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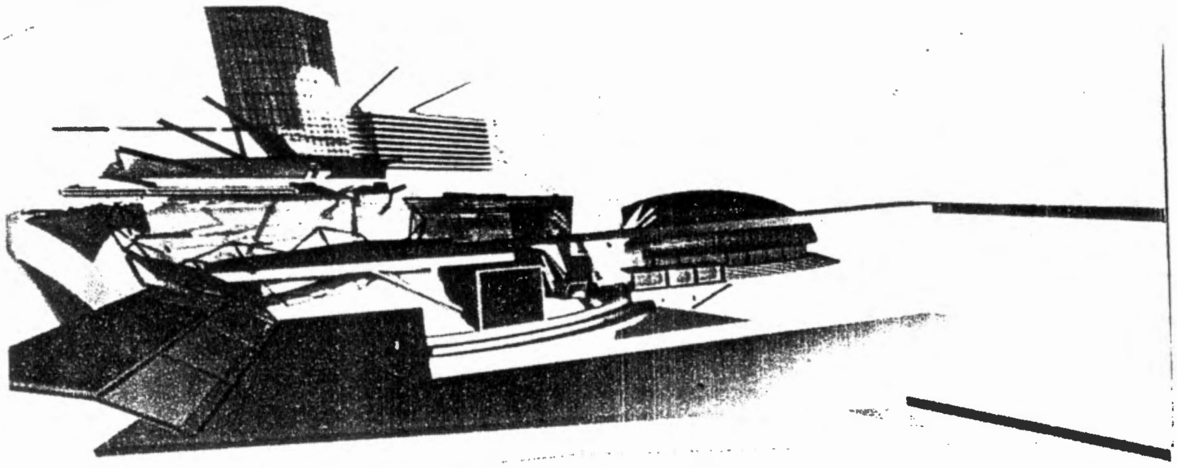

HOUSING CONSTRUCTION

An Interdisciplinary Task

Host Organization

University of Coimbra - Faculty of Sciences and Technology
Department of Civil Engineering - Constructions Laboratory
Portugal

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Affordable Housing Production: The Influence of Traditional Construction Materials

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Key words: affordable housing production, sustainable housing technology, conventional construction materials, traditional construction materials, cost reduction.

Abstract

An aspect of the problems of sustainable housing technology in Nigeria like many other developing countries of the world is the escalating cost of conventional materials input to construction. These materials are not wholly produced locally, often in short supply, involves importation and hence not affordable to the poor masses. One of the paths to sustainable housing technology appears to be production of affordable housing using traditional construction materials which are adjudged to be cheaper and in abundant supply locally. Comparative construction cost analysis between the use of conventional and traditional materials was therefore performed on existing low-income building in an estate in the town of Ile-Ife, Nigeria. The result showed that the cost of two and three bedroom units reduced by 12.5% and 15.44% respectively when cement stabilized earth block was used for the wall construction, deep hardwood section for lintels, palm kernel shells (Kernelrazzo) for floor finish and wood casement window as replacement for glass louvres. It was recommended that the application of these locally sourced materials be standardized and backed up by large scale production so that prospective home owners, housing cooperatives and private developers can buy at affordable prices.

1 Introduction

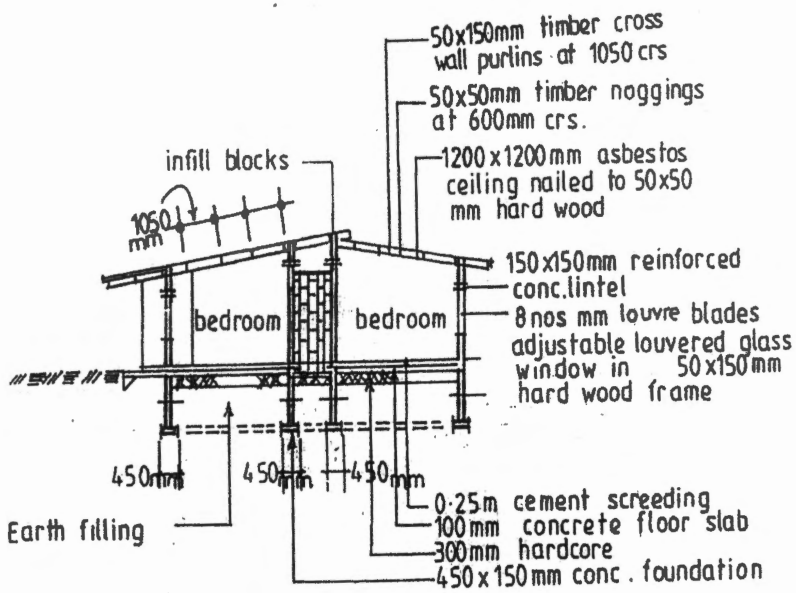
Inadequate housing provision is a common phenomenon in many developing countries of the world. In Nigeria with a population of about 120 million people and rapid urbanization, population growth in the urban centers and supply of housing stock have inadvertently assumed the dimension of a one sided race. While the population densities in urban centers continue to surge astronomically, the rate of increase in housing delivery by governments [local, state and federal], private developers and individuals lags behind demand.
A wide range of problems contributing to the near collapse of housing programmes in the country have been identified by researchers from different viewpoints. Some of these views include inconsistency in government policy [1]; lack of adequate data relating to housing and non-implementation of habitat recommendations [2]; non - consideration of gender issues in housing programmes [3]; inadequate housing finance market [4]; inappropriate project management practices [5] and non-development of traditional construction materials to reduce cost [6, 7, 8]. Research efforts into traditional construction materials are predicated on the assumption that locally sourced materials are cheaper and hence serve as good replacement for expensive conventional materials. To this end, a number of potential construction materials ranging from various species of timber to some agricultural wastes and residues have been investigated and found suitable in terms of strength and durability. However, the cost implication of using these traditional materials as replacement for conventional materials is usually not given. This paper therefore has as its objective to evaluate the cost implications of replacing conventional construction materials with traditional construction materials in the drive towards affordable and sustainable housing technology.

