Investigation of the Causes of Building Failures in Nasarawa State, Nigeria.

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Abstract
This study examines the causes of building failures in order to curb it in Nasarawa sate thereby facilitating a safe environment for both rural and urban dwellers. To carry out the study, three research questions and three hypotheses were formulated. Questionnaire was used to collect relevant data from sample of 35 builders/ masons and 23 Engineers randomly selected from the four local governments of the state. t-test was used to test the null hypotheses. The study revealed that Lack of proper drainage planning of the town causes water to cause erosion that affects the buildings, construction of building without consulting the necessary building experts, lack of appropriate foundation, and failure to carry out proper water/cement ratio were responsible for building failures. Several recommendations were made based on the finding in order to reduce building failures, among which are that: Only qualified architects and engineers should be allowed to present architectural and structural drawings, for approval before any construction work commence, the supervision and monitoring of construction work should be properly carried out and should be by qualified engineers, proper selection of material should be done, the government should also ensure that code of practice is followed in construction works, total loads of building should always be assessed before any construction and the public too should ensure that the right thing is done for them so that issue of building failures will be reduced.

Introduction
Buildings are generally defined as structures utilized principally by people for living, working and storage. A building consists of an assembly of materials and components, joined together in such a way as to allow the building to fulfill its primary purpose of providing shelter to its occupants (Charlett, 2007). Buildings normally serve different purposes. Some examples of buildings are: residential buildings, churches, mosques, schools and factories. Nearly all designed buildings are built from Sand Crete blocks or bricks in form of walls. These could be supplemented with reinforced concrete columns located at corners or at places where it is necessary to support structures. Structure in broad sense, is anything built by man. This covers buildings, power line supports, bridges, storage tanks, railway carriages, airplanes, trucks and many others. In the narrower sense, a structure is the load bearing part of a building, bridges, etc. (Shishman, 1983)

Before the advent of European Architects and Engineers, people used to build houses with mud covered with thatch. Later they develop the idea of moulding mud blocks and using it to build. Even, nowadays people still build with mud blocks covered with thatch. Houses built with mud blocks are not strong enough. Therefore, there was the need to develop new ideas on how they can build houses that will be strong enough to withstand loads or other forces. Thus, the idea of building with concrete blocks (cement blocks) was brought up. Houses that are built with concrete blocks also have some problems due to some factors such as foundation settlement, lack of proper use of specification, lack of material testing and sampling, design problem, non adherence to supervisions and

monitoring, using substandard materials, improper bonding of walls among others. These normally lead to failure of buildings.

Failure of buildings is when part or the whole body of the structure has failed or collapsed. Also, failure is the term used when a structural element can no longer serve the purpose for which it was designed. A building failure is any building accomplished in less than a professional manner and /or with less than adequate results (Enshassi and Mayer, 2001). Arora and Bindra (2004) in their study also defined failure as a behaviour not in agreement with the expected conditions of stability or as lacking freedom from repair or as non-compliance with the desired use of occupancy of the completed structure. The failure of building is a common phenomenon but it becomes a serious problem when this failure leads to collapse of buildings. In order to avoid building failure, the designers are expected to know the properties of materials they specify as well as the structural and economic implications of their designs so that the builder is able to build in accordance with the design. Foster (1975) captured all this when he stated that "Building is no longer limited to a number of standardized techniques based on the use of a few known material, but involves an understanding of the properties and characteristics of an increasing number of materials. It also includes structural principles and building economics so that existing techniques may be used more efficiently and new forms of construction may be developed for the solution of structural problems. The builder is expected to be vast with the design methods (architectural, structural and other services construction and maintenance of building so as to prevent failure.

Building professionals have a lot at stake in averting building failure leading to collapse. Building professionals are those who are trained in all aspect of building construction and are qualified and granted permits or are certificated and licensed to practice the building profession. It should always be those who are well trained in the building profession that should practice the profession. In fact, there are some professionals who play roles that are not theirs which is also contributing to building failures. For example, an architect who suddenly finds himself playing the role of a builder, a civil engineer, or a quantity surveyor playing the role of a builder, even a builder assuming the function of an architect or a structural engineer. Nevertheless, as professionals have important role to play in preventing failures of buildings, Government regulatory agencies such as Standard Organization of Nigeria (SON), Town and Regional Planning Authorities are also of great importance. These are bodies that ensure that standards are met in Nigeria. They serve to enforce the rules regulating the construction of buildings. They prevent the use of substandard building materials.

