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Utilization of Waste Material for Manufacturing of Bricks

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ABSTRACT: A lot of clay is used in the production of bricks. Clay brick use damages the ecosystem, decreases the water table, and causes erosion. In order to avoid utilising clay in the production of bricks, this research tested a variety of waste materials in variable quantities, including fly ash, washed sand, marble dust, and GGBS. The results of tests for compressive strength, water absorption, and size were compared to the requirements for conventional clay bricks. The compressive strength and water absorption values were found to be in compliance with the pertinent requirements for typical construction bricks. In the end, it was determined that bricks constructed from substances such as fly ash, GGBS, washed sand, and cement had demonstrated good results in compression testing, indicating their appropriateness for structural purposes.

I.INTRODUCTION

Bricks have long been a popular building and construction material. Dried clay bricks were initially used approximately 8000 BC, whereas burnt clay bricks were first used around 4500 BC. Global brick manufacturing is currently about 1391 billion pieces per year, with demand likely to climb further. Traditional bricks are made from ordinary Portland cement (OPC) concrete or clay. Clay quarrying consumes a lot of energy, has a detrimental influence on the environment, and generates a lot of waste. High-temperature kiln burning consumes a lot of energy and releases a lot of greenhouse emissions.

The extensive use of natural clay to create brick has resulted in a loss in natural resources represented by clay to preserve it and the environment. As a result, certain nations, such as China, have begun to limit the use of clay-made bricks in order to meet sustainability criteria. The Chinese government has banned the production and use of ordinary clay solid bricks in many cities in order to protect clay resources and develop environmentally friendly building materials, and has actively promoted the use of solid wastes for building materials in order to achieve the phase-out of ordinary clay solid bricks made of solid material.

A brick is a unit of construction used to construct walls, footings, pavements, and other elements in masonry structures. The term brick originally referred to a clay unit, but it is today used to refer to any rectangular unit put with mortar to produce a homogeneous building. A brick can be made from clay-bearing soil, sand, lime, or brick components. Bricks are manufactured in a variety of classes, types, materials, and sizes that change depending on the climatic conditions of the site, the time duration, and the quantity produced. Brick was heated in the olden days. Bricks are set in courses in different patterns known as bonds, and may be laid in various types of mortar to hold the bricks together.

