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AN EXAMINATION OF THE CAUSES AND EFFECTS OF BUILDING COLLAPSE IN NIGERIA

Oke Ayodeji
Department of Quantity Surveying, Federal University of Technology, Akure 234034 Ondo State Nigeria
Corresponding Author: emayok@gmail.com

Abstract

The research investigated the causes and consequence of building collapse in Nigeria using historical data from 1974 to 2006 and also proffers appropriate solutions. Relevant books, seminar papers, workshop papers, articles, etc. were reviewed so as to examine the general view of individuals that have worked on similar study. Data for the study were obtained through historical data of past building collapse in Nigeria. The data were presented and analysed using tables, bar graphs, Pearson moment correlation coefficient (r) and linear regression analysis to generate a model. Sixty (60) buildings that collapsed in the country were gathered, upon which the analysis was carried out. The study revealed that poor maintenance culture, design error, poor quality of materials and workmanship, natural phenomenon and excessive loading contributed to about 7%, 15%, 52%, 7% and 20% respectively of building collapse in Nigeria with most of them being private residential buildings executed by indigenous contractors. The study finally recommended that Standard Organisation of Nigeria (SON) should increase their effort in sanitizing building materials in the market. More so, construction professionals should ensure proper supervision of workmen and efficient checking of materials before incorporation into building works.

Keywords: Building Collapse, Nigeria, Historical

Introduction

Since independence, the Nigeria government has desperately continued to make concerted effort in the area of quantitative (but not qualitative) supply of mass housing through huge budgetary and policy provisions but, surprisingly, the rate at which existing ones are collapsing calls for an urgent attention. The site of building collapse scattered across the length and breadth of Nigeria is quite alarming that it is unimaginable what effects it will have on the building industry and Nigeria economy as a whole. One could imagine what edifices these buildings would have been if only they were constructed accordingly. It has been reported that Nigeria, especially Lagos State has become the "world's junk-yard" of collapsed buildings worth billions of naira (Famoroti, 2005). It is quite unimaginable that a county blessed with so great potentials in its construction industry can experience such magnitude of building collapse.

Fadamiro in 2002 defined building as "an enclosure for spaces designed for specific use, meant to control local climate, distribute services and evacuate waste". Buildings can be defined as structural entities capable of securing self by transmitting weights to the ground. More so, buildings are defined "as structures for human activities, which must be safe for the occupants" (Odulami, 2002). However, these same buildings have been posing treats and dangers to people either during or after construction as a result of its collapse.

Collapse as a whole occurs when part or whole body of a structure fails and suddenly gives way, the structure, as a result of this failure, could not meet the purpose for which it was meant for. Building collapse is an extreme case of building failure. It means the super-structure crashes down totally or partially (Arilesere, 2002). Building failure occurs when there is a defect in one or more elements of the building caused by inability of the material making up the components of such building elements to perform its original function effectively, which may finally lead to building collapse.

Buildings are meant to provide conveniences and shelter to the people, but the same building has been a danger trap to the same people. Building is expected to meet certain basic requirements such as buildability, design performance, cost effectiveness, quality, safety and timely completion (Olusola, Atta & Ayangade, 2002). Generally, buildings are expected to be elegant and functional but many projects are constructed that do not meet any of these basic requirements. The recurring incidence of building collapse, some of which claimed innocent lives is a consequence of this.

Many studies has been carried out and various workshops organised in major cities of the country by various bodies, government agencies and institution in order to look into causes of the incidence of building collapse in Nigeria, but none has been able to come out with how each of the determined factors directly lead to building collapse in the country. There are many factors that cause building collapse in Nigeria and they are structural design and quality management according to Olusola(2002). The quality management entails material variability, testing variability, judgment factor, contractors' variability, poorly skilled workmen and unprofessional conduct. The study aimed at examining causes of building collapse in Nigeria with respect to historical data of available incidence of building collapse.

Literature review

Building industry

The building industry is the most complex of all the industries in the economy and the basis of its complexity is founded on the simple fact that, all other industries and sector of the socio-economy depend on it for the environment in which they operate. The building industry is to all practical purpose an all-comers affair (Akindoyeni, 2002). It is an industry where all manners of local and foreign materials, professionals and equipments co-habit in order to achieve quality buildings of high standard. The building industry plays an important and dynamic role in the process of sustainable

economic growth and development of any nation due to its size and complexity. It is to be noted that up to one-sixth of the total amount allocated to construction projects by Nigeria governments takes the form of building as observed from past budget of the country.

