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Cement Board Using Discarded Peanut Shell (*Arachis Hypogaea)*

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Abstract: This study investigates the use of powdered peanut shells as a sustainable alternative in cement board production. With the growing emphasis on eco-friendly construction materials, exploring alternative resources is essential. Cement boards were fabricated incorporating powdered peanut shells at varying percentages (5%, 10%, and 15% by weight) relative to the total weight of the cement mixture. The preparation involved calculating the sample volume, adjusting the mixture weight to account for the peanut shells, and setting the water-cement ratio to 0.46. The process included grinding the peanut shells, measuring all components, and thoroughly mixing them before molding. The mixtures were cured in a controlled environment to promote proper setting.

The physical, mechanical, and thermal properties of the resulting boards were evaluated according to ASTM standards and analyzed using SPSS. Notably, the 5% mix achieved the highest density (1.60 g/cm³) and demonstrated excellent heat resistance, while the 15% mix exhibited the greatest thickness (1.24 cm) and lowest water absorption (10.99%). The 10% mix resulted in the highest compressive (11.28 MN/m²) and tensile strengths (0.24 N/cm²). The findings suggest that incorporating powdered peanut shells significantly improves the properties of cement boards, presenting a viable and sustainable construction option. Future studies should focus on optimizing these mixtures and assessing their long-term durability.

Keywords: Cement board, Peanut Shell, discarded peanut, parameters, powdered peanut shell, cement mixture

I. Introduction

The construction industry is a major contributor to economic growth and urbanization but also significantly impacts environmental degradation and resource consumption (Smith et al., 2019). Among the materials commonly used, fiber cement boards stand out for their durability and resistance to fire, water, and termites, making them ideal for rapid construction. However, their production can be costly and time-consuming, often making them more expensive than traditional materials like plywood (Visaka Industries, 2023).

Amidst increasing environmental concerns, there is a pressing need for sustainable construction solutions. Agricultural waste, particularly peanut shells, offers a promising alternative. These lignocellulosic byproducts can enhance the properties of cementitious materials while helping to mitigate waste management issues (Brown & Lee, 2018).

This study aims to explore the feasibility of using powdered peanut shells in cement board production. The primary objectives include determining the optimal proportions of peanut shells (5%, 10%, and 15% by weight) that yield superior mechanical, physical, and thermal properties. The methodology involves assessing key properties such as density, thickness, water absorption, and strength characteristics, contributing to the development of eco-friendly construction materials.

II. Methodology

A. Study Location

This study was conducted in a residential house located on Telecom Drive, Talon-Talon, Zamboanga City, owned by researcher Nafisa Salahiron. This location was selected for its ample space and suitability for the experimental procedures.

B. Materials and Equipment

A total of 26 kilograms of peanuts were collected from KCC Mall de Zamboanga. The following equipment was used:

- Grinders
- Chipboard molds
- Measuring tools
- Containers for mixing and measuring

C. Preparation of Materials

The preparation of powdered peanut shells involved several sequential steps:

1. Collection and Washing: Peanuts were collected and thoroughly washed to remove any soil.

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Fig.1. Peanuts used in the study

2. Sun Drying: The washed peanuts were sun-dried for two days, reducing their weight to 15.5 kilograms.
3. Peeling: The dried peanuts were peeled, yielding 3.6 kilograms of shells.

Fig.2. Peanut Shells

4. Grinding: The peanut shells were then ground into a fine powder, resulting in 3.5 kilograms of powdered peanut shells.

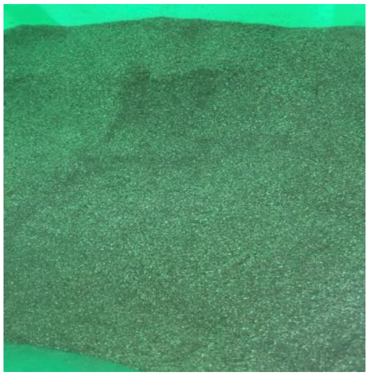

Fig.3 Powdered peanut shell

D. Mold Fabrication

Molds were constructed from chipboard based on specified dimensions aligned with ASTM standards for various tests. The chipboard was marked, cut, and folded to create molds for the following tests:

- Density
- Thickness
- Water Absorption
- Flexural Strength
- Tensile Strength

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Quality control measures were implemented to ensure accuracy in dimensions and construction integrity.

E. Mixing Process

The mixing process involved calculating the required volumes for each mixture, incorporating peanut shell proportions of 5%, 10%, and 15%, while maintaining a constant water-to-cement ratio of 0.46. A total of 72 samples were prepared, with each parameter having nine replicates.

