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Development of Eco-Friendly Bricks Using Industrial and Agricultural Waste

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Abstract- One of the most important and often used building materials in masonry construction worldwide is brick. The environmental load brought on by trash deposition can be reduced by making bricks from waste materials. The purpose of this study is to assess the impact of adding trash made from rice husk ash. Samples were prepared with different percentages of cement, fly ash, lime, river sand, and rice husk ash. recycling a variety of waste materials, including as fly ash (40 – 60%), rice husk ash (15 – 20%), lime (10%), cement, and river sand (15 – 20%), for use in brick production. The dimensions of the brick specimen are 230 x 110 x 75 mm. Experiments are conducted to examine differences in properties including compressive strength, water absorption, hardness, and soundness. This review will lead to recommendations for additional research on the effects of that waste on bricks' mechanical and physical properties. The uses of agricultural wastes as cheap and environmental-friendly construction materials are beneficial towards provision of affordable housing in developing country.

Index Terms- Rice husk ash, Fly ash, lime, cement, river sand, compressive strength and water absorption test.

I. INTRODUCTION

Brick is one of the oldest and most frequently used building materials. These are rectangular or square pieces of clay or other materials that have been baked or heated in a kiln to make them more durable. Bricks are still often employed in construction today because they have mostly remained constant in size over thousands of years. For a number of construction tasks, such as building walls, arches, and other structures, bricks are utilized.

In addition to being decorative, they can be used to pave roads and pavements. Clay is used to make the most popular kind of brick, which is then heated to high temperatures to give it durability and strength. An environmentally beneficial substitute for conventional bricks is provided by eco-friendly bricks manufactured from agricultural waste, such as rice husk ash. These bricks lessen their impact on the environment by avoiding open burning, a significant source of greenhouse gas emissions and air pollution.

Their carbon footprint is further reduced by the fact that these bricks frequently need less energy to make than conventional bricks. By giving farmers an alternative to burning stubble and enhancing soil health by adding organic matter, they also provide a potential answer to the issue of agricultural waste management. Bricks formed by pressing wet clay into molds, then drying and fire in kilns, are known as burnt clay bricks.

The Indian government promoted the use of fly ash bricks as a cost-effective and environmentally friendly alternative to traditional clay bricks, which are made by heating clay in kilns - a process that uses a lot of energy and creates pollution. These days, fly ash bricks are used in building projects all over the world. They are known for being incredibly durable, sturdy, and heat-insulating. In general, the development of technology to utilize waste products and the growing awareness of the need for sustainable building materials are directly related to the history of fly ash bricks.

Traditional bricks are made by shaping clay or shale into a rectangle and then heating the mixture to a high temperature in a kiln. The history of traditional brickmaking dates back to ancient civilizations such as the Babylonians, Egyptians, and Romans. Among the advantages of utilizing clay bricks are their strength, durability, and resistance to weather and fire. For example, the production of traditional bricks consumes a lot of energy and generates a lot of carbon dioxide. Additionally, traditional bricks can be heavy and expensive to install since they need expert labour.

In recent years, there has been a need for more sustainable and eco-friendly building materials. Consequently, prefabricated materials, fly ash bricks, and engineered timber have gained popularity as alternative building materials. Brick is made by the building industry utilizing fly ash, rice husk ash, cement, lime, and river sand. Fly ash contains very trace amounts of toxic metals such as mercury, arsenic, chromium, selenium, lead, cadmium, nickel, and zinc. The environment, plants, and

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people could all be harmed by these metals. When fly ash breaks down on it, it becomes arid land. They are an environmentally friendly substitute that guards against pollution. Fly ash bricks provide excellent fire protection. Fly ash bricks are so strong and stable that they almost never shatter during transportation. Fly ash bricks work well as thermal insulators.

Using non-traditional building materials, such as fly ash bricks, could cut down deforestation. A sizable tract of forest is cut down each year to make soil for brick production. Because it uses less cement and lowers the production process' carbon footprint, rice husk ash can also benefit the environment when used to make bricks. Additionally, rice husk ash is a byproduct of agriculture that is generated in large numbers during the milling of rice; using it to make bricks can reduce waste and promote environmentally friendly practices. Although the initial cost of sustainable bricks may be a little higher than the cost of conventional bricks, they can save you money over time. Sustainable bricks are extremely durable and require less upkeep, which decreases the need for repairs and replacement.

Objectives

- To make bricks with waste materials like rice husk ash in order to use less traditional material like (fine aggregates).
- To solve the issues with industrial and agricultural waste.
- To ascertain the rice husk ash's chemical and physical characteristics.
- To replace burned bricks with cement bricks treated with rice husk ash in order to reduce air pollution.

