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Comparative Cost Analysis of using Conventional Blocks and Interlocking Bricks for Mass Housing in Nigeria

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Abstract: House is the third topmost need of individuals next to food and clothing. The production of this essential human shelter is in deficit in Nigeria. The managing director of the Federal Mortgage Bank of Nigeria (FMBN) reported recently that the housing deficit in Nigeria is 22 million units. Despite numerous government policies and housing reform programmes, housing remains an illusion to an average Nigerian. The solution to this generic problem is a production of mass housing through the use of affordable local materials and interlocking brick is one of such materials. The study compared the cost of producing mass housing using conventional (sandcrete) blocks and interlocking bricks as walling material. A prototype building plan of a three-bedroom apartment was used for the analysis using percentile. Historical costs data were collected from specialist interlocking bricks manufacturer while costs data on conventional blocks and labour were collected through a market survey. The result also indicates that the labour cost for the conventional block was ₦1,025.64/m^2 while the labour cost for the interlocking block was ₦1,709.40/m^2. The overall cost for the conventional block was ₦17,782.19/m^2 while the overall cost for interlocking brick was ₦10, 378.06/m^2. This implies that there is a 58% cost saving in using interlocking bricks. The study recommended that the government should encourage the use of interlocking

bricks for affordable mass housing in Nigeria because of its several advantages such cost-effectiveness, reduced construction time and easy access to the raw materials from the local environment. The study recommended that a regulatory body should be set up to implement compliance with the standard specified by the Nigerian Standard Organisation, to ensure production of quality interlocking bricks for mass housing in Nigeria.

Keywords: Affordable materials, Construction time, Conventional blocks, Interlocking bricks, Mass housing.

1.0 Introduction

According to United Nations estimates the current population of Nigeria is 199.88 million (2019). Dangiwa (2018) asserted that the country housing deficit that would satisfy this teaming population is about 22 million units. Isaiah (2019) indicated that a total of another 2 million homes per year will be required to meet this deficit for a 10-year term. Isaiah (2019) also submitted that it is expected that in the next 25-30 years the government will need about $400 billion funding for the housing sector to address this deficit. Isaiah (2019) concluded that the deficit bridging will cost the World Bank approximately ₦50 trillion, nearly matching the cost estimates of ₦56 trillion of the Federal Mortgage Bank of Nigeria.

There are several challenges to the achievement of housing for all by the government for more than 30 years in Nigeria. They include Land Use Acts of 1978 which resides the ownership of the land in the state governor, the tedious property registration process, the high cost of building materials, un-abating rural-urban migration and associated planning development policy which focus on urban development to the detriment of rural areas. There is also a failure of the Mortgage institutions to fulfil their core mandates.

Adedeji (2002) acknowledged the high cost of housing in Nigeria as one of the main problems in introducing the efficient housing system in Nigeria. The researcher claimed that shelter in Nigeria was easily affordable in the earlier period as construction materials come from human immediate environmental costs. Nigerians, though, also developed a great taste for expensive construction materials such as marble, granite tiles for walls, etc. Most of these goods are manufactured or produced locally but with imported equipment and technology (Obi and Ubani 2014). Ideally, the solution to this generic problem is the production of mass housing through the use of affordable local materials and interlocking brick is one of such materials. This study compared the cost of sandcrete blocks and interlocking bricks as walling for a three-bedroom residential building in Nigeria.

2.0 Literature Review

Product quality is one of the main elements of a healthy construction, according to Okwesilieze, Ekweremadu and Emmanuel (2015). The study further demonstrated that proper selection of construction materials can be achieved by taking

account of their entire lifecycle span, costs and social requirement such as thermal efficiency, power, longevity, environmental effects, aesthetics and capacity to rapidly build with them. The statement that material preference is based on cost, commodity supply, longevity, aesthetics and climate conditions is backed by Raheem, Momoh and Soyingbe (2012). Based on these assertions, Okwesilieze et al (2015) suggested that the housing development phase should be based on the principles of sustainability that can be implemented in the design, creation and use of buildings. Danso (2013) indicated that the high cost of conventionally manufactured products such as cement and steel created an extreme lack of affordable housing in Africa. In the report of Danso (2013), a policy was formulated which will promote the use of local materials in order to reduce housing deficits.

Baiden and Tuuli (2004) observed that more than 90% of Nigeria's physical structure is constructed with sandcrete blocks. Anosile & Oyebade (2012) also suppoted this claim that sandcrete is a building material of great importance and widespread in Nigeria, Ghana, and other countries in Africa as load-bearing and non-load bearing walling units. Sadly, in Nigeria, sandcrete block is being produced without reference to building standard requirements or good quality works in many parts of the country (Oyekan and Kamiyo 2008). Anosile and Oyebade (2012) claimed that the NIS 87: 2007 specification defined by a Nigerian Standard Organisation (NSO) was not consistent with products from sandcrete block manufacturers. The analysis also suggested that the poor quality sandcrete blocks lead to cracks in the walls and sometimes culminated in structural failure or at worse, collapse in the structure.

