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# Reusing Plastic Bottle as Building Material Along with Addition of Coir in Cement Mortar

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**A B S T R A C T**

This study exhibits the details of using waste plastic bottles as building material i.e., replacing Conventional Brick with Eco-Brick along with behavior of cement mortar while adding Coir. The project is prepared with reference to standard codes (IS 2250-1981, IS 516-1959). It has been observed that each year a massive number of plastic bottles are thrown away and wasted every day. People discard plastic bottles without taking into consideration of their potential effects on the human's health and environment. Since plastic bottles cannot easily dissolve due to their chemical qualities, they are frequently found in waste and landfills and can last for up to 450 years before they decompose. Only a very small portion of plastic is recycled. Every year, India recycles between 15 and 25 percent of polyethylene terephthalate (PET) plastic. To minimize hazards to the environment along with reducing the cost of construction the Eco-Brick is introduced, which is well depicted in this project report. This report can be taken as a basic reference for the construction of Eco-Brick wall. The past research illustrates that the strength, stiffness & durability of Eco-Brick wall is higher and better than Conventional wall (Brick Masonry wall). The project elucidates the reduction of cost for wall construction as well as decrease in plastic waste in the environment. It is anticipated that the procedure in this report will have wide application and usage for the wall construction of temporary buildings, compound walls, shed houses.

Keywords: Plastic bottles, Eco brick, Conventional brick, Fly ash, Coir, Pre-treatment of coir, Compressive strength.

## 1. INTRODUCTION

Yearly large amount of plastic is generated and used for different purposes, but the recycling rate of that plastic is very low. This condition causing environmental damage that ruins the quality of soil, air and water which is harmful to the human beings and other living organisms on the earth. The only way to reduce the hazards of plastic is reduction in production and reuse (for purposes other than food processing). On the other side the cost of the construction of building is becoming costlier day by day, this can be a big problem for the people who can't afford the final cost of construction. So, the development and incorporation of low-cost technology in a very low-cost is very important in construction. By using plastic as building material can make big changes in the construction sector by reducing the cost efficiently and also reducing impact on the earth eco system. When a clay brick is made, right from mixing the clay to baking it in the kiln and the firewood used for that are time consuming and energy consuming. The process of producing the brick discharge large amount of Co2. To reduce the pollution caused by the clay brick manufacturing process and plastic residue, Eco-brick is introduced as the replacement of conventional clay brick. To increase the strength of the wall a reinforcing fibrous material is used in the cement mortar mix i.e. coir. To reduce the water absorption capability of coir, it is pretreated and used in mix proportions. Both the plastic bottle and coir assist a good quality wall which is durable and economical. The Eco-brick is more energy efficient. Additionally, the method decreases the carbon emissions produced when a regular brick is baked. Reusing the waste plastic in construction on high amount which minimizes the plastic waste in the environment and reduces the pollution.

## 2. LITERATURE REVIEW

Dr. Mukund P. Choughale, Tejal M. Jain: 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. Compressive strength of PET bottle filled with 50% fine and 50% coarse soil is larger than brick compressive strength.

Yashashvi Arya, Priyanka kumawat, Mr. Navneet Anand: Concluded that this work can achieve its main aim of reducing plastic waste. Plastic bottles can be used as a part of green construction by saving energy and resources, recycling materials, minimizing the emission, having significant stipulated savings and increasing workplace production. there would be fewer thermal conduction in plastic masonry construction compared to conventional masonry hence it would reduce the heat inside the building and less external resources would be needed for cooling purposes.

N. Mohana priya, M.Nirmala, Dr.G.Dhanalakshmi: Concluded that 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. using the concept of Eco-Bricks is cost effective, energy efficient and commercially feasible.

Atul Chaurasia, Mr. SumitGangwar: Concluded that Generally the bottle houses are bio-climatic in design, which means that when it is cold outside is warm inside and vice versa. 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.

AdnyaManjarekar: 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 used to hold the “eco bricks” in place, as in regular masonry. The bottle construction techniques and their benefits must be spread and educate to local community. They are the group of people who are most benefitted by low-cost construction. Plastic bottles are considered as a kind of indecomposable junk which can 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 can be used in some parts of building construction such as walls, roof and etc.

