



REPORT

ON THE COLLAPSE OF 4 BUILDINGS IN 4 MUNICIPALITIES IN GHANA IN MAY, 2023





December, 2023

GHANA INSTITUTE OF ARCHITECTS

FOUNDED 1962

COLLABORATORS

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EXECUTIVE SUMMARY

BACKGROUND

Within a spate of 10 days (1st-9th May, 2023), four (4) buildings under construction collapsed in four (4) different locations in Ghana namely SDA Junction (Madina) in the La-Nkwantanang Madina Municipal Assembly in the Greater Accra Region, Nmai Dzorn in the Adentan Municipal Assembly in the Greater Accra Region, Ajasco Junction (Old Bortianor) in the Ga South Municipal Assembly in the Greater Accra Region, and at Sagnarigu on the City Campus of University for Development Studies in the Sagnarigu Municipal Assembly in the Northern Region.

On hearing the news of the collapse of these buildings under construction, the four (4) built environment professional bodies namely Ghana Institute of Architects (GIA), Ghana Institution of Engineering (GhIE), Ghana Institute of Planners (GIP) and Ghana Institution of Surveyors (GhIS) constituted four (4) Adhoc Committees to go on a facts finding mission with the under-listed terms of reference (TOR):

a. ascertain whether the developers involved had acquired the requisite permit prior to commencement of construction.
b. to assess the general procedures and or processes of physical developments in the municipality
c. assess the professional capacities of the professionals involved in the entire process on the part of both the developer (s) and the Assembly
d. assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy
e. systematically collect data for analysis to determine the cause of the collapse based on initial observations, eye-witness account and available records of the construction activities
f. where necessary and depending on the availability of the required logistics, conduct structural assessment of the collapsed building(s) and any available records of the construction activities
g. identify any liability based on the findings including designs, construction and supervision and building code and building regulation violation.
h. prepare reports including conclusions and recommendations

It must be noted that the Director General of Ghana Education Tertiary Council through the Engineering Council also constituted an Adhoc Committee specifically for the building that collapsed on the City Campus of the University of Development Studies at Sagnarigu.

The methodology employed for the assignment included but not limited to the under-listed:

a. review and documentation of existing documents and other information
b. visual assessment (physical observation)

c. field test/structural analysis
d. interviews with stakeholders
e. meetings with stakeholders

The report will be presented to the Hon. Minister, Ministry of Local Government, Decentralisation and Rural Development, all the stakeholders and the general public. It is our view that the recommendations will inform policy formulation to avert future occurrences of building collapse in the country.

Below is the summary account for the respective locations:

1. DATE BUILDING COLLAPSED: 1ST MAY, 2023:
SDA JUNCTION (MADINA), LA-NKWANTANANG MADINA MUNICIPAL ASSEMBLY

At about 3:00pm on Monday 1st May, 2023, a 3-storey building under construction located in Madina around the SDA Junction (adjacent Kpogas furniture) in the La-Nkwantanang Madina Municipal Assembly collapsed on the workers who got trapped underneath the rubble and were rescued by the National Disaster Management Organization (NADMO).

The Adhoc Committee assigned to this particular site found out during the exercise the under-listed:

a. That the developer did not have a building permit.
b. The building was being constructed on a land filled with imported materials suggesting that the soil was not stable.
c. The Assembly had issued a STOP WORK notice on 20th August, 2023 but the developers continued to work especially during weekends and on holidays.
d. Non-availability of drawings (Architectural, Civil/Structural, etc.)
e. Non-availability of geotechnical survey report to ascertain the characteristics of the soil

Due to the none availability of records on the project at the assembly, the team was unable to have data on the ownership, the professionals engaged on the project, the caliber of tradesmen among others. In the view of the committee, the collapse of the building may be due to some factors but not limited to those listed below:

a. Unstable soil
b. Poor workmanship
c. Use of low-quality building materials
d. The absence of professionals
e. No test conducted on the building materials/construction methodology
d. The absence of periodic inspection by the Assembly (Development Control)

2. **DATE BUILDING COLLAPSED: 4TH MAY, 2023**
NMAI DZORN, ADENTAN MUNICIPAL ASSEMBLY

Designed as a 3-storey residential building to be located at Nmai Dzorn in the Adentan Municipality, the developer(s) in the person(s) of Dr. Esther Wahaga and Mr. Arimeyaw Salley Ibn Saeed applied for building permit at the Adentan Municipal Assembly in the Greater Accra Region in August, 2020 and the permit was granted in September, 2020.

Construction activities commenced in earnest upon receipt of the building permit and at 3:00pm on Thursday 4th May, 2023 it was reported that the building had collapsed resulting in the death of the foreman (per eye witness report).

The adhoc committee during their facts finding mission observed the under-listed:

a. That although designed as a 3-storey residential building and permit issued accordingly by the Adentan Municipal Assembly, during construction, it was revised into a 4-storey mixed use building without the input of any professional and without reference to the Adentan Municipal Assembly.
b. That the owner did the purchase of all materials for construction per the mason's recommendation.
c. That the collapsed building was sited less than 900mm from an existing building that may be affected structurally as a result of the impact from collapse.
d. That geotechnical survey was conducted and report issued per request by the Adentan Municipal Assembly as part of the permit application process
e. That the building (3-storey residential) was designed by an architect.
f. That the structures was designed by a structural engineer.
g. That no geotechnical surgery report was issued at the design stage.
h. That no material testing was performed during the construction period.
i. That the Adentan Municipal Assembly was not notified of the commencement of the project.
j. That neither the architect nor the structural engineer was involved to provide supervision services during construction
k. That the supervision activities was performed by the mason (foreman)

It can be inferred from the findings that, the structure collapsed due to poor quality workmanship, none adherence to specification as well as the non-availability of professionals (architect, structural engineer) to supervise the construction activities.

3a. **DATE BUILDING COLLAPSED: 6TH MAY, 2023**
SAGNARIGU, UNIVERSITY FOR DEVELOPMENT STUDIES, CITY CAMPUS, SAGNARIGU MUNICIPAL ASSEMBLY -Report by Engineering Council's committee

Designed by the professionals at the Works and Physical Development Directorate (WPDD) of the University for Development Studies, construction works of the 6-storey reinforced concrete framed structure situated on the City Campus of the University for Development Studies at Sagnarigu in the Northern Region started in 2021. The building when completed, was to be used for lecture rooms and offices by the Institute of Distance Learning of the University.

Unfortunately, on the night of 6th May, 2023, when progress of the construction works had reached the roof level, the structure catastrophically collapsed.

Upon hearing the news, the Director General of the Ghana Education Tertiary Council through the Engineering Council appointed a committee of experts under the Chairmanship of Ing. Prof. Samuel Innocent Kofi Ampadu of the Kwame Nkrumah University of Science and Technology (KNUST) to conduct a forensic investigation into the collapse.

During the committee's first visit to the site to meet the University authorities and to assess the collapse to define the programme for the investigation, it became apparent that the structure was, in fact an L-shaped structure and that only part of the structure had collapsed. The other part of the structure that was still standing was perhaps of more urgent concern to the staff and students of the Institute. The committee therefore broadened its scope to cover both a forensic investigation of the collapsed structure and a structural integrity assessment of the standing portion of the structure.

The committee's investigation indicated that the structure was designed in-house by the Works and Physical Development Directorate (WPDD) of the University for Development Studies. However, the geotechnical investigation was conducted by a third party. The construction was being executed by a private Construction company under the construction administration and supervision of the Works and Physical Development Directorate (WPDD) of the University.

The committee's methodology included an on-site questionnaire to understand the context of the project and on-site investigations on both the collapsed and standing portions of the L-Shaped structure. The investigation included on-site measurements of the dimensions of structural members, the in-situ measurement of

the strength of structural members by both the Schmidt hammer and Ultra Pulse Velocity (UPV) followed by laboratory measurements of cored concrete and reinforcement steel strengths. The investigation also included a full geotechnical site investigation with five (5) boreholes by percussive drilling sunk to bedrock which varied from 1.5m to 8.0m on site. The building was then modelled using ETABS software with three (3) simulations of load case combinations as follows:

a. Simulation 1: dead loads only
b. Simulation 2: dead and live loads
c. Simulation 3: live and wind loads.

The results showed that most of the columns and foundations failed even under dead-load only simulation. This is an indication that the main cause of the collapse (failure) is attributed to serious design flaws. The collapse itself originated from multiple column failure and may have been triggered by any combination of the following factors which pertained to the site namely:

a. the thunderstorm that occurred on the night of the failure
b. foundation failure
c. lift shaft base slab failure
d. non-uniform subsurface soil condition

The investigation and analysis of the integrity of the portion of the L-Shape structure still standing showed that the design is similar to the collapsed portion and that the columns and foundations are in a much worse state than those of the collapsed portion.

The report by the committee formed by Engineering Council discusses a number of options to make the portion of the L-shaped structure that did not collapse safe during construction and useable including increasing the existing column sizes and the introduction of new columns. Each of the options however carry substantial risk of collapse during the intervention. The safest option therefore is to demolish, redesign and reconstruct the entire structure from scratch.

3b. **DATE BUILDING COLLAPSED: 6TH MAY, 2023**
SAGNARIGU, UNIVERSITY FOR DEVELOPMENT STUDIES, CITY CAMPUS, SAGNARIGU MUNICIPAL ASSEMBLY- Report by a representative of a committee member from Ghana Institute of Planners

Due to the setting up of a parallel committee by the Engineering Council at the directives of the Ghana Education Tertiary Council, the four (4) built environment professional bodies namely; Ghana Institute of Architects (GIA), Ghana Institute of Planners (GIP), Ghana Institution of Engineering (GhIE), and Ghana Institution of Surveyors (GhIS) had to stay its adhoc committee assigned to the University for Development (UDS) collapsed building site.

However, to capture the planning processes per the Land Use and Spatial Planning Act 2016 (Act 925) and the Land use and Spatial Planning Regulations, 2019, (L.I. 2384) as well as the Building Regulations, 2022 (L.I. 2465) required for the development of such buildings, the representative from Ghana Institute of Planners (GIP) on the adhoc committee set up by the four (4) built environment professionals and assigned to the University of Development Studies (UDS) collapsed building site conducted a sole investigation and reported accordingly.
The findings of the sole investigator -a representative of Ghana Institute of Planners were as follows:

a. That the Sagnarigu Municipal Assembly was not aware of the said 6-storey building being constructed on the City Campus (Sagnarigu) of University for Development Studies noting that section 51 of the LUSPA Regulation (L.I. 2384) does not exempt the University from acquiring permits for their developments.
b. That the City Campus does not have a local plan approved by the Sagnarigu Municipal Assembly contrary to section 72 (1)-(3) of the Land Use and Spatial Planning Act 2016, Act 925.
c. That the Physical Planning and Works Departments of the Sagnarigu Municipal Assembly does not have staff covering all the four (4) built environment professional bodies. The architects were conspicuously missing.
d. Physical Planning and Works Departments of the Assembly had logistical and financial challenges.

4. **DATE BUILDING COLLAPSED: 9TH MAY, 2023**

AJASCO JUNCTION (OLD BORTIANOR), GA SOUTH MUNICIPAL ASSEMBLY

On 9th May, 2023, a 2-storey reinforced concrete framed building with a basement under construction, belonging to The Word in Action Church, situated at Old Bortianor in the Ga South Municipal Assembly in the Greater Accra Region collapsed injuring seven (7) individuals.

Per their mandate as spelt out in the Terms of Reference (TOR), the adhoc committee observed the under-listed during the execution of the assigned task:

a. There was no architect involved in the architectural design as well as the production/construction drawings.
b. There was no Structural Engineer involved in the structural design.
c. The drawings (architectural and Structural) were characterised with errors
d. No geotechnical survey was executed
e. The Ga South Municipal Assembly issued permit for construction works to commence
f. The construction materials used were of poor quality. The average in-situ compressive strength of concrete recorded based on a digital Schmidt Hammer test was C12/15, which fell short of the recommended grade of C20/25 for reinforced concrete structures by design codes and standards
g. The construction of works was not supervised by professionals (architects, engineers, etc.). This imply that there was no quality assurance/quality control
h. There were no records of site visits or site inspection by the Ga South Municipal assembly
i. The structural analysis revealed that the building lacked sufficient structural capacity under its own weight and gravity loads, and the addition of an apartment worsened the situation leading to the collapse of the structure.
j. The Ga South Municipal Assembly does not have professionals from all the four (4) built environment professional bodies for effective delivery of their statutory mandate.

CONCLUSIONS

Based on the findings from all the four (4) locations (sites) the following can generally be inferred:

a. The developers failed to employ the services of professionals in the built environment for the design and supervision of the respective projects. Although the University for Development Studies had in-house professionals in the built environment, their knowledge base for the building typology is questionable.
b. All the four (4) Municipal Assemblies does not have the full compliment of the four (4) build environment professional bodies namely Architects, Engineers, Planners and Quantity Surveyors
c. Geotechnical Survey which is essential for the design of the substructure was evidently not conducted on most of the sites (locations). The implication is that the soil bearing capacity, nature of soil, etc. for the respective sites was not known, hence not accounted for in the structural design.
d. There were no records of reports of regular control tests on concrete and reinforcement steel bars or site meeting minutes sighted during the execution of the terms of reference by the committees for the respective sites.
e. The ultimate cause of collapse of the buildings at the respective locations was multiple column failure.

RECOMMENDATIONS

Based on the findings and conclusion, the under-listed recommendations must be implemented fully in other to develop the built environment of the Ghana we all want as a country.

a. To help sanitise the built environment and achieve the desired quality of construction which will eventually help to improve the health and well being of the citizenry, development control must must be seriously enforced through third party. This then falls on the lap of the four (4) key recognised built environment professional bodies namely: Ghana Institute of Architects (GIA), Ghana Institution of Engineering (GhIE), Ghana Institute of Planners (GIP), and Ghana Institution of Surveyors (GhIS).
b. The Physical Planning Department as well as the Works Department must have the required and full compliments of the built environment professionals and adequately resourced and trained for effective delivery of their mandate
c. To improve upon the quality of designs of all building typologies, there must be mandatory peer reviews of submissions by the developer(s) to the respective Metropolitan, Municipal and District Assemblies (MMDAs) across the entire country
d. Instead of the developer(s) directly applying for permits at the assemblies, the applications must be made by the built environment professionals (architects, engineers, and planners) on behalf of the developer(s). This will help in the enforcement of the statutes
e. To improve upon development control and to improve the health and well being of citizenry, government must consciously and progressively make funding available for the preparation of Structure Plans, Local Plans and Master Plans covering the boundaries of the respective Metropolitan, Municipal and District Assemblies. These plans must be done with phasing implementation strategies and based on the comparative advantage of the MMDAs. This will help in the growth of the economy.
f. All the built environment professional bodies namely; Ghana Institute of Architects, Ghana Institution of Engineering, Ghana Institute of Planners and Ghana Institution of Surveyors must as a matter of urgency institute mandatory Continuing Professional Development (CPD) for its membership to help improve in the delivery of their respective task.
g. Similar to the certification of Electricians by the Energy Commission, there must be a system of certification by government for tradesmen in the building and construction industry especially Masons, Steel benders, to mention but a few. This will help in the improvement of the quality of construction

h. University for Development Studies (UDS) and all other tertiary institutions who currently do not comply with section 113 91) of the Land Use and Spacial Planning Act, 2016 (Act 925) and Section 91 (1) of the Local Governance Act 2016 (Act 936) must urgently make the necessary arrangement with the respective authorities (MMDAs) to comply

i. University for Development Studies must as a matter of urgency re-organise its Works and Physical Development Directorate (WPDD) to ensure that
    i. Professionals given design responsibilities have had sufficient and in-depth training and requisite experience commensurate with the level of responsibility or design complexity involved. Until this can be done in-house, the University may wish to depend on properly vetted external Consultants to assist
    ii. Industry best practices including peer review of designs and drawings are introduced and strictly enforced.
    iii. Quality assurance measures are introduced so that its outputs including drawings meet the minimum requirement of the industry prior to designs/drawings being released to the consultants and the contractor

j. To improve on the quality of designs of buildings in the Universities, civic buildings, public spaces and other public infrastructure, the use of in-house professionals in the public sector establishments must be limited to the development of guidelines on the particular building typology relevant to the establishment, design reviews and in addition to acting as Employer(s) representatives. The design and its related activities such as construction administration and supervision of construction works must be competitively outsourced.

k. In situations where developer(s) commence construction works without the requisite permit, the MMDAs should not only write STOP WORK and PRODUCE PERMIT and go to sleep but must go a step further to enforce the necessary laws.

l. The government represented by the MMDAs must develop bye-laws that introduces contractor's All-Risk Insurance on all building construction as part of the development control process.

m. In collaboration with the built environment professional bodies, the MMDAs must develop and establish a robust verification process for checking the authenticity of stamps and signatures of professionals

n. Public education must be intensified by both the built environment professional bodies and the MMDAs on the permitting and development control processes

SUBTITLE 1

INVESTIGATION OF THE 1ST MAY 2023 COLLAPSE OF A COMMERCIAL BUILDING WITHIN THE LA NKWANTANANG MADINA MUNICIPAL ASSEMBLY

ADHOC COMMITTEE (GIP, GIA, GhIE, GhIS)
LA NKWANTANANG MADINA MUNICIPAL ASSEMBLY
3/8/23

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Appendix F – Minutes of LaNMMA meeting post-report

1. EXECUTIVE SUMMARY

On Monday 01 May 2023 at around 3:00pm, news broke of a 3-storey commercial building under construction that had unexpectedly collapsed injuring an unspecified number of persons around the SDA Junction in Madina, Accra. This locality falls within the jurisdiction of the La Nkwantanang Madina Municipal Assembly.

Professional institutions within the built environment; (Ghana Institute of Architects (GIA), Ghana Institution of Engineering (GhIE), Ghana Institution of Surveyors (GhIS) and Ghana Institute of Planners (GIP) teamed up to set up an adhoc committee investigate the cause of this disaster and provide recommendations on the prevention of such occurrences as well as to inform policy.

The two (2) week-long investigation sought to uncover whether the developers involved have acquired the requisite permit prior to commencement of development/construction, assess the professional capacities of the professionals involved in the development and Assembly's teams, assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy, collect data for analysis to determine the cause of the collapse, conduct structural assessment of the collapsed building and any available records and identify any liability based on the findings including designs, construction and supervision and building code violation.

In line with the methodology for the assignment, the committee met with the affected Assembly (LaNMMA) on Thursday 25 May 2023 to conduct interviews and collect relevant data on the collapsed development. We also reviewed witness interviews, the Ghana building code, legislation on local governance, manuals on the operations of the relevant departments of the Assembly as well as photographic evidence gathered from our site visit in the preparation of this report.

Following our review of available documentation as well as meetings and interviews conducted, we found the following:

- The Developer failed to acquire a permit prior to construction on site.
- The Assembly served a 'STOP WORK PERMIT' on the development which was not adhered to.
- No records or information was available on the collapsed development due to its unauthorised nature.
- The Assemblies are faced with field staff and logistical challenges in performing their monitoring role.
- Laid down procedures for building permit exist but are not strictly adhered to.

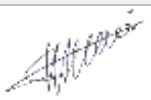
In conclusion, we recommend that payment of building permit fees prior to approval and issuance of permit should cease immediately. The Works and Physical Planning Departments must be strengthened and the Building Regulations strictly enforced. The Planning and Building Inspectorate Division must be strengthened with four (4) additional staff due to the size of the municipality. Adequate provision and maintenance be made for logistics such as vehicles or motorcycles to boost field operations. As part of the permit process, the Assembly should compel the Developer to engage professionals for the Construction works. Public education and awareness on permit acquisition must be improved by both the Assemblies and the Built Environment professionals. Assemblies to enforce their mandate to prosecute defaulters where necessary in a bid to ensure compliance with regulations (Land Use and Spatial Planning Act 925 – Section 117, Sub-section 2).

2. BACKGROUND / INTRODUCTION

On Monday 01 May 2023 at around 3:00pm, a 3-storey commercial building under construction located around the SDA Junction in Madina, Accra unexpectedly collapsed injuring an unspecified number of persons. The injured persons were found and transported to the hospital for treatment.

Varying opinions on the events leading up to the collapse have been brought to bear by the media and members of the general public. Professional institutions within the built environment have therefore taken up the mantle to investigate the causes of this disaster and provide recommendations on prevention of such an event from recurring.

An Adhoc Committee was therefore setup by these institutions with specific assignment to the aforementioned collapse site (SDA Junction – adjacent Kpogas Furniture). The composition of the team is as follows:

Name	Designation	Signature
Arc. Chezrie Degraft Takyi	Architect (GIA) - Chairperson	
Pln. Felix Offei	Planner (GIP)	
Surv. Ruweida Ibrahim-Adam	Quantity Surveyor (GhIS) - Secretary	
Surv. Jacob Kwame Boateng	Land Surveyor (GhIS)	
Surv. Emmanuel Jefferson K. Zumegah	Valuation and Estate Surveyor (GhIS)	
Ing. Johnson Kwasi Obeng-Afari	Structural Engineer (GhIE) - Secretary	
Ing. Joseph Oddei	Geotechnical Engineer (GhIE)	

The above-named professionals have been charged with the task of investigating the conditions surrounding the collapse and giving recommendations on the way forward in preventing such instances from recurring.

3. SCOPE OF THE INVESTIGATION

3.1 Investigation Objectives

The committee's assignment was specifically to investigate the following:

i. Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.
ii. Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.
iii. Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.
iv. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.
v. Conduct structural assessment of the collapsed building and any available records of the building construction.
vi. Identify any liability based on the findings including designs, construction and supervision and building code violation.
vii. Prepare report including conclusions and recommendations.

3.2 Duration of Assignment

The work of the committee span over a period of Two (2) weeks commencing May 22 2023 following which a report on findings and recommendations is to be presented to the appointing authority for further action.

3.3 Deliverables

A detailed report will be submitted at the end of the investigation, highlighting probable causes of the collapse, key findings on topical issues as well as recommendations for policy consideration going forward.

4. THE COLLAPSE

The La Nkwantanang Madina Municipal Assembly is located within the Greater Accra Region and spans across parts of Legon, Madina, Nsamanpom, West Adenta, Oyarifa, Danfa and Amrahia.

The Committee met with officials of LaNMMA to hold discussions pertaining to the collapse and to collect any available data on the development as far as practicable. In attendance at the meeting were all 7 Committee Members as well as three (3) officials from the Assembly.

Information gathered from the affected District Assembly (LaNMMA) indicated that on Monday 1st May 2023 a 3-storey commercial building under construction, located at SDA Junction adjacent Kpogas furniture collapsed around at 3:00pm. The building was being constructed on made up land i.e., filled with imported material to increase levels on site. Incidents leading to the sudden collapse are however unknown.

We uncovered through our investigations that upon the occurrence of the collapse, officials from NADMO arrived at the scene to rescue individuals who were trapped underneath the rubble. This resulted in the collection and removal of all debris, which could have aided our investigations, from the collapse site. We were reliably informed that scrap dealers also appeared at the scene shortly after to harvest exposed reinforcement bars and the like.

The collapse site under investigation was confirmed to be an unauthorised structure, not sanctioned by the Assembly (LaNMMA). The assembly stated that upon their issuance of a “stop work and produce permit” notice to the parties in charge of the site, the notices were not heeded to and works resumed without the Assembly’s authorization. As a result, the building under construction was not documented as an authorized structure by the Assembly and therefore records on key matters relating to the construction or parties involved could not be traced.

Following the incident, we were informed that the Ghana Police Service has commenced investigations into the matter to determine if there are any criminal implications related to the collapse.

5. METHODOLOGY

To fully carry out our mandate under the investigation, we adopted some methods, procedures and techniques to collect and analyse information. We set out to carry out initial fact gathering before commencing a full-scale investigation. It was the plan to conduct initial interviews and check facts to clarify actual events and help develop well informed conclusions. In line with this, we found it necessary to visit the collapse scene and examine available data sources in search of items that may provide us with relevant information.

Upon our initial assessment, if it is brought to light that there are no aggravating factors, a full-blown investigation may not be warranted. On the other hand, the investigation may proceed if it is found that initial evidence examined has merit and could uncover relevant matters that could inform future policy.

Following initial assessment and the decision to proceed with the investigation, further relevant data will be collected, studied and scrutinised to determine possible causative factors, establish links and locate or attribute blame where necessary.

The team would then report on findings and make sound recommendations for future policy to ensure that such events do not recur. Details of the methodology applied in the investigations are as shown below:

- **Desk study:** Comprehensive review of available documentation on the development and assembly structures. This includes but is not limited to drawings, design and other relevant reports, evidence of professional qualifications and personnel capacity, assembly policy documents etc.). This study will aid in identifying lapses in project design and documentation which may have contributed to the collapse.
- **Data Collection:** Gathering of relevant information from meetings and interviews with interested parties (LaNMMA, Developers, Witnesses etc.). A number of meetings were arranged with the relevant parties for the purposes of collection of background information and documents and to document on-site observations. Interviews will also be conducted with key responsible persons identified.
- **Site reconnaissance survey:** Visits to the collapse site to gather relevant data from rubble and remnants following collapse.
- **Structural assessment of collapsed building:** Field and laboratory testing of collapsed structure and sample collection for analysis. Conducting of site investigations where necessary (in the absence of geotechnical reports) to ascertain the nature and bearing capacity of the soil.
- **Data analysis and interpretation:** Analysis of data collected and comparison with acceptable standards/codes of practice. Deductions after vigorous document review. Comments on physical observations on site. Discussion of geotechnical investigation results and structural analysis compared to site observations.
- **Presentation of conclusions and recommendations:** Deductions from data analysis, presentation of findings and recommendations for future action.

6. FINDINGS FROM DESK STUDY

6.1 Background to the Municipal Assembly Structure

The Local Governance Act of 2016, Act 936 stipulates that a Municipal Assembly is that with a population of over 95,000. According to Second Schedule of the Act, the following departments exist in each Municipal assembly:

1. Central Administration Department
2. Finance Department
3. Education, Youth and Sports Department
4. Municipal Health Department
5. Agriculture Department
6. Physical Planning Department
7. Works Department
8. Social Protection and Community Development Department
9. Natural Resource Conservation, Forestry and Game and Wild Life Department
10. Trade and Industry Department
11. Transport Department
12. Disaster Prevention Department
13. Roads Department

The main legislative framework guiding Local Government functions are:

1. The Civil Service Law 1993 (PNDCL 327)
2. The Local Governance Act 2016 (Act 936)
3. The National Development Planning (System) Act 1994 (Act 479)
4. The National Development Planning Commission Act 1994 (Act 480)
5. The District Assemblies Common Fund Act 1993 (Act 455)
6. The Local Government Service Act 2003 (Act 656)
7. The Institute of Local Government Studies Act 2003 (Act 647).

6.2 Staffing Requirements of the Municipal Assemblies

Our desk study revealed the professionals and levels of expertise required to fully carry out the mandate of the district assembly in permit acquisition and construction supervision to ensure compliance. Key reference documents for this aspect of the investigation were the Operational Manuals for the Works Department and the Physical Planning Department.

For the purposes of this investigation, our research focused on the Physical Planning and Works Departments which are responsible for permitting and physical development within the municipal assembly. One key function of the above-mentioned departments is to assist in the review and approvals of building permit applications in line with the Ghana Building Code and other regulatory enactments.

Under the Building Unit of the Works Department are the Building Control Management Section, Physical Projects Development Section and Facilities Management Section. Our particular interest was drawn to the Building Control Management Section which is responsible for participating in vetting

building permit applications prior to approval undertaking stage – by – stage inspection of projects with requisite permits in the district, stopping all on – going unauthorised construction works, submitting inputs for the issuance of certificate of habitation for completed projects, undertaking approved demolition of unauthorised structures, providing technical inputs for prosecutions of recalcitrant unauthorised developers, providing inputs for update of building permits register and updating inventory of unauthorised structures.

Staffing Requirements of the Works Department - Building Unit

Professional:

- Head of Building Unit – Minimum 1, Maximum 1
- Building Control Management – Minimum 3, Maximum 3

Sub-Professional:

- Technician Engineers – Minimum of 6 and Maximum of 12

The following is the list of relevant classes and staff for the Works Department:

1. Professional Class:
   - Chief Architect/Director
   - Principal Architect/Deputy Director
   - Senior Architect
   - Architect
   - Assistant Architect

   - Chief Quantity Surveyor/Director
   - Principal Quantity Surveyor/Deputy Director
   - Senior Quantity Surveyor
   - Quantity Surveyor
   - Assistant Quantity Surveyor

   - Chief Engineer/Director
   - Principal Engineer/Deputy Director
   - Senior Engineer
   - Engineer
   - Assistant Engineer

   - Chief Estate Manager/Director
   - Deputy Estate Manager/Deputy Director
   - Senior Estate Manager
   - Estate Manager
   - Assistant Estate Manager

2. Sub – Professional Class:
    - Chief Technician Engineer
    - Assistant Chief Technician Engineer
    - Principal Technician Engineer
    - Senior Technician Engineer
    - Technician Engineer

    - Chief Estate Officer
    - Principal Estates Officer
    - Senior Estate Officer
    - Estate Officer
    - Assistant Estate Officer

3. Technical Class
    - Chief Technical Officer
    - Principal Technical Officer
    - Senior Technical Officer
    - Technical Officer

Under the Physical Planning Department, are the Administration and Research Unit, Parks and Gardens Unit and Spatial Planning Unit. The Spatial Planning Unit has a Development Control and Planning Inspectorate section whose key function includes monitoring of physical developments to ensure compliance with planning regulations and approved spatial plans as well as the examination of development applications including vetting of site and design plans, site inspection, consultation and negotiation with private developers and public development agencies, expert advice, reports.

Staffing Requirement of the Physical Planning Department – Development Control and Planning Inspectorate

- Head of Physical Planning Department – 1
- Development Control and Planning Inspectorate - Minimum 1, Maximum 3

The following is the list of relevant classes and staff for the Physical Planning Department:

1. Professional Class:
   Chief Physical Planning Officer/Director
   Principal Physical Planning Officer/Deputy Director
   Senior Physical Planning Officer
   Physical Planning Officer
   Assistant Physical Planning Officer

2. Sub – Professional Class:
   Chief Physical Planning Assistant
   Principal Physical Planning Assistant
   Senior Physical Planning Assistant
   Physical Planning Assistant

3. Technical Class:
   Chief Technical Officer
   Principal Technical Officer
   Senior Technical Officer
   Technical Officer

6.3 Building Permit Acquisition Process

According to Act 936 (2016), a person shall not carry out a physical development in a district except with the prior written approval in the form of a written permit issued by the District Planning Authority. The following steps must be followed when a developer intends to embark on a construction project in the acquisition of a building permit which is a statutory requirement:

- Submission of a complete building permit application form.
- Submission of 4 sets of building architectural drawings certified by a registered architect or engineer, land documents and proof of land ownership by the developer to the Physical Planning Department of the Assembly for consideration.
- The Spatial Planning Committee of the Assembly acting through a technical sub-committee (Physical Planning and Works Department, Environmental Health Department, EPA Representatives, NADMO Representatives, Lands Commission, Fire and other co-opted members) sit to review the submitted documents.
- A technical assessment is initially conducted within 2 weeks of the receipt of the application, on the drawings with particular attention to the zoning, structure and suitability of design for the proposed location.
- Where additional requirements are needed, the application is then referred to other sectors such as the Lands Commission, agencies and other professionals.
- If the application is satisfactory at this stage, a joint site inspection is scheduled with the members of the technical sub-committee.
- The applicant is then required to pay a non-refundable processing fee as published in fee fixing resolution for the year.
- Once the fee is paid, a date is scheduled for technical inspections conducted by the Technical Sub-Committee.
- The committee then examines the application and makes a recommendation for approval or otherwise by the Spatial Planning Committee Chaired by the MCE or Coordinating Director.
- The decision of the Committee is then communicated to the applicant and upon approval, the applicant is required to pay the building permit fee.

6.4 Conduct of Construction Supervision and Occupancy

Following building permit approval for any type of development, the developer is required to write to the Engineer at the appropriate Assembly for commencement of work. The Engineer then assigns a Building Inspector to the site for monitoring purposes to ensure compliance with the approved permits and in accordance with the approved schedule and designs provided by the developer to the Assembly on the various stages of the development.

Building Inspectors usually should have an engineering background and operate according to operational manuals from the Works and Physical Planning Departments. These manuals indicate the professional requirements and enforcement processes of the Building Inspectors

7. DISCUSSION

Using all the previously described methods, we have presented our findings in line with the objectives of the assignment which were the guiding principles in our quest to uncover events surrounding the collapse. These are detailed below:

7.1 Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.

Following meetings held with officials from La Nkwantanang Municipal Assembly, it came to light that the developers of the collapsed building did not acquire the requisite building permit from the Assembly prior to commencement of construction on site as required by law. Further probing uncovered that the Assembly through its officers, issued a "STOP WORK, PRODUCE PERMIT" order (Order No.0021431) to the developers upon their discovery of the development on the 20th of April 2023. The construction was therefore halted by officials of LaNMMA until the developer's acquisition of the required permits.

It was however discovered that the developers defied the aforementioned order and continued with construction on the blind side of the Assembly (usually on weekends and at night). LaNMMA resultantly had no records of the construction project, site or developers due to the developer's unauthorised activities at the site.

7.2 Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.

As previously discussed, the Committee were unable to retrieve any relevant information on the construction from the Assembly because the developer or the owner was not known. We therefore are unable to comment on their professional capacity and its suitability for the job.

Our research led us to uncover that, though the law provides for professionals to be engaged to act on behalf of the Assembly under various capacities, the departments are currently adequately staffed per the law. The Physical Planning Department of LaNMMA currently has employed 2No. Professional Planners, 3No. Technical Officers and some supporting staff. The Works Department also has under employment. However, due to the large coverage of the Assembly and the exigencies of the job, additional staff may be required for the departments to fully perform their functions.

Our engagement further revealed that the professionals and levels of expertise required to fully carry out the mandate of the Municipal Assembly in permit acquisition is adequate. However, in the area of construction monitoring, which is a key area directly linked to building collapses and malpractices, staffing levels may require reinforcement to ensure compliance.

7.3 Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.

7.3.1 Adequacy of Existing Institutional Arrangements

With regards to building construction and infrastructure development, the Physical Planning and Works Departments of the Assembly are responsible for assisting in the review and approvals of building permit applications in line with the Ghana Building Code and other regulatory enactments, as well as monitoring of physical developments to ensure compliance with planning regulations and approved spatial plans.

A key challenge of the Assembly is in the area of development control. However, Section 91 sub-section 2 of Act 936 empowers the Assembly to enforce developments that conform to the Assembly-approved plan for any locality under their jurisdiction. Section 94, sub-section (4) states that, "a person who fails to comply with an enforcement notice demanding immediate stoppage of the execution of work commits an offence and is liable on summary conviction to a fine of not less than 200 penalty units and not more than 400 penalty units or to a term of imprisonment of not less than 3 months and not more than 6 months or to both the fine and term of imprisonment; and in the case of a continuing offence to an additional fine of not more than four penalty units for each day that the contravention continues after written notice has been served on the offender." Furthermore, Section 95 of Act 936 states that, "a District Planning Authority may prohibit, abate, alter, remove or demolish a physical development that does not conform to an Approved District Development Plan."

7.3.2 Procedures for Review and Approval of Building Permits

The entire building permit application processing period is One (1) month. Depending on the nature of the development, additional drawings such as structural and services drawings, geotechnical reports, traffic impact assessment and the like are requested from the Applicant by the Spatial Planning Committee to aid reviews. Technical issues such as the zoning of the area for the proposed development and flight restrictions are investigated as part of the application review.

In spite of the previously described laid down procedures, it has been the practice to require applicants to pay the building permit fee prior to approval. The applicants then go ahead to develop their structures ahead of their receipt of formal approval from the Assembly. The Committee discovered that this practice, though unlawful, ensured the generation of funds for the Assembly hence, their reluctance to adhere to the laid down procedures. The Ministry of Local Government Decentralisation and Rural Development through the Local Government Service however, recently instructed (insert date) that all Assemblies should cease the collection of upfront payment of building permit fees and work in line with the laid down regulations. We are however unable to comment on the status of the Assembly's adherence to the directive.

7.3.3 Events After Building Permit Approval

Our findings indicate that most developers fail to engage with the Assembly following permit approval. They do not adhere to by the requirement to inform the Assembly of their commencement of works as well as other operations. The Assembly however, who are backed by law to enforce adherence to building regulations have failed to perform this role. Some challenges identified with regards to the Assembly being unable to carry out their mandate in this regard is the inadequate personnel and logistics as well as excessive and undue political interference.

The inadequacy of logistics such as vehicles and fuel has restricted Building Inspectors, who ought to be field-based to be office based. They are therefore unable to monitor and inspect the full number of sites they have been assigned to. Other logistics such as computers, cameras and PPEs are in short supply or in some cases, unavailable for their use. The field reports produced by these inspectors are therefore of low quality. In the case of this building collapse, inadequate logistics resulted in officials from the Assembly reporting to the scene a day after the event had occurred after all debris had been cleared from the site and virtually no information was available on the incident.

Though the Act allows for the engagement of a number of technical staff under the various departments, these numbers have proven to be inadequate in practice. For a large Assembly such as LaNMMA, additional numbers are required on the field especially, in order for their impact to be truly felt. The Assembly has also been affected by the freeze on employment in the public sector like other government agencies and institutions and this has affected their output significantly.

Another predominant challenge identified from our interviews was the incessant and sometimes excessive political interference in the activities of the Assembly or its agents. Political figures in some cases tend to flout the law regarding the erection of structures, permitting and related matters. Heavy presence of land guards on some sites was also cited as a major deterrent for Assembly officers from gaining access to some sites. It was found that in most cases, the activities of these land guards are backed by influential politicians in the country making such sites untouchable.

7.4 Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.

As previously discussed, real time data on the collapsed building or agents involved was unavailable firstly due to the unauthorized construction works and therefore the Assembly not having access to any documentation on the project. Also, due to the time lapse between when the event occurred and the commencement of our investigations, there was very little evidence available on the site to aid our investigations. We were unable to interview any witnesses to obtain their accounts of the incident.

However, from the description of the incident and nature of the collapse, we are able to make suggestions on the possible causes of the collapse. These are not exhaustive as several other factors could have contributed to the collapse. Nonetheless based on our professional opinion after assessing information available to us, we attribute the possible causes of the collapse to the following:

- Failure of developers to adhere to building regulations: failure to acquire building permits prior to construction and the failure to keep Assembly informed of all site activities to facilitate monitoring.
- Lack of awareness of the general public on building regulations: inadequate public sensitization on the procedures involved in commencing building development and the requirements that must be satisfied for successful execution.
- Poor workmanship on the part of developers: use of unqualified and inexperienced tradesmen and foremen in the execution of construction works to reduce cost.
- Use of low-quality materials: purchase and use of sub-standard materials for construction in a bid to minimize the effect of high cost of construction materials on overall project cost.

- Design challenges: complexity and non-buildability of designs may prove challenging when implementing on site and may fall short of predetermined acceptable standards.
- Delays in the processing of building permits: in most cases, the building permit application process takes longer than the stipulated 1-month turnaround period which frustrates developers and forces them into starting construction prior to receiving approval.
- Low capacity of assemblies to enforce building regulations: inadequate staff, logistics and political interference have incapacitated most assemblies in carrying out their monitoring and regulatory mandate.

7.5 Conduct structural assessment of the collapsed building and any available records of the building construction.

As previously mentioned, upon our visit to the site, all debris or remnants of the collapsed structure had been cleared. This therefore made it impossible to conduct a structural assessment of the collapsed building. Also, due to the developer's unauthorised operations, we were unable to obtain any relevant documentation on the designs and other key documents. This is attributable to the absence of a building permit for the works resulting in the Assembly not having any records of the development.

We are resultantly unable to comment on the structural soundness or lapses of the development.

7.6 Identify any liability based on the findings including designs, construction and supervision and building code violation.

From our investigations, due to the lack of substantial evidence at the collapse site as well as our inability to retrieve and review development documents, designs, information on the developers and supervision protocols, we are unable to form direct links of persons liable for the collapse.

With regards to building code violations however, a number of violations were identified particularly under the Administration and Enforcement Section as well as the Permits Section.

7.6.1 Administration and Enforcement

a. Section 1.4.2 – Applications and Permits

According to the Code, The Head of the Works Department under the Municipal Assembly in this case is responsible for receiving applications, reviewing construction documents and issuing permits for the erection, alteration, demolition and moving of buildings and structures. He/she is also mandated to inspect the premises for which such permits have been issued and enforce compliance with the provisions of the Code.

Violation: The developer failed to submit this application for the works from our investigations. The Assembly was therefore unable to inspect the premises to enforce compliance as no permit was issued.

b. Section 1.4.3 – Notices and Orders

The Code requires the Head of Works to issue necessary notices or orders to ensure compliance.

Violation: We gathered that a "STOP WORK AND PRODUCE PERMIT" notice was served to the developers of the collapsed building in April 2023. The developers however, ignored this notice and continued to execute the works in defiance of the regulation. They did not proceed to apply for a building permit even after the notice was served.

7.6.2 Permits

a. Section 1.6.1 – Required Permits

The Building Code requires any owner who intends to construct a building or structure which is regulated by the code to first make an application to the local authority to obtain the required permit.

Violation: As previously noted, the developer failed to submit this application for the works from our investigations. The Assembly was therefore unable to inspect the premises to enforce compliance as no permit was issued.

8. RECOMMENDATIONS & CONCLUSIONS

Based on the above findings and discussions, the Committee recommends the following:

- Payment of building permit fees prior to approval and issuance of permit should cease immediately. Efforts must be made to adhere to regulations irrespective of revenue losses.
- The Assembly must make use of professional expertise outside the Spatial Planning Committee especially those that they do not possess in-house, in the vetting of designs and associated reports. Professionals with minimum 5 years professional working experience should be considered for such vetting exercises.
- The Works and Physical Planning Departments must be strengthened and the Building Regulations strictly enforced. Staff of these Departments should be allowed to fully carry out their mandate without any interference. Training of current staff to upgrade their skills to meet industry standards and requirements should be regularized and made mandatory in the absence of the government's employment of new staff.
- The Planning and Building Inspectorate Division must be strengthened with four (4) additional staff. The Committee proposes the recruitment of two (2) additional technical staff each for the Physical Planning Department and Works Department due to the size of the municipality.
- Provision and maintenance of adequate logistics such as vehicles or motorcycles to boost field operations. Also, other items such as fuel, cameras, laptops should be made readily available for staff of the above-named departments.
- The Secretariat of the Spatial Planning Committee must ensure that applicants satisfy all requirements prior to accepting their applications and associated documentation for processing.
- As part of the permit process, the Assembly should compel the Developer to engage professionals for the Construction works. Rigorous checks to be conducted by the Assembly on Developers' engagement of professionals in the execution of construction works and supervision. Built environment institutions to furnish assemblies with a list of registered members in good standing to aid verification of professionals presented by developers.
- Public education and awareness on permit acquisition must be improved by both the Assemblies and the Built Environment professionals.
- Construction supervision of all projects 2-storey and above, as a responsibility of the Assembly, should be strictly enforced. The monitoring should be outsourced to professionals where necessary to ensure it is carried out at all times and for all ongoing construction works. The Assembly could include in fees charged, an amount for professional assistance especially in the area of post permit inspections and supervision.
- Geotechnical investigations to be considered for every project irrespective of the nature of the works prior to commencement of construction on site. Particular focus should however be on high rise structures.
- Evidence of insurance cover to be made mandatory for permit applicants for commercial buildings and high-rise residential buildings.
- Assemblies to enforce their mandate to prosecute defaulters where necessary in a bid to ensure compliance with regulations (Land Use and Spatial Planning Act 925 – Section 117, Sub-section 2). Though the litigation process may be lengthy, special courts and timelines should be set up to fast-track permit related issues and prosecute defaulters.

- Assemblies to revive their mandate of ensuring that certificate of habitation is acquired by all developers following the completion, inspection and sign-off of their properties. This will serve as evidence that the right processes were followed in permitting as well as construction.
- Assemblies should not entertain permit applicants with unclear lines of ownership to the land they intend to develop. In view of this, supervision by the Assemblies to be improved upon to uncover developers who have commenced construction works without the appropriate proof of land ownership as well as the absence of a building permit.
- Building permit application and acquisition process should be fully digitized to avoid bottlenecks due to the physical contact with developers. This will eliminate to some extent, the possibility of corruption and overcharging within the Assemblies.
- Assemblies should ensure that registered professionals make submissions for permit applications instead of developers as a means of authenticating the proposed development. This will mandate all developers to engage the services of registered professionals in the planning and execution of their developments and minimize the incidence of such building collapses.

Though mandated by law to ensure that permits are acquired prior to the commencement of construction works, the Assemblies have failed to enforce this. Contributory factors such as payment of building permit fee pre-approval due to revenue losses when paid post-approval, inadequate field staff and logistics as well as failure to sanction offenders where necessary have resulted in this challenge.

Most members of the general public lack knowledge of the law with regards to building permit acquisition procedure as well as monitoring and inspection requirements. This is directly related to the inadequate information dissemination on the area.

The Assembly failed to follow-up on the 'STOP WORK AND PRODUCE PERMIT' notice issued to the Developer to ensure that works had been indeed halted until the necessary permit was acquired and inspections conducted. The Assembly's strict enforcement of the halting of the construction works could have prevented the developer from engaging in construction activities on their blindside and could have averted the collapse.

In conclusion, an adequately resourced Municipal Assembly, free from any forms of interference, is likely to produce tangible results in the areas of ensuring appropriate permitting, construction monitoring and general conformance to building regulations, could prevent buildings from collapsing in the future. This is because, the Assembly will ensure that the right measures are put in place and acceptable construction practices adhered to from inception to completion of building projects.

