The trend of collapse of buildings in concrete materials in Lagos State, Nigeria (2013-2019)

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Abstract. Buildings are essential structures that provide mankind with accommodation in the form of offices, factories, residences, etc. Building Infrastructure aids to increase the Gross domestic product of nations by meeting the present needs as well as helping in the reduction of future deficiencies. Unfortunately, in developing countries like Nigeria, regular occurrence of collapse of buildings in concrete materials have dealt a terrible blow to the nation, leading to losses in the form of death and damage to properties. This study aims to show the trend within the period of 2013 to 2019. This study used statistical methods to assess the fatality rate, types of buildings affected, frequency of occurrences and the causative factors. The result indicates that the year 2017 witnessed 14 collapse incidences making it the highest within the study period in Lagos state. Furthermore, 204 persons lost their lives in 2014, making it the highest within the period. The results obtained showed that the risk of collapse and fatality rises as the building height goes up and when unauthorized floors are added to an existing building.

Keywords: Building collapse, Concrete materials, Lagos State, Poor construction quality, Substandard materials

1. Introduction

Globally, crises such as insecurity, disasters, ill-health and environmental degradation have continued to pose a significant challenge to the human race. Disasters, both man-made and natural, have hindered the attainment of Sustainable Development Goals (SDGs) in most countries. The impact is mostly felt in under-developed and developing nations where capacities to manage such is lacking [1]. One of such frequently occurring disaster in Nigeria is building collapse [2, 3]. Researchers in[1] stated that building collapse is a significant threat to the development goals of Nigeria. Buildings are essential amenities because they provide man with accommodation in the forms of offices, factories, residences, etc. They play a fundamental role in the economy of nations by offering jobs for different professions, class and cadres of people [4]. Building infrastructure ought to increase the National Gross Domestic Product (GDP) by meeting present needs as well as help in the reduction of future
deficiencies [5]. Falobi[6] defined building collapse as the loss in bearing capacity leading to the sudden falling apart of the structure. Buildings are designed to be safe and avoid failure, which could lead to death and damages to property [7]. The effect of building failures has the potential of inhibiting the development of any society [8]. Due to the importance of buildings to the society and the need to contribute towards achieving the SDGs, this research evaluates the trend of building collapse within the period of 2013 to 2019 in Lagos State, the epicentre of building collapse in Nigeria. Statistical approach was used to evaluate the fatality rate, types of houses involved, rate of incidences and the relevant causes.

2. Literature Review
The government of Nigeria has over the years made concerted efforts in increasing the quantitative but not qualitative provision of houses for its citizens and residents [9]. They have done this through budgetary and policy requirements. However, the building collapse phenomenon has continued unabated ever since the first recorded case at Ibadan in 1974 [10]. Available reports show that in Nigeria not fewer than 379 deaths, several undiscovered deaths, injuries and properties worth billions of naira have been lost due to collapse between 1980 and 2005 [11]. In recent years, the situation has become more worrisome due to the incapacity to manage the disaster, frequency of occurrence and increase in the number of casualties. In recent times, two terrible collapse cases have involved church buildings. The first occurred in Lagos on September 2014 with total fatalities of 116 people while the second happened in Uyo on December 2016 with a record of 160 people dead [2]. Causes of building collapse include sub-standard materials, insufficient supervision, greed, corruption, non-adherence to building code, etc. [12]. The consequences of building failure are usually very fatal. They include economic losses, loss of lives, disability, damage to properties, increase in the number of homeless people, loss of time and valuable resources [13, 14]. Due to the frequent collapse of buildings, conserving the existing and future building stock is a significant challenge in Nigeria [14]. The work in[15] reported that 20.3% of collapse cases recorded zero death, 44.4% of collapse cases was responsible for 1-5 deaths, 26% of collapse cases induced 5-20 deaths and more than 21 people in 9.3% of the collapse cases in Nigeria. The number of fatalities further buttresses the severity of the problem and in situations where no life was lost, physical injuries are equally as severe. Apart from the deaths, any incident of building collapse leads to loss of properties and productive time which could hurt the socio-economy of any society [10].