2 Research Methodology

Certain authors, Basavaragjaiah and Raju [9] have indicated that in the analysis of a traditional house, the three principal components of a construction made up of walls, roof, doors and windows are responsible for about 75% of the total cost of the building. To reduce cost and accelerate construction therefore, durable and cheaper materials of construction are required for these three components in addition to optimum structural shape.
In order to meet the requirement of optimum structural shape, prototype rectangular bungalow buildings on Moremi low-income housing estate in Ile-Ife, Osun State, Nigeria were selected for this research. The estate was constructed by Osun State Property Development Corporation (OSPDC) with conventional construction materials. The objective of constructing the estate was to provide low cost houses at affordable tenement rate to low income earners. The estate is made up of two building typologies; two and three bedroom bungalows (fig. 1 and 2). The buildings were constructed with concrete base and traditional strip foundation on which sandcrete hollow blockwalls were raised. The roof comprises of corrugated roofing sheets on hard wood truss (fig.3). For construction cost reduction evaluation, possible substitutes for conventional construction materials were compiled based on plethora of research findings on traditional construction materials. The possible substitutes and those applied in this research are shown in table 1. The cement stabilised hollow earth blocks used as replacement for sandcrete hollow blocks were those with optimum mix of 4% and 20% cement and water content respectively with a compressive strength of 2.12 N/mm2 at 28 days. The Nigerian Standard Organisation [10], specified a strength of 2.10 N/mm2 at 28 days for sandcrete hollow blocks.
To determine construction cost of both conventional and traditional construction materials on the two building typologies, the following procedure were followed:

i. Taking off of quantities
ii. Abstracting
iii. Billing of quantities

The billing of quantities was performed in accordance with the prevailing materials' c[ost] and labour rates in Ile-Ife around January, 2000.



Source: Field Survey (2000)

Figure 1: A section showing typical use of conventional building materials

3 Results and Discussion

The results of the billing of quantities at each stage of construction using the conventional materials and traditional materials are shown comparatively in Tables 2 and 3 for the two-bedroom and three-bedroom typologies respectively. In the substructure, a saving of 8.33% was obtained for the two-bedroom bungalow and 8.23% for the three-bedroom bungalow. The substructure works quantified includes excavation, hard-core filling, lateritic filling, concrete work and blockwalling. The use of traditional construction materials was only possible in the blockwalling of strip foundation where cement stabilized earth brick was substituted for concrete block. The use of cement stabilised earth brick for the foundation work gave 41.67% savings over the use of sandcrete block for this operation.
In the construction of the superstructure the operations quantified are blockwalling, installation of screen wall, lintels (concreting, reinforcement and formwork), hard wood door and window frames, roof frames, roofing sheets and concrete roof ridge. The operations that showed appreciable reductions in cost were blockwalling with 41.67% reduction in both typologies and lintels with a staggering 80% to 80.9% reduction in the respective typologies. The traditional material substituted in the blockwalling of the superstructure was the same as that of the substructure. The substitution of traditional construction materials in the superstructure gave a reduction of 26.04% in the two-bedroom typology and 30.55% in the three-bedroom typology.

Table 1: Possible Substitution of Traditional Construction Materials for Conventional Materials in Low-Income Housing.