9. REFERENCES

1. Local Governance Act (Act 936), (2016)
2. Land Use and Spatial Planning Act (Act 925), (2016)
3. Ghana Standards Authority (2018), *Ghana Building Code – Building and Construction (GS 1207: 2018)*
4. Local Government Service (2018), *Works Department Operational Manual*
5. Local Government Service (2018), *Physical Planning Department Operational Manual*
6. Local Government Instrument (Departments of District Assemblies Commencement) (L.I. 1961), (2009)
7. L. A. Asante & A. Sasu (2018), *The Challenge of Reducing the Incidence of Building Collapse in Ghana: Analysing the Perspectives of Building Inspectors in Kumasi,* Sage Publications

APPENDICES

Appendix A – Minutes of Maiden Committee Meeting

minutes of meeting

assignment title	BCIC: West Adenta/La Nkwantanang Collapsed Building Adhoc Committee - Madina		
meeting type	Kick-Off Meeting		
held at	Via Zoom @ 11:00am	**held on**	Tuesday, 23 May 2023

present

Arc. Chezrie Degraft Takyi	GIA - Architect (Chairman)
Ing. Johnson Obeng Afari	GhIE – Structural Engineer (Secretary)
Surv. Ruweida I. Adam	GhIS – Quantity Surveyor (Secretary)
Pln. Felix Offei	GIP – Planner (Member)
Surv. Jacob K. Boateng	GhIS – Land Surveyor (Member)
Surv. Jefferson Zumegah	GhIS – V&E Surveyor (Member)
Ing. Joseph Oddei	GhIE – Geotechnical Engineer (Member)

Distribution	All	
Recorded by	Ing. Obeng Afari & Surv. Ruweida I. Adam	Secretaries
Apologies	None	

1

minutes of meeting

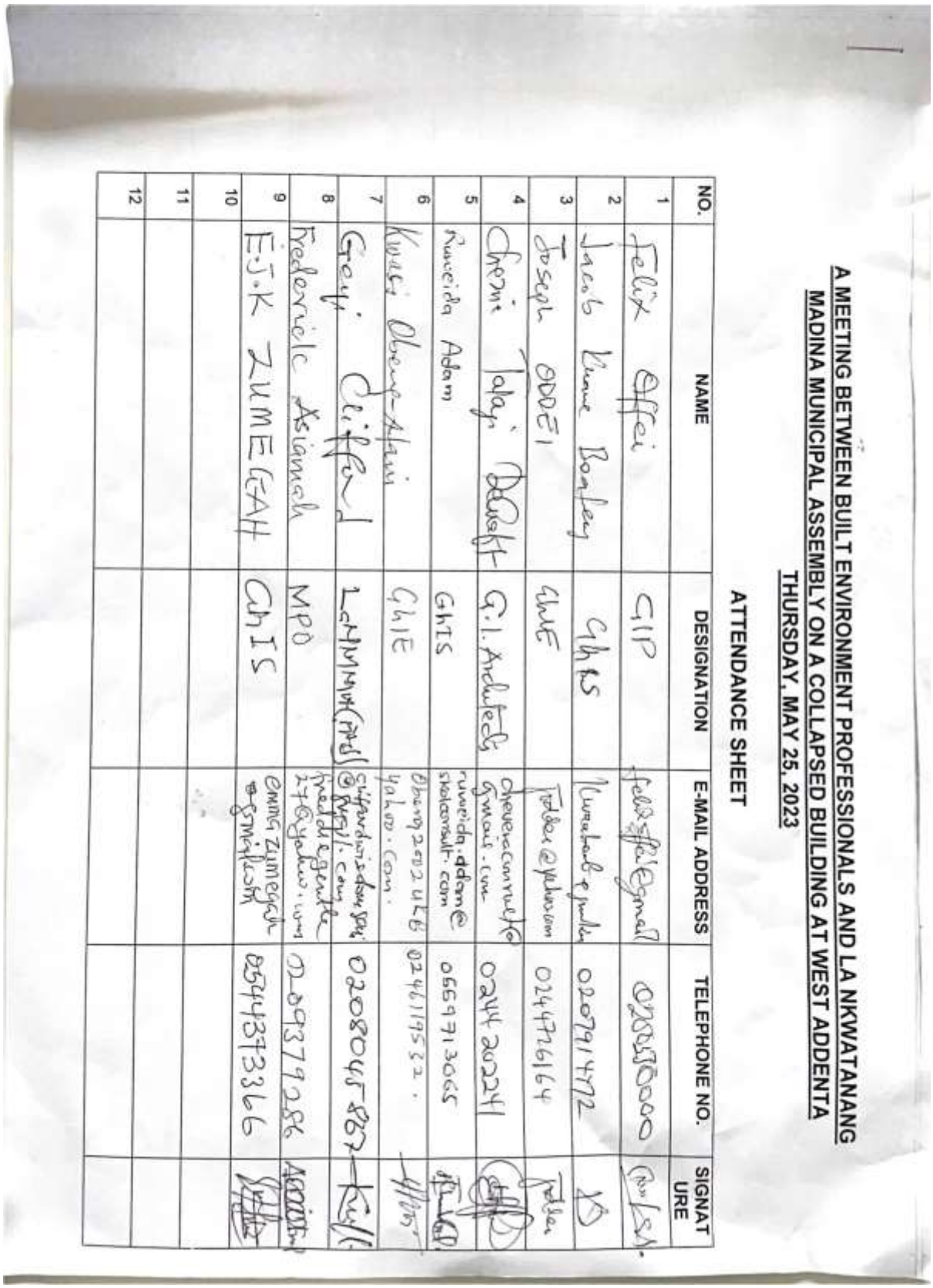
ITEM	DESCRIPTION	ACTION
	Objective of the Meeting 1. Introduction of Team Members 2. Appointment of Leaders 3. Statement of objectives/Strategy 4. Assignment of responsibilities and tasks 5. Timelines 6. A.O.B	
1.0	**Introduction**	
1.1	The meeting commenced at 11:30am with an opening prayer. The Architect then explained the purpose of the meeting which was to discuss key issues concerning the assignment and the way forward in delivering objectives.	Note
2.0	**Appointment of Leaders**	
2.1	The following were nominated and appointed as committee leaders in various capacities: • Arc. Chezrie Degraft Takyi - Chairman • Ing. Obeng Afari - Secretary • Surv. Ruweida I. Adam - Secretary	Note
3.0	**Statement of Objectives/Startegy**	Note
3.1	The Chairman mentioned the following as the objectives of the assignment:	
4.0	**Assignment of Responsibilities and Tasks**	
4.1	Task assignments were made mostly based on the background and strengths of the various professional team members. The task assignments are as follows: • Structural assessment of collapsed building and available records – Ing. Obeng-Afari & Ing. Odei • Assessment of adequacy of procedures for permitting, construction and supervision – Surv. Ruweida Adam • Ascertain whether requisite permits were acquired prior to commencement – Arc. Degraft • Collect and analyse data to determine cause of collapse – • Identify any liability based on research findings and building code regulation – • Report preparation - All	Note
4.2	We were also to look out for the following as a committee: • Professionals involved if any • Stakeholder consultation	Note
5.0	**Timelines**	
5.1	A joint visit to the assembly was scheduled for Thursday 25 May 2023 at 10:00am following which the team would move to the collapse site.	All

2

minutes of meeting

ITEM	DESCRIPTION	ACTION
5.2	Investigations to be concluded by Monday 29 May 2023, following which report writing and compilation will commence.	Note
5.3	All members to prepare beforehand, possible questions to engage Assembly staff to enable us meet our objectives.	Note
6.0	**Any Other Business**	
6.1		
7.0	**End of Meeting**	
7.1	The meeting was concluded with a closing prayer and ended at 2:15pm.	Note

Appendix B - Attendance Sheet from LaNMMA Meeting



A MEETING BETWEEN BUILT ENVIRONMENT PROFESSIONALS AND LA NKWATANANG MADINA MUNICIPAL ASSEMBLY ON A COLLAPSED BUILDING AT WEST ADDENTA

THURSDAY, MAY 25, 2023

ATTENDANCE SHEET

NO.	NAME	DESIGNATION	E-MAIL ADDRESS	TELEPHONE NO.	SIGNATURE
1	Felix Offei	GIP	Felix.offei@gmail	0208150000	
2	Jacob Kwame Bonney	GhIS	kwamebonney@yahoo.com	0207914772	
3	Joseph ODOTEI	GhIE			
4	Chioni Tokpa Dzifa	G.I. Architects	chioniecommunity@gmail.com	0244726164	
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6	Kwasi Obeng-Asiedu	GhIE	Obeng2002uk@yahoo.com	0556971305	
7	Seyi Clifford	LaNMMA(PRO)		0246119552.	
8	Frederick Asiamah	MPO	cliffordseyi@gmail.com freddieagents27@yahoo.com	0208045867	
9	E.J.K ZUMEGAH	GhIS	emmazumegah@gmail.com	0243737286	
10				0544337366	
11					
12					

Appendix C – Report on Collapsed Building from LaNMMA

LA NKWANTANANG – MADINA MUNICIPAL ASSEMBLY
WORKS DEPARTMENT

MEMORANDUM

TO:	MUNICIPAL CHIEF EXECUTIVE
THRO:	HEAD OF WORKS
FROM:	HEAD OF DEVELOPMENT CONTROL
DATE:	2ND MAY, 2023
SUBJECT:	**REPORT ON THE COLLAPSED THREE-STOREY OFFICE STRUCTURE LOCATED AT ADENTA SDA JUNCTION**

Please find attached a copy of the above stated subject matter for your consideration.

ING. RICHARD K. ARTHUR
(DEV'T CONTROL OFFICER)

2ND MAY, 2023

REPORT ON THE COLLAPSED THREE-STOREY OFFICE STRUCTURE LOCATED AT ADENTA SDA JUNCTION

INTRODUCTION:

The three storey structure under consideration is an unauthorised structure. Our preliminary investigation shows that this structure commenced about a month ago on a plot of land which is a made up land. A stop work, produce permit notice **(number 0021431)** was served on the developer on the **20th of April, 2023** by an officer from the building inspectorate unit of LaNMMA. However, the developer had refused to respond to the sermons notice issued on him. To escape the enforcement powers of the assembly, the developer had resorted to working mostly on weekends and overnights.

OBSERVATION:

On **1st May, 2023,** at about 3:00pm, we received a report of the collapse of the said structure located at **SDA junction** after the **KPOGAS shop**. This morning **2nd May, 2023,** at 9:00am officials from LaNMMA visited the site of the collapse structure in the company of the Honourable Chief Executive. It was observed immediately that debris from the collapse structure had been collected overnight and the site cleared leaving no trace. After cursory observation of the site, we identified **6No. 16mm** reinforced bars in each of the demolished columns. We also identified other sizes of reinforced bars. We are however constrained to make judgement on how the reinforced bars were used as the site had been completely cleared. We could not determine the depth of the foundation and columns. We also were unable to determine the column base, column size, beam size, and floor thickness.

RECOMMENDATION:

1. It is recommended that a Structural Engineer is brought to the site to investigate and determine the quality of materials used.

2. The above mentioned engineer will also test the bearing capacity of the soil of the location as the land on which the structure sat was a reclaimed land.

3. It is also recommended that services of a materials engineer from the Ghana Highway Authority is procured to collect and test to determine whether the correct ratios of materials were used for the concrete mixture.

Appendix D – Site Photographs



Fig.1 - View of the collapse site showing remnants of cleared site



Fig.2 - View of the collapse site showing remnants of cleared site



Fig.3 - View of the collapse site showing remnants of cleared site



Fig.4 - View of the collapse site showing remnants of cleared site

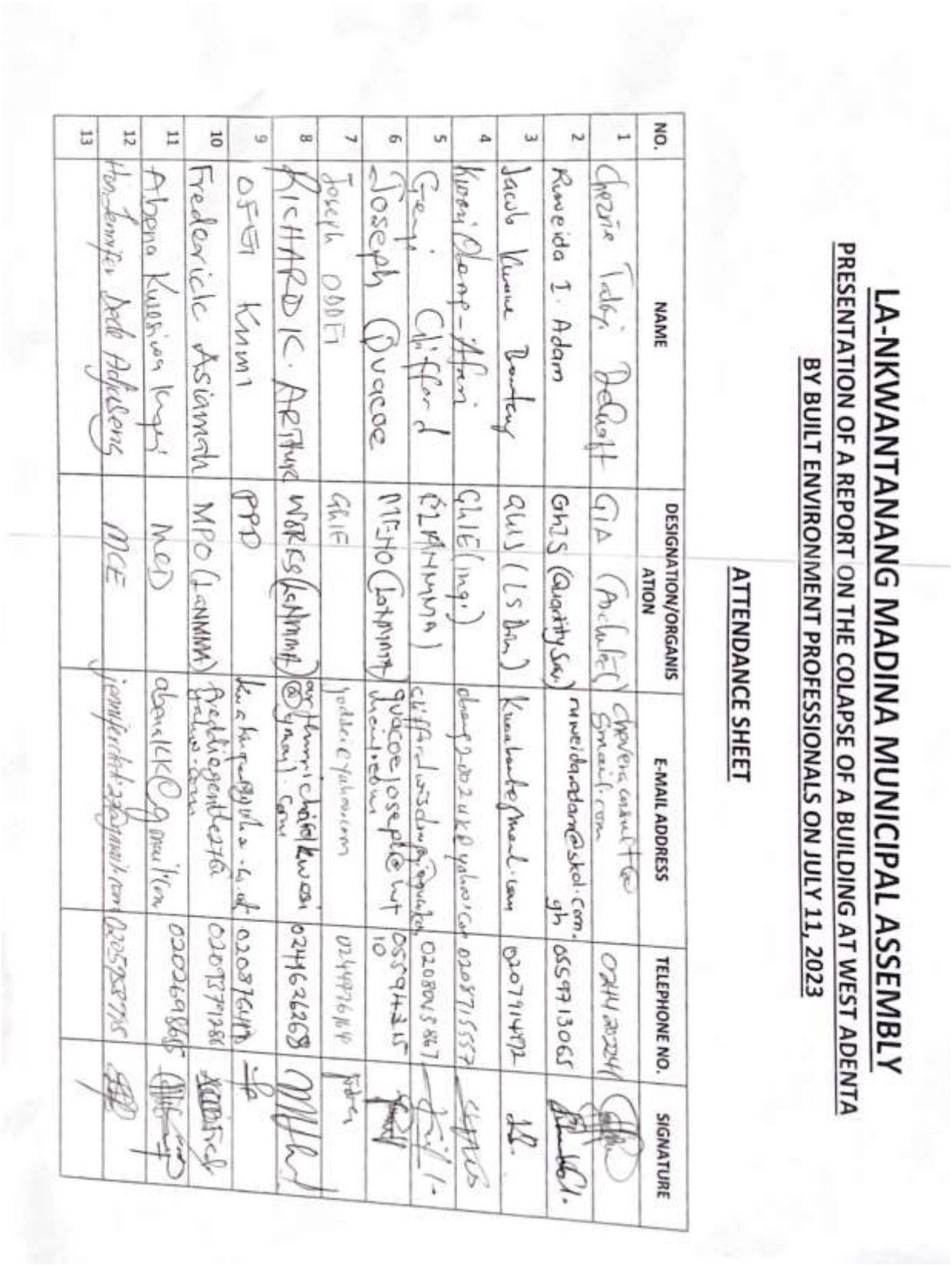


Fig.5 – View of the collapse site showing remnants of cleared site



Fig.6 – Committee Members and Assembly officials at the collapsed building site

Appendix E – Attendance Sheet from LaNMMA Meeting Post-Findings



LA-NKWANTANANG MADINA MUNICIPAL ASSEMBLY

PRESENTATION OF A REPORT ON THE COLAPSE OF A BUILDING AT WEST ADENTA BY BUILT ENVIRONMENT PROFESSIONALS ON JULY 11, 2023

ATTENDANCE SHEET

NO.	NAME	DESIGNATION/ORGANISATION	E-MAIL ADDRESS	TELEPHONE NO.	SIGNATURE
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11	Abena Kuakuwaa Kyei	MED	abenakk@gmail.com	0200269865	
12	Akosua Dede Addisons	MCE	jennifer.addisons@gmail.com	0265257755	
13					

Appendix F – Minutes of Post-Report LaNMMA Meeting

minutes of meeting

assignment title	BCIC: West Adenta/La Nkwantanang Collapsed Building Adhoc Committee - Madina		
meeting type	Stakeholder Meeting on Report Findings and Recommendations		
held at	LaNMMA Head Office @ 10:20am	**held on**	Tuesday, 23 May 2023

present	Arc. Chezrie Degraft Takyi	GIA - Architect (Chairman)
	Ing. Johnson Obeng Afari	GhIE – Structural Engineer (Secretary)
	Surv. Ruweida I. Adam	GhIS – Quantity Surveyor (Secretary)
	Surv. Jacob K. Boateng	GhIS – Land Surveyor (Member)
	Ing. Joseph Oddei	GhIE – Geotechnical Engineer (Member)
	Hon. Jennifer Dede Afagbedzi	LaNMMA – MCE
	Abena Kwesiwa Kyei	LaNMMA – MCD
	Frederick Asiamah	LaNMMA – MPO
	Richard K. Arthur	LaNMMA – Works Department
	Ofei Kumi	LaNMMA – Physical Planning Department
	Joseph Quacoe	LaNMMA – MEHO
	Clifford Geyi	LaNMMA

Distribution	All	
Recorded by	Surv. Ruweida I. Adam	Secretary
Apologies	Surv. Emmanuel Jefferson Zumegah	Member
	Pln. Felix Offei	Member

1

minutes of meeting

ITEM	DESCRIPTION	ACTION
	Objective of the Meeting 1. Introduction and Statement of Purpose 2. Discussions on Findings and Recommendations 3. A.O.B	
1.0	**Introduction**	
1.1	The meeting commenced at 10:20am with the LaNMMA MCE introducing herself and her staff as well as the BCIC team introducing members in attendance. The purpose of the meeting was then established as a discussion of findings and recommendations made in the investigative report.	Note
2.0	**Discussions on Findings and Recommendations**	
2.1	It was proposed that the Assembly ensure that registered professionals make documentation submissions for permits instead of the developers.	Note
2.2	The permit application process to be made online or fully digital to avoid bottlenecks in the Assembly's internal processes.	Note
2.3	Built environment institutions to furnish Assemblies with a list of members in good standing for verification purposes.	Note
2.4	The Assembly confirmed that in ensuring that developers submit full set of required documents, permits are not approved once all requirements are not met.	Note
2.5	It was mentioned that land acquisition challenges are a major cause of developers building ahead of securing building permits.	Note
2.6	It was recommended that the Assembly enforce the request for geotechnical reports from applicants ahead of construction.	LaNMMA
2.7	It was noted that the developers failure to make permit fee payment after approval contributed to the Assembly's practice of collection of permit fee ahead of approval due to revenue losses.	Note
2.8	It was recommended that Assemblies could include in fees charged, an amount for the engagement of professionals to aid in post permit inspections or supervision.	LaNMMA
2.9	It was noted that in the absence of the government's employment of new staff, skills of existing staff should be constantly upgraded to build the Assembly's in-house capacity.	LaNMMA
2.10	The Assembly mentioned that they are faced with challenges in the enforcement of developers' acquisition of the certificate of habitation.	Note
2.11	It was brought to light that the Assembly does not frequently resort to prosecution of defaulters due to lengthy litigation procedures.	Note

minutes of meeting

ITEM	DESCRIPTION	ACTION
3.0	**Any Other Business**	
3.1	The Assembly mentioned that they are faced with challenges in the enforcement of developers' acquisition of the certificate of habitation.	Note
3.2	The officials of the Assembly requested for professional services on a hostel development near UPSA whose developer has flouted recommendations made in the S.I. report by overloading the existing foundation. The developer was instructed to evacuate students currently residing in the facility due to safety concerns of which he has ignored. Our professional advice was therefore being sought in reviewing available documentation.	Note
	End of Meeting	
	The meeting was brought to a close at 12:05pm.	

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SUBTITLE 2

REPORT ON BUILDING COLLAPSE AT NMAI DZORN(NANAKROM) IN THE ADENTAN MUNICIPALITY

PRELIMINARY INVESTIGATION INTO CAUSE OF COLLAPSE

JUNE 2023

ADHOC COMMITTEE ON NMAI DZORN BUILDING COLLAPSE

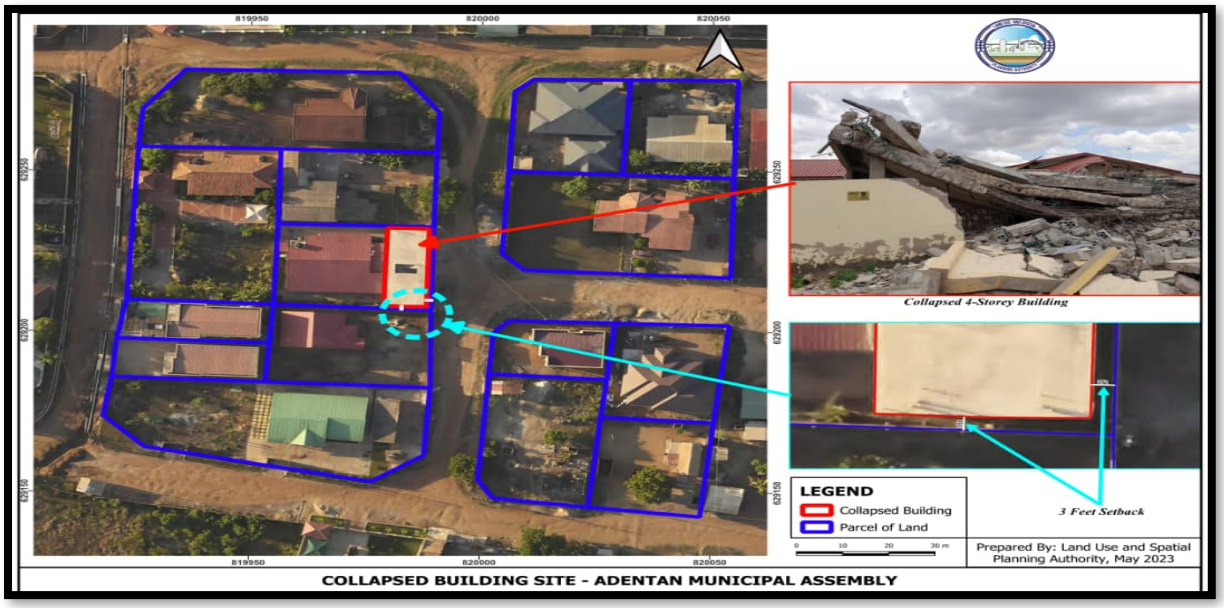
EXECUTIVE SUMMARY

The three-storey building (3 levels) was a mixed-use facility under construction belonging to Dr. Esther Wahaga and Mr. Arimeyaw Salley Ibn Saeed located at Nmai Dzorn in the Adenta Municipal Assembly in the Greater Accra region of Ghana. The development collapsed at Nmai Dzorn in the Adentan Municipal Assembly (ADMA) on the 4th of May 2023 around noon. The collapse resulted in one casualty, who, according to witnesses is said to be the foreman. This report is the outcome of an adhoc committee by built-environment professional institutions in Ghana that was tasked to investigate the incidence, report on key findings and make recommendations for policy consideration. The committee commenced work from Monday 22nd May 2023 to 5th June 2023 as prescribed in the terms of reference.

The Adhoc Committee visited the site of the collapse on Friday 26th May, 2023 and met with the Management of ADMA earlier before the site visit. The participants at the meeting included the Municipal Chief Executive, the Municipal Coordinating Director, the Head of Physical Planning Department, and the Head of Works Department. The information gathered from the meeting suggested that the Developer applied for a three (3) storey residential development permit in August 2020 and permit was granted in September, 2020. The development application permit went through the regular procedure of site visits, Technical Sub-Committee (TSC) and Spatial Planning Committee (SPC) meetings. Included in the application were Fire and Foundation test or Soil Report.

Findings from the land use and spatial planning assessments revealed that the collapsed building was in front of another building within the same parcel and had less than 3 feet setback from the parcel boundary and from the building behind. As a result of this, the collapse affected the property behind and has brought to question, the structural integrity of that building as well. However, upon inspection of the site and the block plan submitted in the development permit application, it was found out that the developer was putting up a 4-storey structure instead of the 3-storey permit granted in the permit application. Also, adequate setbacks were not provided for in the permit application and on the ground as shown in figure 1.

Figure 1: Map showing the site information of the Collapsed Building at Nmai Dzorn (ADMA)



Source: LUSPA, 2023

From the structural assessments, all the categories analyzed showed that the structure was DEAD FROM CONCEPTION TO BIRTH. IT WAS DEAD ON ARRIVAL. This means that, right from the design stage till the through the construction stage till it physically collapsed, the structural integrity of the building was very questionably inadequate. The number of footings and columns that had structurally failed under all the categories are structurally unacceptable. The avoidance or refusal to apply the ground beams was very bad. The size of the cantilever beams and the applied reinforcement suggest that there was no professional design of those beams, the columns and the pad footings.

Findings from the architectural assessment also revealed that there were discrepancies in the intended use of the building (mixed-use) as stated by the architectural drawings and the approved use (dwelling) as indicated in the permit. The interview with the architect confirms that the necessary geotechnical survey was not conducted prior to the submission of architectural and structural drawings to the Assembly. Apart from the initial site visit, the interview established that proper site analysis (desktop study, site recognizance survey, and ground /soil investigations) was not conducted to arrive at a good performance appraisal of the project before commencement of the design. The use

of low-skilled artisans instead of professionals at the construction phase of the project contributed to the low quality of work done on site.

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1.0 Introduction

In response to the spate of the collapse of buildings within a span of ten (10) days in the month of May, 2023 in the Greater Accra and Northern Regions, the Built Environment Professionals responded by calling for an emergency virtual meeting on the 8th of May, 2023 through the Presidents of the Ghana Institute of Architects (GIA), Ghana Institute of Engineering (GhIE), Ghana Institution of Surveyors (GhIS) and Ghana Institute of Planners (GIP). The Presidents of these Built Environment Professionals collectively agreed to commence investigations into the collapsed buildings and recommend strategies to help curb any future occurrences in the future. Based on the investigative powers conferred on built environment institutions, this committee was inaugurated on 18th May 2023 and tasked to investigate the incidence, report on key findings and make recommendations for policy consideration. The committee commenced work from Monday 22nd May 2023 to 5th June 2023 as prescribed in the terms of reference. This report present findings from the Adhoc Committee for Nmai Dzorn Building Collapse and the investigation was done by visiting the site of the building collapse, getting neighbouring residents' account of the incidents, interviewing, and inspecting evidence of development control processes undertaken by the Adentan Municipal Assembly.

1.1 Membership of the Adhoc Committee

The adhoc committee tasked to investigate the building collapse at Nmai Dzorn (Nanakrom) in Adentan Municipal Assembly (AdMA) comprised of representatives from the four built environment professionals in Ghana: Ghana Institute of Planners, Ghana Institute of Architects, Ghana Institution of Engineering and Ghana Institution of Surveyors. By a letter dated 22nd May 2023, the committee members were introduced to AdMA to commence the investigations.

The membership of the committee are:

1. Arc. Justice Kwame Offei-Nketiah (Architect)- Chairman
2. Pln. Dr. Benedict M. Arkhurst (Planner) – Member
3. Surv. Benjamin Kwasi Larbi (Quantity Surveyor) – Member

4. Surv. Franklin Liggie-Kudonoo (Land Surveyor)- Member
5. Surv. Edem Feglo (Valuation and Estate Surveyor)- Member / Secretary
6. Ing. Joshua Allotey (Structural Engineer)- Member
7. Ing. Kweku Solomon (Geotechnical Engineer)- Member

The committee was tasked to complete their work by 5th June 2023 (14 days)

1.2 Scope

The adhoc committee shall be responsible for investigating into circumstances leading to the collapse of the structure. The Committee shall specifically:

i. Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.
ii. Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.
iii. Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.
iv. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.
v. Conduct structural assessment of the collapsed building and any available records of the building construction.
vi. Identify any liability based on the findings including designs, construction and supervision. and building code violation.
vii. Prepare report including conclusions and recommendations.

1.3 Methodology

In order to realize the task assigned to the committee, the team deployed the following methods in getting the results:

- Interviews with key stakeholders
- Site visit (first-hand information and physical observation)
- Desk study
- Taking samples for testing

Interview with Key Stakeholders

In effort to obtain information as part of the investigations, the committee conducted interviews or had interactions with the following stakeholders:

a. Municipal Chief Executive & Municipal Coordinating Director: Hon. Alexander Nii Noi Adumuah and Mad. Jemima _____ respectively.

b. Staff of Works and Physical Planning Department , AdMA

   - Works Engineer
   - Physical Planning Officer

c. Client: Mr. Arimeyaw Salley Ibn Saeed

Meeting with the Municipal Chief Executive

The team met with the Municipal Chief Executive (MCE) in his office on 25th May 2023. The team assured the MCE that the committee was on a fact finding journey to establish the lapses that might have led to the collapse of the 3-storey building in the municipality. He assured the team of his cooperation and support of his staff in making the team's investigation successful. At the introductory meeting between the staff of Physical and Works Department of the Assembly and the team, the MCE gave a narration of the initial response of the Assembly when the incident occurred. He indicated that his outfit together with officials from NADMO, the Police, Military and National Dog Academy worked throughout the night before retrieving the trapped body of the deceased. He expressed disappointment at the lack of necessary machinery and equipment for rescue mission if such incident occurs.

Furthermore, the Ghana Institution of Engineering was contacted. Representatives visited the site and took samples for testing before allowing the owner of the building to clear the site. The Assembly is yet to receive feedback on the investigation. The team was informed that all ongoing projects within the Assembly was halted and developers had to submit structural integrity report of their projects before they were allowed to continue their works. Further engagement with the team highlighted the need for collaboration between professional bodies and the MMDAs to ensure a safe built environment.

Technical Meeting with Works and Physical Planning Departments

The committee had a meeting with the staff of the Physical Planning and Works Department. Present at the meeting were:

i. Head of Works Department -

ii. Head of Physical Planning Department -

iii. Technical Officers (Physical Planning Department)

iv. Building Inspectors/Engineers (Works Department)

v. Quantity Surveyors (Works Department)

The Head of Works Department assured the team that all the necessary documents requested prior to the meeting will be made available to the committee in due course. He indicated that the collapsed building was the first of such incident in the Municipality and confirmed that the incident led to one fatality and leaving the other artisan seriously injured. Further discussions revealed the following:

- There are a number of buildings which the assembly has identified to be defective and liable to collapse.
- Most developers cannot produce drawings they are using for their construction.
- The prevalence of land guards hinders proper inspection of work stages.
- Some developers do not notify the assembly prior to commencement of works.
- Developers often engage draughtsman to design structures and these drawings are endorsed by professionals.

- In most cases, the Assembly is not in the position to verify the status of professionals who endorse drawings submitted to them.

The committee together with the team from the Assembly visited the site of the collapsed building after the meeting. Documents on the project requested by the committee were to be delivered early the following week.

Meeting with the Owner/Client

The committee met with Mr. Arimeyaw Salley Ibn Saeed, the owner of the collapsed building. The interview revealed the following:

- The owner engaged an architect and structural engineer to design the structure.
- Soil test and fire safety report were presented upon request from the Assembly.
- There was no qualified professional engaged for the construction. He commissioned the mason to build the structure after the mason (now deceased) showed him pictures of works he has previously executed.
- It was the responsibility of the mason to recruit all other artisans (carpenter, plumber) involved in the construction of the building.
- The owner was responsible for purchasing all materials upon request from the mason.
- At the substructure phase, the owner alleged that the mason refused to connect the columns with ground beams.
- The owner at a certain stage of the construction realized the columns were deficient and requested for additional columns to be erected.
- The owner was not comfortable with the insertion of service pipes within the columns.
- As at last year, the mason made a request for further reinforcement bars to be purchased upon realizing that the building was undergoing settlement. Materials were delivered to site by the owner but were not utilized until the collapse.
- Mason (deceased) signaled the failure of the structure two (2) days before the collapse of the building.

1.3 Spatial and Land Use Planning Assessments

This section discusses the land use and planning assessment of the application for permit by the applicant pursuant to Section 117(1) of the Land Use and Spatial Planning Act, 2016 (Act, 925), Regulation 45(2) of the Land Use and Spatial Planning Regulations, 2019 (L.I. 2384) and Section 91(1) of the Local Governance Act, 2016 (Act 936) which stipulates that the District Assembly must ensure that a person shall not undertake a physical development without a development permit.

Submission of the Application

The application for the permit was duly submitted to the Physical Planning Department of the Adentan Municipal Assembly on the 28th August, 2020 in accordance with Section 42(1) and Section 185 (5) of Act 925 and Regulation 8(2)(b) of L. I. 2385 which designate the Physical Planning Department as the Secretariat for receiving development applications and further processing. The applicant submitted the following documents as part of the permit application;

i. 4 set of architectural drawings including structural drawings and endorsed by an architect and a structural engineer.

ii. Soil Test Report

iii. Fire Report/Certificate

iv. Land Title Certificate (Certificate No. TD. 13485)

Conformity of Proposed Development to Local Plan

According to Section 79 of Act 925, the District Assembly must ensure that all physical developments conform to an approved land use plan. There is a local plan for the Nmai Dzorn enclave and the site in question is zoned as residential on the Nmai Dzorn Local Plan. The permitted development was therefore in conformity with the approved local plan for the Nmai Dzorn area.

Site Inspection

Officers from the Physical Planning and Works Department inspected the site with the applicant. However, the site inspection report cannot be traced on the application file.

According to the officials of the Physical Planning and Works Department, there was no development on the site at the time of submission and site inspection. Interviews with officials from the Assembly revealed that there was no joint site inspection by the Technical Sub-Committee of the Adentan Municipal Assembly as stipulated by Regulation 44(7f) of L.I 2385.

Review and Approval of Development Application

The application of permit by the applicant was forwarded to the Technical Sub-Committee Meeting in September 2020. The Technical Sub-Committee had a quorum during the meeting and it was chaired by the Works Engineer. The Technical Sub-Committee recommended the application to the Spatial Planning Committee for approval.

The Spatial Planning Committee of the Adentan Municipal Assembly met in September 2020 and approved the application of the client for residential use. The Spatial Planning Committee Meeting was chaired by the Municipal Chief Executive. Minutes of the Technical and Spatial Planning Committee Meetings are available in the records of the Secretariat of the Spatial Planning Committee.

Issuance of Permit

The Adentan Municipal Assembly Spatial Planning Committee issued a residential development permit to the applicant within 30 days as required or stipulated in Regulation 44(10) of L.I. 2384. According to the regulation, a District Assembly must ensure that permits are issued within thirty (30) days. The development permit to the applicant was thus issued on the 1st September, 2020.

Post Permit Supervision

Interviews with officials from the Adentan Municipal Assembly revealed that there was no post permit supervision or inspection by the Planning and Building Inspectorate Unit of the Assembly. The Planning and Building Inspectorate unit failed in their routine inspections to identify the development to monitor the stage by stage inspection as can be seen in Table 1.

Deduction and Conclusion

The development application followed due process in the submission to permit issuance by the Adentan Municipal Assembly. However, the Municipal Assembly according to the investigations issued a development permit for residential development but the client/owner was developing a mixed use facility. The planning and building inspectorate unit of the Adentan Municipal Assembly failed to do post permit supervision and inspection of the development and this contributed to the collapse of the building.

Table 1: Summary of Findings from preliminary inquiries into development control processes and procedures relating to collapsed buildings

MMDA	Adentan Municipal Assembly
PERMIT	The development had permit for: • 3 storeys Residential development at Nmai Dzorn. • Application received on 20th August 2020. • Permit issued on 1st September 2020
DETAILS OF PERMIT APPLICATION	The application had • Architectural Drawings • Fire Report • Soil Test Report for 3- Storey Development.
PROCESS FOR GRANTING PERMIT	• There was a site inspection but no evidence of site inspection report. • Evidence of minutes on TSC vetting and SPC approval meetings.
STATUS OF DEVELOPMENT BEFORE COLLAPSE	• 4-storey uncompleted structure at 3rd floor level.
STAGE BY STAGE INSPECTION	• No inspection or engineering guidance from the Assembly.
STOP NOTICE	• No stop order notice for 4th Floor which was not part of the permit issued.

POSSIBLE CAUSE OF COLLAPSE	• No evidence of professional supervision of the construction from the Assembly. • Soil investigations were made for 3-storey development however, there is no evidence of alternative design consideration for the load bearing capacity of the soil for the 4-storey development.

1.4 Structural Assessment

This part of the investigation covers the view and findings of the Structural Engineering works and architectural design. The methodology included, but not limited to, the following:

- Compilation of information gathered from interview of stakeholders.
- Compilation of information from site observations, including pictures and progress reports
- Review of the Architectural, Structural and Services design drawings and the Structural design calculation report
- Material test reports
- Geotechnical investigation reports

At the time of this investigation, the debris of the collapsed building have almost been totally cleared from the site. It was gathered that another engineering group has been able to obtain information in form of pictures and material tests before the debris were cleared from the site. The Nmai Dzorn Adhoc Committee is yet to receive copies of the information gathered by the other engineering group. Material test results, construction progress reports, site pictures at the time of collapse and Structural design calculations are yet to be obtained and evaluated. Therefore, this report is being compiled without the above-mentioned information.

Information gathered from Interview on and off the site

An interview with the owner of the collapsed building indicated that, someone had hinted that it would be good to introduce ground beams to tie all the columns at the ground floor together. This means that, ground beams were not applied during the construction. It was also intimated that, shortly before the collapse of the building, someone had hinted the project foreman that the building was sinking. Following this assertion, it was realized that several cracks had developed at some parts of the building, from bottom to top. This indicated an on-going serious engineering failure.

Information gathered from site visit

Although almost all the debris had been cleared away from the site at the time this investigation group got to the site, it was realized that the ground seem ‘soft and clayey. It

was also realized that at least stumps of column reinforcement were still showing out in the ground. This indicated 6R16 bars for one such main column. The as-built situation will be found out when information is made available to us by the other engineering group.

Initial failure hypothesis

From the above information and other narrations from the Adentan Municipal Assembly, the initial hypothesis for the probable cause of structural failure was drawn. The hypothesis is: ***there was structural failure of main columns, helped by failure of one or more footings, either by ground break or uneven settlements of the footings, due to over-stressing of the soil or shear failure of the footing or both***. These are what could result in such CATASTROPHIC FAILURE as can be seen in the building collapse in Figure 2. Further investigations need to be carried out to prove this hypothesis.

Figure 2: Pictures showing damage at the Building Collapse at Nmai Dzorn.



Structural Assessment

The Adentan Municipal Assembly made available to this group stamped and endorsed Geotechnical report, Structural drawings and Architectural drawings. These documents were reviewed, and the following are the review results of the structural engineer:

1. Both the Geotechnical engineer's and the Structural engineer's professional stamps bear the names and membership numbers of engineers, who are in good standing with

the Ghana Institution of Engineering at the time of producing the work for the client. But currently, 2023, they are yet to be in good standing.

2. It was realized that the geotechnical report indicated the following results:

No.	Spot	Depth(m)	Allowable bearing capacity (kN/m^2)	Safe bearing capacity (kN/m^2)	Approximate safety factor
1	DCPT 1	1.20	1,765	588	3
2	DCPT 2	0.90	2,021	505	4
3	DCPT 3	0.80	2,472	618	4
4	DCPT 4	0.70	2,084	521	4
5	DCPT 5	1.20	2,435	609	4

Despite this high safe bearing capacity of the soil obtained by the geotechnical report, by the application of very qualified safety factors of 3 and 4, the geotechnical report specified the use of a much lower bearing capacity of 298 kN/m^2 (translated into a Modulus of Subgrade Reaction of $4.768x10^4$ $kN/m^2/m$) for the substructural design. This brings the safety factor to between 5.9 and 8.3! This looks strangely high!

There was also the specification of ground beams for the construction. Several questions arise: what made the geotechnical engineer to apply safety factor of 4 to get the safe bearing capacity, and still reduced the bearing capacity to $298kN/m^2$, and still requested ground beams for the building? Meanwhile, the report said there was no ground water, though the investigation was carried out in the wet season and went ahead to recommend waterproofing in the foundation. More questions need to be answered.

3. The structural design specified concrete grade C30 (cube strength of 30N/mm2 at 28 days) for both substructures and superstructures. The structural engineer also specified ground beams of cross-sectional dimensions of 300mm x 150mm, tying all columns at the ground floor. From the narrations of the various interview, these ground beams seem not to have been constructed.

4. A preliminary analysis, synthesis and redesign of the structure was carried out using the Prota Structural engineering software, Staadpro and self-developed excel spreadsheets. The structural drawings obtained from the Assembly was used as the basis for these analysis/synthesis and redesign. The concrete grade of C30 was used as specified in the structural drawings.

5. The preliminary assessment of the structural design was put into 4 categories

    a. Category 1: As-designed with no live loads – 3 levels structure (application of ground beams)

    b. Category 2: As-designed with live load – 3 levels structure (application of ground beams)

    c. Categroy 3: As-built without live load - 4 levels structure (no application of ground beams)

    d. Category 4: As-built with live load – 4 levels structure (no application of ground beams)

    Apart from the self-weight of the structures according to the dimensions provided in the structural drawings, a superimposed dead load of 1.5kN/m^2 and a live load of 1.5kN/m^2 were applied to the structure, where necessary. A peak ground acceleration of 0.16 was used for the earthquake analysis, as specified by the geotechnical report. The following are some of the significant results obtained:

    i.

Item	**Category 1**	**Category 2**	**Category 3**	**Category 4**
Soil strength (kN/m^2)	404.6	404.6	404.6	404.6
Prevailing stress on the soil (kN/m^2)	509.8	624.5	476.5	530.9

Remarks		**Size of pad footing not adequate. Possible ground break**	**Size of pad footing not adequate. Possible ground break**	**Size of pad footing not adequate. Possible ground break**	**Size of pad footing not adequate. Possible ground break**
Required reinforcement (mm^2/m)	X-dir.	707.9	952.14	914.2	1018.56
	Y-dir.	842.9	1126.1	1076.8	1198.18
Provided reinforcement (mm^2/m)	bothways	754	754	754	754
Remarks		Iron rods woefully not adequate	Iron rods woefully not adequate. Footing fails also in shear	Iron rods woefully not adequate	Iron rods woefully not adequate

ii.

Item	Category 1	Category 2	Category 3	Category 4
No. of columns	48	48	60	60
No. of columns loaded beyond axial load and moment capacity	9	12	8	16
Percentage of columns loaded beyond axial load and moment capacity	19%	25%	13%	27%

Remarks	**unacceptable**	**unacceptable**	**unacceptable**	**unacceptable**

iii.

Item	Category 1	Category 2	Category 3	Category 4
No. of columns	48	48	60	60
No. of columns with unacceptable joint shear with adjoining beams	12	13	20	22
Percentage of columns with unacceptable joint shear with adjoining beams	25%	27%	33%	37%
Remarks	**Columns and beams sections inadequate. They needed to be increased**	**Columns and beams sections inadequate. They needed to be increased**	**Columns and beams sections inadequate. They needed to be increased**	**Columns and beams sections inadequate. They needed to be increased**

iv.

Item	Category 1	Category 2	Category 3	Category 4
No. of columns	48	48	60	60

No. of columns with inadequate reinforcement	8	13	10	14
Percentage of columns with inadequate reinforcement	17%	27%	17%	23%
Remarks	**unacceptable**	**unacceptable**	**unacceptable**	**unacceptable**

a. The 1200mm x 1200mm x 300mm footing was woefully inadequate. Footings were failing in shear, and the stresses under the footing were in some cases above 600kN/m^2, far more than the bearing capacity of 298kN/m^2 they were designed for. It was also realized that the structural drawings had main reinforcement of the order R12/150mm both ways in the pad footings. This seems very inadequate. All these could result in ground break due to over stressing of the soil, and flexure and shear failures of the pad footings.

b. The 300mm x 250mm columns needed at least 8R16 as the main reinforcement bars. In certain cases, the 300mm x 250mm column size was no more adequate, and there would be the need to increase the size. The structural drawings kept all columns the same size. For instance, columns on grid-intersections B/2, B/1, E/2 and E/1 on the ground floor seem to be among such columns.

c. A lot of the beams, especially those on the relatively long cantilevers seem to fail in flexure and shear. They require about 7R16 to 10R16 as reinforcement. However, the design and construction provided about 5R16 bars as cantilever reinforcement

d. The magnitude of the failures above are enough to conclude that, the hypothesis raised at the beginning of this writing, is proven beyond all reasonable doubt. Other information will definitely add up to strengthen the proofs.

Deductions and Conclusion

The current information received by our investigation group was used to produce this preliminary summary findings of the structural engineering view on the probable causes of collapse of the building at Nanakrom. Concrete C30 was used throughout the analysis, although it is very likely, that the concrete grade for the construction of the building might be much lower than the C30 concrete.

From the structural drawings, and information gathered on and off the site, the preliminary structural assessment was put into 4 categories as explained above.

From the above results enumerated, all the categories show that the structure was DEAD FROM CONCEPTION TO BIRTH. IT WAS DEAD ON ARRIVAL. This means that, right from the design stage till the through the construction stage till it physically collapsed, the structural integrity of the building was very questionably inadequate. The number of footings and columns that had structurally failed under all the categories are structurally unacceptable. The avoidance or refusal to apply the ground beams was very bad. The size of the cantilever beams and the applied reinforcement suggest that there was no professional design of those beams, the columns and the pad footings.

The group is yet to receive the material test reports, the pictures taken by other engineering group at the time of collapse, before the debris were cleared from the site, and very importantly, the structural design calculation report from the structural engineer.

These will throw more light into the investigation and bring out to confirmation, the exact causes of the physical collapse of the building.

Until then, the following are the causes of the structural failure of the building in question, that led to its physical collapse:

- Sizing of pad footings was inadequate. That led to excessive stresses in the ground, which are much higher than the soil bearing capacity, and hence might have caused ground break under those footings.

- Reinforcement provided in the pad footings were also inadequate. That led to inability of the footing to take care of the shear and bending forces and might have led to shear and flexure failure.
- The sizing of a large number of the columns was not adequate. This led to those significant number of columns to be loaded beyond their axial load and bending moment capacities. Some of these capacity-overloads were up 50% more than the maximum capacities of those columns. Structural failure is the only expected results.
- The reinforcement in those large number of the columns were under-provided.
- The sizing and the reinforcement of the 2m long cantilever beams look unprofessionally and inadequately provided.
- One of the main failure reasons was the fact that the joint-shear of significant number of the columns and the adjoining beams, were unacceptably more than the allowable. This may have caused shear failure at the various joints. Some of the pictures show this situation exactly.

