

Comparative Cost Analysis Between Hydraform Interlocking Brick and Sandcrete Block as Walling Materials for Low-Cost Housing Development in Nigeria

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Abstract

This study analyzed the cost of production and construction of 225mm hollow sandcrete blocks and hydraform interlocking bricks and walls to compare the findings of the results. The study was conducted in Auchi, Estako West Local Government Area of Edo State, Nigeria. The study compared the construction of two models of 225mm hollow sandcrete blocks and hydraform interlocking bricks, materials employed for wall construction for the study are; clay, cement, sand, water and mould. The result of the study indicates that unit cost of 225mm hollow sandcrete block and hydraform interlocking bricks are ₦168.57 and ₦57.85 respectively. While the cost per square metre of 225mm hollow sandcrete block wall and hydraform interlocking brick wall are ₦3,199.40 and ₦3,079.52 respectively. The study also revealed that it is more costly to apply finishes to sandcrete block wall when compared with hydraform interlocking brick wall. Sandcrete block wall requires rendering or plastering to both faces of the walls, while hydraform interlocking wall requires rendering of not more than 300mm girth to vertical external corners of the brick wall. The study, therefore, recommends the use of hydraform interlocking bricks for low-cost housing to reduce the housing deficit in Nigeria.

Keywords: Sandcrete block; hydraform interlocking brick; walling; cost analysis; Auchi;

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1.0 Introduction

Housing is central to virtually all of the activities of humans. It is required to provide safety, comfort, convenience, learning, and satisfaction to its users [1]. Essentially, housing has become a key social indicator in the assessment of the living standards of humans nationwide [2]. However, despite the importance of housing, the world is witnessing a chronic undersupply of it. Along this line, studies have affirmed that close to a billion persons in the world is displaced concerning housing [3][4].

Similarly, the continent of Africa has equally been reported to be witnessing a severe shortage of housing. The [5]report has affirmed that around 61.7% of the population of Africans are displaced concerning housing. In Nigeria, a recent report from [6]has affirmed that the country's housing deficit figures currently hovers around 17-20 million. Furthermore, researches have affirmed that from among those who are displaced concerning housing globally, the lower-income citizens are the prime sufferers [7, 8, 9, 10, 11]. Similar studies have equally confirmed that low-income earners in Nigeria who are over 90% of the population of the country are homelessness because they reside in squatter settlements and shanty dwellings [12, 13, 14, 15, 16, 17].

However, the increasing cost of building materials has been advanced as one of the reasons for the worsening state of low-income housing in developing nations like Nigeria[18, 19, 20] Building materials have been reported to be the highest cost contributor of the entire cost of a building in most emerging nations. In Nigeria for example, it has been established that building materials alone account for more than half of the total cost housing development [21]. Similar studies have equally affirmed that building materials take up to 70-75 per cent of the total cost of a standard residential development in Nigeria [22, 20]. Of this percentage, walling materials reportedly accounts for more than 15% of the total building cost [23].

Walling materials are an important component of a building as a result of the enormous role it plays concerning thermal comfort through the reduction of external heat gained during the day [24]. Sandcrete blocks have been predominantly used as walling materials for housing development in Nigeria. However, as a result of the worsening state of housing with particular reference to low-income earners in Nigeria occasioned by the increasing cost of building materials, cost-saving strategies in low-cost housing development is expedient.

This study, therefore, aims to compare the cost of sandcrete blocks and hydraform interlocking bricks as walling materials for low-cost housing development in Nigeria. Findings from this study would be of immense value to the government, funding agencies, private developers and the general public in the area of mass housing development for low-income earners in Nigeria and other developing nations. The study's findings shall equally re-direct academics and research interests. To achieve the study's aim, this paper is therefore structured as follows: Introduction, methodology, cost analysis, conclusion and recommendations.