II. METHODOLOGY

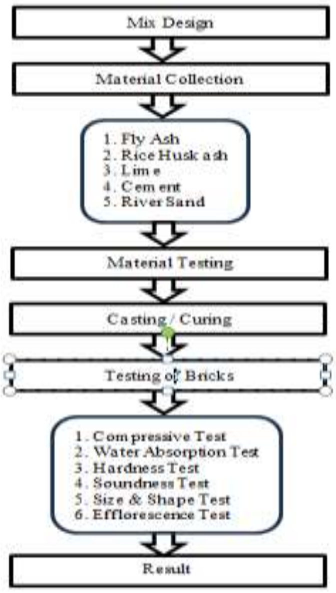

Fig 1 Methodology

Material Collection

Fly Ash

Figure 2 Fly Ash

The byproduct of the burning of coal in thermal power plants is fly ash. Fly ash is rich in silica, alumina and other minerals, and it has pozzolanic properties that make it useful in construction. Compared to clay bricks, fly ash bricks absorb less heat, which is better given the environment in India. Fly ash, which was once considered an environmental hazard, has recently found a useful application in the construction business.

Table 1 Physical properties of fly ash

S.No	Parameter	Obtained value	Permissible limit (IS 3812 Part 1:2003)
1	Specific gravity	2.28	Up to 3
2	Fineness modulus	7.1	Up to 8

Rice Husk Ash

Figure 3 Rice Husk Ash

The by-product left over after the combustion of rice husk is rice husk ash. Pozzolans are materials that react with calcium hydroxide to form cementitious compounds, which help to bind the brick together. Rice husk ash has found to improve the compressive strength durability, and water absorption properties of bricks. The rice husk ash is collected from local suppliers. RHA is a type of agricultural waste that is widely distributed throughout all nations that produce rice.

Table 2 Physical properties of Rice Husk Ash

S.No	Parameter	Obtained value	Permissible limit (International journal)
1	Specific gravity	2.3	2.06
2	Fineness modulus	6.8	9.9

Lime

Figure 4 Lime

The lime powder contains silica. Then it will be dried under the sunlight and binds the particles of brick together which results in strong and durable bricks. It was used as a binding material as well as filler It is primarily used in strengthening and toughening the bricks. This slightly fused silica works as a strong cementing material.

Cement

Figure 5 Cement

To create brick and mortar, Portland Pozzolana cement was employed. Between two bricks, it functions as a bonding agent. In general, cement is crucial for producing strong and long-lasting structures and plays a significant part in the production of bricks. It is a powdery substance made from a mixture of calcium, silicon, aluminium, iron, and other materials.

Table 3 Physical properties of cement

S.No	Parameter	Obtained value	Permissible limit (IS 8112 1981)
1	Specific gravity	3.1	2.9 – 3.15
2	Fineness modulus	5 %	Max 10 %

River Sand

Figure 6 River Sand

River sand is a commonly used material in the production of bricks. When used in brick production, river sand is mixed with cement and water to create a thick, consistent paste. This paste is then moulded into the desired shape and left to dry, resulting in a solid brick. One of the advantages of using river sand in bricks is that it has good compressive strength and can help improve the overall strength and durability of the brick. The river sand is collected from local suppliers.

Table 4 Physical properties of river sand

S.No	Parameter	Obtained value	Permissible limit (IS 2386 part 3 1963)
1	Specific gravity	2.48	2.65 – 2.67
2	Fineness modulus	2.24	2.78

Mix Proportion

Table 5 Mix proportion of Rice Husk Ash brick

Mix id	Fly ash (%)	Rice husk ash (%)	River sand (%)	Cement (%)	Lime (%)
Mix 1	50	30	5	5	10
Mix 2	45	25	10	10	10
Mix 3	40	20	15	15	10
Mix 4	35	15	20	20	10
Mix 5	30	10	25	25	10

Moulding of Bricks
Pour the prepared mix into moulds of desired brick sizes. The mixture is then pressed into the rectangular slabbed brick mould. The bricks are moulded in 230 x 110 x 75 mm.

Figure 7 Moulding

Curing
The moulded bricks are then cured for a period of 7 days. This process helps in the development of the strength and durability of the bricks. After curing, the bricks are dried in the sun for 24 hours.

Figure 8 Curing

III. RESULTS AND DISCUSSION

Compressive Strength Test
Compressive strength testing was done in accordance with IS 3495:1992 (Part 1). After a seven-day curing period, a three-number sample of each mix was tested. The test was conducted using a compressive testing machine (200 T). By applying a constant rate of loading to the brick, the compressive strength value is calculated.

