ASPECTS OF MATERIALS AND METHODS DEPLOYED IN LOW INCOME SELF - HELP HOUSING: THE DELETERIOUS EFFECTS AND PROPOSED REMEDIATION

Arc. Joseph O. Oko & Arc. James I. Demenongu
Department of Architecture,
University of Jos, Jos.
Email: agaba30 @ yahoo.com

ABSTRACT

As a result of the necessity and quest to have own shelter emanating mainly from the ever rising accommodation rent cost, there has been a great thrust by poor urban dwellers, low and middle income earners to move to the urban fringes and start their shelter - somehow. The paucity of funds engenders the practice of cutting expenditure to the extent and effect that several building materials and methods employed are unconventional, deleterious and detrimental to the health, safety and security of such owners and users. This study investigated the extent and depth of this practice in a selected area (Gamajigo community) an urban fringe of the city of Jos, in North Central Nigeria with a view to proffering solution to the anomalous materials and methods. The methodology employed involved first of all identifying buildings that were in active construction process, investigating the methods and materials applied in their construction. Thereafter, knowledge of Architectural theory and practice was applied to propose better and more wholesome materials and methods. The findings were that the use of several cost saving measures (materials and methods) which had detrimental consequences were very pervasive. The study also found that in as much as cost saving measures were desirable to attain a low cost, low budget housing, there were some incontrovertible fundamental costs that building owners should not run away from bearing. The study therefore proffered better ways of attaining cost saving measures that would not jeopardizing health, safety and security of the owners or occupants. This study was significant and contributed to knowledge in that by adhering to the provisions and suggestions of this study, low cost housing could be attained by the urban

low and middle income earners through self – help methods without jeopardizing health, safety and security of the owners of such dwellings. The study also has the promise of enhancing the durability of such structures coupled with the additional benefit of maintaining minimal expenditure for housing procurement.
Keywords: *Building Materials / Methods, Deleterious Effects, Low Cost Housing, low/Middle income earners Income Earners, Self – Help Housing, Urban Poor.*

INTRODUCTION

For the city of Jos, the Plateau State capital in North central Nigeria, developments at the urban fringes are often times spontaneous - by self-help of urban poor, low/middle income earners. This situation was exacerbated by the incessant religious and communal clashes which bedeviled the city since September 2001. These unrests popularly referred to as *Jos Crises* caused a great number of city dwellers to relocate from their erstwhile places of abode to other parts of the town, state or even other parts of the country. There were about 14 such notable areas (fringes) of Jos, in which developments were on - going (at the time of this research – February, 2019) on a relatively pervasive and spontaneous scale as a result of these factors. The most prominent of these areas were Gamajigoarea, , Bidabidi, Howllaza, Russau, and ECWA Staff school area all along Zaria road axis; Eto Baba, Mai Jagab – Bauchi road Filling station area, Ring road, Lamingo and Rukuba road area, amongst others.

STATEMENT OF THE PROBLEM

Most of the buildings that sprouted up as described above were usually by self help effort of the urban poor, low or middle level income earners driven mainly by the need to attain the lowest cost possible to procure accommodation. (It is not a hard and fast rule that the residents here were only poor, low /middle income earners as intermingled with them are affluent neighbours in duplexes). In the effort to attaining these low cost building structures several unorthodox and deleterious methods and materials were employed. These building construction processes and materials had the potential of compromising the health, safety and security of the occupants and also the possibility of

impinging on the integrity and durability of the structure and fabrics of the buildings.

PURPOSE OF THE STUDY

The aim of this study was to portray the unconventional and deleterious building construction materials and methods employed to attain low cost housing in a typical Jos urban fringe and also proffer better ways of achieving the goal of attaining low budget shelter without sacrificing the health, safety and security of occupants and fragility of the shelter.

In order to achieve this, the following objectives were considered:

i. To identify a particular Jos urban fringe with on - going residential construction projects.
ii. To examine and document new residential buildings in the identified neighbourhood that have maximum of 2 – year construction currency.
iii. To identify materials and methods employed to attain low cost Housing status which were unconventional and had the potential of being detrimental to the safety, health and security of the users. .
iv. To critique these unconventional materials and methods at those stages with a view to proffering better ways of attaining low cost housing that employ safe and acceptable means.

