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Utilization of Bagasse Powder and Sugarcane Powder as Partial Replacements for Manufacturing Brick for Construction

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Abstract: *Bricks made from agricultural waste are becoming more popular due to the growing demand for environmentally friendly building materials. This study looks into adding bamboo powder and sugarcane bagasse to clay bricks as partial additives. According to accepted standards, bricks containing different amounts of these wastes were produced and evaluated for water absorption, compressive strength, and dimensional accuracy. The results show that the properties of the bricks are greatly impacted by bagasse and bamboo powder. With a compressive strength of 3.22 N/mm² and acceptable dimensional stability and water absorption, bricks containing 10% bagasse and 10% bamboo powder performed optimally. These bricks provide an environmentally responsible, sustainable, and structurally sound substitute for traditional clay bricks.*

Key Words: *Bagasse, Bamboo powder, Sustainable bricks, Waste materials, Compressive strength, Water absorption, Eco-friendly construction, Clay bricks.*

1. INTRODUCTION:

One of the earliest and most popular building materials, bricks are prized for their strength, resilience, and adaptability. Bricks are traditionally formed, dried, and fired from clay to create a solid, consistent unit that can be used for pavements, walls, and other structural applications. They are resistant to weathering, fire, and pests and offer outstanding load-bearing capacity. Bricks manufactured with additives like industrial or agricultural waste are also used in modern construction to increase performance and sustainability. In addition to having low water absorption, good thermal insulation, sound insulation, and fire resistance, high-quality bricks should have uniform color, the right size, plane faces, and fine texture. Their application helps create structures that are durable, secure, and energy-efficient.

1.1 QUALITY OF BRICKS:

Bricks should have square, sharp edges, be copper in color, and be thoroughly burned in kilns. Bricks should have a consistent size and shape. When bricks are struck together, they should produce a distinct ringing sound. Broken bricks should exhibit a compact, bright, homogeneous structure devoid of voids. After being soaked in cold water for a full day, bricks should not absorb more water than 20% of their weight for first-class bricks and 22% of their weight for second-class bricks.

1.2 PROPERTIES OF BRICKS:

Bricks used in construction should adhere to a number of crucial quality standards. Their shape should have plane faces with sharp, true right-angled corners, and their color should be consistent and bright. The texture should be fine, dense, and uniform, free of fissures, cavities, loose grit, or unburned lime. Standard sizes must be maintained. When struck with a hammer or another brick, bricks should make a metallic sound. After being soaked in cold water for a full day, bricks should not absorb more water than 20% of their weight for first-class bricks and 22% of their weight for second-class bricks. Bricks should also provide sufficient sound insulation (lighter or hollow bricks are more effective), have good fire resistance (often used to protect steel columns in structures), and have low thermal conductivity to keep buildings warm in the winter and cool in the summer.

2. LITERATURE REVIEW:

Kazmi et al. (2016): Reported the results of an experimental study on the manufacturing of sustainable clay bricks using waste sugarcane bagasse and rice husk ashes. The percentage of waste sugarcane bagasse and rice husk ashes added by weight was varied with 0, 25, 50, 75, and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of waste sugarcane bagasse and rice husk ashes on the mechanical properties and durability of the bricks were studied. Their results indicated that the increase in the proportions of waste sugarcane bagasse and rice husk ashes resulted in a decrease in the compressive strength of the bricks. The highest compressive strength was achieved in samples containing 25% waste sugarcane bagasse and rice husk ashes. The overall test performance revealed that waste sugarcane bagasse and rice husk ashes can be utilized as a partial replacement of clay in the manufacturing of sustainable clay bricks.