Aditya Singh Rawat, R. Kansal: Conclude that Cost of construction in case of brick bottle is more economical than standard bricks. Weight of a unit bottle brick was found to be less than that of a standard brick. Compressive strength of the bottle brick is also nearly equal than that of a standard brick. using the concept of brick bottles is cost effective, energy efficient and commercially feasible. Using PET bottles is also Bio-climatic and thus we can say it is a green construction.

NavaratnarajahSathiparan, ArulananthamAnburuvel, Madhuranya Muralitharan, Don AmilaIsuraKothalawala: Concluded that the study results showed that inclusion of 4% coco pith in the mortar increased air-dried compressive strength by 8% compared to that of the control mortar. However, further increase in coco pith content decreased compressive strength. For 6% and 8% coco pith content, the decrease in compressive strength was 3% and 25%, respectively. A similar trend was observed for the flexural strength of mortar blocks. However, even for mortar with 8% coco pith content, the flexural tensile strength was higher than that of the control mortar. Higher coco pith content in mortar tended to increase water absorption and sorption by capillary action. Still, for cement mortar with 4% coco pith content, both water absorption rate and sorpitivity were within the allowable limit. So, it is recommended to use coco pith up to 4%, which provides better mechanical characteristics and sustainable production without compromising important durability properties.

## 3. MATERIALS

The materials used in this study are plastic bottles, Cement, Sand, Fly ash, Water, Nylon thread, Coir.

### *3.1 Plastic Bottle:*

PET (polyethylene terephthalate) bottles are a type of plastic bottle that are frequently used to package food and liquids like juices, sodas, and water. PET bottles are a popular option for packaging because they are lightweight, break-resistant, and have good gas barrier qualities. PET is a kind of thermoplastic polymer that is simple to mould and shape into a variety of shapes.

They can be recycled by melting down and reused to create new PET bottles or other plastic products. By reusing the leftover plastic bottles as eco bricks can also help further reduction in plastic waste. Based on the capacity of bottle we have several types of bottles given in table 1.

**Table 1 – Various types of bottles available in market.**

| Type / Capacity of bottle | Rate per 1 bottle (Rs) | Diameter of bottle (D in cm) | Height of Bottle (H in cm) |
|---|---|---|---|
| 250 ml Bottle | 1 | 5 | 17 |
| 500 ml Bottle | 2 | 6.9 | 18.5 |
| 1 L Bottle | 4 | 8..34 | 21.59 |
| 2 L Bottle | 5 | 10 to 12 | 30 to 33 |

### *3.2 Cement:*

Cement is a vital construction material that is used to bind different building components together. It is a powder substance that is made from a mixture of limestone, clay, and other materials like sand, iron ore, and shale. Cement has become an essential building material in the modern construction industry. It is a strong and durable material that can withstand harsh environmental conditions and is available in various types to suit different construction needs. Mortar is another material made from cement, which is used to bind bricks or blocks together in masonry construction. It is also used as a finishing material to fill gaps and smooth surfaces in construction.

Cement is graded based on its strength and composition. The commonly used grades of cement are Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Rapid Hardening Cement (RHC), Low Heat Cement (LHC), Sulphate Resistant Cement (SRC).

These are some of the commonly used grades of cement. The selection of cement depends on the specific requirements of the construction project and the environmental conditions in which it is being built.

### *3.3 Sand:*

Fine aggregate is an essential component in cement mortar. The quality and properties of the sand used in cement mortar can significantly affect the strength and durability of the finished product. The sand used in cement mortar should be clean, free of debris, and have a consistent size and shape. Sand with irregular shapes and sizes can cause voids in the mortar, reducing its strength and durability. The ideal sand for cement mortar should have a rounded shape and a particle size between 0.15 and 4.75 mm. Generally, a ratio of 1:3 or 1:4 is used for the mix of cement and sand by volume. Sand is typically graded based on the size of its particles. The most commonly used grading system for sand is the Unified Soil Classification System (USCS), which categorizes sand based on its grain size, shape, and sorting.