The building collapse prevention guild (BCPG), which is a body composed of professionals in the construction industry in Nigeria has reported that 80% of construction projects in Lagos State are carried out by charlatans with no involvement of professionals [16]. It has urged the Lagos State government to give attention to buildings in the State, and provide particular attention to buildings at Mushin, Ebute-Metta, Lagos Island, Bariga and Ajegunle. Reports from BCPG also indicates that in 2019 Lagos state had 17 collapse incidences making it the highest and accounting for about 39% of total failure in the country [17]. According to the report, 59% of the collapsed buildings in Lagos state were existing structures while 41% were under construction. 10 were partial collapse while seven were total collapse cases.

It is very disheartening to notice that almost all the building collapse that occur in Nigeria affect structures built with concrete materials, in the form of reinforced concrete or sand-crete blocks of cement materials. This is coming at a time in which sustainability is the watch word across all the nations of the earth. Achieving Sustainable Development Goals (SDGs) is vigorously being pursued all over the world, while buildings and infrastructures needed to improve the quality of human lives are overly collapsing in Nigeria. In other to improve the efficiency and sustainability of built structures, researchers are coming up with innovative materials obtained from intelligent material combinations [18 – 20] or from the transformation of waste materials to useful resources [21- 23].
Another approach to improve the stock of build structures is through sustainable structural health monitoring and continuous structural damage assessment and maintenance [24-26].

Lagos State is located in the south-western area of Nigeria. It holds the status of being the smallest yet possessing the most populous conurbations in the world. It is Nigeria’s largest urban area, with 20 local government areas (LGA) and 57 local council development area (LCDA). Researchers in [27] while assessing the building collapse cases in Nigeria between 2009-2019 noted that the Southwest had 34 cases of building collapses making it the highest number of failures (60% of total failures within the period) with 132 deaths (64% of entire death within the study period). The debris of a collapsed plaza is shown in Figure 1, while Figure 2 shows a typical rescue operation taking place at a collapsed site at Lagos Island.

This study, therefore, seeks to analyse the trend of building collapse in Lagos State, Nigeria, between 2013-2019. It is believed that the results of this research will help the stakeholders to be more informed of the impact of building collapse in the society. The impact of these collapses is enormous. Hence, adequate measures need to be taken by all involved stakeholders in the construction industry to stop this trend.

Figure 1: A collapsed plaza in Lagos state. Source: [16]. The Punch, https://punchng.com/nigeria-recorded-43-building-collapse-cases-in-2019-report/
3. Methodology
The data used for this study was the recorded structural collapse between 2013-2019, obtained from journals, conference proceedings, reports and newspapers, Lagos State Physical Planning and Development Authority and the Lagos State Material Testing Laboratory. They were reviewed to obtain relevant data such as fatality rate, frequency of occurrence, number of buildings affected, locations, major causes, etc. The data obtained were analysed using descriptive as well as mathematical statistical stools. The study area chosen is Lagos State and is shown in Figure 3.

![Figure 3: Lagos State map (Link, 2017).](image)

Figure 3: Lagos State map (Link, 2017).

From the secondary sources, data pertaining to causes of collapse in Lagos State over the past years were gathered. In addition to this, the dates as well as the last type of building, number of lives lost, number of those injured and their dates of occurrence were assembled. These data were organized into tables and charts. The statistical analysis carried featured charts showing the effect of building collapse, types of buildings and their frequency, locations and causes of collapse.

4. Results
Table 1 below shows the year and the number of persons affected, including death, injured and rescued. The types of buildings and their frequency of occurrence within the study period is shown in Table 2. Information of the number of building collapse each year is shown in Table 3. Specific locations and their frequency of occurrence can be seen in Table 4. Table 5 presents the most frequently adduced causes of building collapse for the study period.