1.5 Architectural Assessments

This section presents the architectural assessment and the professional architect who designed the architectural drawings for the proposed development.

- The architectural drawings submitted to the Assembly was a 3-Storey mixed-use facility to be constructed at the site. The design shows an open ground floor with isolated columns supporting suspended slab which houses 2 No. two-bedroom apartments per floor (2 apartments on each floor).
- The isolated columns were approximately 5m apart (span) supporting the suspended slab which had 2m cantilevers at both ends.
- The building was designed by one Abdulai Abdul Gafaru, a registered architect with registration number AGIA 838. He completed his post graduate diploma in Architecture and obtained his license as a registered architect in the year 2013. Most of the projects he has worked on as an architect can be found in Tamale and its

environs where he resides. As at the time of writing this report, a background check indicated that Arc. Gafaru was in good standing at the time he was commissioned to design the structure (June 2020) till 2022.

- The mason (now deceased) referred the architect to the Owners upon request by their daughter. Green Architectural Façade, a company used in procuring the design is not a registered company in the list of companies from the Ghana Institute of Architects.
- The architect was invited to Accra for preliminary site visit where he met the couple (Dr. Wahaga and Mr. Arimeyaw).
- The architect recommended a structural engineer for the project.
- No soil test was conducted prior to the architectural and structural drawings. This gives an indication that the soil test submitted upon request by the Assembly was carried after completion of both architectural and structural drawings.
- The architect was contacted to provide further information on the design during the processing of permit but was unaware that the owners had obtained permit and gone ahead to construct the building.
- The architect was not involved in the construction process. He only recently got to know after the collapse of the building.
- Some of the details and omissions in the architectural drawings submitted does not meet the standard requirements of a proper construction drawings. Although GhBC (1207_2018) clause 1.9.2.1.1 stipulate that construction documents shall be of sufficient clarity to indicate the location, nature and extent of work proposed, the drawings received did not include site layout / block plan showing setbacks that conform to the rear open space and side open spaces as prescribed by the code. There were no specifications accompanying the plans that were submitted to the Assembly. Observations from the site indicate that the design did not comply with provisions on the minimum distance required between separate buildings on the same plot.

Deduction and Conclusion

There are discrepancies in the intended use of the building (mixed-use) as stated by the architectural drawings and the approved use (dwelling) as indicated in the permit. The interview with the architect confirms that the necessary geotechnical survey was not conducted prior to the submission of architectural and structural drawings to the Assembly. Apart from the initial site visit, the interview established that proper site analysis (desktop study, site recognizance survey, and ground /soil investigations) was not conducted to arrive at a good performance appraisal of the project before commencement of the design. The use of low-skilled artisans instead of professionals at the construction phase of the project may have contributed to the quality of work done on site.

1.6 Summary of Key Findings

1. The developer did not engage qualified professionals in the construction phase of the development.
2. There was no post permit supervision by the Planning and Building Inspectorate of the Adentan Municipal Assembly.
3. The test procedure (DCPT) had inadequacies in that there is no visual soil samples from the soil beneath the ground.

1.7 Recommendations

1. The District Assemblies should outsource some aspects of their work particularly development control functions.
2. Clients after being issued permits should engage the services of qualified professionals to undertake the construction of the structure.
3. There should be consideration for the insurance of developments from the construction to habitation stage in the development permitting processes.

4. The District Assembly should resource the Planning and Building Inspectorate Unit of the Assembly with the necessary logistics and human resource to undertake periodic post permit inspections and supervision.

5. To accommodate for the inadequacies of the DCPT, thorough soil investigation such as Standard Penetration Test (SPT) should be conducted.

6. The general public must be educated to use only professionals in the built-environment for the design and construction of their buildings.

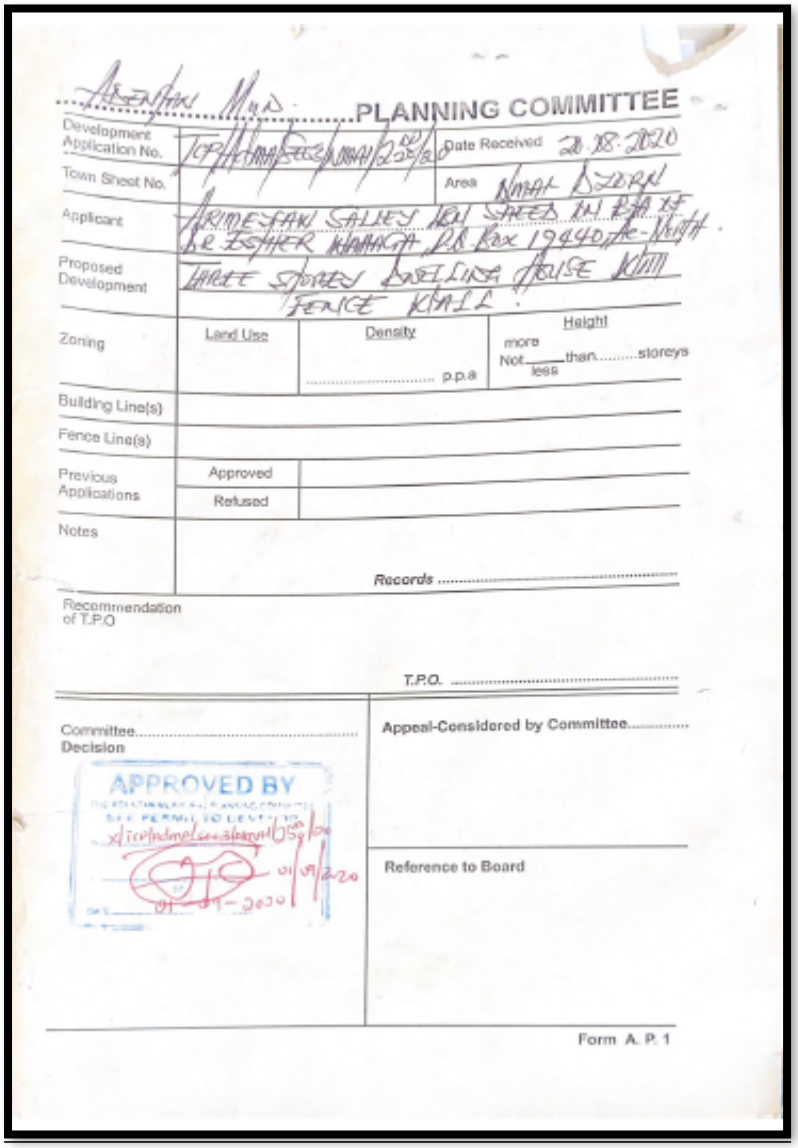
7. Structural designs and accompanied geotechnical investigation must be given a thorough check by professionals in good standing. This must be done in a form of a STRUCTURAL PEER REVIEW, after the client has submitted all Structural drawings, Structural design calculation reports, Geotechnical investigation report to the Assembly. In so doing, the Structural Engineer and the Geotechnical Engineer responsible for the design, will have to own and defend their works before their professional peers. This will avoid the situation, where unprofessional people are made to produce drawings and clone stamps and signatures of others to endorse the drawings.

8. Structural engineers should be made to supervise their designed works, or others may be employed to do so. In any case, there should be definitely a structural engineer in good standing to supervise an on-going construction works at all times.

9. The results as presented here is a preliminary one. It was as the results of the assessment conducted with the limited information received by the group. The final findings and results can only be presented when thorough investigation is conducted. This includes the conduction of material tests, the conduction of geotechnical investigations, a lot of structural analysis and synthesis, both as-designed and as-built, the assessment of theoretical results in comparison with on-site observations and material test results. This complex investigation activities must be carried through to ensure a final solid verdict on this investigation. **Till then, the above findings are limited by the information received to date.**

Appendices

Appendix 1: ***Development Application Jacket _Nmai Dzorn***



ABENTAKU M.M.D. PLANNING COMMITTEE

Development Application No. TCP/ACCRA/SEC/NMAI/2020/0 Date Received 28.08.2020

Town Sheet No. Area NMAI DZORN

Applicant ABIMEYAKU SALLEY NOI SHEED IN ESTATE OF LE ESHER NAMAGA P.O Box 19440 Ac-North

Proposed Development THREE STOREY DWELLING HOUSE WITH FENCE WALL.

Zoning	Land Use	Density	Height
		..... p.p.a	more / Not ____ than ..... storeys / less

Building Line(s)

Fence Line(s)

Previous Applications	
	Approved
	Refused

Notes

Records .....

Recommendation of T.P.O

T.P.O. .....

Committee Decision

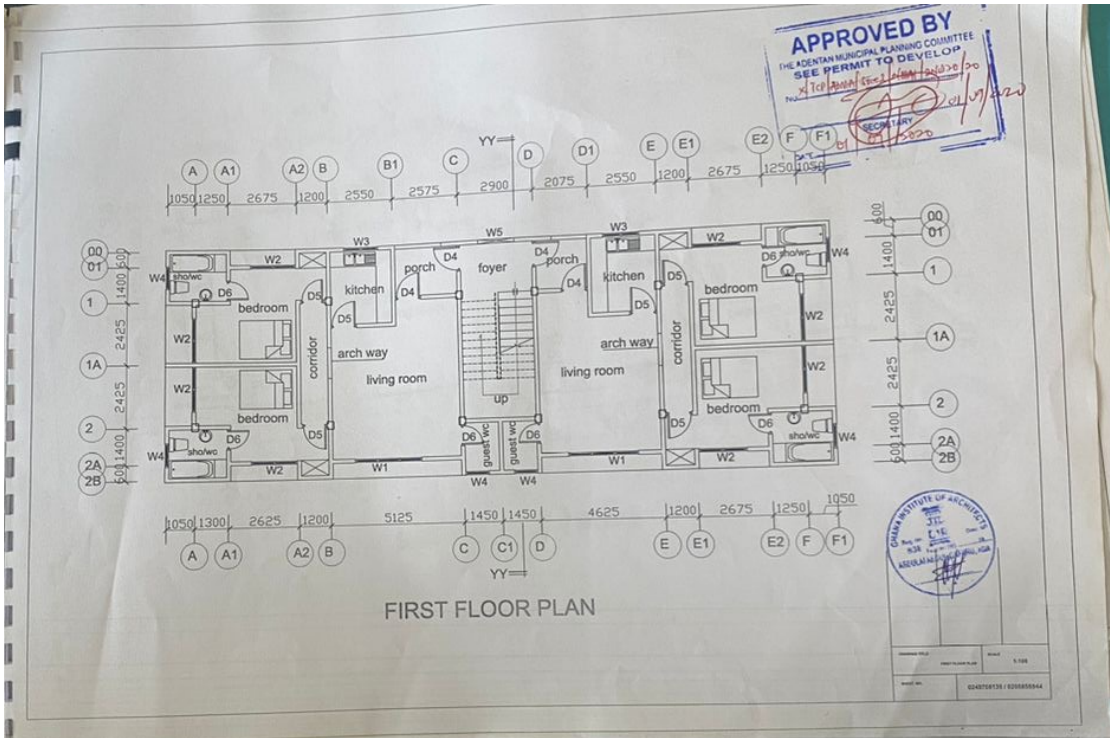
APPROVED BY
SUBJECT TO PAYMENT OF ALL OUTSTANDING LEVIES AND CHARGES
01/9/2020

Appeal-Considered by Committee.....

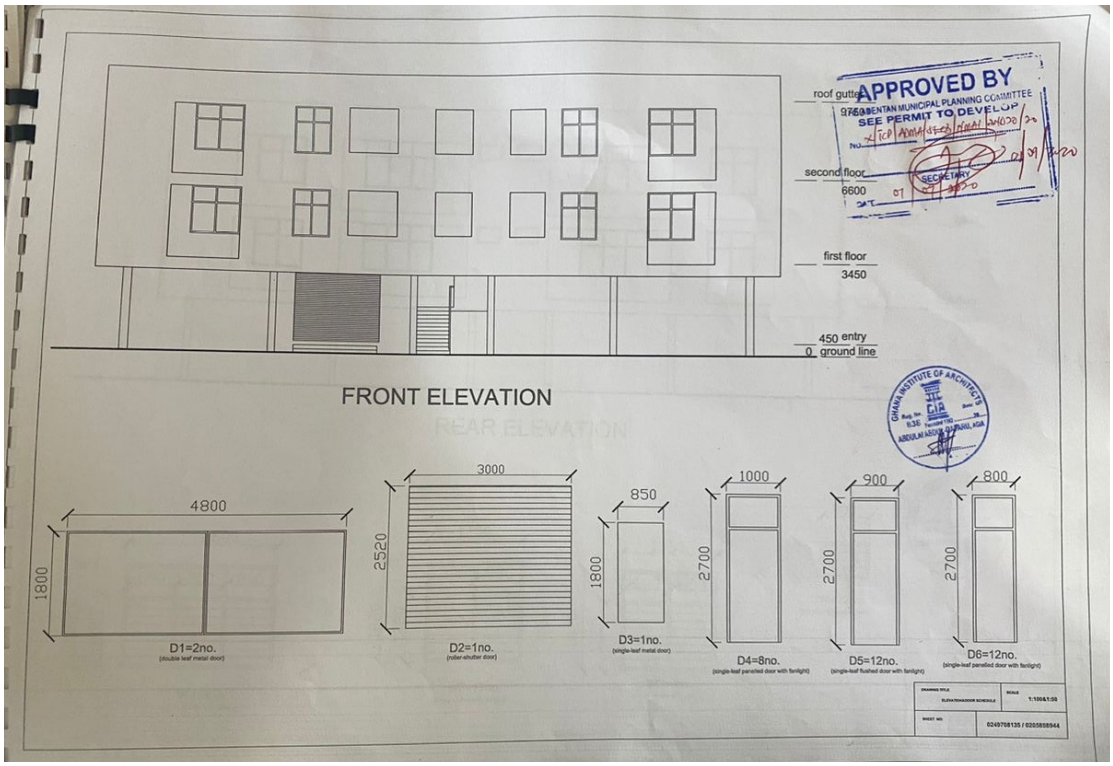
Reference to Board

Form A. P. 1

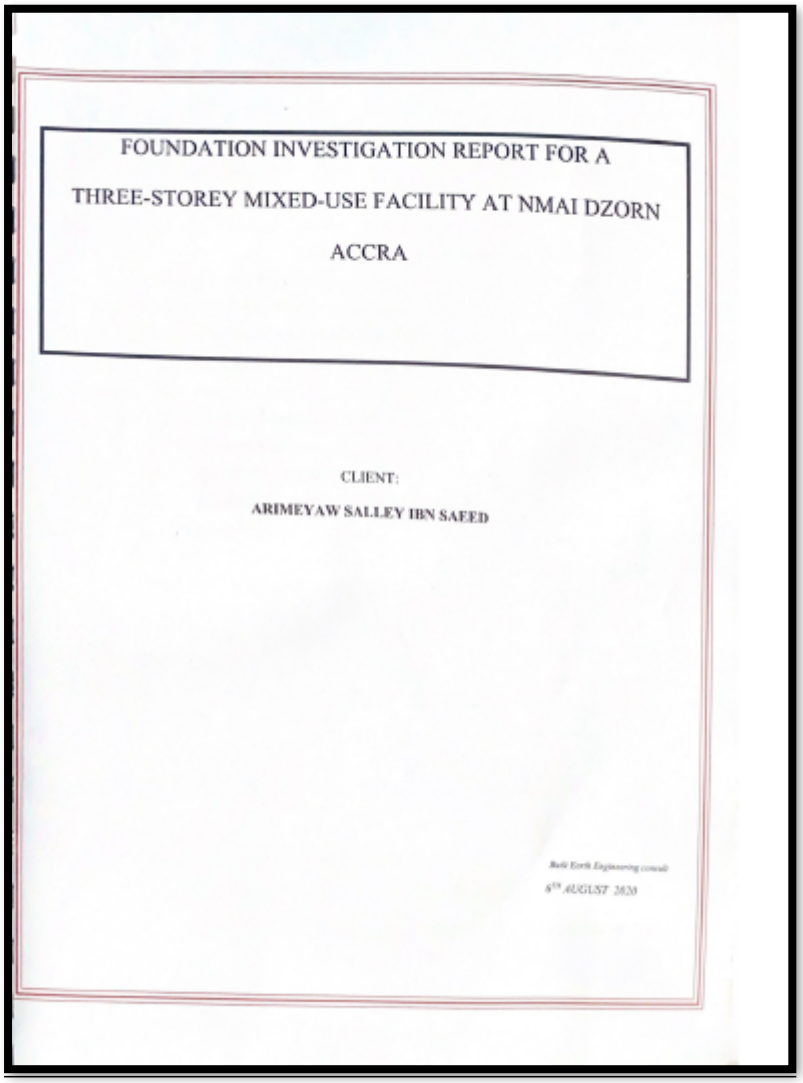
Appendix 2: Floor Plan of Collapsed Development at Nmai Dzorn



Appendix 3: Front Elevation of Collapsed Building at Nmai Dzorn



Appendix 4: Soil Test and Foundation Investigation Report



FOUNDATION INVESTIGATION REPORT FOR A

THREE-STOREY MIXED-USE FACILITY AT NMAI DZORN

ACCRA

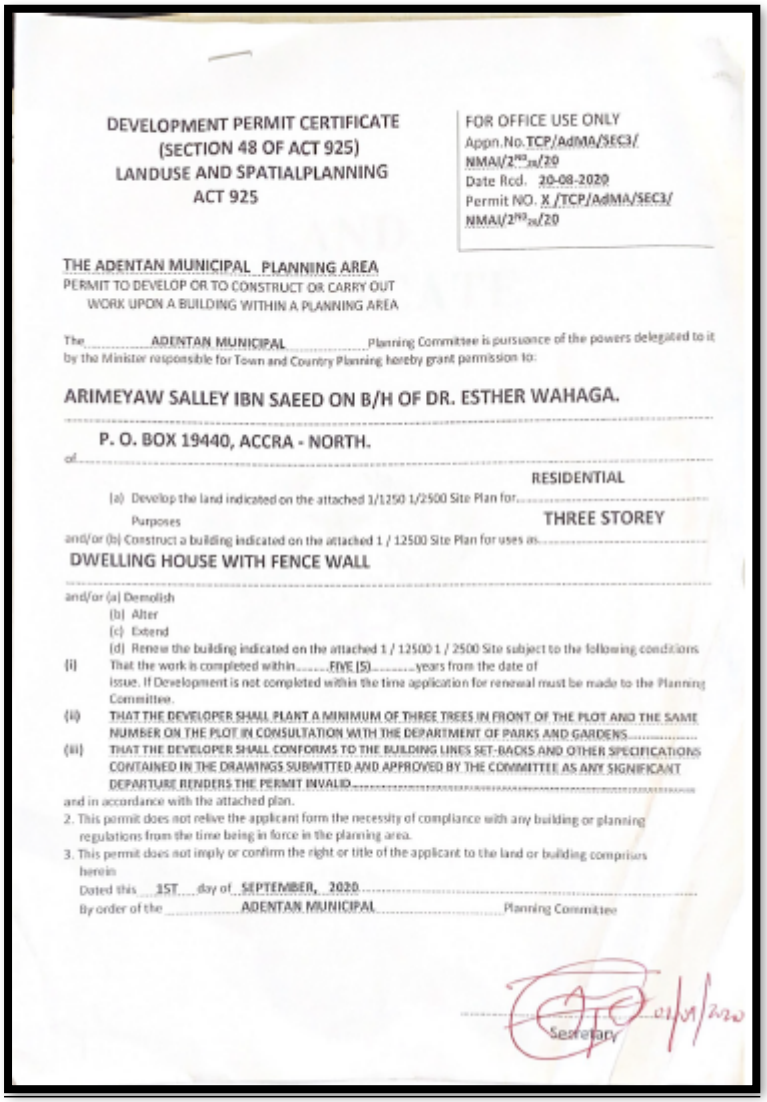
CLIENT:

ARIMEYAW SALLEY IBN SAEED

Built Earth Engineering consult

6TH AUGUST 2020

Appendix 5: Development Permit Certificate of Collapsed Building at Nmai Dzorn



DEVELOPMENT PERMIT CERTIFICATE
(SECTION 48 OF ACT 925)
LANDUSE AND SPATIALPLANNING
ACT 925

FOR OFFICE USE ONLY
Appn.No. TCP/AdMA/SEC3/
NMAI/2[ND]/20
Date Rcd. 20-08-2020
Permit NO. X /TCP/AdMA/SEC3/
NMAI/2[ND]/20

THE ADENTAN MUNICIPAL PLANNING AREA
PERMIT TO DEVELOP OR TO CONSTRUCT OR CARRY OUT
WORK UPON A BUILDING WITHIN A PLANNING AREA

The ADENTAN MUNICIPAL Planning Committee is pursuance of the powers delegated to it by the Minister responsible for Town and Country Planning hereby grant permission to:

ARIMEYAW SALLEY IBN SAEED ON B/H OF DR. ESTHER WAHAGA.

P. O. BOX 19440, ACCRA - NORTH.

of

(a) Develop the land indicated on the attached 1/1250 1/2500 Site Plan for RESIDENTIAL
Purposes
and/or (b) Construct a building indicated on the attached 1 / 12500 Site Plan for uses as THREE STOREY
DWELLING HOUSE WITH FENCE WALL

and/or (a) Demolish
(b) Alter
(c) Extend
(d) Renew the building indicated on the attached 1 / 12500 1 / 2500 Site subject to the following conditions

(i) That the work is completed within FIVE (5) years from the date of issue. If Development is not completed within the time application for renewal must be made to the Planning Committee.

(ii) THAT THE DEVELOPER SHALL PLANT A MINIMUM OF THREE TREES IN FRONT OF THE PLOT AND THE SAME NUMBER ON THE PLOT IN CONSULTATION WITH THE DEPARTMENT OF PARKS AND GARDENS

(iii) THAT THE DEVELOPER SHALL CONFORMS TO THE BUILDING LINES SET-BACKS AND OTHER SPECIFICATIONS CONTAINED IN THE DRAWINGS SUBMITTED AND APPROVED BY THE COMMITTEE AS ANY SIGNIFICANT DEPARTURE RENDERS THE PERMIT INVALID

and in accordance with the attached plan.

2. This permit does not relive the applicant form the necessity of compliance with any building or planning regulations from the time being in force in the planning area.
3. This permit does not imply or confirm the right or title of the applicant to the land or building comprises herein

Dated this 1ST day of SEPTEMBER, 2020
By order of the ADENTAN MUNICIPAL Planning Committee

Secretary 01/9/2020

SUBTITLE 3A

Ghana Tertiary Education Council
JRWH +50R,
Trinity Avenue, Accra

Engineering Council
Ministries-Accra



REPORT OF FORENSIC INVESTIGATIONS INTO A COLLAPSED BUILDING AT THE UNIVERSITY OF DEVELOPMENT STUDIES IN TAMALE



AUGUST 2023

Ghana Tertiary Education Council
JRWH +50R,
Trinity Avenue,
Accra

Engineering Council
Ministries-Accra

Report of

FORENSIC INVESTIGATIONS INTO A COLLAPSED BUILDING AT THE UNIVERSITY OF DEVELOPMENT STUDIES IN TAMALE

August 2023

EXECUTIVE SUMMARY

The University of Development Studies started the construction of a six-storey reinforced concrete framed structure to be used for lecture rooms and for offices by its Institute of Distance Learning on its City Campus in 2021. Unfortunately, on the night of 6th May 2023, when the construction had reached the roof level, the structure catastrophically collapsed. The Director General of the Ghana Education Tertiary Council through the Engineering Council appointed a committee of experts under the Chairmanship of Ing. Prof. Samuel Innocent Kofi Ampadu of KNUST to conduct a forensic investigation into the collapse.

During the committee's first visit to the site to meet the University Authorities and to assess the collapse to define the programme for the investigation, it became apparent that the structure was, in fact, an L-shaped structure and that only part of the structure had collapsed and that there is another part of the structure that was still standing which was perhaps of more urgent concern to the staff and students of the Institute. The committee therefore broadened its scope to cover both a forensic investigation of the collapsed structure and a structural integrity assessment of the standing portion of the structure.

The committee's investigation indicated that the structure was designed in-house by the Works and Physical Development Directorate (WPDD) of the University of Development Studies. The geotechnical investigations, however, were contracted out. The construction was being undertaken by a private Construction Firm under the supervision of the WPDD.

The Committee's methodology included an on-site questionnaire to understand the context of the project and on-site investigations on both the collapsed and standing portions of the structure. The investigation included on site measurements of the dimensions of structural members, the in-situ measurement of the strength of structural members by both the Schmidt hammer and Ultra Pulse Velocity (UPV) followed by laboratory measurements of cored concrete and reinforcement steel strengths. The investigation also included a full geotechnical site investigation with five boreholes by percussive drilling sunk to bedrock which varied from 1.5m to 8.0m on site. The building was then modelled using ETABS software with three simulations of load case combinations: Simulation 1, dead loads only; Simulation 2, dead and live loads and Simulation 3-dead, live, and wind loads.

The results showed that most of the columns and foundations failed even under dead-load-only simulation. This showed that the main cause of the failure is due to serious design flaws. The collapse itself originated from multiple column failure and may have been triggered by any combination of the following factors which pertained to the site, the thunderstorm that occurred on the night of the failure, foundation failure, lift shaft base slab failure and non-uniform subsurface soil condition.

The investigation and analysis of the integrity of the still standing building showed that the design is similar to the collapsed structure and the columns and foundations are in a much worse state than those of the collapsed building. The report discusses a number of options to make the standing structure safe and useable including increasing the existing the existing column sizes and the introduction of new columns. Each of these options however carry substantial risk of collapse during the intervention. The safest option therefore is to demolish, redesign and reconstruct the existing building.

ACKNOWLEDGEMENT

The Committee is grateful to the Director General of GTEC, Prof. Mohammed Salifu who initiated the request and the Chairman of the Engineering Council, Ing. Dr. Kwame Boakye who appointed the committee for the opportunity to be of service to the Commission and the Council.

The Committee is also grateful to Prof. Seidu Alhassan, Vice Chancellor of the University of Development Studies and his team led by Ing. Samuel Abiko, the Director of Works and Physical Development and Mr. Nurudeen, the Registrar for their cooperation and facilitation that allowed us to execute the long and exhaustive field work. Their keen interest in the work of the committee is also greatly appreciated.

The committee also acknowledges the support of the Contractor, ASIB Limited and his team in providing the lifting equipment that was used for the investigation to proceed.

The input of the technicians in the structural and geotechnical engineering laboratories of KNUST who conducted the testing of the samples of concrete, steel reinforcement and soil that were brought from the site is also greatly acknowledged. Special mention is made of Kwaku Oppong Mensah Adjei, an MSc student who assisted with the field measurements.

The support of the Ghana Institution of Engineering who facilitated various aspects of the data collection components of the work is greatly appreciated. The committee acknowledges the support of the Architects Registration Council for their diligence in supplying information that assisted in the preparation of this report.

Ing Prof. Samuel I.K. Ampadu
Chairman

Ing Prof. Charles K Kankam
Member

Pln Prof. Michael Poku-Boansi
Member

Arc. Desmond Opoku
Member

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1 INTRODUCTION

1.1 Background to Report

Following the collapse of a six-storey building at the City Campus of the University of Development Studies (UDS), Tamale, on the 6th of May 2023, the Director General of the Ghana Tertiary Education Commission (GTEC) requested the Board of the Engineering Council to set up a team to carry out forensic investigations into the collapsed building. By a letter of reference ECGh/EFI/UDS/01 dated 10th May 2023 the Engineering Council constituted a team under the leadership of Ing Prof. Samuel Innocent Kofi Ampadu to conduct the investigations.

1.2 Membership of the Forensic Investigation Team

1.2.1 The Core members

The core members of the investigation team mentioned in the letter of appointment were:

1. Ing. Prof. Samuel Innocent Kofi Ampadu — Team Leader
2. Ing. Prof. Charles Kwame Kankam — Member
3. Pln. Prof. Michael Poku-Boansi — Member
4. Arc. Desmond Opoku — Member

Apart from the core team listed above, the structures and geotechnical engineering components of the investigations also constituted teams to conduct the investigations as indicated below:

1.2.2 Structures Team

The following structural engineers joined the core members to constitute the structures team that executed the structural component of this investigation.

1. Ing. Dr. James Wiafe Ampofo
2. Ing. Dr. Jones Owusu Twumasi

1.2.3 Geotechnical Engineering Team

The following geotechnical engineers joined the core members to constitute the geotechnical team that executed the geotechnical component of this investigation

1. Ing Dr. Frederick Owusu Nimo
2. Ing. Dr. Felix Jojo Ayeh

1.3 Terms of Reference

The committee was given the following terms of reference:

i. Assessment of existing institutional arrangements for Design, plan approval, construction and construction supervision.

ii. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness accounts and available records of the building construction.

iii. Conduct a structural assessment of the collapsed building and any available structural drawings of the building.

iv. Identify any liability based on the findings including designs, construction, supervision, and building code violation.

v. Prepare a report including conclusions and recommendations

2 OVERALL APPROACH FOR THE INVESTIGATION

The Committee adopted an investigation approach made up of a combination of physical and online meetings, field measurements and laboratory testing of samples of building materials and foundation soil obtained from the site, as well as computer modelling of the results of the data obtained. The details of the methodology used for the different stages of the assignment are discussed alongside the results of the particular component of the investigation. In this chapter, a general overall description of the approach is presented.

2.1 Meetings

The Investigation Team commenced the assignment with a kick-off meeting on 18th May 2023 which deliberated on the terms of reference and also planned the first field visit. The subsequent first field visit took place from 22nd-24th May 2023. After the first visit, three other field visits were made by the structures and geotechnical teams to conduct various on-site measurements. These were followed by additional physical and online meetings to discuss various aspects of the assignment and to prepare the report. Table 2-1 is a summary of the activities used for the execution of the assignment.

Table 2-1 Table of activities

Date	**Activity**
10th May 2023	Engineering Council appoints Committee
18th May 2023	Committee organizes kick-off meeting to plan first site visit
22nd -24th May 2023	First site visit- Meeting with UDS Vice Chancellor and his team and visit to site
4th -9th June 2023	Structures team conducts field measurements for structural integrity investigation of standing structure and commences field measurements on collapsed structure
15th-18th June 2023	Structures team completes field measurements of lower floor levels of collapsed structure as lifting equipment completes lifting of structural members
5th -8th July 2023	Geotechnical team commences and completes geotechnical investigations at the site
17th August 2023	Committee meets to discuss the structure of the report and consider preliminary collapse modelling
24th August 2023	Committee meets to collate comments on draft report
6th September 2023	Committee meets to finalize the report

2.2 Methodology for the various Components of Investigation

2.2.1 Institutional Arrangements

The methodology for the institutional arrangements consisted of:

- Review of documentation

- Interviews of various persons

2.2.2 Structural Investigations

The structural engineering team adopted a number of methodological approaches to help them assess the general structural integrity of the entire six storey building from the stage of its design through construction and its ultimate failure and the total collapse of one wing. These strategies were:

- Study of all structural drawings;
- Forensic study of all visible structural members in the collapse debris of the collapsed building.
- Physical measurement of structural members in standing building; and
- Modeling of the entire structure (both standing and collapse wings).

2.2.3 Geotechnical Investigations

The geotechnical investigations consisted of:

- Study of the geotechnical report that was commissioned by the Client for the project;
- Geotechnical site investigation within the footprints of the collapsed structure to obtain a model of the subsurface for the collapse mechanism analysis; and
- Geotechnical site investigation near the standing structure to obtain a subsurface model for the structural integrity analysis of the standing structure.

3 Evaluation of the Design and Construction Process

3.1 Evaluation of the Institutional Arrangements

3.1.1 Methodology

The Committee adopted the use of key informant interviews and focus group discussion in evaluating the institutional arrangement for the design and construction process. Specifically, officers of the Directorate of Works and Physical Development (WPDD) and one focus group discussion with membership from the contractor, eyewitnesses, and officers of WPDD were conducted.

3.1.2 Review of the UDS Project Approval Processes

Discussions with stakeholders revealed that the approval process was internal and didn't involve external state actors. Specifically, all preparation of the architectural and structural drawings were done with the personnel from WPDD. The approval process for these drawings were also done by these same people. This practice didn't afford the University the opportunity to have independent reviews and hence their inability to detect any anomaly should there be one.

3.1.3 Key Professionals on Project

The profiles of the key professionals involved in the design of the project are summarized below for the Architect and the Structural Engineer who are part of WPDD and the Geotechnical Consultant who was a consultant from outside the University.

3.1.3.1 Profile of the Architect

The building was designed by Arc. Jawhari Baba-Duah who is a resident architect of University of Development Studies' (UDS) Works and Development Directorate. He is also a licensed Ghana Institute of Architect member (Associate member since July, 2011) with registration number 734. He holds BSc. and P. G. Dip. in Architecture from KNUST and MSc. Eng. Project Management from the Coventry University. He has been involved in a number of projects for UDS, C. K. Tadem University for Applied Sciences and S. D. Dombo University for Business and Integrated Development Studies predominantly in Northern part of Ghana. As at the time of writing this report, a background check indicated that Arc. Baba-Duah was in good standing at the time he was commissioned to design the structure till date

Role on Project	Architect
Name	Yawhari Baba-Duah
Professional	Associate Member, Ghana Institute of Architects
Registration	734
Biodata	1st Sept. 1977
Key Educational Background	2005, PG Dip. Architecture, KNUST, 2003, BSc Architecture, KNUST
Key Professional Experience	2018-Senior Architect, WPDD, UDS 2011-2018, Architect WPDD, UDS 2006-2011, Assist. Architect UDS

3.1.3.2 Structural Engineer

Summary of the professional profile of the Structural Engineer is shown below:

Role on Project	**Structural Engineer**
Name	Ing. Solomon Yampohekya
Professional Registration	2012, PE-GHIE 06675
Biodata	14th June 1982
Key Educational Background	2006, BSc Civil Engineering, KNUST,
Key Professional Experience	2018-Present-Head, Works and Maintenance, WPDD, UDS 2013-2018, Wa Campus Head WPDD, UDS 2012-2013, Civil Engineer UDS 2009-2012, Snr Technician, Civil Eng. UDS 2008-Structural Eng. Intern, AESL, Takoradi Software-PROTA STRUCTURE, 2018. CAB Royale Ltd, Accra REVIT, ARCHITECTURE/STRUCTURE, CAB Royale, Accra

A review of the CV of the structural engineer shows that the key post-graduation on-the-job training in structures appears to be for 8 months as an intern in AESL in 2008. The tallest building the structural engineer has designed is a 5 storey GUSS Commercial Building on the Tamale campus of UDS. The engineer appears to have risen through WPDD at UDS over the years to the head of Works and Maintenance.

3.1.3.3 The Geotechnical Consultant

The summary of the professional profile of the geotechnical consultant that was commissioned to conduct the geotechnical investigation for the project is summarized below:

Role on Project	**Geotechnical Consultant**
Name	Ing. Mahamud Sidi Hamid
Professional Registration	2015, GhIE PE-GHIE Civil Engineer Regd. No. 07576
Biodata	16th December 1987
Key Educational Background	2011, BSc Civil Engineering, KNUST,
Key Professional Experience	2012-present Engineer, Material Division, GHA

The CV of the Geotechnical Consultant clearly showed insufficient experience on geotechnical investigation for structure of similar size and type.

It may be noted that all the key professionals who were involved in the design of the structures in question are registered members of their respective professional bodies.

3.2 Evaluation of the Architectural Design of the Structure

3.2.1 Architectural Design Provisions of the Structure

The architectural drawings submitted by the Works and Physical Development Directorate – UDS to the committee outlined a proposal for six (6) storey lecture halls and an office block for the Institute of Distance Learning – UDS. The spatial provisions of the building include;

Table 3-1 Architectural Design Spatial Provisions of the Building

Floors	Spaces
Ground floor	Lecture halls (3No.); seminar room (1No.); parking space (16 bays); offices (3No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation
First floor	Lecture halls (5No.); seminar room (1No.); offices (3No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation
Second floor	Lecture halls (5No.); seminar room (1No.); offices (3No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation
Third floor	Lecture halls (5No.); seminar room (1No.); offices (3No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation
Fourth floor	Offices (11No.: HOD's – 2No.; secretary – 2No.; others – 7No.); Conference room (1No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation
Fifth floor	Offices (12No.: Dean – 1No.; HOD's – 1No.; secretary – 2No.; others – 8No.); Conference room (1No.); server room (1No.) staircase (3No.); lift well (2No.); cleaners'/ Janitor's room (1No.); washrooms; verandah for circulation

Source: Works and Physical Development Directorate – UDS, (2023)

3.2.1.1 Design Variation

The results of an interview with the Director and the Deputy of WPDD – UDS revealed that there were spatial variations in the design which was implemented during construction prior to the collapse of the structure. This variation involved converting two (2) units of the 120-seater capacity lecture hall (from grid o1 to o6 to j5 to j1 to o1) into sixteen (16) unit parking bays (named parking garage on the drawings) at the ground floor of the collapsed wing (figure 2). Further discussion confirmed that the variation was achieved by eliminating the partition walls and extending the foundation walls and the ground floor slab by 2250mm and 3175mm to the south-east and north-west of the collapsed wing respectively.

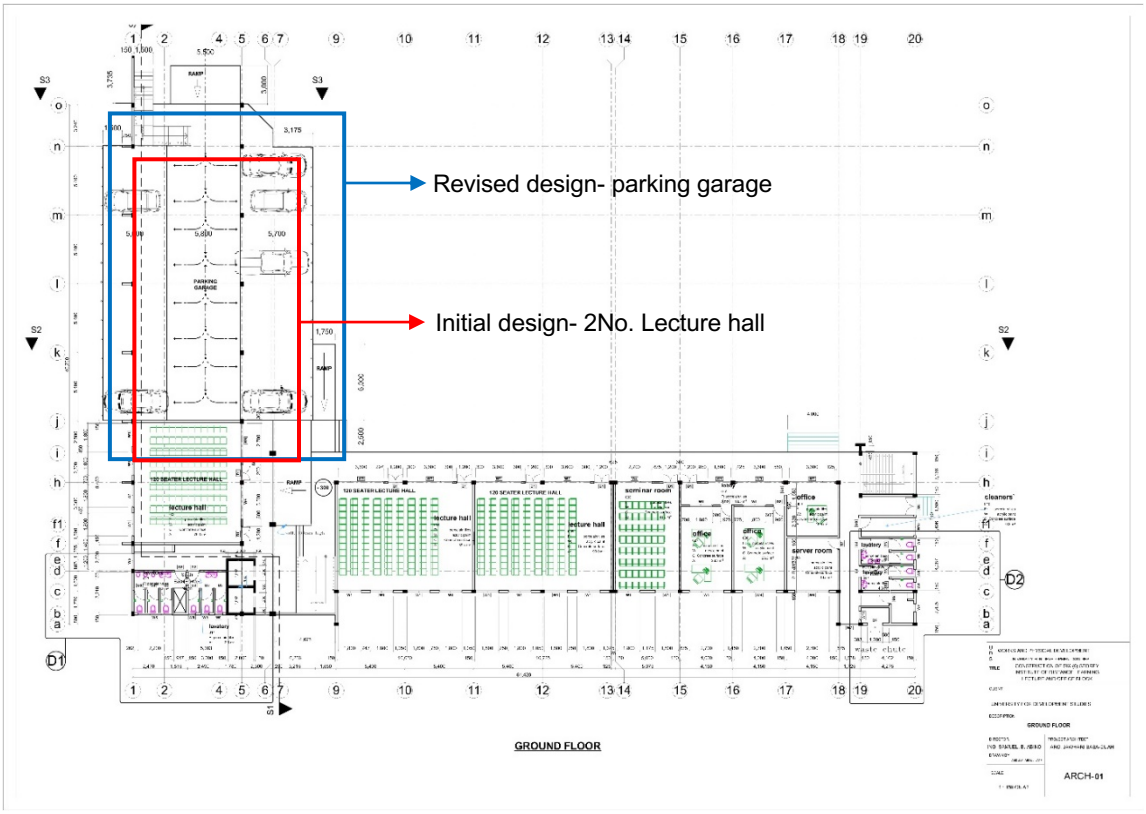


Figure 3-1: Ground floor plan showing design variation

3.2.1.2 Architectural Drawing Documentation

The drawings received by the Committee was printed on an A3 for convenience. However, further interrogation revealed that the drawings submitted to the Contractor was printed on an A2 sheet size at a scale of 1:150. The drawings did not indicate the stamp of the Architect (designer) as it is statutorily required that each page of architectural drawings submitted for permit acquisition should indicate the official signature and registration stamp (issued by the GIA) of the Architect. However, the set drawings had on all pages the name of the project Architect, the Client (herein University for Development Studies), project title (six storey lecture halls and office block for the Institute of Distance Learning – UDS), description/title of drawing, scale and sheet numbers. The foregoing confirms appreciable adherence to standard requirement as stipulated in the GhBC (2018) clause 1.9.2.1.1 which spells out that, construction documents shall be of sufficient clarity to indicate the location, nature and extent of work proposed. The drawings received had clearly dimensioned site layout/block plan showing setbacks that conform to the rear open space and side open spaces as prescribed by the code (see figure 3-1).

On the other hand, there were omissions of structural elements (beams and beam lines) and section S3 from the sections and the set of drawings respectively. The drawings were devoid of legends to describe the specifications proposed by the Architect, especially, that for finishes.

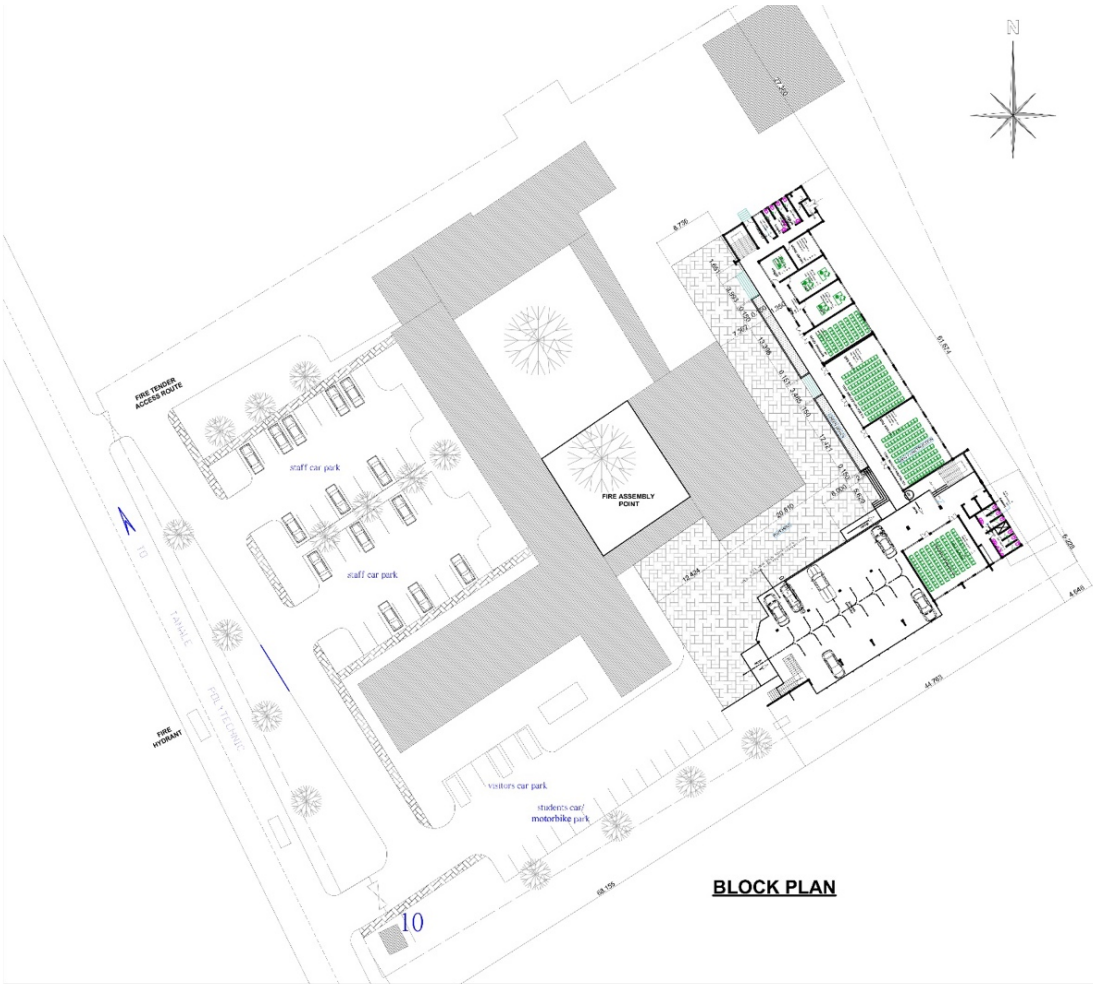


Figure 3-2: Block plan showing setbacks



Figure 3-3: Section S1 showing no architectural indications of beams and beam lines

3.2.1.3 Conclusion on Architectural Design Assessment

Since the architectural drawings communicate information to other stakeholders (Client; Structural Engineer; Geotechnical Engineer; Mechanical and Electrical Engineer and contractor), the importance of clarity cannot be overemphasized. It was observed during the investigation that statutory requirements such as conscious review and stamping of all architectural drawings prior to their release were not rigidly enforced.

3.3 Evaluation of the Structural Design

3.3.1 Structural Drawings

From the architectural design drawings, the Structural Team studied the functional specifications of all floor spaces in each floor story (Figure 3-4). These spaces included lecture halls, classrooms, offices meeting rooms, verandas, corridors, toilet facilities. The team therefore was able to identify and select the characteristic and subsequent design live loads for these different functional areas. Other possible or probable imposed loads were identified by the team as wind load considering the overall height of the building (approximately 40 meters) above ground level and the extent of general exposure of the building with very little or hardly any shielding around by surrounding or nearby structures. The design load would therefore be expected to be a combination of loads involving the dead load (due to self-weight of members), permanent loads, imposed/live loads, wind load and perhaps seismic load. The latter (seismic) being dependent on the seismic activity in Tamale environs which might not be highly consequential.

