

# Assessment of Building Collapse in Nigeria: A Case of Naval Building, Abuja, Nigeria

Fakere, Alexander A.<sup>1</sup>, Fadairo, Gabriel<sup>2</sup>, Fakere, Rufus A<sup>3</sup>

<sup>1,2</sup>Department of Architecture, Federal University of Technology,  
P. M. B. 704, Akure, Nigeria.

<sup>3</sup>Department of Civil Engineering, Ministry of Works,  
P. M. B. 606, Akure, Ondo State

## ABSTRACT

In the past few years, incessant building failure has been reported resulting in the loss of lives and properties in Nigeria. However, there has been a dearth of information regarding any findings about the collapse of the building structures. This study examines the case of structural failure that recently occurred to a Naval Building that was undergoing demolition in Abuja, Nigeria. A study of some selected collapsed buildings in Nigeria is carried out in this work. The methodology includes conduct of investigations, and site inspections. The findings shows that improper demolition method, coupled with its dangerous nature, contributed to the collapse of the building. The coarse aggregates used in the construction contained impurities like biotite and muscovite, which are oxidizing agents capable of accelerating building collapse. Based on the results obtained through this study as well as the recommendations on them, the further occurrence of building collapse will be greatly reduced. The study concludes that building collapse in Nigeria can be greatly reduced by avoiding all pitfalls.

**Keywords**— *building collapse, demolition, impurities, materials, structural failure*

## 1. INTRODUCTION

A structure is a whole building, complex framework or essential part of a building. Marshall & Nelson (1981) defined structure as a body capable of resisting applied loads without any deformation of part relative to one another. In a simpler form, a structure is that which carries load and transfers the load from the point of load application to the point of load support. The structure of the building is therefore that part of building construction which gives the construction sufficient strength to withstand the load to which the whole building is subjected. A building structure does this by carrying the load imposed on it and transferring same safely to foundation hence, into the ground. There are two broad sub-divisions of the structure. The first is the framed structures, which resist applied loads by virtue of their geometry. The second type is the mass structures, which resist applied loads by virtue of their weight.

According to MacGinley (1998), buildings are utilized primarily for living, working and storage. He further categorized them into three broad types. The first is the monumental structures which comprise the churches, city halls and sports arena. The second is the institutional structures represented by the more usual kind, such as block of flats, tertiary institutional buildings for academic and administrative purposes. The third group comprises the

industrial structures represented by the ordinary small scale industrial types.

The collapse of the Naval building, a two storey building in Gwarimpa, Abuja occurred on Saturday, 28<sup>th</sup> January in 2012. The excruciating event, which wounded and killed some people, drew the attention of some Government functionaries, Architects, Engineers and other professionals from within and outside the city to sympathize with the Government and the Naval force, Abuja. The tragedy generated so many palpating questions in the Abuja metropolis on who should be blamed and held responsible for the collapse of the building. Are they the designers, builders, supervisors and the client? Was the contract mismanaged? In fact, nobody has really diagnosed what went wrong with the building except few allegations that there were some structural implications that were not taken into consideration during the demolition.

The collapse of the Naval Building is no doubt an unfortunate one. It is supposed to serve as a lesson to our building contractors, clients and others that negligence on their part could cause a monumental loss to both human and material resources. According to Adepegba (2012), the incident which happened around 10am attracted Nigeria Security and Civil Defense personnel, Federal Road Safety officials and the staff of the Federal Capital Territory (FCT) development control department.

This paper is intended to find out the real causes of the collapse and hence serve as a reference document to Engineers, Designers and Builders in the building profession. The recommendations will also help to reduce the rate and severity of building collapse in Nigeria.

## 2. OBJECTIVES

The objectives of this research are:

- i. To determine the general causes of some building's collapse and especially the reason for the collapse of the two-storey Naval building.
- ii. To evaluate the extent of loss in terms of life and property.
- iii. To make some suggestions on safe delivery of structure particularly building projects.

## 3. METHODOLOGY

Information for the study was received from books, observations, past works, newspapers on building collapse and the internet. Also, the project in question was investigated to ascertain the factors that lead to the collapse.

