Hollow Compressed Earth Block Stabilized (HCEB) with Coir Fiber as Sustainable Low-Cost Housing Wall Material

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***Abstract*: Earth with its availability and advantages to decrease the carbon footprint has been contributing to environmental empowerment, a key factor to construction and materials field. This study focuses on integrating materials with their sustainability and low-cost effectiveness but still bringing the Hollow Compressed Earth Blocks durability on par with standard structural requirement or standard strength. Optimal mixture design significantly achieves a fine balance between compression and flexural strength. Furthermore, using cost estimation to determine and verify the cost effectiveness of the specimen as a Housing Wall Material, it is discovered that it is indeed a desirable option in the market. In addition, ASTM standards and specifications served to verify the consistent increase in flexural strength as the coir fiber percentage increases. The selected soil type, clay, provides good load-bearing capacity with optimal moisture content. Poor dimensional stability and susceptibility to erosion due to rain were mitigated by using cement as a stabilizing agent.**

***Keywords*: Coir Fiber, Compressed Earth Blocks, Hollow Blocks, Sustainable Housing, Low-Cost Construction, Flexural Strength, Compressive Strength.**

1. Introduction

In the pursuit of sustainable and cost-effective solutions for housing, the integration of innovative building materials has become a main consideration [1]. The Hollow Compressed Earth Block Stabilized (HCEB) with Coir Fiber have been the great hope for sustainable construction and might have been a viable alternative to traditional building materials [2]. Hollow compressed earth blocks were gaining in popularity as a building material because they required very little energy to produce and utilize a resource that is very often locally sourced, which of course carried an environmental advantage [3]. However, by incorporating hollow cores, the material's thermally insulating properties were improved and total material requirements were considerably reduced, making for an even more green building process. In this case, the hollow compressed earth blocks (HCEB) were formed when coir fiber, a natural and renewable resource made from coconut husks, was mixed in. The result revealed that HCEBs were not only incredibly strong and durable, but which went a very long way in reducing the environmental footprint of traditional building materials [4].

Meanwhile, coir fiber, with its tensile strength, torsional flexibility and resistance to decay, imparts several beneficial properties to the HCEB. Not only does coir fiber served as a stabilizing agent for the block, augmenting insulating properties, it also helped to keep the blocks' structural integrity intact so that "the block was able to sustain stresses associated with the shipping, transforming, and setting it face to face over time" [5]. Leaving out a portion of the aggregate and replacing with coir fiber made the blocks stronger, reducing traditional reinforcing and lower costs making sustainable housing more viable to low-income populations [6]. The development and application of innovative building materials were of critical importance in addressing the mounting international challenges of housing shortages, environmental degradation, and economic and social inequality. The emergence of Hollow Compressed Earth Block (HCEB) incorporating coir fiber represented a significant event in this transition; it was helping to literally shape the future of affordable, sustainable housing [7]. HCEBs with coir fiber were examined as more than an answer to immediate global dilemmas; they might very well represent the symbol of their eventual economic, ecological, and social transformation [24]. Hollow Compressed Earth Block (HCEB) reinforced with coir fiber made quite the splash as a formidable entrant onto the scene and furthered their viability and validity as the material of the future for low-cost sustainable housing [5]. Their research indicated the huge global economic, environmental and community value to building with coir fiber reinforced HCEB. Including coir fiber (a natural byproduct) transformed HCEBs from a strong material to a stronger material with enhanced environmental profile to create a methodology of building that is more regenerative and sustainable.

Affordable cost was one of the most important advantages of coir fiber HCEBs. It was possible to keep the construction cost low, since the materials could be locally produced, and the production processes could be simplified. Its affordability made it possible for the poor people to have more sustainable habitation and to facilitate their living conditions. The proposed construction technique could be used for mass housing and community development programs because it was very cost effective. There were some compelling reasons why “Hollow Compressed Earth Block Stabilized (HCEB) with Coir Fiber as Sustainable Low-Cost Housing Wall Material” was selected as the research topic; firstly, there was a pressing need for creative affordable solutions since the world’s housing problem had escalated especially in areas with low economies. Therefore, it would be possible to assess affordable building materials that addressed not only the shortage of inexpensive accommodation but also contributed to environmental sustainability by looking through this topic.

