

Remedies of Structural Defects in Residential Buildings in Ado – Ekiti Metropolis, Ekiti State, Nigeria

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Abstract: Defects on building especially in structural parts are caused by faulty designs or executions rather than the use of faulty materials and this has posed a great concern to the government, building professionals and other stakeholders in recent times and considering the increasing number of cases of structural defects in building and high rate of building collapse. This study investigates causes and impact of structural defects in residential buildings in Ado-Ekiti Metropolis. Stratified sampling technique was used for selecting the target populations. Population of the study includes the occupants, clients, contractors, Architects and Quantity Surveyors that involved in construction, management and usage of the residential buildings. Useful information and data required to achieve the set objectives were gathered through structured questionnaires. A total of 120 questionnaires (100 for Residents and 20 for Professionals) were distributed and 111 (91 from Residents and 20 from Professionals) questionnaires were returned and used for the analysis. Data collected were analysed using statistical tools such as descriptive statistics, percentage, mean score and relative importance index (RII) of the software package of Statistical Package for Social Sciences (SPSS). The results of the analysis showed that, majority of the respondents agreed that, peeling, cracking and foundational failures are the most critical factors of structural defects in residential buildings. In conclusion, there should be a proper design of projects and their good execution coupled with constant monitoring and supervision of materials before and during construction.

Key words: Buildings, construction, defects, remedies, residential.

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I. INTRODUCTION

Defects on building especially in structural parts are generally caused by faulty design or execution rather than faulty materials and this has pose a great concern to the government, building professionals and other stakeholders in recent times considering the increasing number of cases of structural defects in building and high rate of building collapse. The construction industry plays an essential role in the economic development of any developing nation most especially in an expanding economy country like Nigeria, Ibrinke (2003). The developing of building construction in simple homes to complex modern structures has not only allowed standardization of materials, affordable and workable methodology of construction and production, but also enhance a highly organized industry with professionals having areas of specialization and generating large volume of economic activities.

The construction industry is still seen as one of the most dangerous sector of an economy due to the number of accidents recorded yearly (Jaselskis and Suazo, 1994). Lingard and Rowlinson (1994) and Spillane et al. (2011) reported that construction industry in most developing and developed countries have been adjudged to be performing very badly in the area of safety by international standards. Omran et al. (2010) added that the construction industry is characterized as one with a poor safety culture globally. A very serious safety problem facing Nigeria is the problem of safety in building as a result of faulty designs, improper execution of approved projects, poor quality materials and workmanship which leads to fatal site accidents due to building collapse.

According to Baiden and Tuuli (2004), “defects and variations in construction projects from standard is persistently a problem of concern in the construction industry”. Defects in construction project could also be seen as incompliance or lack of conformity with contract agreement which includes, working drawing, specification, quality of workmanship, and any other condition not expressly stated such as “durability, aesthetics, performance or design”.

Defects from building can therefore be from either or a combination of the occurrence of the following situation: error in design by the architect, flaws from the manufacturer, defects in materials, wrong use or inappropriate installation of equipment, and inconformity to the specification by the contractor, among others. General forms of defects in construction includes either or a combination of the following; defect in structure giving rise to cracks or collapse, defects or fault in electrical and plumbing installations, inadequacy of drains

for proper disposal, insufficient provision for ventilation, poor cooling and/or heating system, poor sound insulation system and insufficient fire prevention or protection mechanism. In addition, defects in building may also be as a result of the following; fungus, termite or vermin infection, wood rot, mold and dry rot.

Damages as a result of earth settlement or land movement may result to defect in building. Ascertainment of defects in building can only be done by an expert such as an Architect, an Engineer and a Builder who by training and experience will be able to confirm the cause of the problem, either resulting from poor design, low quality of materials or poor workmanship.