THE METHODOLOGY

The methodology employed in this research was the direct field reconnaissance survey during which the study of a sample of residential units was carried out in a selected urban fringe. Using this method the researcher physically investigated the buildings and undertook physical observations, enumeration, annotation to observations, sketches and photographs of materials and methods employed. Additionally, builders, carpenters, metal fitters, labourers and building owners were interviewed. Others were requested to respond to questionnaires. From the knowledge of best practices in architectural theory, building and construction, deleterious construction materials and methods employed in the construction processes were identified at the same time bearing in mind the essence of attaining low cost housing. Finally, constructive and beneficial low cost materials

and methods that could achieve the same or similar effect were proffered. All these were achieved by

i. Selection of one of the thrieving urban fringes of Jos city for study.
ii. Selection of residential developments that were on going or had been completed less than two years previously.
iii. Identification and appraisal of detrimental and unconventional materials and methods employed in those buildings.
iv. Suggestion of materials and methods that could achieve low cost construction without sacrificing safety and security of occupants and also durability of structure.

The Urban Fringe under Study: The Gamajigo Neighbourhood

The urban fringe area under study is the Gamajigo community. This neighbourhood was selected for this study because apart from having several on – going buildings (82 buildings), the area was designated for residential settlement in the current greater Jos master plan (Greater Jos Master Plan for 2008 to 2025 (Master Plan for 2009). This community is along the Zaria road axis bounded at the South by a distributary of the Dilimi River, in the north by NEPA Area residential Settlement, in the west by the Jos – Zaria trunk A road and at the east by another distributary of the dilimi river and the Russau community. The two major roads that make ingress into this area from the Jos – Zaria trunk A road are the El Cortez Hotel road and the Kassa Mines Road. These two roads were not tarred and maintained by self help effort of the residents.

Concomitant developments with these residential units were five private nursery/primary schools, two secondary schools and several small private business concerns like medicine, provision shops and small scale poultry farms. There was also an Islamic tertiary institution, two private tertiary institutions, the Lagos, Western and Northern Nigeria Area of the Apostolic church seminary Institute (LAWNA) and a private Polytechnic (UNITECH).

Before the advent of the Jos crises in 2001, there were less than eighty sparely positioned buildings in this area but as at the time of this study, (February 2019) there were over 1506 residential

units almost all of which were owned by private individuals. Of these, 82 units were in the active construction process or within two year construction currency (that means they had been completed not more than two years before this research). Progress of work in 72 housing units had stalled for several reasons. It was these 82 units that were studied of which 25 were at sub structure level, 15 were up to lintel level, 18 were at different stages of the roofing phase while 24 were at different stages of floor, wall or ceiling finishes. A summary of the stages of work progress as at the start of the research in June 2018 is as shown in Table 1 below.

Table 1
Stages of Work Progress of Buildings under Construction

s/n	Stage of work progress	No of housing units
1	between foundation excavation and end of sunstructure	25
2	between start of super structure and end of lintel	15
3	between lintel completion and end of block work	24
4	start of roofing to different stages of finishes	18
	total	82

Source: Researcher's Field Work, 2015.

Identification and Appraisal of major defective Materials and Methods Employed

i. Failure to treat the ground against termite infestation and potential attack -

Of the 82 houses under construction only 4 representing a paltry 3% conducted this preventive procedure against potential termite attack and potential infestation. The owners of the remaining 78 houses felt that it was a cost saving measure or they did were ignorant of doing so. The remaining 97% did not take this preventive measure.

In hot, dry or humid tropical climates as in Jos termites, ants and other subterranean insects thrive and pose great risk of infestation to building materials. The vulnerable parts of the building are wooden window/door frames, wooden roofing members. wardrobes, and kitchen cabinets. There is therefore the need to treat the grounds of the site and the substructure

compartments of a building with insecticides and insect repellant chemicals. Chemicals like *Gamalin 20* or *DDT* are recommended for use in the diluted form. A single application before commencement of construction or when the construction process is at the substructure level have the potential of annihilating all subterranean insects, larvae, pupa and eggs thereby protecting the house from potential infestation and attack. DDT could also be applied as or by spraying its aqueous suspension (DDT. 2010). The chemical could be applied in the pure form or in combination with other chemicals or dilatants especially those that ensure that its annihilating effect of insects and their metamorphous stages is prolonged.

ii. **Improper Setting out of the Building**

Setting out is the process of physically translating the plan of a building from paper to the ground. Improper setting out of a building leads to buildings with skewed shapes. Of the 82 Housing units assessed 16 had this deficiency of possessing skew shape in plan especially where it was intended to have squared configuration. The buildings with this type of problem were 16 out of 82 representing 19.5 %. If the squared configuration of a building is not achieved the resultant distortion affects several other areas ranging from the interior space dimensions, wall and roof members.

