IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

UTILIZATION OF CONSTRUCTION AND DEMOLITION WASTE, SLUDGE AND FOUNDRY FOR MANUFACTURING OF ECO-BRICKS

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Abstract: This study investigates the creation of eco-bricks using construction and demolition waste (CDW) ash, waste foundry sand, and other waste materials. The primary objective was to determine the properties of the modified eco-bricks and compare them with traditional bricks. Additionally, the study aimed to identify the optimal ratios of waste materials for brick production. Specimens were cast and cured following conventional techniques, with varying proportions of CDW (10% and 20%), foundry sand (10%, 20%, 30%, 40%, and 50%), and sludge (10%, 20%, 30%, 40%, and 50%). After 28 days, the specimens were tested for water absorption, dry weight, and compressive strength. The results demonstrated that the modified eco-bricks had comparable properties to regular bricks and exhibited satisfactory performance characteristics.

Keywords: Construction And Demolition Waste, Foundry sand, Compression, Water absorption, Eco-Bricks

I. Introduction

Significant waste management issues have emerged in developing nations due to rapid urbanization, industrial growth, and population increase. Managing the substantial solid waste from modern production and consumption processes is crucial for environmental preservation and sustainable development. Innovative recycling technologies that convert waste into valuable products are essential.

One effective strategy is to use waste as raw material for new building materials, such as bricks. Conventional brick manufacturing often depletes non-renewable resources and causes environmental harm. In contrast, eco-bricks made from construction and demolition waste (CDW), foundry sand, and other waste materials offer a sustainable alternative, reducing environmental footprints and conserving resources.

Using waste in brick production addresses waste management challenges, reduces production costs, and creates markets for recycled products, aligning with circular economy principles. This study explores the potential of eco-bricks made from CDW ash, foundry sand, and other waste materials, aiming to assess their properties and determine optimal waste material proportions for sustainable construction.

II Objective

1. Examine Material Ratios: To investigate the various ratios of foundry sand, sludge, and construction and demolition waste (CDW) used in the production of Eco-bricks.
2. Assess Compressive Strength: To determine the compressive strength of Eco-bricks in relation to varying ratios of foundry sand, sludge, and CDW.
3. Evaluate Water Absorption: To measure the water absorption capacity of Eco-bricks containing different amounts of foundry sand, sludge, and CDW.
4. Analyze Production Costs: To evaluate the differences in production costs between newly created Eco-bricks and conventional bricks.

1. III EXPERIMENTAL WORK

1. Materials used
1.1. Cement
1.2. All of the mixture contained IS mark 53-grade Ordinary Portland Cement (OPC), and the testing was conducted in compliance with IS:8112-1989 standards. Table 1 provides a description of the chemical and physical properties of the cement.
1.3. Foundry Sand (FS) Foundry sand, an industrial byproduct previously disposed of as waste, is now being explored for useful applications. It is a waste material from the ferrous and nonferrous metal casting industry, consisting of premium size-specific silica sand, various binders, and trace amounts of metal byproducts. Table 2 provides the chemical and physical properties of the foundry sand.
1.4. Sludge-Sludge is a waste material derived from both municipal and industrial sources. Various types of sludge, including wastewater sludge, have been combined with other materials to create bricks. These materials include rubber, fly ash, wood sawdust, limestone dust, processed waste tea, and polystyrene.

1.4. Fly Ash-Fly ash, an industrial byproduct, is used in construction to reduce costs. Its density ranges from 400 to 1800 kg/m³ and it provides thermal insulation, fire protection, and sound absorption. The experiment utilized Class C fly ash with a 20% lime (CaO) concentration and an ignition loss of no more than 6%.
1.5. Construction and Demolition Waste (CDW)-CDW comprises over one-third of all waste generated and includes materials such as bricks, concrete, wood, glass, metals, and plastics. It encompasses all waste generated during the design and maintenance of roads. Table 4 provides the properties of CDW.

IV. MIX PROPORTION AND PROCEDURE-

The CDW, foundry sand, and sludge were mixed in varying proportions to determine the optimal ratios for making blocks. The proportions of CDW used were 10% and 20%, and foundry sand proportions were 10%, 20%, 30%, 40%, and 50%. The specimens were cast in standard sizes (90 x 90 x 190 mm for blocks) and cured for 28 days. The specimens were then tested for compressive strength, density, and water absorption. The test results were analyzed, and the properties of the developed blocks were compared with those of conventional bricks. The blocks were analyzed for both mechanical and durability properties. The mix proportions are shown in Tables 6 and 7.

