Impact of Reliable Built Structures in Driving the Sustainable Development Goals: A look at Nigerian Building Structures

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***Abstract*—The bearing of lasting built structures in driving the Sustainable Development Goals (SDGs) cannot be overemphasized. The SDGs agenda is a plan of action for eradicating poverty among the people of the world, strengthening universal peace and laying the foundation for sustainable development and prosperity for all. The quality of built structures in an environment defines the level of advancement attained by the society, for which the quality of structures that will lay the base for sustainable development must be reliable. No meaningful development can be achieved without reliable built structures. In fact, all the 17 SDGs need consistent built structures to be achieved. This paper researches on the reliability of built structures as a base for sustainable development with particular emphasis on Nigerian building structures. Statistical method is used to analyze data on failed building structures. Results obtained point to the fact that the failure rate and the casualty rate of Nigerian building structures are very high. As safety of human lives is implicitly embedded in the SDGs, much have to be done to raise the standard of building that will contribute to the achievement of the SDGs.**

Keywords—Building Collapse, Building Structures, Casualty Rate, Failure Rate, SDGs

I. INTRODUCTION

Sustainability could be defined as an ability or capacity of something to be maintained or to sustain itself. It's about taking what we need to live now, without jeopardizing the potential for people in the future to meet their needs [1]. The aspiration of the world for sustainable development have kept the United Nations busy for quite a lot of time now. The latest of the UN efforts gave rise to Sustainable Development Goals (SDGs) in 2015. According to [2], the Sustainable Development Goals (SDGs), officially known as "Transforming Our World: the 2030 Agenda for Sustainable Development", are an intergovernmental set of aspiration Goals with 169 targets. The story of the SDGs can be traced to 1972 when the United Nations Human and Environment Conference considered the rights of the human family to a healthy and productive environment [3]. That led to the creation of the World Commission on Environment and Development. In 1992 the first UN conference on Environment and Development held in Rio came up with the first agenda for Environment and Development known as Agenda 21. Agenda 21 is the forerunner to The Future We Want [4] which agreed on the key themes on poverty eradication, energy, water and sanitation, health, and human settlement. Agenda 21 and The Future We Want gave birth to the Millennium Development Goals (MDGs, 2000) which officially ended in 2015 before the takeoff of the SDGs.

The essential challenge of the post MDGs development agenda is to ensure that globalization remain a positive force for all the worlds' peoples of present and future generations. The enormous potentials of globalization are at presently very unevenly shared. The continuous striving for improvements in harnessing materials for human use is threatening the limits of the natural resource base unless there is a radical shift towards more sustainable patterns of consumption and production and resource use. Obstinate struggles for scarce resources have led to situations of conflict, hunger, insecurity and violence, which in turn hold back human development and efforts to achieve sustainable development [4]. The post MDGs agenda for sustainable development focuses on inclusive Social Development, Environmental Sustainability, Inclusive Economic Development, and Peace and Security.

As a successor to the Millennium Development Goals (MDGs), the SDGs builds upon the values agreed upon under the UN Resolution: The Future We Want [4]. The SDGs are articulated in 17 goals with 169 targets entailing a wide range of sustainable development issues.

The goals are poverty, food, health, education, women, water, energy, economy, infrastructure, inequality, habitation, consumption, climate, marine-ecosystems, ecosystems, institutions and sustainability. Goal number 1 can be easily measured by the quality of built structures available in a society. Goals number 2, 3, 4, 6 and 7 need the reliable built structures to achieve. Sustainable economic growth, goal number 8 needs the activities of the built sector to achieve. Activities of the built sector have always propelled national economies and in most cases contributing to more than 20% of the GDP. Goals number 9 and 11, i.e. resilient infrastructure and resilient human settlements are fully built environment goals. Other goals on climate change, sustainable ecosystem

for future development and sustainability will go on to affect how future structures are to be built. From this brief analysis, it is very evident that the contribution of the built environment in achieving the SDGs cannot be over-emphasized. Having established the relevance of built structures in achieving the SDGs, the paper now takes a look at Nigerian building structures to see if they are resilient enough to contribute to the achievement of the SDGs.

A. A Look at Nigerian Building Structures

In Nigeria, the occurrence of Structural Failure has been problem of major concern in development of the nation as the rates of their incidence and the degree of the losses both in terms of death and properties are becoming disturbing [5]. Structural failure is the inability of a building to undertake its structural functions [6]. This may be in form of slackening, winding, crumpling, cracking, deformation or wearing of structural elements of a building.