Furthermore, the opportunity for community empowerment affected the decision to focus on HCEBs with coir fiber. This technology was available to communities, which encourages self-reliance and ownership with its simple manufacturing process and reliance on locally available resources. The purpose of this study was to contribute towards socially inclusive, sustainable and empowering housing solutions by selecting this topic [5]. There were multiple options for studying because this field was transdisciplinary in nature. Full understanding of the implications that come along with adopting such inventive building materials comes from research on HCEBs that used coir fiber which connected disparate aspects of civil engineering, environmental science, and community development [7]. The researcher expected output of this research study is to provide a whole understanding of HCEBs with coir fiber as a sustainable, low-cost housing wall material. This knowledge could inform future construction practices, promote eco-friendly building solutions, and contribute to the advancement of affordable housing initiatives.

2. Methodology

A. Research Process

The following were the methods and procedures used to create the data needed for this study:

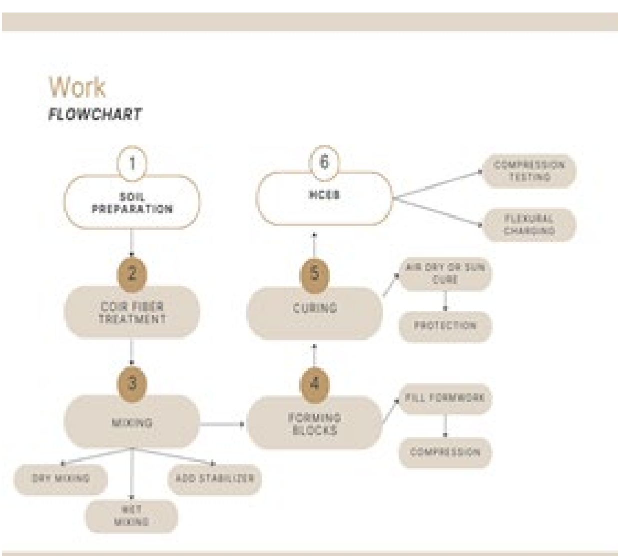

Fig. 1. Work Flowchart

1) *Step 1. Soil Preparation:*
   a. *Collect Soil*: Soil was gathered from the construction site or nearby areas.
   b. *Testing*: The soil was tested for its composition, especially the clay content.
2) *Step 2. Coir Fiber Treatment*
   a. Coconut fiber of the highest caliber, with the desired qualities, such as strength, length, and few contaminants were selected.
   b. The coconut fibers were chopped or shreded into appropriate lengths. Depending on the needs of the compressed earth block design, the fibers' length could be changed.
3) *Step 3. Mixing*
   a. *Dry Mixing*: The soil and coir fiber were fed into the mixer to form a homogeneous mixture in dry condition.
   b. *Wet Mixing*: Water was added in small quantities while mixing, until the desirable final moisture content is attained.
   c. *Add Stabilizer*: A stabilizing agent like cement was added to enhance the strength & durability of the blocks. The quantity of the stabilizer depends upon the soil composition and local conditions.
4) *Step 4. Forming Blocks*
   a. Fill Formwork: The mixed material was put into the formwork level by level and compacted by hand or by machine.
   b. *Compression*: The Earth block/coir was then compressed within the formwork either mechanically or manually. The compression was done to gain strength of the blocks.
5) *Step 5. Curing:*
   a. *Air Dry or Sun Cure*: Blocks were allowed to air-dry or sun-cure for a specific period for additional strength and stability.
   b. *Protection*: Cured blocks were protected against heavy rain, especially rammed earth and soil-cement blocks.

B. Material Requirements

The following is a tabulated list of materials necessary in producing hollow compressed earth blocks.

This study explored the mixed design of Hollow Compressed Earth Blocks (HCEBs) stabilized with coir fiber. The physical and mechanical characterization of the soil was imperative to understand the unique characteristics of a particular local earth by performing a detailed particle size distribution and plasticity analyses. A series of potential stabilizers, from traditional (cement) to environmentally friendly (biopolymers) were also investigated to achieve a good compromise between the increase in the compressive strength and the sustainability of the blocks.

