

# A Comparison of Conventional Blocks and Stabilized Earth Blocks as Building Materials in Uganda

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## ABSTRACT

The high cost of conventional cement and sand blocks in Uganda has led to the widespread adoption of alternatives like wattle bricks, compressed earth blocks, and burnt bricks. Compressed earth blocks are a biodegradable, energy-efficient, and eco-friendly building material made from damp soil compressed at high pressure. They reduce environmental hazards and deforestation without firewood. Case study methodology was used and deliberate sampling for collection of data. SPSS v20 was used for the analysis. The result shows that Stabilized Earth Materials have positive relationship on satisfaction such that it causes 0.651 satisfaction against Conventional Blocks which is 0.602. It revealed a significant impact of Stabilized Earth Materials on cost with 4.8% difference. It is recommended that construction manager should make more use of stabilized earth materials to reduce cost and improve quality

**Keywords:** Conventional blocks, stabilized earth blocks, building materials

## INTRODUCTION

BMI's report indicates Uganda's positive economic trajectory, with a 6.5% growth rate in 2023. The country's housing construction, which requires 300,000 units annually, is booming. The government has allocated 8.5% of its 2023/24 budget to transport and infrastructure, aiming to improve housing development and GDP through construction. Uganda's GDP in Construction rose to 2326.73 UGX Billion in Q2 2023 from 2205.56 UGX Billion in Q1 2023 [1]. The construction industry in Uganda, which contributes over 12% to the country's GDP, has experienced steady growth for the past 20 years. However, the country faces a significant housing deficit, with 2.4 million units in urban areas and 1.395 million in rural areas. With 7.3 million households and a national occupancy density of 1.1 households per unit, there is a total backlog of 710,000 units. The annual need for new housing is estimated at 200,000 units, with a national deficit of 140,000. The high cost of conventional cement and sand blocks in Uganda has led to the widespread adoption of alternatives like wattle bricks, compressed earth blocks, and burnt bricks. Compressed earth blocks (CEB) are a biodegradable, energy-efficient, and eco-friendly building material made from damp soil compressed at high pressure. They reduce environmental hazards and deforestation without firewood. However, they shrink slightly as they dry, requiring curing and

being 15-20 times less energy-efficient than fired bricks. SEB, a durable and cost-effective building material, is underutilized due to factors like production and construction costs, lack of skilled labor, design data availability, and government support. Uganda is experiencing a shortage of building materials due to scarcity of raw materials and fuel prices. This has led to halting ongoing constructions, as site owners have different budgets before inflation. This has resulted in poor productivity and low profitability for construction site workers and clients. For example, a trip of sand costs 130000 UGX, an Elf truck of stones costs 200000 UGX in most developed areas, and clay bricks range from 150000-200000 UGX depending on the location and quality. Cement prices have also increased due to power blackouts on local factories. In 2023, a 25% increase in all construction materials was observed, with the COVID pandemic and Russian invasion of Ukraine contributing to the inflation. The rising cost of non-imported building materials like sand is primarily due to rising fuel prices, prompting the need to promote the use of local materials like stabilized earth blocks. Uganda construction industry depends on professional services, construction services and support services which materials content contributes heavily into as opined by [2].