Building failures have reached an alarming rate in some areas in Nasarawa State. This occurs either in dry or rainy season but most prevalent in the rainy season. Some examples of places that the failures occurred are; Wayas' House at Akwanga, Cassava Processing Company, at Watnba, Jeremiah Audu's house at Awe, ERCC church at Atsember, Azara and Francis Ogbole house at Obi LGA respectively. In view of the fact that building failures have been witnessed in different places in the state, it is important to know the cause of the building failure, how much damage it has done to different houses, and the possible ways to eradicate it or completely reduce it. The issue of building failure has reached a state that calls for concern. It therefore, becomes

necessary to accesses the causes of building failures in Nasarawa state and come out with a strategy to avert the anomalies. This problem calls for a great concern and it is against this backdrop that the study was conceived to assess the causes of these failures.

Purpose of the Study

The main purpose of this study is to investigate the causes of building failures in Nasarawa State. Specifically, the study sought to:

(i) Determine the causes of building failures in Nasarawa State;
(ii) Determine the nature or kind of damages caused by building failures in Nasarawa State; and
(ii) Determine the possible remedies or solutions to building failures in Nasarawa State.

Research Questions

(i) What are the causes of building failures in Nasarawa State?
(ii) What is the nature of kind or damages caused by building failures Nasarawa State?
(iii) What are the possible remedies or solutions to building failures in Nasarawa State?

Research Hypotheses

The following hypotheses were tested at .05 level of significance:

(i) There is no significant difference in the mean responses of building engineers and builders in Nasarawa State concerning the causes of building failures.
(ii) There is no significant difference in the mean responses of both building engineers and builders as regards the damages caused by building failures in Nasarawa State.
(iii) There is no significant difference in the mean response of building engineers, and builders regarding the possible remedies or solutions to failures of building in Nasarawa State.

Methodology

The design adopted for this study was survey research design. The researchers used survey method to elicit information from the respondents on assessment of the causes of building failures in Nasarawa State. The study was carried out in some selected Local Government Areas in Nasarawa State. The selected Local Governments were Awe, Obi, Lafia and Akwanga. The population of this study comprised of all building engineers, builders or masons who have practiced the profession for a period ranging from 5 years and above in Awe, Obi, Lafia and Akwanga Local Governments Areas of Nasarawa State. A population of 35 masons and 23 engineers were chosen for the study. The researchers used simple random sampling in obtaining their population sample. Total sample of 58 respondents were used by the researchers (i-e. 35 Masons and 23 engineers). The instrument was validated by three (3) lecturers in Industrial and Technology Education Department of Federal University of Technology, Minna. The instrument for data collection used for this study was questionnaire. The questionnaires were issued to

building engineers and builders in the local governments areas mentioned under population of the study.

Results

The data obtained from the administration of the instrument for the study of the subjects matter are presented in tables and figures to clarify the results of the study.

Research Question 1: What are the causes of building failures in Nasarawa State?

S/N	Statement of Item	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_G$	Remark
1	Settlement cause by deformation of soil due to imposed load	3.37	3.43	3.40	Agree
2	Settlement cause by volume changes of the soil as a result of seasonal condition	2.82	2.95	2.88	Agree
3	Settlement cause by the mass movement of ground in unstable soil	2.57	2.60	2.58	Agree
4	Failure due to uneven settlement	2.94	3.09	3.01	Agree
5	Lack of proper use of specification leads to failure of buildings	3.76	3.69	3.72	Agree
6	Lack of testing of materials	3.28	3.17	3.22	Agree
7	Change of purpose (building designed for a different purpose but later changed to a different purpose)	3.28	3.33	3.14	Agree
8	Walls are not bonded properly	3.00	3.04	3.02	Agree
9	Designers' ina bility to effect compulsory and regular inspection	3.39	3.00	3.19	Agree
10	Building too close to quarry site (failure as a result of vibration)	3.70	2.86	2.78	Agree
11	Lack of proper inspection/ monitoring the appropriate government regulatory agencies	3.05	2.86	2.95	Agree
12	Variation in the soil strata and unsuitable design	2.77	2.69	2.73	Agree
13	Variation in the foundation loading	2.90	2.90	2.90	Agree
14	Seasonal swelling and shrinkage of expansion of clay	2.50	2.91	2.70	Agree
15	Engagement of inc ompetent professionals in the construction work	2.71	3.73	3.22	Agree
16	Vibratory induced settlement (failure due to vibration of building as a result of demolition of nearby building)	3.02	2.39	2.70	Agree
17	Presence of sulphate in the soil as a result of chemical action	2.70	2.77	2.73	Agree
18	Failure due to swampy nature of the soil	2.77	3.00	2.88	Agree
19	Building without consulting the necessary building expert	3.65	3.69	3.67	Agree
20	Designers' inability to consider certain factors before carrying out and design of a building	3.29	3.21	3.25	Agree
21	Lack of appropriate foundation	3.34	3.17	3.25	Agree
22	Lack of proper drainage planning of the town causes water to cause erosion	3.54	3.39	3.46	Agree
23	Lack of construction culverts in the proper direction cause water to over flow to the other environments causing erosion that can affect buildings	3.51	3.18	3.34	Agree

