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Non-Burnt Soil Cement Bricks Having Flyash, Calcium Carbonate Sand And Bagasse

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Abstract: This study investigates the development of lightweight, eco-friendly soil-cement bricks (SCBs) utilizing industrial sugar by-products, sugarcane bagasse fibers, and industrial waste fly ash as stabilizers. The primary objective is to reduce the weight and cement content of bricks, thereby diminishing greenhouse gas emissions associated with their manufacturing**.** The bricks were subjected to various tests, including compressive strength, hardness, and water absorption, to evaluate their performance. The results indicate that the incorporation of sugar by-products and fly ash enhances the mechanical properties of the SCBs while maintaining low water absorption rates. These findings suggest that SCBs are a viable alternative to traditional bricks, offering reduced environmental impact and cost-effectiveness.

***Key words* - Eco-friendly bricks, soil-cement bricks, sugar by-products, sugarcane bagasse, fly ash.**

I. INTRODUCTION

India's growing population has increased the demand for construction materials. Soil Cement Bricks (SCBs), made from soil, Ordinary Portland Cement (OPC), and water, are a viable alternative to traditional clay bricks due to their higher strength and water resistance. However, they are brittle with low tensile strength. Industrial and agricultural wastes like fly ash and bagasse can be used as partial replacements in SCBs to enhance properties and reduce environmental impact. Fly ash, a byproduct of coal combustion, improves strength and durability. Sugarcane bagasse, a fibrous residue from sugarcane processing, reduces brick weight and improves insulation. Incorporating these wastes into SCBs makes them eco-friendly, cost-effective, and supports sustainable construction.

II. MATERIALS

The following materials are used for the preparation of the preparation of bricks.

2.1 BAGASSE

Sugarcane bagasse (SCB) is a fibrous by-product obtained after juice extraction from sugarcane stalks. It contains approximately 41.8% cellulose, 28% hemicellulose, and 21.8% lignin. For every 10 tonnes of sugarcane processed, around 3 tonnes of wet bagasse are generated. Due to its high moisture content (40–50%), direct use as fuel is limited. SCB, however, possesses pozzolanic properties and can be used as a partial replacement for cement in non-fired soil cement bricks.

Figure 1 Bagasse

2.2 FLY ASH

Fly ash is a fine powder generated as a byproduct from coal combustion in thermal power plants, collected through electrostatic precipitators. It contains aluminous and siliceous materials with pozzolanic properties, allowing it to react with lime and water to form cementitious compounds. Fly ash is widely used in cement, concrete, blocks, and tiles, improving strength and workability.

Figure 2 Fly ash

2.3 CEMENT

Cement is a material with adhesive and cohesive properties that enable it to bind mineral particles into a solid mass. In construction, it refers specifically to the binding material used with sand, stones, bricks, and blocks. The primary raw materials for cement production are lime (Cao), silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3). These oxides react at high temperatures in a kiln to form key compounds such as tricalcium silicate (C_3S), dicalcium silicate (C_2S), tricalcium aluminate (C_3A), and tetra calcium alumino ferrite (C_4AF). C_3S and C_2S contribute to the strength of bricks.

Figure 3 Cement

2.4 CaCO3 SAND

CaCO3 sand is also known as calcium carbonate sand, is a type of sand that is primarily composed of calcium carbonate. The properties of CaCO3 sand are white in color, fine to medium size grain, high Ph level and low hardness. The sources of the caco3 sand are the limestone deposits, marine shells and calcite rich rocks. caco3 sand is used in many aspects like construction (cement, concrete, mortar), glass manufacturing, paper and pulp industry and water treatment.

Figure 4 CaCO3 Sand

2.5 SOIL

Soil is a key component in the production of non-burnt soil cement bricks, especially when combined with industrial byproducts such as fly ash and bagasse, which enhance the workability of the mixture. Soils with high clay content are preferred due to their superior plasticity and binding characteristics. An optimal pH range of 6–8 supports effective cement hydration. The presence of moderate sand improves the strength and durability of the bricks, while low silt content is also desirable for better performance.