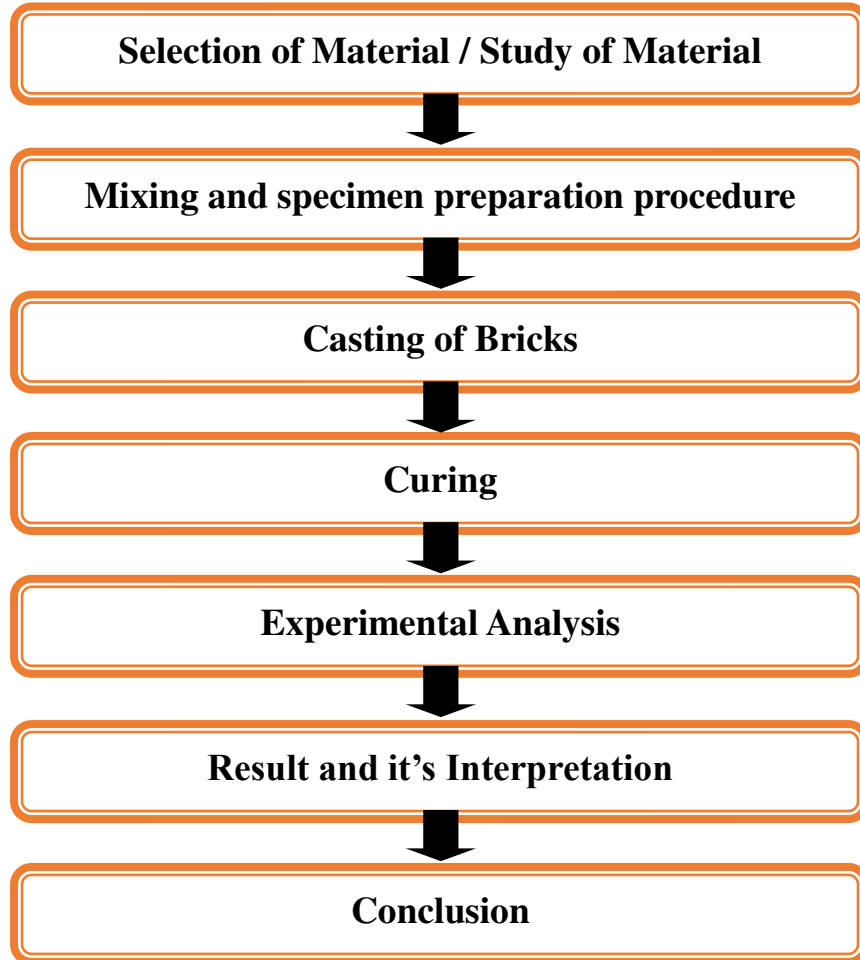
Since bricks are one of the most crucial building materials, this review focuses more on them. They are mostly used to make pillars and partitions inside residential buildings like apartments, bungalows, and public spaces like shopping centres, malls, airports, etc. There have been numerous attempts to incorporate various waste materials into the brick-making process, including natural fibres, cotton waste, sewage sludge, plastic waste, fly ash, sugarcane bagasse ash, bottom ash, rice and wheat husk ash, silica fume, marble and granite waste, ceramic waste, sawdust, wood waste, brick debris, crumbled rubber, etc. The implications of these materials on brick's physical, mechanical, and thermal insulating qualities are highlighted in this article.

1.1 OBJECTIVE

- To replace sand by easily available waste material like fly Ash, GGBS, marble dust and washed sand.

- To put bricks manufactured from waste resources through tests for strength and other physical characteristics.

II.METHODOLOGY



1.2 SELECTION OF MATERIAL / STUDY OF MATERIAL

1.2.1 CEMENT

A binder, or chemical substance that sets, hardens, and attaches to other materials to bind them together, is what cement is in construction. In most cases, cement is used to bond sand and gravel (aggregate), not on its own. Mortar for masonry is made from cement mixed with fine aggregate, and concrete is made from cement combined with sand and gravel. The second most utilised resource on the globe after water is concrete, which is the most often used substance in existence.

1.2.2 FLY ASH

Coal combustion residuals (CCRs) are a byproduct of coal combustion made up of the flue gases and particulates (fine particles of burned fuel) that are forced out of coal-fired boilers. Bottom ash is the ash that collects at the bottom of the boiler's combustion chamber, also known as the firebox. Fly ash is typically collected by electrostatic precipitators or other particle filtration equipment in modern coal-fired power plants before the flue gases reach the chimneys. It is referred to as coal ash along with bottom ash taken out of the boiler.

1.2.3 GGBS (GROUND GRANULATED BLAST-FURNACE SLAG)

A by-product of the blast furnaces used to create iron, GGBS (Ground Granulated Blast-furnace Slag) is a cementitious material that is mostly utilised in concrete. About 1,500 °C is the operating temperature of blast furnaces, which are



supplied with a precisely regulated mixture of limestone, coke, and iron ore. The leftover components create a slag that floats on top of the iron once the iron ore is converted to iron. a by-product of blast furnaces, which are used to produce iron.

This slag is regularly tapped out as a molten liquid and must be quickly cooled in a lot of water if it is to be employed in the production of GGBS. Quenching generates granules resembling coarse sand and optimises the cementitious characteristics. It creates granules that resemble coarse sand. The 'granulated' slag is next dried and processed into a fine powder.

1.2.4 WASHED SAND

The term "washed" describes the procedure used to clean the sand of dust, silt, and clay before allowing it to drain. Sand that has been through this procedure is referred to as "washed," and as a result, its gritiness and application options can vary.