2.0 Methodology

The study compared the construction of two models of 225mm hollow sandcrete blocks and hydraform interlocking bricks. Materials used for producing sandcrete hollow blocks and hydraform interlocking bricks were purchased from Auchi and Agbedearea of Estako West Local Government Area of Edo State, Nigeria

2.1 Materials

Cement: The cement used was Elephant cement an Ordinary Portland Cement (OPC) purchased from a cement depot in Auchi, and it conformed to BS 12 (1978) as cited in [25].

Sharp Sand: Sand purchased from Chinese Quarry at Uloeke in Estako West LGA, Edo State, Nigeria. The material confirmed [26].

Water: water used for the work was sourced from the deep borehole and fit for drinking, free from contaminants either dissolved or in suspension as specified by [27].

Lateritic Clay Soil: The lateritic clay soil used in the study was obtained from a borrow pit in Agbede, Nigeria between a depth of 1.5m to 2.0m using the method of disturbed sampling.

Production of Sandcrete Blocks: Mixes of Cement/Sand ratio 1:14 (1 head pan of cement to 14 head pans of sand) produced 35 hollow sandcrete blocks of 225mm x 225mm x 450mm. And curing of the blocks took place under laboratory conditions for 7, 21, and 28 days. Compaction test was carried out in accordance with [28].

Production of hydraform interlocking bricks: 1:19 (that is, one part of ordinary Portland cement: nineteen parts of clay soil) and Cement/Clay ratio 1:12 (1 head pan of cement to 19 head pans of clay soil) 59 bricks were moulded for each mix, the cement stabilized clay bricks of size 230mm x 230mm x 115mm were produced and cured under laboratory conditions for 7, 21, and 28 days curing periods. Compaction test was carried out in accordance with [28].

Cost Analysis: Cost analysis at the time of this study was based on per square metre of both clay bricks and sandcrete blocks respectively and results are presented in findings and discussion below.

3.0 Cost Analyses of 225mm Sandcrete Block Wall Construction and Hydra Form Interlocking Brick Wall Construction.

3.1 Built-Up Rates for Block Works

225mm sandcrete hollow block wall laid with cement and sand mortar (1:4) in stretcher bond..... m²

i Block Production

Mix Ratio = 1:14

This translates to one bag of ordinary Portland cement to twenty-eight head pans of sand, since there are two head pans in a bag of cement. The cost of one bag of ordinary Portland cement is ₦2,500 as at the time of carrying out the research.

28 head pans of sharp sand @ N 72.8	= ₦ 2,038.40
1 bag of cement @ N 2,500	= ₦ 2,500.00
Total	= ₦ 4,538.40

For 225mm block, N 4,538.4 produced 35 blocks.

Cost of materials for producing 1 unit of 225mm sandcrete block	= ₦129.67
Assume 10% for labour	= ₦ 12.97
Assume also 20% for plant and others	= ₦ 25.93
Total cost incurred in producing one unit of 225mm sandcrete hollow block	= ₦ 168.57

ii Mortar (for 1 block)

Mix ratio	= 1:4 – 25mm thick
Total ratio	= 1 + 4 = 5
Bedding	= 0.45 x 0.225 x 0.025 = 0.0025m ³
Jointing	= 0.225 x 0.225 x 0.025 = 0.0013 m ³
Total volume/block	= 0.0038 x 1 = 0.0038 m ³

Cement

Part by cement	= $\frac{1 \times 0.0038 \text{ m}^3}{5}$	= 0.000760m ³
Add: waste say 5%		$\frac{0.000038 \text{ m}^3}{0.000798 \text{ m}^3}$

Since 1 m³ = 28.82bags of 50kg cement

Nos. of bags = 0.000798 x 28.82 = 0.022998bags

Cost of cement incurred in laying one unit of 225mm sandcrete hollow block	=	N 2,500.00/bag x 0.022998bag/block	= ₦ 57.50
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Sand

$$4 \text{ part by sand} = \frac{4 \times 0.0038 \text{ m}^3}{5} = 0.003040 \text{ m}^3$$

$$\text{Add: waste say 5\%} = \frac{0.000152 \text{ m}^3}{0.003192 \text{ m}^3}$$