The USCS categorizes sand into four grades:

- Very fine sand: Sand particles that are smaller than 0.075 mm in diameter are classified as very fine sand.
- Fine sand: Sand particles that range in size from 0.075 mm to 0.425 mm in diameter are classified as fine sand.
- Medium sand: Sand particles that range in size from 0.425 mm to 2 mm in diameter are classified as medium sand.
- Coarse sand: Sand particles that range in size from 2 mm to 4.75 mm in diameter are classified as coarse sand.

### *3.4 Fly ash:*

Fly ash is a byproduct of the combustion of pulverized coal in thermal power plants. It is a fine, powdery substance that is carried away in the flue gas from the boiler and collected by electrostatic precipitators or bag filters. Fly ash is made up of mineral matter that is transformed into glassy spheres during combustion, as well as unburned carbon, trace elements, and heavy metals. While fly ash has many beneficial uses, it can also pose environmental and health risks if not handled and disposed of properly. Fly ash can contain heavy metals such as arsenic, lead, and mercury, which can leach into groundwater if not properly contained. Therefore, it is important to follow proper disposal procedures, such as storing fly ash in secure landfills or using it in encapsulated applications where it will not come into contact with water. Proper handling and disposal of fly ash can help to minimize its environmental impact and ensure that it can be safely used in a range of applications.

Fly ash is generally classified into two broad categories based on its chemical composition:

1.Class F 2.Class C.

In this study we use fly ash as filler material which having low grade and wastage to environment.

### *3.5 Water:*

Water is an essential component in the production of cement mortar, a mixture of cement, sand, and water used in construction. The amount of water used in the mortar is crucial to its strength, workability, and durability. It is important to use clean water when mixing cement mortar, as impurities in the water can affect the strength and durability of the final product.

### *3.6 Nylon Thread:*

Nylon thread is a strong and durable material that has been used in a wide range of applications, from clothing and accessories to industrial machinery and equipment. Recently, there has been growing interest in using nylon thread as a building material, particularly in projects aimed at reusing plastic bottles. One of the main advantages of using nylon thread in this way is that it provides a flexible and lightweight binding that can withstand significant pressure and weight. Nylon thread is resistant to wear and tear, so it can hold the building blocks together for long periods of time without breaking or degrading.

### *3.7 Coir:*

Coir is a natural fiber extracted from the husk of coconut fruits. It is a versatile material that has been traditionally used in various applications, such as making ropes, mats, and baskets. In recent years, coir has gained popularity as an eco-friendly substitute for synthetic fibers in building materials, including cement mortar. Cement mortar is a mixture of cement, sand, and water that is commonly used as a binding material for masonry and other construction applications. The use of coir in cement mortar has several benefits, including improved strength, workability, and thermal insulation. This makes it a promising eco-friendly alternative to synthetic fibers in building materials, and a sustainable solution for the construction industry.

## 4. QUANTITY ESTIMATION

Quantity estimation for 10 m3 of work

### 4.1 Brick masonry:

No. of Bricks required for 10 m3 of work = 10/((0.2 x 0.1 x 0.1))

= 5000 No.s

Cement mortar:

Cement mortar quantity =10– (5000 x 0.19 x 0.09 x 0.09)

= 2.305 m3

Adding 30% of wastage to the cement mortar quantity Cement mortar = 2.305 x 1.3=2.996 m3

Consider ratio for Cement mortar is 1:3.

Cement = (2.996 / (1+3)) x 1 = 0.749 x 1440 = 1078.56 kg /50 =21.57 = 22 bags

Sand = 0.749 x 3 = 2.247 m3 x 1600 = 3595.2 =3600 kg /1000 = 3.6 Tonne

**Table 2 - Cost estimation of Brick masonry wall for 10 m3.**

| S.No. | MATERIAL | QUANTITY | RATE | PER | AMOUNT |
|---|---|---|---|---|---|
| 1 | BRICK | 5000 | 8 | 1 no. | 40000 |
| 2 | CEMENT | 22 | 400 | 1 Bag | 8800 |
| 3 | SAND | 3.6 | 720 | 1Tonne | 2592 |
| | | TOTAL = | | | 51,395 |