There is therefore the need to investigate causes and impact of structural defects in residential buildings in Ado-Ekiti Metropolis and measures that should be taken to control the frequent causes of building defects were also examined. The aim of the study is to identify the causes of structural defects in residential building, examine the impacts of structural defects in residential building, and develop strategies for mitigating structural defects in residential building. The study will educate and help both the professionals and the clients on how to identify the causes of structural defects in residential buildings, examine the impacts of structural defects in residential building, and develop strategies for mitigating structural defects in residential building and reduce the risk of structural failure on the building.

Research Questions

What are the causes of structural defects in residential buildings?

What are the impacts of structural defects in residential buildings?

What are the strategies for mitigating structural defects in residential buildings?

II. MATERIALS AND METHODS

Study Area, Sample Size and Sampling Techniques

This research work is to examine the causes, effects and possible solution to structural defects in residential buildings at Federal Housing (shelter view) and State Housing Estates at Oke-Ila, Afao Road Area in Ado- Ekiti Metropolis, Ekiti - State. An exploratory research approach was used to assess the causes and impact of structural defect on residential buildings in the study area. Due to the nature of this research work a case study of selected areas was adopted. The sample size was limited to fifty buildings with structural defects and the fifty residential buildings were randomly selected and one hundred structured questionnaires were distributed to the residents in the selected buildings (two questionnaires for a building) and twenty questionnaires were also distributed to professionals involved in building construction. The target population were residents of Zone A & B of Oke-Ila and residents of Federal Housing Estate (Shelter View) also at Oke-Ila Area in Ado-Ekiti Metropolis, Ekiti State living in either 2-Bedroom, 3-Bedroom or 4-Bedroom flats. The valid population sampled of 92.5% used for the analysis meets the suggested benchmark of 30% (Gillham, 2000).

Data Collection, Presentation and Analysis

The primary data for the research were collected through interviewing method, observations and questionnaires. Two types of questionnaire were made use of, one for the residents in Federal and State Housing Estates in Ado-Ekiti Metropolis, Ekiti State on their demographic data and impact of structural defect in their buildings. The second questionnaire was meant for the professionals involve in the constructions such as, Builder, Contractors, Quantity Surveyor, Architect and Engineers in order to collect information on strategies for mitigating causes of structural defect in a residential building. The research instrument was divided into two sections, the first tends to obtain the respondents bio-data while the second part contains the item regarding the subject matter and they were based on a Five-Point Likert scale (5 = Strongly Agreed, 4 = Agreed, 3 = Undecided, 2 = Strongly Disagreed, 1 = Disagreed) that best describes the extent to which the respondents agree with each item in the questionnaire. The method of data analysis used in this study was the descriptive statistics and relative importance (RII). The opinions of the respondents on each question were weighed using simple average. The returned administered questionnaires were sorted out and only one hundred and eight (108) copies of questionnaires were returned representing 90% valid questionnaires used while twelve (12) copies representing 10% that were either unreturned or discarded as a result of incomplete filling of the questionnaires. The 5 scale expression on third and fourth and fifth part of the questionnaire further defined by the interval of 0.7 to determine the level of significance of the factors with 4.30 as a cut-off for high significance based on Kazaz et al.(2008). Based on this baseline, factors with $MS \geq 4.30$ have insignificant influence.

III. RESULTS AND DISCUSSIONS

The respondent strongly agreed that the use of improper building materials and negligence of duties are part of the causes of structural effect. They however agreed that poor workmanship, improper site management, water leakage, moisture, humidity, and poor construction are also factors responsible for structural defects. This

was in agreement with the work of Barry (2005). They strongly agreed that selection of poor quality and cheap materials also cause structural defect while they agreed that improper mix of concrete also cause of structural defects in residential buildings.

Furthermore, the respondents strongly agreed that poor structural designs, poor maintenance, improper installation and unstable foundation are also causes of structural defects in buildings. This was in agreement with what has been reported by Kasim (2009). Aligning materials performances, preventing water leakage and improvement on design clarity, and a top-level management constant examination, monitoring and supervision of materials before and during construction are strategies suggested by respondents to mitigate structural defects in residential buildings. This was in agreement with the Code of British Standards (BS 3811: 1974).