Whether a country is just developing like Nigeria or is already developed like Britain, buildings all over the world, constitute the most valuable assets of mankind (Chinwokwu, 2000). More so, while these buildings provide humanity with a great variety of accommodation in form of residences, mosques, churches, offices, schools, factories, hospitals, stadia, ports, hotels, and so on, it also provides employment for the skilled and unskilled persons. The building industry plays an important and dynamic role in the process of sustainable economic growth and development of any nation due to its size and complexity. It is to be noted that up to one-sixth of the total amount allocated to construction projects by Nigeria governments takes the form of building as observed from past budget of the country.

The aim and objective of the building industry is to provide suitable accommodation for the whole community, of the quality that can be appreciated by the community, at the cost that the community can afford, within the time required by the community and within the capacity of the building industry (Akindoyeni, 2002). However, it could be deduced that the ultimate goal for any building projects is for such projects to be delivered within the shortest possible time, at the lowest possible cost, within the highest possible quality so as to minimise the problem and the burden of future maintenance and building collapse.

Causes of building collapse

Buildings fail through mainly ignorance, negligence and greed (Bolaji, 2002). Ignorance has to do with when incompetent personnel are in charge of design, construction or inspection. One of the major areas of negligence is in specification writing where that of a past project is adopted without crosschecking those areas that need improvement, addition or omission. Greed on the part of building contractors e.g. diversion of building materials, cement in particular, meant for the production on the client's site to his own site, the use of sub-standard materials so as to achieve high profit, etc.

In discussing the issue of building collapse, distinction must be made between buildings, which fail during construction or within the service life and to those that fail after the service life, which is usually 25 years (Olusola, 2002). It can be deduced that the collapse that causes the greatest loss is that which occurs when a building has been in use for long a time or shortly after its construction.

BRIEF AND DESIGN DEFICIENCIES: The inadequacies in the brief supplied by the clients can bring about defects even at the inception of the project when client fail to give all the necessary information on the functional requirements of the building (Fadamiro, 2002). He further said that design deficiencies also come under calculation errors, bearing support problems, deformation, secondary

stresses, elastic cracking, temperature and shrinkage problems, detailing and drafting problems, errors in assumed loading, changes and alterations in existing buildings, all contributing substantially to building structural failures, disasters and may finally lead to building collapse.

Foundation problems: Foundation is one of the major structural members of any building and any problem arising from it will surely affect the whole building. Fadamiro (2002) averred that the crushing and collapse of concrete footing or other foundation members are usually due to unequal settlements which may be cause by changing sub-grade condition or by wrong assumptions in the design, inadequate or unequal support for foundations, soil and ground water movements as well as expanding soils. Hence, the most common form of abuse of foundation occurs due to abnormal loading situations especially in structures being converted to new use or having additional floors.

Natural occurrence: One of the major natural factors that result into building collapse is rainfall; others may include temperature, pressure, etc. When there is a heavy downpour of rain, there is a possibility that one or more buildings (completed or uncompleted), somewhere, would carve in (Chinwokwu, 2000). The fact remain that this is a natural factor that cannot be stopped, buildings therefore need to be constructed adequately bearing in mind such uncontrollable factors.

Quality management: The need for stringent quality control in material utilization within the construction industry in Nigeria today cannot be over emphasized (Olusola, 2002). The neglect of quality control in the construction industry has resulted in many defective and ugly looking buildings and the rise in number of collapse buildings in the past years. A number of factors influence the quality achieved in the Nigerian building industry and they are explained below.

Material and Testing Variability: This has to do with the difficulties that contractors experience in consistently obtaining and/or producing good quality materials as well as the ability of the client's representative to understand the correct control values or make the necessary computation in the field. It goes further into the inability of manufactures to make products of the same sizes and specified quality at all times.

More so, there is difficulty of the client's representative in producing or interpreting field test results. It is often that many of them present on the field are usually no more than clerk of works put there by the architect to record the daily operations.

Contractors' Variability: This is the difficulty a client or his representative experiences on large-scale projects in having all the contractors produce uniform standards of materials and workmanship. Different contractors have their different means of production in terms of method of construction, technology involved, etc.