Figure1.1- Eco Brick

2. Mix proportion, procedure :-

The CDW, foundry sand, and sludge were mixed in varying proportions to determine the optimal proportion of waste materials for making blocks. The proportions of CDW by 10% & 20% and foundry sand by 10%, 20%, 30% , 40% & 50%. The specimens were cast in standard sizes 90*90*190 mm for blocks, respectively. The specimens were cured for 28 days and tested for compressive strength, density, and water absorption. The test results were analysed, and the properties of the developed blocks were compared with those of conventional bricks.These blocks were analysed for both mechanical & durability properties of the concrete blocks. And the mix proportions were shown in the table 6&7.

Table 1 Properties of Cement

Sr.no	Property of cement	Result
1	Normal consistency	33%
2	Initial setting time	32 min
3	Final setting Time	580Min
4	Specific gravity	3.13

Table 2 Properties of Foundry Sand FS

Sr. No.	Properties	Value
1	Specific gravity	2.5
2	Bulk relative density kg/m3	1550 gm/cm3
3	Water absorption	0.4%
4	colour	Gray

Table 3 Property of sludge

Sr. No.	Properties	Remark
1.	Water absorption	6.1%
2.	Specific Gravity	1.27
3.	Density	1100 g/cm 3

Table 4 Property of CDW.

Sr.no.	Properties of CDW	Result
1.	Specific gravity	2.4
2.	Bulk density	1300 g/cm^3
3.	Water absorption	7.2%

Table 5 Property of Fly ash.

Sr.no.	Property of fly ash	Result
1.	Specific gravity	2.33
2.	Bulk density	950 g/cm^3
3.	Water absorption	9.3%
4.	color	Light gray

Table 6 proportion of sample I constitutes

Sr.no	Sample	Cement%	Fly ash %	CDW%	FS %
1.	EFS-1	40	30	20	10
2.	EFS-2	30	30	20	20
3.	EFS-3	30	20	20	30
4.	EFS-4	20	20	20	40
5.	EFS-5	20	10	20	50

Table 7 proportion of sample II constitutes

Sr.no.	Sample	Cement %	Fly ash %	CDW %	FS%
1.	ES-1	40	30	20	10
2.	ES-2	30	30	20	20
3.	ES-3	30	20	20	30
4.	ES-4	20	20	20	40
5.	ES-5	20	10	20	50

IV. Results and discussion

4.1. Compression strength

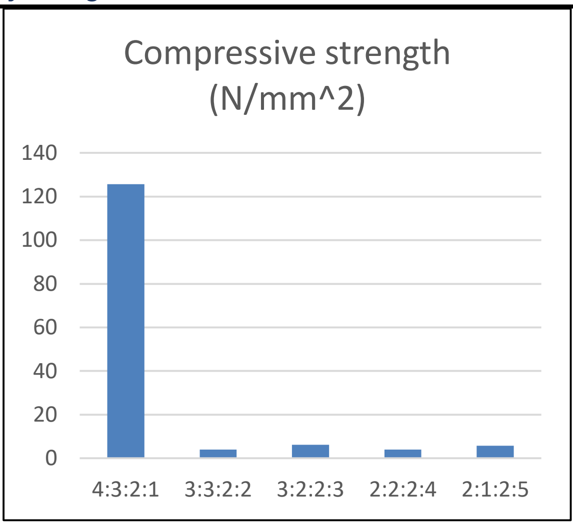
Bricks are moulded with a 9 X 90 X 190 mm of size to define the compression strength of bricks. This testing was done for a period of 28 days as per IS 2185 (Part 3) - 1984. The compressions strength is done for all the specimens for 28 days. Table 8 & 9 shows the compression strength of concrete blocks. The test results showed that the developed bricks had satisfactory properties. The maximum compressive strength of the bricks found 5.94N/mm2 &125 N/mm2 with use of sludge and FS respectively. The study also found that the optimal proportions of sludge & foundry sand for making bricks were 10% with use of sludge and FS respectively.

Table 8 Compression strength test for sludge.