Compressive Strength = Load / Area in N/mm2

Table 5 Compressive Strength test result

S.No	Mix	Weight (Kg)	Compressive Load (kN)	Compressive Strength (N/mm^2)
1	C.B	2.82	179	7.07
2	Mix 1	2.516	225	8.89
3	Mix 2	2.854	248	9.80
4	Mix 3	2.640	258	10.19
5	Mix 4	2.002	196	7.74
6	Mix 5	2.056	142	5.61

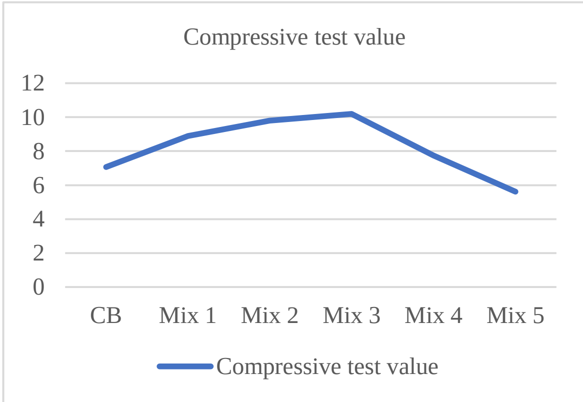

Figure 9 Line graph of Compressive test result

Based on the outcome of the Bricks made of rice husk ash have compressive strengths ranging from 5.61 N/mm2 to 10.19 N/mm2. Conventional brick performs worse than mix 3 when compared to mix 3.

As brick weight increases, so does the bricks' compressive strength. Mix 3 has a higher compressive strength as a result.

Water Absorption Test
The water absorption test was conducted in accordance with IS 3495:1992 (Part 2).

$$\textbf{Water Absorption} = \frac{\textbf{Wet weight} - \textbf{Dry weight}}{\textbf{Dry weight}} \; \mathbf{X\ 100}$$

Table 6 Water Absorption test value

S.No	Mix	Dry weight W1 (Kg)	Wet weight W2 (Kg)	Water absorption (%)
1	C.B	2.82	3.285	14.15
2	Mix 1	2.040	2.10	2.94
3	Mix 2	1.980	2.02	2.02
4	Mix 3	2.660	2.91	9.31
5	Mix 4	2.78	3.10	11.51
6	Mix 5	2.685	3.02	12.47

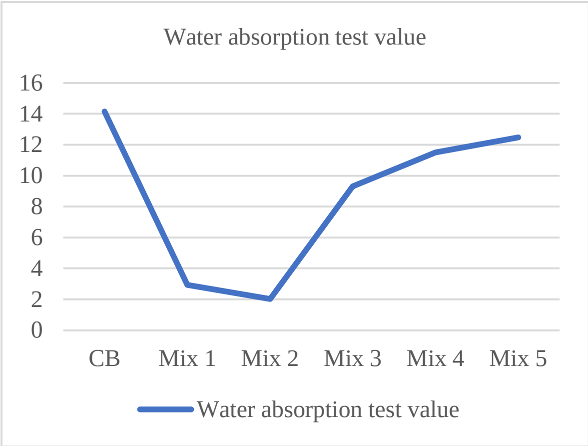

Figure 10 Line graph of Water Absorption test

Rice husk ash bricks' water absorption results range from 9.31 N/mm2 to 12.47 N/mm2. According to the code, it demonstrates that the rice husk ash used in the bricks absorbs less than 20% of the water.

IV. CONCLUSION

- For mix combinations, the rice husk ash brick's compressive strength ranges from 7.07 to 10.19 N/mm2.
- For a mix combination, the water absorption percentage ranges from 2.94 to 12.47.
- One encouraging step toward ecologically friendly and sustainable building is the creation of eco-friendly bricks from agricultural and industrial waste.
- These bricks lessen the environmental impact of conventional brick production techniques, which usually entail the use of non-renewable resources and produce large amounts of greenhouse gas emissions, in addition to assisting in the reduction of waste generation.
- Eco-friendly bricks with much reduced energy consumption and carbon emissions can be made by using waste materials like fly ash, rice husk, and river sand.
- Utilizing waste products can also lessen the quantity of rubbish dumped in landfills, which can significantly improve the environment.

Future Perspectives

- To manage the disposal of waste product into construction raw material.
- To dispose the waste safely.
- Conservation of future generations.
- Unfired bricks emit no carbon dioxide.
- To encourage the waste materials as eco-friendly materials.

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