Plastic bottles
- 3) Cement
- 4) Nylon rope
- 5) Water

A. Soil

Soil is the basic element in any construction project, thus a study of the basic properties of the soil is required and different tests are conducted to check whether the soil sample selected is suitable. The various test conducted according to the relevant IS Code:

- Standard Proctor Test
- Moisture Content
- Direct Shear test
- Specific Gravity Test
- Sieve Analysis

1) *Properties Of Soil*

a) *Soil Texture:*

Soil texture can have an effect on many properties of soil, mainly physical properties. Texture is determined by three mineral particles such as sand, silt and clay. These particles are distinguished by size, and constitute the fine mineral fraction.

b) *Soil Structure:*

Soil structure is the arrangement of soil particles in larger clusters called aggregates. Aggregation is necessary for increasing stability, porosity, fertility and soil water movement. Granular structure consists of loosely packed aggregate pads that are binded together by organic substances.

TABLE.1 SOIL TYPES

SOIL PARTICLE	DIAMETER(mm)
Gravel	>2
Sand	0.05-2
Silt	0.002-0.05
Clay	<0.002

c) *Soil Porosity:*

Most of the soil processes take place in soil pores. Porosity is determined by soil texture and structure by determining the amount and interlinking of pores. Coarse textured soils have large pores because of the loose arrangement of particles with other. Fine-textured soils are closely arranged and have more small pores. Large pores in fine textured soils are found in aggregates. Since fine-textured soils have both types of pores, they have a greater porosity than coarse-textured soils.

B. *Plastic Bottle*

Since plastic bottles are used as a fundamental element, we have gone through every property of the PET bottles so as to ensure a stable structure.



Fig:1 PET Bottle

1) *Properties Of Pet Bottle*

Polyethylene Terephthalate (PET) bottles are thermoplastic materials. This type of plastic are polymers with or without cross linking and branching, and they gets easily softened on the application of heat and pressure and require cooling to get a specified shape. Following are properties of plastic bottle:

- Wax like in appearance, translucent, odourless .
- Flexible over a wide range of temperature.
- Heat resistant.
- Chemically stable.
- Do not absorb moisture.
- Transparent.

C. *Cement*

Binding material is cement. In this paper it is used to bind the plastic bottles to make the constructional unit more durable. The quality of cement is checked by following properties.

1) *Properties of Cement*

• *Fineness:*

Hydration rate and thus the rate of strength gain is affected by fineness or particle size of cement. The smaller the particle size, the greater the surface area-to-volume ratio and thus more area is available for water-cement interaction. The effects of fineness on strength are can be seen during the first seven days.

• *Soundness:*

Soundness is defined as the volume stability of the cement paste.

• *Strength:*

The strength of the cement paste is defined in three ways: compressive, tensile and flexural. The strengths of the cement is affected by a number of factors including: water cement ratio, cement-fine aggregate ratio, type of aggregate, grading of fine aggregate, curing conditions, size and shape of specimen, age and loading conditions.

• *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.

D. *Water*

Water like other material is an active component in mortar. No hydration can take place in the cement mortar in the absence of water. Water accounts for the workability of a fresh mortar. Certain percentage from the overall weight of the cement and soil was used to determine the quantity of water to be used to prepare the mortar. Consistency of fresh mortar was evaluated by conducting slump test and flow test.

V. *COMPRESSION TEST ON BOTTLES*

The compressive strength is the ratio of the highest load to the cross sectional area of the specimen expressed in N/mm². Bottles filled with soil were used for testing in CTM (Compression Testing Machine). Two types of samples were tested to compare and conclude the bottle type yield better strength and has large availability. The two types were Mineral water bottles and Soft drink bottles.



Fig:2 Testing of Mineral Water Bottles



Fig: 3 Soft drink bottles



Fig :5 Pet water retaining structure

Observation:

Failure load calculated for ;

1. Mineral water bottle =40.5kN
2. Soft drink bottle = 39 kN

Results:

Hence we select Mineral water bottle as our sample for bottle brick construction.

VI. CONSTRUCTION PROCEDURE

The following are the steps involved in construction:

- Site Selection
- Collection of Pet Bottle
- Filling Of Bottles

Each bottles collected were tightly packed with locally available soil in five layers, each layer being tamped 25 times and then capped.



Fig:4 Soil Filled Bottles

- Preparation Of Site
- Laying Of Foundation
- Construction Of Side Walls

At the start a mortar (1:4) layer of 5cm was spread over which bottles were radially oriented towards the centre.(i.e., the cap is oriented towards the rod).The gaps in between the bottles were sealed with mortar. Thread was taken and a was knotted at middle of each bottle while placing. Thus the first course of bottles was completed. The succeeding layers were constructed in a similar way.

As a sample we constructed a water retaining structure at our college.

VII. CONCLUSION

Thus plastic mineral water bottles can be efficiently used for the construction purpose .It has been proved that this mode of construction using PET bottles has the following advantages-

- Economical,
- Environment friendly
- Durable
- Aesthetic in appearance

This will result in a rapid decrease of plastic wastes and thus reduces environmental pollution and paves way for sustainable development.

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REFERENCES

- [1] Mojtaba Valinejad Shoubi, Masoud Valinejad Shoubi, Azin Shakiba Barough, Investigating the Application of Plastic Bottle as a Sustainable Material in the Building Construction , International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 1, January 2013.
- [2] Aditya Singh Rawat , R. Kansal ,PET Bottles as Sustainable Building Material: A Step Towards Green Building Construction, Journal of Civil Engineering and Environmental Technology; Volume 1, Number 6; August, 2014 pp. 1-3.
- [3] Aditya Raut, Mohammad Salman Patel, Nilesh B. Jadhwar,Uzair khan, Prof.Sagar W. Dhengare, Investigating the Application of Waste Plastic Bottle as a Construction Material- A Review , Journal of The International Association of Advanced Technology and Science.
- [4] Shilpi Saxena, Monika Singh, Eco-Architecture: Pet Bottle Houses, International Journal of Scientific Engineering and Technology Volume No.2, Issue No.12, pp : 1243-1246.
- [5] Swaptik Chowdhury, Aastha Tashkant Maniar and Om Suganya, Polyethylene Terephthalate (PET) Waste as Building Solution, International Journal of Chemical, Environmental & Biological Sciences (IJCEBS) Volume 1 Issue 2 (2013).