## 4. BASIC BUILDING REQUIREMENTS

Ogunsemi (2002) disclosed the basic requirements that a building must satisfy. Each and every member of a structural system should be able to resist, without failure or collapse, the applied loads under the service conditions. In other words, it must possess adequate strength. This demands that the materials of the structure must be adequate to resist the stresses generated by the loads. The shape and size of the structure must also be adequate.

The components of the structure should be able to resist deformation under loading conditions. Deformation implies a change in size and shape when a body is subjected to stress. This means that the component should possess adequate stiffness. Thus the stiffness of a beam or column is a measure of its resistance to bending or buckling. A material or structure that is very strong but lacking in stiffness will so much deform that it will not be able to resist applied loads.

All the structural members of the building must be firm, otherwise the whole structure is assumed to be unstable. Structural stability is needed to maintain shape since it is the ability of a structure to retain under load, its original state of equilibrium. It can mean anything from resistance to sliding, overturning, partial or complete collapse. Any phenomenon that can alter the load carrying behaviour of a structure, if not properly taken care of can lead to instability; a condition in which the support reaction is less than applied load. Thus to ensure stability, loads must be balanced by reactions, and the moments due to loads must be balanced by the moments due to reactions.

Any building that cannot withstand the load applied upon it will show signs of distress which may lead to failure and invariably total collapse. The possibility of building collapse should not be underestimated. Its occurrence is usually accompanied by loss of properties and lives. A building may collapse when one or more of its essential components fail. When buildings collapse, professional bodies such as Architects' Registration Council of Nigeria (ARCON), Council for the Registration of Engineering in Nigeria (COREN), and even Governments usually set up panels of enquiry to determine the immediate and remote causes of such failures and if possible recommend sanctions against those culpable.

The rate of collapsed buildings in Nigeria has been a source of serious concern to professionals, like Architects, Builders, and Structural Engineers. Building collapse has so often been associated with structural failures. Therefore, structural failures, no doubt, are very dangerous and should be avoided using all necessary precautions and machineries possible. Ultimately, the effect of collapse of a building structure, particularly at its completion stage and when it is occupied by users is devastating on human lives. Even if lives are not lost, much financial investment is wasted. Once the specifications of the building including its materials and components are not complied with during construction, the result is building failure.

## 5. THE COLLAPSED NAVAL BUILDING IN ABUJA

In recent times in Nigeria, there have been several cases of structural collapse of buildings, especially in Abuja, Lagos and Port Harcourt where several construction works are presently going on. Several of these incidents occurred in buildings that had outlived their life spans, some were still undergoing construction, some had been declared unsafe and undergoing demolition (like the case in this study), while others were already completed and in use when the sudden collapse occurred.

The collapsed building in Abuja is located within the Naval Quarters at 45 Road, 1<sup>st</sup> Avenue, Gwarimpa Estate. Plates 1, 2, and 3 show different views of the collapsed building.



Plate 1: The Collapsed Naval Building located at Gwarimpa, Abuja, showing the wreckage. Source: Saharareporters, 2012)



Plate 2: Clearing the debris on the Naval Building site  
(Source: Nnabugwu, 2012)



Plate 3: Another view of the building showing the wreckage  
(Source: Adepegba, 2012)

The tragedy occurred after work has commenced to demolish the building. This followed the fact that the development control office of the Federal Capital Development Authority (FCDA) had previously issued a stop-work order on the renovation works due to the structural defects discovered in the building. They described the building as a 'disaster waiting to happen.' Investigation revealed that the building had deteriorated over time. About 15 people were busy on the site when the building collapsed; 2 died, 1 seriously injured and the others escaped with minor injuries. The columns started wangling and twisting. Also, buckling of the steel at the base, crushing of materials and concrete cover giving way exposing the column reinforcement which are caused mainly by the manual demolition were noticed. Eventually sound of explosion perhaps, after reaching the yield point occurred. According to some respondents, the notice, failure and collapse were sudden, under 60 seconds.

From the investigations conducted, it was discovered that, even though application has been made to the FCDA to approve the demolition, the contractor did not wait for the approval process to be concluded before commencing the works. Hence, the Authority was not involved in the demolition works carried out. Furthermore, the work was carried out by inexperienced labourers, hence, their

decision to commence the demolition from the ground floor instead of the topmost floor, which is the major factor that eventually led to the collapse on the fateful day.