The mix design of Hollow Compressed Earth Blocks (HCEBs) is usually called for 70-85% earth and 10-15% cement (Latha & Murugesan, 2023).

Table 1
Material used for hollow compressed earth blocks

NO.	MATERIALS	SPECIFICATION
1	**Soil or Earth**	The soil used in the hollow compressed earth blocks was a clay type and should passes through sieve no. 200 (0.075mm).
2	Coir Fiber	Coir fiber was known for its natural strength and flexibility. In HCEBs, treated coir fiber was added to the soil mix in an effort to improve overall tensile strength and reduce cracking in the blocks
3	Cement	The cement served as a type of stabilizer for the blocks, in that it gave the blocks more cohesion by binding the earth soil particles. The exact amount of cement was used to give the block the required strength needs for each project. Locally available Type 1 Portland Cement was selected based on the type of soil to be used and the requirements for each project.
4	Water	Water was also added to the earth soil mixture. Water was added throughout the production process to provide the necessary moisture content to achieve adequate binding and compaction. The water content influences the strength and structural integrity of the blocks, and therefore, it was essential that this be closely controlled. It should not have contained contaminants, and specifically to use tap water.

There was a tradeoff in the ratio since the coir fiber was meant to lend tensile strength, and ultimately also the structural stability, to the blocks. However, the call there was also conditional on the specifics of various soils – e.g. consistency, density, type of particles and particle size, level of compaction, etc. – and the overall performance one wished to get out of sustainable and cost-effective construction. According to (Zhang, 2024), the common water-cement-soil mixture for compressed earth block ½:½:5.

C. Dimension:

- *Length*: 40cm
- *Height*: 20cm
- *Width*: 6 in (15.24cm)

Using a water-cement-soil ratio ½:½:5 of Hollow Compressed Earth Block Mixture

1) Sample 1: Using 75% of Clay, 25% Coir Fiber
Buckets of Clay: 5 x 0.75 = 3.75
Buckets of Coir Fiber: 6 x 0.25 = 1.25
Buckets of Cement: ½

2) Sample 2: Using 80% of Clay, 20% Coir Fiber
Buckets of Clay: 5 x 0.8 = 4
Buckets of Coir Fiber: 5 x 0.20 = 1
Buckets of Cement: ½

3) Sample 3: Using 85% of Clay, 15% Coir Fiber
Buckets of Clay: 5 x 0.85 = 4.25
Buckets of Coir Fiber: 5 x 0.15 = 0.75
Buckets of Cement: ½

D. Specimen Details

Hollow Compressed Earth Block (HCEB) specimens were typically 40 cm long, 20 cm wide (both outside dimensions) and about 6 inches in height. The aspect ratio (length-to-width) should remain the same across all specimens. Dimensions for HCEB specimens stabilized with coir fiber were likely very similar and the shape was generally rectangular. Specimen designs addresses surface finish, material thickness and distribution of coir fibers within the block. The number of coir fibers, length of coir fibers and orientation of coir fibers were some of the primary factors that should be documented to assure careful representation and testing in the laboratory.

1) Sample 1: Using 85% Of Clay, 15% Coir Fiber

- Clay =4.25 bucket
- Treated Coconut Coir =0.75 bucket
- Cement = ½ bucket
- Water = ½ bucket

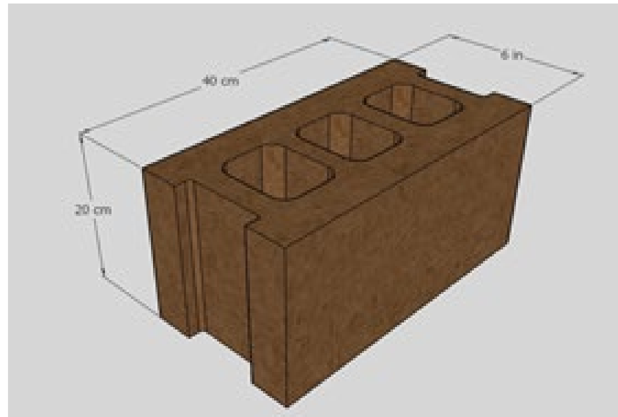

Fig. 2. HCEB physical measurements

2) Sample 2: Using 80% Of Clay, 20% Coir Fiber

- Clay = 4 bucket
- Treated Coconut Coir = 1 bucket
- Cement = ½ bucket
- Water = ½ bucket

