

Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana

Abstract

The extensive use of Sandcrete blocks (SBs) for residential buildings as compared to interlocking bricks (IBs) has significantly increased its cost and has therefore affected the cost of housing delivery in Ghana. The research aimed at comparing the cost of SBs and IBs for residential buildings in Ghana. The study adopted qualitative and physical measurement methods of data collection on a two bedroom self-contain floor plan building. The findings revealed that lesser construction time was required for IBs. It was also established from the study that a total cost of GH¢14,268.54 and GH¢ 18,869.64 were observed for IBs and SBs respectively. The difference in cost of SBs were found to be GH¢4,601.10, representing 24.38%. The consequence is reduction in laborer force, limited finishing time and minimum running cost, without compromising the aesthetic and strength value. The study therefore recommends the use of IBs for prospective building developers, entrepreneurs and individuals due to its cost saving, time and running cost.

Keywords: affordable housing, environmental friendliness, design flexibility, housing policy, housing problems, population, shelter

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Introduction

The Ghanaian populace is facing serious housing problems, particularly for the poor who represent the majority of the Ghanaian population. Hence, adequate shelter is one of the most important basic human needs. Adewole¹ posited that interlocking bricks are considered to have high energy efficiency, structural stability and a high acceptability index in terms of aesthetic as against the use of sandcrete blocks. Adedeji² & Arayela³ opined that building materials constitutes the main factors and the largest single input in housing construction; restrict the supply of housing account for between 50–60 percent of building cost. Interlocking bricks (IB) have always been in use to a lesser extent; however, according to Ogunsemi,⁴ extensive studies on the technology appeared after the first ecological-villages came into being. The Interlocking Brick (IB) is a technology that developed the idea of dry stacking bricks during construction method known as mortar-less bricks. Sandcrete blocks as indicated by Akeem et al.⁵ is known as a walling unit produced from sand, cement and some water, and it is widely used in Ghana as a walling unit. Cement as a binder remains the most expensive input in the production of sandcrete blocks. The National Housing Policy of Ghana, as indicated by Gidigas⁶ through the Ministry of Works and Housing in 1986 emphasized the development and use of local building material to contribute to the solution of the housing crises, thereby, reducing the importation of foreign building materials to a minimum. Its widespread use can be attributed to its availability and satisfactory characteristics.⁷

The accumulated housing deficit in Ghana as point out by Mustapha et al.⁸ was due to neglected use of the use of traditional building materials by developers. The influx of foreign building materials and techniques has also been a major problem facing the construction industry in Ghana. However, Nicco-Annan⁹ exposed the high cost and time overruns as well as poor quality of construction materials perceived to be associated with construction product delivery process in Ghana. This can only be resolved when the

percentage cost difference in putting up a building using sandcrete blocks and interlocking bricks are known. Sarfoh¹⁰ posited that the cost of housing has soared out of control to the point that only few wealthy Ghanaians can afford to buy a house in the urban core. The paper compared the cost of sandcrete blocks (SBs) and interlocking bricks (IBs) for residential buildings in Ghana.

Methodology

The quantitative and case study approaches were adopted in this study to determine the comparative cost analysis between interlocking bricks (IBs) and sandcrete blocks (SBs) for residential buildings in Ghana. This was determined through the qualitative approach and physical measurements of a two-bedroom self-contain floor. The physical measurement of a two-bedroom self-contain house was conducted from the foundation through to the beam level. Prices of IBs and SBs were obtained from various building materials shops in the Cape Coast Metropolis in May 2016. The data collected as shown in Tables 1–10 were used to estimate the cost elements. While Tables 11–16 shows the unit costs of interlocking blocks (IBs) and sandcrete blocks (SBs). All these account for the difference between IBs and SBs, as well as their percentage cost difference. The information was also used to compare and contrast the cost benefit analysis in promoting affordable housing in Ghana. Descriptive statistics was used in the analysis of the data.