While double washed sand, which has had all impurities removed, is perfect for usage in children's playpits, long jump pits, and gold bunkers, general washed sand is fantastic for rendering and external plastering. We can assist you in selecting the ideal washed sand to suit your needs. Around the world, washed sand is frequently used in both private and public construction projects. This is hardly surprising given the numerous advantages it offers over other forms of sand. Without further ado, let's look at a few of the advantages of this crucial building component.

1.2.5 MARBLE DUST

When marble is sawed, shaped, and polished, marble dust is produced as an industrial byproduct, and it is very harmful to the environment. According to research, adding marble dust to cement has no discernible impact on its consistency or initial or final setting times, which are all within the ranges considered acceptable by various standards. In order to determine the ideal proportion of marble dust, this study examines the viability of producing concrete with marble dust as a partial replacement of cement up to 20% (by weight).

Experimental research was done on the compressive strength and workability of concrete utilising marble dust as a partial replacement for cement. SEM was used to examine the micro structural characteristics of concrete that had been changed with marble dust. The study's findings showed that using up to 10% marble dust in place of cement may be done without affecting the concrete's strength.

1.3 MIXING AND SPECIMEN PREPARATION MATERIAL

- Mix Proportion:

The following mix proportions, which are shown in table 2 (a), were determined by trial and error in order to determine the required brick strength. The amount of materials needed to create one brick is shown in table 2 (b) and is calculated using a brick weight range of 3.5 kg to 4 kg.

Proportion	Fly Ash (%)	GGBS (%)	Washed Sand (%)	Marble Dust (%)	Cement (%)
I	30	20	20	10	20
II	30	16	24	10	20
III	40	20	13	12	15
IV	40	22	18	5	15
V	30	20	15	15	20
VI	30	17	17	16	20
VII	30	23	17	10	20
VIII	30	12	15	15	20

Table 2 (a): Material Proportions (%)

Proportion	Fly Ash (g)	GGBS (g)	Washed Sand (g)	Marble Dust (g)	Cement (g)
I	579	381.3	538.7	228.55	460
II	579	305.04	646.44	228.55	460
III	772	381.3	350.15	247.26	345



IV	772	419.43	484.83	114.27	345
V	579	381.3	404.02	342.82	460
VI	579	324.10	457.89	365.68	460
VII	579	438.49	457.89	228.55	460
VIII	579	228.78	404.02	525.66	460

Table 2 (b): Quantity of material used (in g)

1.4 CASTING OF BRICK SPECIMEN

Brick was cast using a mild steel mould with the following dimensions: 235 mm x 78 mm x 110 mm. To prevent leaks during casting, the mould and its base are tightly damped together. Before casting, the base plates and mould's sides were greased to prevent brick and mould from sticking together.

Bricks were made using various material ratios, as stated in table 2 (a). A uniform mixture was created by manually combining the collected elements, water, cement, fly ash, ggbs, etc. It was noted that for each trial, 800 ml to 1 litre of water was added for a weight of 3.5 kg to 4 kg in order to keep the same amount of mixture consistency, and the amount of water used in each trial varied depending on the materials utilised. To ensure a properly cured brick, they received one daily watering for a period of fourteen days.

1.5 CURING

Following casting, the test specimens were allowed 24 hours to dry. For 14 days, the specimens were watered once daily with the aim to produce a brick that was well cured.

III. EXPERIMENTAL ANALYSIS

1.6 COMPRESSIVE STRENGTH TEST:

Compression strength is the overall load that the brick can withstand. The brick crushing test is another name for this evaluation. Brick samples are brought to a lab for testing and examined one at a time. A specimen is placed on a crushing machine and subjected to pressure until it breaks in this test. Brick crushing pressure is taken into consideration. Every brick specimen is examined individually, and the average result is used to determine the compressive strength of the bricks. The Compressive Strength of the brick is calculated by the formula = (max load taken before failure/ Area of the Brick surface) N/mm².