3) Sample 3: Using 75% Of Clay, 25% Coir Fiber

- Clay =3.75 bucket
- Treated Coconut Coir =1.25 bucket
- Cement = ½ bucket
- Water = ½ bucket

Hollow Compressed Earth Blocks (HCEBs) were tested for compression to demonstrate structural integrity and performance. The test utilized a compression testing machine, sometimes called a compressive strength testing machine, which applied controlled axial loads to HCEB specimens until failure. The machine consisted of a load frame that included a loading system and a load cell to measure the force on the HCEB specimen. Modern machines operated under hydraulic or mechanical actuation and incorporated a data acquisition system, which captured and analyzed force & deformation data throughout the test. When carrying out the compression test, representative HCEB specimens were prepared and aligned in the machine. Compressive loads were gradually applied to the specimens, and data was collected to determine the compressive strength of the blocks. The importance of this testing process lies in its ability to serve as an essential quality control in sustainable construction that could ensure the loading capacity and structural suitably of HCEBs for different building applications.

E. Laboratory/Experiment/Field Experiment

1) Compressive Strength Test ASTM C140/140M -14

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2) Flexural Strength Test / Universal Testing Machine (UTM)

The flexural test is a critical stage in assessing the potential construction applications of the hollow compressed earth blocks. This consisted of bending typical specimens over supports, to gauge their deformation resistance. It began by selecting the blocks that meet the desired dimensions and were free from apparent flaws. Once again, those that were featured here satisfied the requirements. A test apparatus was then installed, oriented with the hollow side up, over supports and the blocks were placed within. A continually increasing load is applied at the midpoint of the specimen, with a testing machine capable of universal testing, in accordance with recognized standards, as shown below. A full set of data is collected: load-deflection curves, along with the appearance of any form apparent cracking or deformation. The test stopped either when failure occurs or at a predefined cutoff point. Once the test had concluded, the data was interpreted to determine key attributes such as the flexural strength and the modulus of elasticity of the blocks. These attributes were then compared with industry standards to determine whether the hollow compressed earth blocks were fit for use. The results of the flexural testing would provide a much better sense of how the blocks perform under load structurally.

3) Density Measurement

To determine the density of a specimen, we first need to obtain three key measurements: the saturated weight (Ws), the immersed weight (Wi), and the oven-dry weight (Wd). The saturated weight is the weight of the specimen when it is fully saturated with water, meaning all its pores are filled with water. The immersed weight is the weight of the specimen when it is submerged in water, which helps us determine the buoyant force acting on the specimen. The oven-dry weight is the weight of the specimen after it has been dried in an oven to remove all moisture, ensuring that only the solid material's weight is measured. Using these weights, we can calculate the volume of the specimen (V) and then its density (ρ).

The volume of the specimen is calculated using the difference between the saturated weight and the immersed weight. This difference gives the weight of the water displace by the specimen, which corresponds to the volume of the specimen due to the principle of buoyancy. Since the density of water is approximately 1 g/cm³ (or 1000 kg/m³)(Callister & David Rethwisch, n.d.), the volume V of the specimen can be expressed as:

$$V = \frac{Ws - Wi}{\rho \text{ water}}$$

where ρ water is the density of water.

Once the volume is determined, the density of the specimen (ρ) is calculated by dividing the oven-dry weight (Wd) by the volume (V).

Therefore, the density of the specimen is found by first calculating the volume using the saturated and immersed weights and then using the oven-dry weight to find the density. This method ensures that the density measurement reflects the solid material's true density, excluding any pore space that may be present when the specimen is saturated with water.