Table 1 Cost of estimate for brickwork

Bricks	Amount
Bricks = GH 1.50 per l	
6628 bricks at GH 1.50	GH 9,942
Loading and offloading = GH 200 per 1000 bricks	

Table continued..

$\frac{200}{1000} = 0.2$	GH 1,325
0.2 at 6628	
Total cost	GH 11,268
Cement	
Cement = 18@ 32	GH 576.00
loading = 1.40@ 18	GH 25.20
Total cost	GH 601.20
Fine Aggregate (Sand)	
Sand = 5.4m ³ = 5m ³	GH 250.00
Water	
Water = 72@ 1.00 72.00	GH 72.00
Cost of labour	
Total number of bricks = 6628	
Number of bricks lay per day is 800 (per one mason)	
Therefore number of days that will be used = $\frac{6628}{800}$	8days
Amount paid per day is 50 per mason and 40 per labour	
Cost per mason = 8 x 50	GH 400
Cost per labour = 8x 40	GH 320
Finishing	
Assume 1m ³ for polishing = GH 3.21 @ 422.91m ³	GH 1357.54

Table 2 Cost estimates for block– work

Blocks	Quantity
Area of building = 138.41 m ²	
Area of one block = 0.104 m ²	
Total number of blocks = $\frac{138.41m^2}{0.104m^2}$	1,331 blocks
5% per waste	67 blocks
Total number of blocks	1,398 blocks

Table 3 Cement

I bag of cement laying 50 blocks	Bags
Number of bag of cement = $\frac{1,398}{50}$	30 bags
5% of waste	2 bags
Total number of cement in bags	32 bags

Table continued..

I bag of cement laying 50 blocks	Bags
Fine aggregate (sand)	
A mix ratio of 1: 4	
A bag of cement	50kg
Four (4) parts of sand = 200kg (20 x 4)	
200 kg x 32	6,400kg
1 m ³	1,000kg
$\frac{6400}{1000} \times 1m^3$	6.4 m ³
Water	
Water cement ratio of 0.5 = Water = 0.5	
50kg	
Weight of Water = 50 kg x 0.5	25kg
$\frac{1000kg}{25kg} \times 1m^3$	40 m ³
20% for waste	8 m ³
Total volume for waste	48m³
25m ³ = 1 gallon (big size)	
$\frac{48m^3}{25m^3} = 1.92m$	2 gallons (50 litres)

Table 4 Cost of blocks and bricks

Description	Amount (GH¢)
Blocks	
Blocks =	GH¢2.50 per block
Therefore 1,398 blocks@ GH¢ 2.50	GH¢ 3,495.00
T&T/ loading and offloading GH¢0.40/block	GH¢ 559.20
Total cost	GH¢ 3,550.20
Cement	
Cement = 32bags@ GH¢ 32.00	GH¢ 1,024
T&T/loading and offloading = GH¢ 1.40@ 32 bags	GH¢ 45.00
Total cost	GH¢ 1,069.00
Fine aggregate (sand)	
Sand = 6.4m ³ = 6m ³ @ GH¢ 41.67/ m ³	GH¢ 250.00
Water	
Water = 64gal.@ GH¢ 1.00	GH¢ 64.00

Table 5 Cost of labour

Total number of blocks to be laid	1,398 blocks
Number of blocks lay per day per mason	80 blocks
Therefore number of days that will be used = $\frac{1,398 \text{ blocks}}{80 \text{ blocks}}$	18days
Amount paid per day = GH¢ 50.00 per mason	
Amount paid per day = GH¢ 40.00 per labour	
Cost per mason = 18days@ GH¢ 50.00/day	GH¢ 900.00
Cost per labour = 18days@ GH¢ 40.00/day	GH¢ 720.00
Total cost	GH¢ 1,620.00
Concrete works (Tie- Beam)	
Plain in- situ concrete (1:3:6) in lintel	GH¢ 295.1 per m ³
Volume of concrete for lintel = 3.1m ³ @ GH¢ 295.1	GH¢ 914.81
Form work	
Surface area formwork = 41.2m ²	GH¢ 824.00
Therefore area of formwork = 41.2m ² @ GH 20	