Also, investigation from the appropriate Authorities revealed that the building was not approved by the FCDA and the Federal Housing Authority (FHA). Hence, there were no approved drawings in the archives of the Federal Housing Authority.

**Findings:** The building under investigation had been described by the FCDA as precarious and had been marked for demolition before it eventually collapsed. This elicits the fact that the structure was defective, hence, the need to investigate the factors responsible for this. According to Twidale (1982), granite chipping is the end product of granitic rock after crushing. Aggregate stone is composed of quartz, feldspar and mica. The mica is made up of biotite and muscovite, which are oxidizing agents which can weaken building structures over time. Granite is an important building structure stone because of its good appearance, hardness and resistance to weathering except when crystals of mica (biotite and muscovite) are large and weathered leaving void at the surface. All these have their significant role in building construction. In general terms, a granite rock consists of quartz, feldspar, biotite and muscovite. Hence, it was observed that impurities were noticeable in the aggregates used for the construction of the collapsed building and therefore is one of the factors that led to the precarious state of the structural members of the building. The oxidation that would have occurred as a result of the presence of impurities weakened the concrete over time and reduced its strength.

A critical look at the debris reveals the structural weakness of the construction materials used. Sub-standard materials were used in the construction of the building, which includes the reinforcement bars, concrete mixture ratio, etc. The mixture of the concrete was not distributed evenly. Therefore, it could be obtained that the workmanship during the construction of the collapsed building was poor. This as a matter of fact must also have contributed to the weak structural members such as columns, beams and slabs which led to the unsafe nature of the building.

## 6. FACTORS RESPONSIBLE FOR BUILDING COLLAPSE IN NIGERIA

Building collapse can be attributed to many factors. Many buildings in Nigeria have collapsed due to some of the following reasons.

- i. **Inadequate preliminary works:** Preliminary works are operations which include site investigation and foundation. Building collapse is imminent where these operations are carried out shoddily. Site investigation is to determine the properties of the soil strata. Seeley (1987) said that all potential building sites would need to be investigated to determine their suitability for

buildings and the nature and extent of the preliminary work that would be needed. Particular attention should be given to the nature of the soil and its probable load-bearing capacities, as there may be variations over the site. The past history of the site should be investigated with particular reference to the former existence of trees, water level, borehole log, underneath soil strata and waste dumps. A careful study should be made of adjacent structure to ascertain whether failure can result due to localized conditions. According to Bell (1987), soil is an unconsolidated assemblage of soil particles between which voids. These voids may contain water, air or both. Soil is derived from the breakdown of rock materials by weathering and erosion and may have suffered some amount of transportation prior to deposition. Neville and Chatterton (1987) asserted that the development of soil mechanics which relates to the understanding of the physical properties of any particular soil type in relation to loads was really the main stepping stone towards a scientific approach to foundation problem and construction. However strong, rigid or structurally stable a building may be, its satisfactory performance depends exclusively upon the ground which supports it. Adequate site investigation prevents the issue of foundation problem because it would ensure that the most appropriate foundation is prescribed.

- ii. **Adoption of wrong foundation:** Lambe and Whitman (1979) defined foundation as the part of the structure in direct contact with the ground and which transmits the load of the structure to the ground which plays an important role in the construction of building structures. Foundation is expected to carry all the dead, super-imposed and wind loads from a building to the soil on which the building rests in such a way that settlement of the structure is limited, so that failure of the underlying soil is prevented. The depth of soil strata in response to the loadings from the structure has to be located properly in order to safely bear the foundation of the building. Otherwise, the structure will fail.
- iii. **Poor concrete mix ratio:** Usually concrete is a mixture of cement, sand, gravel and water in definite proportion. In providing support for a building, concrete is the most common material used in Nigeria. Tomilson (1980) reiterated that poor materials do not make good concrete. The cement, sand and stone must all be sound and have the types and qualities specified. The result of poor concrete works is building collapse. The steel reinforcements are embedded in concrete, so that compressive stresses are taken by concrete, while tensile stresses are catered for by steel reinforcements. For this purpose to be fulfilled,

steel rods must be bent in accordance to design. Otherwise, it will fail and cause collapse.

