

# CAUSES OF STRUCTURAL FAILURE OF BUILDINGS IN NIGERIA

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## ABSTRACT

Structural failure of buildings is a common phenomenon in Nigeria and many other developing nations. These failures could stem from design, construction and post-construction stages of a project. The main causes of structural failure in Nigeria can be attributed to non availability of local standards, defective design by quacks, use of sub-standard building materials, poor workmanship, lack of adequate supervision which are largely linked to corruption, etc. The negative effects of structural failure in Nigeria manifest in loss of lives and property, lack of confidence and integrity by the international community on the local building/construction industries. These lead to drain in the nation's economy.

**KEY WORDS:** Structural failure, Buildings, Design, Construction, Local standards, Economy

## INTRODUCTION

"Shelter for all" has been a popular slogan in Nigeria. If this slogan is to be a reality, failures and effects of engineering structures must be seen as one of the challenges for the twenty first century, and have to be addressed seriously by both the Federal Government and the professionals involved in the construction industry. In this paper, attention is given to causes of failures of building structures.

Structural failure of a building can be defined as the state of the building in which it can no longer perform its intended function. The failure of a building structure may be partial or complete collapse. The former involves failure of some structural elements, and the latter involves failure of all

structural elements, including at times the walls. Excessive deflection and cracks in a structure are other forms of failure. Structural failure of buildings is a world wide phenomenon. However, it is more common and frequent in developing countries than in advanced countries. In Nigeria, structural failure of buildings occurs throughout the Federation due to various causes as shown in Table 1. It can be seen from Table 1 that the commonest cause of structural collapse in Nigeria is structural defects (43%) followed by use of sub-standard materials (19%). It is therefore pertinent that causes of structural failure of buildings be identified and solutions to them propounded in order to prevent the negative effects of the structural failure of buildings on the development of the nation.

**Table 1:** Sampled Records of Collapsed Buildings in Nigeria

Date of Incident	State	Type of Building	No. of Lives Lost/Injured	Remote Causes
Dec. 1976	Ondo	1-Storey	8 died	Sub-standard building material / structural defects.
May 1977	Oyo	2-Storey	10 died	Sub-Standard building materials/ structural defects
June 1977	Kaduna	School building	16 died (several injured)	Poor workmanship by contractors
Oct. 1977	Borno	4 – storey	10 died	Poor job performance by contractors
March 1978	Rivers	4-storey	16 died	Lack of concrete devices to hold foundation
June 1982	Ondo	2 – storey	7 died	Heavy downpour/structural defects
Sept. 1983	Lagos	2 – storey	8 died	Structural defects
Dec. 1983	Lagos	4 blocks of flats	6 died	Heavy downpour
July 1985	Lagos	3 – storey	9 died	Heavy downpour / structural defects
May 1987	Lagos	2 – storey	4 died	Structural defects
Sept. 1987	Lagos	3 – storey	8 died	Structural defects
Nov. 1988	Lagos	School building	1 died (others injured)	Structural defects
June 1990	Rivers	School building	50 died (several injured)	Defective design
July 1991	Lagos	1 – storey	3 died	Sub-standard building materials
July 1991	Kano	1 – storey	4 died	Heavy downpour
July 1991	Sokoto	1 – storey	3 died	Heavy downpour/ structural defects
Aug. 1991	Lagos	2 – storey	10 died (several injured)	Poor workmanship/defective design
March 1992	Lagos	Hotel building	2 died (several injured)	Defective design
Oct. 1993	Kano	1 – storey	5 died	Dilapidated structure
March 1994	Oyo	2 – storey	4 died 11 injured	Structural defects
June 1994	Lagos	3 – storey	17 injured	Structural defects
Aug. 1994	Kwara	1 – storey	3 died (4 injured)	Structural defects / poor workmanship
Aug. 1994	Oyo	2 – storey	10 died 74 injured	Structural defects / sub-standard mat.
June 1994	Lagos	4 – storey	4 died (several injured)	Structural defects / sub-standard mat.
Aug. 1994	Ondo	1 – storey	1 died (several injured)	Structural defects / sub-standard mat.

Source: The Guardian Newspaper of July 16, 1998.

### CAUSES OF STRUCTURAL FAILURES OF BUILDINGS

Structural failure of buildings is experienced in all the countries of the world. In advanced countries, a lot of work has been done to find out the causes of structural failures of buildings and their remedies. As a result, there are many Building Research Stations in such countries using highly sophisticated scientific equipment to find lasting solution to the ugly trend of building failure and its attendant problems.

In Nigeria, not much work has been done on structural failure of buildings in terms of research, except some discussion on related topics by concerned individuals in the form of seminars, newspaper interviews and magazine publications. As a result, building failures occur frequently throughout the Federation. The Governments of the Federation appear to adopt a lukewarm attitude in finding ways of fighting this disturbing phenomenon.

The origin of the causes of building failures can be traced to three stages, namely the design, construction and post construction stages.