Poorly Skilled Workmen: This sometimes in conjunction with contractors' variability is one of the reasons behind the incidents of building collapse in Nigeria. The level of competencies of different categories of labour in Nigerian building industry (though varies from one city and contractor to another), through

investigation, is found to be reducing day after day. It has been noted that even the workmen that went through apprenticeship training are no better than their master. Poor skill makes it difficult or impossible for workers to perceive and apply the concepts of quality control and limits of tolerance for building production (Olusola, 2002).

Inadequate Maintenance: Generally, less attention is paid to maintenance in Nigeria as observed by Dare (2002). Normally, the maintenance of a building should start from the very time excavation is dug. For instance, if the foundation excavation shares before or after placement of concrete, it must be cleared and maintained because earth impurities impair the strength of concrete.

Unprofessional conduct: Generally, it is believed that unprofessional conducts contribute in not small measure to the menace of building collapse in Nigeria. Such unprofessional conduct such as bribe collection from contractors, professional acting in the capacity beyond the scope of his profession, etc. has a negative effect indirectly on the building and may finally result into building collapse.

The role of professionals in the construction of buildings in Nigeria is such a fundamental one (Adebayo, 2005). It is therefore a shame that a large population of building construction in the country still does not have the full participation of the relevant professionals.

Consequences of building collapse

Apart from lost of lives (mostly innocent citizens), many other people has been rendered permanent disable in one form or the other as a result of increasing rate of building collapse in the country. Economic loss as a result of this incidence is immeasurable in that many have been rendered homeless with loss of countless properties. More so, various site of building collapse scattered across the length and breadth of Nigeria is making the environment unhealthy as such collapsed buildings has become hidden houses for robbers, touts, etc. a very good example is that of NIDB building located in the heart of commercial area of Lagos state in Nigeria. Dangerous animals like snake have also made such buildings their place of abode, which is a danger threat to the people living within the vicinity of the environment.

Research methodology

Relevant and necessary data were collected from secondary sources in order to achieve the aim of the research, which is to investigate the causes and effect of building collapse in Nigeria and suggest various ways of eliminating the incidence. The data were collected through investigation of past building collapse in Nigeria.

Analysis of past documents (secondary data) from both internal and external sources was adopted as the research instruments in gathering data on various incidence of building collapse in the country. The data (regardless of the location and based on the available information) were partly gotten from The Nigeria Institution of Building, previous research works and various newspapers were also consulted (through the dailies and their website). All the available incidences of building collapse as at the

date of analysis of the data were included in the historical data. The following factors were considered as the bases of the findings:

- Name of the building,
- Type of the building (private or public),
- Purpose of the building (commercial, residential, educa-tional or religious),
- Date of collapse,
- Location of the building,
- Major cause of the collapse,
- Calamities (deaths and injuries), and
- Type of the building contractor (indigenous or non-indigenous).

Tables, line graphs and bar graphs were used for data presentations. The analysis of the collected data was carried out using the following descriptive and analytical scientific methods: percentiles, Pearson product moment correlation coefficient and regression analysis methods.

Pearson Product Moment Correlation Coefficient (r): This method was adopted in this research to assess the causal relationship between building collapse and its causes.

The basis of decision according to Okonko (2001) is on the premise below:

Correlation Coefficient	***Nature of relationship***
0.0 to 0.30 (0.00 to -0.30)	Little or no correlation
0.30 to 0.50 (-.30 to -.50)	Low positive (negative) correlation
0.50 to 0.70 (-.50 to -70)	Moderate positive (negative) correlation
0.70 to 0.90 (-.70 to -.90)	High positive (negative) correlation
0.90 to 1.00 (-.90 to -1.0)	Very high positive (negative) correlation

Findings and discussion

Causes and Effects of Building Collapse

Table 1 show the summary of information on past building collapse in Nigeria as detailed in the appendix. This is based on the available information that was gathered as at the time of this research. Five factors that cause building collapse were adopted as highlighted by Bamidele (2000) in Fadamiro (2002). Sixty cases of collapsed buildings were summarized out of which poor quality of materials and workmanship led to thirty-one of them, representing about 52%.

It could be observed that out of these sixty buildings, forty-six of them are public while the remaining fourteen are private. Of these buildings, poor quality of materials and workmanship led to collapse of twenty-five private and six public buildings respectively. This is a very significant factor as it represents 54% and 43% respectively, showing that the factor has more effect on private than public buildings. This can be justified since most of the public buildings residents are owner-occupied and they are only interested in getting shelter, but not the resultant effect of their action.