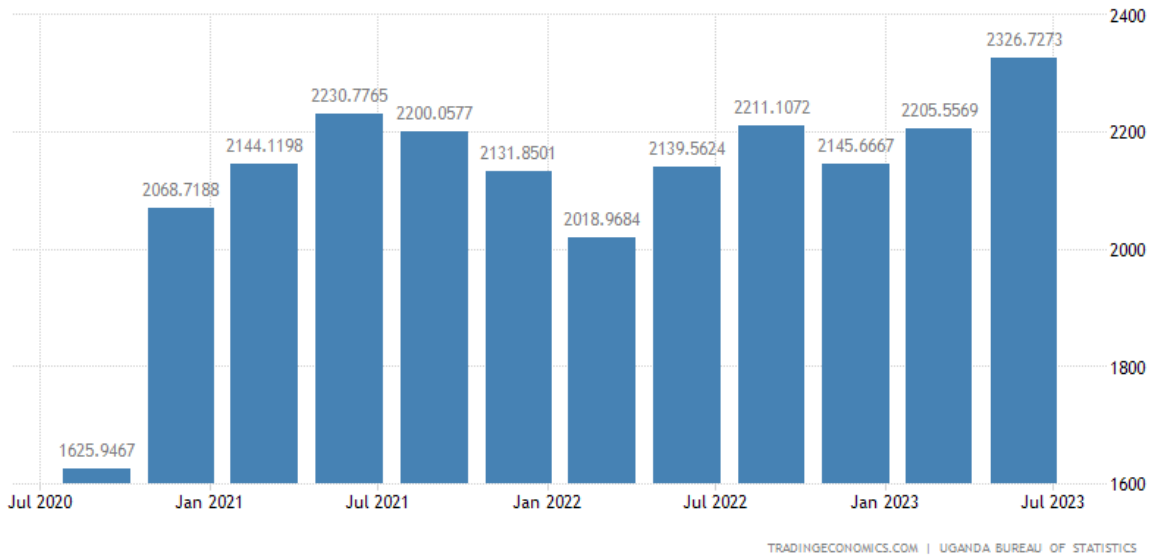


Fig. 1 – Contribution of Construction Industry to Uganda GDP. Source: [1]

### Literature Review

#### Historical concept of bricks usage in Uganda

Stabilized earth is a method for building foundations, floors, and walls using natural materials like earth, chalk, lime, or gravel. The soil is compacted into building blocks, either in a box-shaped mold or layer by layer. The soil must be high in sand and low in clay, with cement and water sometimes added. Stabilized earth houses are durable, lasting over 1000+ years. Stabilized earth walls are ideal for high humidity climates and moderate temperatures, like Uganda. They are warm, dry, energy-efficient, sustainable, environmentally friendly, and non-toxic.

They require minimal energy to manufacture and construct, and can be safely spread on site. Stabilized earth homes are low maintenance, offer excellent sound insulation, reduce pest problems, and are fire-resistant due to their solid nature. They also require additional insulation in colder climates and locations with high rainfall. Stabilized earth walls offer unique beauty and character, can be customized, and complement contemporary or rustic homes. They complement natural timber and stone building materials.

#### Cost of Stabilized earth

Cost of stabilized earth materials and final products vary from one locality to the other. Factors such as availability, awareness and usability determines the cost of such products. The perception of the users and the durability, including aesthetics also adds to the choices of the materials' selection. Examination of

Andy Bynes reports carried out by [3] asserts that the prices of using earth materials for a building construction starts at \$75 (US\$ 267,500) per square foot which include major elements such as foundation construction, building height, floor-to-ceiling height and construction complexity.

#### Stabilized Earth materials in Uganda

Entebbe Children's Surgical Hospital, located near Lake Victoria, is one of the world's largest modern

Stabilized earth projects, featuring Stabilized earth walls and monumental glass facades.



Fig. 2: Renzo Piano completes Uganda Children's Hospital with Stabilized earth walls. Image source: [4]

Renzo Piano designed a pro bono hospital using Italian firm Zintek, utilizing an ancient Stabilized earth wall construction method, which is environmentally friendly, strong, and aesthetically appealing. Stabilized earth soil (STEB) is a cost-effective and environmentally friendly construction material that addresses housing needs in many communities [5]. Its affordability surpasses sandcrete block work in modern construction technology. Assessing STEB strength and sandcrete block use can integrate STEB into the building industry, boosting government focus on low-income housing. A survey among building industry stakeholders revealed several reasons for preferring Sandcrete blocks over burnt bricks, including lack of design data, lack of experts, high initial construction costs, market availability, irregular shapes and colors, and flaky and algae formation. Burnt bricks, on the other hand, have performance indicators such as durability, strength, sustainability, affordability, and user satisfaction. However, longevity depends on ingredients quality, climate, and artisans' skill. Burnt bricks are permanent, weatherproof, age-proof, and non-combustible, making them ideal for bushfire-prone areas. They require low maintenance but may deteriorate if not maintained regularly. Sustainability is a key factor, as bricks have thrived over thousands of years due to their longevity, energy efficiency, and reduced environmental impact. Sustainable construction efforts have focused on soil/earth

construction, with the introduction of stabilized and enhanced soil blocks. Mixing stabilized earth with cement yields more blocks than sandcrete cement blocks, reducing housing construction costs. However, the high cost of cement and modern construction materials makes it difficult for low-income earners to own a house [6]. Brick-making involves shaping blocks using a steel plate mould, allowing them to dry and shrink. Three technologies are presented: ISSB, concrete blocks, and burnt bricks. Each method has its advantages and disadvantages, including specialized design, high wastage, deforestation, and construction time. Skilled workers and a long preparation time are required for successful brick-making. Blocks can be made using simple machines, wooden moulds, or steel moulds. The wooden mould is initially oiled overnight and doesn't need to be oiled each time filled. Concrete is placed in layers and compacted with a 3 kg rammer. Steel moulds are often used in large-scale production. Net steel plates can prevent damage during tamping and reduce wear on the mould. Stabilized earth blocks production is more economical in developing countries due to its low water consumption, low resource requirements, and low emissions [7]. Earth construction is easy to work with, fireproof, and load-bearing, reducing the need for structural supports and reducing building costs. It also offers good insulation properties. House construction in Uganda is shifting from traditional fired bricks to concrete blocks, which