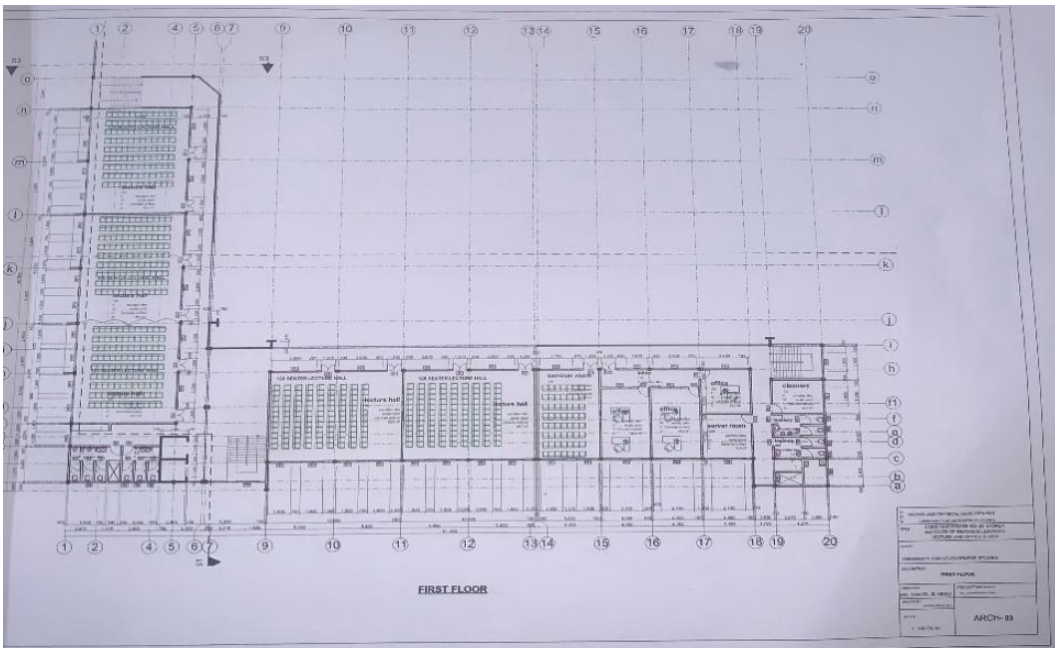


Figure 3-4: Functional specifications of typical floor space

The design processes would typically follow certain standard procedures and specifications in accordance with a national code of practice. The structures department of WPDD has adopted the PROTA software for their structural design and drawings. A typical output of the structural design process of WPDD is shown in Figures 3-5 and 3-6.

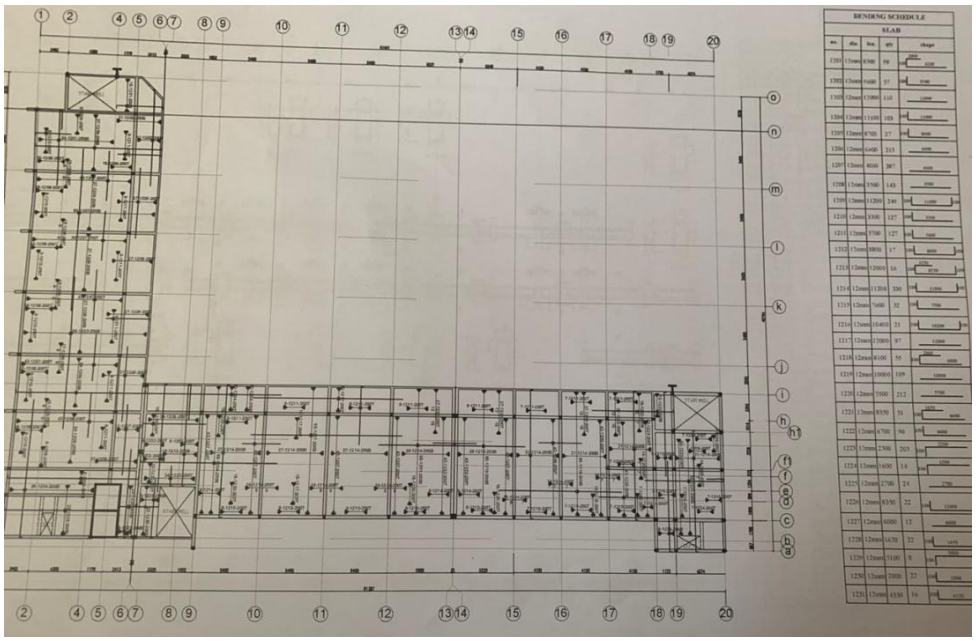


Figure 3-5 Typical floor slab reinforcement details

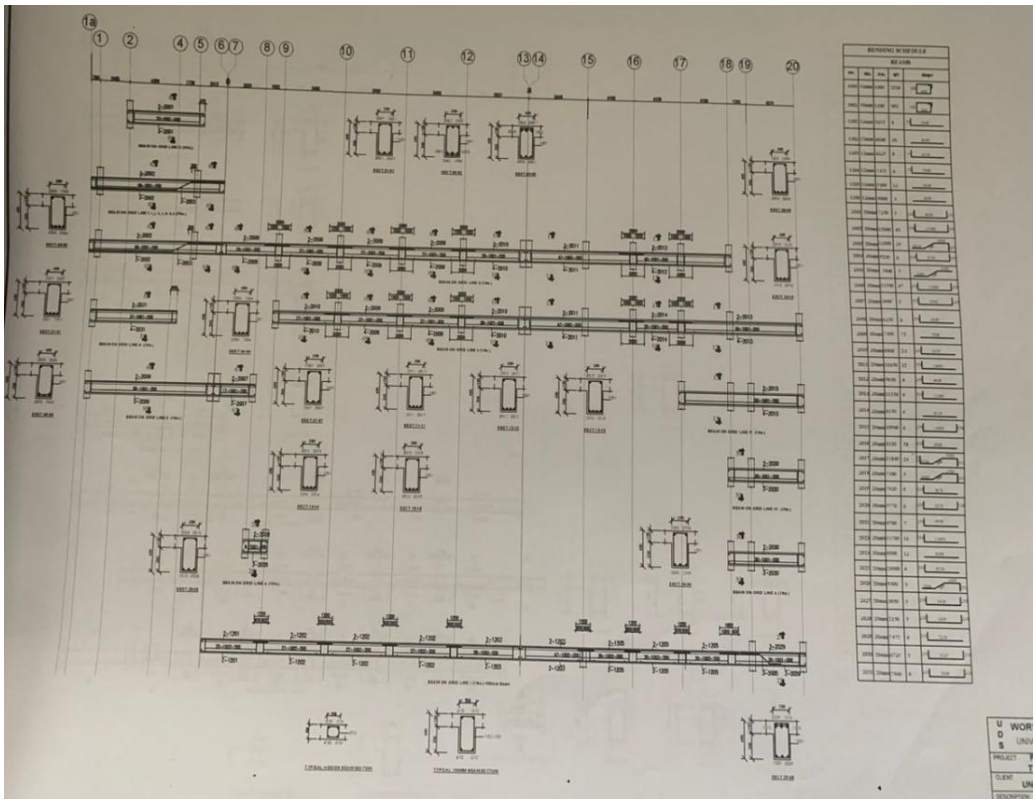


Figure 3-6 Typical structural design print output for beams

The legibility of details in the structural design drawings which were found to be printed outputs from PROTA software design delivered to the integrity assessment team on request to the WPDD and the project Contractors were of low quality and hardly legible for any meaningful communication.

The structural drawings lacked sufficient details for constructional purposes. There were no sections for the foundation drawings to show the depth of excavation nor were there sections

for the building as a whole to indicate the story heights. For the project, only sixteen (16) sheets of structural drawings were contained in a set. As an illustration of the level of drawings deficiency, a similar L-shaped classroom/office building but only five stories high had as many as fifty (50) sheets per set.

3.3.2 The Geotechnical Investigations Carried out for the Design

The geotechnical Investigation Team was given a report titled "*Report of Geotechnical Investigations-Proposed 6-Storey Building for the Institute of Distance Learning, UDS*"- February 2022. The Geotechnical Consultant who executed the geotechnical investigation is a registered member of the Ghana Institution of Engineering with a valid registration.

The report indicated that the geotechnical site investigation for the project was conducted in January/February 2022. The fieldwork consisted of three (3No.) trial pits together with six (6No) Dynamic Cone Penetrometer tests. The 1.2m x 1.0m Trial Pits were sunk manually and they attained depths ranging from 1.0m to 1.5m. The DCP equipment was a DIN 4094 and the tests were performed to depths of 1.8m.

The following comments may be made on the geotechnical investigation report

1. The geotechnical investigations were conducted in January/February 2022 while the project went of tender in September 2021. This implies that the results of the geotechnical investigation could not have influenced the foundation design as all designs were completed and the tender issued four clear months before the investigation was undertaken
2. The choice of the investigation methods consisting of trial pits and DCP are completely inappropriate for a six-storey reinforced concrete structure. The limited depth of coverage of these methods meant that the subsurface profiles and material properties including the laboratory tests were identified to a depth of no more than 1.5m. The implication is that the investigation provided no information on the kind of soil that exists beyond a depth 1.5m. The in-situ strength values of the material beyond a depth of 1.8m where the DCP tests were terminated are also not known
3. There was no attempt to relate the location of the investigation points to the different portions of the structure and there was no attempt to take into account the obvious low DCP blow counts encountered in some of the investigation points such as DCP3. The implication is that the subsurface profile was presented as a uniform profile with a single allowable foundation pressure of 200kPa
4. Apart from this, the analysis of the in-situ data is also of questionable validity.

3.4 The Construction and Construction Supervision

3.4.1 Contractors staffing and equipment on site

3.4.1.1 Contractor's key Staff

The profiles of key staff of the contractor who were directly involved in the construction as provided in the Contract Document are as follows:

Works Manager

Role in Project	Works manager
Name	Rodney Laryea Affotey

Educational background	Bsc. Civil Engineering
Professional Registration	N/A
Professional years of experience with ASIB Ltd	7 years

Site Engineer

Role in Project	Site Engineer
Name	Augustine Amankwaa
Educational background	Bsc. Civil Engineering
Professional Registration	N/A
Professional years of experience with ASIB Ltd	7 years

Quantity Surveyor

Role in Project	Quantity Surveyor
Name	Alex Owusu Badu
Educational background	Bsc. Building Technology
Professional Registration	N/A
Professional years of experience with ASIB Ltd	8 years

General Foreman

Role in Project	General Foreman
Name	Alhaji Abubakar
Educational background	HND Building Technology
Professional Registration	N/A
Professional years of experience with ASIB Ltd	8 years

Carpentry Foreman

Role in Project	Carpentry Foreman
Name	James Ayawli
Educational background	N/A
Professional Registration	On-the-job training
Professional years of experience with ASIB Ltd	6 years

Mason Foreman

Role in Project	Mason Foreman
Name	Stephen Ebo Antwi
Educational background	N/A
Professional Registration	On-the-job training
Professional years of experience with ASIB Ltd	7 years

Steel bending Foreman

Role in Project	Steel Bending Foreman
Name	Augustine Yeboah
Educational background	N/A
Professional Registration	On-the-job training
Professional years of experience with ASIB Ltd	5 years

Surveyor

Role in Project	Surveyor
Name	Solomon Ntow Densu
Educational background	Bsc. Geodetic Engineering
Professional Registration	N/A

Professional years of experience with ASIB Ltd	6 years

Surveyor

Role in Project	Surveyor
Name	Alfred Osei
Educational background	HND Geodetic Engineering
Professional Registration	N/A
Professional years of experience with ASIB Ltd	6 years

From information gathered from the Contract document of the project and summarized as above, it is noted that the relevant lead Contractor's staff on the project had their first educational qualification in civil engineering, building technology and geodetic engineering but without respective professional registration although they have had adequate number of years field training in employment with ASIB Ltd, the contractor. The artisans such as mason foreman, carpentry foreman and steel bending foreman all had their qualification and experience through on-the-job training.

3.4.1.2 Contractor's equipment

The contractor's equipment found at the site at the time of visit were: Tower crane; Metal scaffolds; Tipper truck; Pick- up truck. However, from the Contract Document, the contractor has several key equipment units including the following for the project:

(i.) Heavy duty concrete mixers (ii.) Mobile concrete mixers (iii.) Metal scaffolds (iv.) Tower crane (v.) Tipper trucks (vi.) Pick Up trucks	(i.) Steel bar cutter and bender (ii.) Steel bending and cutting machine (iii.) Block moulding machine (iv.) Water tankers (v.) Surveying equipment

3.4.2 The supervision and QC organization

It is required of the contractor to ensure consistency of the building materials' quality by conducting regular material control tests on concrete and reinforcing steel bars, particularly upon receipt of new stocks of cement and steel bars. Despite persistent request from the Investigation Team to both the Project Manager (The Director of WPDD) and Contractor's site Agent, the only test results submitted were mix design test results of concrete conducted at the beginning of the contract as listed below:

Table 3-2 Results of Mix Design Testing on Concrete

Test Date	Test Type
28/02/2022	7 days Compressive Test results of C15, C10, C25
23/03/2022	28 days Compressive Test results of C10 blinding, C15 mass concrete, C25 structural member

There were no test results of reinforcing steel bars or other concrete during the course of the project. Contrary to Section V, Subsection 4.21 of the Contract Conditions, there were no monthly reports. The fact that this situation was not rectified clearly indicates the weakness in the quality assurance supervision

4 Investigations on the Collapsed Structure

4.1 Methodology

4.1.1 Structural Measurements

4.1.1.1 On site Measurements

Forensic diagnosis was conducted by following a series of activities including site inspection/visual observation of the collapse mode in the form of horizontal rotational motion and almost straight vertical drop or motion from the roof level to the ground level (see Figure 4-1).



Figure 4-1: Rotational and vertical drop manner of collapse

The rotational movement assessment was made by identifying the approximate center, line of rotation and angle of rotation. The extreme line of points of the collapsed building from the center was also identified through flying drones and photography (Figure 4-2).



Figure 4-2: Rotational manner of collapse from drone photography

The rotational direction was also ascertained through aerial photography and observation by means of flying drones as depicted in Figure 4-2. The collapsed heap debris was removed carefully and sequentially by excavators starting from the top to expose each floor level and the structural members of that respective floor at a time. Each structural member namely, reinforced concrete beam, column and slab was inspected and studied to record its dimensions, in-situ concrete strength and steel reinforcement details. The actual positions/ locations and spacing of columns at the ground level were observed and recorded to compare with details in the structural design drawings.



Figure 4-3: Removal of collapse debris

The ground was excavated to expose column bases /footings to observe and assess the state of the sub-structure (Figure 4-4). The depth of the foundation was evaluated and so were details of column bases in terms of length, breadth and depth or thickness.

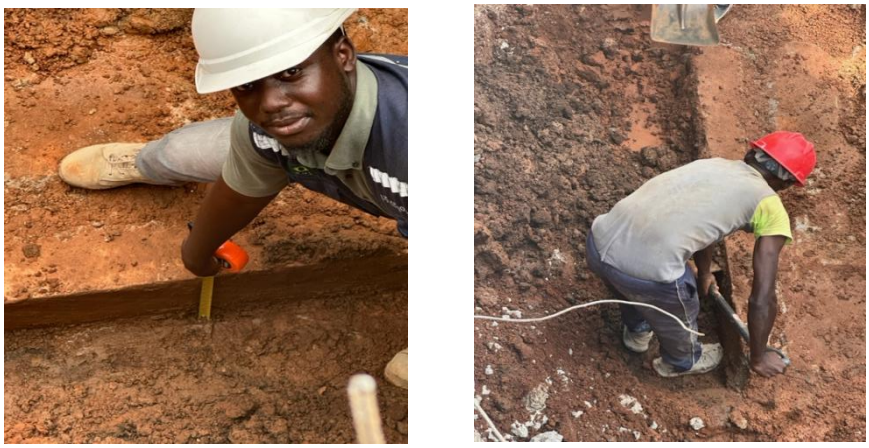


Figure 4-4: Excavated column base

In addition, the sub-structural columns and footings were inspected for the presence of cracks. The in-situ concrete strength of sub-structural columns and footings/bases was ascertained by a non-destructive method using the Schmidt rebound hammer UPV as illustrated.

4.1.1.2 Laboratory Testing of Samples of Steel and Concrete

Furthermore, some specimens of reinforcing steel bars and concrete cores were retrieved and cut from the collapsed structure for further laboratory testing to ascertain their residual strength. Figure 4-5 shows a pile of reinforcing steel bars retrieved from the collapsed structure.



Figure 4-5: Retrieved reinforcing steel bars from the collapsed building

4.1.2 Geotechnical Investigation

The purpose of the geotechnical investigations within the footprint of the collapsed building is to provide the subsurface model to be used for analyzing the behaviour of the structure under the various load scenarios used to determine why and how the structure collapsed.

4.1.2.1 Field Investigations

A total of four boreholes were sunk within the footprint of the collapsed structure using the Dando 2500 Percussive Drilling Rig. The borehole locations are shown on the google earth map of the structure prior to failure in Figure 4-6. During the percussive drilling, the Standard Penetration Test (SPT) was performed in accordance with ASTM D 1586-99 at 0.5m and 1.0m depth and thereafter at 1.0m intervals. The SPT N-values, (i.e., N_{SPT}-value) were computed from these tests. The tests were terminated when the N_{SPT}-value consistently registered refusal. Disturbed samples (DS) were recovered from the cutter and from the Split Spoon Sampler (SS samples), examined, logged and labelled and sealed in plastic bags to prevent moisture loss while undisturbed samples were obtained in U-100mm tubes. The borehole was logged and all samples were sent to the laboratory for further testing. Figure 4-7 shows the SPT test in progress.



Figure 4-6: Location of Investigation Points



Figure 4-7 SPT Test in Progress

4.1.2.2 Laboratory Testing of Soil Samples

In the laboratory, the soil samples were air-dried and the index property and one-dimensional consolidation tests were performed in accordance with relevant portions of the British Standard BS 1377-90

4.2 Discussion of Results of Investigation

4.2.1 Measured Dimensions of Structural Members

4.2.1.1 Reinforced Concrete Slabs

All the real reinforced concrete slabs were found to have a depth/thickness of 150mm irrespective of their span length and spanning mode (one-way or two-way action). This 150mm thickness was the same for slabs in both the un-collapsed and collapsed wings/blocks of the entire 6-storey building. The steel reinforcement details generally comprised 12mm diameter high yield deformed/ribbed bars that were spaced apart at 200mm in the top and bottom faces of the slab. The top face bars were located wherever the slab support occurred.

4.2.1.2 Reinforced Concrete Beams

At all floor levels, the beams could be described and considered as flange beams (L-beam and T- beam) in which the flange constituted part of the floor slabs and therefore had a thickness or depth of 150mm (same as slab) and web depth of 300mm. The width of the beam web was either 250 mm or 300 mm depending on their alignment with the column orientation. In several positions, the alignment of the column with respect to its major and minor axis was improper in the sense that the column's principal axis did not correspond to the plane of bending of the supported beams. This lack of proper structural judgment in construction would mean that these columns' potential higher stiffness for bending/flexural actions and reduced deflections were ignored and not utilized.

All the primary RC beams generally spanned 8.55 meters between RC columns and extended with 2.3m as overhangs/cantilevers across verandas on all floors at the front of the building. Internally, the length of the beams varied, and the maximum span was measured to be 8.55 meters. The main reinforcement steel bars in the beams comprised generally a total of six (6) 20mm high-yield ribbed bars with three (3) at the top and three (3) at the bottom, 10mm high-yield bars as stirrups and spaced at 200mm.

In the collapsed wing, there was visible evidence of a toppling effect and subsequent collapse or fall-out of two (2) overhanging beams/ cantilevers that were deemed in the opinion of the structural team members to have been constructed without adequate and proper anchorage within a transverse beam support at their ends. At best these two cantilevers should have been extended back adequately for effective anchored support. These two overhanging beams constituted a support system for a canopy slab over a staircase at the extreme end of the block where a car park was added to the construction after the original design of the building. The canopy slab and overhanging beam supports were all later additions to the construction which were most likely inadequately designed.

4.2.1.3 Reinforced Concrete Columns

Physical measurement of column dimensions by the team at the site produced the same cross-section of 250mm x 300mm (breadth x Depth) and floor to floor height of 3.15m. *In several cases, the column orientation was not optimized, since the columns were not*

aligned to exploit their major axis (hence greater stiffness) in the place of bending. The steel reinforcement in each column consisted of a total of 6 (six) 20-mm high-yield ribbed bars three (3) in each of the two opposites. Stirrups were made of 10mm bars at spacing of 200mm.

4.2.2 Concrete and Reinforced Steel Strength tests

4.2.2.1 Laboratory results of concrete strength tests

In-situ tests by NDT using the rebound hammer were carried out on some seemingly intact structural members of the collapsed block. In addition, compression test was conducted in the laboratory on concrete cores taken from the collapsed debris. The results are presented in Table 4-1. The average in-situ concrete strength of the collapsed block of the building was about 12.5 N/mm^2, much less than the design strength value of 25 N/mm^2. This may be due to the fact that the total collapse of the building created micro-cracks in the concrete.

Table 4-1: Laboratory Compressive Strength of Concrete in Collapsed Block

Type of structural member	Concrete strength by NDT (N/mm^2)	Cored concrete strength (N/mm^2)
Column (from 5th floor)	17.7	
Column (from 2nd floor)	11.2	
Beam (roof)	12.1	
Beam (from 5th floor)	13.6	
Beam (roof)	11.2	8
Column (unidentified in debris)	9.6	7

4.2.2.2 Laboratory results of tensile test of steel bars

The results of laboratory tensile tests in 20mm, 16mm and 12mm nominal reinforcing steel bars used in the concrete columns, beams and slabs of the collapsed building are shown in Table 4-2.

Table 4-2: Results of tensile test of reinforcing steel bars

Bar size (mm)		Yield strength (average) (N/mm^2)	Maximum Strength (average) (N/mm^2)
Nominal	Actual		
10	10.5	537	658
12	12.4	484	606
16	16.0	578	653
20	20.2	533	636

4.2.3 Subsurface Profile and Test Results

4.2.3.1 The subsurface Profile

The subsurface profiles obtained from the borehole logs are shown in Appendix 1. The profile shows the sandstone bedrock is overlain by a mudstone layer with a silty sand layer underlying the top fill material. BH1 shows a hardcore filling at the top to a depth of about 2.5m on top of a lateritic gravel layer and a thin sand layer. Below this is a consolidated clay layer which gets hardened into mudstone with depth. The sandstone is encountered at a depth of 8m. In BH2,

however the clay and its hardened mudstone and overlying sand layer is absent and the sandstone is encountered at a depth of 1.5m

4.2.3.2 Laboratory Test on Soil Samples

The index property test results of samples from the various layers are summarized in Table 4-3. The results of one-dimensional consolidation test on samples taken from the clay layer in BH1 at the depth of 3.6m are also summarized in Table 4-4.

Table 4-3: Summary of Laboratory Test Results of Soil Samples

Location	Depth (m)	Natural Water content (%)	Atterberg Limits (%)		Particle Size Distribution (%)			
			LL	PI	Clay	Silt	Sand	Gravel
BH1	4.00	21.7	45	22	23.0	33.0	42.8	1.2
	5.80	14.5	41	22	24.0	57.0	18.4	0.6
BH2	1.00	9.1	29	11	5.0	16.0	31.5	47.5
BH3	2.00	12.8	19	NP	2.0	60.0	5.6	32.4
	4.00	11.7	27	10				
BH5	2.00	22.7	32	16	34.0	28.0	37.8	0.2

Table 4-4: Summary of Consolidation characteristics of clay sample from BH1

Effective stress (kPa)	6	12	25	50	100	200	400	799
Coefficient of Volume Compressibility, m_v (m^2/MN)	0.016	0.025	0.263	0.343	0.287	0.187	0.119	0.073
Coefficient of Consolidation, C_v (cm^2/s)	0.020	0.093	0.123	0.171	0.044	0.026	0.041	0.059
Permeability, k (cm/s x 10^{-6})	0.032	0.232	3.182	5.755	1.246	0.471	0.474	0.425
Compression Index, Cc	0.173							
Swell Index, Cs	0.074							

4.2.4 The Subsurface Model under the Collapsed Structure

The subsurface profiles were used to develop the subsurface model shown in Figure 4-8. A two-dimensional section through BH1-BH3-BH2 shows that the underlying sandstone slopes from BH2 towards BH1. The mudstone is hardened with very high N_{SPT}–values with a minimum value of 28. The fill however is loose so that at a typical depth of 1.8m used for the foundation of the structure, the N_{SPT} value is of the order of 8 in the vicinity of BH1, while BH2 is in the sandstone with refusal for N-value. This observation which implies a possible differential settlement is important for the structural behaviour of the collapsed structure.

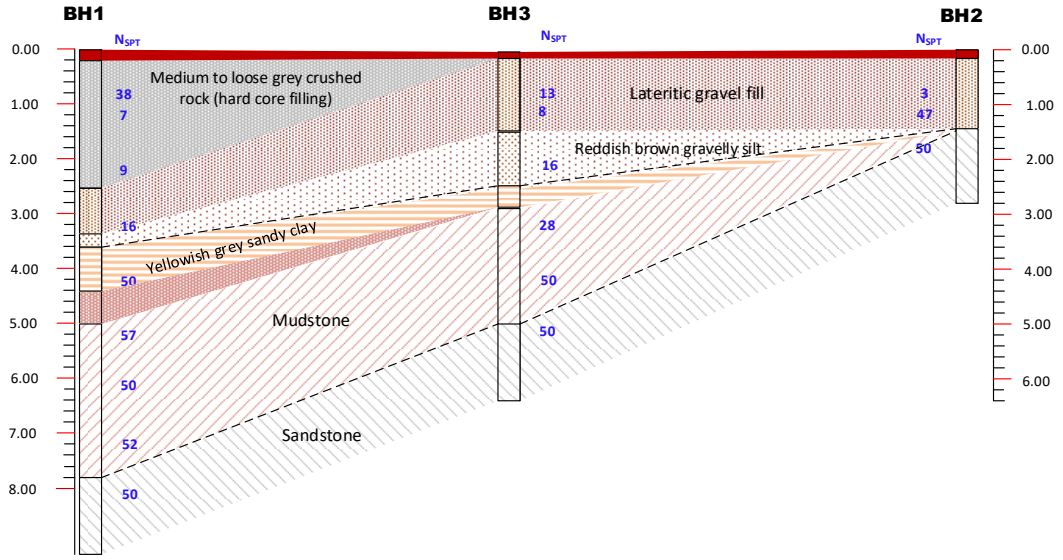


Figure 4-8: Subsurface 2-D Model beneath collapsed structure

4.3 Modeling the Response of the Building

4.3.1 Description of the Building

The building is a six storey, L-shaped facility with moment-resisting frames and block infill. A general layout of the building is shown in Figure 4-9 where the collapsed part is bounded by gridlines 1 and 7.

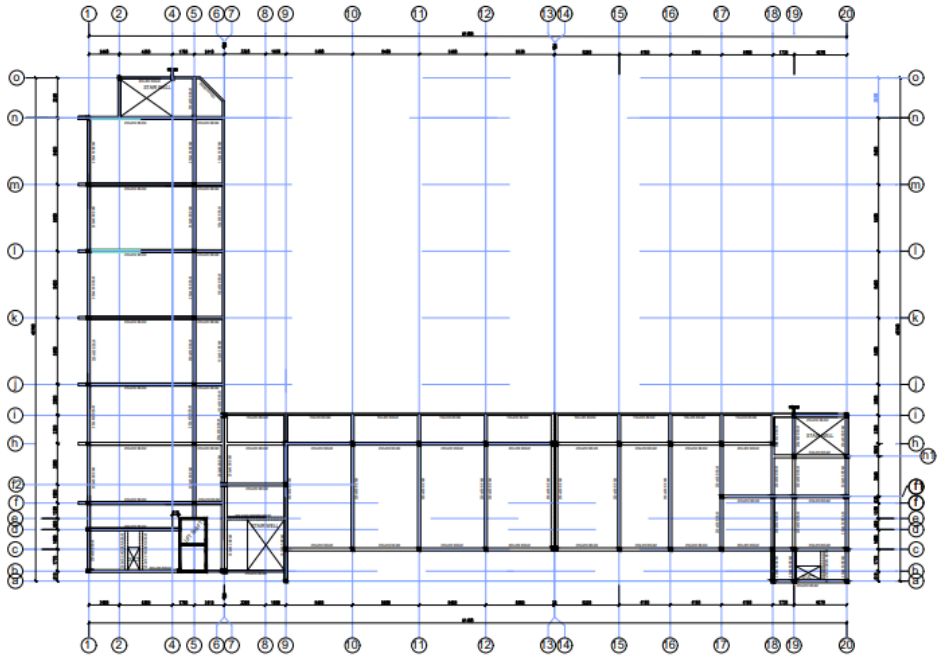


Figure 4-9: General Layout of the building

After the visual inspection, site measurements and desk study of the structural drawings, two critical observations were made:

- The moment resisting frames of the building comprise only two columns 8.55 meters apart rigidly joined by 250mm x 450mm beams at floor levels. The floor

beams have an overhang of 2.3m for verandas. The columns are mainly 250mm x 300mm in section for both the collapsed and still-standing buildings. A typical frame of the building, which is spaced at 5.4m centers, is shown in Figure 4-10.

- Single pad footings of plan dimensions 2000 mm x 2000 mm and 300 mm thick support the columns. The safe bearing pressure of the soil is given as 200 kN/m^2.

These observations immediately raised red flags about the sufficiency of the structural design of the facility, namely:

- For a six-storey building supported only by 2 lines of columns per frame, the column size of 250mm x 300mm used for the design and also for the construction seems to be woefully inadequate.
- For the given soil safe bearing pressure and the expected foundation load from a six-storey building, it was very obvious that the footings were under-dimensioned.

Besides these, the structural drawings lacked some components required for construction and structural detailing was poorly done. In some cases, it is even doubtful whether the structural component was actually designed. The lift foundation (Figure 4-11), for example, does not extend beyond the vertical walls. The lift was simply placed there like a container whose base is only 300mm thick.

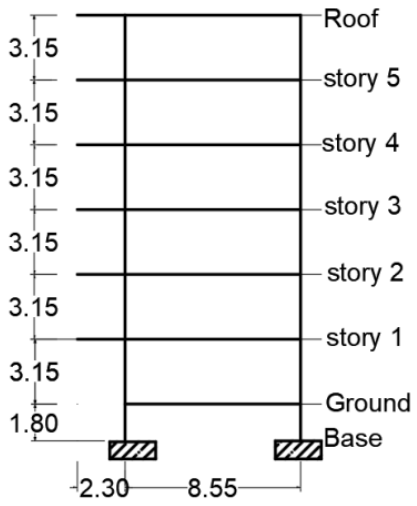


Figure 4-10: Typical frame of the building on Collapsed Structure

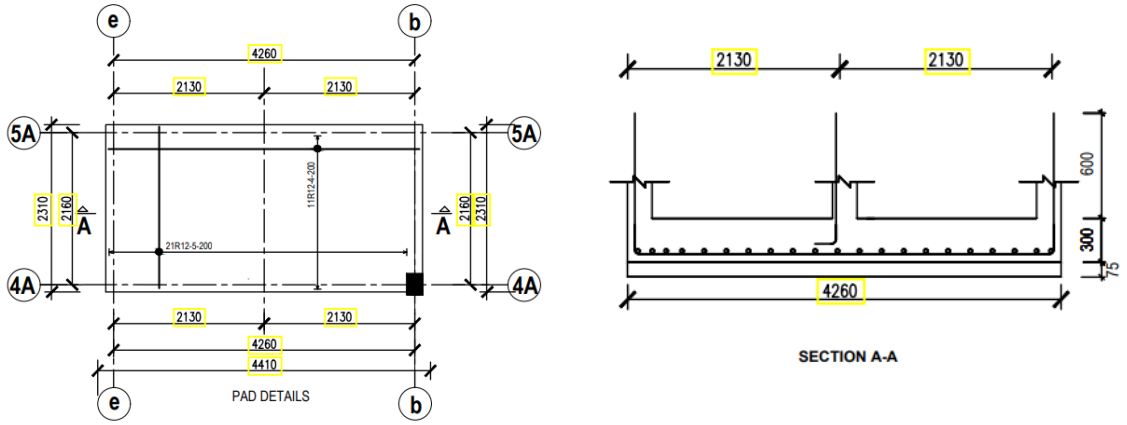


Figure 4-11: Lift Shaft foundation on Collapsed Structure

4.3.2 Analysis of the collapsed building

The design calculation was not provided so it was not possible to confirm the design loads used. The design engineer, however, provided verbally the values shown in Table 4-5 when interviewed. These are compared to corresponding normative values adopted from BS 6399 code which were used to check the design.

Table 4-5: Design Loading versus Normative values

Load Type	Values used by Design Engineer*	Normative Values and Source	
Additional Dead Load (kN/m^2)	0	1.5	Estimated
Live Load (Offices) (kN/m^2)	2.5	2.5	BS 6399 Part 1 1996
Live Load (Classrooms) (kN/m^2)	2.5	3.0	BS 6399 Part 1 1996
Live Load (Corridors) (kN/m^2)	1.5	4.0	BS 6399 Part 1 1996
Wind Speed in m/s	34	34	Ghana Building Code

*From conversation with the Structural Design Engineer

4.3.2.1 3D Model and Simulation

One of the factors suspected to have played a role in the collapse of the building was the slenderness of the columns. To help determine what really happened, a 3D model of the as-built structure was generated for simulation as shown in Figure 4-12.

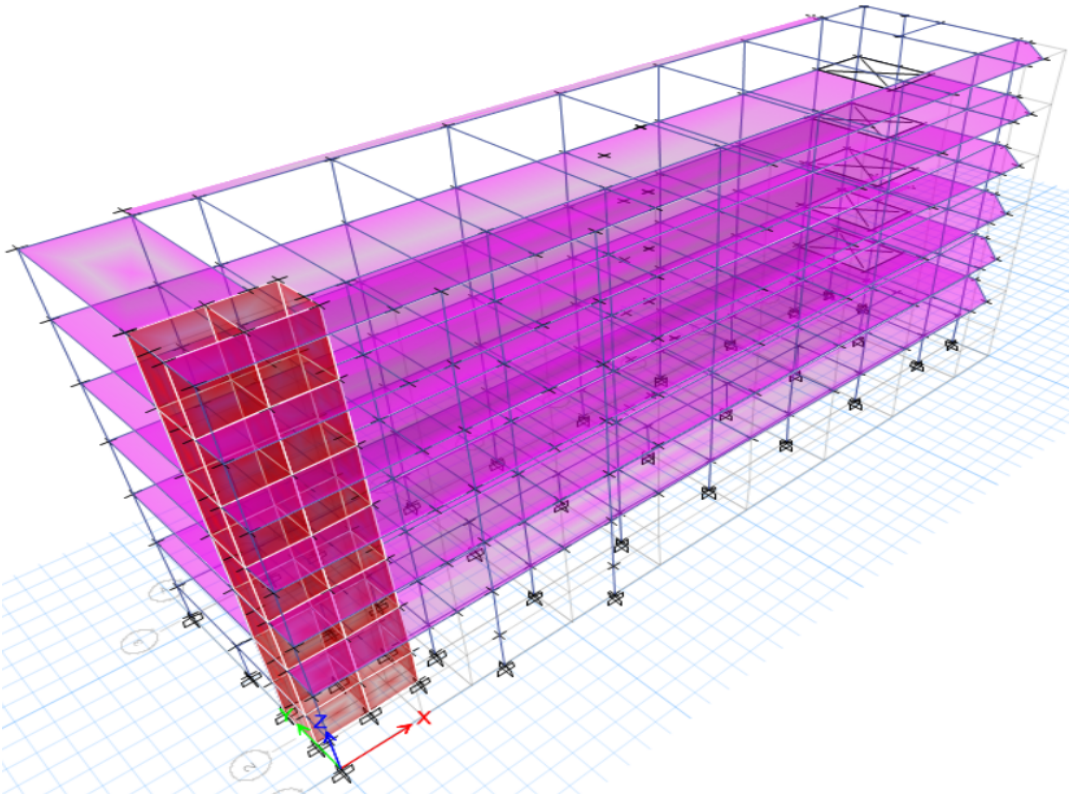


Figure 4-12: 3D model of the collapsed building

A typical floor plan of the collapsed building is shown in Figure 4-13. Apart from the lift shaft and staircase at the extreme ends of the building, the structure comprises seven lateral frames on gridlines C to I.

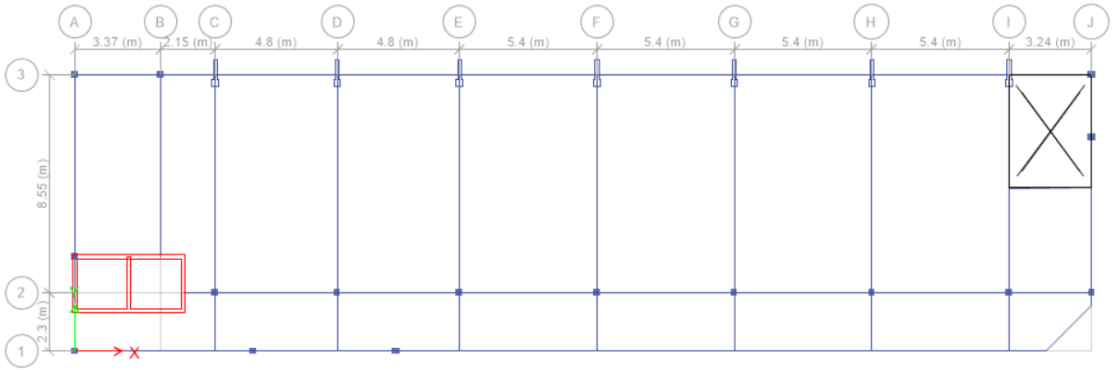


Figure 4-13: Typical floor plan on Collapsed Structure

The column cross sections and their reinforcement dimensioned in millimeters used for the construction of the building are shown in Figure 4-14.

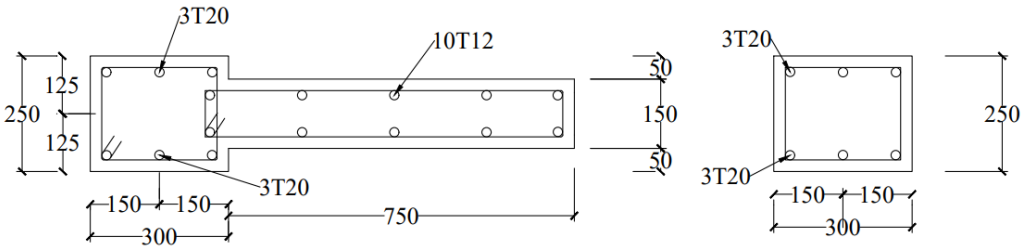


Figure 4-14 Columns on (a) GL 3- C, D, E, F, G, H, I and (b) GL 2 and all other columns

The grid system used for the modelling of the collapsed building (Figure 4-13) is different from the architectural grid (Figure 4-9). The relationship between the two grid systems is shown in Table 4-6.

Table 4-6. Relationship between model and architectural grids on Collapsed Structure

LAYOUT	GRIDLINES												
MODEL	1	2	3	A	B	C	D	E	F	G	H	I	J
ARCHITECTURAL	6	5	1	b	d	f	h	j	k	l	m	n	o

Three simulations were done on this model.

- Simulation 1 – Modal Analysis
  The purpose of this simulation was to determine the fundamental vibration mode shape which gives an indication of the weak parts of the collapsed building. The analysis gave the fundamental period as 1.07 seconds and the corresponding mode shape (not shown) was torsional with the lift shaft located at the lower left corner (Fig 4-12) as pivot. Torsion as a first mode of vibration is not good for any building.

The remaining two simulations were for static analysis and design, reflecting the possible load combinations of the building at collapse. These are:

- Simulation 2 – Analysis/Design under Dead Load Only
- Simulation 3 – Analysis/Design under Dead Load and Wind

The building was analyzed and designed under dead load only to reflect the presumed state at collapse. Here, the actual collapsed shape of the building (Figure 4-15) is compared to the deformed shape of the model (Figure 4-16) under dead loads. For the latter, the position at roof level where the drifts are maximum is shown.



Figure 4-15: Plan view of collapsed Structure

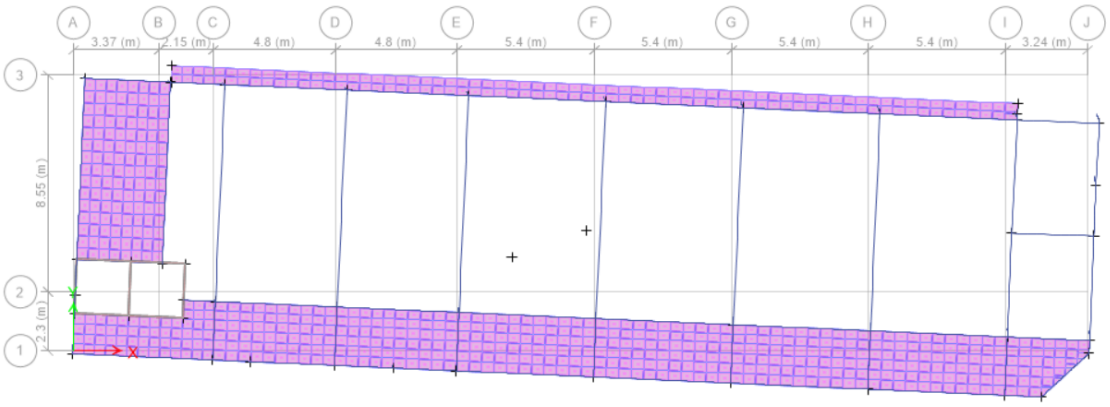


Figure 4-16: Plan of the deformed roof of the model under Dead Loads Only on Collapsed Structure

As can be seen, there is a striking similarity between the two. It is obvious from the deformed shape of the model and that of the collapsed shape that, like the first vibration mode shape, the building rotates about the lift shaft during deformation. The addition of live load and/or wind load only increases the rotation. The building was then designed to BS8110-1997, the same code used by the Design Engineer. Although at the time of collapse the design live loads had not been applied, for completeness, the combination with live loads was also considered. In all the simulations, the beam sections passed but not all the columns. To show the failed columns and the degree of overstress, the column P-M-M capacity ratios were computed and shown graphically in Figures 4-17 to 4-22. Failed columns have capacity ratios greater than one and are shown in red.