5. Discussion
From table 1, it can be seen that 2014 had the highest fatality rate of 232 persons while only four persons were confirmed dead in 2019. Table 2 showed that three-story buildings were the most frequently collapsed type of building with a value of 11 and was closely followed by four-story buildings with nine collapses. From here, it can be seen that that the risk of collapse and fatalities increases as the building heights rises. Table 3 showed that within the study period, 2017 was the year with the highest number of building collapse with a value of 14 which is half the total number of
failures within the study area and period. From table 4, it appears obvious that Lagos Island is the area with the highest incidence of collapse. This may not be unconnected with the fact that they host a higher number of high-rise structures and that many of the buildings in the area are aged and unmaintained buildings. Based on table 5, it can be seen that between 2013 and 2019, the primary cause of building collapse in Lagos State was the addition of extra floors to pre-existing structure not designed for such. Efforts must also be made at curtailing the incessant availability of substandard building materials in the Nigerian market.

Table 1: Number of persons affected by structural collapse between 2013-2019 in Lagos state

| YEAR | NUMBER OF DEATHS OR FATALITES | NUMBER OF INJURED PERSONS | NUMBER OF RESCUED PERSONS |
|------|-----------------------------|--------------------------|--------------------------|
| 2013 | 16                          | 35                       | 0                        |
| 2014 | 232                         | 0                        | 0                        |
| 2015 | 120                         | 131                      | 11                       |
| 2016 | 36                          | 0                        | 0                        |
| 2017 | 31                          | 64                       | 52                       |
| 2018 | 4                           | 0                        | 36                       |
| 2019 | 34                          | 72                       | 7                        |
| TOTAL| 439                         | 302                      | 106                      |

Table 2: Types of building collapse with their frequency of collapse.

| TYPE OF BUILDING       | FREQUENCY | PERCENTAGE |
|------------------------|-----------|------------|
| Others                 | 4         | 9.76       |
| Unidentified           | 5         | 12.20      |
| Three storey building  | 11        | 26.83      |
| Four-storey building   | 9         | 21.95      |
| Five-story building    | 4         | 9.76       |
| Six-storey guest house | 2         | 4.88       |
| Bungalow               | 4         | 9.76       |
| Church                 | 2         | 4.88       |
| Total                  | 41        | 100.0      |
Table 3: Number of building collapse per year in Lagos state between 2013-2019

| YEARS  | NUMBER OF BUILDING COLLAPSE | PERCENTAGE |
|--------|-----------------------------|------------|
| YEAR 2013 | 5                              | 12.20      |
| YEAR 2014 | 2                              | 4.87       |
| YEAR 2015 | 3                              | 7.31       |
| YEAR 2016 | 2                              | 4.87       |
| YEAR 2017 | 14                             | 34.15      |
| YEAR 2018 | 2                              | 4.87       |
| YEAR 2019 | 13                             | 31.70      |
| Total    | 41                             | 100        |

Table 4: Specific location of collapse and their frequency

| LOCATION                  | FREQUENCY | PERCENTAGE |
|---------------------------|-----------|------------|
| Lagos, Alagbado           | 1         | 2.43       |
| Lagos Island              | 13        | 31.7       |
| Lagos, Alaba Market       | 1         | 2.43       |
| Lagos, Lekki              | 6         | 14.63      |
| Lagos, Illasa             | 1         | 2.43       |
| Lagos, Ebute Meta         | 3         | 7.31       |
| Lagos, Surulere           | 2         | 4.87       |
| Lagos, Ikeja              | 1         | 2.43       |
| Lagos, Agege              | 2         | 4.87       |
| Lagos, magodo             | 2         | 4.87       |
| Lagos                     | 8         | 19.51      |
Table 5: showing the reasons of building collapse and their frequency