Note: using a tipper capacity of 3.82m³

$$\text{No. of trips} = \frac{0.003192 \text{ m}^3}{3.82 \text{ m}^3} = 0.000836 \text{ trip}$$

Cost of Sand incurred in laying one unit of 225mm sandcrete hollow block
 = ₦ 22,500.00/3.82 Trip x 0.000836 trip /block = ₦ 18.80

Cost of Cement in mortar = ₦ 57.50
 Cost of Cement in mortar = ₦ 18.80
 = ₦ 76.30
 Assume 5% for Water in mortar = ₦ 3.82
 = ₦ 80.12

Total cost of Mortar in laying one unit of 225mm sandcrete hollow block = **₦ 80.12**

iii Labour(for 1 block)

Laying: skilled and unskilled
 0.10hrs @ ₦437.50 (skilled) = ₦ 43.75
 0.10hrs @ ₦275.00 (unskilled) = ₦ 27.50
 = ₦ 71.25

The total cost of Labour in laying one unit of 225mm sandcrete hollow block = **₦ 71.25**

Summary

Production of block = **₦168.57**
 Mortar of laying block = **₦ 80.12**
 Labour cost of laying block = **₦ 71.25**
 The total cost incurred in producing and laying one unit of 225mm block = **₦ 319.94**

iv Cost Per Square Metre Of Sandcrete Blocks

Elevation area of sandcrete block = 0.450m x 0.225m = 0.1013m²
 Number of sandcrete blocks in one square metre = 1.00 ÷ 0.1013 = 9.87
 Approximately 10 Blocks
 Cost of 225mm sandcrete hollow blocks per square metre = 10 x 319.94 = **₦3,199.40**

3.2 Built-Up Rates For Hydraform Interlocking Bricks Works

230mm x 115 mm interlocking brick m²

i Unit Cost of Laterite Interlocking Brick

Mix Ratio = 1:19 (that is, one part of ordinary Portland cement: nineteen parts of laterite)
 A four (4) litre Plastic container was used as the gauge in measuring the composition of laterite interlocking block. There is four number of a plastic container (each 4litre capacity) in one head pan. Since there are two head pans in one bag of cement, this means that eight number of plastic containers (each 4litre capacity) are contained in one bag of cement.

Cost of buying 1 cement bag of laterite = N500
 The cost of one bag of ordinary Portland cement is ₦2500 as at the time of carrying out the research.
 Cost of one, 4litre plastic container of Laterite = 500 ÷ 8 = ₦ 62.50
 Cost of one, 4litre plastic container of Cement = 2,500 ÷ 8 = ₦ 312.50
 19 parts of laterite @ N 62.05/ part = ₦ 1,178.95
 1 part of cement @ N 312.50/ part = ₦312.50
 Polythene sheet for curing = ₦200.00
 Cost of materials used = ₦ 1,690.95
 N 1,690.95 produced 38 blocks
 Cost of producing one unit of laterite interlocking block = ₦ 44.50
 Assume 10% for labour = ₦ 4.45
 Assume also 20% for plant and others = ₦ 8.90
 Total cost incurred in producing one unit of laterite interlocking block = ₦ 57.85

ii *Labour (For 1 Block)*

Brick laying: skilled
 0.053hrs @ ₦437.50 (work study) = ₦23.19

The total cost of Labour in laying one unit of hydra form interlocking brick = ₦23.19

Summary

Production of Hydra form interlocking brick = **₦57.85**
 Labour cost of laying block = **₦23.19**
 The total cost incurred in producing and laying one unit of 225mm block = **₦81.04**

iii *Cost Per Square Metre Of Sandcrete Blocks*

Elevation area of sandcrete block = 0.230m x 0.115m = 0.02645m²
 Number of hydra form interlocking brick in one square metre = 1.00 ÷ 0.02645 = 37.81
 Approximately 38 Blocks
 Cost of 225mm X 115mm hydra form interlocking brick per square metre = 38 x 81.04 = **₦3,079.52**