Table 6 Aggregate for plastering and rendering (sand)

Fine aggregate (sand) for plastering	
Where 1m ³ = 1.484m ³	
Therefore 7.55m ³ @ 1.484m ³	11.204 m ³
Fine aggregate (sand) for rendering	
Where 1m ³ = 1.39m ³	
Therefore 3.03m ³ @ 1.39m ³ =	4.212 m ³
Total volume of sand	15.42 m ³
Add 5% for waste	0.771 m ³
Total	16.20 m³

Table 7 Cost of finishing

Fine aggregate (sand)	
Assume 6m ³ truck capacity= GH 250.00	GH 250.00
Therefore 16.20m ³ /6 m ³ @ GH 250	GH 675.00
Cement	
GH 32.00@100 bags	GH 3200.00
Labor cost	
Assume a mason per day = 3 days	
Therefore 100 bags/3 days = 33 days	33 days
Assume GH 40/ mason/day@33 days	GH 1320.00
Assume GH 30/labour/day@33 days	GH 990.00
Total cost	GH 2310.00
Water for plastering	
Assume 1 bag of cement = 2 gallons (50 litres)	

Table continued..

Therefore 100 bags at 2 gallons = 200 gallons	
Assume a gallon = GH 1.00	
Therefore 200 gallons @ 1.00	GH 200.00
Total cost	GH 6385.00

Table 8 Material cost (MC)

The mix ratio was 1:6 (one part of ordinary Portland cement to six parts of sand)	Amount GH¢
The total number of IBs required was	6,628 bricks
The cost per IBs was	1.5
Therefore 6,628 bricks@ GH¢1.50p	9,942.00
Transport and loading/off- loading: GH¢200.00 per 1000 bricks	1,325.00
Cost of cement: 18bags@ GH¢32.00	576
Transport and loading/off- loading: GH¢1.40p@ 18 bags	25.2
Cost of Sand: 5m ³	250
Cost of water: 72gallons (25litres/gal.)@ GH¢ 1.00	72
Total Material Cost	12,191.00

Table 9 Labor cost (LC)

Total surface area:	422.91m ²
Cost per m ² for polishing	3.21
Total cost of polishing:– GH¢3.21 @ 422.91m²	1,357.54
Grand total cost of A, B and C	14,268.54

Literature review

Interlocking and sandcrete blocks

Both interlocking blocks and sandcrete blocks as shown serve similar purpose.¹¹ The research report further indicated that both interlocking blocks and sandcrete blocks, as shown in Figs. 1 and 2 have varied differences and similarities in terms of price, durability, choices, convenience, and their advantages over each other.¹¹ Assiamah et al.¹² in their study of interlocking and sandcrete blocks for building walling systems realized a 50% from the output of the masons when interlocking blocks were used as compared to sandcrete blocks. Material cost for the use of mortar by each mason for both interlocking blocks was lower than sandcrete blocks. Cost of labour also reduced drastically and this result concur with that of Danso et al.¹³ This is in relation to construction of walls. Assiamah et al.,¹² posited that the reduction in cost was due to minimum mortar used during the construction. Assiamah et al.,¹² concluded that the cycle time of bonding blocks in interlocking blocks reduced significantly and subsequently increased the speed of wall construction. Interlocking blocks are also affordable in terms of cost and weather conditions. The use of materials also was cut down significantly and labour cost reduced (Figure 1).

A research by Ghana Homes Block¹¹ show that the use of interlocking block has reduced drastically due to its limited use in the country. Even Ghana has a clay deposit in all the regions, but non patronization of the products of the industry has resulted to close of the brick industry in Ghana (Figure 2).