| CAUSES                                      | FREQUENCY | PERCENTAGE |
|---------------------------------------------|-----------|------------|
| Substandard building materials              | 7         | 17.07      |
| Defective and illegal construction          | 5         | 12.20      |
| Additional storey                          | 8         | 19.51      |
| Distressed building                        | 5         | 12.20      |
| False Prototype and fake COREN stamps       | 1         | 2.43       |
| Natural disaster Rain                      | 1         | 2.43       |
| Noncompliance to building regulation       | 2         | 4.87       |
| Unidentified                               | 1         | 2.43       |
| Under construction                         | 3         | 7.32       |
| Faulty foundation                          | 1         | 2.43       |
| Collapsed building fell on it               | 1         | 2.43       |
| Staircase collapse                         | 1         | 2.43       |
| Defiance                                    | 1         | 2.43       |
| Mudslide                                    | 1         | 2.43       |
| Others                                      | 3         | 7.32       |
| Total                                       | 41        | 100.0      |
6. Conclusion
The rate of building collapse especially in Lagos State has become a concern to all. The impact of such collapse is tremendous leading to loss of lives and properties. It was observed that most collapses occurred within the Lagos Island metropolis possibly due to high rise buildings in the area. The year 2017 within the study period, witnessed the highest number of collapses in Lagos state. However, 204 persons lost their lives in 2014, making it the highest within the study period. It is recommended that regulatory bodies like town planning authority assess buildings from time to time to prevent this reoccurring disaster and take stiff measures to punish defaulters in order to serve as a deterrent to others. Standard materials should be used and professionals should be involved in construction projects. Further studies can be carried out to assess the trend of collapse in recent time.
From this research, it can be seen that the risk of collapse and fatality becomes high as the height of buildings rise. It is also very evident to notice that the adding of unauthorized floors to an existing building can be very catastrophic. For these reasons, it is very important that only qualified professionals handle building projects, more especially for high-rise buildings. It is also vital that government agencies saddled with the oversight of building construction projects live up to the expectations of their mandate. These measures will help to reduce the risks of building collapse and fatalities.

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References
[1] Egunjobi, L and Adebayo, A. (2016) Incidence of Building Collapse in Nigeria: Case of Lagos State, OIDA International Journal of Sustainable Development 107-114.
[2] Akpabot, A. I., Ede, A. N., Olofinnade, O. M., Bamigboye, G. (2018). Predicting buildings collapse due to seismic action in Lagos state. International Journal of Engineering Research in Africa, ISSN: 1663-4144, vol. 37, 91-102. doi: 10.4025/www.scientific.net/JERA.37.91
[3] Ede, A. N., Olofinnade, O.M., and Awoyera, P.O. (2018). Structural Form Works and Safety Challenges: Role of Bamboo Scaffold on Collapse of Reinforced Concrete Buildings in Nigeria, International Journal of Civil Engineering and Technology 9(9), pp. 1675-1681.
[4] Ayodeji, O. (2011) An Examination of the Causes and Effects of Building Collapse in Nigeria, Journal of Design and Built environment 9, 37-47.
[5] Brundtland, G. (1987). Our Common Future, Report of the World Commission on Environment and Development, Oxford, UK.
[6] Falobi, F. (2009). Information on http://dailysunnewspapers.ng
[7] Ede, A. N., Olofinnade, O.M., Bamigboye, G., Shittu, K. K. and Ugwu, E. I. (2017) ‘Prediction of fresh and hardened properties of normal concrete via choice of aggregate sizes, concrete mix-ratios and cement’, International Journal of Civil Engineering and Technology, Vol. 8, No. 10, pp.288–301.
[8] Akpabot, A. I., Ede, A. N., Olofinnade, O. M., and Bamigboye, G. O. (2019), Risks of seismic activities on built environment in Nigeria. International Journal of Environment and Sustainable Development, 18(3),259–269
[9] Oke, A. (2011) An examination of the causes and effects of building collapse in Nigeria, Journal of Design and built environment, Vol. 9, December 2011, pp. 37–47.
[10] Windapo, A. O. and Rotimi, J. O. (2012). Contemporary Issues in Building Collapse and Its Implications for Sustainable Development, Buildings, 2, 283-299.
[11] Windapo, A. O (2006). The threat of building collapse on sustainable development in the built environment, Sustainable Development Conference, Jos, 59-65.
[12] Ede, A. N. (2010) Building collapse in Nigeria: the trend of casualties the last decade (2000–2010), International Journal of Civil & Environmental Engineering, Vol. 10, No. 6, pp.32–
36. [13] Ede, A. N., Bamigboye, G. O., Omore, D. O., Olofinnade, O. M., Adeyemi, G., Ngene, B. U., (2016) Impact of Reliable Built Structures in Driving the Sustainable Development Goals: a look at Nigerian Building Structures, International Conference on African Development Issues 369-372 Ota, Nigeria.