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To calculate the density of the specimen, the following equation was used:

$$\text{Density (D), kg/m3} = \frac{Wd}{Ws - Wi} \times (1000)$$

where:

Ws = saturated weight of specimen, (kg),

Wi = immersed weight of specimen, (kg), and

Wd = oven-dry weight of specimen, (kg)

F. Description of Research Instrument Used

This study employed a quantitative experimental research methodology, utilizing two distinct test specimen types: the uncontrolled and controlled variable. Both were observed and tested. In a controlled environment, samples containing three (3) ratios of mixture were tested to create non-load bearing Hollow Compressed Earth Blocks (HCEBs) using stabilizer agent, cement, and treated coir fiber. The mechanical properties of the HCEBs were compared to those of conventional concrete hollow blocks. The literature review or secondary data with another research tool that was employed. Researchers could increase or broaden their knowledge related to the field of study through literature reviews.

In addition, the researchers also used conceptual framework and research design flowchart that were essential to emphasize the important processes and provide better understanding by using a step-by-step illustration. Moreover, the researchers used graphical and tabulated representations for the result and discussions using graphs and tables.

3. Discussion

A. Compression Test of HCEB

Using ASTM C140 as a guideline, the compression test of a single HCEB was conducted accordingly. The load was applied at a controlled rate, based on the data of a single block with a cross-sectional area of 0.065 m². The load was gradually applied at a rate of 0.5 to 1 MPa/s. Three specimen groups were tested, with each group consisting of three samples of the same properties.

Table 2
Compressive strength test result

Specimen	Sample Description	Specimen ID	Age (days)	Strength(Mpa)	Average	Age (days)	Strength(Mpa)	Average	Age (days)	Strength(Mpa)	Average
1	15% Coir & 85% Clay Buckets of Clay: 5 x 0.75 = 3.75 Buckets of Coir Fiber: 6 x 0.25 = 1.25 Buckets of Cement: ½	S-1A	7	0.52	0.553	14	0.6	0.67	28	2.8	2.2567
		S-2A	7	0.38		14	0.68		28	1.94	
		S-3A	7	0.76		14	0.73		28	2.03	
2	20% Coir & 80% Clay Buckets of Clay: 5 x 0.8 = 4 Buckets of Coir Fiber: 5 x 0.20 = 1 Buckets of Cement: ½	S-2A	7	0.61	0.523	14	0.5	0.55	28	1.65	2.0933
		S-2B	7	0.44		14	0.53		28	1.88	
		S-2C	7	0.52		14	0.62		28	2.75	
3	25% Coir & 75% Clay Buckets of Clay: 5 x 0.85 = 4.25 Buckets of Coir Fiber: 5 x 0.15 = 0.75 Buckets of Cement: ½	S-3A	7	0.59	0.55	14	0.5	0.483	28	1.96	1.9767
		S-3B	7	0.67		14	0.55		28	1.87	
		S-3C	7	0.39		14	0.4		28	2.1	

As seen in the figure, the operator capped the block to ensure even load distribution, placing it horizontally and centrally under the machine's loading plate. In relation to Specimen A, which contained 15% coir fiber and 85% clay, a 7.5% decrease in strength was observed in Specimen B. Additionally, Specimen B exhibited a 6% decrease when the coir fiber content was increased to 25%.

Fig. 3. Compression strength test on the specimen

Each group of tests corresponded to a coefficient of variation. It was observed that the mean coefficient of variation for HCEB in Specimen A was 4.95%, while for HCEB in Specimen B, it was 8.034%. and the last specimen has 0.34%. This indicates that the variation in strength decreased when the percentage or quantity of clay was higher. Based on the results in the table, the compressive strength of the specimens corresponded to the amount of clay used in the mixture. As the percentage of clay decreased, the compressive strength also decreased.

The indicated Coefficient of Variation shows a low percentage in each specimen showing a consistency of strength during the three different curing days and achieving the optimized strength in the 28th day. As shown in the graph below, the increase in clay content of the specimen is the increase in the strength base on the average result of the samples.