$\bar{x}_1$ = mean scores for building or masons, $\bar{x}_2$ = mean scores for engineers, $\bar{x}_G$ = Grand mean

Table 1 shows that the two groups of respondents agreed with all the items on causes of building failures in Nasarawa State from items 1 to 24

Research Question 2: What is the rature or kind of Damages caused by building failures in Nasarawa State

S/N	Statement of Item	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_G$	Remark
25	Lost of lives as a result of building failure	3.00	2.73	2.86	Agree
26	Efforts are wasted due to failures	3.34	3.04	3.19	Agree
27	Waste of resources i. e. valuable materials and money	3.42	3.69	3.55	Agree
28	Sustaining injuries by people due to building failures	3.17	2.90	3.03	Agree
29	Some time people lost jobs	2.65	2.43	2.54	Agree
30	Time is wasted	3.17	3.00	3.08	Agree
31	Lost on confidence in the building professionals	2.51	2.04	2.27	Disagree

$\bar{x}_I$ = mean scores for builders or masons, $\bar{x}_2$ = mean scores for engineers, $\bar{x}_G$ = Grand mean

Table 2 shows that the two groups of respondents agreed with items 25,26,27,28, 29 and 30 but disagreed with item 3 1, concerning the damages caused by building failures in Nasarawa State.

Research Question 3: What are the possible Remedies to Building Failures in Nasarawa State

S/N	Statement of Item	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_G$	Remark
32	There should be proper testing and sampling of materials that will be used for carrying out construction	3.57	3.45	3.51	Agree
33	There should be assessment of the ground on which the building will stand	3.45	3.30	3.37	Agree
34	Ensuring that proper or right type of foundations are used for different type of soil	3.45	3.69	3.57	Agree
35	Ensure that proper adherence to bui lding specification	3.64	3.65	3.64	Agree
36	Appropriate design should be used and well inspected during construction	3.51	3.69	3.60	Agree
37	There should be proper monitoring by appropriate government regulatory agencies during construction	2.20	3.09	3.14	Agree
38	Total loads of the building should always be assessed before any construction	3.37	3.17	3.27	Agree
39	Attempt should be made to improve the bearing capacity of the soil by compacting and consolidating it	3.14	3.13	3.13	Agree
40	Competent prof essionals should be engaged in all construction works	3.68	3.83	3.75	Agree

41	Building should be sited by very far from the quarry site to prevent them from being affected by the vibration from the quarry site	3.34	3.52	3.43	Agree
42	Foundation should be uniformly or evenly loaded	3.34	3.21	3.27	Agree
43	All buildings should be used for the purpose of which they were constructed	3.35	3.39	3.48	Agree
44	Construction should be done putting in to consideration all seasonal conditions	3.22	3.39	3.30	Agree
45	All culverts should be constructed facing the right direction	3.62	3.47	3.54	Agree
46	Efforts should be made to reduce the effect of sulphate attacks	3.00	3.00	3.00	Agree
47	All walls of building should be well bonded during construction	3.50	3.30	3.40	Agree
48	There should be proper maintenance after a building has been constructed	3.48	3.47	3.47	Agree

$\bar{x}_1$ = mean scores of masons, $\bar{x}_2$ = mean scores of engineers, $\bar{x}_G$ = Grand mean

Table 3 indicates possible remedies or solutions to building failures in Nasarawa State it shows that both the two groups of respondents, that is masons and engineers agreed with all the items concerning remedies to building failures in Nasarawa State. That is from item 32 to 48.

Table 4: The t-test comparison for masons & engineers on the causes of of building failures in Nasarawa State?