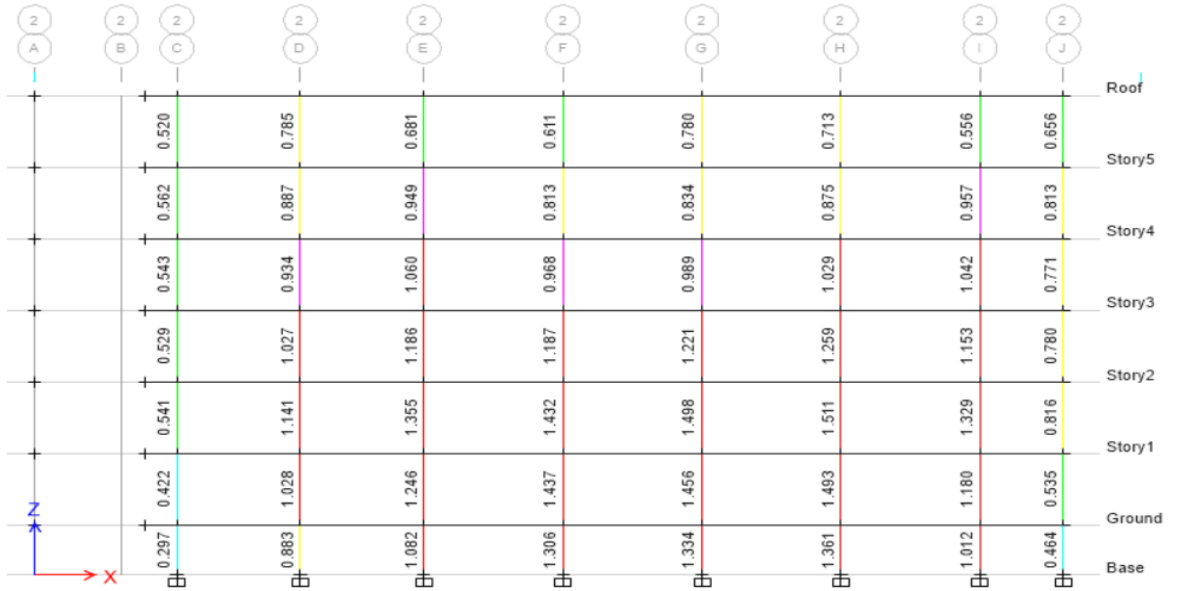


Figure 4-17: Gridline 2 Column capacity ratios (dead load only) on Collapsed Structure

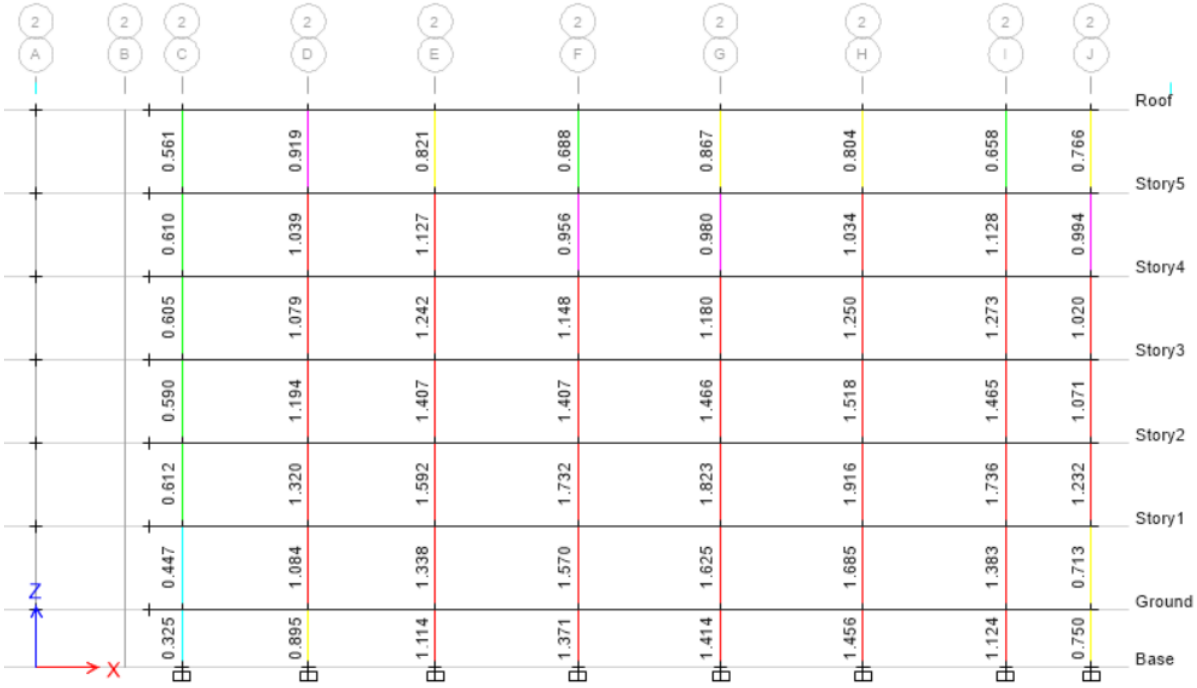


Figure 4-18: Gridline 2 Column capacity ratios (Dead + Wind Load) on Collapsed Structure

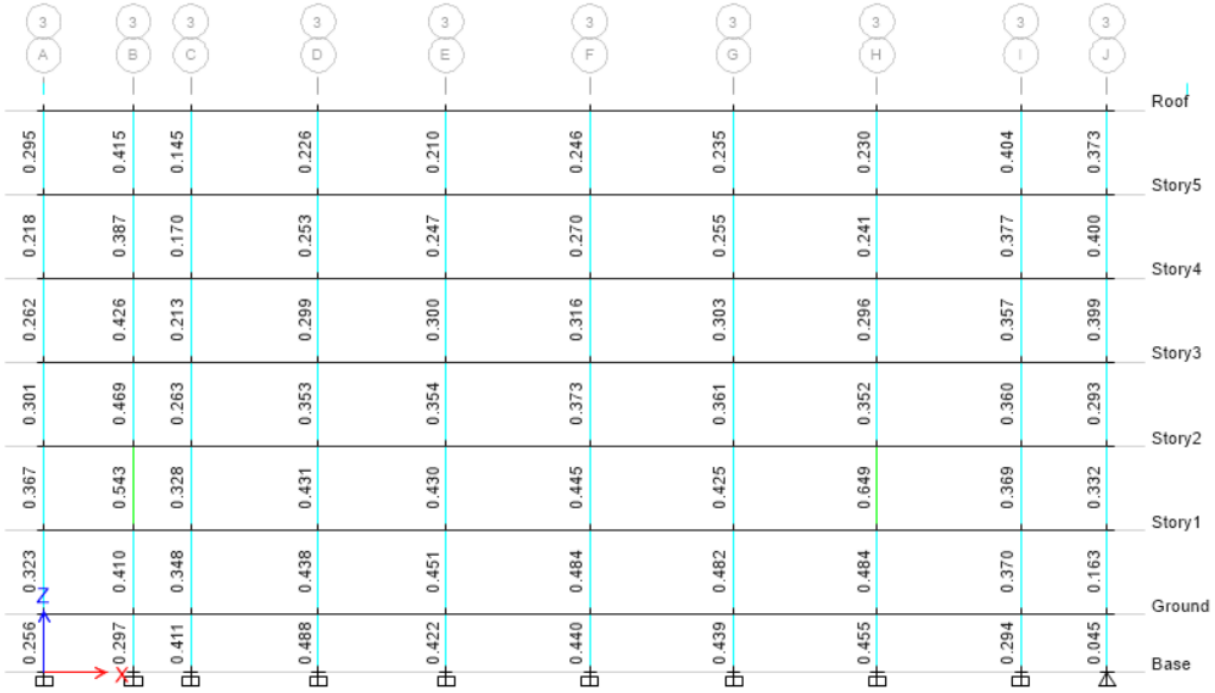


Figure 4-19:Gridline 3 Column capacity ratios (Dead Load Only) on Collapsed Structure

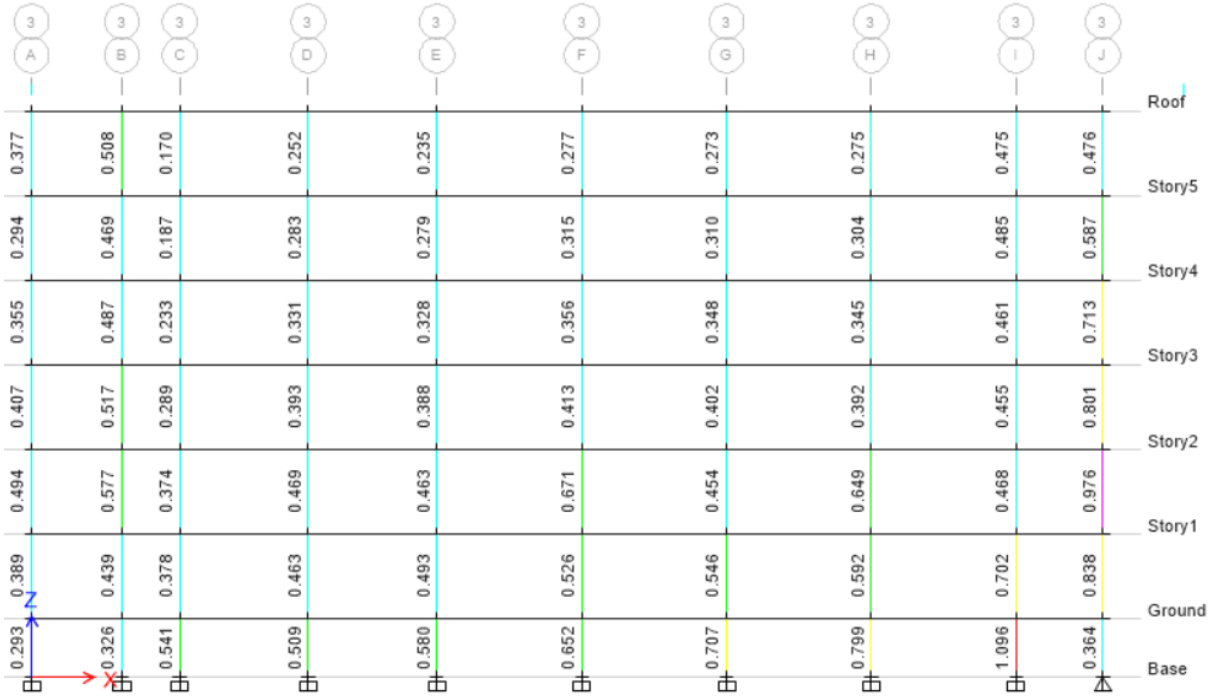


Figure 4-20: Gridline 3 Column capacity ratios (Dead + Wind Load) on Collapsed Structure

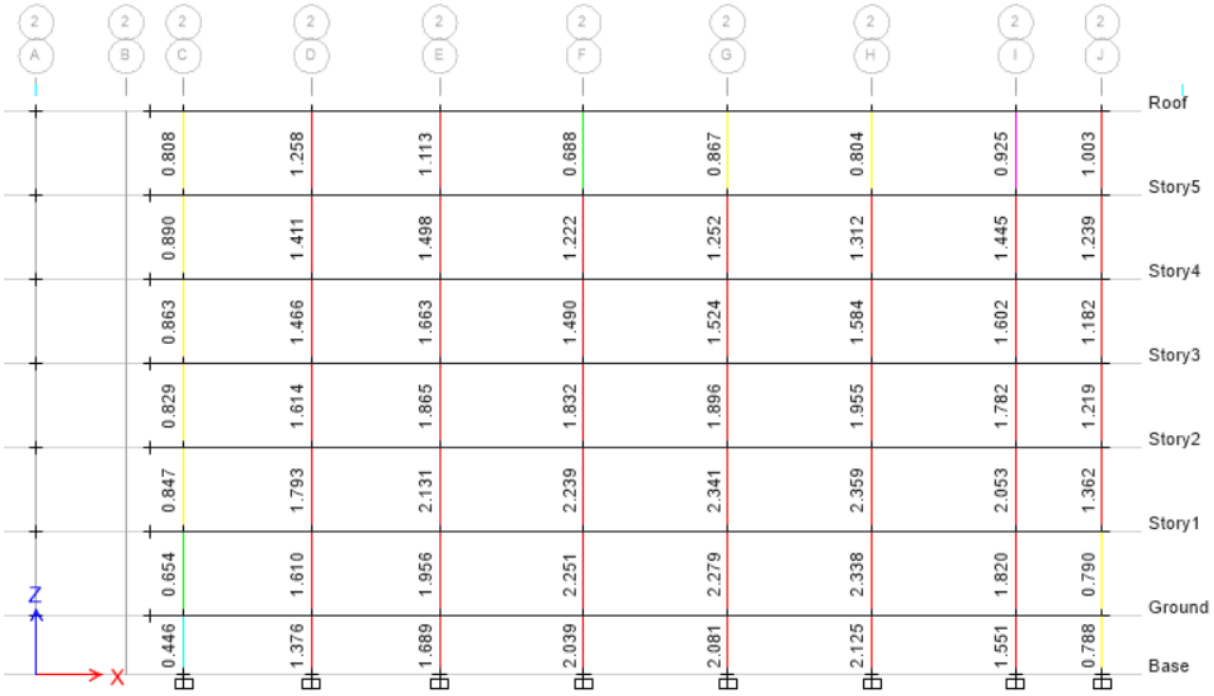


Figure 4-21: Gridline 2 Column capacity ratios (dead + Live + Wind Loads) on Collapsed Structure

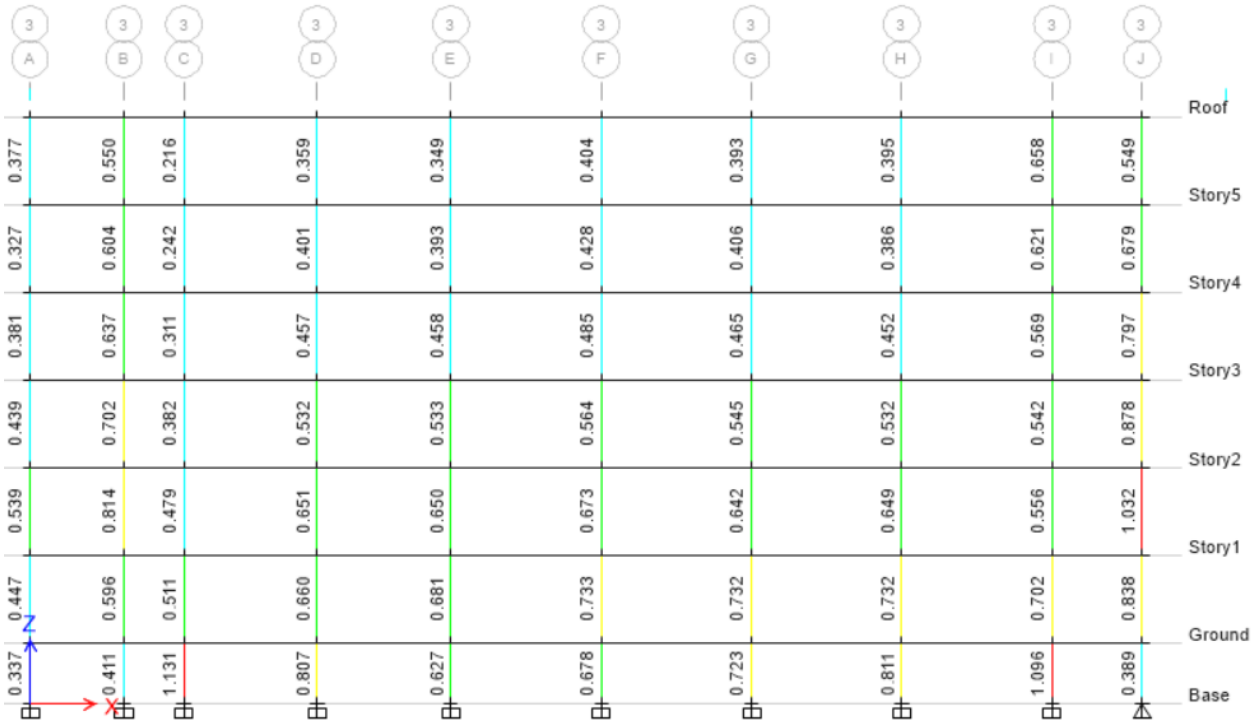


Figure 4-22: Gridline 3 Column capacity ratios (dead + Live + Wind Loads) on Collapsed Structure

The graphical results above are summarized in Table 4-7 and Table 4-8 for columns on gridline 2 and 3 respectively.

Table 4-7: Summary of failed columns on GL 2 on Collapsed Structure

Simulation	Total No. of columns	No. of failed columns	Percentage of failed columns	Maximum capacity ratio
Dead Load only	56	26	46.4	1.511
Dead + Wind	56	34	60.7	1.916
Dead + Live + Wind	56	43	76.8	2.359

Table 4-8: Summary of failed Columns on GL 3 on Collapsed Structure

Simulation	Total No. of Columns	No. of failed Columns	Percentage of failed Columns	Maximum capacity ratio
Dead Load Only	70	0	0	0.649
Dead + Wind	70	1	1.4	1.096
Dead + Live + Wind	70	3	4.3	1.131

The results above for the modelling were obtained using grade C25 concrete and high yield steel of strength 460 N/mm^2. Since the presence of microcracks that develop in concrete that has fallen over significant heights reduce the strength, the in-situ and laboratory concrete strength of the collapsed debris will not be representative. The pre-failure concrete strength of the collapsed building may therefore, be assumed to be similar to that of the standing building. The characteristic material strength therefore did not differ significantly from the values used in the modelling. Furthermore, tensile test results on the reinforcing steel bars retrieved even from the collapsed wing gave highly adequate yield strength of about 500N/mm^2 indicating high-yield steel which was not different from the design strength used for the structure.

The pad footings of plan dimensions 2000mm x 2000mm and 300mm thick supporting the frames were checked in the theoretical modelling assuming a safe earth bearing pressure of 200 kN/m^2. All failed for excessive soil pressure and for punching. However, these failures were not confirmed by results of visual inspection when a column base was exposed at the site.

4.3.3 Causes and Likely Trigger of Collapse

Visual inspection, desk study of structural drawings and 3D simulations of collapsed structure all point to design flaws and lack of effective supervision. The columns and the column footings used in the design were under-dimensioned and although the building collapsed before the application of the design live loads, these loads were grossly underestimated. A study of the architectural drawings suggests that the Engineer assumed the dimensions and orientations of the structural members (columns, beams and slabs) as proposed by the Architect. It appears he did not embrace his responsibility to size the members and, in consultation with the Architect, even change their position if that ensured the safety of the structure. The design Engineer appeared to have relied on the PROTA software which he probably did not fully comprehend its intricacies. The ultimate cause of the collapse was due to multiple column failure. Even under dead load alone, ground floor and first floor columns 2F, 2G and 2H (Figure 4-18) had capacity ratios above 1.4. Most likely, the ground floor and first floor columns on

2H, being the highest stressed, failed and the neighboring columns on 2F and 2I also failed instantly because they did not have the capacity to accommodate the redistributed forces. A progressive collapse mechanism was thus initiated. The inertia from the weight of the building, in its rotational movement, accelerated the collapse.

The collapse was initiated by multiple-column failure resulting from a design flaw but building collapses are normally triggered by an event. What could have triggered this collapse? While it was not possible to find the answer from the debris of the collapsed building, possible culprits can be inferred from the simulations and structural drawings.

4.3.3.1 Wind gust

On the night of the collapse on 6th May 2023, information from the Ghana Meteorological Agency (See Appendix 2 for their report) indicated that there was a moderate to severe thunderstorm. The assessment of the Agency is that "…*At 1700UTC we had the storm moving from the east into our country engulfing the eastern areas of the country. The storm stagnated and expanded further inland till it reached its maturity stage at around 1900-2000 UTC (7-8p.m) to produce moderate to heavy rains of which CSIR-SARI, Nyankpala–Tamale a METEO. station close to your area of interest city campus UDS Tamale, recorded rainfall amount of 47.1mm...*"

The collapsed building is aligned in the north–south direction so that the easterly wind direction is directly against its longer face. The wind could do one of two things; either directly further increase the column capacity ratios or the reported variable wind speeds could set the building into small vibratory motions. Either is not good for the integrity of the already heavily compromised building.

4.3.3.2 Sudden Foundation Movement

In addition to this, it was noted during the simulations that the column footings were under-dimensioned and were failing in punching and excessive ground pressure. The concern here is about punching failure which occurs suddenly and may trigger collapse through the large vertical impulsive force generated.

4.3.3.3 Lift Shaft Base Failure

Reference is made here to the design drawings of the lift shaft substructure (Figure 4.12). Assuming that soil pressure under the base is correct thus providing the basis for calculating the base slab reinforcement, we observe that the calculated reinforcements are placed only at the bottom of the slab. The span (top) reinforcements are missing. The slab is therefore not reinforced in the spans and, with the prevailing large upward pressure, likely to fail in accordance to the known yield pattern. Such a failure can also be accompanied by a large vertical force which could trigger the collapse.

4.3.3.4 Soil-Related Failure:

Apart from structural failure in the foundation members mentioned in the subsection above the issue of settlement in the foundation soil is also of concern in this project. The subsurface model of the soil under the collapsed building (Figure 4-8) shows highly non-uniform subsoil conditions.

It may be noted that the foundation under columns in the vicinity of Gridlines H, I and J (Figure 4-16) (i.e., Location of BH2 and BH4 in Figures 4-6 and 4-8) were placed at the foundation depth of 1.8m within the sandstone bedrock. However, the columns in the vicinity of Gridlines A, B and C (i.e. borehole location BH1) at the same foundation depth were placed in the *loose hard core fill* (N_{SPT}=8). The implication is that since there were no ground beams, whereas the columns in the vicinity of Gridlines A, B and C including the lift shaft likely settled substantially, those along Gridlines H, I and J could not settle because they are founded on rock. This may have been exacerbated by the high foundation loads. In fact, for the footing dimensions of 2mx2m used at the depth of 1.8m for N_{SPT}=8, the allowable foundation pressure should not have exceeded about 170kPa.

It is worth mentioning here that settlement-related collapses, although not rare, are often long-term events rather than instantaneous but considering the state of the building, even under dead load only, this case cannot be precluded as a small tilt may trigger the collapse.

5 Investigation of Structural Integrity of Standing Structure

5.1 Methodology

Integrity evaluation was conducted on all structural members of the standing building of the six-storey structure. This action involved physical dimensional measurements in reinforced concrete beams, columns and slabs; nondestructive testing for concrete strength using this Schmidt rebound hammer and ultrasonic pulse velocity equipment.

5.1.1 Physical on-site Measurements

The integrity assessment team evaluated the design output noting the dimensions of columns (cross sections and height), beams (depth, weight and length) and slabs (length, width and thickness/depth). The dimensional measurements for these structural members were also taken and recorded from the as-built structure of the standing (un-collapsed) wing to help the team arrive at their well-informed structural assessment and judgment.



Figure 5-1: Measurements being taken by team on Standing Building

5.1.2 Geotechnical Investigation

5.1.2.1 Methodology

The methodology for the subsurface investigation was the same as used for the collapsed structure except that by necessity, the investigation point was sunk in front of the existing structure. One borehole BH5 was sunk by percussive drilling in front of the existing structure. Figure 5-2 shows the drilling operation at the location.



Figure 5-2: Drilling in BH5 in front of the Standing Structure

5.2 Structural Analysis

5.2.1 Description of Building Structure

Like the collapsed part, the standing part of the facility is a six-storey building with moment resisting frames as shown in Figure 4-10. The columns of the standing building are all the same with 250mm x 300mm cross sectional dimensions and reinforced with 6T20 bars as shown in Figure 4-14. The frame dimensions, material properties and loading are the same as those of the collapsed part. The standing part, however, has no lift shaft or shear walls making it even more flexible than the collapsed part. The building is therefore in a much worse state than the collapsed building in terms of its resistance to collapse. To immediately increase its resistance to collapse, the team engaged the Contractor to prop the building at critical points from the ground floor up to roof level.

In the un-collapsed standing block, the slabs that spanned over relatively large spaces/areas (measured to be 8.55 meters by 5.4 meters and therefore behaved in two-way action were observed and found to vibrate in a frighteningly excessive manner and that stomping by a single person to the extent of discomfort to the occupying persons of the integrity assessment team. This behavior of the generally large spanning slabs could be attributed to the inadequacy of the slab/thickness and steel reinforcement design and detailing. In consequence, therefore, these slabs were not designed to satisfy the serviceability limit state of vibration and possibly could fail or collapse under the full design load comprising dead and live loads during their lifespan.

5.2.2 Results of In-situ Strength Measurement

The average concrete strength of the various structural members of the un-collapsed wing of the six-storey building measured by means of non-destructive rebound hammer and ultra pulse velocity methods gave the following results as in Table 5-1. The in-situ concrete strength of the standing, un-collapsed block of the building was found to be generally less than the design strength value of 25 N/mm^2.

Table 5-1: Average in-situ concrete compressive strength in Standing Structure

Structural member	Average strength from Schmidt hammer (N/mm^2)	Average strength from UPV (N/mm^2)
Beams	26.0	24
Slabs	21.1	20
Columns	22.0	21

5.2.3 Subsurface Model

A geological section was made by taking a section through BH5 and BH3 to create the subsurface model shown in Figure 5-3 for the existing structure. It can be seen that the subsurface model, unlike that at the location of the collapsed structure, is fairly uniform. At the foundation depth of 1.8m used for the project, the N_{SPT} values are similar. No differential settlement is therefore expected.

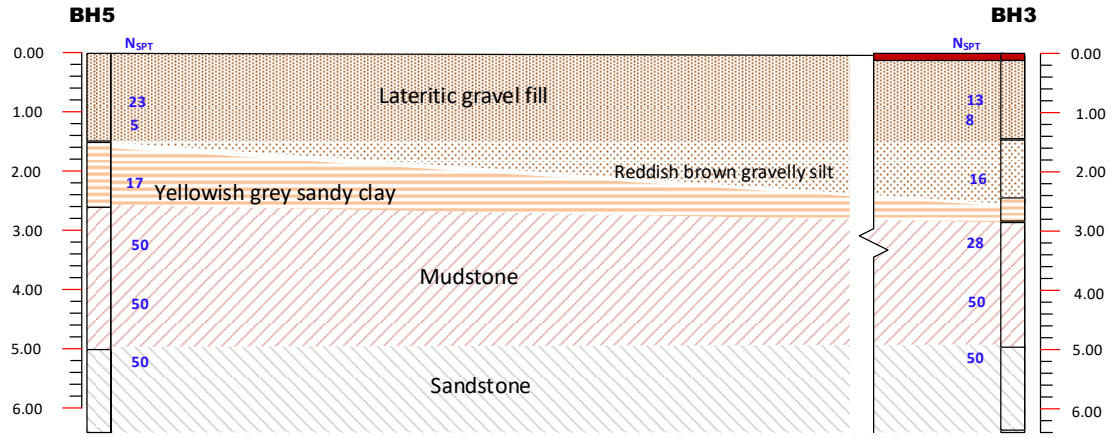


Figure 5-3: Subsurface 2-D Model beneath the Standing structure

5.2.4 Analysis of the Design of the Standing Building

A typical floor plan of the building is shown in Figure 5-4 and its full 3D model is in Figure 5-5. For this model, only two simulations were performed:

Simulation 1 - Dead load + Wind to reflect the present state of the structure
Simulation 2 – Dead Load + Live Load + Wind

In both simulations, the output is a graphical display of the column P-M-M capacity ratios depicting the extent of column overstress.

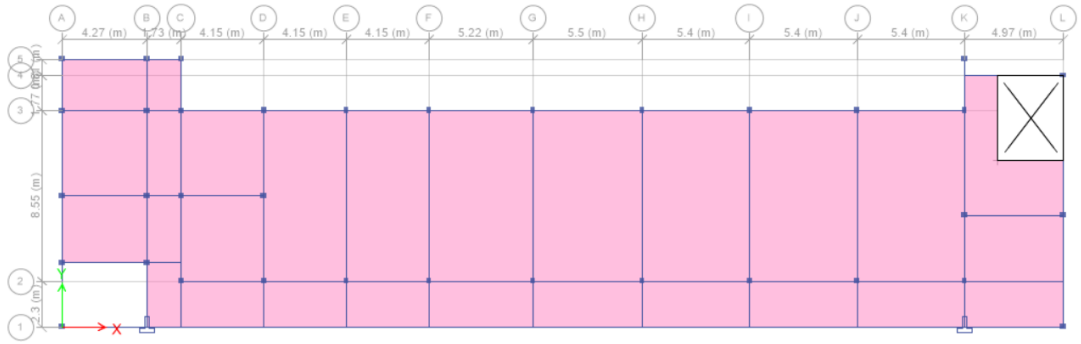


Figure 5-4 Typical floor plan of standing building

The grid system used for the modelling of the standing building (Figure 5-4) is different from the architectural grid (Figure 4-9). The relationship between the two grid systems is shown in Table 5-2.

Table 5-2: Relationship between model and architectural grids on standing building

LAYOUT	GRIDLINES																
MODEL	1	2	3	4	5	A	B	C	D	E	F	G	H	I	J	K	L
ARCHITECTURAL	i	h	c	b	a	20	19	18	17	16	15	13	12	11	10	9	7

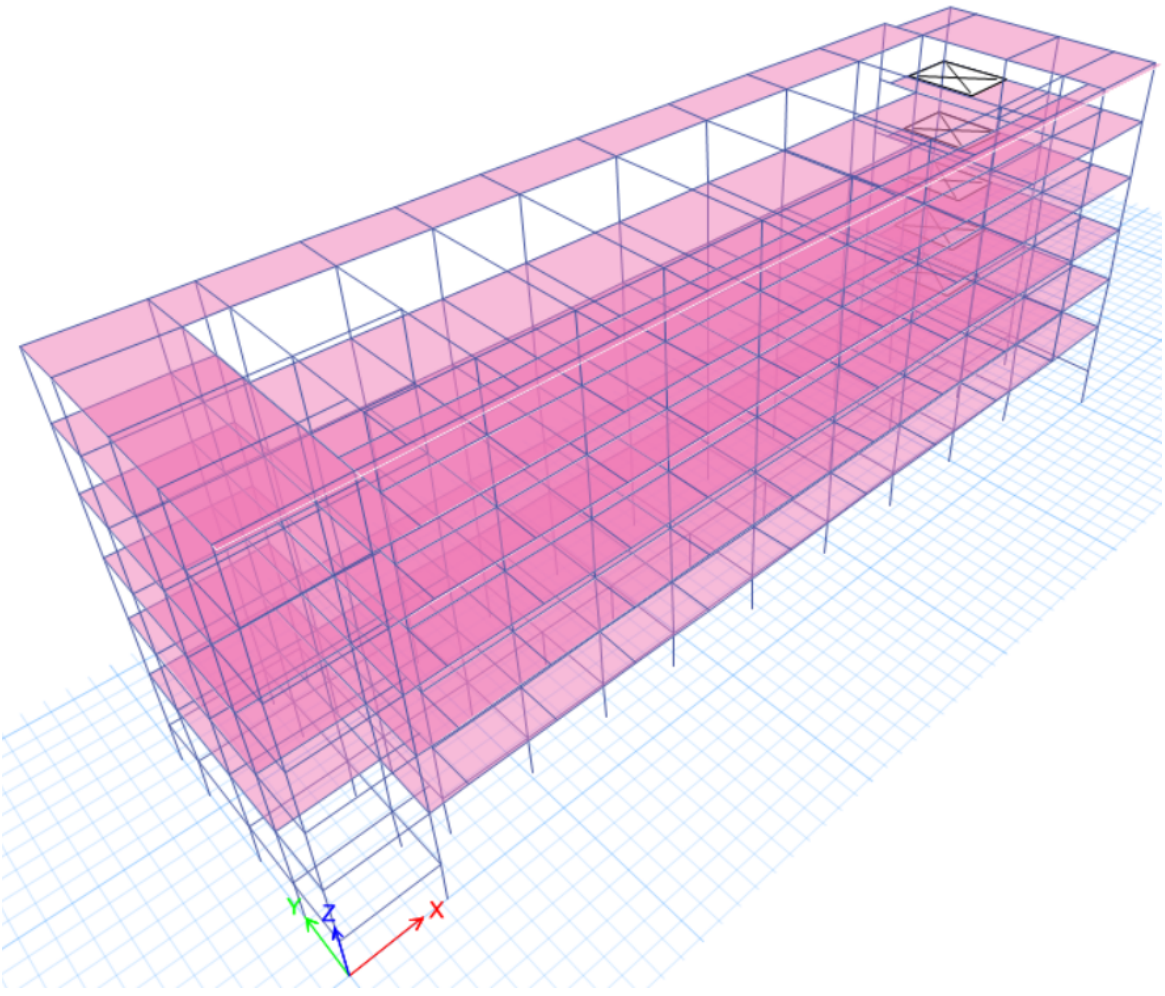


Figure 5-5: 3D model of Standing Building

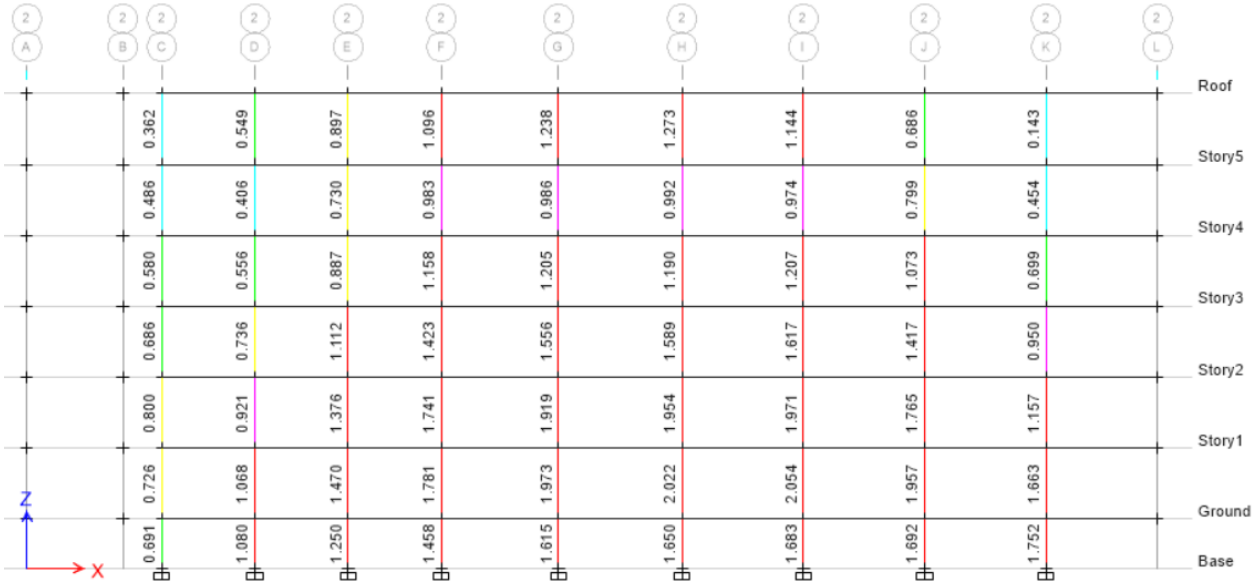


Figure 5-6: Gridline 2 Column capacity ratios (dead + Wind Loads) on Standing Building

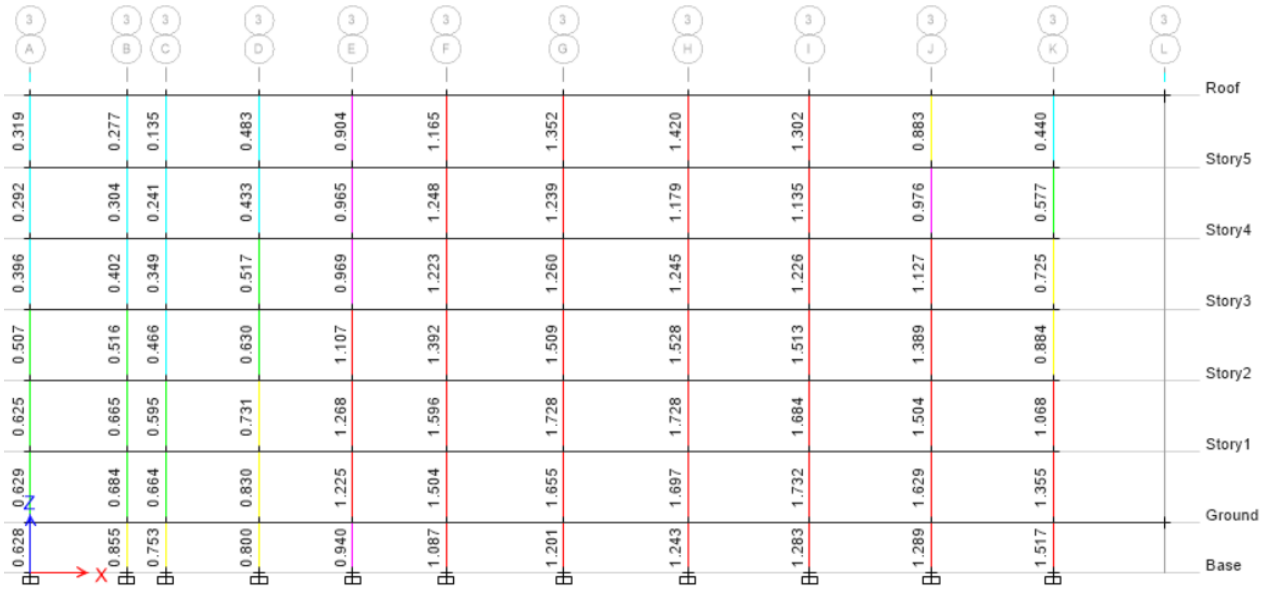


Figure 5-7: Gridline 3 Column capacity ratios (dead + Wind Loads) on Standing Building

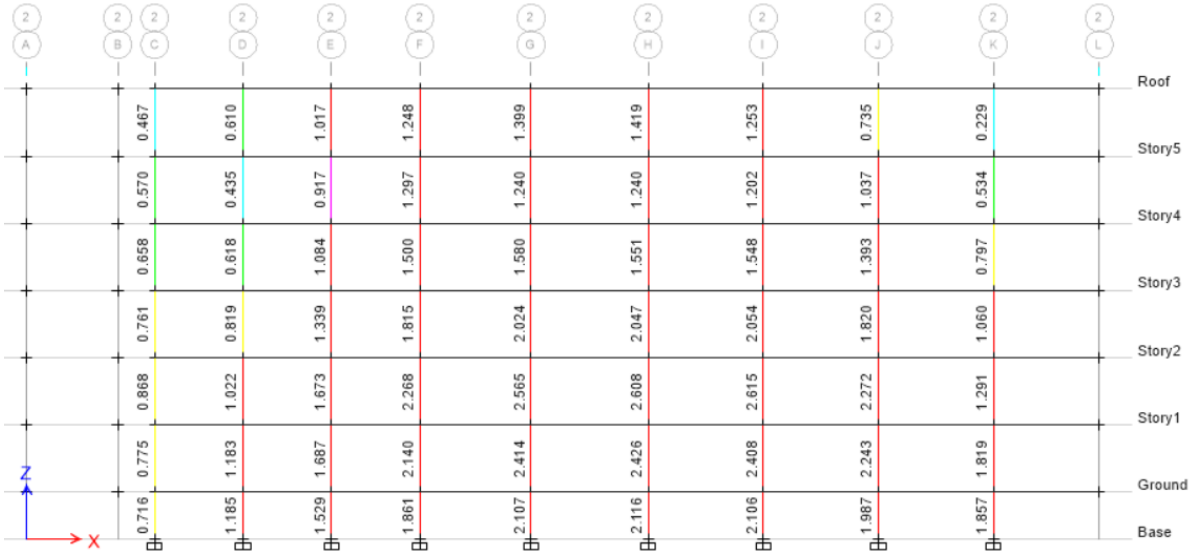


Figure 5-8: Gridline 2 Column capacity ratios (dead + Live + Wind Loads) on Standing Building

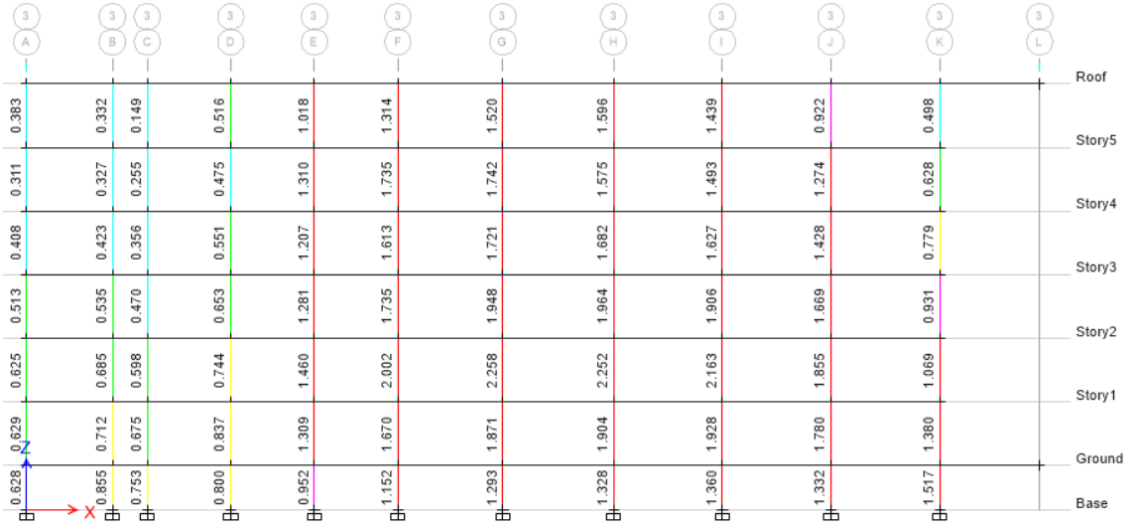


Figure 5-9: Gridline 3 Column capacity ratios (dead + Live + Wind Loads) on Standing Building

The graphical results above are summarized in Table 5-3 and Table 5-4 for columns on gridline 2 and 3 respectively.

Table 5-3: Summary of failed columns on GL 2 on Standing Structure

Simulation	Total No. of columns	No. of failed columns	Percentage of failed columns	Maximum capacity ratio
Dead + Wind	63	38	60.3	2.054
Dead + Live + Wind	63	47	74.6	2.615

Table 5-4: Summary of failed columns on GL 3 on Standing Structure

Simulation	Total No. of columns	No. of failed columns	Percentage of failed columns	Maximum capacity ratio
Dead + Wind	63	39	61.9	1.729
Dead + Live + Wind	63	43	68.3	2.258

As expected, the column capacity ratios are much greater than values obtained from similar simulations of the collapsed building. Almost all the columns are over-stressed with capacity ratios in excess of 2.0 for simulation 1 and 2.6 for simulation 2. Though the building still stands, all that is needed is a trigger and it will likely collapse in a similar fashion. The question is whether the building can be rescued.

5.3 Intervention Options on Standing Building

The structural integrity investigation of the building has raised some concerns which must be addressed if the building is to be made safe, stable and serviceable. These concerns include the following:

1. The high column capacity ratios indicate that the columns are too small therefore column size must be increased for all the affected columns.
2. The single pad footings under the columns failed for excessive soil pressure and for punching. This requires that the plan dimensions and thickness of the footings must be increased.
3. The suspended floors exhibit unacceptable level of vibration. This may require increasing the floor thickness or introducing additional beams to support the floors. Here, it is not certain but possible that a rich screed to the floors may add the needed thickness to reduce vibrations.

Based on the above, and operating within the confines of the architectural grids, three options are considered.

5.3.1 Option 1

The option involves the following four actions:

1. Increase the size of the twelve columns on gridlines 2 and 3 from gridline E to J from 300mm x 250mm to 300mm x 600mm.
2. Add a longitudinal beam joining the floor beams at their mid-spans (Figure 5.10) to limit floor vibration level. Fortification of the central columns on gridlines C, D and K from the foundation to the second floor (Figure 5.10).
3. Increase the footing size under each of the twelve columns from 2000mm x 2000mm x 300mm to 3000mm x 3500mm x 600mm.

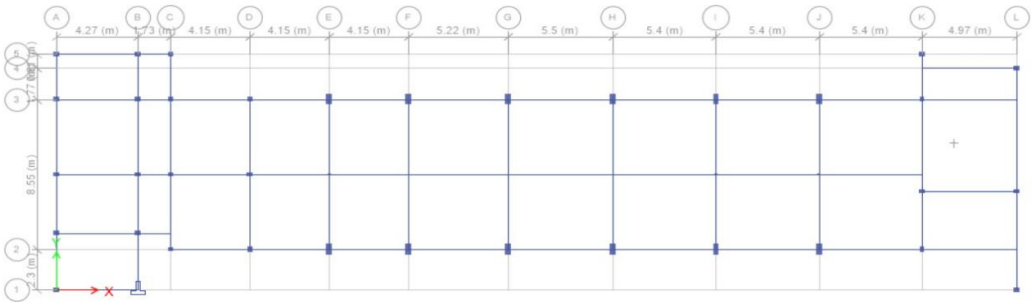


Figure 5-10: Intervention Option 1-Layout

The main advantage of this option is that the building can be saved and can serve its intended purpose despite the moderate cost of the repairs. However, a major disadvantage is having to work on extremely compromised structural members – the columns and the footings. Though Contractors may follow standard procedures to successfully carry out such repairs, there is always the possibility that something may go wrong and if it does, not only will the building be lost but possibly human lives as well.

5.3.2 Option 2

This option seeks to construct additional columns to relieve the overstressed existing columns of part of their loads. One way to achieve this while keeping the capacity ratios of the existing columns below unity is to follow the following four steps:

1. Constructing six 450mm circular columns inside of the building on gridlines E to J.
2. Constructing 250mm x 300mm rectangular columns at the corresponding positions on gridline 2 as shown in Fig.5-11.
3. Adding a longitudinal beam joining the circular columns at floor levels to limit vibration levels.
4. Constructing pad footings of dimensions 2750mm x2750mm x 450mm under the circular columns.

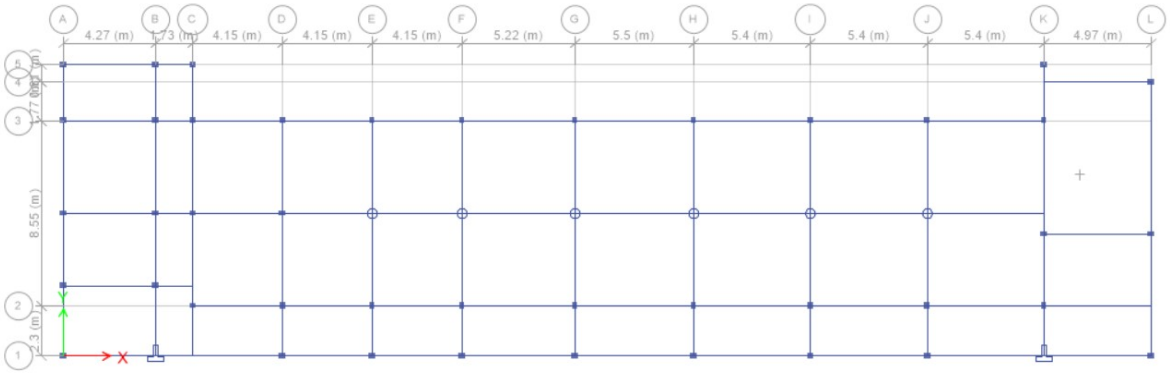


Figure 5-11: Intervention Option 2-Layout

With this option, for the existing footings a few marginally fail on punching which can be compensated for by the safety factors used in the design.

The advantage of this option is that no work is done directly on the over-stressed columns and footings, thus minimizing the chances of catastrophic failure. An obvious disadvantage is that each of the six large classrooms in the building has a column at its centre, a feature not architecturally desirable for the intended use of the building.

5.3.3 Option 3

The third option and probably the most expensive is the complete demolition of the building. Looking at the state of the building with so many structural issues resulting from design flaws, the two options above while attempting to save the building may lead to its collapse with loss of human lives if proper caution is not taken during its salvage. Option 3 operates on the side of human safety, arguably the most important principle of structural design.

6 Liability Assessment

6.1 Codes and local regulations violations

6.1.1 Local Building Regulations

Section 113 (1) of the Land Use and Spatial Act, Act 925, and Section 91(1) of the Local Governance Act, Act 936 state that 'A person shall not undertake any physical development of land within a district unless that person has been issued with a permit by the District Assembly within the jurisdiction in which the land is situated. However, our field investigation revealed that there was no permit issued by the local authority prior to the commencement of the building project. This was in contravention of the provisions in the laws, Act 925 and Act 936.

6.1.2 Design Codes and Norms

Code	**Breach**
Clause 2.4.1.1 of BS 8110 Part 1 1997 states: The following loads shall be used in design. *Characteristic dead load G_k, i.e the weight of the structure complete with* ***finishes, fixtures and partitions***	The italicized loads, collectively called ***Additional dead loads*** were ignored
Table 1 of BS 6399 – 1996 gives the minimum live loads for classrooms and corridor as 3.0 kN/m^2 and 4.0 kN/m^2 respectively	The values used in the design are 2.5 kN/m^2 and 1.5 kN/m^2 which are below the minimum design values
Norms entrenched in the structural engineering profession requires one "**never to use a design software one does not understand"** and every professional engineer ought to know.	Despite these low values the PROTA software indicated failure of the structure. Despite this the designer did not notice the red flags in the design output, clearly suggesting that the designer did not fully understand the PROTA software he was using

6.2 Liabilities of Client-UDS

The procedures adopted by the client, which is embedded in the organization of the WPDD, to appoint the Consultants for the design of such a large building were faulty.