are a mixture of sand, gravel, cement, and water. These bricks are more environmentally friendly and superior to local burned bricks. Industrially manufactured bricks, produced by factories using machinery, are preferred in urban centers and are fired in specialized kilns using biomass like coffee husks. Decorative concrete or sand/cement blocks

offer light, security, ventilation, and aesthetic appeal. Some are designed to prevent rain or mosquitoes. Simple shapes can be created in wooden moulds, while more complex designs require a professionally made steel mold.

**METHODOLOGY**

This paper employed a case study methodology to investigate a phenomenon, utilizing both quantitative and qualitative methods. It uses deliberate sampling and semi-structured surveys sent by Google Surveys

to government employees and building industry professionals in the study area. A five-point Likert scale and SPSS v20 analysis were used for reliability.

**Findings**

**Table 1: Determinants of choice of materials in housing construction**

Criteria	Conventional Blocks		Stabilized Earth Blocks	
	N	%	N	%
Stability	45	37.5	75	62.5
Thermal comfort	35	29.1	85	70.9
Cost	39	32.5	81	67.5
Aesthetic	68	57.1	51	42.9
Class	78	65	42	35
Texture	67	56.7	51	43.3
Fire resistance	40	33.3	80	66.7
Security purpose	45	37.5	75	62.5
<b>Average determinant sum</b>		<b>43.59</b>		<b>56.41</b>

Table 1 indicates that thermal comfort, stability and cost are the main criteria of using stabilized earth in Uganda which is 100% in use in eastern, and western region. Meanwhile, aesthetic, texture and class are the main determinants of selecting conventional blocks as the main case in Uganda central. In all, stabilized earth block has higher average criteria value of 56.41% which makes it the most preferred. The study was in line with previous study of [5] that

the strength of earth materials used for blocks in southern Nigeria increases with age and it also in conformity with [6] of the thermal advantage of stabilized earth material over the conventional. This also aligns with a [8] stating that the experimental prototype school, built using compressed stabilized soil blocks, was cost-effective and strong by acceptable standards as also applicable in Sudan.

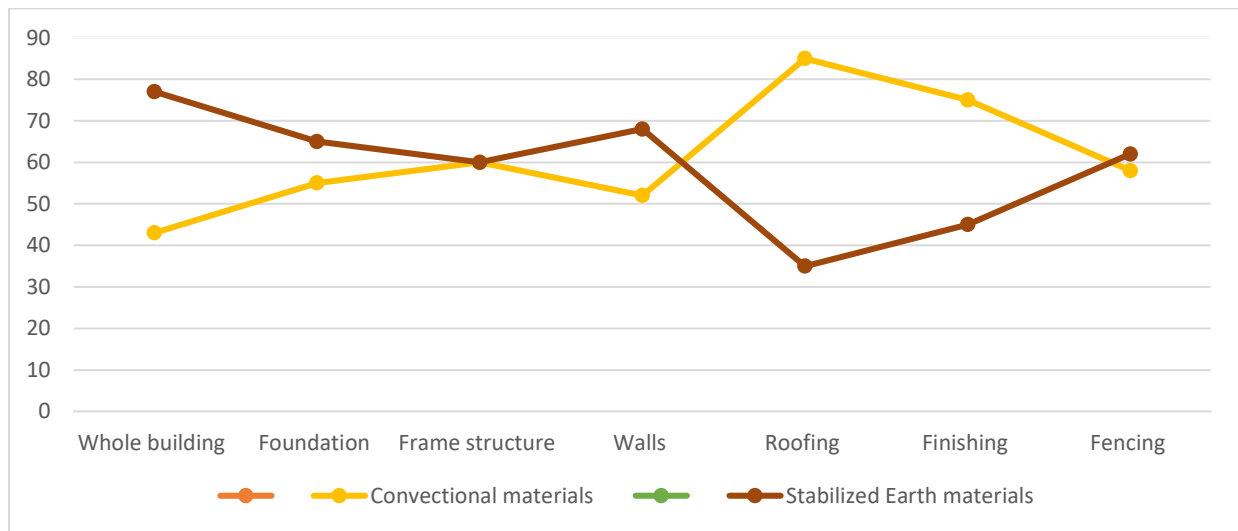


Figure 1: Preferred location of materials in a building

The location of using the materials vary from one end user to the other. Figure 1 indicates that stabilized