To avert this problem, building materials should be produced from locally available raw materials and interlocking brick is an alternative to the conventional sandcrete block. Raheem (2006) observed that technically enhanced use of laterite interlocking blocks was led by people because cement mortar is not required while joining bricks to further reduce costs during building. Raheem et al. (2012) found that the Nigerian Building and Road Research Institute (NBRRI) introduced interlocking blocks to the Nigerian construction industry because a very small amount of cement is needed for it and because laterite is readily accessible in Nigeria. Danquah, Abrokwah, Twumasi and Ankrah (2015) has verified the consistency and durability of brick as an alternate building material for a thousand years in terms of its total life cycle costs. Okwesilieze et al. (2015) proposed that the interlocking of masonry is a good substitute for typical forms of Nigerian housing construction, due to lower prices, reduced building duration and energy efficiency. Adedeji (2011) concluded that appealing facial brick finishes are available in a variety of natural colours which contributes to aesthetic view of the material.

3.0 Methodology

The study adopted quantitative and case study approaches to establish a comparative cost analysis between interlocking bricks and sandcrete

blocks. A typical three-bedroom floor plan was used for comparative cost analysis of the selected two walling materials as shown in Appendix 1. The total floor area of the building is 116.89 m^2. The overall cost estimate of measured 303 m^2 walling was determined using a market survey of the unit price of the two materials for the three-bedroom at Akure, Ondo State. The measurement of the wall of the three-bedroom was calculated from the foundation to the roof level. The data collected were used to estimate the cost of the elements as shown in Calculations 1 and 2.

Calculation 1 Cost estimate for interlocking bricks walling

According to Raheem et al. (2012), the mix ratio for the production of interlocking brick is 1: 19 (that is, one part of ordinary Portland cement: nineteen parts of laterite).

A 4-litre plastic container was used as a gauge in measuring the composition of laterite interlocking brick. There are 4 number of a plastic containers (each 4-litre capacity) in 1 head- pan. Since there are two head-pans in one bag of cement, this means that 8 number of plastic containers (each 4-litre capacity) are contained in one bag of cement (Raheem et al. 2012).

3.1 **Calculations**

Cost of 1 cement bag of laterite = ₦400.00 (6.4m^3 cost ₦20,000.00, 6.4m^3 contains 100 head-pans, therefore 1 head-pan = ₦20,000.00/100 = ₦200.00).
Cost of 1 bag of ordinary Portland cement = ₦2, 600.00
Cost of one, 4 litre plastic container of Laterite = ₦400.00 / 8 = ₦50.00
Cost of one, 4 litre plastic container of Cement = ₦2,600.00 / 8 = ₦325.00

19 parts of laterite @ ₦50.00	= ₦950.00
1 part of cement @ ₦325.00	= ₦325.00
Polythene sheet for curing (say)	= ₦250.00
Cost of materials used	= ₦1,525.00
₦1,525.00 produced 40 bricks	
Cost of producing 1 unit of laterite interlocking brick	= ₦38.13
Labour cost (say 35%)	= ₦13.35
Machine cost (say 75%)	= ₦28.60
Cost of 1 unit of laterite interlocking brick	= **₦80.08**

Cost per square metre of laterite brick

Elevation area of laterite interlocking brick = 0.225m x 0.115m = 0.025875m^2
Number of interlocking bricks in one square metre = 1.00 / 0.025875 = 38.65
Approximately = 39 Bricks
Number of laterite interlocking bricks in 303m^2 wall for the three-bedroom
= 303 x 39
= 11,817
Add 5% waste = 591

Total =**12,408**
Cost 12,408 laterite interlocking bricks @ ₦80.08 = ₦993,632.64
Cost labour for laying 12,408 bricks
According to Geoff (2015) a bricklayer ca lay 300 -500 bricks per day
(Gang of one mason and one labour). Average = 400 bricks per day
Therefore number of days that will be used = 12,408/400 = 32 days
Cost of Mason = 32 @ ₦3,500.00 per day = ₦112,000.00
Cost of Labour = 32 @ ₦1,500.00 per day = ₦48,000.00
Cost of polishing (say) @ ₦200.00 per m^2 ($303m^2$) = ₦60,600.00
Total cost of Walling the three- bedroom residential building = **₦1,214,232.64**
Cost per m^2 = ₦1,214,232.64 / 117 = ₦10,378.06/m^2

Calculation 2: Cost estimate for sandcrete block walling

According to Raheem et al. (2012) the mix ratio for the production of sandcrete block is 1: 9 (that is, one head-pan of ordinary Portland cement to nine head-pan of sharp sand). This implies that a bag of ordinary Portland cement to eighteen head-pans of sharp sand because there are 2 head-pans in a bag of cement.