There are different methods available for accurate setting out to ensure that the building has accurate and squared configuration. Chudley and Greeno (2010) maintain that 90^{o}angles could be obtained using site square, the theodolite or the builders square. Alternatively, the geometric Pythagoras theorem for right angle triangle using ratios of 30, 40 and 50 could be used to obtain perpendicularity (Macrae, M.F. Kalejaiye, A. O. Chima, Z.I. Garba, G.U. Ademosu, M.O. Channon, J. B. Mcleish Smith, A. Head, H; 2011). For setting out involving circular or curvilinear shapes it is necessary to always carefully establish the Centre or the focal point for the curve or the circle and proceed to get the walls radiating from the centre using a carefully constructed or accurate protractor.

iii. **Building without Architectural Services**

Several residential building projects took off without Architectural design or any form of service or input from an architect. Of the 82 housing units investigated, 45 representing 57% were without Architectural Plans. In 50% of this (23) artisans (masons / bricklayers) merely relied on past projects to set out the buildings mentally, without any prepared plans. Some others simply used pen or pencil to produce very rough sketches of the building on any pieces of papers for the client and also used as basis for estimation, costing and discussion on the labour and materials. Several building owners seemed to like this approach since it saved them the trouble of paying any fee to a registered architect. Of these 82 buildings only 12 developments representing 14.6% had architectural plans of which none had any plan prepared or endorsed by a registered or licensed architect.

The advantages of having architectural services before, during and sometimes after any building is erected far outweigh the cost of the architect's fee. According to Policy and Legal Advocacy Centre (2012), the Architects Registration Council of Nigeria (ARCON) defines Architecture and the scope of architectural services as follows:

The art and science in theory and practice of design, erection, commissioning, maintenance and management and coordination of allied professional inputs thereto of buildings, or part thereof and the layout and master plan of such building or groups of buildings forming a comprehensive institution, establishment of neighbourhood as well as any other organized space, enclosed or opened, required for human and other allied activities.

The architect could therefore use any of these means which is within the ambit of his line of duty and training to achieve low cost housing. The fee that would be paid to the architect fades into insignificance when compared to the amount of money that could be saved by the using the service of the architect.

iv. **Building without** Structural, **Mechanical or Electrical Engineers' Design**

A great majority of the residential building projects are done without Structural, Mechanical or Electrical Engineers' design.

When the building is in progress an electrical or plumbing technician, is called in to commence piping based on the technicians knowledge and past experience. Several building owners seemed to also like this since it seemed to save them the trouble of ever paying fee to any Structural, Mechanical or Electrical Engineers' Design. Of the 82 units surveyed, only 18, representing 22%, had either mechanical and / or electrical design. None of these 82 buildings had structural design.

In the residential building, the Mechanical / Electrical designs are very important. In small residential buildings the mechanical design deals mainly with the sewage piping and disposal water supply, waste and foul water disposal (Barry, 1979). Improper and unprofessional handling of these aspects of building design and construction leads to cost overrun, abandonment of projects, shoddy job delivery.

v. Construction of Improper Foundation Base

Every building deserves an appropriate and sound foundation for it to stand. The foundation of the building is composed of the foundation base or footings and the foundation walls. It is the foundation that transmits all the imposed loads from the superstructure to the ground. Cracks in walls and settlement (sinking of building), ensue when even the basic rules for the construction of a simple strip are not observed.. Another defective construction method of the foundation is the non filling of the substructure hollow block with weak concrete. If this space is left hollow, it could become a conduit through which termites and other subterranean creatures crawl and their activities are usually detrimental to the building fabrics and structure.

38 out of the 82 units representing 46.3% had inappropriate foundation based on shortcomings in the aforementioned basic technical specification for strip foundations. These are foundations either with very shallow trench, inappropriately thin foundation footing, and thin foundation base or hollow substructure block work.

There are some basic rules guiding the application of the strip foundation. The minimum rule of thumb requirement for a strip foundation is as specified in figure 2. It is expected that the thickness of the foundation base be at least of the same thickness

as the wall incident on it, while the overhang or projection of the strip foundation base on either side of the wall line should be a minimum of the wall thickness. The foundation being an essential part of the building should not be subjected to any cost saving measure as any misstep in the composition of this component could spell disastrous structural consequences sometimes in the life of the building. This study is of the opinion however that instead of attempting to cut cost by using such unconventional means (as committed by the developers) they could have employed stone in the foundation which is ubiquitous in the Jos area.