By dividing the total force by the specimen's initial cross-sectional area, the compressive strength was calculated. The compression strength test configuration and average compressive strength findings are displayed in Chart No. 3 (a). Chart no. 3 (b) shows that, when compared to other compositions used in other trials, the composition used in trial 3 had the maximum compressive strength.

Sample	Compressive Strength (N/mm ²)			Average (N/mm ²)
	Trial 1	Trial 2	Trial 3	
1	8.45	8.38	8.41	8.41
2	7.50	7.45	7.52	7.49
3	4.66	4.63	4.65	4.64
4	6.32	6.30	6.33	6.31
5	11.06	11.10	11.03	11.06
6	5.73	5.75	5.68	5.72
7	9.09	9.06	9.09	9.08
8	6.67	6.64	6.65	6.65

Table 3 (a): Compressive strength result of brick samples

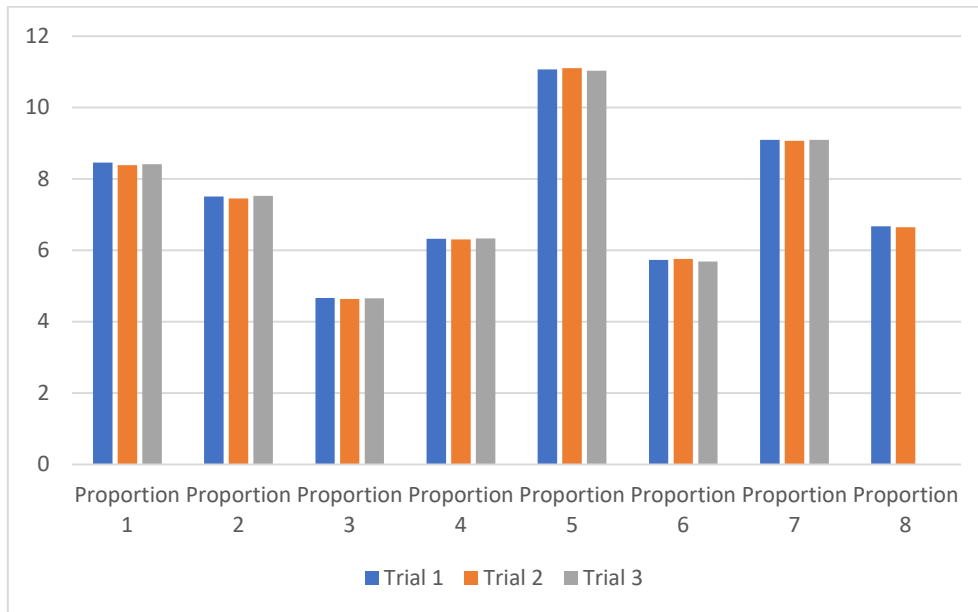


Chart no. 3 (a): Trial proportions v/s Compressive strength

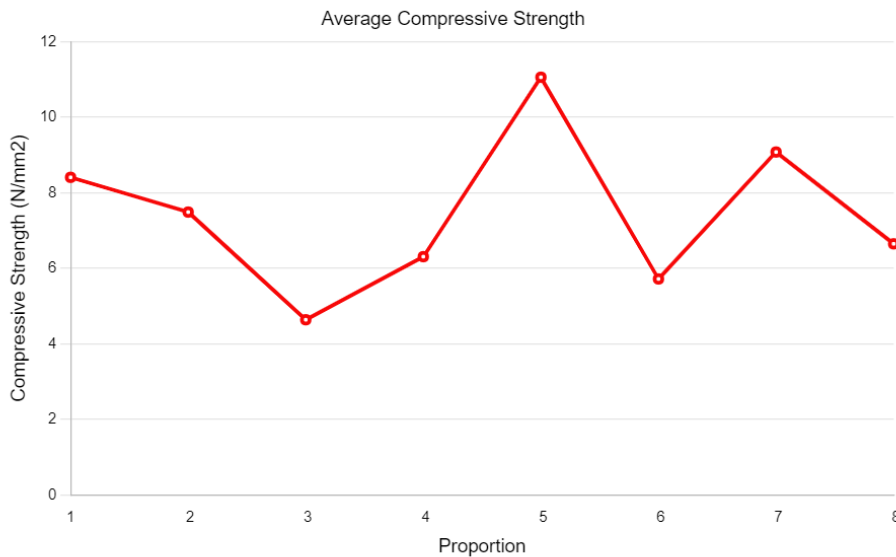


Chart no. 3 (b): Compressive strength result for brick samples

1.7 WATER ABSORPTION TEST

This test is performed to find out how much water the brick can hold before becoming saturated. According to IS:3495-Part 2- 1992, after being submerged in cold water for 24 hours, water absorption must not exceed 20% for classes