### 4.2 Bottle masonry:

#### 4.2.1 By using 250 ml bottle {D = 5cm, H= 17cm}

No. of Bottles required for 10 m3 of work = 10/(((3.14/4)x 0.062 x 0.18))

= 19648.758 = 19650 no's

Cement mortar:

Cement mortar quantity = 10 – (19650 x (3.14 /4) x 0.052 x 0.17)

= 3.441 m3

Adding 30% of wastage to the cement mortar quantity Cement mortar = 3.441 x 1.3=4.47 m3

Consider ratio for Cement mortar is 1:3.

Cement = (4.47 / (1+3)) x 1 = 1.118 x1440 = 1609.92 kg

Consider Coir quantity is 0.5% to the cement quantity. Coir = (0.5/100) x 1609.92 = 8.0496 kg ~8.05 kg

Coir replaces cement space in cement mortar.

So, Cement = 1609.92-8.05= 1601.87 =1602 kg /50 =32.04 = 32 Bags

Sand = 1.118 x 3 = 3.352 m3 x 1600 = 5364 kg = 5364 kg /1000= 5.364 Tonne

Filler material fly ash

One 250ml bottle is filled by approximately 400g of fly ash. Fly ash = 0.4 x19650 = 7860kg /1000= 7.86 tons.

**Table 3 - Cost estimation of Bottle masonry wall for 10 m3 by 250ml Bottles.**

| S.No. | MATERIAL | QUANTITY | RATE | PER | AMOUNT |
|---|---|---|---|---|---|
| 1 | BOTTLE (250ml) | 19650 | 1 | 1 no. | 19650 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | CEMENT | 32 | 400 | 1 Bag | 12800 |
| 3 | SAND | 5.364 | 720 | 1 Tonne | 3862 |
| 4 | FLYASH | 7.86 | 100 | 1 Tonne | 786 |
| 5 | COIR | 8.05 | 25 | 1 Kg | 201.25 |
| | | TOTAL = | | | 37300 |

**4.2.2 By using 500 ml bottle {D = 7cm, H= 18.5cm}**

No. of Bottles required for 10 m3 of work = 10/(((3.14/4) x 0.082 x 0.195))

= 10202.24 ~10203 no.s

Cement mortar:

Cement mortar quantity = 10 – (10203 X (3.14 /4) X 0.072 X 0.185)

= 0.768 m3

Adding 30% of wastage to the cement mortar quantity Cement mortar = 0.768 x 1.3=0.9991 m3

Consider ratio for Cement mortar is 1:3.

Cement = (0.9991 / (1+3)) x 1 = 0.249 x1440 = 358.56kg

Consider Coir quantity is 0.5% to the cement quantity. Coir = (0.5/100) x 358.56= 1.792kg =1.8 kg

For replacing coir with cement in cement mortar.

So, Cement = 358.56-1.8= 356.76 =357 kg /50 =7.14 ~ 8 Bags

Sand = 0.249x 3 = 0.749 m3 x 1600 = 1198.92 kg = 1200kg /1000=1.2 Tonnes

Filler material fly ash:

One 250ml bottle is filled by approximately 400g of fly ash. Fly ash = 0.4 x 10203 = 4081.2 /1000= 4.08 Tonnes.

**Table 4 - Cost estimation of Bottle masonry wall for 10 m3 by 500 ml Bottles.**

| S.No. | MATERIAL | QUANTITY | RATE | PER | AMOUNT |
|---|---|---|---|---|---|
| 1 | BOTTLE (500ML) | 10203 | 2 | 1 no. | 20406 |
| 2 | CEMENT | 8 | 400 | 1 Bag | 3200 |
| 3 | SAND | 1.2 | 720 | 1 Ton | 864 |
| 4 | FLYASH | 4.08 | 100 | 1 Ton | 408 |
| 5 | COIR | 1.8 | 25 | 1 Kg | 45 |
| | | TOTAL = | | | 24923 |

## 5. METHODOLOGIES

### 5..1 PREPARATION OF ECO-BRICK:

**5.1.1 Collect:**

- Collect the waste plastic bottles from plastic waste collection center or dump yard. Remove labels and food residue inside the bottles and clean the bottles. Dry the bottles in the sunlight, let the bottles fully dry and make the bottles ready to use.
- Collect Fly ash from the nearby cement manufacturing unit or fly ash bricks manufacturing unit. Make sure the fly ash is free from impurities and in dry condition.