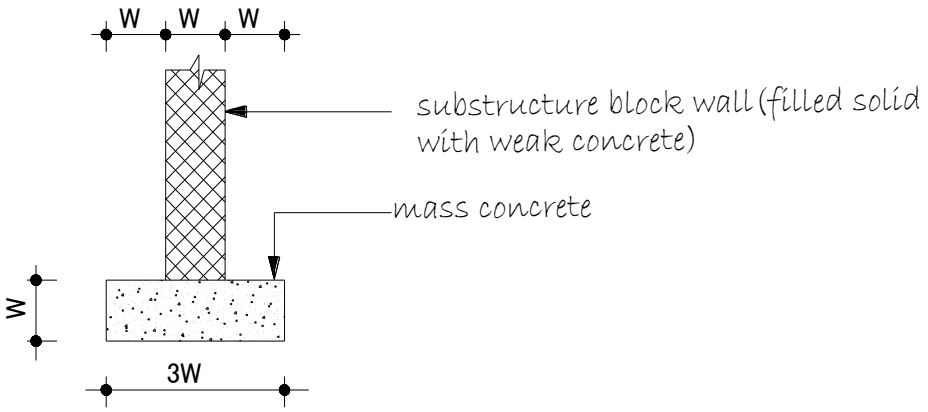

Figure 2: The rule - of - thumb for the Strip Foundation
Source: Chudley and Greeno (2010).

vi. Inadequate and Inappropriate Reinforcement

As a "cost saving measure" there were instances where small diameter rods were used in the reinforced concrete instead of the appropriate or specified quantity and quality of reinforcement. In other instances malleable metals like rims of metal barrel beaten into shape and used for 'reinforcement'. This was observed in 32 of the 82 buildings under construction representing 39%. In most of these 32 instances, the lintels assumed catenary shape thereby indicating that the reinforcements were inadequate. In matters of structural reinforcement of lintels, columns and beams it is advisable to comply with informed professional design and specifications since going contrary to them could prove very costly and disastrous later on by way of structural failure.

Concrete is good in compression but poor in tension. The reinforcement rod therefore is the strength of any concrete component as it is enables the reinforced concrete component to resist, tension albeit within the limits of design. It is therefore of utmost importance that all tension components like lintels, beams and suspended slabs should be designed and supervised by the civil or structural engineer. A cost saving alternative to having a reinforced concrete column is to use solid block piers. Additionally, where a low cost building is the object a way of avoiding much reinforcement is to ensure that the fenestrations are narrow. In that case openings could be created without any need for reinforcement by taking advantage of the arching effect of the block work or through the use of masonry arches. Furthermore, in the design process with focus on low cost housing effort should be made by the architect to effect designs that would not require much tensile components. This is because it is the opinion of this study that wherever components are in tension, the needful has to be done by providing commensurate reinforcement to address the structural requirements.

vii. Non Application of Damp Proof Membrane (DPM) or Damp Proof Course (DPC)

Damp Proof Membrane (DPM) and Damp Proof Course (DPC) are moisture barriers placed at the interface of substructure and superstructure. This protects the superstructure especially base of walls against rising dampness (Chudley and Greeno, 2005). Additionally, DPM and DPC present physical or mechanical barriers against the progression of termites and other subterranean organisms from the substructure to the superstructure of the building. The procedure to prevent rising dampness in walls is usually ignored by many building owners, builders and masons. Some architects could also be complicit by not specifying DPM or DPC. The study revealed that of the 82 buildings investigated only 18 used either DPM or DPC, meaning that in 78% of the buildings, moisture barrier were not used. The failure to use these damp proof materials could lead to deterioration of building materials such as timber skirting, fire clay skirting, wall paper, paints and adhesives. Additionally it poses health challenges to humans as a result of excessive humidity and dampness which encourages the growth of mould and fungus.

There are several impervious materials that could be employed to achieve this effect. As a cost cutting measure, broken clay tiles could be procured as construction wastes and laid horizontally in between mortar beds and grout to serve as a DPC. Materials for DPC range from bituminous coated lead, copper, bitumen in various bases, bitumen polymer, pitch polymer, polypropylene mastic asphalt and engineering bricks (Chudley and Greeno, 2010). For DPM, in order to cut cost, according to Plastic (2010), Poly Vinyl Chloride (PVC) mixed with plasticizer additives (at manufacture) could be used as it enhances the biodegradability of the material. This particular material is recommended because it is cheaper than other proprietary materials used as DPM. Its cost is in the region N100/m^2 as at February 2019. This means that about Ten Thousand Naira (N 10,000.00) would be required to cover a 100 m^2 for a spacious two bedroom.

viii. Inadequate Concrete Cover to Reinforcement Bars.

