International Journal of Civil Engineering, Construction and Estate Management

Vol.1,No.2, pp.16-30, September 2014

Published by European Centre for Research Training and Development UK (www.eajournals.org)

DEFECTIVE CONSTRUCTION IN RESIDENTIAL BUILDINGS: A STUDY OF SUNSHINE GARDENS, AKURE NIGERIA.

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ABSTRACT: *Defective construction refers to works which fall short of complying with specified descriptions or requirements of a construction contract, especially any drawings or specifications, together with any implied terms and conditions as to its quality, workmanship, durability, aesthetics, performance or design. This research evaluated defective construction works in a residential estate in Akure, Nigeria. Reviewing relevant literature and focusing on Sunshine Gardens, Oba-Ile, Akure as a case in point, some major factors were discovered to be influencers of defective construction, these include: the use of substandard building materials, poor workmanship, inadequate supervision, and design deficiencies. Strict supervision, proper construction management and quality control, thorough training and education of artisans and the use of quality materials were recognized as possible preventive measures against the construction of defective buildings. It was recommended that proper construction management and quality control measures be employed to curb the incidence of defective construction so as to promote a liveable residential environment.*

KEYWORDS*:* Defective Construction, Building Materials, Workmanship, Supervision, Deficiency.

BACKGROUND OF STUDY

The construction industry plays an essential role in the economic development of any developing nation (Kheni, Gibb & Dainty, 2008), and especially in an expanding economy like Nigeria (Ibironke, 2003; Shittu & Shehu 2010). Okeola (2009) averred that at least 50% of the investment in various development plans is primarily in construction and the industry is the next employer of labour after agriculture in underdeveloped countries. The construction industry in Nigeria generates almost 70% of the nation's fixed capital formation, in spite of that, its performance within the economy is very poor (Federal Office of Statistics, Abuja as cited in Arazi & Mahmoud, 2010). The last decade however exposed the declining level of clients' satisfaction from the built facilities as a result of poor quality performance in addition to the perennial problems of time and cost overruns in the Nigerian construction industry (Arazi & Mahmoud, 2010).

Defective construction is not limited to developing economies alone. Pole (1997) stressed that there had been claims of defective construction in the California housing market which focused on the development of condominium subdivisions; this has resulted to rapid increase of *"Construction Defects Litigation" since the "building boom" of the 1980's"*. This is a proof of the existence of the problem of defective construction in developed counties. It is however not astonishing that it is a significant challenge found in the Nigerian

building industry. "*Defective construction work can be as a result of inadequate design, faulty workmanship or poor materials – or some combination of these failings. Someone is actually to blame, either the builder (or artisan) or one or more of the professional consultants, or even the entire project team. It is important therefore that the project team should possess a good working knowledge of their responsibilities and liabilities*" (Barrett, 2008).

In construction projects the nature and type of defects can vary strikingly, as can the point at which they become obvious or readily perceived (Outlaw, 2011). Sometimes minor defects can simply be corrected before the building is handed over to the employer, at other times significant defects may occur long after the original work has been finished and require large remedial works to repair. In instances where these defects are abandoned on account of being unnoticed or they are beyond correction, such buildings are left to the clients or users to maintain, endure the unpleasant aesthetics, and risk possible failures in very terrible cases (outlaw, 2011).

In the entire lifecycle of any building, defective construction can be both a bane and a burden to that building, its users and its neighbourhood. Generally, this deficiency can be traced to design errors, poor or inferior materials, supervision lapses, and the incompetence of artisans. Sometimes, designers may not be conscious of the implication of their design decisions and the ability of contractors to meet or fulfill them safely. The client or contractors are sometimes culpable of the procurement of poor building materials. During construction, supervision which helps in resolving certain misinterpretations and unprofessionalism is sometimes needlessly insufficient. The contractors and artisans who bring the designer's dream to reality are either incompetent, looking for the easiest way out, or in haste in order to create time and clinch other contracts. In the construction stage, these delinquencies affect the cost and time of construction because such works have to be revisited. During use, such buildings are left to the clients to grapple with and maintain. As a result, Nigerians lack confidence in indigenous professionals, therefore they invite expatriates to design and build for them.