- iv. **Improper walling:** the wall is a very important part of the building that also provides support. Other function is to enclose or divide space. A wall that will adequately provide support is a load-bearing wall which must provide adequate strength and stability, weather resistance and durability. The commonest walling material in Nigeria now is sandcrete blocks of various sizes. As a matter of fact, walls which provide support to buildings must be straight, perpendicular and produced of sound materials. The appearance of a crack line in a building is a sign of failure. Failure in block-laying may lead to eventual collapse of the building.
- v. **Lack of approved structural design:** According to Ataev (1985), the basic requirement of any structural component of a building is that it should be strong enough to carry and support all possible types of loads to which it is likely to be subjected. Therefore, building design is not just the Architectural design; it also includes structural, electrical and mechanical engineering. A building that is poorly designed structurally will eventually collapse. The final object of structural analysis is to enable the Engineering design and construct a building structure, which is satisfactory in service, and that such design must be approved by the approving body. This means that it must not collapse when loads are applied and the deformation must not be excessive. In addition, some clients, in order to try and save cost, patronize quacks to do designs for them. This is very common in Nigeria and such designs are grossly inadequate and usually result in building failure.
- vi. **Poor building material specification:** the uses of poor building material specifications have been possible root causes of collapse. In buildings, the materials that are essentially used on construction sites are cement, sand, gravel, granite chipping, timber, iron rods and sandcrete blocks. Other materials are aluminium, glass and ceramics. Good building constructions are enhanced by materials of good quality. Proper handling and storage must be given to building materials. Materials specifications must relate exactly to the intended construction and must be of adequate standard. Specifications are to prescribe what materials should be used and where there is a deviation, failure, that is, building collapse should be expected.
- vii. **Ineffective supervision:** Averting building collapse depends largely on effective supervision of works. Hence, improper supervision will lead to the collapse of the building structures.

Supervision involves the intricate knowledge of workmanship and materials, while inspection is only to ensure adherence to contract documents, especially the drawings. The object of the supervision is primarily to ensure that employer's requirements as expressed in the contract documents are correctly interpreted and the problems which are bound to arise are satisfactorily resolved. In the case of the building under study, there was no proper supervision for the demolition works.

**viii. Climate:** Apart from failure arising from negligence or negligent behaviour, many of our buildings have failed due to persistent incidence of weather. Ogunsemi (2002) remarked that a good building is not that which merely fulfils the purpose for which it is designed and erected, but a building comely and able to withstand the onslaught of weather conditions.

Other factors are: poor workmanship, use of substandard and poor quality building materials, wrong conversion of building, lack of qualified and appropriate professional,

inadequate quality control, fire disaster, bomb explosion, lack of maintenance culture, natural disasters.

## 7. BUILDING COLLAPSE IN NIGERIA

In recent times, building collapse in Nigeria has been a source of concern to so many people particularly those associated with the building industry. This is so because there are so many cases of building collapse all over the world and particularly Nigeria. Most of these cases had resulted into colossal economic losses in terms of lives and property. Building collapse are some of the cardinal issues, which have created serious concern to all the professionals like Architects, Structural Engineers, and the Builders. The government also is worried about the frequency of collapse of buildings Nigeria. However, Aderibigbe (2001) admitted that the recurring event of collapse of buildings has forced some state governments to enforce and enact some laws recommending forfeiture of such buildings and prosecution of their owners. Table 1 shows some occurrences of building collapse in Nigeria in the 70's and 80's, while table 2 shows such cases from year 2000 till date.