***5.1.2 Filling:***

- Take some amount of fly ash in a tray and tamping rod for compaction.
- Fill the bottle 1/3 portion of bottle with fly ash with the help of trowel or by hand with gloves.

***5.1.3 Packaging:***

- Compact with the tampering rod.
- For each layer give 25 blows for good compaction of fly ash.

- After Filling the entire bottle with filler material. Now seal the bottle.

***5.1.4 Seal:***

- Finally, seal the bottle tightly.
- To seal the bottle use cap. You can also use duct tape to secure the cap.
- The weight of the bottle may vary depending on the size of the bottle.
- Collect all filled bottles and keep aside for the further process.
- Now the Eco-brick is read to use.
- Remember, the key to making a good eco brick is to pack the waste materials tightly and make sure the bottle is sealed properly. If the Eco-brick is not sealed properly while using the Eco-brick it may allow moisture into it and may cause leakage of filler material. This may cause failure of the Eco-brick as well as structure.

Fig.5.1 Preparation of Eco brick

***5.2 COIR PRETREATMENT PROCESS:***

To use coir as a reinforcement in cement mortar, it needs to undergo a pretreatment process to improve its binding properties. Collect the coconut shell and remove exocarp, then collect the mesocarp/husk for the pretreatment process. Clean the coir fiber to remove any impurities, such as dust, dirt, and debris. You can do this by soaking the coir in water for a few hours and then washing it thoroughly with clean water. All fiber is soaked in the water for 24 hours, after then take out the fiber and dry it. Then start separating the fiber from the husk. Soak the cleaned coir in water for about a week or until the fibers start to separate from the husk. Stir the mixture regularly to speed up the process. Once the fibers are separated from the husk, wash them again thoroughly with clean water to remove any residual chemicals and dirt. Dry the fibers in the sun or using a dryer until they are completely dry. Beat the dried coir fibers with a wooden mallet to soften them and make them more pliable. This will improve the bonding properties of the fiber with cement mortar. Then dry coir is made into 5cm length with help of scissor. To make the coir less water absorbent, the fibers are soaked in oil for 4 hours. Remove from the oil and dry it in sunlight for 1 hour before using in cement mortar mix. Now your coir fiber is ready for use in cement mortar preparation. Mix the pretreated coir fibers with cement and sand in the desired proportion and prepare the mortar mix. The pretreatment process helps to produce good reinforcing material for the cement mortar.


Fig. 5.2 Pre-treatment process of Coir

***5.3 MIXING OF COIR AND CEMENT MORTAR:***

Following steps are followed to prepare the mix:

- Ensure that the coir fibers are clean and free from impurities.
- Take the required quantities of cement, fine aggregate, water, coir and collect them using a tray.

Fig. 5.3 Collecting Cement in tray.

Fig. 5.4 Measuring Jars

Fig. 5.5 Trays

Fig. 5.6 Mixing tools

- For mixing the mortar take the required tools and a clean platform.
- Mix the coir fibers with the dry ingredients of cement mortar, including cement, sand, in the desired proportions.
- Add water gradually to the mixture. The amount of water added depends on the desired consistency of the mortar.
- Continue mixing until the mortar is smooth and uniform texture.
- Mix the mortar up to the coir fibers are evenly distributed throughout the mixture.
- Place the mortar mixture on the desired surface where it is required, using a trowel.

The addition of coir fibers to cement mortar provides better tensile strength, impact resistance, and crack resistance to the mortar. Coir fibers also enhance the workability of the mortar, making it easy to apply and spread on the surface.