The design process did not appear to have had a review of the designs before they were issued for construction

6.3 Liabilities of Contractor

Contract condition	Comment
No stated obligation on the part of the Contractor	It was incumbent on the contractor as part of their contractual responsibilities to comment and report design deficiencies in the building during construction. For example, the probable vibration of the large and relatively thin two-way spanning slabs upon removal of shuttering and supporting props was most likely felt by the contractor's supervising team and workers. The inadequacies in the sectional dimensions of all the designed and constructed columns should have been commented on and reported at requisite forums such as site meetings as expected of Contractor of his caliber for necessary design revisions and modifications
GCC Section V, subsection 4.21 Unless otherwise stated in the Particular Conditions, monthly progress reports shall be prepared by the Contractor and submitted to the Engineer… (e) copies of quality assurance documents, test results and certificates of materials"…"	It was required of the contractor to ensure consistency of the building materials' quality by conducting regular material control tests on concrete and reinforcing steel bars, particularly upon receipt of new stocks of cement and steel bars. There were no reports of consistent material testing despite persistent requests from the Investigation team and despite the contractor making provision for it in the preliminaries

6.4 Liabilities of Consultants

1. The likely causes of collapse of one wing of the six-storey building as well as the structural deficiencies found in the standing building following the forensic study and structural integrity assessment are the shortcomings and inadequacies in the design by the structural engineer.
2. The monitoring and supervision by the site engineers and architects appointed by the consultants appeared ineffective. Consequently, it appears there was no proper forum for the Contractor's site agents to report their observations on site for the appropriate intervention action to be taken.
3. The geotechnical Consultant whose services were procured from outside WPDD, failed to provide full and accurate geotechnical information to the structural engineer to be used to design appropriate foundation to ensure a safe and stable structure.

7 Conclusions and Recommendations

7.1 Conclusions

Based on the results of key informant interviews and focus group discussion together with field and laboratory measurements on the collapsed and standing parts of the L-shaped structure, as well analysis the following conclusions were arrived at:

7.1.1 The Institutional Arrangements for the Project

1. The arrangements for project approval did not involve the city authorities but rather originated and terminated within Works and Physical Development Directorate of the University of Development Studies (WPDD).
2. The current set up within WPDD with its limited pool of experienced engineering staff does not appear to have the capacity to provide additional in-house professional development for its staff.
3. All the three key professionals who were involved in the design of the structure in question are registered and certified members of their respective professional bodies- the Engineering Council and the Architects Registration Council.

7.1.2 The Design and Drawings of the Structure

4. The architectural drawings were not clear enough. Statutory requirements such as conscious review and stamping of all architectural drawings prior to acquisition of permits from various institutions were not adhered to.
5. The choice of the geotechnical investigation methods consisting of a combination of trial pitting and DCP testing is completely inappropriate for the six-storey reinforced concrete structure and the subsequent analyses were of doubtful validity.
6. The timing of the geotechnical investigations which were conducted in January/February 2022, was such that the results of the geotechnical investigation could not have influenced the foundation design since the tenders were issued in September 2021, four clear months before the investigation was undertaken.
7. The legibility of details in the structural design drawings which appeared to be printed outputs from PROTA design software which were delivered to the Investigation team on request to the WPDD and also to the project Contractors were of low quality and not legible enough for construction detailing.
8. The structural drawings lacked sufficient details for constructional purposes. There were no sections for the foundation drawings to show the depth of excavation nor were there sections for the building as a whole to indicate the storey heights. The total of only sixteen (16) sheets of structural drawings issued for the project were is considered inadequate by the norm.
9. In several cases, the column orientation was not optimized, since the column were not aligned to exploit their major axis (hence greater stiffness) in the plane of bending.

10. Single pad footings of plan dimensions 2000 mm x 2000 mm and 300 mm thick used to support the columns were inadequate for most of the columns.

7.1.3 Construction Quality Control

11. No records of reports of regular control tests on concrete and reinforcing steel bars or of site meeting minutes were sighted by the Investigation Team despite persistent requests

7.1.4 Collapsed Structure

12. The subsurface model, at the location of the collapsed structure, is highly non-uniform and the foundation was placed on bedrock at one end of the collapsed structure while on the other longitudinal end it was placed on a loose fill without provision for tie beams making the design susceptible to differential settlement.
13. The average in-situ concrete strength of the collapsed block of the building was about 12.5 N/mm^2, much less than the design strength value of 25 N/mm^2. This may be due to the fact that the total collapse of the building created micro-cracks in the concrete.
14. The columns and the column footings used in the design were under-dimensioned and some applicable loads were either omitted or underestimated.
15. In the 3D simulations, material strengths of 25 N/mm^2 and 460 N/mm^2 were used for concrete and steel respectively.
16. The modal analysis of the structure gave the fundamental period as 1.07 seconds. The corresponding fundamental vibration mode shape was torsional which is not good for any building.
17. In the simulation using the dead loads alone, 46.4% of columns on one gridline had failed with maximum capacity ratio of 1.511.
18. In the simulation using the dead loads and wind, 60.7% of columns on the same gridline had failed with maximum capacity ratio of 1.916.
19. In the simulation with all the applicable loads; dead, live and wind for which the building was supposed to have been designed, the percentage of failed columns increased to 76.8 and the maximum capacity ratio to 2.359.
20. The ultimate cause of collapse of the building was multiple column failure some highly stressed ground floor and first floor columns followed by failure of neighboring columns, thus initiating a progressive collapse.
21. The failure may have been triggered by any or a combination of the following: wind gust during the thunderstorm that occurred on the night of the failure, sudden failure from punching shear of the foundation, sudden lift shaft movement resulting from failure of its unreinforced base slab and foundation differential settlement due to highly non-uniform subsurface model.

7.1.5 Structural Integrity Assessment of Standing Structure

1. The subsurface condition in the standing structure is fairly uniform. At the foundation depth of 1.8m used for the project, the N_{SPT} values at the opposite longitudinal ends of the structure are similar implying no differential settlement is expected.
2. The average in-situ concrete strength of the standing block of the building was about 22.35 N/mm^2, slightly less than the design strength value of 25 N/mm^2.
3. The columns and the column footings used in the designs were under-dimensioned and some applicable loads were either omitted or underestimated
4. The suspended floor slabs in areas earmarked for classrooms were found to vibrate in a frighteningly excessive manner such that stomping by a single person created much discomfort to the occupying persons of the integrity assessment team
5. In the 3D simulations, material strengths of 25 N/mm^2 and 460 N/mm^2 were used for concrete and steel respectively.
6. In the simulation using the dead loads alone, 60.37% of columns on the front line gridline had failed with maximum capacity ratio of 2.054.
7. In the simulation using the full complement of loads; dead, live and wind, 74.6% of columns on the same gridline had failed with maximum capacity ratio of 2.615.
8. The standing structure is structurally in a much worse condition than the collapsed building in terms of its resistance to collapse.
9. It is still standing probably because the thunderstorm direction was parallel to the longer dimension of the building and the subsurface condition is uniform.
10. The two intervention options considered include the following but each carries substantial risk of the building collapsing during the interventions:
    (a) increasing the sizes of the existing columns from 300x250mm to 300x600m, add a longitudinal beam and increase the size of the footing. This carries the risk of working on highly stressed structural members.
    (b) constructing additional structural members consisting of columns and beams with corresponding footings at designated locations to relieve highly stressed members. Though this carries the advantage of not working of overstressed structural members, it has implications on clearance for classrooms with danger of structure collapsing during the construction.

7.2 Recommendations

Based on the conclusions arrived at in this investigation, the following recommendations to the different stakeholder institutions are made:

7.2.1 The Professional Regulation Bodies

1. The Engineering Council may need to seriously consider the issue of scope of practice for those who are issued licenses. For example, it may need to issue special certification for design of high-rise buildings.
2. Built environment professional in Ghana should seriously consider introducing mandatory peer review of designs for structures of certain magnitude

7.2.2 The Contractor

1. Contractors on projects should demand a forum for discussion of issues such as inadequacies in the sectional dimensions of designed and constructed columns for necessary design revisions and modifications.
2. Contractors should ensure compliance in material testing to protect their liability

7.2.3 University of Development Studies

1. UDS will need to work out arrangements with the city authorities to comply with Section 113 (1) of the Land Use and Spatial Act, Act 925, and Section 91(1) of the Local Governance Act, Act 936 to ensure that they obtain approval for its projects.
2. UDS will need to re-organize its WPDD to ensure that
   (a) Professionals given design responsibilities have had sufficient and in-depth training and requisite experience commensurate with the level of responsibility or design complexity involved. Until this can be done inhouse, the University may wish to depend on properly vetted external Consultants to assist
   (b) Industry best practices including peer review of designs and drawings are introduced and rigidly enforced
   (c) quality assurance measures are introduced so that its outputs including drawings meet the minimum requirement of the industry prior to drawings being released to other consultants and the contractor
3. The Still Standing Structure in its current form is unsafe and two intervention options considered to make it safe and useable, each carry substantial risk of collapse during the intervention. The safest intervention option for the existing structure is to completely demolish it, redesign and reconstruct it.

APPRECIATION

The execution of a forensic investigation involves many professions. The expanded list of professionals who played various key roles in conducting this investigation is shown in below

Ing. Prof. Samuel I.K. Ampadu
Civil Engineering Department KNUST
Chairman and Geotechnical Team leader

Ing. Prof. Charles K. Kankam
Civil Engineering Department KNUST
Member, Structures Team Leader

Pln. Prof. Michael Poku-Boansi
Department of Planning, KNUST
Member-Planner

Arc. Desmond Opoku
Department of Architecture, KNUST
Member-Architect

Ing. Dr. Frederick Owusu Nimo
Civil Engineering Department, KNUST
Member Geotechnical Team

Ing Dr. James Wiafe Ampofo
Civil Engineering Department, KNUST
Member Structures Team

Ing. Dr. Felix Jojo Ayeh
Civil Engineering Department, KNUST
Member Geotechnical Team

Ing Dr. Jones Owusu Twumasi
Civil Engineering Department, KNUST
Member Structures Team

APPENDICES

APPENDIX 1: BOREHOLE LOGS

CIVIL ENGINEERING DEPARTMENT - KNUST

PROJECT NAME:	UDS City Campus - Collapsed Building	Weather: Sunny	BH 1
LOCATION:	UDS - Tamale	Logged by: FJA N	9.4314988
DRILLING METHOD:	Cable Percussion	Checked by: SIKA E	-0.861585
EQUIPMENT TYPE/NO.	Dando 2500	Hole dia.: 150mm Z	181
		Date co Completed:	06-Jul-23

Depth (m)	Elevation	Ground Water	Symbol	Soil Description	SOIL SAMPLE Depth	Sample Type	Sample No.	SPT test	SPT N-value	Casing	Comments	Depth (m)
0.00	181.0			0.12m thick reinforced concrete slab								0.00
					0.50-0.95	SS	1		38			
1.00	180.0			Dry to moist, Medium to loose grey, sandy crushed rock aggregate (hard core filling)	1.00-1.45	SS	2		7			1.00
						DS	3					
2.00	179.0				2.00-2.45	SS	4		9			2.00
						DS	5					
						DS	6					
3.00	178.0			Moist, very firm, reddish brown, sandy latheritic GRAVEL (fill)	3.00-3.45	SS	7		16			3.00
						DS	8					
				Moist, Medium dense, reddish brown silty SAND		DS	9					
				Moist, very firm, yellowish grey, CLAY (Rebound at 4.43m)		US	10					
4.00	177.0				4.00-4.45	SS	11		50			4.00
						DS	12					
				Weathered Rock (Siltstone)		DS	13					
5.00	176.0			Dry to moist, very stiff to hard, coffee brown with grey patches, SILTSTONE/MUDSTONE (Occasional light grey fine sand seen at 7.7m)	5.00-5.40	SS	14		57			5.00
						DS	15					
6.00	175.0				6.00-6.285	SS	16		50		Drilling advanced with intermittent chiselling and	6.00
						DS	17					
7.00	174.0				7.00-7.45	SS	19		52			7.00
						DS	18					
				Dry, hard, light grey, fine grain SANDSTONE	8.00-8.069	SS	20		50		Hammer rebounding	
8.00	173.0			Hole terminated at								8.00
9.00	172.0											9.00

NOTES:

SS	Split spoon sample
DS	Disturbed sample
US	Undisturbed sample

Figure 7-1 Field Log for BH1

CIVIL ENGINEERING DEPARTMENT - KNUST

PROJECT NAME:	UDS City Campus - Collapsed Building	Weather: Sunny	BH 2
LOCATION:	UDS - Tamale	Logged by: FJA N	9.4312176
DRILLING METHOD:	Cable Percussion	Checked by: SIKA E	-0.861434
EQUIPMENT TYPE/NO.	Dando 2500	Hole dia.: 150mm Z	182
		Date Completed:	07-Jul-23

Depth (m)	Elevation	Ground Water	Symbol	Soil Description	SOIL SAMPLE Depth	Sample Type	Sample No.	SPT test	SPT N-value	Casing	Comments	Depth (m)
0.00	182.0			Reinforced Concrete Slab								0.00
				Dry to moist, loose reddish brown latheritic GRAVEL (fill)	0.50-0.95	SS	1		3			
1.00	181.0				1.00-1.45	SS	2		47			1.00
						DS	3				Hammer rebounding	
				Hard brown SANDSTONE	1.40-1.529	SS	4		50			
				Hole terminated at 1.529m								
2.00	180.0											2.00
3.00	179.0											3.00

Figure 7-2 Field Log for BH2

CIVIL ENGINEERING DEPARTMENT - KNUST

PROJECT NAME:	**UDS City Campus - Collapsed Building**	**Weather: Sunny**	**BH 3**
LOCATION:	**UDS - Tamale**	**Logged by: FJA** N	**9.4314**
DRILLING METHOD:	**Cable Percussion**	**Checked by: SIKA** E	**-0.8615**
EQUIPMENT TYPE/NO.	**Dando 2500**	**Hole dia.: 150mm** Z	**181**
		Date c Completed:	**07-Jul-23**

Depth (m)	Elevation	Ground Water	Symbol	Soil Description	SOIL SAMPLE Depth	Sample Type	Sample No.	SPT test	SPT N-value	Casing	Comments	Depth (m)
0.00	181.0			0.15m thick reinforced concrete slab								0.00
				Dry to moist, Medium t,reddish brown, sandy GRAVEL (fill)	0.50-0.95	SS	1		13			
1.00	180.0				1.00-1.45	SS	2		8			1.00
						DS	3					
				Moist, medium dense, reddish brown silty SAND		DS	4					
2.00	179.0				2.00-2.45	SS	5		16			2.00
				Moist, very firm, brownish grey CLAY								
3.00	178.0				2.92-3.37	SS	6		28			3.00
				Moist, very firm, coffee brown with grey patches MUDSTONE with clay and fine sand		DS	7				Drilling advanced with intermittent chiselling and addition of water	
4.00	177.0				4.00-4.375	SS	8		50			4.00
						DS	9					
5.00	176.0			SANDSTONE	5.00-5.075	SS	14		50		Hammer rebounding	5.00
				Hole terminated at 5.075m								
6.00	175.0											6.00

Figure 7-3 Field Log for BH3

CIVIL ENGINEERING DEPARTMENT - KNUST

PROJECT NAME:	UDS City Campus - Collapsed Building	Weather: Cloudy	BH 4
LOCATION:	UDS - Tamale	Logged by: FJA N	9.4312
DRILLING METHOD:	Cable Percussion	Checked by: SIKA E	-0.8614
EQUIPMENT TYPE/NO.	Dando 2500	Hole dia.: 150mm Z	182
		Date Completed:	

Depth (m)	Elevation	Ground Water	Symbol	Soil Description	SOIL SAMPLE Depth	Sample Type	Sample No.	SPT test	SPT N-value	Casing	Comments	Depth (m)
0.00	182.0			Reinforced Concrete Slab								0.00
				Dry to moist, medium dense, reddish brown lateritic GRAVEL (fill)	0.50-0.95	SS	1		17			
1.00	181.0			Moist, medium dense, reddish brown silty SAND	1.00-1.45	SS	2		17			1.00
						DS	3					
				SANDSTONE	1.67-1.795	SS	4		50		Hammer rebounding	
2.00	180.0			Hole terminated at 1.795m								2.00
3.00	179.0											3.00

Figure 7-4 Field Log for BH4

CIVIL ENGINEERING DEPARTMENT - KNUST

BH 5

PROJECT NAME:	UDS City Campus - Collapsed Building	Weather: Sunny	
LOCATION:	UDS - Tamale	Logged by: FJA	N 9.4313
DRILLING METHOD:	Cable Percussion	Checked by: SIKA	E -0.8619
EQUIPMENT TYPE/NO.	Dando 2500	Hole dia.: 150mm	Z 182
		Date Completed:	07/07/2023

Depth (m)	Elevation	Ground Water	Symbol	Soil Description	SOIL SAMPLE Depth	Sample Type	Sample No.	SPT test	SPT N-value	Casing	Comments	Depth (m)
0.00	182.0											0.00
				Moist, firm, reddish brown to brown, SAND	0.50-0.95	SS	1		23			
1.00	181.0				1.00-1.45	SS	2		5			1.00
						DS	3					
				Moist, very firm, brownish grey CLAY		DS	4					
2.00	180.0				2.00-2.45	SS	5		17			2.00
3.00	179.0			Dry to moist, hard, coffee brown SILTSTONE/ MUDSTONE	3.00-3.132	SS	6		50		Drilling advanced with intermittent chiselling and addition of water	3.00
						DS	7					
4.00	178.0				4.00-4.29	SS	8		50			4.00
						DS	9					
5.00	177.0			SANDSTONE	5.00-5.145	SS	14		50		Hammer rebounding	5.00
				Hole terminated at 5.145m								
6.00	176.0											6.00

NOTES:

SS Split spoon sample

DS Disturbed sample

US Undisturbed sample

APPENDIX 2-ADMINISTRATIVE LETTERS:

The picture can't be displayed.

www.engcouncilofghana.org

ENGINEERING COUNCIL

Ministries - Accra
Post Office Box OS 3301
Osu- Accra
Tel: 030 3975 228/9, 0303941052
E-mail: engcouncilgh@gmail.com

Our Ref: ECGh/EFI/UDS/01 **10th May, 2023**
Your Ref:……..

Dear Sir

NOMINATION TO BE MEMBER OF A TEAM
TO CONDUCT FORENSIC INVESTIGATIONS
ON THE COLLAPSED BUILDING AT UDS IN TAMALE

Following the recent collapse of a six story building at the University of Development Studies(UDS), Tamale, the Board of the Engineering Council has accepted your nomination to be a member of a team to carry out Forensic investigations on the collapsed building in Tamale.
The proposed duration for the investigation is two months commencing not later than the 18th May 2023. The composition of the team is given below.

No.	NAME	Expertise	PHONE	EMAIL	POSITION
1	Ing. Prof. Samuel Ampadu	Geotechnical Engineer	0208165506	sikampadu@yahoo.co.uk	Team Lead
2	Ing. Prof. Charles Kwame Kankam	Structural Engineer	0208168662	ckkankam@gmail.com ckkankam.coe@knust.edu.gh	Member
3	Prof. Michael Opoku Boansi	Planner	0208402373	pokuboansi@yahoo.com	Member
4	Arc. Desmond Opoku	Architect	0244029103	desphlex@gmail.com	Member

Terms of Reference for the Assignment

1. Assessment of existing institutional arrangements for Design, plan approval, construction and construction supervision.
2. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.
3. Conduct structural assessment of the collapse building and any available structural drawings of the building.
4. Identify any liability based on the findings including designs, construction , supervision and building code violation.
5. Prepare report including conclusions and recommendations.

Ing. Wise Ametefe (PE)
Registrar

CC:

Ing. Kwame Boakye(PE)
Board Chairman, EC
Accra

PROF. Dr. Salifu M Mohammed
Executive Secretary
National Council for Tertiary Education

Board members: *Ing. Dr. Kwame Agyeman Boakye, Ing. Prof. Mark Adom-Asamoah, Ing. Fredrick K Akwaboah, Ing. Wise Ametefe, Eng.Rev.Dr.Eric Otenkoran Ankrah , Eng. Philip Kwame Aheto, Engr. Eric Atta Sonno, Ing. Ebenezer Haizel, Esq., Mad. Alberta Kwarko*

GHANA INSTITUTION OF ENGINEERING

GhIE/CMT/MBR/10/311

September 5, 2023

Ing. Prof. Samuel Innocent Kofi Ampadu
Civil Engineering Department
College of Engineering
KNUST - Kumasi, Ghana

Dear Sir,

RE: FORENSIC INVESTIGATIONS ON THE COLLAPSED BUILDING AT UDS IN TAMALE
REQUEST FOR CONFIRMATION OF REGISTRATION

The Ghana Institution of Engineering (GhIE) presents its compliments to you.

We confirm that **Ing. Mahamud Sidi Hamid** is a registered member of the Ghana Institution of Engineering with membership number **07565** and of the **Civil** division.

His registration authorizes him to do Civil Engineering works. **Ing. Mahamud Sidi Hamid** a member in good standing as at **Monday, July 31, 2023.**

We also confirm that **Ing. Solomon Yampohekya** is a registered member of the Ghana Institution of Engineering with membership number **06675** and of the **Civil** division.

His registration authorizes him to do Civil Engineering works. **Ing. Solomon Yampohekya** a member in good standing as at **Friday, June 30,2023.**

We recommend him for any assistance that he may require in this respect.

Counting on your cooperation.

Yours faithfully,

Ing. Nyante, David Kwatia FGhIE

Executive Director

OfficialGhIE
@OfficialGhIE
@OfficialGhIE

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President: Ing. Kwabena Bempong, FGhIE
Executive Director: Ing. David Kwatia Nyante, FGhIE

ARCHITECTS REGISTRATION COUNCIL

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ARC55/OBEP/001/0-23

28th August, 2023

Ing. Prof. Samuel Innocent Kofi Ampadu
Civil Engineering Department
College of Engineering
KNUST - Kumasi

Dear Sir,

RE: FORENSIC INVESTIGATIONS ON THE COLLAPSED BUILDINGS AT UDS IN TAMALE

REQUEST FOR CONFIRMATION OF REGISTRATION

We bring you compliments from the Architects Registration Council (ARC/Council) and refer to your letter dated 21st July, 2023 on the above subject matter.

The Council writes to inform you that **ARC. JAWHARI BABA-DUAH** is registered as an Architect with the Architects Registration Council (ARC) with registration number **ARC.S. 734** and is licensed to practice.

ARC. JAWHARI BABA-DUAH is in good standing with the ARC and in accordance with the Architects Act 1969 (NLCD 357) is permitted to fully practice Architecture as a profession.

Please accept the assurances of our highest esteem.

Thank you.

Yours faithfully,

Arc. Dr. Emmanuel Eyiah-Botwe
(Registrar)

GHANA METEOROLOGICAL AGENCY

P.O Box LG 87 Legon, Accra
Main Line: +233-303-965-563
Client Service: +233-307-010-019
Digital Address: GA-485-3581

E-mail: gmet@meteo.gov.gh
Website: www.meteo.gov.gh.
Location: East Legon-Mpehuasem

AUGUST 15,2023

Our ref: MET-9/Vol.25/145
Your ref:

GHANA INSTITUTE OF ENGINEERING
ACCRA

Dear Sir,

RE: REQUEST FOR WEATHER REPORT ON SATURDAY 6TH MAY, 2023

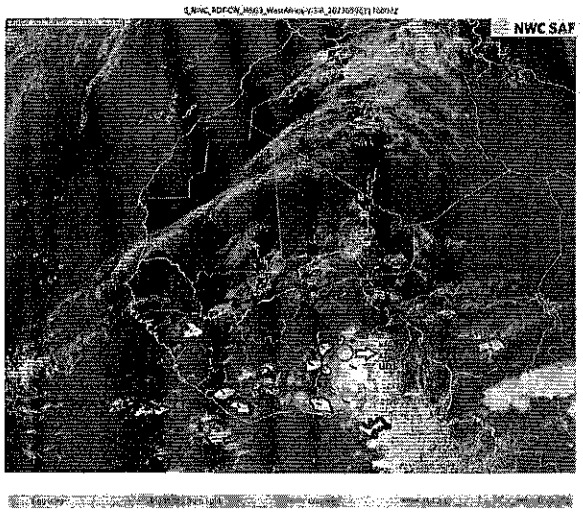
With reference to you letter dated 14th August, 2023 requesting for weather report on 6th of May 2023 for the City campus of University of Development Studies in Tamale between 5pm and 11pm, I write to respond as follows;

The date stated above fell within the rainy season for which rainfall activities are expected to occur across the country not excluding the northern sector within which UDS Tamale falls.

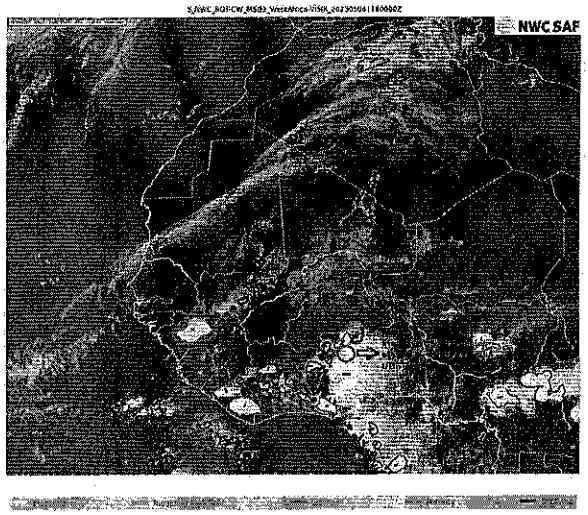
A moderate to severe thunderstorms with and without rain propagated from our eastern boarder countries that engulfed and affected most areas within Ghana. Generally light breeze affected some places, however some had moderate to strong windy conditions that GMET RECORDING STATIONS are not sited.

Below are the satellite imageries captured on that day showing the time and locations of the thunderstorm that tracked over Ghana including Northern Region that affected UDS Tamale too.

SATELLITE IMAGE AT 1700UTC 06/05/2023



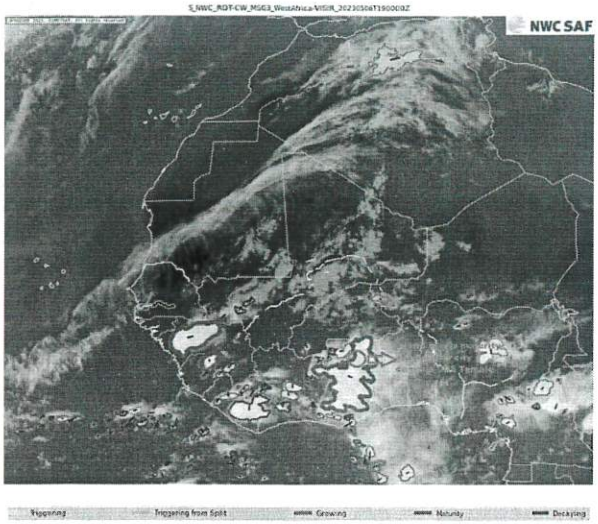
SATELLITE IMAGE AT 1800UTC 06/05/2023

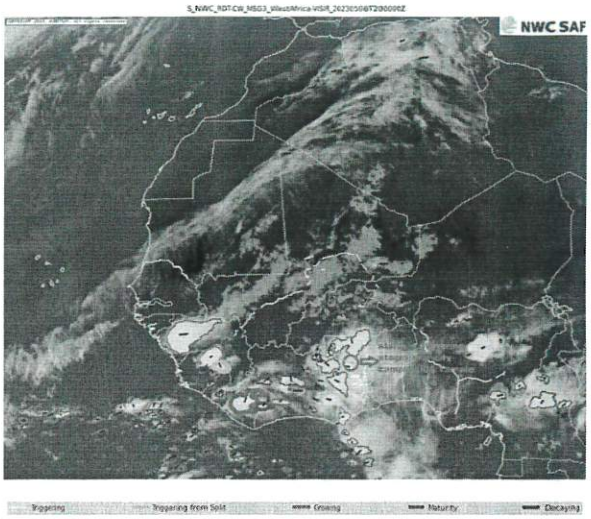


At 1700 - 1800UTC the thunderstorm moved from the east into our country engulfing the eastern flank of the country.

SATELLITE IMAGE AT 1900UTC 06/05/2023

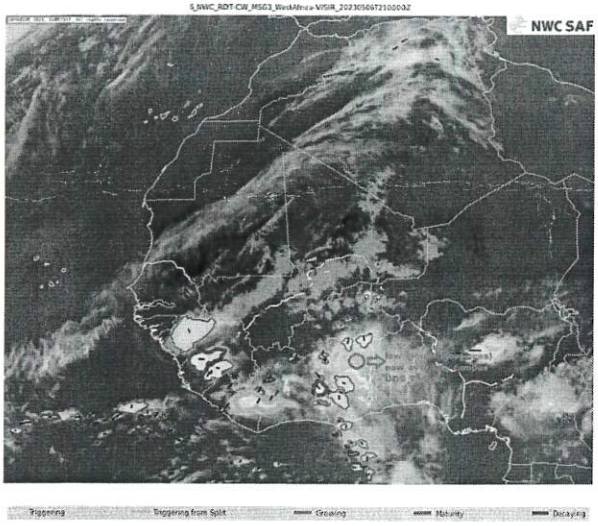
SATELLITE IMAGE AT 2000UTC 06/05/2023



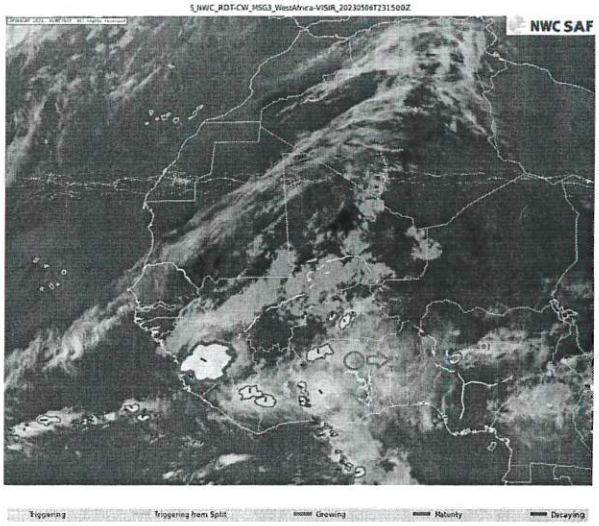


The storm stagnated and expanded further inland till it reached its maturity stage at around 1900 – 2000(7-8pm)UTC to produce moderate to heavy rains of which CSIR-SARI, Nyankpala – Tamale a METEO station close to your area of interest city campus UDS Tamale, recorded rainfall amount of 47.1mm. At 2000UTC we had the storm splitting and further decaying or dying off whiles exiting the country within the hours of 2100UTC and 2200UTC.

SATELLITE IMAGE AT 2100UTC 06/05/2023



SATELLITE IMAGE AT 2300UTC 06/05/2023



At 2300UTC the storm had completely decayed and exited, leaving the country to be under cloudy conditions.

In Conclusion, between the hours of 1700GMT and 2300GMT, the country experienced cloud developments and rain bearing systems that were tracked from our east pushed through and has capable of producing thunderstorms to affect the country on that day.

Kindly follow us on WhatsApp or call or email (+223 (0) 553538292), gmetclient@gmail.com for daily, seasonal and customized weather forecast at a moderate fee.

Thank you.

Yours sincerely,

FOR: A.G DIRECTOR GENERAL
FELICITY AHAFIANYO
HEAD OF CENTRAL ANALYSIS AND FORECASTING OFFICE

SUBTITLE 3B

INVESTIGATION INTO THE COLLAPSE OF A SIX STOREY BUILDING AT THE CITY CAMPUS OF THE UNVERSITY FOR DEVELOPMENT STUDIES (UDS) TAMALE

1. INTRODUCTION

The collapse of four buildings within three weeks in April and early May this year was of concern to the Professionals of the Built Environment (PBE). Three of the collapsed structures were in the Greater Accra region and one in the Northern region. The Professionals of the Built Environment Institutions comprised of the :- Ghana Institute of Planners (GIP), Ghana Institute of Architects (GIA), Ghana Institution of Engineers (GhIE) and Ghana Institution of Surveyors (GIS). At an emergency meeting of the Executives of the aforementioned Professional Institutions, four ad-hoc committees representing each site where a building collapsed were set up. A Terms of Reference (TOR) was also provided to guide their work. The GIP also prepared a checklist to guide the planners in their investigations. I was selected to represent the GIP on a seven member committee to investigate the UDS City Campus building. The Committees were to commence work on the 22nd of May 2023 and submit a report to the Built Environment Committee Coordinator by the 6th June 2023.

The UDS Investigation Committee met with a challenge from the very start. It was realized that the Ghana Engineering Council had set up a parallel committee to investigate the same collapsed building. That committee comprised of academics from the KNUST with some members of the ad-hoc committee who were already at the site working. Thus to clarify issues as to the way forward a Zoom meeting was held at the instance of Arc. Foster Osae-Akonnor -President, Ghana Institute of Architects. At the meeting, Mr. Fred Nimo a member of the ad hoc committee who was with the KNUST team gave a brief of the work they had done and promised to share the findings with the ad-hoc committee after which point the committee could determine how to proceed. This has not happened for reasons I do not know so the report presented here is based on my findings and not the ad-committee. I had interactions earlier with the some staff of the Works Dept of UDS, and later with the Physical Planning and Works departments of the Sagnarigu Municipal Assembly (SMA) in May and June 2023.

2. SCOPE OF WORK OF THE COMMITTEES

The four committees were guided by the scope of work provided below. As the UDS committee did not meet my report concerns the planning issues of items (i) – (iv). Each of the four Committees shall be responsible for investigating into circumstances leading to the collapse of the structure. The Committee shall specifically:

i. **Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.**
ii. **To assess the general procedures/processes of physical developments in the University (or municipality).**
iii. **Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.**
iv. **Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.**
v. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.
vi. Conduct structural assessment of the collapsed building and any available records of the building construction.
vii. Identify any liability based on the findings including designs, construction and supervision and building code violation.
viii. Prepare report including conclusions and recommendations.

3. SITE LOCATION AND ANALYSIS.

The collapsed six storey structure is an L-shaped building (the shorter side collapsed) is located at the City Campus of UDS in the Sagnarigu Municipal Assembly area. The City Campus site forms part of the Education Ridge acquisition by the Colonial government before independence. The Education Ridge accommodates four schools: - the Tamale SHS, Tamale College of Education, Bagabaga College of Education and the Tamale Technical University (Tatu) previously a Polytechnic. The City campus is located to the south eastern end of the Tatu land that was ceded to the UDS. The City campus is for educational purpose and therefore conforms to the

zoning of the area. The site is accessed from the Tamale - Kumbungu road to the east and 50 meters away.

The City campus, for a greater part is low-lying and liable to waterlogging which accounted for the absence of developments there by the then Polytechnic. Prior to late 1980s, the area was noted for indiscriminate dumping of rubbish, waterlogging and burrowing of earth. The area was later graded for development.

4. FINDINGS

4.1.Acquisition of Permits and other Statutory Documents

The Sagnarigu Municipal Assembly has the responsibility of granting permits to developers within the Assembly area. Its Physical Planning and Works Depts are charged with monitoring and supervision of development so that unauthorized structures and non-conforming uses are stopped among others. An enquiry as to whether the UDS acquired the legal documents for the construction of the building was in the negative. The Assembly was not privy to the development. The UDS Works Department indicated that the university was autonomous and did not need a permit, alluding to exemption from acquisition of permits in the old National Building Regulations LI. 1630 (1996) Part II 4 (1) – (5). They however failed to satisfy the condition of that same provision which required the depositing of plans one month ahead of the execution of the work. Secondly the structure under investigation was started last year when a new National Building Code was in place which the university required a permit from the Assembly. The LUSPA Regulations LI. 2384 section 51 does not exempt the university from acquiring permits for their developments. The university authorities seem to be ignorant about these regulations.

A Local Plan of the City Campus (Campus Master Plan)

The City Campus has no local plan or if they have it has not been submitted for approval by the Assembly. Campus master plans provide the overall development framework of the university with its vision, goals and objectives which form the basis for its physical development. Secondly, it gives details on the site analysis, type of structures, landscaping, access, infrastructure services, etc. The campus plan will be in accordance with Section 72(1) – (3) of the LUSPA Act,

Act 925 (2016). It is noteworthy that the Planning Authorities also seem to be unaware of the fact that these local plans of institutions need approval because their development has an Impact on the Context They Locate.

4.2.Staffing and Capacity Of The Physical Planning And Works Dept of The Sagnarigu Municipality.

The Physical Planning and Works Departments of the Assembly as stated earlier, jointly have the responsibility of supervising, monitoring developments and processing of development applications for permits. It was on record that the Municipal Spatial Planning Committee (SPC) held regular monthly meetings or twice a quarter. This is to ensure expeditious processing of permits to avoid delays and frustration to developers. However both agencies need to be adequately staffed and resourced to undertake their responsibilities. The following tables illustrate the staffing situation of both agencies and official vehicles.

The Physical Planning Dept. staffing and vehicles:

No	Category	Number	Qualification	Work experience
1	Head of Department	1	M.Sc. Member of GIP	12 years
2	Assistant physical planning officers	3	Bsc Planning	I year work experience each
3	Technical officers	nil		
4	Motorbikes (broken down)	1 no.		

The Works Engineers Dept

No	Category	Number	Qualifications	Remarks
1	Head of Dept	1	Msc (Member GhIS)	15 years' work experience
2	Engineers	3	Bsc (all Building Technology)	Their work experience varies from 4 to 20 years

3	Technician engineer	1	Electrical Part II	17years work experience
4	Vehicles – Nissan double decker Hardbody pickup	1		Good Condition
5	Motorbike	1		Good Condition

The Works Department lacks personnel to undertake some assignments like geotechnical and structural engineering work. Thus in the case of multi-storey structures it can be a challenge to vet these drawings unless they recourse to AESL for technical support.

4.3 Funds and logistics to the Physical Planning and Works Depts.

The Heads of the Physical and Works departments indicated that there was no committed budget for monitoring and supervision developments. Fuel for monitoring and supervision of development was a challenge, thus field work was undertaken on an ad-hoc basis but not regular e.g. weekly or every two weeks. Fieldwork was also undertaken when the Technical Sub-committee of the SPC is to hold its monthly meetings. The Physical Planning Dept. has no mobility support and officials use their private means to do inspections and other works.

5. RECOMMENDATIONS

5.1.The Procurement Processes, Acquisition Of Legal Documents For Development

The University authorities undertook the design, execution and procurement /tendering of the project as an “in house” matter. They claimed they were an autonomous body as such their documents were not subject to any external input and vetting by the Assembly. The Works Department of the university undertook the design, the procurement of contractor, all technical requirements and supervision of the construction. Thus the university must accept blame for the collapse of the building. The autonomy the university believes it has over its infrastructure and housing development has led to this situation. The university as already stated did not obtain the requisite permit documents for the development but relied on the “exempt from permit”.

It is recommended that the LUSPA issue a directive to agencies that were classified under "exemption of permit" to acquire the permits and the various MMDAs monitor and ensure compliance - LUSPA Regulations LI. 2384 Section 52 (1)(2019)

The City Campus did not have an approved local plan as entities developing large tracts of land are required under section 72 (1) – (3) of the LUSPA Act, Act 925 of 2016. It is recommended that LUSPA issue directives to public institutions and the MMDAs to comply with the regulations. It is realized that educational institutions do not comply as well as public institutions. A local plan of the campus with appropriate site analysis would have indicated the waterlogging nature of the land and need for robust geotechnical studies to inform developments there. The remaining structure that did not fall should be subject to further test to ascertain its safety as the expansion joint between the fallen wing and the northern wing saved it.

5.2. Capacity of the Physical Planning and Works Dept. of The Assembly in monitoring and supervising developments.

The PPD is adequately staffed but need technical officers to assist in plan preparation and fieldworks. The level of professional planners can cope with the planning work. The monitoring of developments and field work is challenging as there are inadequate funds and no vehicle. The only motorbike for the department is broken down. There is need for vehicular and other financial support to the department to work efficiently. The MMDAs are however by Section 113 (5) of the LUSPA Act required to allocate funds generated by the permitting processes to the planning functions of the Assembly.

The Works Department like in most Assemblies in the country lacks some specialist engineers to undertake structural and geotechnical services. Thus the Assemblies will be handicapped to vet multi-storey and complex structures. Private developers will find it difficult or expensive to procure the services of these categories of engineers from the private sector. The Assemblies should collaborate with AESL to provide these services in the Districts.

It is suggested that MLRD consider the staffing of the Works depts. Of the MMDAs to address the absence of some key important staff (structural and geotechnical engineers)

5.3. Planning and Building Inspectorate Unit

The LUSPA Act, section 158 advocates for the establishment of a Planning and Building Inspectorate at the Assemblies to monitor physical development and ensure compliance with the approved permits. It was evident that the Planning and Works departments occasionally undertake joint monitoring of development but a well-resourced unit is yet to be established to undertake its functions. It is recommended that these units be set up by all MMDAs, well-resourced with work schedules to ensure regular supervision and monitoring of developments.

6. CONCLUSION

The collapse of the UDS City campus building and other structures that have fallen in recent times in the country can largely be attributed to weak enforcement and disregard of statutory regulations. The laws and regulations pertaining to physical developments in the country provide ample guidance for safe delivery of buildings and other structures. The compulsory acquisition of permits by developers before developments will safeguard the structural integrity of buildings.

Secondly, the element of development supervision and monitoring has been challenging to the Assemblies. This is due to lack of funds and other logistics for regular field inspections, supervision and monitoring of developments by the Physical Planning and Works departments. The MMDAs after a permit is granted do not make follow-ups to ascertain whether changes have not been made to the approved plan or the quality of materials have not been compromised.

Thirdly, the Ministry of Local Government Decentralisation and Rural Development (MLGDRD) need to address the capacity of the MMDAs as some caliber of personnel very important to the building industry are absent e.g architects, geotechnical (soil) engineers, structural/civil and electrical engineers. The Works Departments are staffed with officers who lack the expertise to supervise and monitor the construction of multi storey structures. The private developers also cannot hire their services and the Assemblies could collaborate with the AESL to assist developers who need such specialized services. In a similar vein, the Professionals of the Built Environment should sanction their members who due to their incompetence of design or poor supervision cause the collapse of buildings.

7. PHOTOS OF COLLOAPSED BUILDING (pictures taken by staff of LUSPA at my first visit)















SUBTITLE 4

THE WORD IN ACTION CHURCH BUILDING COLLAPSE INVESTIGATION REPORT

JULY, 2023

THE WORD IN ACTION CHURCH BUILDING COLLAPSE INVESTIGATION REPORT

EXECUTIVE SUMMARY

This report presents the findings and recommendations of a 7-member Ad-hoc Committee established to investigate the collapse of **'The Word In Action Church'** building which occurred on 9th May 2023 at Old Bortianor in the Greater Accra Region of Ghana. The structure was a 2-storey reinforced concrete framed building with basement, which was being used as a church. The site is located at Ajasco junction in Old Bortianor and at 794221.48 m E and 609044.25 m N (UTM 30N) in the Ga South Municipal Assembly of the Greater Accra Region. The collapse of the building resulted in injuries to seven individuals. The committee was mandated to investigate the cause the cause of the collapse and submit a report outlining the methodology for the investigations, key findings and recommendations for policy consideration.

Methodology

The methodology (methods and techniques) adopted for the investigation included: review of existing documents and other information, visual assessment (physical observation) and documentation, field test, interview with stakeholders, periodic meetings, and structural analysis and control design to ascertain the adequacy and safety of the as-built structure.

The field test conducted was Schmidt Hammer test on selected structural elements to ascertain the in-situ compressive strength of concrete. Information obtained was used as input for the structural analysis and controll design to ascertain the adequacy and safety of the as-built structure. The assessment methodology adopted was based on relevant codes, standards, and guidelines for structural integrity assessment of existing buildings.

Due to the time constraints, there was no laboratory testing on concrete cores, tensile tests on steel reinforcement, and geotechnical assessment. Notwithstanding, the information obtained was adequate for the assessment of adequacy and safety of the collapsed structure.

Key Findings:

1. The architectural and structural designs were not performed by qualified and licenced professionals; and the drawings were characterised by errors and lacked adequate details for construction purposes.
2. No geotechnical investigations were conducted at the site before the design and construction of the structure.

3. The Municipal Assembly issued permit for the construction works.
4. The construction work lacked proper supervision and quality control measures.
5. There were no records of site visit or inspections by the Municipal Assembly during the construction phase.
6. The average in-situ compressive strength of concrete recoded based on a digital Schmidt Hammer test was C12/15, which was of poor quality and fell short of the recommended grade of C20/25 for reinforced concrete structures by design codes and standards.
7. There was an extension (additional storey) to the existing building at the reinforced concrete roof level intended to be used as apartments (about 20 rooms).
8. The structural analysis revealed that the building lacked sufficient structural capacity under its own weight and gravity loads, and the addition of an apartment worsened the situation leading to the structural collapse.
9. The Municipal Assembly lacked adequate professionals to conduct inspections and enforce regulations.

Recommendations

The report provides recommendations to various stakeholders, including the government, Municipal Assembly, professional bodies, building owners/developers, the media and the general public. Key recommendations include:

1. Enforce existing laws and regulations regarding infrastructural development, and develop e-permit systems to minimize human interference and improve record keeping.
2. Establish an independent unit to monitor the operations of Municipal Assemblies in granting permits and conducting inspections.
3. Implement mandatory design review by qualified and licensed professionals as part of the permit process.
4. Introduce all-risk insurance for public building projects and ensure projects are insured before permits are granted.
5. Allocate adequate resources for Planning and Building Inspectorate Divisions to conduct post-permit inspections.