**Table 1: Showing Some Reported Cases of Collapsed Buildings in Nigeria**

| S/N | Building location                     | Type                                     | Date                        | Suspected cause(s)                    | Remarks<br>Life lost |
|-----|---------------------------------------|--|-----------------------------|---------------------------------------|----------------------|
| 1   | Mokola, Ibadan Oyo state              | Multi-storey building under construction | Oct 1974                    | Excessive loading                     | 27                   |
| 2   | Bamawa Housing Estate Kaduna          | Residential building                     | Aug. 1977                   | Faulty design                         | 28                   |
| 3   | Govt. Sec. Schl. Markafi Kaduna state | School buildings                         | July 1977                   | Carelessness                          | 7                    |
| 4   | Bamawa Housing Estate Kaduna          | 3 residential buildings                  | 1980                        | Faulty design                         | 6                    |
| 5   | Iponri Lagos                          | Uncompleted 4 storey building            | May 1995                    | Excessive carelessness                | 13                   |
| 6   | Ojuelegba Road Lagos                  | Residential building                     | May 1985                    | Rain storm                            | undisclosed          |
| 7   | Lagos Island, lagos                   | Uncompleted                              | July 1985                   | Excessive loading                     | 9                    |
| 8   | Gboko, Benue                          | Residential                              | Sept. 1985                  | Carelessness                          | 1                    |
| 9   | Allen Avenue                          | Residential                              | 1985                        | Carelessness                          |                      |
| 10  | Adeniji Adele, Lagos                  | Residential                              | 1985                        | Carelessness                          | 2                    |
| 11  | Osogbo, Osun State                    | Mosque                                   | May 1986                    | Faulty design                         | 2                    |
| 12  | Ona Street, Enugu Anambra State       | Residential                              | 1986                        | No investigation                      | 2                    |
| 13  | Isiala, Imo State                     | High court                               | 1986                        | Collapse ceiling                      | 2                    |
| 14  | Agege, Lagos State                    | 2 storey building under construction     | May 1987                    | Carelessness                          | undisclosed          |
| 15  | Idusagbe lane, Idumota Lagos          | Residence                                | Sept. 14 <sup>th</sup> 1987 | Ignorant client, no structural design | 17                   |
| 16  | Ikorodu road,                         | Commercial                               | Sept. 1987                  | Storm (nature)                        | 4                    |
| 17  | Calabar, cross river                  | Residential                              | Oct.9 <sup>th</sup> 1987    | Storm (nature)                        | 3                    |
| 18  | Akinwumi street, Mende village ,Lagos | 6 storey hotel                           | Oct. 1989                   | Faulty design                         | No death             |

Source: Iyangba, (2000)

**Table 2: Recent Occurrences of Building Collapse in Nigeria**

| S/N | Building Location           | Date | Suspected Causes  | Remarks (life lost)          |
|-----|-----------------------------|------|---|------------------------------|
| 1   | Mushin, Lagos               | 2000 | Faulty Construction   | Nil                          |
| 2   | Oke-Bola, Ado-Ekiti         | 2000 | Poor quality control, rain storm                                | Nil                          |
| 3   | Ogbagi street, Ikare        | 2001 | Fire disaster   | Nil                          |
| 4   | Odo Ikoyi, Akure            | 2001 | Foundation problem  | Nil                          |
| 5   | Odoso compound, Ikare       | 2002 | Fire disaster   | Nil                          |
| 6   | Ojuelegba, Akure            | 2003 | Poor workmanship & under-reinforcement                          | Nil                          |
| 7   | Stadium road, Akure         | 2003 | No structural members   | Nil                          |
| 8   | Onyearugbulem market, Akure | 2003 | Poor workmanship & under-reinforcement of the cantilevering end | Nil                          |
| 9   | Ebute Meta                  | 2003 | Structural defect   | 8 injured                    |
| 10  | Elias Street, Lagos         | 2004 | Rain storm  | 8 Died                       |
| 11  | Iponri                      | 2005 | Inappropriate Foundation  | Nil                          |
| 12  | Oke Suna, Lagos             | 2005 | Structural degeneration   | 1                            |
| 13  | Broad Street, Lagos         | 2006 | Rainstorm   | Not disclosed                |
| 14  | Ebute Meta                  | 2006 | Structural defect   | 37                           |
| 15  | Oworonsoki                  | 2006 | Faulty Construction   | 1                            |
| 16  | Abuja                       | 2008 | Faulty Construction   | 3 died, 10 injured           |
| 17  | Apongbon                    | 2008 | Structural defect   | 3 injured                    |
| 18  | Ikeja                       | 2008 | Faulty Construction   | Several Injured              |
| 19  | Alade Street, Lagos         | 2008 | Structural defect   | 3 Died,5 Injured             |
| 20  | Ojerinde Street,Idiaraba    | 2009 | Excessive Loading, Faulty Construction                          | 9 Died,3 missing, 21 Injured |
| 21  | Ajgunle, Apapa Lagos        | 2009 | Structural degeneration   | Not disclosed                |
| 22  | Abuja                       | 2010 | Faulty Construction   | Not disclosed                |
| 23  | Garki, Abuja                | 2010 | Overloading   | 23 died, 10 injured          |
| 24  | Kano                        | 2011 | Rain storm  | 6 died                       |
| 25  | Abuja                       | 2011 | Overloading   | 100 died                     |
| 26  | Abuja                       | 2012 | Unsupervised demolition   | 2 died                       |