Congress, conferences and conventions should be organized to improve the policy behind construction. Also, several review meetings should be held and Architects and Building Engineers should work hand in hand to make sure the work is done appropriately.

Table 1: Analysis of Demographic Characteristics of Respondents (Professionals) Used in the Study Area

Category	Number of respondents		Percentage
<u>Gender</u>			
Female	14		20
Male	16		80
Total	20		100
<u>Educational status</u>			
OND		4	35
HND/B.SC	7		30
M.A./M.Sc.	6		20
Ph.D.	3		15
Total	20		100
<u>Working experience</u>			
Less than 10 years	4		20
11-15 years	5		25
16-20 years	6		30
20 years	5		15
Total	20		100
<u>Profession</u>			
Architect	4	20	
Builder	4	20	
Engineer	4	20	
Estate Surveyor	4	20	
Quantity Surveyor	4	20	
Total	20	100	
<u>Age</u>			
Less than 30years	3	15	
31-40 years	10	50	
41 years above	7	35	
Total	20	100	

Source: Authors' Data Analysis (2018)

Table 1 shows the analysis of demographic characteristics of the respondents that were professionals and it reveals that 20% of the respondents were females while 80% of the respondents were males. This implies that a high majority of the respondents (80%) were male and it indicate that there were more male professionals in the built industry than their female counterparts. This also emphasizes that the males still dominate the professions in built industry. The result also shows that majority of the professionals have adequate educational qualifications with about 80% having first degree and above, that is, HND/B.Sc., M.Sc. and Ph.D. in their various chosen professions. This indicates that majority of the respondents were competent enough and capable to participate in the survey 80% of the respondents have adequate requisite knowledge and experience of handling construction projects. The professional background the respondents shows each of Architects, Builders, Engineers, Estate surveyors and quantity surveyors was 20%. This was purposefully distributed in this manner in order to make distributed in this manner in order to make distribution equally among the professionals. The results also shows the age distribution of the respondents were 31 years and above. This indicates that the majority of the respondents were groomed adults and experienced professionals. The result

also shows that 38.47% complained of grossly inadequate facilities in the building they were occupying, 35.16% complained that the condition of the buildings they were occupying to be fairly good, 17.58% reported that the facilities in the buildings they were occupying were adequate while 8.79% reported that the facilities in the building they were occupying were very adequate

Table 2: Analysis of Demographic Characteristics of Respondents (Residents) Used in the Study Area

Category	Number of respondents	Percentage
<u>Gender</u>		
Female	34	37.36
Male	57	62.64
Total	91	100
<u>Educational status</u>		
Illiterate	2	19.78
Islamic Education	4	32.97
Non-Formal Education	7	23.08
WASC O/L	6	3.30
OND	18	6.59
HND/B.Sc.	30	7.69
M.A/M.Sc.	21	4.40
Ph.D	3	2.19
Total	91	100
<u>Working Experience</u>		
Less than 10 years	11	12.09
11 - 15 years	30	32.97
16 - 20 years	26	28.57
Over 20 years	24	26.37
Total	91	100
<u>Occupation</u>		
Civil Servant	34	37.36
Self employed	23	25.27
Trading	15	16.48
Unemployed	12	13.20
Others	7	7.69
Total	91	100
<u>Age</u>		
Less than 30years	28	30.77
31-40 years	43	47.25
41 and above	20	21.98
Total	91	100.00

Source: Authors' Data Analysis (2018)

