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 less 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

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. Adewole 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. Adedeji & Arayela opined that building materials constitute 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 (IBs) have always been in use to a lesser extent; however, according to Ogusemi, 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. 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 Gidigasu 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.

The accumulated housing deficit in Ghana as point out by Mustapha et al. 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–Annan 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. Sarfoh 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. The investigation of prices of IBs and SBs was 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 bricks (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 1      |          |
| 6628 bricks at GH 1.50     | GH 9,942 |
| Loading and offloading = GH 200 per 1000 bricks |          |
Table continued..

| Description                       | Quantity | Amount (GH¢) |
|-----------------------------------|----------|--------------|
| Cement                            |          |              |
| Total cost                         | GH 11,268|
| Cement = 18@ 32                   | GH 576.00|
| loading = 1.40@ 18                | GH 25.20 |
| Total cost                         | GH 601.20|
| Fine Aggregate (Sand)              |          |              |
| Sand = 5.4m³ =5m³                 | 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 = | 8days |
| 100                               |          |              |
| 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 1m³ for polishing = GH 3.21@ 422.91m³ | GH 1357.54|

Table 2 Cost estimates for block– work

| Blocks                        | Quantity |
|-------------------------------|----------|
| Area of building = 138.41 m²  |          |
| Area of one block = 0.104 m²  |          |
| Total number of blocks = 138.41m² / 0.104m² | 1,331 blocks |
| 5% per waste                  | 67 blocks |
| Total number of blocks        | 1,398 blocks |

Table 3 Cement

| Description                       | Quantity |
|-----------------------------------|----------|
| 1 bag of cement laying 50 blocks |          |
| Number of bag of cement = 1,398 / 50 | 30 bags |
| 5% of waste                      | 2 bags   |
| Total number of cement in bags   | 32 bags  |

Table continued..

| Description                       | Bags |
|-----------------------------------|------|
| 1 bag of cement laying 50 blocks |      |

Table continued...

| Description                       | Bags |
|-----------------------------------|------|
| Fine aggregate (sand)             |      |
| A mix ratio of 1:4                |      |
| A bag of cement                   | 50kg |
| Four (4) parts of sand = 200kg (20 x 4) | 6,400kg |
| 1m³                               | 1,000kg |
| 64000 × 1m²                       | 6.4m³ |
| 1000                              |      |
| Water                             |      |
| Water cement ratio 0.5 = Water = 0.5 | 50kg |
| Weight of Water = 50 kg x 0.5     | 25kg  |
| 1000kg / 25kg × 1m³               | 40m³  |
| 20% for waste                     | 8m³   |
| Total volume for waste            | 48m³  |
| 25m³ = 1 gallon (big size)        | 2 gallons (50 litres) |
| 48m³ / 25m³                       | 1.92m |

Table 4 Cost of blocks and bricks

| Description                       | Amount (GH¢) |
|-----------------------------------|--------------|
| Blocks                            |              |
| Blocks =                          |              |
| 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 = 6.4m³ = 6m³@ GH¢ 41.67/ m³ | GH¢ 250.00  |
| Water                             |              |
| Water = 64gal@ GH¢ 1.00           | GH¢ 64.00   |

Citation: Jackson EN, Mustapha Z, Aburam AJ, et al. Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana. MOJ Civil Eng. 2018;4(4):206–211. DOI: 10.15406/mojce.2018.04.00120
Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana

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 = 1, 398 blocks

80 blocks

Amount paid per day = GH¢50.00 per mason

8 days @ GH¢50.00/day

Therefore 6,628 bricks @ GH¢1.50p

Total cost: GH¢1,620.00

Concrete works (Tie–Beam)

Plain in–situ concrete (1:3:6) in lintel: GH¢295.1 per m²

Volume of concrete for lintel = 3.1m³ @ GH¢295.1

GH¢914.81

Form work

Surface area formwork = 41.2m²

GH¢824.00

Therefore area of formwork = 41.2m² @ GH¢20

Table 6 Aggregate for plastering and rendering (sand)

Fine aggregate (sand) for plastering

Where 1m³ = 1.484m³

Therefore 7.55m³ @ 1.484m³ = 11.204 m³

Fine aggregate (sand) for rendering

Where 1m³ = 1.39m³

Therefore 3.03m³ @ 1.39m³ = 4.212 m³

Total volume of sand = 15.42 m³

Add 5% for waste = 0.771 m³

Total = 16.20 m³

Table 7 Cost of finishing

Fine aggregate (sand)

Assume 6m³ truck capacity = GH¢250.00

Therefore 16.20m³/6 m³@ 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

Assume GH¢40/labor/day@33 days

GH¢1320.00

Assume GH¢30/labor/day@33 days

GH¢990.00

Total cost

GH¢2310.00

Water for plastering

Assume 1 bag of cement = 2 gallons (50 litres)

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: 18 bags @ GH¢32.00

576

Transport and loading/off–loading: GH¢1.40p @ 18 bags

25.2

Cost of Sand: 5m³

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:

422.91 m²

Cost per m² for polishing

3.21

Total cost of polishing: – GH¢3.21 @ 422.91 m²

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. 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. Assiamah et al. 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. This is in relation to construction of walls. Assiamah et al., posited that the reduction in cost was due to minimum mortar used during the construction. Assiamah et al., 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 Block showed 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).