Fig. 5.7 Mixing of Cement mortar with coir

## 6. CONSTRUCTION PROCEDURE

CONSTRUCTION PROCEDURE INVOLVES:

### *6.1 Collection of materials:*

Model construction involves creating a wall using Eco bricks, which are plastic bottles stuffed with fly ash. Here are some materials needed to collect for Eco brick masonry model construction:

- Eco bricks
- Mortar
- Coir
- Gravel (Optional)
- Tools
- Waterproofing material
- Paint or plaster

Fig. 6.1 Coir

Fig. 6.2 Eco Brick

***6.2 Preparation of eco bricks:***

An eco-brick is a building block made entirely from unrecycled plastic. It is created by filling a plastic bottle with Fly ash. The plastic bottles are collected and cleaned. Bottles are kept in sunlight for drying. The Fly ash which is collect from the cement manufacturing unit. Make sure the fly ash is free from impurities, Fill the fly ash in the plastic bottle and compact by using tamping rod. A well compacted bottle produces a good Eco brick. All the filled bottles are collected and kept for further use in construction.

***6.3 PREPARATION OF COIR FIBERS:***

Coir is a natural fiber obtained from the husk of coconut fruit. So, coir should have good treatment to form as good fiber. Coir is a sustainable and eco-friendly material that is biodegradable and recyclable. By using coir, you are not only contributing to the environment but also supporting the livelihoods of coconut farmers and workers in the coir industry. Coir needed pretratment before using in mixing as already discussed in methodologies.

***6.4 CONSTRUCTION THE WALL:***

Constructing a wall using eco-bricks with the addition of coir mixed in cement mortar is a sustainable and eco-friendly way to build walls that are strong, durable, and environmentally friendly. Here are the steps to construct a wall using eco-bricks and coir mixed in cement mortar:

- Prepare the eco-bricks
- Prepare the coir-cement mortar
- Lay the foundation
- Lay the first row of eco-bricks
- Apply the coir-cement mortar
- Lay the second row of eco-bricks
- Repeat the process
- Finish the wall

By using Eco-bricks and coir-cement mortar, you are creating a wall that is strong, durable, and environmentally friendly. The use of Eco-bricks reduces plastic waste and helps to prevent pollution, while the addition of coir fibers to the cement mortar adds strength and durability to the wall.

***6.5 PLASTERING OF WALL:***

After constructing a wall using eco-bricks with the addition of coir mixed in cement mortar, you may choose to finish it with plastering. Plastering not only provides a smooth finish to the wall, but it also helps to protect the wall from weathering and damage.

## 7. TESTS

The following are the tests required to conduct in this project.

1. Water absorption test
2. Compressive strength test.

### *7.1 PREPARATION OF TEST CUBES AND SPECIMENS:*

The following are the required types of test cubes.

- **Test cubes:**
  - Brick masonry – 2 Samples of 20X20X20cm Cubes.
  - Bottle masonry – 6 Samples of 20X20X20cm Cubes.
- **Test Specimen:**
  - Cement mortar cubes (Without coir) - 2 Samples of 7 cm X 7 cm X 7 cm.
  - Cement mortar cubes (with coir of 0.5% of cement) – 2 Samples of 7 cm X 7 cm X 7cm.

### *7.2 PROCEDURE FOR PREPARING TEST CUBES AND SPECIMENS:*

- **Brick Masonry:**
  - Prepare a cement mortar mix with mix proportion of 1:3 ratio without mixing coir and prepare another cement mortar mix with coir.
  - Prepare 4 specimen for testing. 2 specimen of brick masonry without coir and 2 specimen of brick masonry with coir.

Fig. 7.1 Brick Masonry without coir

Fig. 7.2 Brick Masonry with coir

Fig. 7.3 Test specimen casting

- **Bottle Masonry:**
  - Prepare 6 moulds of size 20cm X 20cm X 20cm.
  - Preparation of eco-brick masonry test cubes are shown below, in which bottles are replaced with bricks.
- Cement mortar cubes (without coir):
  - Take moulds for preparing blocks of size 7cm x 7cm x7cm.
  - Mix cement mortar of 1:3 ratio and place in the mold for 2 samples.
- Cement mortar cubes (with coir):
  - Adding coir of 0.5% of cement in the cement mortar.
  - Prepare samples as similar as above cement mortar blocks.