The importance of buildings to man's survival and endurance both as a residence and for his activities is significant [7]. The conservation of the existing housing stock and those still to be constructed remains a great challenge to Nigeria. In spite of the numerous available Nigerian professionals of construction industry that the cases of building collapse have not abated in the recent years is very worrisome. The rising cases of building collapse in Lagos State, particularly around the Lagos Island axis and Lekki testifies to the sorrow state of buildings in Nigeria.

In one of the most recent cases, a five storey building under construction in Kushenla Road, Ikate Elegushi Lekki area of Lagos State collapsed on the 8 of March, 2016, killing more than 30 people. The collapsed building was served a contravention notice for exceeding approved floors and thereafter sealed by Lagos State Building Control Agency, but the owners unsealed and proceeded to build beyond the approved 3 storey, until the collapse occurred. In the collapsed scene, two floors sank into the ground. While investigations into the true causes of the collapse is ongoing, built environment professionals all point accusing fingers to the common causes of building collapse in Nigeria such as lack of due process, due diligence, poor foundation, as well as the use of substandard materials.

Among the principal causes of building collapse in Nigeria is the use of substandard materials, in particular poor quality concrete and reinforcing bars [8-9]. This particular problem of substandard materials is becoming very evident such that Nigerian Government agencies are bracing up to tackle the problem. According to the Standards Organization of Nigeria [10], most of the re-enforcement bars in the markets are deficient and do not comply with diameter, length and carbon contents standard, among others. The standard diameters for reinforcement bars of 25mm, 16mm and 12mm, are commonly substituted by 23.4mm, 14mm and 10mm respectively. The standard length of 12m is commonly substituted for 10m while the carbon contents exceed 0.37%.

II. METHODOLOGY

For the study of the state of Nigerian buildings, structured questionnaires were given to professionals and non-professionals that have experienced or witnessed building collapse in the past. Visual inspections of collapsed buildings and visitations to sites of building collapse cites were conducted to obtain firsthand information on the causes and effects of building collapse. Samples of available commercial steel reinforcement were collected and analyzed for conformity sizes with the standard diameters prescribed in design. Secondary data on building collapse in Nigeria were also collected from the professional bodies of the built environment. Analysis of the data collected were performed with MS Excel statistical tools.

III. RESULTS AND DISCUSSION

50 questionnaires were shared to the professionals in building industries and 41 of them were returned and were valid for analysis while 50 other questionnaires were given to non-professionals that have had firsthand experienced of building collapse in the past. The distribution of the questionnaires among the professionals can be seen from the pie chat in figure 1.

The professional respondents were mainly Architects and Structural Engineers. Over 50% of the professionals involved have been engaged in the construction industries for more than 10 years. From the analysis of the data collected, it emerged that the possible causes of building collapse in Nigeria are corruption, substandard materials, absence of site investigation and faulty foundations, poor building plans approval procedure, poor supervision and construction procedures, environmental factors such as rain storm and flood, wrong usage of structures, Contractors' inefficiency in terms of poor methods of construction and technology, urban population surge which inspire greedy landlords to erect unhealthy structures that collapse, fire outbreak and unforeseen modes of failure. Figure 2 summarizes the common causes of building collapse in Nigeria.