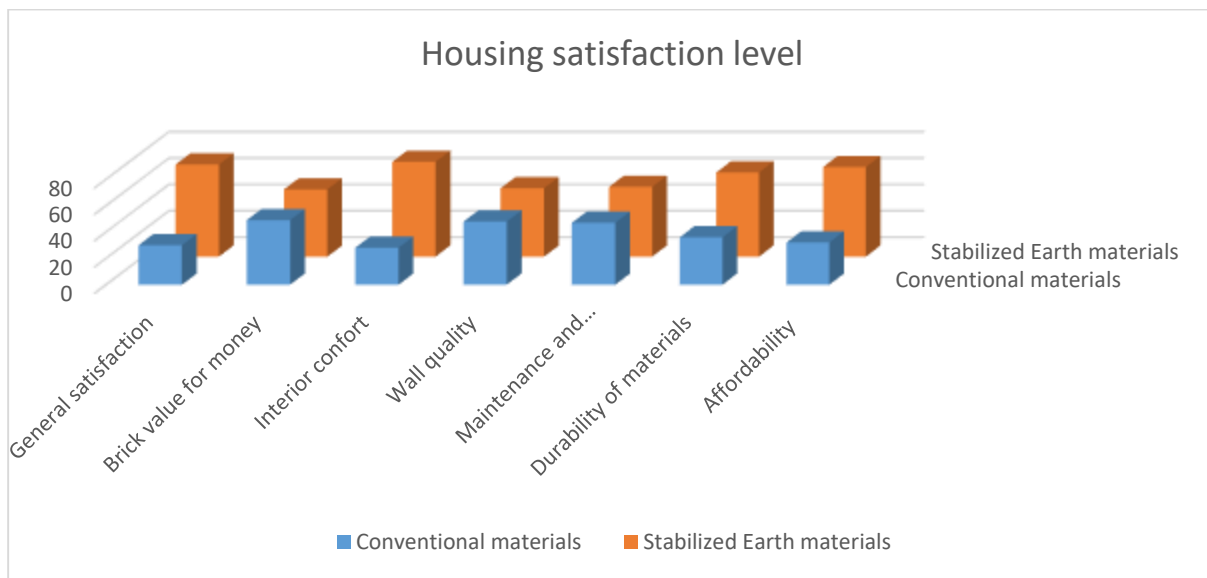
earth are preferred in the construction of the entire location with the exception of doors and windows. It

is mainly used in foundation (65%) and walls (68%) while convectional are mostly applied in the roofing (85%) and finishing (75%). Meanwhile, both conventional and earth materials has equal

application in constructing frame structure (60% each)

**Table 2: Housing Satisfaction levels**

S/N	Section	Conventional materials (%)	Stabilized Earth materials (%)
1	General satisfaction	30	70
2	Brick value for money	49	51
3	Interior comfort	28	72
4	Wall quality	48	52
5	Maintenance and sustainability	47	53
6	Durability of materials	36	64
7	Affordability	32	68



**Fig. 2: Housing Satisfaction level**

The study aimed to assess the satisfaction levels of brick houses by asking respondents to rate their satisfaction levels in various aspects of the house. The results showed that 30% and 70% of respondents were very satisfied with the general construction quality of the housing units, indicating that bricks have value for their money compared to other building materials. 51% of respondents were satisfied with the interior comfort of earth bricks as a building material, as bricks absorb and release heat slowly, reducing stress load and keeping the house cool during daytime and

warm at night. 72% of respondents were satisfied with the wall quality of Earth bricks. 49% and 36% of respondents were very satisfied with the maintenance and sustainability of burnt bricks as a building material, as little or no maintenance works have been done on the brick walling itself. 53% of respondents were satisfied with the durability of the building material, and 49% and 36% of respondents were very satisfied with affordability as a building material. Overall, brick houses were rated as attractive and well-valued compared to other building materials.