Citation: Jackson EN, Mustapha Z, Aburam AJ, et al. Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana. MOJ Civil Eng. 2018;4(4):206–211. DOI: 10.15406/mojce.2018.04.00120
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 148.71m$^2$ and 0.023m respectively. The total number of blocks and bricks were found to be 148m$^2$ 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 1m$^2$ area and 9m$^2$ 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 80m$^3$ with 20% (16 m$^3$) utilized 96m$^3$. 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)

| Description | Material Cost (GHc) | SBS | IBs | Diff GHc | % Diff |
|-------------|---------------------|-----|-----|----------|-------|
| Total       | 7175.81             |     | 12191.00 | 4015.19 | 41.14% |

### Table 11 Labor cost (LC)

| Description | Labor Cost (GHc) | SBS | IBs | Diff GHc | % Diff |
|-------------|------------------|-----|-----|----------|-------|
| Total       | 2340.00          |     | 720  | 1620.00  | 69.23% |

Table 12 Finishes

| Description | Finish Cost (GHc) | SBS | IBs | Diff GHc | % Diff |
|-------------|-------------------|-----|-----|----------|-------|
| Total       | 9353.83           |     | 1357.54 | 7996.29 | 85.49% |

Grand total cost of I, II and III

| Description | Total Cost (GHc) | SBS | IBs | Diff GHc | % Diff |
|-------------|------------------|-----|-----|----------|-------|
| Total       | 18869.64         |     | 14268.54 | 4601.10 | 24.30% |

Table 13 Percentage cost difference between IBs and SBs

| Description | IBs | SBS | Diff GHc | % Diff |
|-------------|-----|-----|----------|-------|
| Material cost | 12191.00 | 7175.81 | 5015.19 | 41.14% |
| Labor cost | 720 | 2340.00 | 1620.00 | 69.23% |
| Finishing cost | 1357.54 | 9353.83 | 7996.29 | 85.49% |
| Total Cost | 14268.54 | 18869.64 | 4601.10 | 24.30% |
Percentage cost difference between IBS and SBS block for residential buildings

Table 13 presents the percentage cost difference between IBS and SBSs.

Discussion

This section presents the discussions on the cost 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 excluding the roof and substructure. The prices of interlocking bricks and sandcrete blocks were obtained from the market. Sandcrete blocks (450x225x150) were sold at GH¢ 2.90, whiles interlocking bricks (250x125x100) mm were sold at GH¢ 1.70. The cost includes loadings/offloading and transportation. It was observed from the findings that the use of IBSs required only 18 bags of cement for the total of 6,628 bricks, while 1,398 SBSs 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 IBSs required only 5m² of sand costing GH¢250.00/6m², while the use of SBSs required a total of 22.20m² for block-laying works, plastering and rendering costing GH¢925.00. Additionally, a gang of one mason plus one laborer may possibly lay between 800–1000 IBSs per day, thereby using only 8 days in laying a total of 6,628 IBSs with a labor cost of GH¢720.00. On the other hand, a gang of 1 mason plus 2 laborers could rather be used in 18 days in laying 1,398 SBSs costing a total of GH¢2,340.00 for labor. In the case of finishing, IBSs 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 SBSs 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 IBSs was GH¢12,791.00 while SBSs 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 IBSs and SBSs 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 finishing, the total cost of IBSs was GH¢1,357.54 while SBSs 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 IBSs was GH¢14,268.54 while that of SBSs was added up to get GH¢ 18,869.64. The finishing cost for IBSs 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 IBSs is cheaper than that of SBSs. Despite the fact that material cost for IBSs is more than SBSs, there is also an indication that the labor and finishing cost are more when you consider the use of SBSs. Assiamah et al., 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 IBSs at GH¢14,268.54 and SBSs 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.

Acknowledgements

The authors wish to acknowledge the effort of the laboratory technicians at Building Technology Department, Cape Coast Technical University, Cape Coast, Ghana.

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 building 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. Oguntomilehin J. 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. Gidigasu MD. Lateritic soil construction for housing in Ghana. Journal of the Ghana Institute 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):199–198.
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.