Cost of 1 bag of ordinary Portland cement = ₦2, 600.00
Cost of 1 head-pan of sharp sand (same as laterite) = ₦ 200.00
Cost of 18 head-pans of sharp sand @ ₦ 200.00 per head-pan = ₦3,600.00
Cost of 1 bag of cement = ₦2,600.00
Total = ₦6,200.00
₦6,200.00 produced 25 block of 225mm thick
Cost of production of 1 unit of 225mm block = ₦248.00
Cost of labour (say) 15% = ₦37.20
Machine cost (say 25%) = ₦62.00
Cost of 1 unit of sandcrete block = **₦347.20**
Elevation area of sandcrete block = 0.450m x 0.225m = $0.10125m^2$
Number of interlocking bricks in one square metre = 1.00 = 9.88
0.10125
Approximately = 10 Blocks
Number of sandcrete blocks in $303m^2$ wall for the three-bedroom = 303 x 10
= 3,030
Add 5% waste = 152
Total = **3,182** No.
Cost 3,182 sandcrete blocks @ ₦ 347.20 = ₦1,104,790.40
Mortar (1:4)
1 bag of cement laying 50 blocks
Number of cement = 3,182 = 64 bags
50
Add 5% waste = 3 bags
Total = 67 bags
Cost of 67 bags of cement @ ₦ 2,600.00 = ₦174,200.00
Sharp sand: 4 parts 200kg (50kg x 4)
200kg x 67 bags = 13,400kg

1 m^3 = 1000kg
Therefore 13,400 x $1m^2$ = $13.4m^3$
1000
$6.4m^3$ = ₦20,000.00, $1m^3$ = ₦20,000.00/6.4 = ₦3,125.00
Add 5% waste = ₦ 156.25
Total cost per m^3 = ₦3, 281.25
Cost $13.4m^3$ of sharp sand @ ₦3,281.25 per m^3 = ₦43,968.75
Water for work @ (say) ₦1,500.00 per m^3, $13.4m^3$ = = ₦20,100.00

Cost labour for laying 3,182 blocks

According to Jackson, Mustapha, Aburam & Quuayson (2018) the standard is 80 blocks per day for one mason and one labour.
Therefore, the number of days that will be used = 3,182/80 = 40 days
Cost of Mason = 40 @ ₦3,500.00 per day = ₦140,000.00
Cost of Labour = 40 @ ₦1,500.00 per day = ₦60,000.00

Cost estimate for rendering

Mix ratio was 1: 4 (One part of ordinary Portland cement to six parts of soft sand)
12mm thick (C. & S.) rendering = 303 x 2 = $606m^2$ @ ₦ 550.00 = ₦333,300.00
Ditto returns and reveals = 77m @ ₦190.00 = ₦ 14,630.00
Emulsion paint $606m^2$ @ ₦305.00 = ₦ 184,830.00
Ditto returns and reveals = 77m @ ₦61.00 = ₦ 4,697.00

The total cost of walling the three-bedroom residential building
= ₦2,080,516.15

Cost per m^2 = ₦2,080,516.15/$117m^2$ = ₦17,782.19/m^2

4.0 Calculations and Discussion

The result shows that the cost per unit for interlocking brick was ₦80.08 while the cost per unit of sandcrete block was ₦347.20. However, the prevailing price of 225mm sandcrete blocks in the study area was between ₦220.00 and ₦240.00. This is because the manufacturers produced about 35 blocks per bag of cement against 25 blocks produced in this study as specified by NIS. The current market price of interlocking was ₦450.00 per unit (including delivery to the site) which is higher than the calculated amount because of the monopoly of the manufacturers of bricks. There is no single manufacturer of interlocking brick in Ondo State. The overall material cost for interlocking bricks was ₦1,214,232.64 whilst the material cost for sandcrete blocks was ₦2,080,516.15. This indicates that materials cost for interlocking bricks was ₦10,378.06/m^2 whereas the materials cost for sandcrete block as ₦17,782.19/m^2. This implies that the overall cost saving for using interlocking brick is about 58%.

The duration for the laying of interlocking bricks was 32 days for a gang of one mason and one labour while the period for laying sandcrete blocks was 40 days for the same gang. This result also indicates that the cost of labour for laying interlocking bricks and sandcrete blocks was ₦120,000.00 and ₦200,000.00 respectively. This suggests that the labour cost for interlocking bricks and sandcrete

blocks are ₦1,025.64/m^2 and ₦1,709.40/m^2 respectively. This implies that labour cost saving for using interlocking brick is about 67%. The result has shown that it was cheaper to construct a three-bedroom residential building with the use of interlocking bricks than sandcrete blocks. The use of interlocking bricks saves about 35% without rendering and painting whilst the overall cost saving is about 58%. The cost-saving for labour is about 67%. The finding on material costs agreed with Adedeji (2002) and Okwesilieze et al. (2015). Considering the time required to complete the three-bedroom apartment, the result also revealed that more time was saved with the use of interlocking bricks. This was also in line with Okwesilieze et al. (2015).

5.0 Conclusion and Recommendations

The study concluded that the government should encourage the use of interlocking bricks for affordable mass housing in Nigeria because of its several advantages such cost-effectiveness, reduced construction time and easy access to the raw materials from the local environment. The government should also encourage the use of a machine designed by NBRRI for mass production interlocking bricks in every part of the country as presently obtainable in the case of sandcrete blocks. The study recommends that a regulatory body should be set up to implement compliance with the standard specified by Nigerian Standard Organisation for the manufacturing of interlocking bricks, to ensure production of quality interlocking bricks for mass housing in Nigeria.

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