up to 12.5 and 15% of weight for classes greater than that. Bricks were initially taken, and all of the loose material was removed. Bricks should be dried in a ventilated oven at 110°C until their weights are nearly constant. Bricks were cooled to room temperature, and each sample's weight, W1, was recorded.

The bricks were then submerged for 24 hours in clean water that was between 25 and 29 degrees Celsius. The specimen was then removed, the water had been dried with a moist cloth, and each sample was weighed using a W2 scale. Finally, the formula below was used to determine the proportion of water absorbed for each brick.

$$\text{Water Absorption} = [(W2-W1)/W1] \times 100$$



W1 = Weight of oven dried brick
 W2 = Weight of soaked brick

Sample	Water Absorption (%)			Average (%)
	Trial 1	Trial 2	Trial 3	
1	8.93	7.45	7.59	7.99
2	10.75	11.76	10.90	11.13
3	12.92	12	11.22	12.04
4	12.46	12.56	12.50	12.50
5	5.44	5.47	4.41	5.10
6	2.68	2.66	3.21	2.85
7	11.36	11.68	12.07	11.70
8	9.51	8.92	8.97	9.13

Table 3 (b): Water absorption average result for brick samples

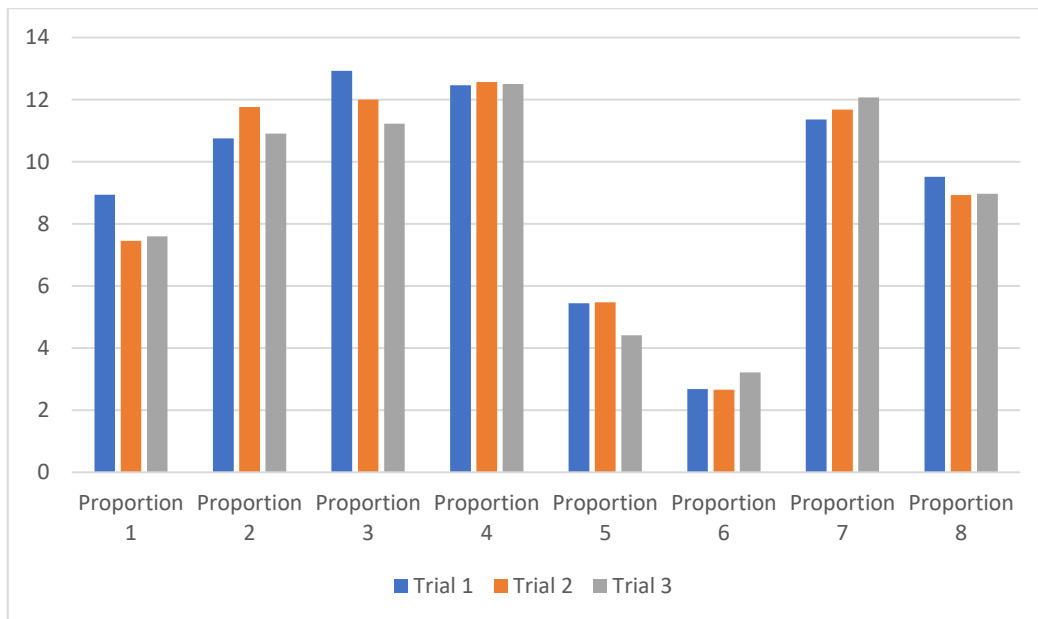


Chart no. 3 (c): Trial proportion v/s Water absorption (%)