Table 3
Average compressive strength test result

Specimen	Compressive Strength	Mean	Standard Deviation	Coefficient of Variation
A	0.62- 0.9 Mpa	2.2566	0.11	4.95%
B	0.67 - 0.94 Mpa	2.093	0.17	8.04%
C	0.8- 1.09 Mpa	1.976	0.007	0.34%

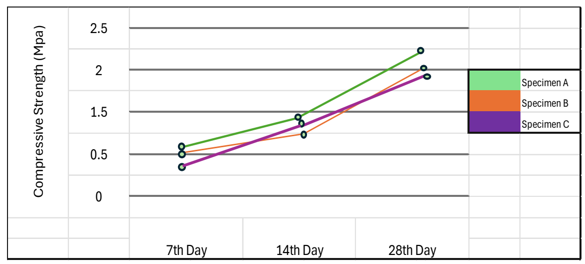

Fig. 4. Average compressive strength test result

B. Flexural Test of HCEB

Eliminating the undesirable properties of clay and reinforcing it with coir fiber is an environmentally sustainable approach that helps reduce pollution from concrete cement production, aligning with a global movement toward greener construction materials. This highlights the value of research, particularly in evaluating the effectiveness of coir fiber as a reinforcement material. The addition of coir fiber has been studied to determine its effectiveness in increasing axial load capacity. As presented in the table, the results show a notable increase in flexural strength. Following the guidelines of ASTM C78/C78M, the flexural strength test was carefully conducted using the three-point bending test on the same compression testing machine to ensure consistent and accurate results.

Table 4
Flexural strength test result

Specimen	Sample Description	Specimen ID	Age (days)	Strength(Mpa)	Average	Age (days)	Strength(Mpa)	Average	Age (days)	Strength(Mpa)	Average
1	15% Coir & 85% Clay Buckets of Clay: 5 x 0.75 = 3.75 Buckets of Coir Fiber: 6 x 0.25 = 1.25 Buckets of Cement: ½	S-1A	7	1	0.887	14	1.09	0.9767	28	1.24	1.0533
		S-2A	7	0.92		14	0.97		28	0.99	
		S-3A	7	0.74		14	0.87		28	0.93	
2	20% Coir & 80% Clay Buckets of Clay: 5 x 0.8 = 4 Buckets of Coir Fiber: 5 x 0.20 = 1 Buckets of Cement: ½	S-2A	7	0.87	0.817	14	1.14	0.98	28	2.1	1.4
		S-2B	7	0.9		14	0.87		28	1.02	
		S-2C	7	0.68		14	0.93		28	1.08	
3	25% Coir & 75% Clay Buckets of Clay: 5 x 0.85 = 4.25 Buckets of Coir Fiber: 5 x 0.15 = 0.75 Buckets of Cement: ½	S-3A	7	0.78	0.943	14	1	1.12	28	1.15	1.7467
		S-3B	7	0.95		14	1.07		28	1.22	
		S-3C	7	1.1		14	1.29		28	2.87	

In summary, the data indicates that the flexural strength of the Hollow Earth Compressed Blocks is significantly affected by the proportion of coir fiber and the duration of the curing period. Sample 1, with 15% coir fiber, achieved the highest flexural strength after 28 days at 1.7467 MPa, with a mean of 1.053 MPa. Sample 2, with 20% coir fiber, showed moderate strength gains, reaching 1.4 MPa. Sample 3, with the highest clay content, exhibited a consistent linear decrease in strength across all curing periods, with a final strength of 1.24 MPa, representing a 5% decrease from the 7th to the 28th curing day. This suggests that an optimal balance of clay and coir fiber, combined with appropriate curing times, is crucial for maximizing the flexural strength of these blocks. The coefficient variation shown for Specimens A, B, and C resulted in a lower percentage, indicating consistency among the three samples with the same properties within a specimen.

