Original Article

Incessant building collapse: A case of a hotel in Akure, Nigeria

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ABSTRACT This article examines the case of structural failure that occurred recently to a hotel building that was under construction in Akure, Nigeria. A brief history of structural failure in developed countries and how such failures have been reduced to the barest minimum level is also examined. The issue of punitive measures that should be given to offenders were stressed. Proposed preventive measures are also suggested in the Nigerian context in order to reduce and possibly stop the incessant cases of building collapses.

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INTRODUCTION

Failure of structure is not a strange thing in the construction industry all over the world with particular reference to the developing countries, but it is never designed to happen. Incidents of collapsed buildings, collapsed bridges or other structures of various types are not peculiar to Nigeria alone. But, the continuous reports of collapsed buildings most especially in Lagos state area of Nigeria needs to be checked urgently. Arayela and Adam (2001) affirmed that an informal survey conducted by the Nigeria Institute of Buildings (NIOB) has revealed that more buildings may have collapsed during construction in Lagos state than in the rest of the country put together over the past 45 years (1955–2000). There are similar cases of collapsed buildings across the country.

Buildings are structures that serve as shelters for man, his properties and activities. They must be properly planned, designed and constructed to obtain desired satisfaction from the environment. The factors to be observed in building construction include durability, adequate stability to prevent its failure or discomfort to the users, resistance to weather, fire outbreak and other forms of accidents.

Failure is an unacceptable difference between expected and observed performance. A failure can be considered as occurring in a component when that component can no longer be relied upon to fulfil its principal functions. Limited deflection in a floor that causes a certain amount of crack/distortion in partitions could reasonably be considered as defect but not a failure, whereas excessive deflection resulting in serious damage to partitions, ceilings and floor finishes could be classed as a failure (Roddis, 1993).

Failure in buildings could be of two types, namely: cosmetic failure that occurs when something has been added to or subtracted from the building, thus affecting the structure's outlook. On the other hand, structural failure affects both the outlook and structural stability of the building.

Major structural failures of buildings are currently well known in Nigeria because many are described in the print media. These failures become known to the public, because someone is killed or seriously hurt, not just to discredit the structural engineer, the builder and the other professionals involved in the case of the collapsed buildings. This article examines the case of a collapsed hotel building that was under construction in Akure, Nigeria. Unfortunately, buildings fail for many reasons and when they fail, devastating effects are felt more painfully by the inhabitants than the owner. Case studies by Ogunsemi (2002) and Folagbade (2002) show that poor structural design, use of substandard building materials, non-compliance with approved building design, poor workmanship, and lack of qualified and appropriate professionals to ensure quality construction, and cost control among others are major causes of building failures in the contemporary Nigeria.

HISTORICAL REVIEW OF STRUCTURAL DESIGN FAILURES

Structural failure has a much longer history than other types of buildings failures. Cowan (1989) investigated and stated that in the ancient world structural failures were often severely punished. For example, the legal code promulgated by Hamurabi, a Babylonian king (1792–1750 BC), stated among other things that if a builder has built a house for a man and his work is not strong, and if the house he has built falls in and kills the occupant then that builder shall be slain. This shows that there were building collapses in very distant time past and the government then set Code of Laws, first in history. It was a very harsh code dealing with the social structure, industries, law, economic conditions and family life. On the contrary, the Romans attitude to building collapses was not quite harsh. Cowan (1989) affirmed that there was also a tendency to make sure important structures do not fail by using materials generously, and that is, of course, one reason why so many of the Roman architecture survived till today.

In the European Middle Ages, structural materials were often used far more sparingly. The reasons were partly religious and partly economic. People were more inclined to look for supernatural causes of structural failure. With traditional materials, buckling was not a major structural problem, and multi-storey structures were rare. The emphasis was therefore on size of horizontals spans. In the Roman times, the arch and dome came into use for horizontal spans, with a consequent increase of several hundred per cent in the predictable length of spans. Arches, vaults and domes remained an important part of European structure thereafter.

Cowan (1989) further revealed that there was no structural theory of any sort before the fifteenth century, and none that was practically useful before the seventeenth century. How did the builders formulate their factors of safety? One may ask. The failure of arches, vaults and domes of bricks, stones or concrete occurred through the opening up of a sufficient number of joints or cracks to form a collapse mechanism. Collapse occurs

when the line of thickness to span (where '*t*' is the thickness or depth of the structure and '*l*' is its span), *t*/*l*, which depends on the dome. The minimum safe ratio of *t*/*l* could be determined by observing collapses. If the structures fell down, the ratio was too small. It would require a lot of observations, but structural innovation was slow. Egyptian temple structure hardly changed over 3000 years, and the structure of Ancient Roman domes and vaults and of the Gothic cathedrals developed slowly, in each case over a period of several centuries. Columns were usually grossly oversized, but comparatively long horizontal spans for collapse, that is, those that survived, many undoubtedly did collapse.