Building components	Conventional materials	Alternative traditional materials	Materials used in this research
Foundation	In-situ concrete with sandcrete block	Burnt brick, stabilized earth brick /block	In-situ concrete with stabilized earth blocks
Walls	Sandcrete block	Burnt bricks, stabilized earth brick/block, saw dust-crete block	Stabilised earth blocks
Lintels	In-situ concrete with reinforcing steel bars	Deep hardwood section	Deep hardwood section (Mahogany)
Floor	Mass in-situ concrete	Clay block	Mass in-situ concrete
Floor finish	Cement sand mortar	Palm kernel shell `kernel-razzo'	Palm kernel shell `kernelrazzo'
Ceiling	Asbestos sheets	Hardboards, fibrous core bamboo	Asbestos sheet
Doors	Plywood flush doors	Plywood flush doors	Plywood flush doors
Windows	Glass – louvre	Wood casement	Wood casement
Roof	Corrugated Iron sheet	Clay slates, fibre reinforced concrete tile	Corrugated iron sheet

Source: Field Survey 2000

The operations considered for the finishes were rendering and plastering of walls, floor finish, window glazing, door fixing and locks, ceiling, woodwork painting and polishing and wall painting. However, traditional materials were substituted for floor finish and window glazing only. Palm kernel shells otherwise referred to as kernelrazzo was substituted for floor finish. This finish was devised in the Department of Building, Obafemi Awolowo University, Ile-Ife as part of the ongoing research into traditional construction materials. This finish was found to compete favourably with the conventional terrazzo both in strength and durability [11]. The use of this material gave 34.47% and 32.67% reduction for the two-bedroom and the three-bedroom typologies respectively. Wood casement windows were substituted for glass louvres and this gave a saving of 31.20% in the two-bedroom typology and 43.03% in the three-bedroom typology. The overall percentage reduction for finishes was 7.43%.

The operations considered under services were plumbing fixtures and electrical installations. No traditional materials were found suitable for these items and hence no reduction in the cost was obtained for this element of work. The situation is the same for the preliminaries. For all the substitutions made, it was found that a two-bedroom typology would cost 12.59% less when traditional construction material is used than the conventional construction materials. Similar reduction for three bedroom typology was found to be 15.44%.

Table 2: Comparative cost of conventional and Traditional Construction Materials

Key Components/ Operations Exhibiting Cost Reduction	Conventional Materials		Traditional Materials		Reduction in Cost	Percentage Reduction
	Cost of Construction	Cost of Key Operations	Cost of Components	Cost of Key Operations		
1. Preliminaries	4000		4000		0.00	0.00
2. Substructures	183085		167,835			8.33
Block Work		36,600		21,350	15,250	41.67
3 Superstructure	244,195		180,631			26.04
Blockwork		80,400		46,900	33,500	41.67
Lintel		37,584		1,520	30,064	80.00
4 Finishes	203,802		188,665			7.43
Flooring		33,600		21,683	11,917	35.47
Window (Glazing)		10,320		7,100	3,220	31.20
5. Services	110,900		110,900		0.00	0.00
Total Cost/ Savings	745,982	-	652,031	- -	93,951	12.59

Source: Field Survey, 2000: US$1 ≈ 110 Naira

Table 3: Comparative Cost of Conventional and Traditional Construction Materials

Key Elements/ Operations Exhibiting Cost Reduction	Conventional Materials		Traditional Materials		Reduction in Cost	Percentage Reduction
	Cost of Elements	Cost of Key Operations	Cost of Elements	Cost of Key Operations		
1. Preliminaries	4,500		4,500		0.00	0.00
2. Substructures	215,715		197,965			8.23
Block Work		46,600		24,850	17,750	41.67
3 Superstructure	296,225		205,705			30.55
Blockwork		126,000		73,500	52,500	41.67
Lintel		46,980		8,960	38,020	80.93
4 Finishes	268,128		248,108			7.47
Flooring		42,000		28,280	13,720	32.67
Window (Glazing)		14,640		8,340	6,300	43.03
5. Services	110,900		110,900		0.00	0.00
Total Cost/Savings	895,468	-	757,178	-	138,290	15.44

Source: Field Survey 2000

4 Conclusions and Recommendations

Cost analysis has shown that traditional construction materials have high potentials in reducing the construction cost of low-income houses. This is more evident in the construction of the superstructure where between 26% and 31% reduction in cost is obtained. Specific construction operations leading to substantial cost reduction are in the use of cement stabilized earth for wall, deep hardwood section for lintel, palm kernel shell floor finish and wood casement windows in place of glass louvres.

Concerted efforts must be made to reduce to the bearest minimum, the use of cement and reinforcing bars in low income housing for the purpose of reducing cost. The local production of these two materials are inadequate and currently being supplemented by importation which is expensive. Even the quantity of cement being produced locally depends wholly on importation of gypsum a major ingredient in the manufacture of cement. This is the reason why the price of locally manufactured cement competes favourably with the imported one. An aspect of the problems of low-income housing production in the country is non-use of material production plants. It is therefore recommended that the use of these traditional materials be standardized and large production plants created for the manufacture of these materials. The materials can then be sold to prospective home owners, developers and housing cooperatives. The traditional materials introduced in this work do not in any way impair quality and aesthetic of the building.

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