S/N	$\bar{x}_1$	$\bar{x}_2$	SD_1	SD_2	t-cal	Remark
1	3.37	3.43	0.59	0.65	0.12	Accepted
2	2.82	2.95	0.66	0.81	0.24	Accepted
3	2.57	2.60	0.51	0.71	0.07	Accepted
4	2.94	3.09	0.42	0.41	0.44	Accepted
5	3.76	3.69	0.41	0.46	0.21	Accepted
6	3.28	3.17	0.72	0.56	0.19	Accepted
7	3.28	3.33	0.66	0.69	0.53	Accepted
8	3.00	3.04	0.71	0.85	0.07	Accepted
9	3.39	3.00	0.58	0.84	0.82	Accepted
10	3.70	2.86	0.73	0.80	0.27	Accepted
11	3.05	2.86	0.71	0.85	0.33	Accepted
12	2.77	2.69	0.79	0.55	0.21	Accepted
13	2.90	2.90	0.44	0.89	0.37	Accepted
14	2.50	2.91	0.64	0.77	0.80	Accepted
15	2.71	3.73	1.15	0.53	1.13	Accepted
16	3.02	2.39	0.70	0.71	1.12	Accepted
17	2.70	2.77	0.77	0.97	0.11	Accepted
18	2.77	3.00	0.76	0.88	0.37	Accepted
19	3.65	3.69	0.67	0.69	0.07	Accepted
20	3.29	3.21	0.56	0.77	0.45	Accepted
21	3.34	3.17	0.53	0.70	0.39	Accepted
22	3.54	3.39	0.60	0.64	0.31	Accepted
23	3.51	3.18	0.56	0.63	0.73	Accepted
24	3.34	3.26	0.63	0.73	0.50	Accepted

$\bar{x}_1$ = mean score for masons, $\bar{x}_2$ = mean score for engineers, SD_I = standard deviation for masons, SD_2 = standard deviation for engineers, T = t-cal, N_1 = Number of masons, N_2 = Number of engineers

As shown in Table 4, the hypotheses is accepted for all the items because the t-cal value is not equal or more than the t-table value. Hence, there is no significant difference between the mean responses between engineers and masons concerning the causes of building failures in Nasarawa State

Table 5: The t-test comparison for masons and engineers on the damages caused by building failures in Nasarawa State, Nigeria

S/N	$\bar{x}_1$	$\bar{x}_2$	SD_1	SD_2	t-cal	Remark
25	3.00	2.73	0.63	0.94	0.35	Accepted
26	3.34	3.04	0.53	0.75	0.69	Accepted
27	3.42	3.69	0.73	0.46	0.47	Accepted
28	3.17	2.90	0.56	0.66	0.60	Accepted
29	2.65	2.43	0.82	0.97	0.33	Accepted
30	3.17	3.00	0.56	0.78	0.37	Accepted
31	2.51	2.04	1.02	1.04	0.57	Accepted

$\bar{x}_I$ = mean score for masons, $\bar{x}_2$ = mean score for engineers, SD_I = standard deviation for masons, SD_2 = standard deviation for engineers, T = t-cal, N_I = Number of masons, N_2 = Number of engineers

As shown in Table 5, the hypothesis is accepted for all the items because the t-cal value is not equal or more than the t - table value. Hence, there is no significant difference between the mean responses of engineers and masons on the damages caused by building failures in Nasarawa State

Table 6: The t-test analysis on the possible remedies to building failures in Nasarawa State

S/N	$\bar{x}_1$	$\bar{x}_2$	SD_1	SD_2	t-cal	Remark
32	3.57	3.45	0.64	0.92	0.23	Accepted
33	3.45	3.30	0.56	0.81	0.33	Accepted
34	3.45	3.69	0.60	0.46	0.51	Accepted
35	3.64	3.65	0.47	0.48	0.03	Accepted
36	3.51	3.69	0.50	0.46	0.45	Accepted
37	2.20	3.09	0.56	0.71	0.24	Accepted
38	3.37	3.17	0.48	0.61	0.52	Accepted
39	3.14	3.13	0.59	0.68	0.02	Accepted
40	3.68	3.83	0.42	0.37	0.33	Accepted
41	3.34	3.52	0.58	0.50	0.39	Accepted
42	3.34	3.21	0.47	0.51	0.34	Accepted
43	3.35	3.39	0.49	0.77	0.44	Accepted
44	3.22	3.39	0.54	0.57	0.39	Accepted
45	3.62	3.47	0.59	0.77	0.31	Accepted
46	3.00	3.00	0.56	0.51	0.46	Accepted
47	3.50	3.30	0.49	0.46	0.51	Accepted
48	3.48	3.47	0.50	0.50	0.03	Accepted

$\bar{x}_1$ = mean scores for masons, $\bar{x}_2$ = mean scores for Engineers, SD_1 = Standard deviation for masons, SD_2 = Standard deviation for engineers, T = t-cal, N_1 = Number of masons N_2 =Number of Engineers