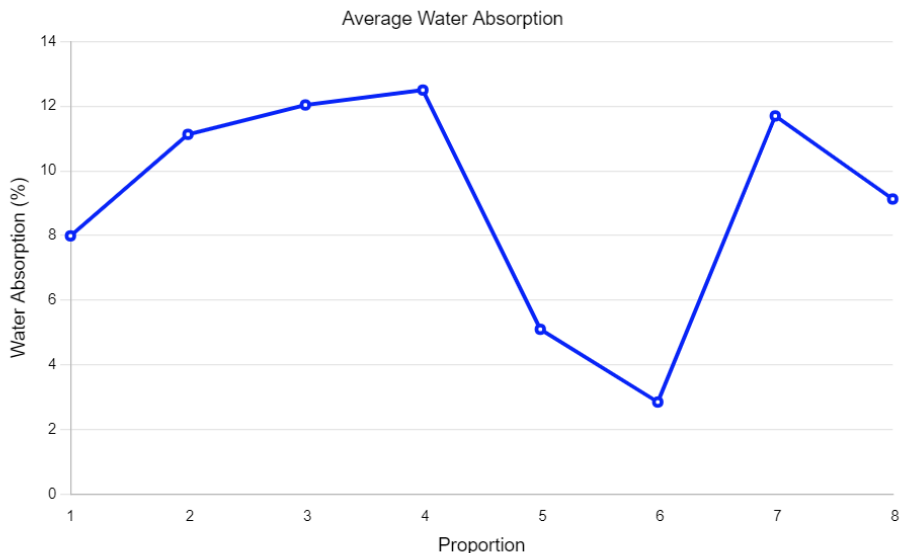


Chart no. 3 (c): Water absorption result for brick samples

1.8 DIMENSION TEST

Twenty samples were randomly selected from each mixed ratio, and the blisters were scraped off with a trowel before to the test. According to Indian industry standards (IS: 1077(1992), clause 6.2), brick dimensions were tested. Prior to measuring the length of the total bricks, all the chosen bricks were first stacked lengthwise in five rows on a flat surface. Each row's values were written down.

The bricks were stacked similarly, width-wise, and the values were noted. After all the bricks had been placed according to height, the final height was calculated. The observed values were noted, and Table 4(c) displays the standard deviations. The dimension tolerance values for bricks were discovered to be within the IS limitations.

Trial	Dimensions			Limit as Per IS 1077		
	Length	Width	Height	Length	Width	Height
1	4530	2230	1480	4410 mm to 4590 mm	2180 mm to 2260 mm	1380 mm to 1480 mm
2	4523	2230	1473			
3	4525	2234	1475			

Table 3 (c): Dimension test result

IV. CONCLUSION

- Bricks made from waste material such as fly ash, GGBS (Ground Granulated Blast Furnace Slag), washed sand, and cement offer several advantages in terms durability. These materials can be utilized effectively in brick manufacturing, contributing to a more environmentally friendly and economically viable construction industry.
- By incorporating fly ash and GGBS, which are industrial by-products, into brick production, the reliance on traditional cement can be reduced. This not only minimizes the environmental impact associated with cement production but also helps in utilizing waste materials that would otherwise end up in landfills. The use of fly ash and GGBS also contributes to the conservation of natural resources.

- Bricks made from materials like fly ash, GGBS, washed sand, and cement have shown promising results in compression tests, indicating their suitability for structural applications. The combination of these materials offers several advantages, including improved strength, durability, and environmental sustainability.

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