Michele Paradiso (2019): Reported the results of an experimental study on the usage of bamboo powder as an additive in adobe bricks and bamboo canes frame for the reinforcement of adobe structure. The percentage of bamboo powder added by weight was varied with 0, 25, 50, 75 and 100% as a replacement of traditional materials used in adobe bricks. The bamboo canes were used as a frame for reinforcement of the adobe structure. The effects of varying percentages of bamboo powder on compressive strength, tensile strength, and durability of the adobe bricks were studied. Their results indicated that the increase in the proportions of bamboo powder resulted in a change in the structural properties of the adobe bricks. The highest compressive strength was achieved in samples containing 25% bamboo powder, which was significant after a certain period. The overall test performance revealed that bamboo powder can be utilized as a partial replacement of traditional materials in adobe bricks and bamboo canes can effectively reinforce the adobe structure. This approach not only enhances the structural properties of the adobe bricks but also contributes to sustainable and eco-friendly construction practices.

Tripathi & Chauhan (2021): Reported the results of an experimental study on the usage of waste glass powder (WGP) as an additive in fired brick manufacturing. The percentage of WGP added by weight was varied with 0, 25, 50, 75 and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of WGP on compressive strength, water absorption, dimension tolerance, color variation, hardness, soundness, efflorescence, structure, and resistance against impact on the clay-only bricks and the bricks incorporating the WGP with varying proportions were studied. Their results indicated that the increase in the proportions of WGP resulted in a change in the structural properties of the bricks. The highest compressive strength was achieved in samples containing 20% WGP, which showed only 8.5% water absorption and a 77% rise in the compressive strength of the brick. Also, it was noted that a kiln temperature of 800 to 900 °C was required for baking the brick containing WGP, which is less than that required for the brick prepared by clay only. Economic analysis indicates that there can be an 11.3% saving of manufacturing cost with the use of 20% by weight of the WGP in the clay brick. The overall test performance revealed that WGP can be utilized as a partial replacement of clay in the manufacturing process of fired clay bricks. This approach not only enhances the structural properties of the bricks but also contributes to sustainable and eco-friendly construction practices.

Abbas et al. (2021): Reported the results of an experimental study on the manufacturing of clay bricks using hybrid waste marble powder and sugarcane bagasse ash. The percentage of waste marble powder and sugarcane bagasse ash added by weight was varied with 0, 25, 50, 75 and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of waste marble powder and sugarcane bagasse ash on the bricks' compressive strength, water absorption, and durability were studied. Their results indicated that the increase in the proportions of waste marble powder and sugarcane bagasse ash resulted in a change in the structural properties of the bricks. The highest compressive strength was achieved in samples containing 25% waste marble powder and sugarcane bagasse ash. The overall test performance revealed that waste marble powder and sugarcane bagasse ash can be utilized as a partial replacement of clay in the manufacturing of clay bricks. This approach not only enhances the structural properties of the bricks but also contributes to sustainable and eco-friendly construction practices.

Jagadeshwaran & Vijaya Sundravel (2019): Reported the results of an experimental study on the manufacturing of clay bricks using hybrid waste marble powder and sugarcane bagasse ash. The percentage of waste marble powder and sugarcane bagasse ash added by weight was varied with 0, 25, 50, 75 and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of waste marble powder and sugarcane bagasse ash on compressive strength, water absorption, and durability of the bricks were studied. Their results indicated that the increase in the proportions of waste marble powder and sugarcane bagasse ash resulted in a change in the structural properties of the bricks. The highest compressive strength was achieved in samples containing 25% waste marble powder and sugarcane bagasse ash. The overall test performance revealed that waste marble powder and sugarcane bagasse ash can be utilized as a partial replacement of clay in the manufacturing of clay bricks. This approach not only enhances the structural properties of the bricks but also contributes to sustainable and eco-friendly construction practices.

Pawar (2014): Reported the results of an experimental study on the engineering properties of clay bricks with the use of fly ash. The percentage of fly ash added by weight was varied with 0, 25, 50, 75 and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of fly ash on compressive strength, water absorption, and durability of the bricks were studied. Their results indicated that the increase in the proportions of fly ash resulted in a change in the structural properties of the bricks. The highest compressive strength was achieved in samples containing 25% fly ash. The overall test performance revealed that fly ash can be utilized as a partial replacement of clay in the manufacturing of clay bricks. This approach not only enhances the structural properties of the bricks but also contributes to sustainable and eco-friendly construction practices.