Table 2 shows the analysis of the demographic characteristics of the respondents that were residents in the study area and it revealed that 37.36% were males while 62.64% were females. This indicates that the majority of the respondents residing in the study area were females . This could be as a results of the fact that the male counterparts might be working outside the study area .The result also shows the educational background of the respondents in the study area . The result also shows that educational background of the respondents in the study various educational qualifications of the respondents ranging from illiterates and from non-formal to formal education. The table however reveals that the majority (81.42%)of the respondents had one form of formal education to another ranging from WASC O'LEVEL to a doctoral degree (Ph.D) while 18.58% of the respondents had no formal education.The result also revealed that the majority of the respondents had over 11years work experience in their various sectors .The occupation of the respondents varied widely . The result shows that 37% Civil servants,Self employed ,16.48% trading ,13.2% unemployed and 7.69% for other unspecify type of occupation . The result also revealed that 30.7% of the respondents were less than 20years of age ,47.25% were between 31-40 years of age and 21.98% were 41years and above . This indicates that majority (77.77%) were less than 41years of age. The implication of this is that majority of the respondents are still in their youthful and working age

Table 3: Types and Condition of buildings Occupied By Respondents in the study Area

Category	Frequency	Percentage
<u>Types of building</u>		
Bungalow	44	48.35
Storey building	08	8.79
Block of flats	39	42.86
Total	91	100.00
<u>Condition of building</u>		
Grossly Inadequate	35	38.47
Fairly Good	32	35.16
Adequate	16	17.58
Very adequate	08	8.79
Total	91	100.00

Source: Authors' Data Analysis (2018)

Table 3 shows the analysis of the types and condition of building occupied by respondents in the study area and it revealed that 48.35% of the respondents occupied bungalows, 42.86% occupied block of flats and 8.79% occupied storey buildings .The implication of this is that the majority (91.21%) of the respondents occupied bungalows and block of flats and this indicates that storey buildings are not so common in the study area. The result also shows that 38.47% complained of grossly inadequate facilities in the building they were occupying, 35.16% complained that the condition of the buildings they were occupying to be fairly good,17.58% reported that the facilities in the buildings they were occupying were adequate while 8.79% reported that the facilities in the building they were occupying were very adequate

Table 4: Causes of Structural Defects in Residential Buildings

Causes	Mean Rating	Mean Ranking
Use of improper materials	4.81	1
Negligence of duties	4.86	2
Poor Workmanship	4.81	3
Poor supervision	4.79	4
Improper site investigation	4.76	5
Water leakage	4.69	6
Moisture	4.66	7
Humidity	4.62	8
Poor construction practice	4.59	9
Selection of poor quality and cheap materials	4.51	10
Improper of mix constituents of concrete, mortar etc.	4.45	11
Poor structural design and specification	4.36	12
Poor maintenance	4.22	13
Improper installation	3.90	14
Unstable foundation	3.70	15

Source: Authors' Data Analysis (2018)

Table 4 shows that 12 factors have high significance with mean scores ranging from 4.89 to 40.36. The factors are :use of improper materials ,negligence of duties, poor workmanship, poor supervision ,improper site investigation, water leakage, moisture , humidity , poor construction practices ,selection of the poor quality and cheap materials ,improper mixing of constituents of concrete ,mortar etc and poor structural design and specification .However ,of all these factors ,use of improper materials and negligence of duties were ranked highest by the residents and professionals used in the study area followed by poor workmanship. The third highly ranked factor is poor workmanship while poor supervision by the site supervisor was ranked fourth with improper investigation by the contractor ranked fifth factors below MS =4.30 baseline include poor maintenance

by property owners ,improper installation and unstable foundation were classified as insignificant factors to causes of the structural defects in residential buildings

Table 5: Impact of Structural Defects on Residential buildings

Factors	Mean Rating	Mean Ranking
Peeling of wall	4.55	1
Cracking in wall	4.52	2
Foundation failures	4.41	3
Expansion and lifting of structures	4.39	4
Unequal settlement of section of the foundation	4.36	5
Deflection in beam, lintel and columns bucking	4.32	6
Dampness of wall	4.31	7
Insect or termite attack	4.25	8
Sagging of roof	4.16	9
Movement of the soil	3.89	10
Cracking of floor	3.66	11