**Cost value of different materials**

The comparison of the cost of production of blocks and laying; then the usage of materials for plastering were considered for conventional materials (CM) and stabilized earth materials (SEM). The results are shown in Table 3

**Table 3: Cost Implications**

Work Process	Qty CM	Qty SEM	Unit	Rate	Amount CM	Amount SEM
<b>Production (a)</b>						
Cement	0.050	-	bag	45,000.00	2,250.00	-
Sand	0.004		trip	130,000.00	520.00	-
Earth		0.086	trip	2,500.00	-	215.78
Water	0.304	0.442	litre	25.00	7.61	11.05
Labour including bonding				1,500.00	85.00	150.00
<b>Materials cost</b>					<b>2,862.61</b>	<b>376.83</b>
Cost Difference %					2,485.78	
Difference					86.84	
<b>Laying (b)</b>						
Cement	0.167	0.180	bag	45,000.00	7,515.00	8,078.63
Sand	0.012	0.009	trip	130,000.00	1,560.00	1,170.00
Water	0.013	0.013	litre	25.00	0.33	0.33
<b>Materials cost</b>					<b>9,075.33</b>	<b>9,248.95</b>
Cost Difference %					173.63	
Difference					1.88	
<b>Plastering (c)</b>						
Cement	0.083	0.125	bag	45,000.00	3,735.00	5,602.50
Sand	0.012	0.009	trip	130,000.00	1,560.00	1,170.00
Water	0.013	0.016	litre	25.00	0.33	0.41
<b>Materials cost</b>					<b>5,295.33</b>	<b>6,772.91</b>
Cost Difference %					1,477.58	
Difference					<b>21.82</b>	

CM Total Cost = a+b+c                      17,233.3

SEM Total Cost = a+b+c                      16,398.7                      834.57                      **4.8%**

The study provides quantitative cost data affirming that earth blocks are more cost efficient with an average value of 4.8% reduction per unit cost of production. Meanwhile, it has production savings of 86%, which agrees with [9] where cost analysis carried out on the convectional blocks and stabilized earth blocks affirmed that earth blocks are cheaper alternatives to conventional blocks, giving a 46%

reduction in the total production cost. Findings revealed that it has 60% economic stability. That is, has a lesser fluctuation effect. Previous authors, [10, 11, 12, 13, 14] have shown that the blocks from earth or adobe are cost-effective, viable and more sustainable alternatives to the widely used conventional sand concrete blocks.

**Relationship between the determinants and level of satisfaction**

**Table 4: Analyses of the descriptive statistics**

	Mean	N
Conventional Blocks	48.1250	8
Stabilized Earth Materials	51.2500	8

The result of the descriptive statistics shown in Table 4 that the mean coefficient of conventional blocks is

48.125. More so, the result indicates that the mean value of stabilized earth materials is 51.250.

**Table 5 Correlation Analyses**

		Conventional Blocks	Stabilized Earth Materials
Conventional Blocks	Pearson Correlation	1.000	.031
	Sig. (2-tailed)	.000	.602
	N	8	8
Stabilized Earth Materials	Pearson Correlation	1.000	.038
	Sig. (2-tailed)	.000	.651
	N	8	8

From the result of the correlation analysis in Table 5, Stabilized Earth Materials have positive relationship

on satisfaction such that it causes 0.651 satisfaction against Conventional Blocks which is 0.602.

**Table 6: one-sample test of the hypotheses**

*H<sub>0</sub>*: There is no significant impact of Stabilized Earth Materials on cost

**One-Sample Test**

	Test Value = 0				95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Cost Difference	Lower	Upper
					There is no significant impact of Stabilized Earth Materials on cost	0.037

The value of the t-statistics as shown in Table 6 is (0.037), which is below 0.05 (the critical value), so we reject the null hypothesis and conclude that Stabilized Earth Materials has a significant impact on cost. This is based on the decision rule that states, accept the

null hypothesis if the value of the t-statistics is greater than 0.05.

**CONCLUSION**

Uganda is experiencing a shortage of building materials due to a scarcity of raw materials and high fuel prices. This has led to halting ongoing constructions, as site owners have different budgets before inflation. This has resulted in poor productivity and low profitability for construction site workers and clients. Stabilized earth is a method for building foundations, floors, and walls using

natural materials like earth, chalk, lime, or gravel. Sustainable construction efforts have focused on soil/earth construction, with the introduction of stabilized and enhanced soil blocks. Mixing stabilized earth with cement yields more blocks than sandcrete cement blocks, reducing housing construction costs. It is therefore noted that earth blocks production and

usage can be achieved both in the urban and rural areas.

### RECOMMENDATIONS

Construction manager should make more use of stabilized earth materials to reduce cost and improve quality. Government should reduce the tax levy on

local manufacturers in order to improve more productivity of stabilized earth materials products like bricks, tiles etc.

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