Potential Usage of Solid Waste Composites in the Manufacturing of Eco friendly Cement Bricks

Mr. Mohammed Yaseen[1], Mr. Puttaraj M H[2], Mr. Pruthviraj S R[3], Mr. Srinivas V R[4] Ravitej M Bandlekar [5],Sharathraj R M[6]

1. Assistant Professor, Department of Civil Engineering, GMIT, Davangere
2. Assistant Professor, Department of Civil Engineering, GMIT ,Davangere
3. Undergraduate student, Department of Civil Engineering, GMIT, Davangere
4. Undergraduate student, Department of Civil Engineering, GMIT, Davangere
5. Undergraduate student, Department of Civil Engineering, GMIT, Davangere
6. Undergraduate student, Department of Civil Engineering, GMIT, Davangere

Abstract- *The disposal of solid waste is a major problem faced by many countries of the globe and this problem continues to grow with the growth of population and development of industries. Disposal of waste in landfills, incineration and open dumping are the routine methods in majority of places which causes environmental impacts.In the present study an attempt is made to use the inert solid waste fractions i.e inorganic solid waste fractions like waste plastic, waste glass, bed ash is used in the preparation of moulded bricks, road kerbs, Manhole inspection chambers covers. In this study the cement, waste glass, waste plastic bed ash is used in various proportions of combined aggregate for the casting of Eco friendly Cement bricks. The brick with 1:6 proportions of the Binder to combined aggregate will result in the compressive strength of 5.45MPa and water absorption of 17.21% which satisfy the IS codal provisions for the bricks. Hence the attempt of using solid waste in the preparation of Eco friendly bricks is a sustainable method of brick manufacturing and can be adopted for practical purposes which will reduce the environmental impacts caused due to the disposal of inorganic solid waste fractions.*

Keywords- Eco friendly brick, plastic waste recycling

I. INTRODUCTION

Solid waste is generated worldwide in large quantities. Rapid industrialization and population growth has led to exponential growth of solid waste generation. Solid waste disposal is a major challenge for most of the countries and especially the developing nations.

Presently in India, about 960 million tons of solid waste is being generated annually as by-products during industrial, mining, municipal, agricultural and other processes. Of this 350 million tons are organic wastes from agricultural sources; 290 million tons are inorganic waste of industrial and mining sectors and 4.5 million tons are hazardous in nature. Advances in solid waste management resulted in alternative construction materials as a substitute to traditional materials like bricks, blocks, tiles, aggregates, ceramics, cement, lime, soil, timber and paint.

Solid waste is the unwanted or useless solid materials generated from human activities in residential, industrial or commercial areas. It may be categorized in these ways.

- Biodegradable waste
- Recyclable waste
- Inert waste
- Electrical and electronic waste
- Hazardous waste
- Biomedical waste

A. PLASTIC

Not all plastics are recyclable. There are 4 types of plastic which are commonly recycled

- Polyethylene (PE) - both high density and low-density polyethylene
- Polyvinyl chloride (PVC)
- Polystyrene (PS)
- Polypropylene (PP)

B. BRICKS

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials.

Types: Common Burnt Clay Brick, Sand lime Bricks, Engineering bricks, Concrete fly ash brick.

C. NEED FOR THE STUDY

Mass production of plastics, which began just six decades ago, has accelerated so rapidly that it has created 8.3 billion metric tons, 6.3 billion metric tons has become plastic waste. Of that, only nine percent has been recycled. The vast

majority 79 percent is accumulating in landfills or sloughing off in the natural environment as litter. Meaning at some point, much of it ends up in the oceans, the final sink. If present trends continue, by 2050, there will be 12 billion metric tons of plastic in landfills.

In the present study the main objective is to reduce the quantity of cement in manufacturing of bricks also various attempts are made for using inorganic solid waste fractions in the manufacturing of moulded bricks, kerbs, paver blocks, inspection chamber cover. This study deals with the effective use of inorganic solid waste fractions in a sustainable way.