Table1. Mixture proportion for Density Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	53 x 3 = 159	688 x 3 = 2,064	316 x 3 = 948
10%	106 x 3 = 318	652 x 3 = 1,956	300 x 3 = 900
15%	159 x 3 = 477	615 x 3 = 1,845	283 x 3 = 849
Total	954	5865	2697

Table2. Mixture proportion for Thickness Test

Mixture %	Peanut (g) (3 Trials)	Cement (g)(3 Trials)	Water (g) (3 Trials)
5%	53 x 3 = 159	688 x 3 = 2,064	316 x 3 = 948
10%	106 x 3 = 318	652 x 3 = 1,956	300 x 3 = 900
15%	159 x 3 = 477	615 x 3 = 1,845	283 x 3 = 849
Total	954	5865	2697

Table3. Mixture proportion for Water Absorption Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	11 x 3 = 33	146 x 3 = 438	67 x 3 = 201
10%	22 x 3 = 66	139 x 3 = 417	63 x 3 = 189
15%	34 x 3 = 102	130 x 3 = 390	60 x 3 = 180
Total	201	1,245	570

Table4. Mixture proportion for Compressive Strength Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	12 x 3 trials = 36	153 x 3 trials = 459	70 x 3 trials = 210
10%	24 x 3 trials = 72	145 x 3 trials = 435	67 x 3 trials = 201
15%	35 x 3 trials = 105	137 x 3 trials = 411	63 x 3 trials = 189
Total	213	1,305	600

Table5. Mixture proportion for Tensile Strength Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	3.5 x 3 = 10.5	46 x 3 = 138	21 x 3 = 63
10%	7 x 3 = 21	43 x 3 = 129	20 x 3 = 60
15%	10.5 x 3 = 31.5	40 x 3 = 120	18 x 3 = 54
Total	63	387	177

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Table 6. Mixture proportion for Flexural Strength Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	53 x 3 = 159	688 x 3 = 2,064	316 x 3 = 948
10%	106 x 3 = 318	652 x 3 = 1,956	300 x 3 = 900
15%	159 x 3 = 477	615 x 3 = 1,845	283 x 3 = 849
Total	954	5865	2697

Table7. Mixture proportion for Flammability Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	51 x 3 = 153	666 x 3 = 1,998	306 x 3 = 918
10%	102 x 3 = 306	631 x 3 = 1,893	290 x 3 = 870
15%	153 x 3 = 459	596 x 3 = 1,788	274 x 3 = 822
Total	918	5,679	2,610

Table 8. Mixture proportion for Heat Resistance Test

Mixture %	Peanut (g) (3 Trials)	Cement (g) (3 Trials)	Water (g) (3 Trials)
5%	46 x 3 = 138	595 x 3 = 1,785	274 x 3 = 822
10%	92 x 3 = 276	557 x 3 = 1,671	266 x 3 = 798
15%	137 x 3 = 411	526 x 3 = 1,578	242 x 3 = 726
Total	825	5,034	2,346

Table 9. Mixture Proportions for the Total Ratio and Proportion of Materials

Cement (kg)	Powdered Peanut Shell (kg)	Water (kg)	No. of Trials
6,882	529.5	3,162	24
6,501	1,059	3,018	24
6,132	1,585.5	2,760	24
Total 19,515	3,174	9,000	72

Testing Procedures

Various physical and mechanical properties were tested as follows:

- Density: Specimens measuring 300 mm x 150 mm x 12 mm were weighed, and their volumes were calculated to determine density.
- Water Absorption: Specimens (100 mm x 100 mm x 12 mm) were submerged in water for 24 hours, and the water absorption percentage was calculated.
- Thickness: The thickness of samples sized 300 mm x 300 mm x 12 mm was measured using a ruler.
- Compressive Strength: This was assessed in a laboratory setting at the Department of Public Works and Highways in Tumaga.
- Tensile Strength: Specimens (10 cm x 5 cm x 1.2 cm) were tested using G-clamps and a digital scale.
- Flexural Strength: Specimens measuring 300 mm x 150 mm x 12 mm were evaluated using established bending tests.
- Heat Resistance: Specimens (200 mm x 200 mm x 10 mm) were heated in an oven to evaluate their response to high temperatures.

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- Flammability: Specimens (230 mm x 230 mm x 10 mm) were tested using a stove to assess ignition and combustion characteristics.

G. Data Analysis

Data were analyzed using IBM SPSS Statistics (version 20). Normality and homogeneity of variance were assessed, followed by One-way ANOVA to compare group differences across the tested parameters.

IV. Results

The investigation into discarded peanut shell boards reveals critical insights into their physical, mechanical, and thermal properties based on varying compositions.

A. Physical Properties

The 5% peanut shell mixture shows high density (1.60 g/cm³), while the 15% mixture achieves the best thickness (1.24 cm) and the lowest water absorption (10.99%). Lower peanut content generally enhances density, while higher content increases thickness, though it also leads to higher water absorption.