Scientific concepts began to play a role in structural design from the sixteenth century onwards, but the sizing of buildings remained predominantly empirical until, and well into nineteenth century. The main causes of structural failure were the inadequacies of these empirical rules, although there were other causes as well. Surprisingly, outright mistakes are still a major cause of failure today, they presumably always have been a cause, although one that might get lost within the inaccuracies of empirical rules. Poor construction has always been, and still is a cause of structural failure. A major cause of structural failure in the developing countries of the world is an inadequate understanding of the structural consequences of a new building technology. This would have been regarded as a minor cause before the eighteenth century when building technology changed very slowly, so that there was ample time to study the consequences of new methods and materials. Thus, there has been a very major change in the causes of structural failure. Lack of adequate theories and inadequate factors of safety had been the main cause of failure before the eighteenth century. No major failure since the end of the Second World War in 1945 can be attributed to that as asserted by Cowan (1989). In that area, the developed countries have therefore been spectacularly successful. Major structural failures are remarkably rare these days in the developed countries of the world; exceptions are, however, noticed in cases of man-made disasters such as terrorist attacks like the September 11, 2001 attack on the twin towers of the World Trade Centre in New York (Gjelten, 2008), or natural disasters such as the Tsunami disaster of December 26, 2004 (Tsunami, 2008).

STRUCTURAL FAILURE OF BUILDINGS IN NIGERIA

According to Oyewande (1992), causes of building failures in Nigeria are attributed as follows; 50 per cent of the causes being owing to design faults, 40 per cent to fault on construction site and 10 per cent to product failure. Building failures could be as a result of defects under any or all of the stages in design approval of drawings and the supervision/construction stage. Almost all the tragic incidents recorded in Nigeria have been blamed on either the developers for failure to comply with building regulations, or professional builders, architects and engineers, as well as government agencies whose duty is to ensure compliance. Fredericks and Ambrose (1989) suggested that the overturning of structures owing to heavy wind loads, sliding of structures due to lateral loads are major types of failures of buildings. In addition, Akinpelu (2002) categorised the following as the major causes of structural failures: environmental changes, natural and man-made hazards, improper presentation and interpretation in the design. Richard (2002) opined that deterioration of reinforced concrete could occur as a result of: corrosion of the reinforcement caused by carbonation and chloride ingress, cracking caused by overloading, subsidence or basic design faults, and construction defects.

Those that are usually first accused of professional negligence are the architect, structural engineer, the contractor and planning authority officials. The inability of the

architect and especially the structural engineer to properly carry out his own part of the work to see to the fact that the right number and sizes of reinforcements are used often times lead to collapse of buildings. The inability of the Town Planning Authorities to ensure that architectural and structural designs (and structural calculations) conform to design principles before approvals are given can also be attributed to structural failures. From past occurrences, the town planning authority that ought to enforce its development control regulations can hardly be seen to be firm in enforcing its regulations, so that the incidences of collapsed buildings are prevented or abated. Some officials of the planning authorities sometimes compromise their position and allow developers/landlords to recklessly contravene development control regulations. Added to this dimension is the very slow pace at which the planning authorities enforce the law. During construction, the consultants and the contractors must have competent persons on site to monitor work as it progresses, failure to do so could lead to bad or poor workmanship and therefore results in structural failure. Often, developers and landlords of collapsed building try to cut corners in the use of materials for construction. They deliberately deviate from what was approved for them and begin to contravene in the process of construction.

THE COLLAPSED HOTEL IN AKURE

Several cases of structural collapse of buildings are reported in Nigeria, particularly in Lagos and Abuja, where a lot of construction works are presently going on. Some of the reported cases have to do with buildings that have lived beyond their life spans, others are being renovated, some were under construction (like the case in this article), whereas other buildings were already occupied and suddenly the collapse occurs.

The collapsed hotel building is located after Oba-Ile Housing Estate, on the way to Oba town in Akure, Nigeria (Figures 1–5 show different views of the collapsed hotel). It was observed that substandard materials were used in the construction of the hotel building. The quality and quantity of cement used in the construction was very poor. The concrete mix was not evenly distributed. From observation, one could easily assert that the concrete was mixed manually, which made the non-even distribution of the cement, sand and coarse aggregate possible. The reinforcement steel bars used in the construction of this building had low area of steel in the beams, columns and floor slabs,

Figure 1: Concrete slab full of cracks and disintegrating from steel reinforcement.

Figure 2: The hotel under construction that collapsed along Oba-Ile road, Akure, showing the wreckage.