6. Conduct structural integrity assessments on remaining structures and trace other buildings designed and built by the unqualified individuals.
7. Create a digital platform to regulate construction projects and collaborate with the government to monitor developments.
8. Educate the public on engaging licensed built environment professionals and the importance of securing permits before construction.
9. Establish a verification process for checking the authenticity of stamps and signatures of professionals on development drawings.
10. Enhance public awareness through media collaboration and investigative reporting on structural defects.

Conclusion

The collapse of 'The Word In Action Church' building was primarily due to poor architectural and structural designs, lack of supervision, and inadequate construction practices. The report highlights the need for stricter enforcement of building regulations, enhanced professionalism, and public education. Implementing the recommended measures will contribute to safer and more resilient construction practices in Ghana, ensuring the well-being of the public and integrity of built structures.

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1.0 BACKGROUND

A building collapse is a sudden structural failure, partially or entirely, of a building, which results in the impairment or destruction of the building and may result in injury or loss of life. Within a space of two weeks in the month of May 2023, it was reported that four (4) storey buildings had collapsed across the country resulting in deaths and injuries, with three of the collapse happening in the Greater Accra Region and one in the Northern Region. In response to these incidents, the joint leadership of the built environment professionals – the Ghana Institute of Planners (GIP), Ghana Institute of Architects (GIA), Ghana Institution of Engineering (GhIE) and the Ghana Institution of Surveyors (GhIS) – held a press conference to address the media on 18th May 2023. Subsequently, four (4) Ad-hoc Committees (each comprising of 7 professionals – engineers, architects, planners, and surveyors) were inaugurated and mandated to investigate the cause of the collapse and submit a report on their findings and recommendations for policy consideration. The four (4) Ad-hoc Committees were inaugurated on 18th May 2023 and were mandated to commence their investigation on 22nd May 2023.

This report contains the findings and recommendations of a 7-member Ad-hoc Committee comprising of engineers, architects, planners, and surveyors mandated to investigate the collapse of **'The Word In Action Church'** Building at Old Bortianor which occurred on Tuesday, 9th May 2023 in the Ga South Municipality in the Greater Accra Region of Ghana. It was reported that seven (7) persons were injured with six (6) of them treated locally and discharged, and one (1) was transferred to the Korle-Bu Teaching Hospital for further medical attention. The structure was a 2-storey reinforced concrete framed building with basement, which was being used as a church. The site is located at Ajasco junction in Old Bortianor and at 794221.48 m E and 609044.25 m N (UTM 30N) in the Ga South Municipal Assembly of the Greater Accra Region. See **Appendix B** for membership of the investigation committee.

2.0 PURPOSE OF THE INVESTIGATION

The objective of the Committee was to investigate the cause of the collapse of **'The Word In Action Church'** building at Old Bortianor, which occurred on Tuesday, 9th of May 2023, and submit a report outlining the methodology for the investigations, key findings and recommendations for policy consideration.

3.0 SCOPE OF WORK

The scope of work of the committee included the following:

i Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.

ii Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.

iii Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.

iv Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.

v Conduct structural assessment of the collapsed building and any available records of the building construction.

vi Identify any liability based on the findings including designs, construction and supervision and building code violation.

4.0 SITE LOCATION AND DESCRIPTION OF THE STRUCTURE

The site is located at Ajasco junction in Old Bortianor and at 794221.48 m E and 609044.25 m N (UTM 30N) in the Ga South Municipal Assembly of the Greater Accra Region of Ghana. The site measures 0.94 acres (0.38 ha). The site can be accessed off the Bojo Beach - Kokrobite road at the intersection of Ajasco Junction. The access to the Church premises is off the road that joins the Bojo beach – Kokrobite road at the Ajasco Junction. That minimises interference with the traffic on the Bojo beach – Kokrobite road (see **Figure 4-1**).

The Word In Action Church Building which collapse was a 2-storey building with basement. The structure was made up of reinforced concrete (RC) framed structural system (with sandcrete block infill panels) comprising a basement and first floor with RC concrete roof as shown in **Figure 4-2**. It was a rectangular building (with an entrance a foyer) measuring approximately 32.00 m wide by 33.00 m long on plan. The basement was used as a church auditorium (**Figure 4-3**) and the first floor was used as a multi-purpose arena (**Figure 4-4**) for conferences and offices. Rubbles from the collapsed building is shown in figures **Figure 4-5** and **Figure 4-6**.



Figure 4-1: Google map location of the collapsed structure under investigation



Figure 4-2: Building view before collapse

(Source: https://web.facebook.com/profile.php?id=100083154799390&sk=photos)



Figure 4-3: Church auditorium (sanctuary) at the basement level

(Source: https://web.facebook.com/profile.php?id=100083154799390&sk=photos)



Figure 4-4: Multipurpose arena at the first floor level

(Source: https://web.facebook.com/profile.php?id=100083154799390&sk=photos)



Figure 4-5: Rubbles from the collapsed structure



Figure 4-6: Rubbles from the collapsed structure

5.0 METHODOLOGY

Methodology is a brief description of the approach to the investigations. The methodology included investigation planning and coordination, data collection, development of testing protocol, interview with stakeholders, data analysis and interpretation, and reporting (see **Table 5-1** for details)

The investigation of the collapsed building was conducted in accordance with but not limited to the following standards and guidelines:

- BS EN 1998-3 (2005) - Eurocode 8: Design of Structures for Earthquake Resistance. Part 3.
- ES ISO 13822 (2012) - Bases for Design of Structures – Assessment of Existing Structures.
- IStructE (2008) - Guide to Surveys and Inspections of Buildings and Associated Structures.
- IStructE (2010) - Appraisal of Existing Structures (3rd edition).
- SEI/ASCE 11-99 (2000) - Guideline for Structural Condition Assessment of Existing Buildings.
- Professional Engineers Ontario (2016) -Structural Condition Assessments of Existing Buildings and Designated Structures Guideline.
- EN 13791 (2007) - Assessment of In-situ Compressive Strength in Structures and Precast Concrete Components
- ACI 201.1R-08 (2008) - Guide for Conducting a Visual Inspection of Concrete in Service.
- Ghana Building Code (GhBC 2018) *Ghana Building Code*. Accra: Ghana Standards Authority.

Other relevant codes and standards used for the investigation, test programme, analysis and control design are cited in the text as appropriate, with details provided in the references.

The methodology used for the assessment is shown in **Table 5-1**. Details provided include methods and techniques used, the information sought, and the dates when the various activities were undertaken.

Table 5-1: Methods and Techniques adopted for the investigation

Methods & Techniques	Information Sought	Date
Maiden Meeting of the Committee	The essence of this meeting was to discuss the terms of reference (TOR) and to develop strategies and plan of work to carry out the investigations	22nd May, 2023
Meeting with the Ga South Municipal Assembly	To introduce the Committee to the Assembly, brief the assembly on the plan of work of the committee, and to obtain official permission to gain access to the site	23rd May, 2023
Review of Existing Documents	To obtain existing information about the geometry, details and material properties of the collapsed structure and other relevant information to assist the investigation process	30th May, 2023
Visual Inspection and Documentation	Physical observation and documentation of the geometry/details of the structural elements of the collapse structure, observation of the possible collapse mechanism and checking of material properties and other necessary information	30th May, 2023
Schmidt Hammer Test	To determine the in-situ compressive strength of concrete of the RC structural elements	30th May, 2023
Interview with stakeholders	Interview with stakeholders to obtained further information about the collapsed building and also to obtain eye witness account	1st June, 2023 2nd June, 2023 21st June 2023
Camera (smart phones)	For photographs	During all site visits/fieldwork
Analysis & Reporting	Analysis and Reporting	Final phase

6.0 REVIEW OF EXISTING DOCUMENTS

As part of the investigation process, existing documents and other relevant information were reviewed. The objective of the review is to obtain background information about the existing structure for planning the investigation and test programme, and obtain existing data for analysis and reporting. To this end, a request was made to both the Ga South Municipal Assembly (GSMA) and the Building Owner/Developer (through the GSMA) on 24th May 2023, to provide the Committee with existing documents and other information for review. The letters of request, signed by the Chairman and the Secretary of the Committee were sent to the Assistant Engineer (acting on behalf of the GSMA) on 24th May 2023 via email, and he acknowledge receipt on the same day. List of existing documents requested from the Building Owner/Developer and the Ga South Municipal Assembly are provided in **Table 6-2** and **Table 6-1** respectively. See appendix for details.

Table 6-1: List of existing documents/ information requested from the Building Owner/ Developer and their remarks

S/N.	Existing Document/Information requested	Remarks
1.	Original Drawings (Architectural and Structural)	Not Provided
2.	As-built Drawings for the structure (Architectural and Structural)	Not Provided
3	Structural Analysis and Design Report (Structural Calculations Report)	Not Provided
4.	Geotechnical Report (Soil Report)	Not Provided
5.	Building Permit(s)	Not Provided
6.	Name of Original Contractors and Consultants	Not Provided
7.	Information on the date of construction (date of commencement, completion and habitation) of the structure	Not Provided
8.	Original test reports on materials (i.e. test on concrete, steel reinforcement) performed during the construction phase	Not Provided
9.	Construction Progress Reports and Site Photographs	Not Provided
10.	Documents/information on any alteration or major maintenance works on the structure	Not Provided
11.	Any other available documents, historical records and information about the structure.	Not Provided

Table 6-2: List of existing documents/ information requested from the Ga South Municipal Assembly and their remarks

S/N.	Existing Document/Information requested	Remarks
1.	Permit application documents	Provided
	(a) Architectural Drawings	Provided
	(b) Structural Drawings	Provided
	(c) Proof of Ownership	Provided
	(d) Geotechnical Report	Not Provided
	(e) Traffic Impact Assessment (TIA)	Not Provided
	(f) Environmental Impact Assessment (EIA) permit	Not Provided
	(g) Fire Safety Report/Certificate	Not Provided
	(h) Any other documents requested by the assembly	Not Provided
2.	Minutes of Technical Sub-Committee meeting including schedule of applications in connection with the proposed development application	Not Provided
3.	Joint Site Inspection Report of the Technical Sub-Committee on the site of the proposed development	Not Provided
4.	Minutes of Spatial Planning Committee at which a decision on the proposal development was made	Not Provided
5.	Copy of approved Permit Documents	Provided
6.	Application for Certificate of Habitation FORM 43D (LI 2384)	Not Provided
7.	Inspection Report of the Planning and Building Inspectorate Unit (Section 158 of Act 925)	Not Provided
8.	Certificate of habitation FORM 43E (LI 2384)	Not Provided
9.	Additional information (inspection report on church gazetting)	Provided

The Ga South Municipal Assembly indicated that some documents were not available because the permit was granted during the transition period, that is, as at the time, the Assembly was newly carved from the old Ga South Municipal Assembly (Weija), hence the Assembly was operating from a rented place before finally moving to the current permanent place.

The Building Owner/Client on the other hand did not provide any of the documents

requested claiming that the documents have been trapped under the debris of the collapsed building.

6.1 Review of Architectural Drawings

The Architectural drawing (see **Appendix D**) was observed to be inadequate through the following observations:

- The project title was not reflective of the development carried out. The cover page read a “Proposed Residence for The Word In Action Church at Bortianor - Greater Accra”
- Sheet A/01 indicated the same scale for site plan and block plan i.e. 1: 16 =1’-0’’. This is a clear indication that the drafter of the drawing had no idea about scaling of drawings; the endorsing Architect too did not inspect the drawings thoroughly to raise red flags on the misrepresentations. The approving body i.e. the Assembly did not also raise a query about such errors before the grant of first Permit. A clear lack of understanding of professional standards .1:25 (1/2″=1′-0″) 1:50 (1/4″=1′-0″) actual equivalent – 1″= 4.17′, 1:100 (1/8″=1′-0″) actual equivalent – 1″= 8.33′, 1:200 (1/16″=1′-0″) actual equivalent – 1″ = 16.66′.
- The Block plan did not show the parking allocation and vehicular and pedestrian flow per the use of the facility.
- The Basement plan should read Level: -01 then Level 00 as the ground floor and 01 and 02 in that order for better understanding by the project team stating the reference level on the floor plans.
- The inner round columns had no dimension to aid proper sizing of the columns on site during execution.
- Dimension errors were also observed: distance between grid line 2a-grid 8 indicated overall dimension of 105’3” on sheet A/02 and on A/03 the overall distance between grid lines 1 to grid 8 was indicated same as 105’-3’’, a clear dimensional error confirming lack of professionalism and attention to detail.
- The endorsing Architect, Arc. Charles Yao-Atta Dawson with registration number 633 , was not in good standing since 2017 and had graduated as an associate Member of the Ghana Institute of Architect in 2006 hence the drawing ceased to be a valid document to obtain approval - *According to the GIA records*
- There was no clear description for the two diagonal lines running through the floor

plan.

- The Planning Committee secretary granted approval for the drawing and was subsequently approved by the Municipal Engineer.
- Drawing A/06 indicated the prescription of concrete roofing for the development; however, the drawing did not show details of typical concrete roofing details for construction.
- The section M-M on sheet A/07 did not indicate a parapet wall and blown- up details for the wall to slab details.
- Section line M-M was not indicated on all the floor plans for referencing and drawing interpretation purposes.
- For such a project, only one section was not adequate.
- Column details and dimensions were not legible.
- The various column sections and details were not cross-referenced on the foundation plan and the section.
- Right -side elevation did not show the curved wall on the first floor of the project as rendered on the front elevation of Sheet A/08
- Plans and elevations were not complete with doors and windows tags, floor levels, and section and elevation annotations for cross-referencing.
- Architectural drawings were mixed with structural details as shown on sheet A/12.

6.2 Review of Structural Drawings

The structural drawings received were reviewed and details provided in **Table 6-3** (see **Appendix D**). Observations from the review of the structural drawings included the following:

- The structural drawings were stamped and signed by an architect.
- The drawings were approved and endorsed by the Assembly and subsequently issued permit for construction.
- Concrete grade, concrete cover and reinforcing bar type were not indicated on the structural drawings.
- No bending schedules were provided for columns, beams and slabs, except for

the staircases.

- No structural notes/ specifications were provided on the structural drawings and the details provided are not adequate to be used for construction.
- Architectural and structural drawings were mixed up on same pages. There were discrepancies in dimensions (floor-to-floor height) comparing the structural drawings to the architectural drawings.
- There were discrepancies between sizes and number of column bases indicated on the foundation plan and member details.
- Cross-section through structural elements such as beams, columns and slabs were not provided.
- Structural details of some structural members such as the RC roof slab was not provided.
- Metric and imperial units were mixed together and used interchangeably on the drawings.
- Metric and imperial bar sizes mixed up and were used interchangeability on the drawings.
- The architectural and structural drawings for some elements were mixed up on same pages.

Generally, the structural drawings were not standard drawings and lacked adequate details for construction purposes. For example, there were no concrete grade, concrete cover, reinforcing steel type, structural notes and specifications provided, and there were no general arrangements/layout drawings, and cross-sectional details of beams and columns, and bending schedule for beams slabs and columns were not provided. The nature of the drawing and details provided suggests that the structural drawings were not produced nor checked by a competent and licenced structural engineer. See **Table 6-3** for further details on the review of the structural drawings.

Table 6-3: Review of original structural drawings approved by the Assembly for the works

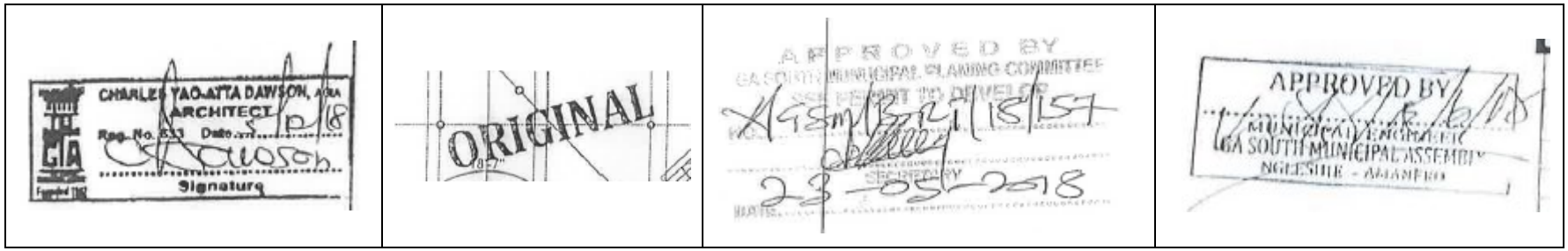
Item	Geometry/Details	Observations	Remarks
Floors	Basement/Ground Floor – Concrete bed of 150 mm thick. (Ref: Dwg. No: A/07)	General arrangement/ layout of ground floor not provided; Fabric reinforcement was indicated in the ground floor bed but details of the type of fabric reinforcement was not provided	Details of drawings not appropriate and not adequate to be used for construction purposes
	First Floor: RC floor of 6" (150mm) thick; Rebar: #4@ 6" c/c (Ø12 @ 150 c/c). (Ref: Dwg. Nos: A/07, A/10)	Slab details not readable; grade of concrete not indicated; concrete cover not indicated; grade of steel not indicated; bending schedule not provided; location of rebars (whether top or bottom) also not indicated on drawing; no structural notes/specifications provided on drawing	No structural notes/ specifications provided and the details provided are not adequate to be used for construction purposes
	Roof Slab – RC roof slab of thickness 6" and 7". Rebar: not provided. (Ref: Dwg. No: A/07)	No structural details of RC roof slab provided	Ditto
Beams	Beams – Size 9" x 18" (225 x 300 mm)-top; Rebars: main bars - 3#7 (3Ø22), bottom 3#7 (3Ø22) -bottom, links #6@225 c/c (Ø6@225 c/c). (Ref: Dwg. Nos: A/13, A/14, A/15)	Beam spans ranges from 6' to 20' (1.80 m to 6.0 m). No general arrangement drawings provided; beam details not readable; imperial bar sizes and metric bar sizes were mixed up on the drawings; sections details of beams not provided; concrete grade and cover not provided; bending schedule for beams not provided; beams details shown not indicated whether for first or roof beams. Type of reinforcing steel not provided. No structural notes/specifications provided on drawing.	Structural drawings provided not standard and did not provide adequate details to be used for construction purposes
Columns	Columns – Type 1 & Type 2 Type 1: size 300 x 300 mm; rebar: longitudinal bars 4#5 (4Ø16), links #3@225 c/c (Ø10@225 c/c. Column height: G. Floor to First floor level is	Column spacing ranges from 6' to 20' (1.80 m to 6.0 m) and floor-to-floor height of 3150 mm as per the structural drawings (see Dwg. A/07, A/12). Discrepancies between floor-to-floor height of columns specified on structural and architectural drawings – column height (floor-to-floor) on structural	Structural drawings provided not standard and do not provide adequate details to be used for construction. Architectural and

Item	Geometry/Details	Observations	Remarks
	3150 mm and first floor to roof slab level is 3000 mm (Ref: Dwg. Nos: A/02, A/03, A/04; A/06, A/07, A/12) Type 2: size 400 mm dimeter; rebar: longitudinal bars 6#5 (6Ø16), links #3@225 c/c (Ø10@225 c/c). Column height: G. Floor to First floor level is 3150 mm and first floor to roof slab level is 3000 mm. (Ref: Dwg. Nos: A/02, A/03, A/04; A/06, A/07, A/12)	drawings is 3150 (see Dwg. A/07, A/12) as opposed to dimensions specified on the architectural drawings indicating column height: G. floor to first floor level is 20'-8" (6200 mm) and first floor to roof slab level is 17'-2" (5150 mm) (see Dwg. A/07). No general arrangement drawings provided; column elevations quite readable but no sections provided showing rebar layout; imperial bar sizes and metric bar sizes mixed up on the same drawings. Concrete grade not provided; concrete cover not provided; bending schedule for columns not provided; column elevation drawings showing substructure, ground floor and first floor columns provided. Column details for basement not provided. Type of reinforcing steel not provided. No lap length indicated. No structural notes/specifications provided on drawing. Peripheral columns are generally square shaped and internal columns are circular shaped as per Dwg Nos A/02 – A/04, however, quantities indicated on column details differ. Mismatch between column positions on various floors	structural drawings mixed up on same pages. There were discrepancies in dimensions (floor-to-floor height) comparing the structural drawings to the architectural drawings
Foundations	Footing – Type: pad footing; size 1100 mm x 1100 mm x 300 mm thick and size 1200 mm x 1200 mm x 300 mm thick; Rebar: #5@150 c/c; 150 mm blinding; death below ground level is approx. 1.40 m. (Ref: Dwg. Nos: A/05, A/07, A/12)	Foundation plan (Dwg No. A/05) showing column bases for 20nr columns only – 13nr circular columns shown on the foundation plan have no foundation provided. Size of footing size on foundation plan differ from size indicated on details. Details of basement walls were also not provided	Discrepancies between sizes and number of bases indicated on foundation plan and details
Staircase	Stairs – Type: Dog-leg stair; waist = 6" (150 mm) thick; main bars: #4@6" (Ø12@150 c/c) –bottom, #4@9"	Standard details provided; bending schedule provided. Concrete grade, cover and rebar type not provided.	Details provided in terms of readability and rebar arrangement okay.

Item	Geometry/Details	Observations	Remarks
	(Ø12@225 c/c) –top. (Ref: Dwg. Nos: A/12, A/15)		

NOTES

1. Drawings reviewed were the original drawings approved, stamped and signed by the Ga South Municipal Assembly with Development Permit No: GSMA/BORT/m020-0518/157 (see Appendix D)
2. Both architectural and structural drawings (including services drawings) were approved, stamped and signed by Registered Architect, Charles Yao-Atta Dawson with Reg. No. 633 , dated 05/12/2018 (Appendix D)
3. Address and name indicated on the drawings is NACRAB AND COMPANY CONSTRUCTION CO. LTD., P. O. Box 14714, Accra. Location: Opposite Korle-Bu police station. Tel.: 0244548896/ 0277678867. Website: www.nacrab.com. Email: nittoah@yahoo.com, nittoah@hotmail.com (see Appendix D)



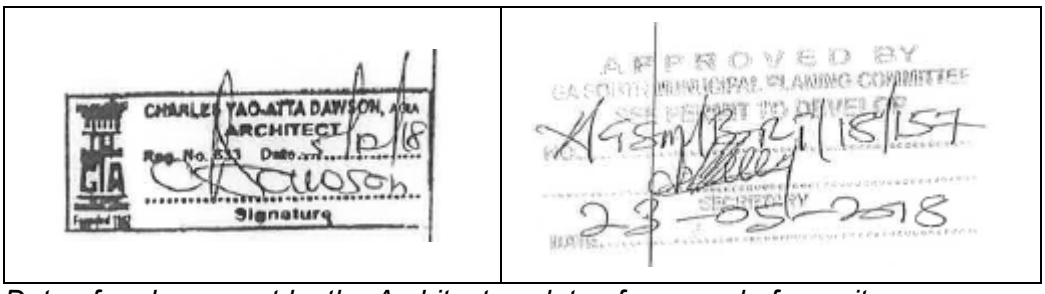
[1,2] Signatures / endorsement on the Drawings

6.3 Review of Permit Documents

The permitting procedure depicted in **Appendix E** is in accordance with the Land Use and Spatial Planning Act, 2016 (Act 925) section-38 (1) e and Land Use Regulations, 2019 (L.I. 2384) Regulation 44 and 45. It is expected that the Ga South Municipality had governed their permit processes using the above legislations.

Details of the review of permit documents are provided in **Table 6-4**. Key findings from the review of the permit documents included the following:

- From the permitting procedure (8.0) in **Appendix E,** majority of the relevant documents were not sited. They are as follows:
  - Minutes of the Technical Sub-committee meeting
  - Report of the Joint Technical Sub-committee
  - Minutes of the Spatial Planning Committee meeting
  - Certificate of habitation
- From the building permit folder (see Appendix D), it was observed that the date of the approved permit was on **18/06/2018** whiles the Architect's signature on the building drawing for the permit was dated **5/12/18**. The date format adopted by the Architect is quite ambiguous – this indicates that either the Architect used a different date format (i.e. mm/dd/yyyy instead of the usual dd/mm/yyy) or the permit was given 7 months ahead of the endorsement of the drawings by the Architect.



Date of endorsement by the Architect vs date of approval of permit

- For a public use structure, Fire permit/certificate and Environmental permit is required but was not sighted. Additionally, a two-storey building with a basement requires a geotechnical investigation report and a structural engineer's endorsement of the structural drawings of the Church, which both were also not sighted.
- With reference to the building permit folder, there was no indication that the works

department or the Planning and Building Inspectorate had checked the following during construction:

  - Set-out checked
  - Excavation inspection
  - Concreter foundation inspection

- Upon the observation of the Works Department inspection team as per their inspection report dated 8th May 2022 and engagement with the Assembly, the extensions that have taken place at the Church premises have not been permitted.

The permit process has been instituted for the purpose of ensuring that physical developments pre-permit and post permit issuance prevents such occurrences. However, when both the Local Planning Authority (the Assembly) and the developer renege on their responsibilities, room is created for such incidents. Consequently, both the Assembly and the Developer (The Work In Action Church) have failed to fully comply with their respective responsibilities in the permit process resulting in the building collapse.

6.4 Other Relevant Documents

Deed of Assignment - Even though the Deed of Assignment covering the land is not registered, the root of title is from a registered title with the following details:

- Land title Certificate issued to Unique Guest House Limited
- Lease dated 10th June 1998
- From : Nii Akotey IV
- To : Unique Guest House Limited

Table 6-4: Review of permit documents – Permit procedure and observations

Step	*Duration*	*Activity*	*Purpose*	*Observations*
1		Submission of development application to the Secretariat (Physical Planning Department) of the Spatial Planning Committee (SPC)	Preliminary vetting of application documents is undertaken at the point of submission to ensure all required documents for the specific application is presented by the applicant and guidance is given on the whole process	Building documents **(See Appendix D)** sighted show a two-storey Church building with basement and fence wall. A registered architect "Charles Yao-Atta Dawson" of **Reg. No. 633** endorsed the building and structural drawings on **5/12/18** whiles the building permit No. GSMA/BORT/m020-0518/157 was signed **18/06/2018** The description of the building above effectively makes a three (3) storey structure with the inclusion of a basement. This development therefore requires a geotechnical report to guide foundation design and the structural drawings requires endorsement by a registered Structural Engineer. A Church building being a public building requires a fire permit/certificate to ensure the safety of worshipers and an Environmental permit from the EPA both of which was not sighted.
2	Day 7	Review of development application by Technical Sub-committee (TSC) (*)	Eleven (11) committee members of various disciplines related to the built environment and development in general review the development application to ensure it complies with approved spatial plans, necessary regulations, and complements development in general	No document sighted in this respect of this step (minutes of the Technical Sub-committee was the required document)
3	Day 14	Joint site inspection by Technical Sub-committee (TSC)	On-site inspection by the TSC provides the opportunity for the team to jointly evaluate the proposed development with respect to existing conditions on the site	No joint Technical Sub-committee inspection report was sighted, or any inspection report conducted before the issuance of the permit. However, an inspection report conducted by the works department dated 9th May 2022 for the purposes of gazetting the premises of the Church to officiate

Step	Duration	Activity	Purpose	Observations
				marriages was provided by the Assembly. It was this inspection that drew the attention of the Assembly that the Church had undertaken modifications to the structure without permit
4	Day 21	Technical Sub-committee meeting and recommendation on development application	The TSC meets after the meeting to jointly make recommendations based on the review of documents and the site visit for each development application and documented for the SPC	No document (minutes of the Technical Sub-committee) was sighted
5		Spatial Planning Committee (SPC) (**) meeting to take decision on development application	The SPC reviews the recommendations of the TSC and takes a decision (Approve, Defer or Reject) on each development application	No document (minutes of the Spatial Planning Committee (SPC)) was sighted
6	Day 30	Procession of SPC decision (notification of applicant, payment of permit fee and or payment of penalty)	The Secretariat takes the necessary steps to inform applicants of the decision of the SPC	The building permit folder was sighted with permit number GSMA/BORT/m020-0518/157 (see **Figure 6-1**)
7		Issuance of development permit	A copy of all documents submitted for the development application is given to the applicant with the designated signatories (***) endorsing the documents	The building permit folder was sighted with permit number GSMA/BORT/m020-0518/157 as well as the approved building drawings document bearing the signatures of the respective personnel The building permit documents indicated that the permit process ended in June of 2018 whiles the architect's signature date is in December 2018. Also, no entries were made in the building permit folder to indicate that the following were inspected (**Figure 6-2** and **Figure 6-3**):

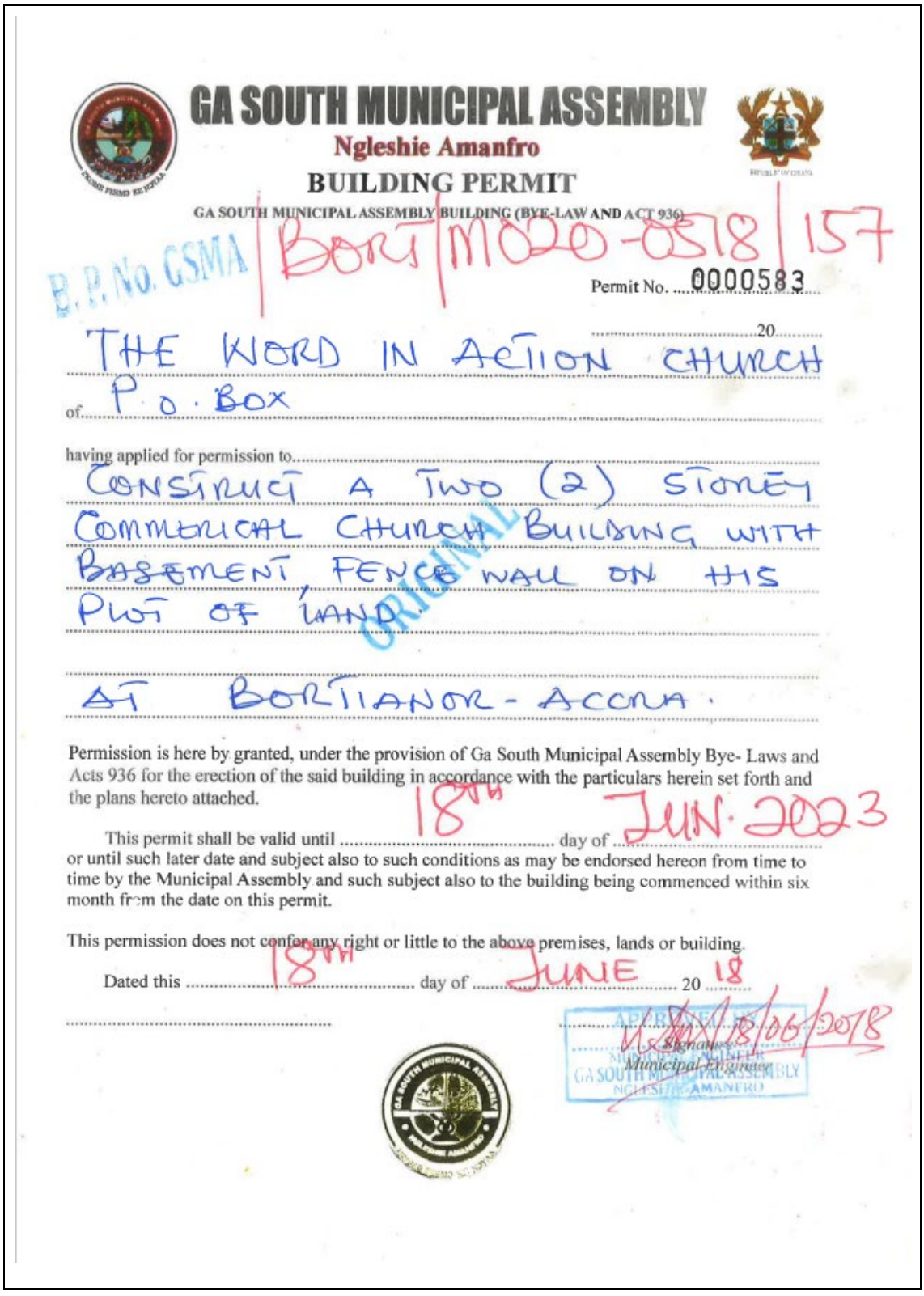
Step	Duration	Activity	Purpose	Observations
				• Set-out checked • Excavation inspection • Concreter foundation inspection
8		Submission of appeals where applicable	An applicant may petition the District SPC if unsatisfied with its decision. The applicant may petition the Regional Spatial Planning Committee (RSPC) if unsatisfied with the decision of the District SPC and the Board of LUSPA if unsatisfied with the decision of the RSPC	No document was sighted to this effect.
		Certificate of Habitation	This certificate is issued after the Planning and Building Inspectorate Unit have inspected the new development and are satisfied that the development has complied with the provisions of the issued permit and is suitable for human habitation	No document was sighted to this effect.

(*) see **Appendix E** for full list of members of the TSC

(**) see **Appendix E** for full list of members of the SPC

(***) District Physical Planning Officer and District Works Engineer

NOTE: the information in the table above refers to the permit secured by the Word in Action Church in June of the year 2018. The additional works have not been permitted and therefore are not referred to in the table above.



GA SOUTH MUNICIPAL ASSEMBLY

Ngleshie Amanfro

BUILDING PERMIT

GA SOUTH MUNICIPAL ASSEMBLY BUILDING (BYE-LAW AND ACT 936)

B. P. No. GSMA | BORT/M020-0518 | 157

Permit No. 0000583

.....20.....

THE WORD IN ACTION CHURCH

of P. O. BOX

having applied for permission to.....

CONSTRUCT A TWO (2) STOREY COMMERCIAL CHURCH BUILDING WITH BASEMENT, FENCE WALL ON THIS PLOT OF LAND.

ORIGINAL

AT BORTIANOR - ACCRA.

Permission is here by granted, under the provision of Ga South Municipal Assembly Bye- Laws and Acts 936 for the erection of the said building in accordance with the particulars herein set forth and the plans hereto attached.

This permit shall be valid until 18TH day of JUN. 2023 or until such later date and subject also to such conditions as may be endorsed hereon from time to time by the Municipal Assembly and such subject also to the building being commenced within six month from the date on this permit.

This permission does not confer any right or little to the above premises, lands or building.

Dated this 18TH day of JUNE 20 18

.....

.....

APPROVED 18/06/2018

Municipal Engineer

GA SOUTH MUNICIPAL ASSEMBLY NGLESHIE AMANFRO

Figure 6-1: Building Permit folder – Page 1

DESCRIPTION OF MATERIAL, ETC. TO BE USED IN THE WORK

All Plans must be full Dimensioned

DESCRIPTION

FOUNDATION:	Material
	Proportions
WALLS:	Material
	Proportions
FLOORS:	Material
	Proportion
	Joists Dimensions
	Joists Spacing
	Covering Thickness
WINDOWS:	Type
	Dimensions
DOORS:	Type
	Dimensions
ROOF:	Type
	Covering
	Spacing of Trusses
STEPS AND STAIRS:	Material
VERANDAHS:	
	Material
FENCING:	Material
	Height
YARDS:	
OUT BUILDING:	
VERANDAHS:	

Figure 6-2: Building Permit folder – Page 2

DESCRIPTION OF MATERIAL, ETC. TO BE USED IN THE WORK

All Plans must be full Dimensioned

DESCRIPTION

FOUNDATION:	Material
	Proportions
WALLS:	Material
	Proportions
FLOORS:	Material
	Proportion
	Joists Dimensions
	Joists Spacing
	Covering Thickness
WINDOWS:	Type
	Dimensions
DOORS:	Type
	Dimensions
ROOF:	Type
	Covering
	Spacing of Trusses
STEPS AND STAIRS:	Material
VERANDAHS:	
	Material
FENCING:	Material
	Height
YARDS:	
OUT BUILDING:	
VERANDAHS:	

Figure 6-3: Building Permit folder – Page 3

6.5 Summary of Findings

- The architectural design was not performed by a competent and licensed architect. The architectural design and drawings were done by a draughtsman; the drawings were characterised by errors and lacked adequate details to be used for construction purposes (see Appendix D).

- The structural design was not performed by a competent and licensed structural engineer, and the structural drawings were conceived and produced by a draughtsman who lacked basic competency in structural engineering. The structural drawings were not standard and lacked adequate details for construction purposes. For example, no concrete grade, concrete cover, reinforcing steel type, or structural notes/specifications were provided. Similarly, there were no general arrangements/ layout drawings or cross-sectional details of beams and columns nor bending schedules for beams, slabs and columns (except for stairs). (see Appendix D)

- Both the architectural and structural drawings were endorsed/signed by a registered Architect with Reg. No. 633, however, considering the nature of the building the structural drawings should have been endorsed by a registered Structural Engineer

- The Ga South Municipal Assembly issued permit for the construction of the collapsed chapel building.

- With reference to the building permit folder, there was no indication that the works department or the Planning and Building Inspectorate had made any inspection during the construction phase (see Appendix D).

- No geotechnical investigations were conducted at the site before the design and construction of the structure.

- The Ga South Municipal Assembly issued permit for the construction of the collapsed chapel building.

- It was noted that the Assembly inspected the facility on 9th May 2022 upon application by the church for gazetting of the premises to “officiate marriages”. The inspection report from the assembly indicated that they noticed some variations of the as-built structure compared to the original permit drawings, and requested the church to provide architectural and structural drawings of the as-built structure including a structural integrity report before the permit could be

granted. (See Appendix D for details of the reposrt).

7.0 FIELD INVESTIGATIONS AND LABORATORY ANALYSIS

The field investigations involved site analysis, visual inspection and documentation, field tests on selected structural elements and evaluation of results.

7.1 Site Security and Safety

The team arrived at the site on 30th May 2023 to commence the field investigations. Prior to the commencement of the fieldwork, the Committee had already been introduced to the Ga South Municipal Assembly by an introductory letter dated 22nd May 2023 (with Ref. No. GIA/COR/HS/230516/123) to the Municipal Chief Executive by the Coordinators. Subsequently, the Committee also visited the Assembly on 23rd May 2023 for in-person introduction, and to seek access to the site to commence the investigations. The site was secured by the National Disaster Management Organisation (NADMO) and the Ga South Municipal Assembly; hence, the debris were not cleared prior to the commencement of the investigation. The team was assisted by the Assembly each time we visited the site throughout the investigation phase. There was no interference from the owners or the public during the fieldwork.

7.2 Site Analysis

This analysis is to provide a context of 'The Word in Action Church' at Old Bortianor. The context is in the general dynamics of development close to the site and geophysical features that may impact the development and vice versa.

7.2.1 Location and Size

The site is located at Ajasco junction in Old Bortianor and at 794221.48 m E and 609044.25 m N (UTM 30N) in the Ga South Municipal Assembly of the Greater Accra Region of Ghana. The site measures 0.94 acres (0.38 ha)

7.2.2 Zoning of Site

A Local Plan extract was not sighted as part of the documents reviewed. It was deduced that, since there is an initial permit for the constructed Church, then the zoning of the site must have been in conformity with the use.

7.2.3 Accessibility

The site can be accessed off the Bojo beach - Kokrobite road at the intersection of Ajasco Junction. The access to the Church premises is off the road that joins the Bojo beach – Kokrobite road at the Ajasco Junction. That minimises interference with the traffic on the

Bojo beach – Kokrobite road.



Figure 7-1: Site location

7.2.4 Elevation and Slope

The subject site falls within the elevation ranging of 3.6 -16 meters above sea level as shown by **Figure 7-2**. The general vicinity of the site shows high elevation (24-49m) to the North and low elevation (-900-3.5m) to the South getting to the sea. This creates the situation whereby run-off from higher elevations (North of the site) to flow southwards where the site is located towards the sea for final discharge.

The slope of the site in question ranges from very gently sloping to strongly sloping as shown by **Figure 7-3**. However, the site is dominated by gentle slopes. This therefore requires adequate measures for drainage to cater for run offs.

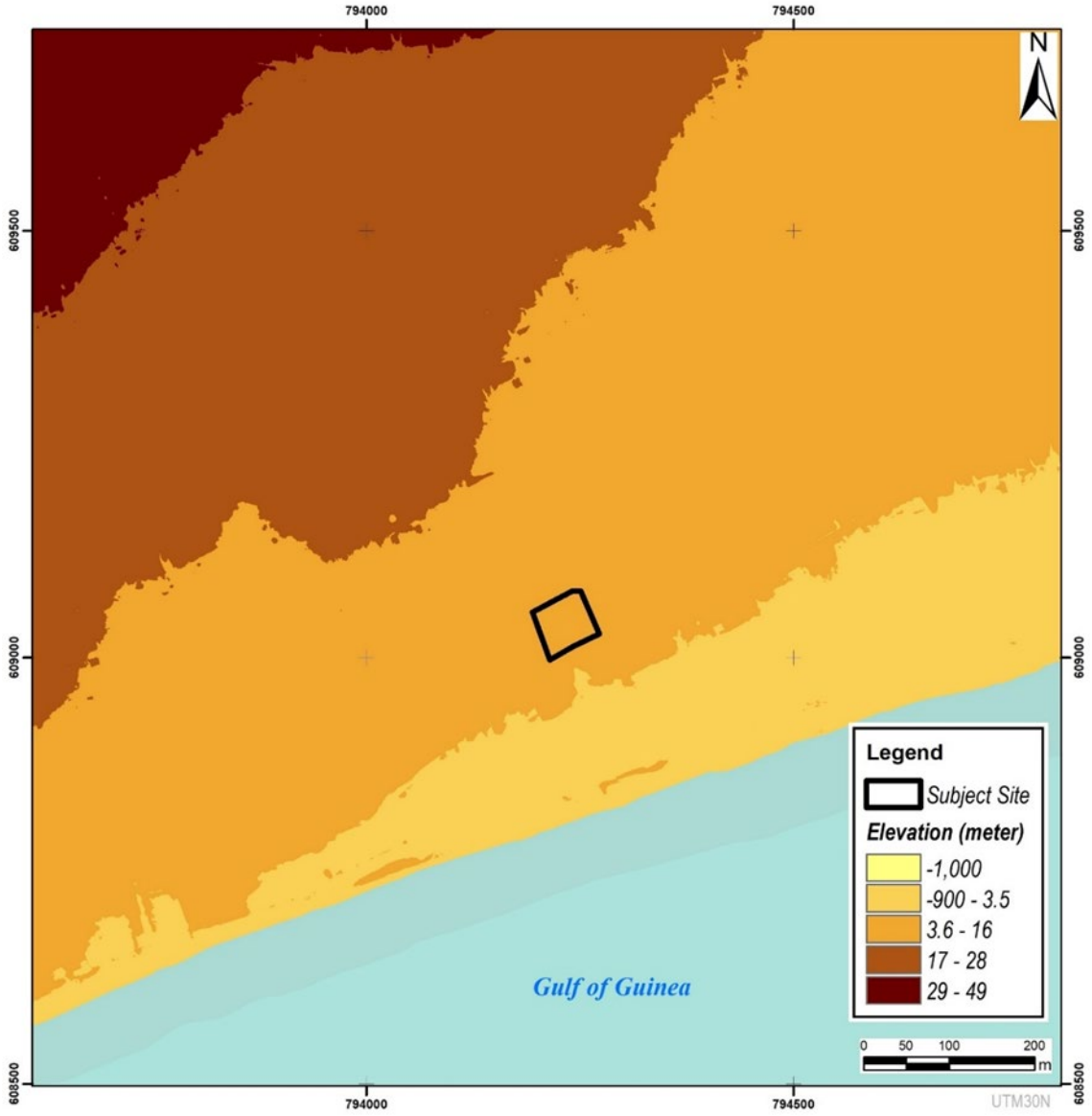


Figure 7-2: Elevation of the site

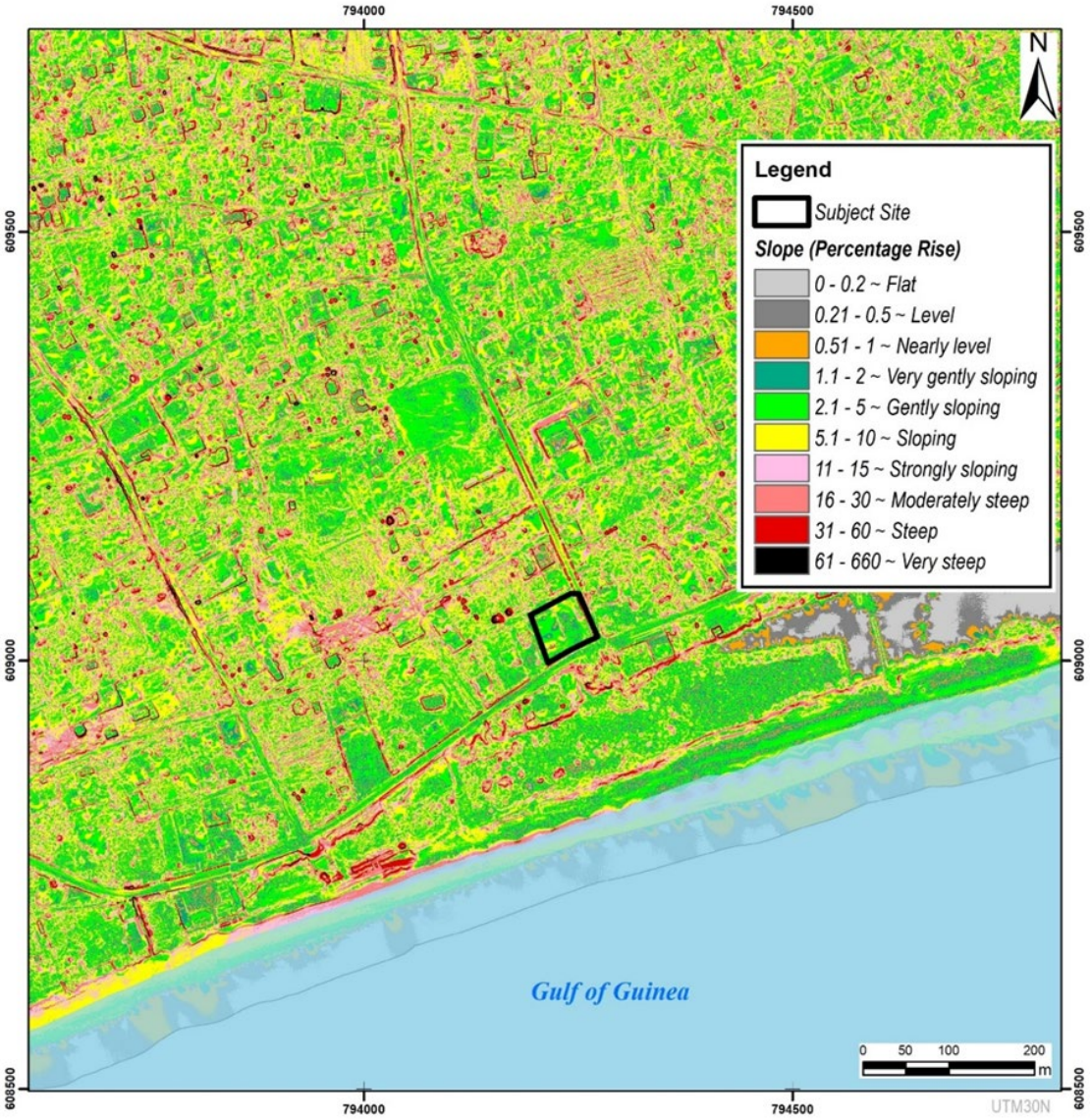


Figure 7-3: Slope of the site

7.2.5 Drainage of site and environs

The site in question has a drain in front that leads to a culvert that crosses the Bojo Beach – Kokrobite road to transport water to ponds along the road and finally into the sea. The closest pond to the site is approximately 72 meters, which is permanent throughout the year but changes size seasonally. The site in question is approximately 163 meters from the seashore. The proximity of the sea suggests that there may be salt intrusion in the ground and therefore a geotechnical investigation will be required to inform the design of foundations as well as the kind of materials to be used in such conditions.