Figure 1 Sandcrete blocks.

Source Ghana Homes Block.¹¹

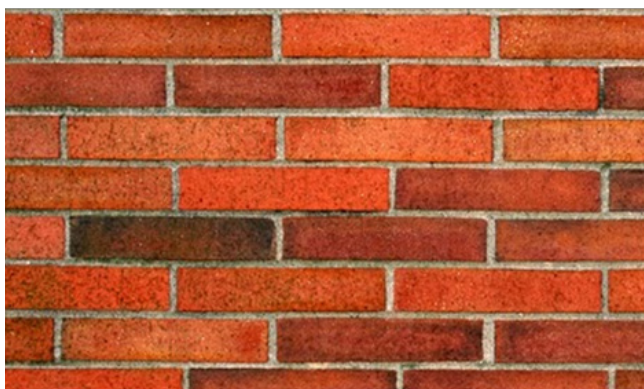


Figure 2 Interlocking blocks.

Source Ghana Homes Block.¹¹

Findings

The cost estimates for both brick-work and block-work brickwork which comprised of materials, labor and finishing are presented in this section. The area of the building and one brick were found to be 148.71m² and 0.023m respectively. The total number of blocks and bricks were found to be 148m² and 6466. Twenty-five percent (2.5%) waste was added to obtain 162 blocks and 6628 bricks. One bag of cement was required to lay 44bricks within a 1m² area and 9m² area utilized 18bags of cement, 396 of blocks and 6628 of bricks with 0.85 waste. A mix ratio of 1:6 was used with a bag of cement; weighing 50kg and 18 bags of cement utilized 5400kg of aggregate. Water, cement ratio of 0.025 and 50kg, utilized 12.5kg of aggregate. An area of 80m³ with 20% (16 m³) utilized 96m³. The rendering process utilized a mix ratio of 1:4 and 72gallons of water and 63bags of cement (Tables 1-7). Table 4 presents cost of materials for blocks, which comprises of blocks, cement, fine aggregate (sand) and water.

This section presents the discussions on the unit cost and the cost per the area of a single storey two bedroom self-contained using IBs and SBs to determine their cost difference. It begins with the unit cost of IBs and followed by SBs to determine cost of materials and labor. Tables 8–10 present the unit cost of interlocking blocks, comprising of material cost, labor cost and finishes.

Unit cost of sandcrete blocks (SBS)

Tables 11-13 present unit cost of sandcrete blocks, comprising of material cost, labor cost and finishes.

Table 10 Material cost (MC)

Mix ratio was 1:4 (one of ordinary Portland cement to four head pans of sharp sand)	GH¢
The total number of sandcrete blocks required was	1,398 blocks
Cost per sandcrete blocks:	2.5
Therefore 1,398 blocks@ GH¢2.50	3,495.00
Add T&T and loading/off-loading:– GH¢0.40 @ 1398blocks	559.2
Cost of cement:– 32bags@ GH¢32.00	1,024.00
Add T&T and loading/off-loading:– GH¢1.40p @ 32bags	44.8
Cost of Sand = 6m ³ @	250
Cost of water = 64 gallons (25litres/gal)@ GH¢ 1.00	64
Cost for concrete works: – GH¢295.1@ 3.1m ³	914.81
Cost for form works: – GH¢20.00@ 41.2m ²	824
Total Material Cost	7,175.81

Table 11 Labor cost (LC)

The labour cost per mason: GH¢50.00@ 18 days	900
The labour cost per 2 labourers: GH¢80.00@ 18 days	1,440.00
Total labour cost	2,340.00

Table 12 Finishes

Plastering (P) and Rendering (R)	
Cost of cement = 100bags × GH¢ 32.00.	3,200.00
Cost of sand = 16.20m ³ /6m ³ @ GH¢ 250.00	675
Cost of water = 200gallons (25litres/gal)@ GH¢ 1.00	200
Labour cost per mason = GH¢ 40.00 for 33days	1,320.00
Labour cost per labourer – GH¢ 30@ 33days	990
Total cost for P & R (a)	6,385.00