Figure 3: Structural failure: As a result of substandard materials used.

Figure 4: Another view of the collapsed hotel building.

Figure 5: Clearing debris on the collapsed hotel building site.

which eventually gave rise to cracks that led to the collapse of the structure under the massive weight of the dead loads.

Proper supervision was not given to this hotel project both from the professionals involved in the project and the Housing Authority officials in charge of the housing estate where the incident occurred. When the authors of the article went to the Housing Authority office to enquire if the owner of the collapsed hotel had obtained approval in terms of the architectural and structural drawings from the Housing Authority before commencing on this project, the officials claimed ignorance of any approval given to the developer. There were no traces of the approved drawings in the archives of the Housing Authority. In addition, quacks were used for the design, supervision and construction.

CAUSES OF BUILDING COLLAPSE IN NIGERIA

The causes of structural failure in Nigeria are numerous, and can be complex depending on the type and complexity of the structure. According to Folagbade (1997), the inability of the engineer to carry out proper site investigations, inability to calculate design loads accurately, inability to prevent the use of substandard building materials, inability of the engineers/planning authority to have good design layout and inability of the engineers to understand structural analysis and design principles lead to structural failures.

The possible causes of building collapse in Nigeria are listed below:

- the absence of soil test report;
- structural designs and details handled by quacks;
- absence of co-ordination between the professional bodies and the local town planning authority;
- lack of adherence to specifications by the unqualified and unskilled personnel;
- poor and bad construction practices;
- the use of substandard building materials;
- lack of proper supervision by professionals;
- inadequate enforcement of the existing enabling building regulations;
- illegal conversion of buildings which often lead to structural deficiencies;

- flagrant disobedience of town planning regulations by developers/landlords;
- the compromising attitude of some workers of the town planning authority;
- lack of sanctions against erring professionals and landlords.

Report of soil test of any site is very useful to the architect and the structural engineer. This will enable them to specify what type of foundation is to be used. And also they will know what precaution to take in order to avoid collapse of the structure because of settlement and other foundation problems. In some cases, buildings that are above the ground floor level do not have structural designs and details, and often times lead to failure of the structure. On the whole, the professional bodies such as Nigerian Institute of Architects, the Nigerian Society of Engineers, the NIOB and the Planning Authorities, who represent the government share in the blame (as stated in the possible causes of building collapse above) that cause collapse of buildings in Nigeria.

PROPOSED PREVENTIVE MEASURES

Having considered the remote causes of collapse building structures in Nigeria, remedial actions such as those listed below could be used as preventive measures. Preventive actions are those that are taken when design and construction standards are appropriately stated, adhered to and tailored by the professionals and the planning authority officials.

In order to reduce the problems of collapsed buildings to a manageable proportion, the following preventive measures are proposed:

(i) Stringent penalties should be applied for those responsible for collapse of buildings, particularly when loss of lives is involved.
(ii) Town Planning Authorities should be adequately staffed and equipped with professionals in the construction industry. For effective monitoring of projects during and after construction.
(iii) Continuing professional development should be emphasised by both the professional bodies and the government on modern trends in the building industry. To keep members of the building industry abreast with new trends in construction.
(iv) Government should provide an enabling law for the training, and effective control of artisans and craftsmen in the building industry.
(v) Government should screen those getting involved in housing projects. For any structure more than a bungalow, a structural engineer must be involved.
(vi) Construction work should only be carried out by registered contractors and supervised by registered architects, engineers and builders rather than engaging unskilled contractors.
(vii) Clients should obtain approvals before they begin construction. At the same time, they should work with the approved drawings and specifications. Any alterations should be approved before their implementations.
(viii) To promote the safety of buildings therefore, a holistic approach is required whereby all relevant outfits and organisations must be involved apart from the recognised professional bodies.
(ix) A regular audit of defective structures must be carried out and such structures marked for demolition should be demolished before it causes havoc on lives and properties.
(x) Government at all levels should intensify public enlightenment, placing emphasis on how building disasters could be prevented rather than managing situations which might be costlier.

CONCLUSION

This article has been able to identify major causes of building collapse in Nigeria with particular reference to the collapsed hotel building in Akure. It recommends some preventive measures in order to ameliorate the incessant occurrences of collapsed buildings in the country in general. It identified the fact that there are lapses on the part of the professionals in the building industry and in the Town Planning Authorities. The various professional bodies in the building industry also have a duty to constantly educate and remind their members of the ethics of the profession. The authors strongly feel that the enactment and implementation of the National Building code has no substitute, with this, construction of buildings will be effectively regulated. The authors believe that if the recommended preventive measures are taken seriously, then the issue of collapsed buildings in our society will be ameliorated or completely eradicated, as is the case in the developed nations.

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