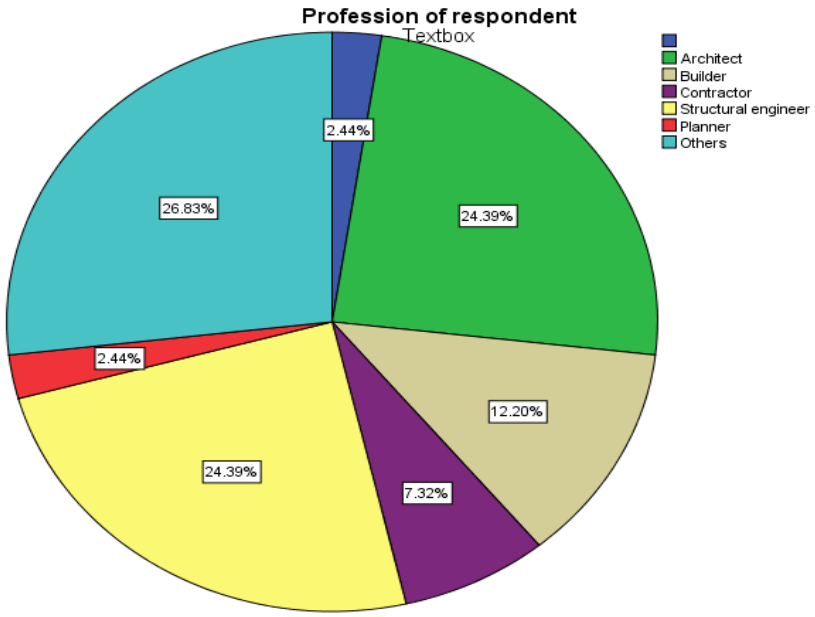

Fig. 1. Pie Chart Showing the Profession of Respondents

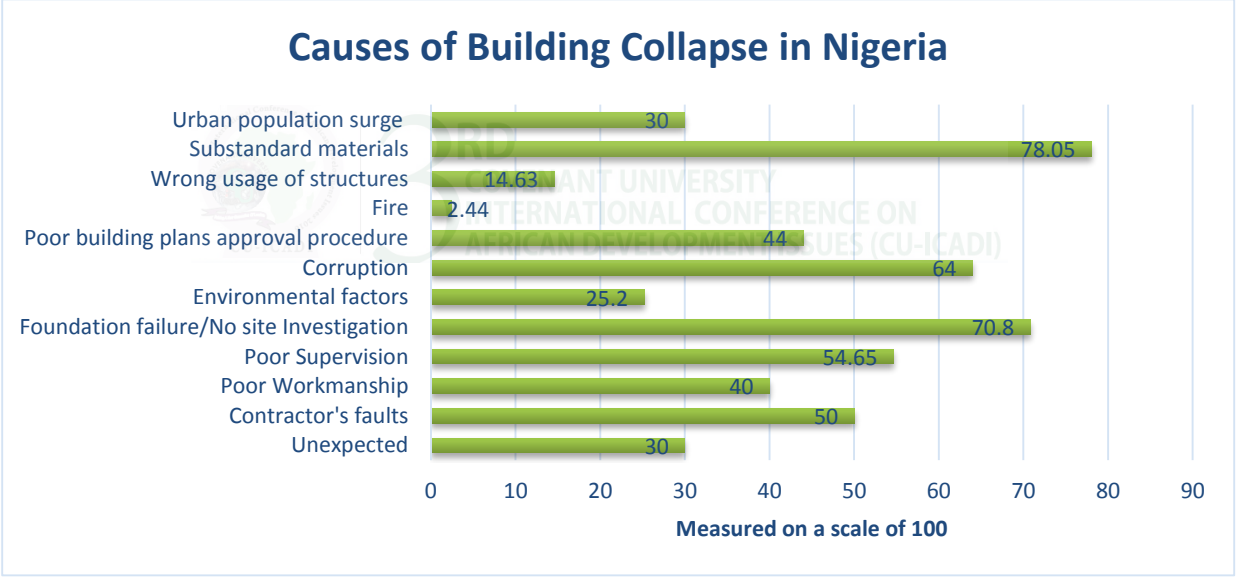

Fig. 2. Causes of Building Collapse in Nigeria

Common pre-collapse signs verified in this research include excessive cracks, deflection, settlement and vibrations. Among the effects of building collapse, ranked very high loss of human lives, human injuries, damage to properties, lost of economic resources and means of livelihood, emotional stress and poor national reputation.

Analysis of data on 18 collapse cases verified in Nigeria in the past 18 months (from September 2014 to March 2016) showed over 178 mortality rate. This is so high in terms of human loss and the grave repercussions that accompanied the gravely injured and the loss of properties and means of livelihood.

Scrutiny of variations of diameters for commercially available reinforcement bars from 25mm to 23.4mm, 16mm to 14mm and 12mm to 10mm translates to an average loss of reinforcement bar cross-section area of about 12.4%, 23.5% and 28% respectively with respect to the design prescriptions. This leads to gross under-reinforcement in conjunction with the low-strength reinforcement commonly available in the nation. This portend a great risk for the reinforced concrete structures

as the possibility of achieving ductile structures is highly compromised.

IV. Conclusion

Results obtained from this research point to the fact that the casualty rate of Nigerian building structures is very high. The analysis of the variation of diameters of reinforcing bars reveals great danger to the structures where these reinforcements are used. This gross material defect and other ones which the SON is striving to achieve, like the improved calibration status of the weighing equipment in the steel factories, compulsory chemical analysis on all steel reinforcement batches and the replacement of all non- electric arc furnaces in Nigeria within the next 6 months will all help to shore up the danger of building collapse. Also, the move by the Lagos State Government in the recent time to vigorously enforce the building and construction regulations in the State is highly commendable and will go a long way to checkmate this gruesome incidence of building collapse. As the safety of human live and the wellbeing is implicitly embedded in the SDGs, much still need to be done to raise the standard of building structures that will contribute to the achievement of the SDGs.

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