Painting works

Total surface area to be painted: 422.91 m ²	
Total Cost of painting per m ² (b)422.91 m ² @ GH¢7.02/ m ²	2,968.83
Total cost of finishes (a) and (b)	9,353.83
Grand total cost of I, II and III	GH¢ 18,869.64

a – Total cost of plastering and rendering

b – Total cost of painting per m²

I – Total cost of materials; II – Total cost of labor; III – Total cost of finishes (a) and (b)

Table 13 Percentage cost difference between IBs and SBs

IBs	Total cost (GH¢)	SBs	Total cost (GH¢)	Cost diff. (GH¢)	% Cost diff.
Material cost	12,191.00	Material cost	7,175.81	5,015.19	41.14%
Labor cost	720	Labor cost	2,340.00	1,620.00	69.23%
Finishing cost	1,357.54	Finishing cost	9,353.83	7,996.29	85.49%
Total Cost	14,268.54	Total Cost	18,869.64	4,601.10	24.30%

Percentage cost difference between IBS and SBS block for residential buildings

Table 13 presents the percentage cost difference between IBs and SBs.

Discussion

This section presents the discussions on the cost of element which account for the difference. Table 13 shows that comparative cost of interlocking bricks and sandcrete blocks were obtained by estimating for the cost of a two bedroom single-storey self-contained building plan excluding the roof and substructure. The prices of interlocking bricks and sandcrete blocks were obtained from the market. Sandcrete blocks (450x225x150) mm were sold at GH¢ 2.90, while interlocking bricks (250x125x100) mm were sold at GH¢ 1.70. The cost includes loading/off-loading and transportation. It was observed from the findings that the use of IBs required only 18 bags of cement for the total of 6,628 bricks, while 1,398 SBs required 132 bags of cement for both block-laying works, plastering and rendering for the completion of single-storey two-bedroom self-contained bungalow. The use of IBs required only 5m³ of sand costing GH¢250.00/6m³, while the use of SBs required a total of 22.20m³ for block-laying work, plastering and rendering costing GH¢925.00. Additionally, a gang of one mason plus one laborer may possibly lay between 800–1000 IBs per day, thereby using only 8 days in laying a total of 6,628 IBs with a labor cost of GH¢ 720.00. On the other hand, a gang of 1 mason plus 2 labor could rather be used in 18 days in laying 1,398 SBs costing a total of GH¢2,340.00 for labor. In the case of finishing, IBs do not require any painting unless the user for no apparent reason decides to do so. Nonetheless, a chemical known as PVC bond is applied as a polish to the surface which cost GH¢ 3.21 per m², hence a total of GH¢1,357.54 is required for the finishing. On the other hand, GH¢ 5.40 per m² is required for SBs which translates into a total cost of GH¢ 9,353.83 for painting.

Discussion on percentage cost difference between interlocking bricks and sandcrete blocks

The total material cost for IBs was GH¢12,291.00 while SBs was GH¢7,175.81 making a cost and percentage difference of GH¢5,015.19 and 41.14% respectively (Table 13). Labor cost for both IBs and SBs was GH¢720.00 and GH¢2,340.00 which makes the cost difference of GH¢1,620.00 and the percentage cost difference of 69.23%. In the case of finishes, the total cost of IBs was GH¢1,357.54 while SBs was GH¢9,353.83 which also makes the cost and percentage cost difference of GH¢7,996.29 and 85.49%, respectively. On a whole, the total cost of IBs was GH¢14,268.54 while that of SBs was added up to get GH¢ 18,869.64. The finishing cost for IBs was higher than the material cost and least among the three was labor cost. However, the cost difference as well as the percentage cost difference was established to be GH¢4,601.1 and of 24.38%. This shows that constructing with IBs is cheaper than that of SBs. Despite the fact that material cost for IBs is more than SBs, there is also an indication that the labor and finishing cost are more when you consider the use of SBs. Assiamah et al.,¹² has also attested to the fact that interlocking blocks are more economical than sandcrete blocks. They further indicated that have the potential of supporting the affordable housing concept in Ghana.