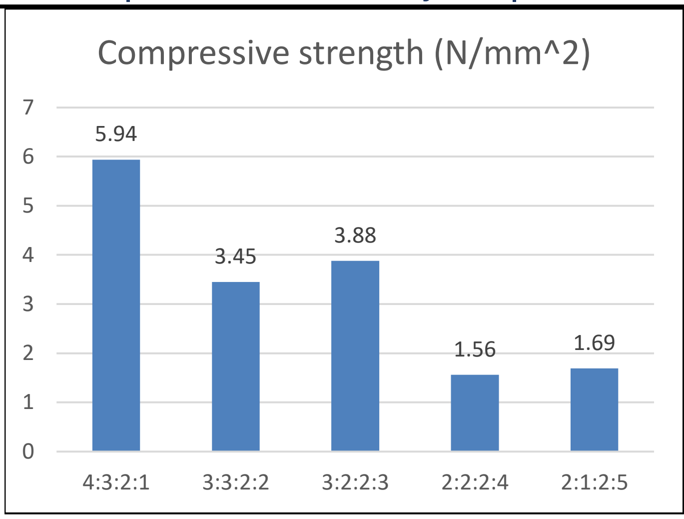
Mixes of foundry sand	Compressive strength (N/mm^2)
4:3:2:1	125.6
3:3:2:2	4.03
3:2:2:3	6.26
2:2:2:4	4.03
2:1:2:5	5.79

Table 9 Compression strength test for FS.

Mixes of sludge	Compressive strength (N/mm^2)
4:3:2:1	5.94
3:3:2:2	3.45
3:2:2:3	3.88
2:2:2:4	1.56
2:1:2:5	1.69



Graph No.1 Compression strength of bricks with varying % of sludge



Graph No.2 Compression strength of bricks with varying % of FS

4.2. Water absorption

The purpose of this test is to evaluate the blocks' ability to absorb water. Following the casting process, the specimen needs to be dried in 300°C sunshine for 24 hours. It then needs to be weighed and taken as W1. Finally, it needs to be removed and submerged in water for 24 hours. The specimen needs to be taken out, allowed to dry in the sun, weighed, and the value recorded as W2. Additionally, the formula will be used to calculate the water absorption %. The brick's water absorption percentage varied between 8.30% and 14.86%.

The formula for finding the percentage of the water absorption,

Water absorption % = 100(W2-W1)/W1

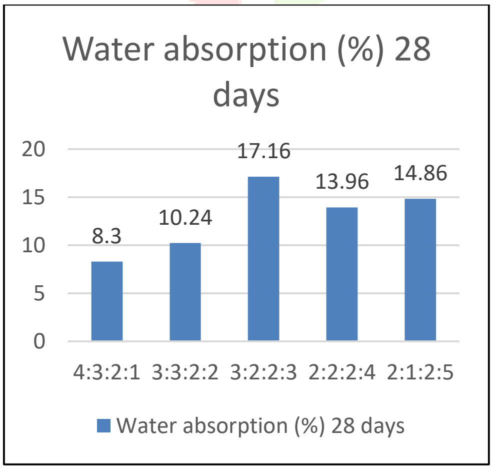
The water absorption test was conducted using various mixes of concrete bricks, and the findings showed that the amount of sludge and CDW added decreased the amount of water absorption. As foundry sand and CDW amounts increased, water absorption steadily reduced as indicated by tables 10 and 11, respectively.

Table 10 Water absorption test for sludge.

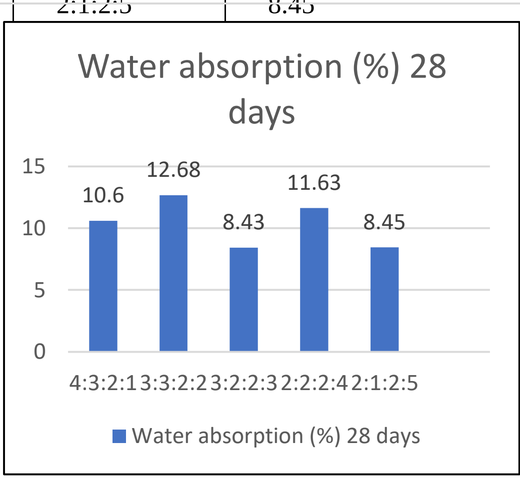
Mixes of sludge	Water absorption (%) 28 days
4:3:2:1	8.30
3:3:2:2	10.24
3:2:2:3	17.16
2:2:2:4	13.96
2:1:2:5	14.86

Table 11 Water absorption test for foundry sand.