More so, it was observed that out of the sixty building that collapsed, poor quality of materials and workmanship was responsible for twenty-one of the thirty-eight residential buildings (representing 55%), six of the fifteen commercial buildings (representing 40%), three of the five religious buildings (representing 60%) and one of the two educational buildings (representing 50%). This showed that this very factor has

Table 1: Building collapse in Nigeria and their causes

No	CAUSES	Total		Building type		Major building use				Calamities		Contractor	
		No	%	Priv	Pub	Re	Co	Rel	Ed	Death	Injury	I	N
1	Poor maintenance culture (PMC)	4	6.67	3	1	3	1	0	0	23	10	4	0
2	Design error (DE)	9	15.00	6	3	6	1	1	1	125	41	8	1
3	Poor materials and workmanship (PMW)	31	51.67	25	6	21	6	3	1	111	112	28	3
4	Natural phenomenon (NP)	4	6.67	3	1	2	2	0	0	72	40	3	1
5	Excessive loading (EL)	12	20.00	9	3	6	5	1	0	95	28	12	0
	Total	**60**	**100.0**	**46**	**14**	**38**	**15**	**5**	**2**	**426**	**231**	**55**	**5**

Source: Gathered historical data of building collapse in Nigeria attached as appendix
KEY: Priv – Private, Pub – Public, Re – Residential, Co- Commercial, Rel – Religious, Ed – Educational, I – Indigenous, N – Non-indigenous

more effect on religious buildings, followed by residential buildings while it has the least effect on commercial buildings. This can be justified since most of the religious buildings are erected without consulting any professionals neither are they ready to search for appropriate materials, but make use of the available one all in the name of getting a place of worship.

The type of contractor that executed these collapsed buildings was viewed from two perspectives i.e. indigenous and non- indigenous. The former accounted for 55 cases of the collapse (representing 92%) while the latter accounted for five cases (representing 8%). Poor quality of materials and workmanship lead to collapse of twenty-eight buildings by indigenous contractor (representing 51%) and 3 of non-indigenous (representing 60%) respectively. Buildings erected by indigenous contractors are more prone to building collapse than non-indigenous and this can be as a result of the following factors: inexperience, lack of trained personnel, lack of technical know how, lack of exposure, etc. which were factors affecting quality of materials and workmanship in Nigerian building industry as identified earlier.

Four hundred and twenty-six (426) deaths and two hundred and thirty-one (231) injuries were observed as resultant calamities of building collapse in Nigeria out of which poor quality of materials and workmanship accounted for one hundred and eleven deaths (representing 26%) and one hundred and twelve injuries (representing 45%) respectively. This also depict that this very factor has a significant resultant effect on building collapse in Nigeria.

Relationship between Quality of Materials and Workmanship and Building Collapse

Due to high percentage of poor quality of materials and workmanship as observed, there is a need to examine the overall impact of this factor on building collapse in Nigeria.

Hypothesis 1

Ho = Quality of materials and workmanship has no significant effect on building collapse in Nigeria.

H_1 = Quality of materials and workmanship has significant effect on building collapse in Nigeria

In order to assess the causal relationship between quality of materials and workmanship and building collapse in Nigeria, two test statistics were employed i.e. regression analysis and Pearson product moment correlation coefficient as shown in appendix 3. Number of collapsed buildings as a result of poor quality of materials and workmanship (X) were recorded against the total number of collapsed buildings (Y) within the range of the years (5 years interval) as shown in table 2.

A mathematical model (linear regression equation) was generated to show the relationship between these variables as shown below.

$$\mathbf{Y = 2.06 + 1.56X}$$

Where Y is the rate of building collapse and
X is poor quality of materials and workmanship.

In order to further test the strength of the model, Pearson product moment correlation coefficient was calculated to be:

N= 5: **Rcal = 0.95:** Rcritical = 0.81 for p < 0.05 (0.05 level of significance)

Decision: Rcalculated > Rcritical at 5% level of significance: a very high positive correlation (or relationship).