#### The Design Stage

It is astonishing that in Nigeria almost all the buildings which have been found to be structurally defective have official approved plans. This calls for the question the need for the continued existence of such approval authorities. Through corruption, buildings designed by quacks are approved by the local planning authorities. Prospective building owners prefer to patronize quacks rather than professionals such as architects and structural engineers because they want to 'save' money and therefore, faulty designs are prepared which sooner or later cause failure of buildings.

In an attempt to exploit the shortage of accommodation prevalent in urban areas in the country to make quick money, buildings that have not been designed have been erected on sandy, marshy or made-up grounds without the advice and/or participation of structural engineers. The result has been that the underlying soil collapses with time because of its inability to sustain the imposed weight of the structure.

Inadequate foundation design and care for wind forces and earth movements which tend to induce stresses in the structure are some of the factors responsible for structural failures of various kinds (Lasabi, 1994). In all the building designs carried out by quacks, wind forces and earth movements are neglected even where they constitute a serious factor in the design. The result is that such buildings collapse sooner or later after construction.

In Nigeria, the owner-contractor practice also causes structural failure of buildings. Due to economic reasons, the owner of a building, who is neither an architect nor an engineer, 'designs' and constructs the building himself. By the so-called direct labour system involving the purchase of materials by the owner, and the engagement of a relative of the owner who is a self-styled 'engineer', followed by the daily employment of the owner's dependants, and/or other labourers (masons, iron benders, carpenters and so on) the setting for possible disaster is hatched.

Structural failure may occur in a building if a wrong foundation is adopted, and the workmanship is poor. In all building construction works, particularly high-rise buildings, site investigations are always carried out to ascertain the nature of the soil which will support the foundation of the building. From the site investigation results, appropriate foundation type for the building can be adopted. In Nigeria site investigations for building construction are often seen as a waste of time and consequently neglected. This often results in collapse of the building if a wrong foundation is adopted. Climatic conditions such as rainfall, wind force, temperature variations, and relative humidity also affect buildings in varying degrees. It is

therefore important that adequate provisions be made at the design stage to protect buildings from climatic influence.

Technical inefficiencies on building constructions could be as a result of unrealistic building standards, building regulations, byelaws, and code of practice. Ezeh and Yussuf (2006) identified absence of local standards in the construction industry as being responsible for the incessant building collapses witnessed in the country over the years. The British Standards are adopted in Nigeria, but the climate conditions of tropical Nigeria environment and their effects on properties of building materials are not the same as those obtained in Britain. It is therefore necessary that the Federal Government of Nigeria should initiate action in the establishment of standards and reliable codes of practice for designs and constructional materials in use in the country. Various organizations and institutions such as the Standard Organisation of Nigeria (SON), the Nigerian Institute of Building (NIOB), the Council of Registered Builders of Nigeria (CORBON), the Council for Regulation of Engineering in Nigeria (COREN), and the Nigerian Institute of Architects (NIA) must be actively involved.

#### The Construction Stage

In the Building Industry, the construction team is headed by a qualified builder. Because of his vast knowledge in the industry, the builder coordinates and supervises all the activities on building sites in all the advanced countries of the world. In Nigeria, the architect is seen as the sole authority in the Building Industry. This has made the architect usurp the responsibilities of the builder on building construction sites. This practice often results in construction deficiencies because the architect is not knowledgeable in the quality of materials, the construction process and techniques. The vital precautions to be taken during construction to enhance quality are often ignored leading to poor workmanship which sooner or later results in failure of buildings due to construction deficiencies. It should be mandatory that every building construction team in Nigeria be headed by a qualified builder (a structural based civil engineer or an engineer with building bias and over five years experience).

The failure on the part of a contractor to adhere strictly to the design specifications also causes structural failure of buildings. In an attempt to maximize profit, contractors in Nigeria use cheap and sub-standard construction materials on buildings designed to sustain heavy loads. Ezeh and Yussuf (2006) blamed the collapse of buildings in Lagos State on the use of sub-standard materials and non-adherence to specifications. It is not surprising to discover that contractors use one part of cement to twenty parts of sands (1:20) mix in moulding blocks for building construction though the mix of 1:8 is clearly specified. In some cases, a specified mix of 1:2:4 is replaced with a weaker one of 1:3:6 in casting suspended slabs, beams and columns. In most cases the aggregates used for concrete work are not graded and clean. Dirty water, instead of clean and drinkable water, is always used on building construction sites in mixing concrete for construction. The reinforcement rods used are rusty, and often under-sized. All these are aimed at maximization of profit at the expense of the strength of the building structure. This action, coupled at times with constructional deficiencies, make some of the buildings to collapse during construction or, sooner or later, after construction.

According to Ogunsemi(1994), other constructional factors responsible for building failures are the adoption of improper constructional methods, and lack of proper supervision. On some construction sites, unqualified personnel or self-styled "builders" or "engineers" are employed to supervise the construction works. This results in adoption of wrong construction methods and techniques which subsequently lead to collapse of such buildings because architectural and structural drawings are always mis-interpreted.