Figure 5 soil

2.6 WATER

Water is a crucial element of brick as it surely used for production of brick. Since it allows to bind all the raw materials for giving proper mix. Water used for making brick should be free from impurities

III. MIX DESIGN

The mixing of Sand, Cement, Bagasse, Fly ash and soil is done, later this mix is compacted in 3 layers into the mould which has the dimensions of 9”X4X”3”. The mix of Bagasse and Fly ash in soil cement bricks with different proportions of Bagasse ash and Fly ash. The percent of Bagasse ash considered in different types of samples.

Table 1 Mix proportion of bricks

Mix Designation	Soil (Kg)	Cement (Kg)	Fly ash (Kg)	CaCo03 Sand (Kg)	Bagasse (Kg)	Water (Lit)
B0	8	1	2	5	0	2
B0.5	8	1	2	5	0.5	2.2
B1	8	1	2	5	1	2.4
B1.5	8	1	2	5	1.5	2.6
B2	8	1	2	5	2	2.8

IV. METHODOLGY

Mix proportions were prepared by partially replacing cement with fly ash and bagasse ash. A typical mix consisted of 70% soil, 20% cement, and 10% industrial waste (fly ash and bagasse ash). The dry materials were thoroughly mixed, followed by the gradual addition of water to achieve a workable consistency. The mixture was then placed into standard brick moulds and compacted manually or using a mechanical press. After 24 hours, the moulded bricks were demoulded and cured in water for 28 days to allow proper cement hydration and strength development. After curing, the bricks were tested for compressive strength, water absorption, and density to evaluate their performance and durability. These tests helped determine the suitability of fly ash and bagasse ash as partial replacements in soil cement bricks.

V. EXPERIMENTAL PROCEDURES

5.1 COMPRESSIVE STRENGTH TEST

Compressive strength tests were conducted on soil cement brick samples using a compression testing machine. Five samples were tested per batch to ensure consistency and reliability of the results. The average compressive strength of the five tested samples was calculated to represent the overall strength of the cement bricks for each mix ratio. For the test, each brick specimen was placed with its flat horizontal face positioned between two plywood sheets. The plywood sheets ensured uniform load distribution across the surface of the brick during testing. The specimen was then carefully centered between the two plates of the compression testing machine to ensure proper alignment and load application. A uniform load was applied at a rate of 14 N/mm^2 per minute until the brick failed. The load was applied axially, meaning it was directed straight through the center of the specimen to simulate real-world stress conditions. The failure point was noted when the brick could no longer withstand the applied pressure, causing visible cracking or fracture. The maximum load at failure was recorded as the peak compressive strength

Compressive strength on brick = (Load taken by the sample/Area of the specimen).

Figure 6 Set up of compressive strength testing of brick

5.2 WATER ABSORPTION TEST

Dry specimen is place in ventilated oven at a temperature of 105 to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (Dry Weight W1). Dry specimen is completely immersing in clean water at a temperature of 27 ± 2 °C for 24 hours. Remove the specimen from the water and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from water (wet weight W2). Water absorption, percent by mass, after 24-hour immersion in cold water is given by formula:

Water absorption in % by weight = (W2 – W1/W1) x 100

V1. TEST RESULTS

6.1 COMPRESSIVE STRENGTH TEST

Table 2 Compressive strength test results

Mix Designation	Compressive Strength (N/mm^2)
B0	6.1
B0.5	10.27
B1	12.36
B1.5	13.68
B2	15.45