### *7.3 CURING:*

- Place all the test cubes in the curing tank.
- The water should be free from impurities.
- Based on the standard code the curing period for test specimen is 28 days.

***7.4 TESTING:***

- Machinery and equipment required for testing:
  1. Compressive testing machine (CTM).
  2. Weighing balance.
- Procedure for testing:

1. Water Absorption test:

- After completion of curing period take the test cubes out of tank. Then place each cube on the weighing balance and note down the weights of cubes (wet weight)

Fig. 7.4 7cm x 7cm x 7 cm test specimen

- Let the cubes dry for 24 hours, leave the test cubes in atmosphere.
- Take the weights of dry specimens and record them in observation note.
- We have wet and dry weight of all test cubes.
- The difference between dry weight and wet weight is known as water absorption weight multiplying with water density, we get the water content absorbed by test cube during curing period is identified.

2. Compressive strength test:

- The test specimen placed under the compressive strength testing machine.
- Load is applied and increased gradually.
- After the test specimen is failed at some load and cracks are formed, that load is considered and noted in observation book.
- Each specimen is placed under machine and note down the load values in the observation book.
- Evaluating the values of cube strength.

Fig. 7.5 weighing of test specimens

- While placing brick masonry test specimen in compressive strength test machine compulsory place wooden sheet above and below the test cube for uniform load distribution over the surface.

Fig. 7.6 Testing of specimen

**Table 5 – Observation values of Water absorption:**

| Type of Sample | Weight of Wet Specimen (w-1) | Weight of dry Specimen (w-2) | Water absorption (W in%) |
|---|---|---|---|
| Brick Masonry (Without coir) | 15.07 | 14.530 | 3.7 |
| Brick Masonry (With coir ) | 15.45 | 15.03 | 2.8 |
| **BOTTLE MASONRY (WITHOUT COIR)** | | | |
| Bottle Masonry (Corners type) | 15.500 | 15.390 | 0.714 |
| Bottle Masonry (in wall as parallel) | 15.860 | 15.75 | 0.698 |
| Bottle Masonry (alternatively) | 16.840 | 16.74 | 0.597 |
| **BOTTLE MASONRY (WITH COIR)** | | | |
| Bottle Masonry (Corners type) | 16.110 | 15.937 | 1.085 |
| Bottle Masonry (in wall as parallel) | 15.750 | 15.650 | 0.64 |
| Bottle Masonry (alternatively) | 17.060 | 16.910 | 0.887 |
| **CEMENT MORTAR SPECIMENS** | | | |
| Cement mortar block without coir (s-1) | 0.77 | 0.767 | 0.4 |
| Cement mortar without coir (s-2) | 0.77 | 0.761 | 1.182 |
| Cement mortar with coir (s-1) | 0.76 | 0.756 | 0.53 |
| Cement mortar with coir (s-2) | 0.76 | 0.756 | 0.53 |