This study evaluates issues relating to defective construction works as it results from deficiencies from the design and construction teams. Attempts were made to emphasize the essence of avoiding defective works and the role of supervision and quality control during construction in alleviating the incidence of defective works in buildings. Hence the study proposes to look at the visual defects in buildings, their causes, and the possible ways these occurrences can be prevented. It as well hopes to be a useful reference for indigenous professionals and workmen, and authorities concerned.

DEFINING DEFECTIVE CONSTRUCTION

Defects according to Harris (2006) are faults that may reduce the durability, usefulness, or strength of a construction work. They are the unacceptable quality of a project which can be identified and remedied. Atkinson (1999) defines defective construction works as those which fell short of complying with the specific descriptions or requirements of the contract,

especially any drawings or specifications, together with any implied terms and conditions as to its quality, workmanship, durability, aesthetics, performance or design. More importantly, in considering 'defects' as a matter of principle, work may be defective even if it has been carried out with all due skill and care but it fails to satisfy or meet a particular specification. For example, brickwork may be erected correctly but the wrong type or colour of brick could have been used in breach of planning permission (Outlaw, 2011). A construction defect, as defined by California Jury Instructions and cited by Pole (1997) is the: "*failure of the building or any building component to be erected in a reasonably workmanlike manner or to perform in the manner intended by the manufacturer or reasonably expected by the buyer, which proximately causes damage to the structure*." Furthermore, the California State Assembly Bill, AB 2959, as cited in Pole (1997) stated that a construction defect would result from:

1. Defective building materials or components;
2. A violation of Building Codes at the time of construction;
3. Failure to meet professional standards for design at the time plans was approved;
4. Failure to build according to accepted trade standards for good and workmanlike construction.

Finally, the researchers' opinion is that: construction defects refer to those flaws in the physical structure of a building that may occur in any element of the building and interferes with the aesthetics, durability and structural stability of the building. They include cracked walls, sloping floors, poor finishing, uneven staircase threads and risers, beams and columns that are not perfectly horizontal or vertical, and the likes.

CLASSIFICATION OF DEFECTIVE WORKS

Defective construction works can be classified as follows:

Qualitative Defects

According to Kevin (2008, p. 2), qualitative defects can be categorized in various ways, including:

1. Work (including design) or materials not of acceptable quality;
2. Work (including design) or materials that are in themselves of acceptable quality, but which nonetheless do not conform with the specification or the design brief; and
3. Work that is incomplete.

Patent and Latent Defects

Defects, whatever their qualitative nature can be patent or latent. "The fact that there may be different consequences means that it is important to be able to decide when a defect is patent or latent" (Barrett, 2008, p3). A patent defect is one that is detectable either at or before apparent practical completion or during the defects liability period. By contract, a latent defect is one which has been concealed in the works and may not become apparent for many years.

The terms latent and patent are opposites. A patent defect is discoverable and may be open to view, exposed, manifest, evident or obvious. A latent defect will exist before it is

discovered as hidden or concealed flaws in the work. When a latent defect becomes manifest it ceases to be a latent defect and becomes patent. At the moment a latent defect becomes patent the mechanisms under contract for dealing with latent defects are usually relevant.

THE STUDY AREA

Lying approximately between latitude 7^0 15' North of the Equator and longitude 5^0 15' East of the Greenwich Meridian, Akure, an emerging millennium city, existed long before the British colonial rule alongside other traditional Yoruba towns in Nigeria. Akure is the largest settlement in Ondo State, South-West Nigeria, and is also the State Capital. It is a medium-sized urban area that was made the provincial headquarters of Ondo province in 1939. It also became both the capital of Ondo State as well as Akure Local Government Council Headquarters in 1976. As a result of its status as the capital city, the massing of people and activities in the city became heterogeneous. The form and structure of the city has changed over time to assume its present status with its attendant housing problem, as experienced in similar medium-sized cities in Nigeria. Akure is located approximately 700 kilometers South-West of Abuja, the Federal Capital of Nigeria, and about 350 kilometers from Lagos, the former capital of Nigeria. It is located within the tropical rain forest vegetation where rainfall is prevalent for at least 8 months of the year. Studies and records show that the increased relative political influence of Akure as a state capital since 1976 has greatly promoted its rapid growth and increased socioeconomic activities. Akure is an agricultural trade centre for the yams, cassava, corn (maize), bananas, rice, palm oil and kernels, okra, and pumpkins grown by the Ondo branch of the Yoruba people. Although cocoa is by far the most important local commercial crop, cotton, teak, and palm produce are also cultivated for export. The town's industries include electronics manufacturing, soft drink bottling, weaving, and pottery making.