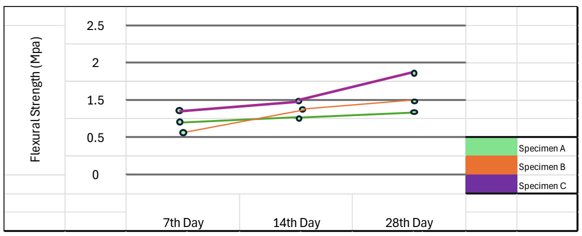

Fig. 5. Average flexural strength test result

Fig. 6. Flexural strength test using third point loading

C. *Density Test of HCEB*

The table below presents the results gathered from the density test conducted at the Quality Assurance Section of DPWH on April 11, 2024. Following the established standards of ASTM C140, the density test procedure was properly carried out with the assistance of the Quality Assurance Section to oven-dry the selected specimen after 28 days of curing.

The test involved weighing the saturated weight, immersed weight, and oven-dry weight, as shown in the figure. Additionally, volume measurements were recorded to calculate the density using the formula provided in the density measurement section.

The density of the hollow compressed earth block with a mixture of 75% of clay and 25% coir fiber varied in the range of 1500 to 2000 kg/m³. Based on the graph indicated, the sample 1(b) has a highest density of 1748 kg/m³ and the lowest density is sample 1(c) around 1547 kg/m³.

The density of other examples of the hollow compressed earth block with 80% of clay and 20% coir fiber varied in the range of 1500 to 2000 kg/m³. There are 3 samples in the graph, the sample 2(b) has a lowest density around 1484 kg/m³ and the sample with the highest density is sample 2(a) with a value of 1735 kg/m³.

The last sample of the hollow compressed earth block with 85% of clay and 15% coir fiber, with the density varied in the range of under 1500 to 2000 kg/m³. There are 3 samples in the graph, the sample 3(a) has the highest density around 1623 kg/m³ and the two remaining sample having a density of 1519 and 1506 kg/m³.

Fig. 7. Density measurement results

D. *Cost Analysis*

The samples involve constructing a 10m x 10m building with an external wall height of 3 meters using hollow blocks. The hollow block dimensions are 0.6 meters (length) x 0.2 meters (height) x 0.2 meters (depth). The analysis also considers reductions for a door and windows with areas of 1.89 m² and 2.88 m², respectively.

The total perimeter of the building is 40 meters (10m + 10m + 10m + 10m). Given a height of 3 meters, the total wall area is:

Table 5
Bill of quantities

A) MATERIALS:CONST / UNIT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Cement	pcs	2	261	522
Clay soil	bucket	18	0	0
Coir fiber	bucket	6	0	0
Sub total (A)	522			
B)LABOR COST	**No.of Personnel**	**Total Hours**	**HOURLY RATE**	**TOTAL COST**
Skilled Labor	1	3	90	270
Sub total (B)	270			
C)EQUIPMENT COST	**No.of Equipment**	**Total Hours**	**HOURLY RATE**	**TOTAL COST**
Hollow block machine	1	3	65	200
Sub total (C)	200			
TOTAL DIRECT COST =		992		

40 m x 3 m = 120 sq²

To account for the door and window areas:

120 m² − 1.89 m² − 2.88 m² = 115.23m²

Block calculation

Hollow block dimension: 0.6m (length) x 0.2m (height) x 0.2m (depth)

Area per block: 0.6m × 0.2m = 0.12m²

Total Number of Blocks Needed: 0.12m2/block115.23m2 = 960.25blocks

Table 5: Unit cost of 81 pcs samples of hollow compressed earth block.

To determine the cost per block for 81 hollow compressed earth blocks, given a total expenditure of 992 pesos, the researcher divided the total cost by the number of blocks.

Cost per block= 81 blocks/992 pesos

Cost per block≈12.25 pesos

Thus, for 81 hollow compressed earth blocks, with a total cost of 992 pesos, the cost per block is approximately 12.25 pesos.

1) Price Comparison of Hollow Compressed Earth Blocks and Concrete Hollow Blocks

When constructing a building with a size of 100 square meters (10m x 10m) and a height wall of 3 meters, it's essential to compare the costs of different materials to determine the most economical option. This analysis focuses on the price difference between using hollow compressed earth blocks (HCEBs) and concrete hollow blocks (CHBs), considering both types are required in the same quantity—960.25 pieces, rounded up to 961 blocks.