Mixes of Foundry sand	Water absorption (%) 28 days
4:3:2:1	10.6
3:3:2:2	12.68
3:2:2:3	8.43
2:2:2:4	11.63
2:1:2:5	8.45



Graph No.3 Water Absorption of bricks with varying % of sludge



Graph No.4 Water Absorption of bricks with varying % of FS

4.3. Dry Density

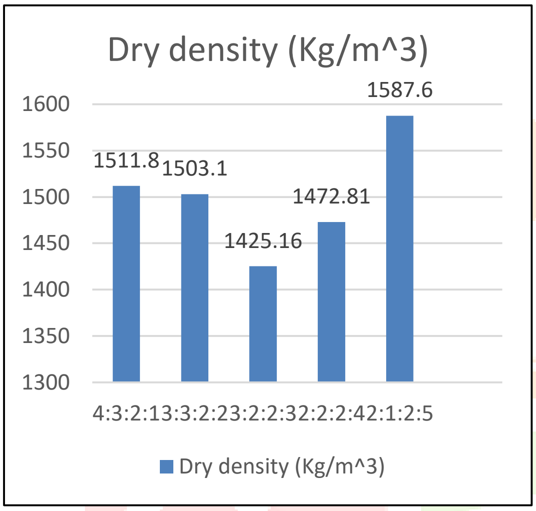
According to Table Nos. 12 and 13, respectively, the dry densities of the bricks varied from 1425.16 to 1587.60 gm when using varying percentages of sludge and from 1570.27 to 1771.70 gm when using varying percentages of FS.

Table 12 Dry Weight test for sludge

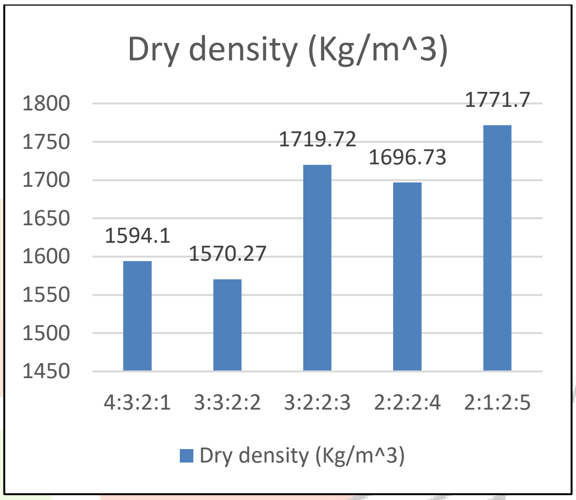
Mixture of sludge	Dry density (g/cm^3)
4:3:2:1	1511.80
3:3:2:2	1503.10
3:2:2:3	1425.16
2:2:2:4	1472.81
2:1:2:5	1587.60

Table 13 Water absorption test for FS

Mixes of foundry sand	Dry density (g/cm^3)
4:3:2:1	1594.10
3:3:2:2	1570.27
3:2:2:3	1719.72
2:2:2:4	1696.73
2:1:2:5	1771.70



Graph no.5 Dry Density of bricks with varying % of sludge



Graph no. 6 Dry Density of bricks with varying % of FS.

4.4 Properties Comparison

Properties	Traditional Brick	AAC Block	Manufactured Eco-brick
Water Absorption	27.03%	17.43%	8.30%
Compressive Strength	2.81 N/$mm2$	3.2 N/$mm2$	6.26 N/$mm2$
Dry Density	1760 kg/$m3$	673 kg/$m3$	1503.10 g/$cm3$ For 20% Sludge and 1570.27 g/$cm3$ For 20% FS
Weight Comparison	2.71 kg	0.800 kg	2.47kg
Cost per piece	Rs. 8 to10	Rs. 8.23	Rs.7

V. CONCLUSION

The produced Eco-Bricks with acceptable properties, according to the study, are composed of fly ash, cement, sluge, foundry sand, and building demolition waste. Designed bricks fared better in terms of compressive strength, dry density, and water absorption. It was determined what combination of waste materials was best for making bricks. Using waste materials in the production process can lessen the environmental impact of producing Eco-Bricks and provide a useful, cost-effective option for building. The study also determined that, in order to manufacture Eco-Bricks, the proper ratios of cement, fly ash, foundry sand, and building demolition debris were, in order, 30%,30%,20%& 20%.

Future Scope:

Research may be conducted to determine the effects of changing the ratios of waste materials on the properties of Eco-Bricks and bricks in general. Examining the use of other waste products is another option. To ascertain the environmental impact of the newly manufactured bricks and bricks, a life cycle analysis may be employed. Another alternative is to look into the feasibility of using waste materials to make bricks and blocks on a commercial scale.

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