2.1 SUNSHINE GARDENS, OBA ILE

Plate 1: Entrance to the Estate

Source: Researchers' Field Survey, 2013

The Sunshine Gardens located in Oba Ile, a Housing Estate in the northern part of the fast developing city of Akure, is a newly commissioned residential development provided to meet growing housing needs and encourage ownership of landed properties by the public. The housing project commenced on April 28, 2009 and was commissioned August 16, 2012, during the first term administration of the State Governor, Dr. Olusegun Mimiko. The housing project is a public-private partnership in which the government provides infrastructure, while the developer provides the structure. The developer in this case is Locke Homes Limited, a construction company, and specialists in housing development. The project has been commissioned although construction work is still in progress and many buyers have registered their interests, purchased, and occupied or let out their properties (Fagbemi Tope, personal communication, May 17, 2013). This is a very good step to housing provision and development. An electronic or physical visit to this neighbourhood will confirm this statement. In this account, the study is concerned with the examination of some defects that are the results of common construction activities in Nigeria and how such issues may be corrected in subsequent building projects.

SITE LAYOUT AND PROTOTYPES

The site layout is as shown in the figure below indicating the locations of 5 prototypes.

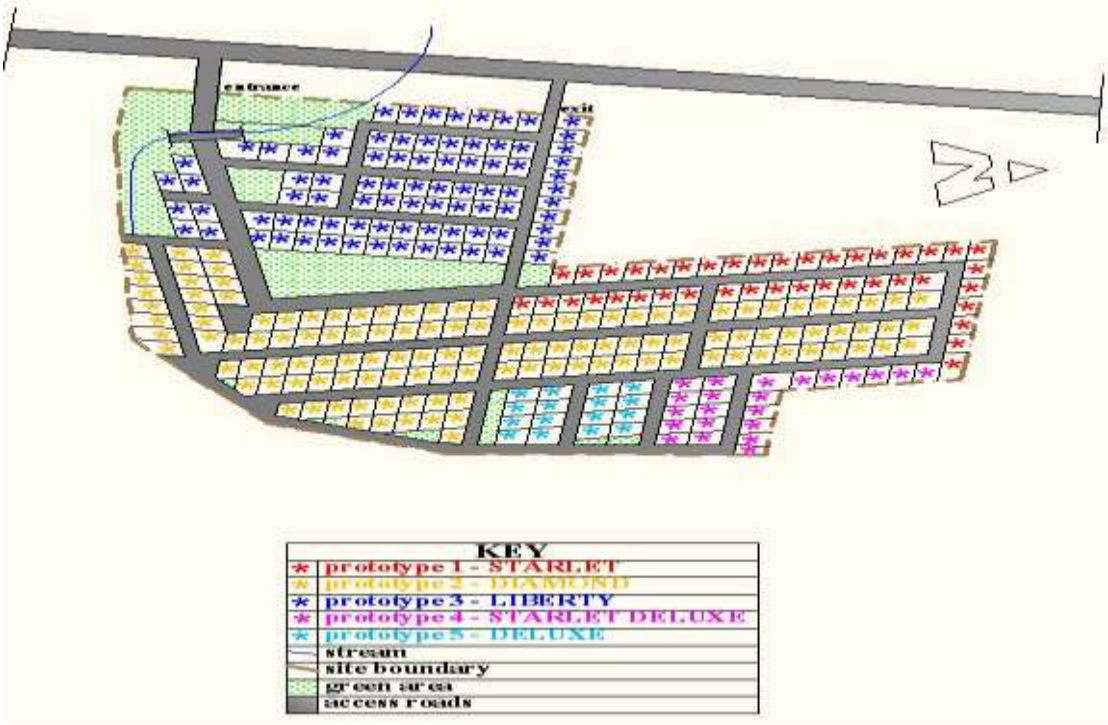

Figure 1: Site layout and prototypes
Source: Researchers' Sketch, 2013

METHODOLOGY

To determine a considerable sample size which must be representative of the population, 10% of each building prototype was selected; and resultantly, a total of 25 buildings were selected randomly.