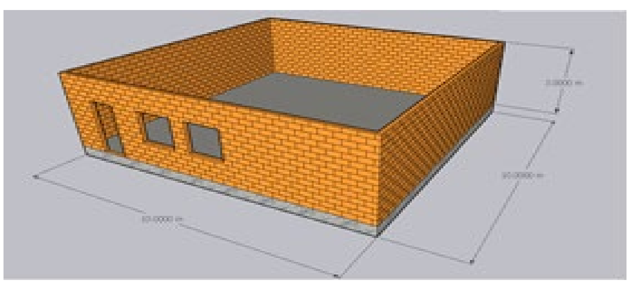

Fig. 8. 120sq² wall area using hollow compressed earth block

Price Calculation for Hollow Compressed Earth Blocks

Hollow compressed earth blocks are priced at 12.25 pesos per piece. The total cost for 961 CEBs is calculated as follows:

961 blocks ×12.25 pesos/block = 11,765.25 pesos

Fig. 9. 120sq² wall area using concrete hollow block

Price Calculation for Concrete Hollow Blocks

Concrete hollow blocks are priced at 18 pesos per piece. The total cost for 961 CHBs is calculated as follows:

961 blocks × 18pesos/block = 17,298pesos

Price Difference

The difference in the total cost between using CEBs and CHBs is:

17,298pesos (CHBs)−11,765.25pesos (HCEBs)=5,532.75pesos

Using hollow compressed earth blocks instead of concrete hollow blocks results in significant cost savings. For the required 961 blocks, using CEBs costs 11,765.25 pesos, whereas using CHBs costs 17,298 pesos. This results in a total saving of 5,532.75 pesos when opting for CEBs. The cost-effective nature of HCEBs makes them a preferable choice for this construction project, providing a large reduction in material costs while maintaining structural integrity.

The evaluation of correlated research aimed to evaluate the appropriateness and compatibility of using hollow compressed earth block (HCEB) with coir fiber as low-cost housing wall material. In addition, the goal of this review was to find methods in producing these hollow compressed earth block as well as treatments for coir fiber to enhance its properties. Given that coir fiber has a property for an abrasion resistance to withstand the wear and tear of friction caused by mechanical parts and instances of repetitive scraping or rubbing, it could be concluded that this material was suitable for the hollow compressed earth block making with a proper and optimal ratio of coir fiber and cement to be used. In conclusion, the integration of coir fiber into the composition of Hollow Compressed Earth Blocks represented a viable and sustainable solution for low-cost housing. The optimal ratio ensured a balance between structural strength and environmental benefits. The treatment procedure for coir fiber played a crucial role in maximizing its effectiveness as a stabilizing agent. This research underscored the potential of coir fiber to positively influence the characteristics of compressed earth blocks.

4. Conclusion

This study investigated the use of Hollow Compressed Earth Blocks (HCEBs) stabilized with coir fiber as a sustainable and low-cost housing wall material. The research demonstrated that the mix of coir fiber enhances the mechanical properties of HCEBs, particularly in terms of flexural strength and durability, while maintaining an acceptable level of compressive strength. The study confirmed that an ideal balance between clay content, coir fiber percentage, and cement stabilization is crucial to achieving strong and cost-effective construction materials.

The results indicate that increasing the percentage of coir fiber leads to improved flexural strength, which is essential for the structural integrity of the blocks. However, higher coir fiber content slightly reduces compressive strength, necessitating an optimal mix ratio for practical applications. Additionally, the cost analysis highlighted that HCEBs are significantly more affordable than conventional concrete hollow blocks, making them a viable alternative for low-cost housing, particularly in communities with limited financial resources.

Overall, this study reinforces the potential of coir fiber-stabilized HCEBs as an innovative and sustainable building material. The findings contribute to the ongoing efforts to promote environmentally friendly and cost-efficient construction solutions, offering a practical approach for addressing housing shortages in economically disadvantaged areas. Further research could focus on long-term durability assessments, environmental impact analysis, and real-world implementation of these blocks in housing projects.

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