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REPLACEMENT OF BRICKS WITH PLASTIC BOTTLES IN CONSTRUCTION

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Abstract - *In building construction, brick is the major ingredient used for construction. In the process of brick making, it has to be burnt in kiln which emits CO2 gas and pollutes the environment. Waste plastic bottles are non-biodegradable and its disposal has always been a problem. Therefore, replacing the bricks with an alternative material, i.e.bricks made from waste plastic bottles is the solution. Waste Polyethylene Terephthalate (PET) bottles packed with dry solid wastes, sand or soil has been successfully used in a number of countries. The main objective of this paper is to use the waste plastic bottles and construction demolition waste in building construction which reduces the environmental pollution. Plastic bottles of size 600 ml are filled with finely crushed construction demolition waste in three layers and tamped each layer with tamping rod by 25 blows and used. These bottles were called as Eco-Bricks. The Prism is made with the size of (28 x 16 x 24) cm in which 6 Eco-Bricks were placed. Composite Eco-Brick is made with the size of (23 x 10 x 7) cm in which a single Eco-Brick is placed. The Compression test is carried out for an Eco-Brick, Composite Eco-Brick and for Prism and compared with the Conventional one. As a result, the Eco-Brick shows 90% increase in load carrying capacity than conventional one. Eco-Bricks are stronger than the Conventional Bricks. Composite Eco-Bricks and Prism shows 12% increase in strength. Therefore, it can be used for low rise buildings and temporary structures.*

Key Words: Polyethylene Terephthalate, Construction Demolition Waste, Eco-Brick, Eco-Brick prism, M-Sand, etc .,

1. INTRODUCTION

PLASTIC WASTE

Plastic bottles are increasingly becoming a menace to the environment due to the use of chemicals in the manufacture, use and disposal. It has resulted in pollution problems in waterways, landfills and continues to grow. Taking into account the increase of pollution new concept of eco bricks has been introduced. When these bottles are filled with sand, gravel and cork or wood particles, they have great insulating capability. These walls can absorb abrupt shock loads; being non-brittle they produce much less construction waste compared to conventional bricks. They also reported that compared to brick and concrete block walls, plastic bottle walls cost 75% less. Being lighter, plastic bottle walls can be better against earthquakes due to the compaction of filling material in the bottles, they are 20 times more load resistant than conventional bricks these filling materials also make these walls bullet proof. These walls can also support themselves.

2. MATERIALS USED

2.1 Pet Bottles

PET is Polyethylene Terephthalate. Plastic bottles are used to store liquids such as water, soft drinks, oil, milk, medicine, and ink, etc., It provides good chemical resistance and a high degree of impact resistance and tensile strength. The maximum temperature it can bear is upto 200 degree Celsius. The biggest advantage of plastic bottles have over glass is their superior resistance to breakage.

Fig.1 Waste PET Bottles

Fig.2 600 ml Bottle

2.2 Construction Demolition Waste

These construction demolition wastes were produced while constructing a building and also by demolition of a structure. These wastes include materials such as concrete, bricks, wood and other wastes. As the volume of construction waste is huge the waste to be crushed, processed & reused as aggregate in building works. Moreover, the concrete and brick wastes can be crushed and used. Earlier these wastes were dumped in landfills unnecessarily. Broken bricks are used as a construction infill or as an aggregate for non – structural purpose. Brick masonry rubble contains a volume of 20% mortar.

Fig.3 Construction Demolition Waste

2.3 Cement

Cement is a binder used for construction of structures that sets, hardens and binds well to other materials. Portland cement is a basic ingredient of concrete, mortar and specialty grout used around the world. It is a fine powder produced by heating limestone and clay minerals in a kiln to form clinker, grinded and 2 to 3 percent of gypsum is added.

Fig.4 Cement

2.4 M-Sand

Manufacturing Sand is a substitute of river sand for construction purpose. It is prepared by crushing hard granite stone up to its fineness and is of cubical shape. The size of manufactured sand is less than 4.75 mm.

2.5 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.