Table 1: A breakdown of the sampling size

Prototype	Frequency	10%(of frequency)	Sampling Size
1(Starlet)	34	3.4	3
2 (Diamond)	106	10.6	11
3 (Liberty)	85	8.5	9
4 (Starlet Deluxe)	8	0.8	1
5 (Deluxe)	1	0.1	1
Total	**234**	**23.4**	**25**

Source: Researcher's Field Survey, 2013

The estate is situated on 8 hectares of land. So far, there are about 234 buildings already completed out of the proposed number of 320. The estate comprises 5 different prototypes of housing units. Details of the prototypes are as follows:

3.1 Prototype 1 – Starlet

This is a semidetached bungalow, with two bedrooms, one bathroom, one toilet, living room, dining and kitchen with a small terrace. 32 buildings are already completed, most of which have been purchased and occupied; 2 are under construction.

Plate 2: Starlet View
Source: Researchers' Field Survey, 2013

3.2 Prototype 2 – Diamond

This is a detached 3-bedroom bungalow, with one bedroom en-suite, one toilet, one bathroom, living room and kitchen with a small terrace. 106 buildings have been completed, most of which have been purchased and occupied.

Plate 3: A view of prototype Diamond
Source: Researchers' Field Survey, 2013

3.3 Prototype 3 – Liberty

This is a detached 3-bedrrom bungalow, with all bedrooms en suite, a visitor's toilet, lounge, dining and a kitchen with a small terrace. Over 78 buildings have been completed on site with many purchased and occupied, and with 7 under construction.

Plate 4: A view of prototype Liberty
Source: Researchers' Field Survey, 2013

3.4 Prototype 4 – Starlet Deluxe

This is a detached 3-bedroom bungalow, with all bedrooms en suite, one of which is a guest room. Additional spaces include an ante room and visitor's toilet, a large lounge, a distinct dining, and a kitchen with a store and sizeable terrace. 7 of these prototypes have been completed with one under construction.

Plate 5: A view of prototype Starlet Deluxe
Source: Researchers' Field Survey, 2013

3.5 Prototype 5 – Deluxe

This is a detached duplex with a large entrance porch, ante room, visitor's toilet, large living room, en suite guest room, kitchen and store. The first floor provides spaces for a family lounge, two en suite bedrooms, and a master bedroom with a walk-in closet, bathroom, and terrace. According to the site architect, intending buyers are not satisfied with the simplicity of the design. This explains the reason only one of this prototype has been built so far.

Plate 6: A view of prototype Deluxe
Source: Researchers' Field Survey, 2013

Building Materials and Finishes

The materials and finishes used in all prototypes are basically the same. These include hollow sandcrete blocks, cement-sand wall plaster, timber roof trusses, aluminium longspan roofing sheets, timber fascia board, PVC ceiling strips (exterior), suspended laminated gypsum board (interior), emulsion paint, aluminium frame sliding windows, steel doors, unpolished vitrified tiles, among others.

Merits and Demerits

The merits of the buildings and the enitre estate as a whole include good infrastructural facilities (telecommunication masts, good road networks, electricity, security), adequate setbacks, and functional design flow. On the other hand, the demerits include small sizes of spaces, unattractive elevations, and definitely evidence of defective construction.

Table 2: Shaded areas indicate identified defects in each prototype.