[14] Oluwatobi, B.O., Thang, N. T. and Olutoge, F. A. (2012). Management of building collapse in Nigeria: a lesson from earthquake-triggered building collapse in Athens, Greece, Civil and Environmental Research, Vol. 2, No. 6, pp.36–41.

[15] Oseghale, G. E., Ikpo, I. J., and Ajayi, O. D. (2015). Causes and Effects of Building Collapse in Lagos State, Nigeria. Civil and Environmental Research, 7(4), 34–43.

[16] Ihua-Maduenyi, Maureen (2019), The Punch newspaper, accessed May 2020. https://punchng.com/36-000-potential-collapse-waiting-to-happen-says-building-collapse-prevention-guild/

[17] Ihua-Maduenyi, Maureen (2020), The Punch newspaper, accessed May 2020, https://punchng.com/nigeria-recorded-43-building-collapse-cases-in-2019-report/

[18] Ede, A.N., Olofinnade, O.M., Ugwu, E.I., and Salau, A.O. (2018). Potentials of Momordica angustisepala fiber in enhancing strengths of normal portland cement concrete Cogent Engineering 5(1),1431353. pp. 1-17

[19] Joshua, O., Tunji-Olayan, P.F., Olusola, K.O., Ede, A.N., and Adewale, B.A. (2018). Investigating for pozzolanic activity in the blend of ground glass waste with cement for sustainable concrete. International Journal of Mechanical Engineering and Technology 9(6), pp. 808-816.

[20] Ede, A.N., Olofinnade, O.M., Joshua, O., Nduka, D.O., and Oshogbunu, O.A. (2020). Influence of bamboo fiber and limestone powder on the properties of self-compacting concrete, Cogent Engineering, 7:1, 1721410

[21] Olofinnade, O. M., Ede, A. N., Ndambuki, J. M., Bamigboye, G. O., 2016. Structural Properties of Concrete Containing Ground Waste Clay Brick Powder as Partial Substitute for Cement, Materials Science Forum, Vol. 866, pp 63-67.

[22] Ofuyatan, O., Ede, A.N., Rotimi, O., (…), John, O., Adeoye, O. (2018). Assessment of strength properties of cassava peel ash-concrete International Journal of Civil Engineering and Technology 9(1), pp. 965-974

[23] Oyebisi, S., Ede, A., Ofuyatan, O., Oluwafemi, J., Akinwumi, I. (2018). Comparative study of corncob ash-based lateritic interlocking and sandcrete hollow blocks International Journal of GEOMATE15(51), pp. 209-216.

[24] Ede, A. N. and Pascale, G., 2016 Structural Damage Assessment of FRP Strengthened Reinforced Concrete Beams under Cyclic Loads, Materials Science Forum, Vol. 866, pp 139-142. doi:10.4028/www.scientific.net/MSF.866.139

[25] Ede, A.N., Olofinnade, O.M., and Sodipo, J.O. (2017). Use of building information modelling tools for structural health monitoring. Proceedings of the IEEE International Conference on Computing, Networking and Informatics, ICCNI 2017, pp. 1-4.

[26] Ede, A.N., Olofinnade, O.M., Ofuyatan, O.M., Joshua, O., Aremu, O., (2018). Use of non-destructive tests to avert the risk of building collapse, International Journal of Civil Engineering and Technology 9(7), pp. 2028-2035.

[27] Odeyemi, Giwa and Abdulwahab (2019), Building Collapse in Nigeria (2009- 2019), Causes and Remedies – A Review, Journal of Science and Engineering Production, 1(1), pp122-135.