Ramakrishnan et al. (2023): Reported the results of an experimental study on the manufacturing of low-cost bricks using waste materials. The percentage of various waste materials, including fly ash, quarry dust, marble dust, eggshell powder (ESP), and rice husk ash (RHA), added by weight was varied with 0, 25, 50, 75, and 100% as a replacement of clay used in brick manufacturing. The effects of varying percentages of these waste materials on compressive strength, water absorption, and durability of the bricks were studied. Their results indicated that the increase in the proportions of these waste materials resulted in a change in the structural properties of the bricks. The highest compressive strength was achieved in samples containing 25% of these waste materials. Furthermore, the cost of manufacturing bricks from waste materials was estimated, and the findings show that manufacturing bricks from waste materials cost less than conventional bricks. The overall test performance revealed that these waste materials can be utilized as a partial replacement of clay in the manufacturing of low-cost bricks[1]. This approach not only enhances the structural properties of the bricks but also contributes to sustainable and eco-friendly construction practices.

3. OBJECTIVES :

To develop sustainable bricks incorporating waste materials such as bagasse and bamboo powder as additives for sustainable Construction.

4. METHODOLOGY :

Three samples were manufactured using different proportions of Soil, Fly ash, bamboo and Bagasse Powder as shown in Table 1, Table 2, & Table 3 respectively.
Dimensional, compressive strength, and water absorption tests were performed, and the results were compared with standard bricks available in the market.

Table 1: Composition of Soil in Bricks

S.No	Mix Details	% of Soil Added
1	Sample 1	50%
2	Sample 2	50%
3	Sample 3	50%

Table 2: Composition of Fly Ash in Bricks

S.No	Mix Details	% of Fly Ash Added
1	Sample 1	35%
2	Sample 2	30%
3	Sample 3	25%

Table 3: Composition of Bagasse and Bamboo Powder in Bricks

S.No	Mix Details	% of Bagasse Added	% of Bamboo Powder Added
1	Sample 1	7.5%	7.5%
2	Sample 2	10%	10%
3	Sample 3	12.5%	12.5%

5. RESULTS :

5.1-Dimensional Test Results:

Table 4: Conventional Sample

Specimen No.	Length (L) mm	Breadth (B) mm	Height (H) mm	Average Dimensions (mm) L × B × H
Specimen 1	224	101	73	224 × 102 × 74.33
Specimen 2	227	103	75	
Specimen 3	221	102	75	

Table 5: Sample 1 (7.5% Bagasse and 7.5% Bamboo Powder)

Specimen No.	Length (L) mm	Breadth (B) mm	Height (H) mm	Average Dimensions (mm) L × B × H
Specimen 1	228	101	72	228 × 102 × 71.33
Specimen 2	228	103	70	
Specimen 3	228	102	72	

Table 6: Sample 2 (10% Bagasse and 10% Bamboo Powder)

Specimen No.	Length (L) mm	Breadth (B) mm	Height (H) mm	Average Dimensions (mm) L × B × H
Specimen 1	227	103	71	227 × 102 × 71
Specimen 2	226	101	70	
Specimen 3	228	102	72	

Table 7: Sample 3 (12.5% Bagasse and 12.5% Bamboo Powder)

Specimen No.	Length (L) mm	Breadth (B) mm	Height (H) mm	Average Dimensions (mm) L × B × H
Specimen 1	224	102	72	226.33 × 102 × 72.67
Specimen 2	228	103	72	
Specimen 3	227	101	74	

5.2 Compressive Strength Test Results:

Table 8 : Conventional Sample

Specimen No.	Maximum Load at Failure (kN)	Area of Cross-Section (mm^2)	Compressive Strength (N/mm^2)	Average compressive strength (N/mm^2)
Specimen 1	72	228.6 x 101.6	3.10	3.61
Specimen 2	87	228.6 x 101.6	3.74	
Specimen 3	93	228.6 x 101.6	4.00	

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Table 9 : Sample 1 (7.5% Bagasse and 7.5% Bamboo Powder)