**Table 4 - Cost estimation of Bottle masonry wall for 10 m3 by 500 ml Bottles.**

| SAMPLE TYPE | L (cm) | B (cm) | H (cm) | AREA $Cm^2$ | VOLUME $Cm^3$ | WEIGHT (Kg) | DENSITY ($Kg/m^3$) | FAILURE LOAD (KN) | COMPRESSIVE STRENGTH ($N/mm^2$) |
|---|---|---|---|---|---|---|---|---|---|
| **BRICK MASONRY** | | | | | | | | | |
| Brick Masonry (Without coir) | 20 | 20 | 20 | 400 | 8000 | 14.530 | 1816.25 | 120 | 3 |
| Brick Masonry (With coir) | 20 | 20 | 20 | 400 | 8000 | 15.03 | 1878.75 | 142.5 | 3.562 |
| **BOTTLE MASONRY (WITHOUT COIR)** | | | | | | | | | |
| Bottle Masonry (Corners type) | 20 | 20 | 20 | 400 | 8000 | 15.390 | 1923.75 | 116.7 | 2.917 |
| Bottle Masonry (in wall as parallel) | 20 | 20 | 20 | 400 | 8000 | 15.75 | 1968.75 | 171.35 | 4.283 |
| Bottle Masonry (alternatively) | 20 | 20 | 20 | 400 | 8000 | 16.74 | 2092.5 | 175.30 | 4.3825 |
| **BOTTLE MASONRY (WITH COIR)** | | | | | | | | | |
| Bottle Masonry (Corners type) | 20 | 20 | 20 | 400 | 8000 | 15.937 | 1992.125 | 275.55 | 6.888 |
| Bottle Masonry (in wall as parallel) | 20 | 20 | 20 | 400 | 8000 | 15.650 | 1956.25 | 233.45 | 5.836 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bottle Masonry (alternatively) | 20 | 20 | 20 | 400 | 8000 | 16.910 | 2113.75 | 206.62 | 5.165 |
| **CEMENT MORTAR SPECIMENS** | | | | | | | | | |
| Cement mortar block without coir (s-1) | 7 | 7 | 7 | 49 | 343 | 0.767 | 2236.15 | 49 | 10 |
| Cement mortar Without coir (s-2) | 7 | 7 | 7 | 49 | 343 | 0.761 | 2218.65 | 54 | 11.02 |
| Cement mortar with coir (s-1) | 7 | 7 | 7 | 49 | 343 | 0.756 | 2204.081 | 75.70 | 15.45 |
| Cement mortar with coir (s-2) | 7 | 7 | 7 | 49 | 343 | 0.756 | 2204.081 | 75.36 | 15.38 |

## 8. RESULTS AND DISCUSSION

- The compressive strength for Brick masonry without coir is 3 N/mm2, with coir is 3.56 N/mm2, and for Bottle brick masonry without coir is 3.86 N/mm2, with coir is 5.96 N/mm2.
- The average density of Brick masonry without coir is 1816.85 Kg/m3, with coir is 1878.75 Kg/m3, and for Bottle masonry without coir is 1995 Kg/m3, with coir is 2020.7 Kg/m3.
- The water absorption of Brick masonry without coir is 3.7%, with coir is 2.8%, and for Bottle brick masonry without coir is 0.67%, with coir is 0.87%.
- The percentage of water absorption is greater for brick masonry.
- The results shown that compressive strength of the Eco brick masonry (with coir) is greater than the brick masonry. It is almost twice the strength of brick masonry.
- There is an increase in the compressive strength of eco brick masonry with coir than without coir, as well as the bottle brick masonry with coir exhibits the good strength than without coir.
- The density of bottle brick masonry is greater than Brick masonry.

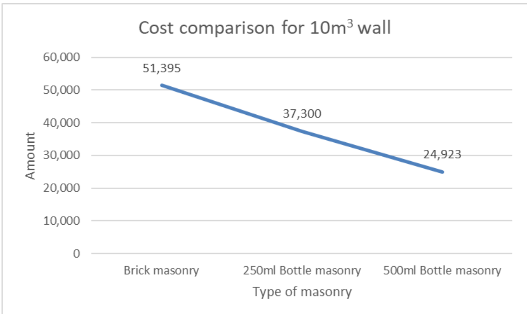


Fig. 8.8 Cost comparison

## 9. CONCLUSION

The Plastic waste is causing major threat to the environment to overcome this issue eco brick is introduced, eco brick can reduce the plastic waste in the environment along with reducing the cost of construction of wall. The Filling material used to fill the empty plastic bottle can determine the weight of the eco brick/structural wall, based on the study we found that fly ash has less weight after filling when compared to any other filling material. Addition of coir in the cement mortar mix can enhance strength and makes it more durable. From the literature survey we found that eco brick facilitates thermal comfort inside the building, and it is earthquake resistant. Cost comparison between eco brick masonry and conventional brick masonry are total cost of 10m3 brick masonry wall is Rs. 51,395 and total cost of 10m3 eco brick masonry wall is Rs. 24,923. It shows that the cost of construction of wall is drastically reduced by using eco brick. The eco-brick is durable and can survive for longer than the structural life. Based on the strength, durability and cost it is quite clear that a best alternative material which can replace the Conventional Brick is found.

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