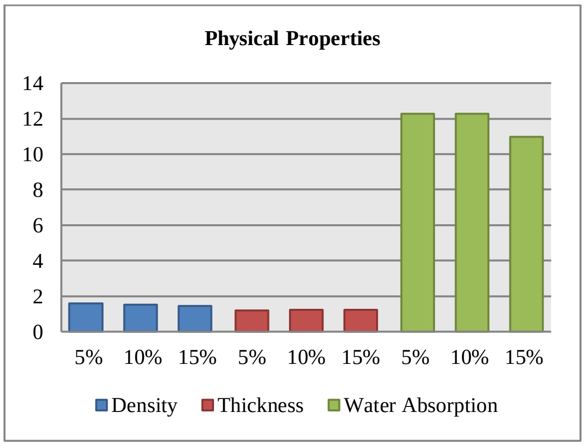

Figure 4.8 Proportions of Physical Properties

B. Mechanical Properties

For compressive strength, the 10% mixture excels at 11.28 MN/m², and the same proportion shows superior tensile strength at 0.24 N/cm². Conversely, the 5% mixture demonstrates the highest flexural strength at 0.0703 MPa. This indicates that higher peanut shell content often results in lower mechanical strength, impacting the board's suitability for construction.

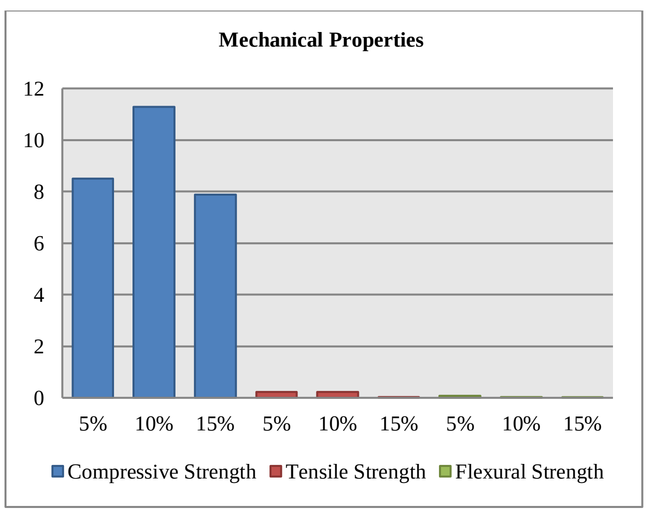

Figure 2. Proportions of Mechanical Properties

C. Thermal Properties

The 5% mixture also exhibits the longest flammability time (308 seconds), indicating better fire resistance. Consistent results in heat resistance tests show no structural damage at elevated temperatures across all mixtures. However, the 15% mixture produces a stronger odor compared to the milder scent of the 5% mixture.

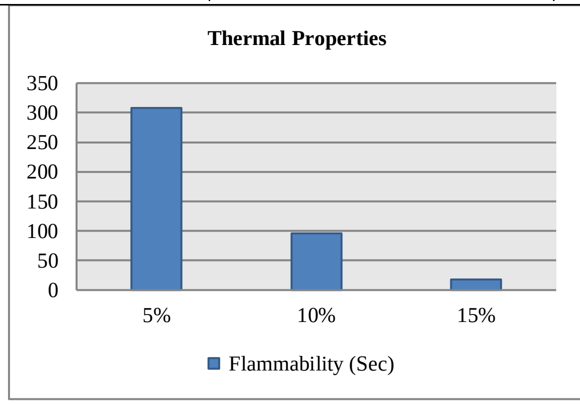

Figure 3. Proportions of Thermal Properties

D. Summary of Findings

Overall, a lower peanut mixture correlates with higher density, flammability resistance, and heat resistance, while higher mixtures tend to lower compressive, tensile, and flexural strength. These results underscore the necessity of carefully optimizing the composition of discarded peanut shell boards to enhance their performance for various applications in construction and fire safety.

V. Conclusion

This study investigated the impact of varying proportions of peanut shells (5%, 10%, and 15%) on the physical, mechanical, and thermal properties of cement boards.

In terms of physical properties, the results indicated that density, thickness, and water absorption were largely unaffected by the different proportions of peanut shells. Despite variations in the mixtures, no significant differences in density or thickness were observed, suggesting that the addition of peanut shells does not meaningfully alter these characteristics in the tested proportions.

Conversely, mechanical properties exhibited significant variations, particularly in tensile, flexural, and compressive strengths. The amount of peanut shells in the mix had a direct influence on these strength characteristics, with notable differences identified across the various proportions. This indicates that the composition of peanut shells plays a crucial role in determining the structural integrity of the cement boards.

Regarding thermal properties, the findings revealed that the 5% peanut shell mixture demonstrated the best flammability performance, with a combustion time of 308 seconds, highlighting its potential for applications requiring enhanced fire resistance. This mixture also positively influenced the material's heat resilience, making it suitable for fire safety-related construction. Importantly, all trials showed no signs of discoloration or cracking at elevated temperatures, indicating stability across different mixtures. However, higher peanut shell proportions were associated with increased odor intensity, with the 15% mixture exhibiting a significantly stronger smell than the 5% mixture.

In conclusion, while the physical properties of the cement boards remained consistent across the tested proportions, both mechanical and thermal properties were significantly affected by the inclusion of peanut shells. Future research should focus on optimizing these proportions to enhance the performance of cement boards, particularly in applications where mechanical strength and thermal resilience are essential.

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