Specimen No.	Maximum Load at Failure (kN)	Area of Cross-Section (mm²)	Compressive Strength (N/mm²)	Average compressive strength (N/mm²)
Specimen 1	66	228.6 x 101.6	2.84	2.72
Specimen 2	61	228.6 x 101.6	2.62	
Specimen 3	63	228.6 x 101.6	2.71	

Table 10: Sample 2 (10% Bagasse and 10% Bamboo Powder)

Specimen No.	Maximum Load at Failure (kN)	Area of Cross-Section (mm²)	Compressive Strength (N/mm²)	Average compressive strength (N/mm²)
Specimen 1	41	228.6 x 101.6	1.76	3.22
Specimen 2	117	228.6 x 101.6	5.03	
Specimen 3	67	228.6 x 101.6	2.88	

Table 11: Sample 3 (12.5% Bagasse and 12.5% Bamboo Powder)

Specimen No.	Maximum Load at Failure (kN)	Area of Cross-Section (mm²)	Compressive Strength (N/mm²)	Average compressive strength (N/mm²)
Specimen 1	45	228.6 x 101.6	1.93	1.81
Specimen 2	47	228.6 x 101.6	2.02	
Specimen 3	35	228.6 x 101.6	1.50	

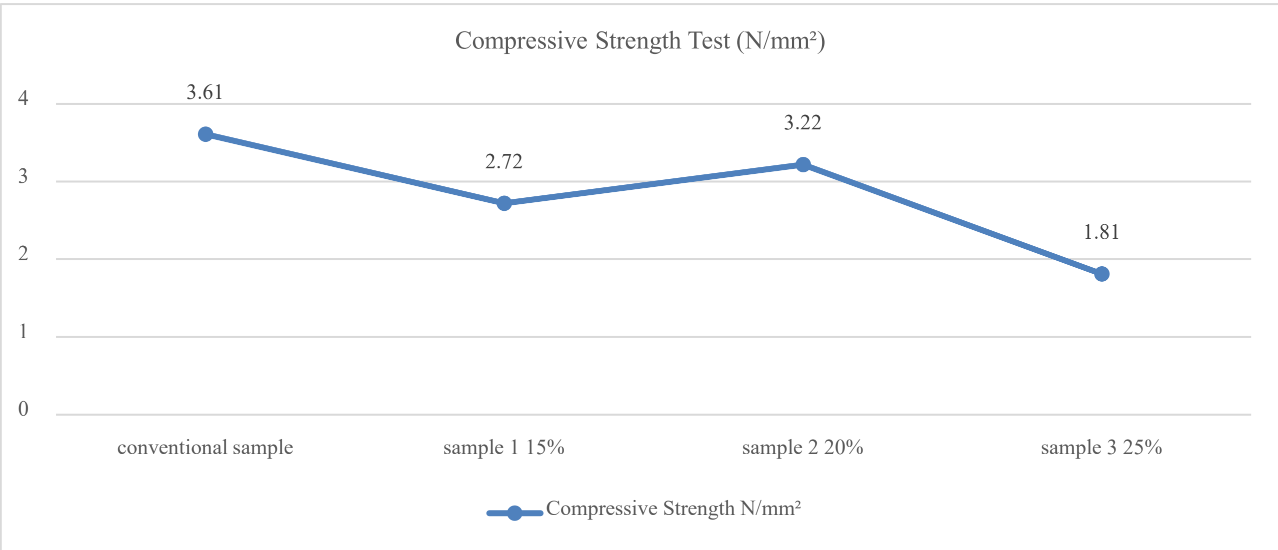

Fig 1 : Compressive Strength Test (N/mm²)

5.3 Water Absorption Test Results:

Table 12: conventional sample

Specimen No.	Dry Weight (W1) kg	Wet Weight (W2) kg	Water Absorption (%)	Average Water Absorption (%)
Specimen 1	2.242	2.971	32.51	30.69
Specimen 2	2.266	2.972	31.16	
Specimen 3	2.268	2.912	28.39	

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Table 13: Sample 1 (7.5% Bagasse and 7.5% Bamboo Powder)