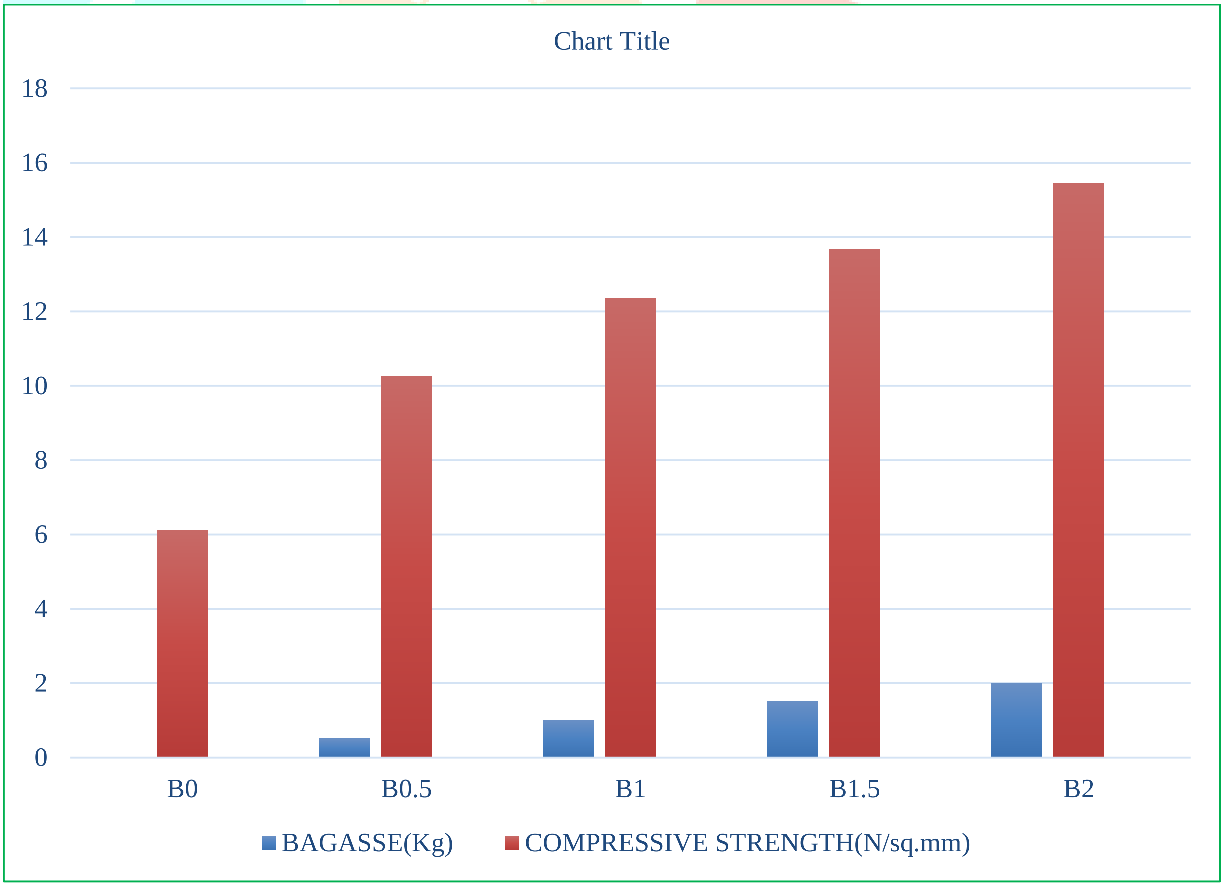

Figure 7 Compressive strength of bricks with percentage of bagasse

6.2 WATER ABSORPTION TEST

Table 3 Water absorption test results

MIX DESIGNATION	WATER ABSORPTION (%)
B0	3.0
B0.5	3.1
B1	3.5
B1.5	3.9
B2	4.9

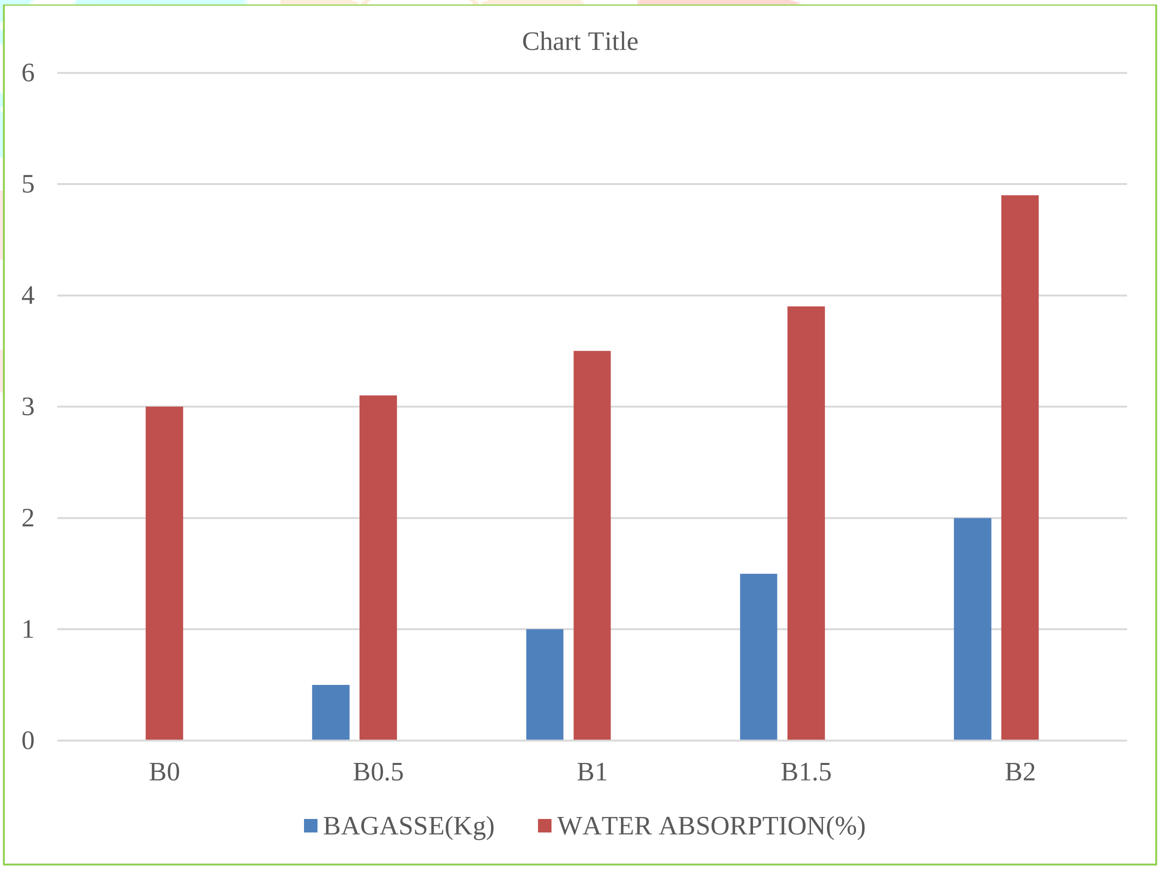

Figure 8 Water absorption of bricks with percentage of bagasse

VII. CONCLUSION

Non-burnt soil-cement bricks containing calcium carbonate sand, sugarcane bagasse, and fly ash present a viable and sustainable solution for the construction industry. They not only meet the necessary structural requirements but also offer environmental and economic advantages. Their adoption could pave the way for more eco-friendly construction practices.

From the above study the following conclusions are made:

1. The water absorption value increases as the percentage of bagasse increases. It can be observed that the water absorption value does not exceeding 20 % in any sample.
2. The compressive strength of bricks increases as the percentage of bagasse increases.
3. Non burnt soil cement bricks having CaCo3 sand, bagasse and fly ash offer a sustainable and environment friendly alternative to traditional burnt clay bricks.

Additional Benefits:

1. Cost-Effectiveness: The production cost of these bricks is lower due to the use of readily available industrial by-products.
2. Thermal Insulation: The bricks can significantly reduce room temperatures, contributing to energy savings in buildings.
3. Waste Reduction: Incorporating by-products like fly ash and bagasse helps in managing industrial waste effectively.

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