Source: Authors’ Data Analysis (2018)

Table 5 above revealed the impact of the structural defects on the residential buildings and it shows that 7 factors have high significance with mean scores ranging from 4.55 to 3.66. The factors are: peeling of wall, cracking in wall, foundation failure, expansion and lifting of structures, unequal settlement of section of the foundation, deflection in beam, lintel and columns bucking and dampness of wall were ranked highest by the respondents. The third highly ranked factor is foundation failures while the expansion and lifting of structures was ranked fourth with unequal settlement of section of the foundation ranked fifth .Factors below M.S = 4.30 Baseline include insect or termite attack, sagging of roof, movement of the soil and cracking of floor are classified as insignificant factor to impact of structural defects on residential buildings

Table 6: Strategies for Mitigating Structural Defects in Building

Strategies for Mitigating Structural Defect in Building	Mean Rating	Mean Ranking
Aligning material performance against adverse weather conditions	4.61	1
Preventing impacts from occupants and loads	4.58	2
Preventing water leakage that cause other defects	4.51	3
Improved specification	4.47	4
Improved on design clarity, design details and layout	4.44	5
Examine the building materials before use	4.41	6
Top- level management of construction firm should be given adequate training	4.39	7
Constant monitoring and supervision of materials and labour should be ensured by the designers during the construction stage.	4.36	8
Continuous researches and findings on the possible avoidance and diagnosis of agencies causing deterioration on building elements should be stipulated for under graduate building team scholars in Nigeria higher institution of learning.	4.33	9

Source: Authors’ Data Analysis (2018)

Table 6 above illustrates the mean scores and ranks of each factor by all respondents. Based on the baseline established earlier in this study, all the 9 factors have mean score above 4.30 and were classified as significant factors as shown in the table. The results shows that aligning material performance against weather conditions was ranked 1st while preventing impacts from occupants and loads on the building and preventing water leakage that can cause other defects on the buildings were ranked 2nd and 3rd respectively. Improved specification specification, improvement on design clarity, design details and layout, and examination of the building materials before use were ranked 4th 5th and 6th respectively. Below the table, were three other factors ranked seventh, eighth and ninth, these are top-level management of construction firm should be given adequate training constant monitoring and supervision of materials and labour should be ensued by the designers during the construction stage, continuous researches and finding on the possible avoidance and diagnosis of agencies causing deterioration on the building elements respectively.

IV. CONCLUSION

This project shows that there are too many defects and designers that are unable to eliminate all of them effectively. Many designers are not aware of standards and codes like the American Standard for Testing of Material (ASTM) and British Standard (BS). Many defects continue to be repeated in every building as designer failed to obtain important feedback from property managers on these defects. Also, this project confirmed designers can improve overall building quality by consolidating efforts on a few major defects and gathering existing knowledge. Cost and other design issues should be important as a way of eliminating structural defects. However, new materials and technologies emerged every now and then and the performance of these materials and technologies should be properly evaluated and documented structural and geotechnical problem can only be resolved with better design and test and should continue to upgrade their knowledge improve design.

V. RECOMMENDATIONS

In controlling the measure procedure for the usual failure occurring in building this following recommendation will be applied.

- Top – level management of construction firms should be given training to their personnel, especially the maintenance personnel, over the necessary control measure suitable for a particular defect.
- Constant monitoring and supervision of materials and labour should be ensured by the designer during the construction stage include this should be preceded by standard expected user requirement.
- Continuous researches and findings on the possible avoidance and diagnosis of agencies causing deterioration on building elements which should be stipulated for under graduate building team scholars on all Nigeria higher institution of learning.
- The local and town planning authorizes need to control both the clients and contractors that are in contractual relations and ensure that their building is constructed to acceptable standard and regulation.

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