3. MATERIAL PROPERTIES

Table 1 Propertie of PET Bottles

Property	Result
Chemical Formula	$(C_{10}H_8O_4)n$
Density	1.38 g/cm^3(20 °C)
Melting point	> 250 °C, 260 °C
Boiling point	> 350 °C(decomposes)

Table 2 Properties of Cement

Properties	Results
Consistency	35 %
Initial setting time	30 Minutes
Final setting time	600 Minutes
Fineness	8.16 %
Specific Gravity	3.43

Table 3 Properties of M-Sand

Properties	Results
Specific Gravity	2.57
Fineness Modulus	3.15

4. EXPERIMENTAL WORKS

4.1 Preparation of Eco-Bricks

Waste PET bottles were collected and construction demolition wastes were crushed them upto the most possible fineness. These wastes were filled into the PET bottles. It is compacted well without any voids by tamping each layer with 25 blows and the Eco-Bricks are ready.

Fig.5 Eco-Brick

4.2 Eco-Brick

It is made up of plastic bottle filled up with construction demolition waste.

4.3 Composite Eco-Brick

It is a brick casted with single Eco-Brick and cement mortar.

4.4 Conventional Prism

For a size of 28 x 16 x 24 cm three normal bricks were placed in position and casted with cement mortar.

4.5 Eco-Brick Prism

For the same sized prism 6 Eco-bricks were placed in the prism mould with 2 Eco-Bricks in each layer.

4.6 Water-Cement Ratio

The cement mortar for the cubes were made of 1:3 (Ordinary Portland Cement: sand) by weight with a water cement ratio of 0.6.

4.7 Casting of Specimens

4.7.1 Composite Eco-Brick

It is prepared with a single Eco-Brick of size 500 ml bottle with cement mortar. The size of the Composite Eco-Brick is 23 x 10 x 7 cm (Length x Breadth x Height). The weight before curing is 0.037 kN.

Fig.6 Composite Eco-Brick

4.7.2 Conventional Prism

For a prism size of 28 x 16 x 24 cm, three normal bricks were placed in position and casted The weight of the conventional prism before curing is 0.265 kN.

4.7.3 Eco-Brick Prism

6 Eco-bricks were placed in the prism mould with 2 Eco-Bricks in each layer for the same sized prism. The weight of the Eco-Brick Prism before curing is 0.256 kN.

Fig.7 Eco-Brick Prism

5. RESULTS AND DISCUSSION

Compressive Strength Test is carried out for all the specimens and the result is discussed.

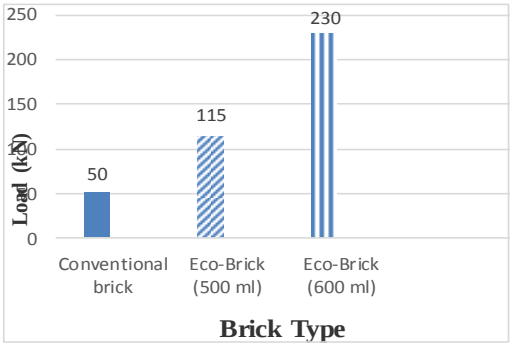
5.1 Test for Eco-Brick

The Eco-Bricks were tested under Compression Testing Machine and the load carried by each is tabulated in table 4.

Table 4 Load Undertaken by an Eco-Brick

S.No.	Brick Type	Weight (kg)	Load (kN)
1	Conventional brick	3.576	50
2	Eco-Brick (500 ml)	1.586	115
3	Eco-Brick (600 ml)	1.897	230

Chart-1 Load Carried Out by an Eco-Brick



The above graph shows an increase in load carried out by an Eco-Bricks. As the Eco-Brick size increases the load carried out by it also increases. 90% increase in load carrying capacity of Eco-Bricks was observed compared to conventional bricks.

5.2 Test for Composite Eco-Brick

The Composite Eco-Brick is made with single Eco-Brick covered with cement mortar. After 28 days of curing the compressive strength is carried out.