Table 2: Causal relationship between causes of building collapse and no of collapsed buildings in Nigeria

YEAR	Total	PMC	DE	PMW	NP	EL
1981 – 1985	7	0	1	3	1	2
1986 – 1990	11	0	4	5	1	1
1991 – 1995	5	0	0	3	0	2
1996 – 2000	15	2	1	9	1	2
2001 – 2005	13	2	0	8	0	3
Total	**51**	**4**	**6**	**28**	**3**	**10**

KEY: PMC – Poor maintenance culture, DE – Design error, PMW – Poor materials and workmanship, NP – Natural Phenomenon, EL – Excessive loading.

Hence, the null hypothesis is rejected and the alternative which state that "Quality of materials and workmanship has significant effect on building collapse in Nigeria" is accepted. The relationship is of a very high and positive type.

This denotes that quality of materials and workmanship has a very high causal effect on building collapse in Nigeria. The equation also show that when there are eighteen cases of building collapse, ten of them will be as a result of this factor.

Discussion of findings

The findings revealed that poor quality of materials and workmanship has accounted for more than 50% of causes of building collapse in Nigeria. Contrary to this finding, Ogunsemi (2002) confirmed that this factor has been responsible for only 37% while it accounted for 27% in another study by Fadamiro (2002). This is due to the fact that this research relies on a larger number of past building collapse in Nigeria for its finding (making use of sixty cases and five major causes) while Ogunsemi (2002) made use of seven (7) cases of building collapse and ten different causes. Due to increased population sample for this finding, the result of the research could be said to be more comprehensive than that of Fadamiro (2002) despite the fact that the same number of factors were adopted as the causes of building collapse.

In furtherance to what Chinwokwu (2000) asserted that, private buildings are more prone to collapse than public ones, the analysis also confirmed that poor material and workmanship is the most significant factor of all the causes of collapse in all type of buildings regardless of their developer nor the use subjected to. In Dare (2002) view, buildings executed by indigenous contractor are more prone to building collapse than that executed by non-indigenous ones, the study confirmed this and also revealed that poor quality of materials and workmanship is the most significant cause of collapse of buildings executed by these contractors in Nigeria.

Further to the study by Akindoyeni (2002), Chinwokwu (2000), Dare (2002) and Ogunsemi (2002) on building collapse in Nigeria, the findings confirmed that poor quality of materials and workmanship has a very large and positive causal effect on building collapse in Nigeria i.e. there is a very high causal relationship between them. Ogunsemi (2002) asserted that poor quality of materials and workmanship accounted for over 36% of building collapse in Nigeria (the highest of all the examined factors) while Chinwokwu (2000) confirmed that failure to investigate the quality of materials and workmanship in Nigeria building industry will certainly continue to result into building collapse.

Conclusions

The study revealed that, poor maintenance culture, design error, poor quality of materials and workmanship, natural phenomenon and excessive loading contributed to about 7%, 15%, 52%, 7% and 20% respectively of building collapse in Nigeria with most of them being private building executed by indigenous contractors.

Moreover, the study concluded that poor quality of materials and workmanship has a very high and positive effect on building collapse in Nigeria (r = 0.95) with respect to the mathematical model (linear regression equation) generated from the findings of the research.

$$Y = 2.06 + 1.56X$$

Where Y is the rate of building collapse in Nigeria and
X is the effect of poor quality of materials and workmanship

Recommendations

Based on the findings, the following are recommended:

i. The Standard Organisation of Nigeria (SON) need to have a more positive response to their responsibility in sanitizing building materials that are offered for sale in Nigerian market.

ii. The Nigerian Institute of Building (NIOB) and The Nigerian Institute of Structural Engineer (NISE) members should be involved in the building materials sanitization process by the federal government. Material Engineers should also be attached to large building projects by their developer.

iii. Various means of motivation of workmen like giving of incentives, good sick pay, better salary, etc. should be in place by the management of any building work as this will increase the will of workmen, thereby enhancing excellent quality of workmanship.

iv. Building professionals should also ensure proper and efficient supervision of workmen as well as efficient checking of materials before incorporation into building works.

v. The design team in any building work should be very careful when selecting supplier of building materials i.e. nominated supplier. Materials supplied to site by such should also be checked and vet appropriately in conformance to the contract specification. The design for building projects should also be vetted and checked at periodic interval of the construction.

vi. Workmen with the appropriate training should be employed for building works especially those working on the structural members. The personnel manager of building firms in Nigeria should also employ site management education scheme charged with the responsibility of organizing workshops and other forms of trainings for site personnel on regular basis.

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