D. OBJECTIVES OF THE STUDY

The present study aims at reduction of natural resources in the manufacturing of cement bricks and the inorganic solid waste. Evaluating the properties of cement bricks, pavers blocks and kerbs. Estimating the cost of Eco friendly cement bricks.

II. MATERIALS AND METHODOLOGY

A. MATERIALS USED

- Cement
- Plastic
- Bottom ash
- Glass
- Quarry dust

Waste scrap glass is collected from the Avaragolla village, Davangere, Karnataka solid waste disposal facility after sorting it out from municipal solid waste. The collected waste glass is crushed and powdered using crushing apparatus into the small pieces and it is further sieved in 4.75 mm IS sieve and used for the present study.

The waste plastic used in the study is LDPE and HDPE which was being procured from the Plastic industry and then shredded to small pieces. During the experimentation the the plastic is sieved through the 4.75 mm IS sieve.

For the preparation of moulds for casting of the ecofriendly brick specimen waste plywood pieces were being cut accordingly and joined using the double side plaster.

Fig 1: Shredding of waste plastic

Fig 2: Crushed waste plastic

Fig 3: Ready moulds prepared from plywood waste.

B. METHODOLOGY

Bricks of standard size of 19x9x9 cm were casted using appropriate binder to combined aggregate proportion. The combined aggregate will be having the constant proportion of the quarry dust (40%), waste glass particles (10%), Bottom ash (40%) and Shredded Waste Plastic (10%) by weight of the

Sl. No	Particulars	Experimental results
1.	Initial setting	36 minutes
2.	Final setting	295 minutes
3.	Compressive Strength (28 days)	44.2 MPa
4.	Specific gravity	3.11
5.	Fineness	2 %

binder. Specimens were kept for curing for 14 days and were tested to obtain the optimum mix through various mix proportions.

Table 2.1: Various Mix Proportions used in the Casting

Mix designation	Mix ratio	Water cement ratio
M1	1:5	0.7
M2	1:6	0.8
M3	1:7	0.9
M4	1:8	1.0

Fig 4: The Eco friendly brick specimen

III. RESULTS AND DISCUSSIONS

A. MATERIALS CHARACTERIZATION:

Cement: In the present work Ordinary Portland Cement (OPC) of 43 grade was used for the casting of bricks for different proportions.

Table 3.1: Preliminary Test results on the Cement

Fine aggregate: The Fineness Modulus of the quarry dust used in the experimentation is **3.56** and the fine aggregate belongs to **zone III (As per IS: 383-1970**) with specific gravity being **2.53**.

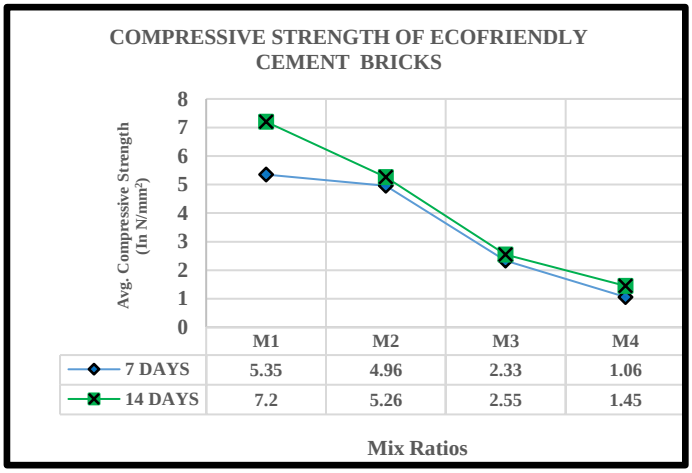
Bottom ash: The Fineness Modulus of the bottom ash used in the experimentation is **2.66** and the fine aggregate belongs to **zone IV (As per IS: 383-1970)** with specific gravity being **2.38**.