Sources: Fakere, (2005); Nigeria Daily Newspapers (2000-2003); Ogunsemi, (2002); Oke. (2009); Personal Investigations

## 8. RECOMMENDATIONS

The following recommendations will help reduce the incidence of building collapse in Nigeria:

- All clients or building developers should be compelled to comply with approved building regulations before the construction and demolition of their buildings and that all building construction works should be well designed and supervised by a registered member of Architects' Registration Council of Nigeria (ARCON), Council for the Regulation of Engineering in Nigeria (COREN) and Council of Registered Builders of Nigeria (CORBON). Only competent registered contractors should be employed to execute construction works or projects.
- The professional bodies should hold regular workshops and Continuous Professional Development Programmes (CPDP) in order to improve the professional competence of members.
- There should be a law in every state in Nigeria, providing heavy penalties for contractors who fail to have registered professionals in supervisory capacity in major building projects. Systematic inspection of building works should be enforced at the Local Government level and penalties for failure to comply with the building standard regulation should be provided for.
- All building construction materials like sand, cement, aggregates, reinforcement bars and particularly foundation soil should be tested before commencement of any construction. The mineralogy and alkalinity tests of coarse aggregates should be done to know whether the material contains some percentage of impurities, which deleterious and injurious to cement and reinforcement rods.
- Government should quickly promulgate a National Building Regulation for the elimination or considerable reduction of the incessant collapse of buildings in Nigeria and quick response committee

for investigating incidents of building collapse should be formed.

6. The law governing all approved structural details of buildings, materials and effective supervision by the local Town Planning Authorities should be enforced and not compromised. Section 30(1) of the Nigerian Urban and Regional Planning Decree 88 of 1992, which demands that no building or structure or any part thereof should be erected, converted, altered or enlarged unless a development permit has been obtained by the owner or his agent from the ministry should be enforced. The Government should fund this board established through the decree so as to ensure adequate monitoring of the building approval and construction in our society.
7. Government should exercise leadership in protecting and enhancing the quality of all the buildings by encouraging and enforcing regular maintenance so as to protect human life and properties.
8. All Government functionaries and building developers should be properly trained and encouraged to always give construction of large scale buildings to competent and registered contractors who will also be supervised by a registered Structural Engineering consultant and Architect who preferably have designed such projects.

## 9. CONCLUSION

From the study the following conclusions are made: This study has been able to identify several causes of building failure in Nigeria. It has highlighted several case studies of building failure in Nigeria including casualties of those incidents. This phenomenon dates back to just over a decade after the country's independence. The losses always experienced as a result of building failure are enormous; ranging from loss of lives, several forms and degrees of injuries, loss of properties, etc. The National Building Code is a very important document which will greatly reduce the occurrence of building failures in Nigeria. It is always better to prevent building collapse than to try and salvage an already problematic situation.

The observations of the construction materials of the collapsed Naval building site showed that the FCDA was right to have declared the building unsafe and recommend demolition. This shows poor quality control arising from the adoption of poor mix ratios and the presence of impurities in the aggregates, poor concrete work arising from poor formwork resulting in reduced cross-section of members and inadequate placing and compaction of concrete resulting in voids and poor bonding between concrete and reinforcement. The observations of the coarse aggregate used for the construction of the collapsed building showed that the

aggregate contained certain percentage of impurities like biotite and muscovite, which are injurious to concrete in building structure. The oxidation that occurred as a result of the presence of impurities weakened the concrete over time and reduced the strength. This invariably contributed as part of the reason for its precarious nature.

Consequently, the collapse of Naval building, Abuja where two people died and properties worth millions of naira was destroyed was caused by poor workmanship, lack of thorough supervision during construction, unsupervised manual demolition and defect of the coarse aggregate materials.

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