Specimen No.	Dry Weight (W1) kg	Wet Weight (W2) kg	Water Absorption (%)	Average Water Absorption (%)
Specimen 1	2.040	2.735	34.07	33.23
Specimen 2	2.050	2.703	31.85	
Specimen 3	2.054	2.748	33.78	

Table 14: Sample 2 (10% Bagasse and 10% Bamboo Powder)

Specimen No.	Dry Weight (W1) kg	Wet Weight (W2) kg	Water Absorption (%)	Average Water Absorption (%)
Specimen 1	2.049	2.696	31.56	30.96
Specimen 2	2.099	2.752	31.10	
Specimen 3	2.068	2.692	30.23	

Table 15: Sample 3 (12.5% Bagasse and 12.5% Bamboo Powder)

Specimen No.	Dry Weight (W1) kg	Wet Weight (W2) kg	Water Absorption (%)	Average Water Absorption (%)
Specimen 1	2.067	2.655	28.44	29.60
Specimen 2	2.040	2.666	30.68	
Specimen 3	2.040	2.646	29.70	

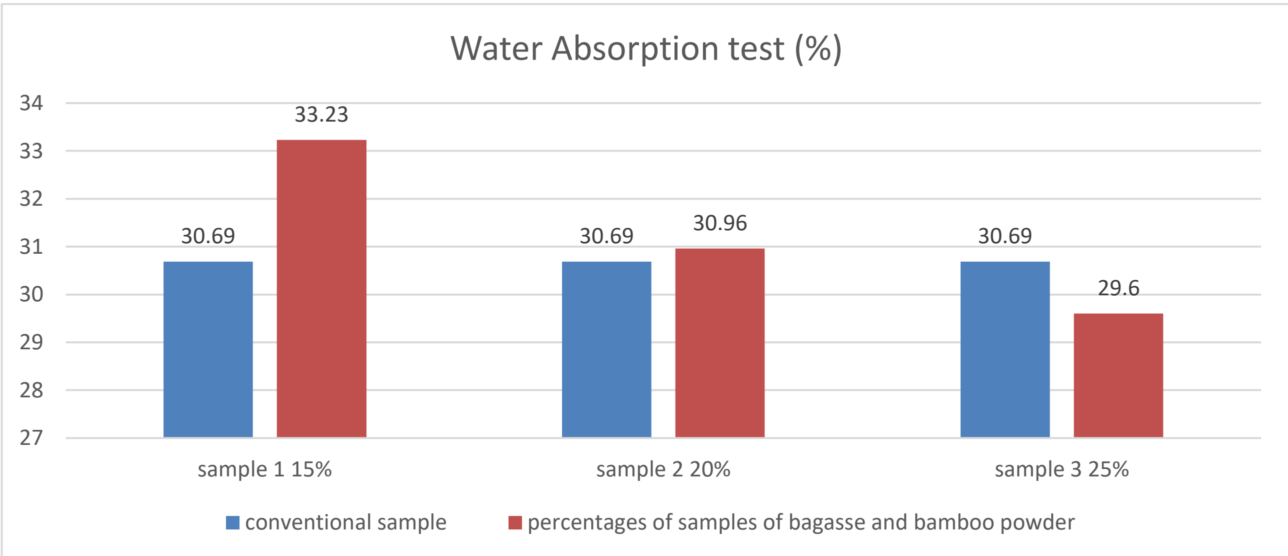

Fig 2: Water Absorption Test (%)

6. CONCLUSION :

- The study on the utilization of bagasse and bamboo powder in brick manufacturing provided valuable insights into the influence of these waste materials on the physical and mechanical properties of bricks.
- Based on the experimental results, bricks containing 10% bagasse and 10% bamboo powder exhibited the optimum compressive strength of 3.22 N/mm².

- Therefore, bricks incorporating a total of 10% admixture of bagasse and 10% of bamboo powder are recommended as a viable alternative to conventional bricks, offering a sustainable, eco-friendly, and structurally reliable solution for construction applications.

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