Glass: The Fineness Modulus of the glass used in the experimentation is **4.56** and the fine aggregate belongs to **zone I (As per IS: 383-1970)** with specific gravity being **2.44**.

Plastic: The mechanically shredded plastic used in this test are the Low density polyethylene and High density polyethylene which are tested for its specific gravity which tends to be **0.93**.

B. TESTS ON ECO FRIENDLY CEMENT BRICKS

1. Compressive Strength Test Results:



From The test results M2 mix is having Strength of 5.26 MPa which is more than 3.5MPa, So according to BIS1077:1992 it can be used as building unit.

Fig 5: Eco friendly cement brick specimen being tested in CTM

Fig 6: Eco friendly cement brick after the compression test

2.Water absorption test:

A brick will be considered as good quality if it does not consume more than 20% water of by its weight. The water absorption of ecofriendly cement bricks is tabulated below:

Table 3.2: Water absorption of ecofrienfly cement bricks

Mix designation	**Water absorption (in %)**
M1	14.39
M2	15.63
M3	16.29
M4	16.83

3.Falling Test:

Free falling test is conducted for the brick specimen as per the BIS 10719-9557 and 1970 the fall test is conducted i.e., themoulded brick is allowed to fall from a height of 1m and it is checked for its breaking property.The Eco Friendly Cement brick will satisfy this condition.

Fig 7: Falling test

4.Shape and Size Test:

Size and shape test is conducted on the eco-friendly cement bricks which is one of the important parameter in bricks. In the present experimentation the bricks so casted had a purely rectangular shape with sharp edges and with standard brick size consists of **19 x 9 x 9 cm.**

5. Efflorescence Test:

The bricks were tested for efflorescence by immersing them in water for 24hrs and then it was found that the eco-friendly cement bricks had no perceptible deposit of efflorescence on its surface.

6. Density Test:

The experimentation result of the density test on the Eco friendly cement bricks are tabulated below:

Table 3.3: Density test on eco-friendly cement bricks

Mix designation	Density (in g/cc)
M1	2.30
M2	2.27
M3	2.12
M4	2.09

C. COST ANALYSIS

Table 3.3: Cost analysis for the Ecofriendly Cement Bricks

Materials	Eco friendly Cement Brick (in Rupees)
Cement	2.06
Quarry dust	0.52
Fly ash	-
Bottom ash	0.52
Waste Glass particle	0.5
Waste Plastic particles	0.6
Labors Charge	1.4
Machinery Charge	0.80
Owners Profit	1.6
Total amount for 1 brick	**8.0**

The above cost analysis is done based on the Schedule of rates shivamoga region values.

D. APPLICATIONS

The following mortar elements were made using the above mix as per standard procedures and specifications which is done by comparing it with commercially available moulds.

- Kerbs
- Inspection chamber covers
- Interlocking paver blocks

Fig 8: Interlocking paver block

Fig 9: Inspection chamber cover

Fig 10: Kerb

IV. CONCLUSIONS

In the present study the bricks were casted for various trial mixes using the solid waste materials like waste glass, waste plastic, fly ash, bed ash, and in addition of cement. The specimens were tested for the compressive strength, free falling tests, shape test and water absorption.

From the test results fallowing conclusions were made.

Compressive strength being obtained for different ratios **1:5**, **1:6**, **1:7** and 1**:8** at 14 days of curing are **7.2N/mm^2**, **5.26N/mm^2**, **2.55N/mm^2, 1.45N/mm^2**respectively. From the above results it can be said that the trial mix ratios of 1:5 and 1:6 has crossed the average compressive strength of standard brick i.e. **3.5 N/mm^2**for 14 days. Hence it can be concluded that since the mortar mix 1:6 contains more part of cement. The trail mix ratio of 1:6 i.e 1 parts of cement along with 6 parts of solid waste composites can be effectively used.

The study can be extended by using the solid waste fractions as coarse aggregate and using different plastics other than LDPE and HDPE and further experimentation can be made by adding suitable admixtures the curing period can be decreased.

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