### The Post-Construction Stage

Lack of maintenance of existing building structures can cause structural failure of buildings. It is a common practice in Nigeria that once a building has been constructed and occupied, it is left un-maintained for years if not for the whole of its life-span. All structures deteriorate with time. As such, routine maintenance of such structures is essential if they are to perform their intended functions for a long time. A systematic maintenance policy and programme formulation could be effected in Nigeria. "Defective Premises Act" of 1972 enacted in the United Kingdom can similarly be enacted by the Federal Government with regards to:

- (a) Structural integrity and safety;
- (b) The conditions of building materials;
- (c) Equipment and services;
- (d) Layout; and
- (e) The quality of the surrounding environment.

Building owners and tenants should be properly educated on the need for routine building maintenance and its implications. The rate at which the deterioration occurs can be regulated and the ultimate failure of the buildings in whole or in part can be avoided if regular maintenance of buildings is adopted. Adanu (1993) suggested that as a way of reducing structural failures of buildings to the barest minimum and encourage planned maintenance of buildings, the architects and builders should design a Project Information Manual (PIM) which should contain all the essential and necessary information about the construction of a building together with all necessary sources of information for its proper maintenance. He suggested further that building maintenance managers should be constituted to assist architects and builders to discover the causes of design and construction failures and to maintain a feed-back, not only on failures, but also on the good points of structures. Before a building is constructed, appropriate maintenance programme should be carefully conceived and noted.

Mis-use or "change of use" of a building can cause failure of buildings at the post-construction stage. In Nigeria, alterations are carried out on the existing building structures without careful examination of the stage of stability of such structures. As a result, no adequate provisions, if any, are made to avoid destabilization and subsequent failure of the existing structures. According to Ketter (1979), excessive movements, vibrations, erosion, flood, and other similar activities can impair the stability of existing structures, and must always be taken into account whenever any alteration or extension is to be carried out on any existing structure. It is therefore imperative that before any alteration or extension work is to be carried out on any existing building structure; a structural engineer must be consulted for possible alteration or extension specifications. Because excessive vibrations can cause failure of buildings, no residential building should be turned into a discotheque without necessary adjustments on the structural elements of the building.

### EFFECTS OF STRUCTURAL FAILURES OF BUILDINGS ON THE DEVELOPMENT OF A NATION

The failure of any building structure, whether wholly or partially, constitutes a waste, and therefore has negative effects on the development of any nation. In any building project, huge sum of money is invested at both design and construction stages. The failure of such a building results in waste of money and subsequently leads to drain of economy of the nation. Any materials and manpower used in erecting a building structure which later fails cannot be recovered, and therefore constitute a waste.

Any country, in which building failures are frequent, will sooner or later lose credibility internationally. Neighbouring and other countries of the world will lose confidence in the quality and strength of buildings constructed in that country,

particularly those constructed by the country's construction firms. No sensible and serious government of any country will allow any of the construction firms from the country with frequent building failures to undertake any of the building construction projects in its country. Further more, international visits to the country with frequent building failures by indigenes of other countries will be impaired because they will feel unsafe to lodge in the country's hotels.

Another serious effect of building failures is the loss of standard in the international market. Construction materials produced in the country with frequent building collapses will not be accepted in other countries. As such, the standard that could have been attained without structural failures will be greatly lowered, resulting only in frustration.

### CONCLUSION

Building failures in any country can be traced to defects or deficiencies at the design, construction and post-construction stages. In Nigeria, absence of local codes of practice and use of sub-standard materials in order to maximize profits are responsible for structural failures of buildings. There is also the problem of mis-use and lack of maintenance of buildings.

Structural failure in any nation drains the nation's economy. It also results in the loss of construction materials, manpower, confidence by other countries, and standard in the international market. Nigeria should therefore take the issue of structural failures very seriously in order to avoid its catastrophic effects.

### RECOMMENDATIONS

In view of the issues raised in this paper and urgency of the subject matter, the following recommendations are made:

- (1) All building designs of more than one storey high must be accompanied by soil investigation results duly stamped by a licensed engineer as a pre-condition for approval.
- (2) The Nation's approval authorities should be reshuffled, limiting membership to only professionals in the Ministry of Works and Housing.
- (3) The Federal Government should enact a law with severe punishment on both the design team and approval authorities for any building failure due to design deficiencies.
- (4) Professional bodies in Nigeria should produce design codes of practice and standards for construction materials in use in the country based on the country's environmental and climatic conditions. The Federal Government should enact a law making it mandatory that construction teams on all building construction sites in the country be headed by a qualified builder. Severe punishment should be inflicted on both the contractor and supervisor if building failure is due to the use of sub-standard materials, weaker mixes or construction deficiencies.
- (5) All building owners should be properly educated on the effects of non-maintenance and mis-use of existing building structures. A law should be enacted by the Federal Government of Nigeria compelling all building owners in the country to carry out any alteration or extension works on their buildings (storey buildings) with the full participation of a qualified structural engineer and a builder.

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