Conclusion

The results revealed that the cost incurred in the use of interlocking bricks for construction of the proposed two bedroom single-storey self-contained building plan under study was cheaper than using

sandcrete blocks for construction of the same building in terms of material and labor cost. Considering the cost elements which account for the difference, the study further revealed that the use of sandcrete blocks requires mortar for the laying of blocks as well as associated non-contributory activities like sorting, taking, breaking, laying and leveling of blocks as well as taking, mixing, laying and spreading of mortar and finally, waiting for materials. All of these affect the cost as well as the net output. Hence, these activities together with the use of mortar are eliminated in the use of interlocking bricks. There is flexibility in the design, environmental friendliness reduction in the time for setting operation and elimination of associated wastage. There is also cost saving in the case of IBs at GH¢14,268.54 and SBs at GH¢ 18,869.64. The percentage in the cost difference was established to be GH¢4,601.1 and of 24.38%, respectively, without compromising the aesthetic and strength quality. Interlocking bricks have been found to be better alternatives to sandcrete blocks and should, therefore, be used to promote affordable housing delivery in Ghana for building developers. This will facilitate cost efficiency and make housing provision available and more affordable.

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Conflict of interest

The author declares there is no conflict of interest.

References

1. Adewole HA. *Building Materials in South Western Nigeria (Affordability In Building Construction Through The Use of Interlocking Bricks)*. Department of Architecture, Federal University of Technology, Akure, Nigeria; 2008.
2. Adedeji YMD. Technology and standardized composite cement fibres for housing in Nigeria. *J Niger Inst Archit*. 2010;1:19–24.
3. Arayela O. *Laterite bricks: before now and hereafter*. Inaugural lecture series 40 delivered at Federal University of Technology, Akure. 2005;5–15.
4. Ogunsemi DR. *The use of enough quality and quantity materials for building a durable edifice*. A Lecture delivered at Campus Transformation Network, Federal University of Technology, Akure, Nigeria; 2010.
5. Akeem AR, Ayodeji KM, Aliu AS. Comparative Analysis of Sandcrete Hollow Blocks and Laterite Interlocking Blocks as Walling Elements. *International Journal of Sustainable Construction Engineering & Technology*. 2012;3(1):79–88.
6. Gidigas MD. Lateritic soil construction for housing in Ghana. *Journal of the Ghana Institution of Engineers*. 2005;3(2).
7. Andam AK. *Bricks, blocks and the future administrative capital of Ghana*. A report delivered during the Inaugural lecture of the Ghana Academy of Arts and Sciences. Accra, Ghana; 2004.
8. Mustapha Z, Akani M. Earthen Construction, as a Solution to Building Industries in Ghana. Department of Building Technology, School of Engineering, Cape Coast Polytechnic Cape Coast. *Journal of Economics and Sustainable Development*. 2013;4(3):190–198.
9. Nicco-Annan J. Partnering in Construction. *The Quantity Surveyor*, 2006;1:14–19.
10. Sarfoh O. *Brief History of Housing in Ghana*; 2007.

11. *Ghana Homes Block*. The Price of Building Blocks & Bricks in Ghana; 2014.
12. Assiamah S, Abeka H, Agyeman S. Comparative study of interlocking and sandcrete blocks for building walling systems. *International Journal of Research in Engineering and Technology (IJRET)*. 2016;2319–1163.
13. Danso H, Manu D. High cost of materials and acquisition problems in the construction industry in Ghana. *International Journal of Research in Engineering & Applied Sciences (IJREAS)*, 2013;3(3):18–33.