As shown in Table 6, the hypotheses is accepted for all the items because the t- cal value is not equal or more than the t- table value Hence, there is no significant difference in the mean responses between engineers and masons concerning the possible remedies to building failures in Nasarawa State

Major Findings

This research has revealed that the major causes of building failures in Nasarawa State, Nigeria: this includes:

1. Lack of proper drainage planning of the town causing water to cause erosion that affects buildings;
2. Building without consulting the necessary building experts;
3. Lack of constructing culverts in a proper direction;
4. Lack of appropriate foundation;
5. Failure to carry out proper water I cement ratio;
6. Failure due to the swampy nature of the soil;

Discussion of Findings

Lack of proper drainage planning for the town causes erosion that affects buildings. Many places in Nasarawa State have not been provided with proper drainage system which will collect water and discharge it outside the town accordingly. This, from time to time, causes water to force its way to different places, creating various ditches in those areas where people live. For the fact that there are no side drains on some existing roads, water runs on roads and minor paths in the town causing some building to be affected. Analysis of the results also indicates that building without consulting the necessary building experts. This is the practice carried out by many people in Nasarawa State. They don't always seek advice from experts before building houses. Many factors that are supposed to be observed before carrying out any construction are not normally observed. This causes failures of buildings as a result of those factors that were not considered. Analysis as presented also indicates that lack of constructing culverts in the proper direction. Culverts are not constructed in the right direction, water washes sand from other areas and blocked those culverts because they are not facing the right direction to enable water passes through them. This causes water to overflow to other environments causing failure to buildings.

Another factor responsible for the failure of building in Nasarawa state is the lack of appropriate foundation. In Nasarawa State, some people failed to care about constructing a strong foundation before building houses. Some people just dig or excavate their foundation trenches without proper foundation but only laid a simple blinding layer and start their block work on it. Also responsible for the building failure was improper mixing of water/cement ratio. Water/cement is the proportion of water to cement and is expressed in terms of weight of water divided by the weight of cement. A water cement ratio of 0. 6 mean that the water in a batch of concrete weighed 6/10 as much as the cement. Just enough water should be used in every mix. When too much water is added to a mix, it reduces the strength of the mix, which is identified in this work

as a major practice in Nasarawa state. Results as presented also identified the failure of the swampy nature of the soil. This is in accordance with the observation of Obande (1990). According to him, the channel through which dampness or water enters a building is in three ways, i.e. through the ground, through the external surface of the wall (as in driving rain) and through the toy of the walls, flows and roofs. This is not normally taken into consideration before carrying out construction in Nasarawa State. Even if it was considered it was by those engineers that are not competent enough about how to proffer necessary solutions to the problem. The study also revealed that building without consulting necessary building experts can lead to failure, so masons should ensure that the necessary building experts are consulted, before carrying out construction work. The study also revealed that the masons and engineers should construct culverts facing the right direction to prevent them from blockage, so that their effects will not be seen again. Another cause was water/cement ratio. The masons should use the right proportion of water to cement on buildings and will ensure that the right proportion is used.

Conclusion

Building failure is the term that is used when a structural element can no longer fulfill the purpose for which it was designed. From the study carried out, it has been revealed that the total loads of building have to be assessed before carrying out any construction work. The type of design is also an aspect to be considered with great concern. The material used for the construction, the engineers and masons play important roles in the work that will be carried out. Every building personnel have to carry out his function properly in order to achieve a good job. It can be inferred from the analysis of the results obtained from this study that most areas in Nasarawa State are loose sand which washes away by rain fall. This factor has to be taken care of to ensure that all the buildings constructed in the state have no problem of failure.

Recommendations

The following recommendations are therefore made:

1. Only qualified architects and engineers should be allowed to present architectural and structural drawings for approval before any construction work commences;
2. The supervision and monitoring of construction work should be properly carried by qualified engineers;
3. Selection of the architects and design team for the new construction of building by clients should be based on the quality and performance of buildings they have previously designed;
4. There should be proper selection of the builders or masons who will carry out the building construction work by either the architects or engineers;
5. Proper selection of material for the construction should be done;
6. There should be inclusion of the brief' concerning requirement for maintenance manual;
7. Government should ensure proper certification process before approving building plans;
8. The government should also ensure that code of practice is followed in construction works;

9. Total loads of building should always be assessed before any construction; and
10. The public too should ensure that the right thing is done for them so that issue of building failures will be reduced.

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