3.3 Cost Comparison of Sandcrete Block Wall and Hydra form Interlocking Bricks

Items	Description	Cost Activities	Sandcrete Block Wall	Hydra form interlocking Brick Wall
A	Preliminary	Setting out	●	●
B	Builders' work	Block/ Interlocking brick Mortar (Bedding and jointing) Labour	● ● ●	● ● ●
C	Wall Finishes	Rendering/plastering to the wall (Externally and internally) Rendering to corners of the wall (Externally) Painting to wall	● ● ●	○ ● ●

Legend:

- Applicable step
- Eliminated / non-value adding step

4.0. Cost Analyses

The above results show the various cost for the production of 225mm hollow sandcrete blocks alongside the cost of producing hydra form interlocking cement stabilized bricks. At the time of the research, the cost for the production of a unit of the block was ₦168.57, while the cost of producing a unit of hydra form interlocking cement stabilized bricks, on the other hand, was ₦57.85. In constructing hydra form interlocking bricks wall, apart from the base mortar that requires a thin layer of mortar to link the first course to the floor, no mortar is required for the subsequent courses of the hydra form interlocking walling system. The absence of mortar bedding and jointing in the hydra form interlocking brick walling process led to a significant reduction in the quantity of mortar used compared to the case of the sandcrete block. The total cost for constructing one metre square of sandcrete block wall was ₦3,199.40 inclusive of material and labour. While that of the hydra form of the interlocking brick wall was ₦3,079.52.

The results revealed that it is more costly to apply finishes to sandcrete block wall when compared with hydra form of an interlocking brick wall. Sandcrete block wall requires rendering or plastering which include the application of a smooth coat of material to walls to provide a joint-less, hygienic, easily decorated smooth finish to walls as well as to covers up the unevenness in the block wall. While on the other hand, hydra form interlocking bricks wall do not require rendering or plastering thereby resulting in significant cost savings on plastering. Painting can be applied to both sandcrete block wall and brick wall; however, hydra form interlocking blocks are also aesthetically pleasing and may not require painting. It is therefore recommended for affordable low-cost mass housing development.

5.0 Conclusion

The following conclusions can be drawn from the results of cost analyses of hollow sandcrete block and hydra form interlocking brick wall as experimented:

- i. Hydra form interlocking brick wall construction significantly reduces non-value-adding steps when

- ii. compared with the conventional sandcrete block wall construction.
- ii. Interlocking brick wall construction eliminates the cycle time of block bonding thus increasing the speed of wall construction for interlocking blocks.
- iii. Hydra form interlocking blocks are affordable in terms of cost. There is also a significant reduction in the material required for the interlocking block wall construction process due to the absence of mortar jointing.
- iv. Reduction in the labour and material requirements in the hydra form interlocking block wall construction makes the cost associated with the process of building walls using the interlocking blocks less expensive.
- v. The cost of applying basic wall finishing to hydra form interlocking brick wall construction is significantly cheaper when compared with sandcrete block wall construction. Hydra form interlocking brick wall does not require plastering to both faces of the wall, thereby resulting in cost savings for plastering to the wall.

6.0 Recommendations

The study, therefore, recommends the following:

- i. The use of hydraform interlocking bricks for the production of low-cost to reduce the housing deficits in Nigeria.
- ii. The government should provide affordable mass housing schemes using hydraform interlocking bricks for her low-income earners through mortgage arrangement.
- iii. Stakeholders in the construction industry should commercialize the technology for the production of hydraform interlocking bricks walling system in Nigeria.

Future researches are encouraged in the areas of:

- i. Comparative analysis of sandcrete block wall and hydra form interlocking bricks concerning functionality.
- ii. Performance of the two (2) walling materials in different atmospheric conditions.

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