Table 5 Compressive Strength Test of an Composite Eco-Brick

Size (cm)	Load (kN)	Compressive Strength (N/mm²)
Conventional Brick (19x 9x 9)	50	5.85
24 x 10.2 x 7.5 (500 ml Bottle)	80	6.54
28 x 12.5 x 8.5 (600 ml Bottle)	120	6.85

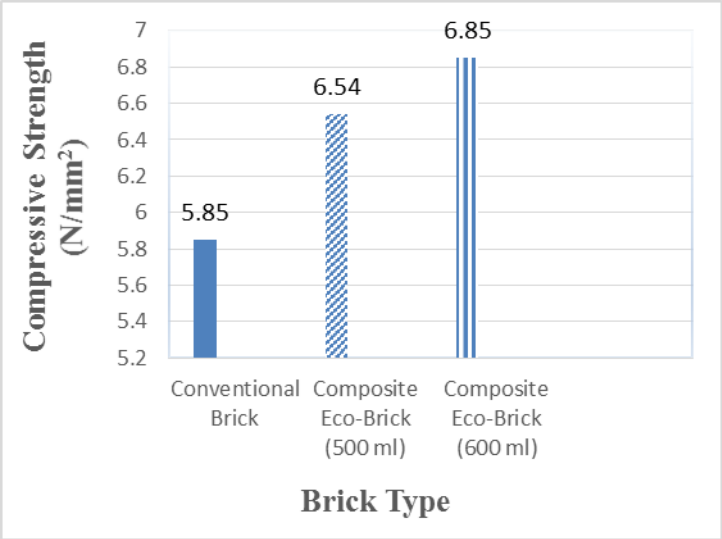


Chart-2 Compressive Strength of Conventional Brick and Composite Eco-Brick

The graph shows that the Composite Eco-Brick shows an increase in compressive strength than the conventional brick. The strength of the Eco-Brick is more. Composite Eco-Brick shows 17% increase in strength than the conventional one.

5.3 Test for Prism

The Eco-Brick prism is made with the size of about 28 x 16 x 24 cm with 6 numbers of Eco-Bricks inside and the conventional one is made with 3 normal bricks. Load is applied on the prism under the compression testing machine until it bears the maximum load.

Table 6 Compressive Strength Test of an Prism

Prism	Load (kN)	Compressive Strength (N/mm²)
Conventional Prism (28 x 16 x 24)	70	3.13
Eco-Brick prism (28 x 16 x 24)	75	3.35

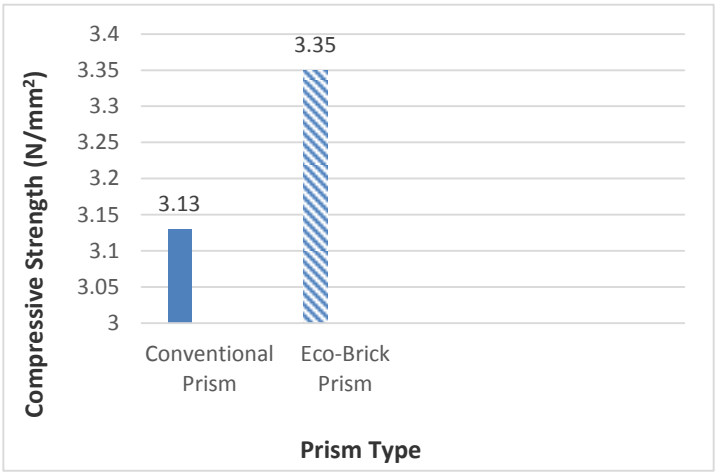


Chart-3 Compressive Strength of Conventional and Eco-Brick Prism

Eco-Brick prism has 7% increase in strength when compared with the conventional prism. It shows that the Eco-Brick prism is more stronger than the Conventional prism and hence the Eco-Brick gives high strength.

6. CONCLUSION

- The technique of using waste PET bottles as bricks has become popular in low income communities around the world.
- 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 CO2emission in manufacturing the clay Brick.
- PET Bottles also have a durability of more than 300 years which is more as compared to the standard bricks and these bricks are very thick.
- It is Eco-friendly as we make use of the waste materials in the project and which does not cause any harmful to the environment.

- 90% increase in load carrying capacity of Eco-Bricks was observed compared to conventional bricks whereas Composite Eco-Bricks and Eco-Brick Prism shows only 12 % increase in strength than the conventional one.
- Therefore, it can be used in low rise building, temporary structures and for compound walls and cannot be used for high rise buildings.
- From the test results it can be concluded that the strength of Eco-Brick is more when compared to the conventional one.
- Thus we can conclude that using the concept of Eco-Bricks is cost effective, energy efficient and commercially feasible.

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