S/n	prototype / Defects	Starlet	Diamond	Liberty	Starlet deluxe	Deluxe
	Defects On Roof					
1.	Open roofing sheets and ridge caps	■	■		■	
2.	Rough roofing sheets and ridge caps		■			
3.	Detached roofing sheet and ridge cap		■			
4.	Detached roof flashing		■			■
5.	Fascia board splits		■	■		
6.	Warping fascia board/ noggin	■	■	■		
7.	Sagging ceiling (exterior)	■	■			
8.	Detached ceiling (exterior)	■	■			
9.	Poorly installed suspended ceiling (interior)			■	■	
	Defects On Walls					
10.	Cracked/ broken lintel		■			
11.	Cracked/ broken window sill		■	■		
12.	Wall cracks		■	■		
13.	Overhanging lintel				■	
	Defects On Floors					
14.	Floor screed cracks	■				
15.	Chipped tile edges	■	■	■	■	

Source: Researcher's Field Survey, 2013

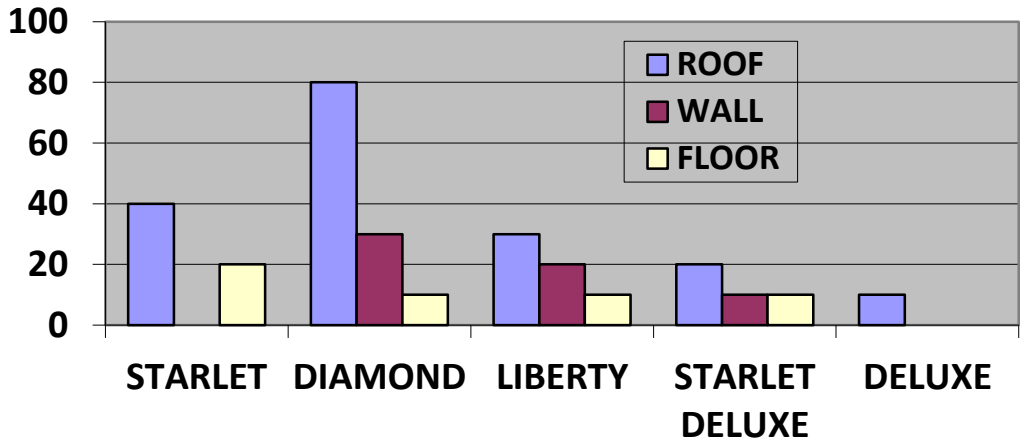

Figure 2: A chart showing the degree of occurrence with respect to the defects identified and the different prototypes Source*:*
Researcher's Field Survey, 2013

GENERAL DEDUCTION

This case study has revealed existing situations which point to the fact that the most frequent defective construction occurred in roof installation, followed by that on the walls, and then on the floors. Defective construction occurred mostly in the Diamond prototype which has the highest frequency (106) amongst the building prototypes. Some materials and finishes used were of poor quality.

OBSERVED CAUSES OF IDENTIFIED DEFECTS
From the field findings, the causes of these defects are as follows:

DEFECTS ON ROOFS

1. **Manufacturer's Deviation**
   When the manufacturer fails to meet the specification of the architect due to various reasons, the resulting material will be substandard. Some of the roofing defects from the case study can be attributed to this.
2. **Inadequate Timber Treatment**
   Seasoning is the reduction of moisture content of timber to that of the surrounding air. During the seasoning process, shrinkage occurs and sometimes this produces defects within the timber (Carpenter et al, 1989). Wood warping is a deviation from flatness as a result of stresses and shrinkage from the uneven drying of lumber (Wikipedia, 2014).
3. **Poor Workmanship**
   According to Abdul Rahman et al (1996), workmanship was classified as one of the most frequent non-conformance on construction sites. Poor workmanship can be the result of many factors including poor project management, complicated role of subcontractor, lack of experience and competency of labours, language barrier to communication and lack of

communication, unsuitable construction equipment, poor weather condition, limited time, limited cost.

4. **Poor Supervision**
   The role of building professionals in supervision of works cannot be over emphasized. Supervision is the only way of ensuring that works conform to drawings, specifications and the Codes of Practice in executing each work (Obande, 1981)