Where inadequate concrete cover to reinforcement bars exist the exposure to the exterior, moisture and air could easily lead to rust. Of the 82 buildings investigated 26 were discovered to have this shortcoming at the soffit of lintels and sides of columns and lintels. This figure represents 32% of the number of houses under study.

Specially prepared sandcrete Spacers (colloquially referred to as biscuits) ensure adequate concrete cover by being secured to the reinforcement bars inside the formworks before casting of concrete. This ensures that upon casting, there exists a confirmed spacing as concrete cover to the thickness of the spacers hitherto attached to the reinforcement bars inside the formworks. The concrete cover also protects the reinforced concrete element from failure in case of fire.

ix. Improper anchorage of Roof Structure to the Wall

There is the need to properly anchor the roof structure at the terminal point of the wall. It was observed that at the terminal course of the block wall, timber of about 50mm x100mm was placed on the block wall as wall plate upon which the Tie Beams rested. The wall plate was then fastened to the walls using flat flexible steel straps. During violent gale or rain storm, the wind could lift up the roof at the eaves and the force could cause the block wall to break or split at mortar joints. In the attempt to

attain low cost housing this important procedure is not properly undertaken as in 38 of the houses under construction, representing 46%. For the roof structure to be safely secured in a building there is the need to terminate the wall with a ring beam which should be reinforced preferably with the aid of 6mm or 8mm quarter rods the tie beam and/or rafters are secured to the ring beam or reinforced concrete head course. The advantage of this important component and procedure is that the reinforced concrete's dead weight is big enough to counteract the lifting force of the wind at the eaves thereby preventing the roof from being blown off easily.

x. Use of Substandard Timber for structural Roofing members

The timber used for roofing in some of the completed buildings were neither matured, dried, seasoned nor of the appropriate dimension. Of the 18 buildings that had reached this stage, 16 buildings representing 89% had deficiency in the type of timber used. Standard timber for timber roof structure should be mature, fully dried, well seasoned hardwood and of appropriate dimension. It is however recommended that the noggins for ceiling should be of soft wood. This is to enable the nail to penetrate easily without breaking the timber or the roofing sheet being deformed as a result of too much hitting with the hammer. It appeared that no special effort was made to ascertain the specification as the type and quality of timber brought to construction sites for roofing depended simply on what was available in the market and also the marketing prowess of the timber traders.

Table 2
Summary result obtained from the field

s/n	Identified defective materials and methods employed	Housing units investigated	Housing units with defective methods/materials	% of housing units with defective methods/materials
1	failure to treat ground against termite	82	78	97
2	defective setting out	82	16	20
3	absence of architectural design	82	45	57
4	absence of strutural, mechanical or electrical design	82	64	78
5	construction of defective foundation base	82	38	46
6	inadequate reinforcement	82	32	39
7	non application of DPC/DPM	82	78	95
8	inadequate or absence of conc.cover to reinforcement	82	26	32
9	insufficient securing of roof structure to the wall	82	38	46
10	use of substandard structural roofing members	82	16	89

SUMMARY

Ten items as enumerated in Table 2 were investigated in the course of this study. The outlook of the number and percentage of buildings using defective materials and methods is alarming. These factors enumerated are not the only deviations from the standard building construction practice however, in the course of the study; these were the most glaring. This trend if not remedied by statutory and benevolent interventions from professional bodies, would continue to cause not only economic and health losses, lives and limbs could be at stake as well.

CONCLUSION AND RECOMMENDATIONS

From the investigation, a great majority of these breaches were instigated by the building owners who were 'supported' by work men (and women). These enumerated factors in materials and methods were not the only deviations from the standard building construction practice however, in the course of the study, the enumerated factors were the most glaring. As a result the fact that these observations have been made and documented, there is the need to take steps at the governmental and professional bodies' levels. Such bodies as Nigeria Institute of Architects (NIA), Council of Registered Engineers of Nigeria (COREN), Nigeria Institute of Builders (NIOB), and Nigeria Institution of Quantity Surveyors Engineers (NQIS) to assist in the elimination of this nuisance. This could be in the form of free advocacy or consultancy by some public spirited members to indigent members of the society. Alternatively these volunteering members of the professional bodies could have their consultancy fees undertaken by the government since the effort would be for the common good of the society.

The state government is the repository of land in the Land Use Act of Nigeria. A situation where 'development' at the urban fringes just take place without proactive participation of the state government is a main cause of these house owners using unconventional an deterimental construction methods and materials.

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Reference to this paper should be made as follows: Arc. Joseph O. Oko & Arc. James I. Demenongu (2019). The Deleterious Effects And Proposed Remediation *J. of Environmental Science and Resources Management* Vol. 11, No. 2, Pp. 56-70