DEFECTS ON WALLS

1. **Poor Materials**
   The sand to be used for wall rendering and plastering is to be of the right and appropriate sharpness and consistency. Also the mix ratio for the mortar must be correct. If any of these is compromised, superficial wall cracks will be unavoidable. The fact that suppliers of building materials may be cunning, dishonest and deceitful makes it difficult to get quality materials (Fagbemi Tope, personal communication, May 17, 2013). This calls for the alertness of the site architect in recognizing poor materials and rejecting them if supplied.
   Weak sandcrete blocks is a result of various factors such as use of poor materials, inappropriate mix ratio, poor workmanship, inadequate curing and impacts during transportation. The cracks that occur in this case are structural in nature. Use of such weak blocks can cause problems where they are used for load bearing walls. It is therefore expedient that the site architect and respective artisans learn how to recognize such weak blocks and reject them if supplied to site (Fagbemi Tope, personal communication, May 17, 2013).
2. **Short Span of Precast Lintel**
   This specifically is responsible for cracks that occur at the top corners of window and door openings. In order to fast track the construction as well as minimize quantity of materials, precast lintels were used. However it is necessary to have a minimum of 225mm projection over the width of the opening. (Fagbemi Tope, personal communication, May 17, 2013). Cracks in this case occur when this requirement is not met.
3. **Poor Workmanship**
   When work is carried out by incapable hands or done inappropriately, neglecting necessary processes and precautions, incidence of defects are inevitable. This is a keen issue because poor workmanship is enough to mar a construction structurally and aesthetically, even when other factors are adequately met. In this case, block laying and plastering, which were not done properly have caused wall cracks. (Fagbemi Tope, personal communication, May 17, 2013)

4 Blasting

As noted before now, facilities as electricity, road networks, security (police post), nursery & primary schools, sports centre are provided by the authorities, while provision of water supply, waste management and individual site development (external works) are left to the discretion of intending buyers. The buyers that have provided water supply through well sources have faced a common problem of encountering underlying bedrocks during digging. Hence, they need to blast off such obstacles to reach desirable water quantities (Fagbemi Tope, personal communication, May 17, 2013)

These seismic-like impacts are responsible for wall cracks in houses with high proximity to the blast source.

DEFECTS ON FLOORS

1. **Poor Material**
   The chipped tile edges are simply a result the poor quality of materials used (Fagbemi Tope, personal communication, May 17, 2013). Materials and finishes of good quality will have the necessary characteristic of durability. Hence, the incidence of defects would be drastically reduced before, during and after construction.

SUMMARY OF FINDINGS

The study focuses on the appraisal of defective construction in Nigerian buildings, taking a case study of Sunshine Gardens, Oba Ile, Akure, Nigeria. The study discovered that:

1. Defective construction is mostly a result of defective building materials, construction methods, poor workmanship, and inadequate supervision.
2. Most of it can be attributed to poor building materials and poor workmanship.
3. The incidence of defective construction can be minimized by the use of quality building materials and finishes, competent workmen, and adequate supervision.
4. Proper communication is a necessary tool in building construction to provide communication between supervisors and construction labours, proper communication and teamwork are also necessary.

RECOMMENDATIONS

1. Proper construction management and quality control measures are required during execution of projects.
2. Strict supervision of building projects must be provided.
3. To improve the productivity of building construction workers, building training and education would be necessary. Training of workers should be on a regular basis. This can be in the form of on-the-job training, workshops, seminars or conferences,
4. More awareness campaigns should be carried out by the three tiers of government and their agencies on the need for compliance with the appropriate building regulations (e.g. among contractors, professionals, stakeholders and the general public) and the dangers associated with their non-compliance/evasion.
5. The Town Planning Authority should maintain competent professionals in the relevant areas for design approval and from a long term perspective, provide the necessary training. Moreover, there should be regular monitoring visits to all the construction sites with a view to ensuring compliance with the approved building plans.
6. More attention should be focused towards the private or informal sector, with a view to curbing their excesses.
7. There is a need for further awareness-raising on the danger in patronizing incompetent people for construction activities.

CONCLUSION

Defective construction in buildings are numerous and varied, either in the local construction scenario, or in other parts of the world. This problem of defect in new building constructions must be overcome as it severely affects the aesthetics and liveability of the environment. This project has looked into some common defective construction and the factors influencing such construction. Also, it has revealed the impact of workmanship, supervision, materials, and quality control on the quality of construction. Preventive measures to defective construction include strict supervision, proper construction management and quality control, thorough training and education of artisans, and the use of quality materials. A reduction in the incidence of defective construction will positively influence the economy of Nigeria. Also, it is important that necessary awareness is created for building professionals and workmen of the dissatisfaction of the general public with defective works. As such, they will carry out their duties with a greater sense of responsibility and take up the challenge of creating value.

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