7.2.6 Development on Site

The site at the time of inspection was full of rubble from the collapsed two-storey Church structure. The remaining structure as shown in **Figure 7-4** is constructed on the fence wall of the Church premises. This forms part of the extension taking place on the Church premises that has not gone through the permit process.



Figure 7-4: Development on the site – remaining structure

7.2.7 Adjoining Development

With reference to **Figure 7-1** the Eastern and Northern sides of the site across the roads has residential developments, a block factory is located to the Western side of the site and to the South is the Bojo Beach – Kokrobite road.

7.3 Visual Inspection and Documentation

Visual inspection was conducted on 30th May 2023. The purpose of the visual inspection was to make physical observation and documentation of the geometry/details of the structural elements of the collapsed structure, observation of the possible collapse mechanism and checking of material properties and other necessary information. It was also partly to ascertain the conformity of the as-built structure to the original drawings and specifications. List of inspected items, geometry/details and observations are presented in **Table 7-1**

Key findings from the physical observations of the collapsed structure included the following:

- Circular columns of 400 mm diameter were generally used for the structure, and square column sizes of 250 x 250 mm observed around the staircase areas.
- The arrangement of steel reinforcing bars (longitudinal and tie bars) in the circular columns were placed halfway in the column cross-section and about half of the concrete column cross-section was without longitudinal nor tie bars. Tie bars used in columns were square-shaped measuring 200 x 200 square instead of circular-shape. This was completely wrong way of placing reinforcement in columns which is at variance with standard practice and code requirements because the longitudinal bars have to be placed around the periphery of the column (less concrete cover) and the entire longitudinal bars and concrete core must be effectively tied together with links.
- Internal columns generally failed in compression by crushing and the peripheral columns failed in shear.
- Floor Beam sizes were generally 250 x 600 mm with spans of approximately 6.0m reinforced with 3Ø16 bars at the top and 2Ø16 at the bottom, and 2-leg link sizes of Ø6 @ 250 c/c and Ø8 @ 250 c/c in the beams – different sizes of links were used in different beams. Further observations made was that two layers of steel reinforcement bars were place at the top and bottom of the beams around areas of the edge columns with the bras extending about 1.0 m to either sides of the supports. Rebars in the peripheral beams (and some internal beams) were arranged within the web of the beams, hence, there were no connection (tie) between the beam and slab rebars leading to total separation of the beam web from the slab. Concrete cover to beams ranges from 25 mm at the bottom to 150 mm at the top.

- It was also observed that the thickness of plaster on columns ranges from 25 mm to 100 mm and that for the screed on the slabs was approximately 125 mm thick.
- Debris from newly constructed block walls and asbestos roofing sheet were observed at the last floor level. This suggests that addition storey was built on the existing structure (which was possibly still under construction because the plastered surface observed were not painted).
- The exterior columns pulled towards the centre of the building, which suggests that the failure was due to compressive failure of internal columns in the structure.
- A 2-storey building (L-Shaped) under construction was observed on the site, which has been built along the fence wall. *The team recommends that a structural integrity assessment should be conducted on the structure to ascertain its structural adequacy and safety*.

These observations made clearly indicates poor workmanship that can be attributed to lack of skill and competency, and poor supervision during the construction phase. Refer to **Table 7-1** for list of the inspected items, geometry/details and remarks.

Table 7-1: List of inspected items, geometry/details, observations and remarks

Inspected Items	Geometry/Details		Observations	Remarks
	Original Drawings	As-built		
Floor Slabs	First Floor: RC floor of 6" (150mm) thick; Rebar: #4@ 6" c/c (Ø12 @ 150 c/c). (Ref: Dwg. Nos: A/07, A/10)	Floor Slab – thickness of 150 mm; Rebar: Ø12 @150 c/c (bottom) in one direction and Ø12 @ 150 c/c (bottom) in the other direction. Support top bars – there was no access for inspection; concrete cover: 10-25 mm	Concrete cover was not adequate in some part of the exposed slab soffits observed; several crack patterns observed on the slabs but the concrete was still held together with the rebars; exposed slab rebars observed showed signs of corrosion; rebar size and spacing matches what was specified on the drawings. Overall thickness of screed observed on floors was about 125 mm laid in 3 layers of varying thickness (see **Figure 7-15**)	Spacing and diameter of rebars used in the slabs were same as indicated on drawing
Beams	Beams – Size: 9" x 12" (225 x 300 mm)-top; Rebars: main bars - 3#7 (3Ø22), bottom 3#7 (3Ø22) -bottom, links #6@225 c/c (Ø6@225 c/c). (Ref: Dwg. Nos: A/13, A/14, A/15)	Floor Beams – size 250 x 600 mm deep; Rebars: 3Ø16 (top), 2Ø16 (bottom); links: Ø6 @ 250 c/c and Ø8 @ 250 c/c; concrete cover: 25 mm (bottom and sides) and 150 mm (top). Two layers of main rebars provide at the top and bottom of supports of edge columns: 6Ø16 (top), 4Ø16 (bottom) – extending 1.0 m to both sides of column.	At the beam/column joints at the corners and edges of the building, it was observed that top bars had 150 mm bend and bottom bars had no bend (straight ends) (see **Figure 7-8**). Rebars in the peripheral beams (and some internal beams) were arranged within the web of the beams hence there were no connection (tie) between the beam and slab rebars leading to total separation of the beam web from the slab (see **Figure 7-14**). Two layers of rebars (same number as first layers) were observed in beams at supports, extending to either sides of the support by approximately 1.0m. Size of links varies in beams; some beams had Ø6 @250 c/c whilst others had Ø8@250 c/c. Fractured links were observed in some beams, which may be due to the size used, or inadequate number provided. Rusting of rebars were observed which might	Beam sizes and rebar details in the as-built structure is at variance with the original drawings

Inspected Items	Geometry/Details		Observations	Remarks
	Original Drawings	As-built		
			be due to poor bonding or poor concrete quality. Concrete cover in beams ranges from 25 mm at the bottom to 150 mm at the top	
Columns	Columns – Type 1 & Type2 Type 1: size 300 x 300 mm; rebar: longitudinal bars 4#5 (4Ø16), links #3@225 c/c (Ø10@225 c/c(Ref: Dwg. Nos: A/02, A/03, A/04; A/06, A/07, A/12) Type 2: size 400 mm dimeter; rebar: longitudinal bars 6#5 (6Ø16), links #3@225 c/c (Ø10@225 c/c). (Ref: Dwg. Nos: A/02, A/03, A/04; A/06, A/07, A/12)	Columns – Type 1 & Type 2 Type 1: size 250 x 250 mm; rebar: longitudinal bars 4Ø16, links Ø10@225 c/c; Concrete cover ranges from 25 mm to 150 mm Type 2: size 400 mm dimeter; rebar: longitudinal bars 6#Ø16, links Ø10@225 c/c; Concrete cover ranges from 25 mm to 150 mm	Columns generally failed in compression by crushing, especially interior columns and some edge columns (see **Figure 7-10**). Longitudinal and tie bars in circular columns were arranged halfway in the column cross-sections and square-shaped links of dimensions 200 x 200mm were observed in virtually all circular columns (lack of adequate confinement of concrete) – this led to explosion of the concrete in the column similar to failure mode of plain concrete (see **Figure 7-11**). Concrete cover varies from 25 mm to 150 mm generally due to due to wrong arrangement of rebars and use of square-shaped links in circular columns. Lack of adequate connection (anchorage) at beam/column joints leading to failure of the joints. The arrangement of rebars in the circular columns to some extent suggest that the initial column size was 250 x 250 mm but was later casted as circular columns. Overall thickness of plaster observed on columns was about 100 mm, applied in 3 layers of varying thickness	Poor arrangement of rebars in circular columns, lack of confinement of concrete and use of square links in circular columns – rebars concentrated in half of the cross-section and about other half of the concrete core was not confined. Number and size of bars in columns same as the original drawings
Rubbles from additional storey	-		Rubbles from new construction at the last floor level were observed including asbestos roofing sheet, which suggest that there was additional storey added to the existing	-

Inspected Items	Geometry/Details		Observations	Remarks
	Original Drawings	As-built		
			structure (see **Figure 7-13**). Concrete stairs were also sighted completely destroyed	
New development (2-storey building under construction)			A 2-storey building (L-Shaped) under construction was observed on the site, which has been built along the fence wall (see **Figure 7-4**). Visual inspection of that structure suggest there was poor supervision and poor workmanship. Schmidt Hammer test conducted on few columns in the structure recoded no readings suggesting a poor quality concrete was used. The team recommends that a structural integrity assessment should be conducted on the structure to ascertain its structural adequacy and safety.	Structural integrity assessment should be carried out to determine the adequacy and safety of the structure
Sumps			Sumps were observed on the compound which suggests that the site is has high water table	



Figure 7-5: Exposed rebars at the soffit of slab due to lack of adequate concrete cover leading to signs of corrosion of the rebars



Figure 7-6: Signs of corrosion of rebar in columns and beams



Figure 7-7: Fractured links in beams



Figure 7-8: Poor anchorage of bottom and top rebars at beam/column joints



Figure 7-9: Failed beam/column joints due to poor rebar anchorage



Figure 7-10: Compression failure of concrete in columns by crushing



Figure 7-11: Longitudinal and tie bars in circular columns placed halfway of the concrete cross-section, and square-shaped links were used in the circular columns instead of circular-shaped links, leading to lack of confinement of concrete core in columns



Figure 7-12: Typical failure mode of peripheral columns – peripheral columns generally failed by shear



Figure 7-13: Rubbles from new construction works observed at the last floor level



Figure 7-14: Separation of beam web from slab due to lack of connection (tie) between beams and slab

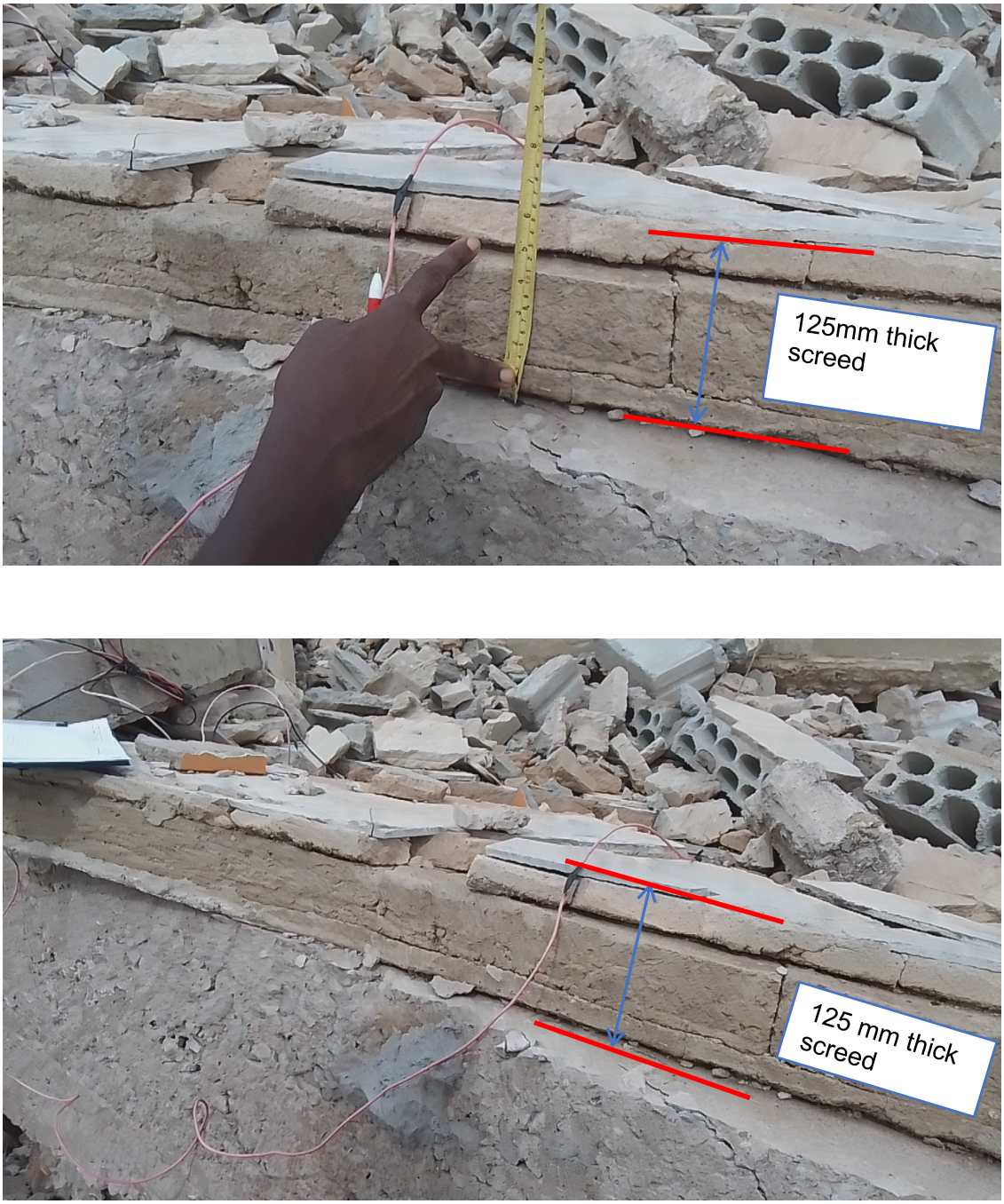


Figure 7-15: Excessive screed on floors, approximately 125 mm thick.



Figure 7-16: Rubbles from asbestos roof covering of additional storey extension to the existing structure



Figure 7-17: 2-storey building under construction built along the fence wall



Figure 7-18: Sump/well observed on the site

7.4 Structural Assessment

This section provides information on the field test performed on the site. A Schmidt hammer test on selected structural elements to determine the average compressive strength of the in-situ concrete. There was no Covermeter tests since the reinforcing steel sizes, number of reinforcing bars and concrete cover were already exposed and were readily visible by physical observations.

7.4.1 Schmidt Hammer Test

The Schmidt Hammer test is a Non-destructive test (NDT) method used to assess the in-situ compressive strength of concrete of the as-built structure. The test was performed with a GTJ-HT225 Digital Integrated Schmidt Hammer to the manufacturer's specification (range of strength measurement is between 10-60 MPa). The Schmidt hammer used was also capable of taking both digital and analogue readings. The test was performed on 30th May 2023. The test was performed in accordance with BS EN 12504-2 (2001). A minimum of nine (9) readings per test location is recommended by the code and the actual number of readings taken per test location was sixteen (16) readings. The plaster was removed from the selected members (where applicable), and the surface prepared with grinding stone (abrasive stone) before the testing was done. Beams selected for the test were those without visible cracks on the surface and were considered less disturbed, and the columns selected were remaining parts of the columns (left standing) at the ground floor level. Due to the nature of the collapse, the slabs were not accessible for testing. Refer to **Appendix A** for details of the Schmidt Hammer Test results. Overall, five (5) beams and six (6) columns were tested.

For the purpose of analysis and control design, the statistical computation of the characteristic in-situ compressive strength (f_{ck}) of concrete is generally required. The **characteristic in-situ compressive strength** is the value of in-situ strength below which 5 % of the population of all possible strength determinations of the volume of concrete under consideration, are expected to fall (EN 13791). The characteristic in-situ compressive strength (as shown in **Table 7-2**) were computed in accordance BS EN 13791 (2007) (see **Appendix A** for details). In the **Table 7-2**, f_{cu} represents in-situ compressive strength, f_{cm} is mean in-situ strength, and f_{ck} is the characteristic in-situ compressive strength of concrete. The strength class of concrete was determined in accordance with Table 1 of BS EN 13791.

With reference to **Table 7-2**, the estimated compressive strength of concrete in columns is 15 MPa and the in-situ characteristic compressive strength class of C12/15. Estimated

Compressive Strength of concrete in Beams is 15 MPa and the in-situ characteristic Compressive Strength class is C12/15.

With reference to the Eurocode and the Ghana Building Code, the minimum class of concrete for design of structural elements is C20/25. This implies that the characteristic in-situ compressive strength class of C12/15 for the concrete in columns and beams do not meet the minimum code requirements (C20/25), hence, classified as poor (see **Table 7-3**).

From the results obtained in **Table 7-2** and **Table 7-3**, the characteristic in-situ compressive strength class of **C12/15** for beams and columns is recommended as inputs for the analysis and control design of the structure to assess the structural adequacy and safety. The estimated strength indicates a poor quality concrete, which do not meet the minimum requirements of the codes.

Table 7-2: Estimation of in-situ Characteristic Compressive Strength of concrete

Element	Location	ID	f_{cm} (MPa)	STDEV (s)	f_{ck} (MPa)	Strength Class (EN 13791)
Column	Ground Floor	C1, C3	15	0.49	12	C12/15
Beam	-	B1 – B3	15	2.4	12	C12/15

***Note**: The computation was based on test points where readings were recorded – test points where no readings were recorded is disregarded.*

Table 7-3: Summary of Compressive Strength of various structural elements

Structural Element	In-situ Compressive Strength		Compressive Strength Class (EN 13791)	Remarks*
	Average Strength (MPa)	Characteristic Strength (MPa)		
Columns	15	12	C12/15	Poor
Beams	15	12	C12/15	Poor

**Recommended minimum concrete strength class for RC concrete is C20/25*

7.4.2 Laboratory Tests

Based on the initial plan of work of the Committee, it was intended to take samples of reinforcing steel and concrete cores from slabs, beams, and columns for laboratory testing. However, due to time constraints and lack of funding, there were no laboratory

tests performed during the investigations. This limitation, however, did not affect the analysis of the structure, however, if further investigations is desired, the tests indicated can be carried out.

7.5 Geotechnical Assessment

There was no existing geotechnical report available on the project. The initial plan of work for the investigation included geotechnical assessment, however, due time constraints and lack of funding, there was no geotechnical assessment carried out on the site. This limitation, however, did not affect the analysis of the structure, however, if further investigations is desired, this can be carried out.

7.6 Summary of Findings

Summary of findings from the field investigations are as follows:

- The geometry and details of structural elements do not conform to the original structural drawings.
- Wrong and poor arrangement of rebars in circular columns by arranging bars halfway of the column cross-section and using of square-shaped links in circular columns instead of circular-shape leading to lack of confinement of concrete.
- The average in-situ compressive strength of concrete recoded based on a digital Schmidt Hammer test conducted on selected beams and columns was C12/15 (cylinder/cube strength). This grade of concrete is of poor quality and falls short of the recommended grade C20/25 for reinforced concrete structures by design codes and standards.
- It was also observed that the thickness of plaster on columns ranges from 25 mm to 100 mm and that for the screed on the slabs was approximately 125 mm thick. These thicknesses are clearly excessive adding additional weight to the structure.
- Debris from newly constructed block walls and asbestos roofing sheets were observed at the last floor level. This suggests that addition storey was built on the existing structure, which was possibly still under construction because the plastered surface observed were not painted.
- The exterior columns pulled towards the centre of the building, which suggests that the failure was due to compressive failure of internal columns in the structure.
- A 2-storey building (L-shaped) under construction was observed on the site,

which has been built along the fence wall. The team recommends that a structural integrity assessment should be conducted on the structure to ascertain its structural adequacy and safety.

8.0 INTERVIEW WITH STAKEHOLDERS

As part of the investigation process, the Committee interviewed the Ga South Municipal Assembly, Building Owner/Developer, Foreman, architectural draughtsman, structural draughtsman, endorsing architect, Adjoining Owners and some selected Church Members. The committee adopted structured interview approach (see **Appendix F** for details). Summary of key findings are presented in the following sections.

Table 8-1: List of stakeholders interviewed

S/N	Stakeholders	Date of interview	Remarks
1.	Ga South Municipal Assembly	1st June 2023	Face-to-face
2.	Building Owner/ Developer	2nd June 2023	Via Zoom
3.	Foreman	2nd June 2023	Via Zoom
4.	Architectural Draughtsman	2nd June 2023	Conference Call
5.	Structural Draughtsman	2nd June 2023	Via Zoom
6.	Endorsing Architect	21st June 2023	Via Phone Call
7.	Block Factory (adjoining owner)	2nd June 2023	Via Zoom
8.	Selected Church Member(s)	2nd June 2023	Via Zoom

8.1 Ga South Municipal Assembly

The Ga South Municipal Assembly was interviewed (face-to-face) on 1st June 2023 in a conference hall at the assembly premises. The assembly was represented by an assistant engineer in the person of Engr. Emmanuel Dowuona. Key findings from the interview revealed the following:

- The assembly issued building permit number GSMA/BORT/m020-0518/157 to the church for the construction of the collapsed building with validity period of 18th June 2018 to 18th June 2023.
- The assembly indicated that the inspection team from the assembly visited the site (once) during the construction stage (at the basement level) and that the works done to that stage complied with the original building permit. However, he

admitted there was no official report nor documentation after the site inspection.

- The assembly engineers are both responsible for site inspection and revenue mobilisation

- Upon the church's application for gazetting of the church premises to officiate marriages, the assembly carried out inspection of the premises on 9th May 2022, in connection with the application for gazetting. Upon the inspection, the team noted that there were some variations of the as-built structure form the original permit. To this end, the team recommended that the church should provide as-built architectural and structural drawings including structural integrity report to the assembly for review before the permit is granted. He added that, the Pastor was invited to the Head of Works at the assembly and was informed of the outcome of the inspections and necessary documents to be submitted before the permit is granted. He added that the church indicated the said requested documents had been submitted but he had not sighted the documents nor information concerning the status of the permit application for the gazetting,

- He indicated that, certain documents requested such as minutes of meeting of the Technical Sub-Committee and Spatial Planning Committee could not be found because the permit was granted during the transition period when the assembly was carved from the then Ga South Municipal Assembly (Weija). He added that as at the time the Assembly was operating from a rented place before finally moving to the current permanent place.

8.2 Building Owner/ Developer

The building owner, Rev. Mark Afrifa Mintah was interviewed on 2nd June 2023 via Zoom. At the time of the interview, he had travelled out of the country; hence, there was no possibility of granting a face-to-face interview. Key findings from the interview included the following:

- Rev. Mark Afrifa Mintah confirmed he is the owner of the collapsed church building, and head Pastor of "The Word In Action Church". His area of expertise is theology and had been a Pastor for over 27 years.

- The construction works commenced in November 2018; completed in February 2021; and dedication of the chapel was done in March 2021.

- The church acquired building permit from the Ga South Municipal Assembly for the construction works.

- The main use of the building was for church; the basement was used as the sanctuary (church auditorium) and the first floor was used as a multi-purpose arena for conferences including some offices.
- He indicated the church does not have a building /project committee.
- He indicated that the construction works was not awarded to any contractor because they wanted to take advantage of him (i.e. steeling of materials and over charging). To this end, he sacked those who were earlier engaged on the project and took over the supervision and management of the by himself – that is, the management and supervision works were done by the Pastor.
- The Pastor indicted he engaged some artisans for the construction works but directly purchased the materials and also supervised and managed the construction works himself.
- There were no quality control measures such as testing of concrete and steel reinforcement on the project and there were no defined criteria for checking quality of the work done.
- He indicated ground water was not encountered during the excavation phase. However, after the completion, it was notice that there was ground water coming from the sanctuary (basement) during the raining season. This problem was later solved by construction of French Drain around the perimeter of the building and provision of sumps and pumps at specified location on the compound.
- The Pastor confirmed that the church applied for permit to gazette the church premises to officiate marriages. In response to the application, the assembly inspected the church property and later requested for as-built drawings and structural integrity report. According to the Pastor, the documents requested by the assembly in connection with the application for the gazetting had been submitted to the assembly.
- He indicated that there were no reports of signs of structural defects or distressed (cracks) observed nor vibrations experienced in the building prior to the collapse. He added that there were no vibrations experienced on the church premises; however, he indicated the block factory had buried some equipment underground, which causes some minor vibrations when operational but admitted the collapse could not be attributed to the vibrations from the equipment.
- He confirmed that there was 1-storey extension of 20 rooms (2 persons per

room) on the existing structure to provide accommodation for members who travel from remote areas for church programmes. According to the Pastor, the assembly issued permit to the church for the extension works.

- In his opinion, quality work was done. However, he added that since the structure had collapsed, it suggests that something was not right.
- The Pastor finally indicated that he did not come to vitiate the laws of the land but had come to do good, feed people in the community and transform the community.
- Finally, when asked what he will do differently in any future projects, he indicated that going forward he will engage the right professionals on any future projects.

8.3 Foreman

The committee also interviewed the Foreman who was engaged on the project to undertake the construction works. The interview was held on 2nd June 2023 via Zoom. Keynotes from the interview included the following:

- Mr. Emmanuel Boateng indicated he was engaged on the project as a Foreman to undertake the construction works in 2019.
- Mr. Emanuel Boateng indicated that he is a mason and had his technical education in masonry from St. Pauls Technical School. He has over 20 years' experience as a mason, and started operating as a masonry foreman since 2014 and had built about 6 to 8 buildings so far ranging from residential, school and church buildings.
- He does not have a company name nor have registered any company; he was engaged on the project as a masonry foreman.
- He indicated that duration of the project was about 2-3 years but work was actually done in piece meal method. Upon his engagement, he was given the building drawings of the structure. He added that he was engaged after the basement had been completed and he continued the project to completion.
- Mr. Emmanuel Boateng later engaged about 4-10 artisans to undertake the construction works
- He indicated there were some minor changes made during the construction phase.

- He also indicated that, they experienced some groundwater moving into the sanctuary (basement) about 1½ years into the project and was later solved by laying of French Drain around the building including sumps and pumps to pump the excess water collected.
- He attributed the collapse to the additional storey built on the existing structure, about 20 rooms for accommodation purposes, which was done later (some years later) after the original construction had been completed and handed over.
- Finally he indicated that going forward he will ensure the right professionals are engaged to do necessary soil tests amongst others before commencement of work. He added that, the building owners should be advised to desist from interfering with the work of construction professionals.

8.4 Architectural Draughtsman

The Committee also interview the architectural draughtsman who produced the architectural drawings for the church building. The interview was held on 10th June 2023 via a conference call. Key findings from the interview revealed the following:

- Mr. Felix Pobee Boateng admitted he was the draughtsman who produced the architectural drawings for the collapsed church building.
- Felix indicated he has 4 years certificate in architectural draughtsmanship from 'Modesco', with over 20 years' experience in architectural draughtsmanship. He added that he has worked on several buildings and the highest number of stories he had ever worked on was a 4-story building.
- Felix Pobee Buabeng admitted he is not a member of any professional body.
- He indicated he only produced the architectural drawings and the structural drawings were produced by Nana Yaw. Further, he added that he did not signed the drawings himself but was signed by an architect.
- Felix indicated he was initially engaged to carry out the construction works but was sacked by the client after the excavation works had been done due to some misunderstandings he had with the client with regard to some payment issues. He further added that, after the completion of the project, he was later invited to produce drawings for the extension works on the existing structure for apartments. He added that, he was the one who produced the drawings for the extension works and submitted the drawings to the assembly for permit but did

not take part in the supervision of the construction works.

- In his opinion, poor workmanship is the probable cause of the collapse.
- Finally, he added that clients should be advised to respect artisans and to stop interfering with the work of construction professionals.

8.5 Structural Draughtsman

The one who designed and produced the structural drawings was interviewed on 2nd June 2023. Keynote from the interview included the following:

- Mr. Reuben Nii Yaw Azu-Crabbe admitted he designed and produced the structural drawings for the collapsed church building.
- He introduced himself as architectural and structural engineering specialist with specialisation in architectural, structural engineering and survey. He added that, he had been a member of the Ghana Institute of Planners for over 5 years and had been given licence to practice in all areas. Further interrogation revealed that these were false claims and that he had no professional nor formal training in architecture nor structural design and that he is only but a draughtsman.
- He indicated he had been designing for clients since 2002, and had designed over 20 buildings (ranging from 1-10 stories) with the highest number of stories being 10-storey apartment building designed and built at Adenta. He promised of sending the drawings and structural calculations of the 10-storey building to the committee but failed to provide the details as promised.
- It was discovered that he had no basic training nor understanding in basic structural design concepts (i.e. no knowledge about live loads, concrete grade, etc.). This further revealed that the structural drawings were produced without any design nor calculations whatsoever.
- He admitted he received the architectural drawings from Felix Pobee Boateng (the architectural draughtsmen) and was very much aware that the intended use of the structure was for a church and that he also noted there was a basement.
- He indicated he was not engaged for the construction works but passed by the site and noticed that some first floor columns were not in line with those in the basement but did not made any official comments or recommendations since he was not engaged in the construction.
- In his opinion, the cause of the collapse was due to the additional floor added to

the existing structure.

- Finally, when asked of what he will do differently, he indicate that he will thoroughly study drawings before designing. However, the team made it clear that he is engaging in illegal practice hence he should avoid practicing without requisite knowledge and licence. He was further admonished to register with the required professional body.

8.6 Endorsing Architect

The committee also interviewed the endorsing Architect on 21st June 2023 via a phone call. Key findings from the interview included the following:

- Mr. Charles Yao-Atta Dawson confirmed that he was the one who endorsed the drawings. He is a registered Architect with Reg. No. 633 but admitted he was not in good standing as at the time of endorsing the drawings.
- He indicated that he did not check the drawing thoroughly before endorsement.
- He accepted not being in good standing and expressed his readiness to regularise with the professional body.
- He accepted the fact that he did not act professionally, and takes responsibility for being negligent.
- He confirmed that he has been endorsing many drawings, especially from draughtsmen, and few of which he scrutinises.
- He added that he saw the collapse of the church building in the news; however, he was not aware he was the endorsing architect until the team pointed it out to him.
- He confirmed that as the endorsing Architect, he did not visit the site to inspect the works during the construction phase.
- He expressed readiness to regularise his membership with Ghana Institute of Architects.
- The team made it clear that he has acted unprofessionally and that his actions has brought the reputation of the professional body into disrepute.

8.7 Block Factory

The manager of a block factory (Morelead Enterprise) was interviewed on 2nd June 2023 via Zoom. Keynote findings included the following:

- The manager indicated that the block factory was in existence prior to the commencement of the construction works of the church building.

- The manager indicated that at the time of the collapse, some of the workers (of the block factory) were around and experienced some vibrations but there was no video footage captured.
- According to the manager, the machine used by the factory is a conveying machine for block moulding (15 HP) – the team also inspected the machine during one of the site visits. Further details of the machine were expected to be provided but were not received.
- According to the manager, the block factory had not received any form of complaints from the church concerning any vibrations experienced in the church when their machine is operational.
- In the opinion of the manager, the probable cause of the collapse may be due to the additional apartment added to the existing structure.

8.8 Selected Church Member(s)

The Committee was able to interview one church member via zoom on 2nd June 2023. Keynote from the interview included the following:

- He indicated the church had issues with leakages from the concrete roof but any attempt to fix it proved futile. On this note, they planned to provide roofing sheet to cover the concrete but an afterthought was rather to create some rooms up so that they can use roofing sheet to fix the leakage problem.
- He also confirmed the addition of one more storey to the existing building, which started late 2022 to the early part of 2023.
- Finally, he added that due diligence and processes must be followed by the assembly after building permit had been issued; the assembly needs to supervise the work during construction stage; and the officials of the assembly need to do their work diligently.

8.9 Summary of Findings

Key findings from the interview with the stakeholders included the following:

- The Ga South Municipal Assembly issued permit for the construction of the collapsed chapel building.
- The structure was not designed; both the architectural and structural drawings were not produced by competent, qualified and licensed construction

professionals.

- Endorsing Architect did not act professionally, did not check the drawings thoroughly before endorsement, was not in good standing as of the time of endorsing the drawing in 2018, and did not follow-up to ensure the right construction methods were utilised for the project.
- The construction works was not supervised by competent construction professionals and there was lack of proper quality control measures during the construction.
- There was enough evidence and confirmation that there was additional storey (under construction) added to the existing building to be used as apartments (about 20 rooms).
- That the church indicated they applied for permit variations for the construction of the additional apartments on top of the existing structure and was given the go-ahead by the assembly. However, the assembly did not provide any such documents to the committee nor provide any information on this issue.
- The church applied for permit to gazette the church premises to officiate marriages; and upon inspection of the facility by the assembly, they requested for as-built architectural and structural drawings including a structural report, which had to be submitted before the permit is granted.

9.0 ANALYSIS AND CONTROL DESIGN

This section consists of design information, analysis, control design, findings and discussion of results.

9.1 Analysis and Design Information

This section presents the analysis and design parameters adopted based on the results obtained from the investigations. It includes design codes and standards, material properties, the geometry of structural elements, applied loads and load combinations.

9.1.1 Design Codes and Standards

The design codes and standards used for the analysis and control design are shown in **Table 9-1** below. The analysis and control design was based on Eurocode with UK National Annex.

Table 9-1: Design Codes and Standards

BS EN 1990-2002	-	Eurocode: Basis of Structural Design
BS EN 1991-1-1:2002	-	Actions on Structures - Part 1-1: General actions—Densities, self-weight, imposed loads for buildings
BS EN 1991-1-4:2005	-	Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions
BS EN 1992-1-1: 2004	-	Eurocode 2: Design of concrete structures—Part 1-1: General rules and rules for buildings
BS EN 1996-1-1: 2005	-	Eurocode 6: Design of masonry structures structures—Part 1-1: General rules for reinforced and unreinforced masonry structures
BS EN 1997-1:2004	-	Eurocode 7: Geotechnical design —Part 1: General rules
BS EN 1998-1:2004	-	Eurocode 8: Design of structures for earthquake resistance —Part 1: General rules, seismic actions and rules for buildings
BS EN 1998-3:2005	-	Eurocode 8: Design of structures for earthquake resistance —Part 3: Assessment and Retrofitting of Buildings.
CSDCS (BRRI 2006)	-	Code for the Seismic Design of Reinforced Concrete Structures
BS 4466-1989	-	Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.
GhBC 2018	-	Ghana Building Code (GhBC -2018)

9.1.2 Material Properties

The material properties adopted for the analysis and control design (**Table 9-2**) were based on the findings from the review of available documents, visual inspection and testing.

Table 9-2: Material properties

Item	Material Properties
Columns	C12/15
Beams	C12/15
Slabs	C12/15
Characteristic yield strength of steel reinforcement	250 N/mm^2
Allowable Bearing Capacity of soil	-

9.1.3 Geometry and Details of Structural Elements

The geometry and reinforcement details of structural elements used for the structural safety assessment (analysis and control design) are shown in **Table 9-3**. The geometry and details presented in the table are based on information gathered from a review of available documents, visual inspection and testing. The floor-to-floor height of the structure considered was 6.20 m from basement to first floor level and 5.15 m from first floor to roof level.

Table 9-3: Geometry and details of the structural element for analysis

Element	Geometry/Details
Slabs	Thickness: 150 mm; rebar: Ø12 @ 150 mm c/c
Beams	Size: 250 x 600 mm; rebar: 3Ø16 (top) and 2Ø16 (bottom); links Ø8 @ 250 mm c/c
Columns	Size: circular columns of 400 mm diameter; rebar: 6Ø16; links: Ø10 @ 225 mm c/c
Foundation	Not inspected

9.1.4 Applied Loads and Load Combinations

The applied loads used for the analysis and control design are as shown in **Table 9-4**. The combination of actions is based on Clauses 6.4, 6.5, and Annex A1 of BS EN 1990.

Table 9-4: Applied Loads

Load	Location	Value	Reference
Dead Loads:	Reinforced Concrete	25 kN/m^3	EC1-1-1
	Plain Concrete	24 kN/m^3	
	Steel	78.5 kN/m^3	
	Blockwork	3.2 kN/m^2	
	Ceiling and Services	0.5 kN/m^2	
	Partitions	1.0 kN/m^2	
	Screeding	24 kN/m^3	
	Plastering and Rendering	22.62 kN/m^3	
Live Loads:	Bedrooms	2.0 kN/m^2	EC1-1-1
	Offices	2.5 kN/m^2	
	Multi-purpose Arena	5.0 kN/m^2	
	Washrooms	1.5 kN/m^2	
	Balcony/Corridors	3.0 kN/m^2	
	Staircases	3.0 kN/m^2	
	Roof with access	1.5 kN/m^2	

Four (4) loading scenarios were considered for the analysis and control design to ascertain the safety and adequacy of the existing building leading to the collapse. The load combinations adopted for the analysis are all factored loads. The loading scenarios considered are indicated in **Table 9-5**.

9.2 Analysis

The structure was modelled and analysed with the aid of a structural analysis and design software, ETABS (version 18). The Structure was modelled as a three-dimensional structure with verification for stability, robustness, safety, strength, and serviceability criteria to ensure that the structure's performance was within acceptable limits as required by the design codes. Manual checks were also performed on critical members to cross-check the results from the computer analysis. The section properties (geometry and reinforcement details of the structural elements) were defined in ETABS using the "section designer". This approach was used because the purpose of the control design was to check the structural adequacy and safety of the members based on the geometry and details of structural elements of the as-built structure. This modelling approach is more suitable for the assessment of existing structures.

The structural model and analysis was based on the existing 2-storey structure as per the original permit drawings. *The extension works (apartment) on the existing structure*

was not considered in the analysis and control design due to lack of available details.

Table 9-5: Loading scenarios and combination

Loading Scenario	Load Combinations
Scenario 1	Only the dead load (DL) due to the self-weight of the structure was considered (LC1 = 1.35 DL)
Scenario 2	Dead load (DL) due to the self-weight of the structure plus superimposed dead load (SDL) of floor finishes of 125 mm thick screed was considered and tiling. The screed thickness used was as per the thicknesses observed and measured during the physical observation of the collapsed structure. (LC1 = 1.35DL +1.35 SDL)
Scenario 3	Dead load (self-weight) of the building plus superimposed dead load (SDL) 125 mm thick screed and tiling plus live load (see **Table 9-4**) was considered. (LC2 = 1.35DL + 1.35SDL + 1.5LL)
Scenario 4	Dead load (self-weight) of the building plus superimposed dead load (SDL) of 125 mm thick screed and tiling plus live load (see **Table 9-4**) plus blockwork (SDL) on peripheral beams and beams on grid line 3a only was considered. Note that the block wall was applied on the first floor peripheral beams and beams on grid line 3a only since the first floor was used as a multi-purpose arena with large open space without partition walls. (LC 4 = 1.35DL + 1.35 SDL + 1.5LL)

Linear method of analysis was used based on the limit state concept. The structure was analysed for gravity loads only (dead and live loads). *Lateral loads (wind and seismic) were not considered since the structure did not have adequate capacity to sustain gravity loads*. It was intended to assess the structure for lateral capacity after it has passed capacity checks for gravity loads – however, since this was not achieved, the structure was not assessed for wind and seismic loads. Moreover, there is high probability that wind and seismic loads were not considered in the original analysis, hence, it was logical to analyse the structure for gravity loads only in the first instance.

The geometry and details of structural elements were based on information obtained from the investigations, as shown in **Table 9-3**. The analysis included slabs, beams, and columns. The model was also checked for stability, robustness and safety. The 3D model, analytical model and typical layout of columns and beams are shown in **Figure 9-1**, **Figure 9-2** and **Figure 9-3** respectively. The analysis and verification was performed separately for the loading scenarios indicated in **Table 9-5**.

The analysis was performed in a stepwise manner based on the four (4) loading scenarios as shown in **Table 9-5**. Each scenario was considered separately. The analysis was done for the as-built structure only. There was no structural verification of the original permit drawings because the original structural drawings lacked adequate details for modelling.

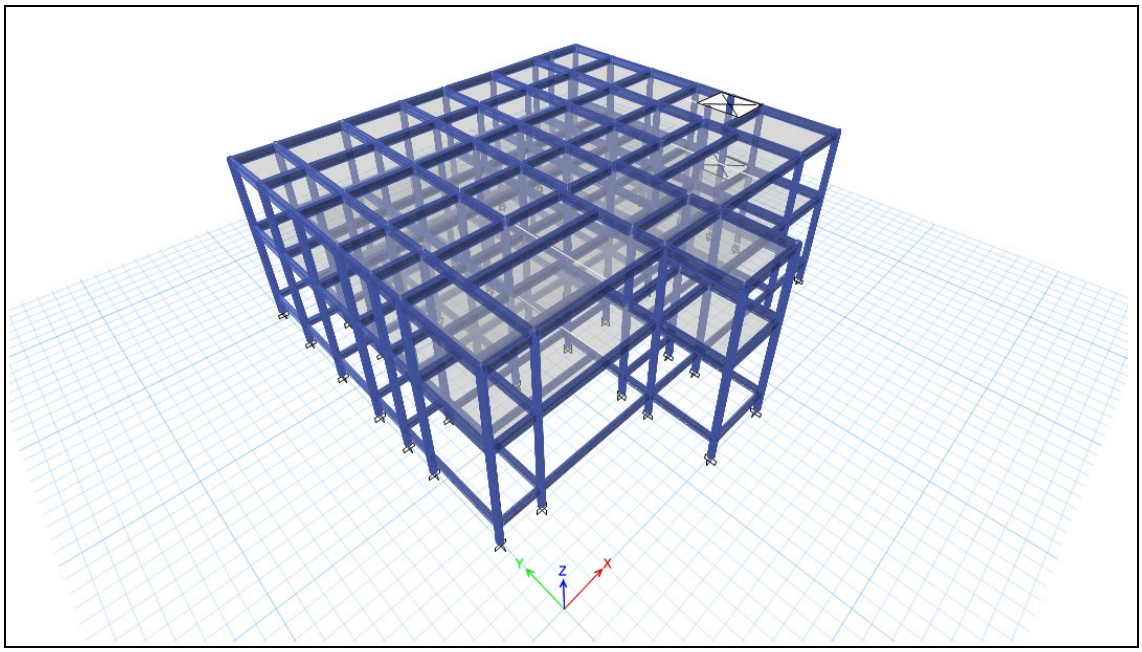


Figure 9-1: 3D model of the structure

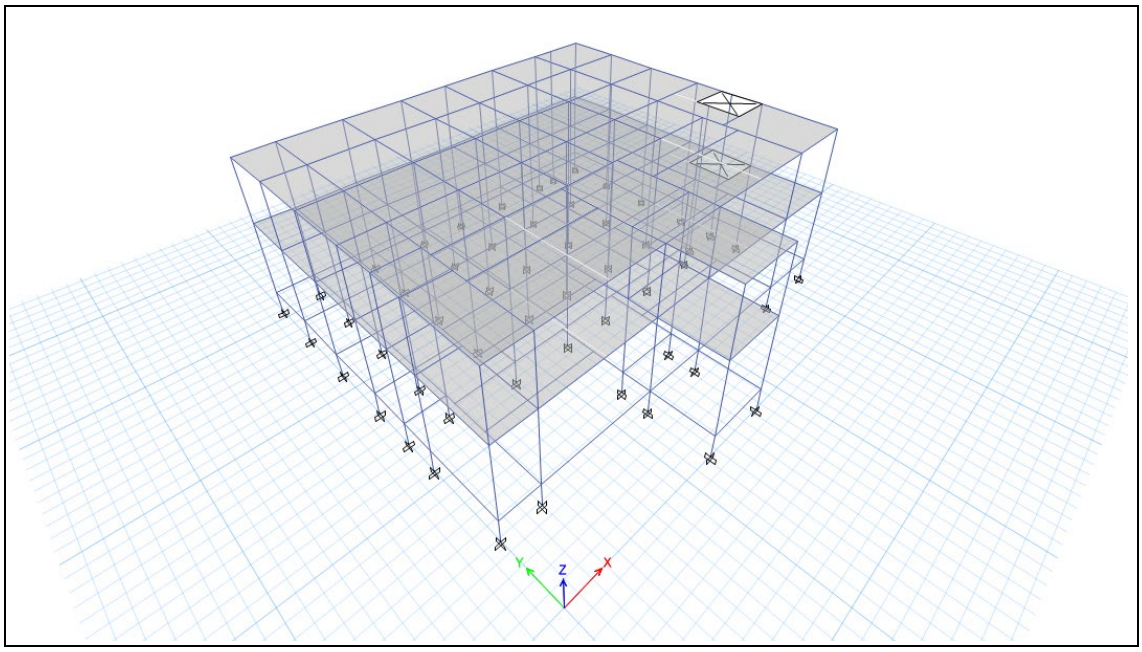


Figure 9-2: Analytical model of the structure.

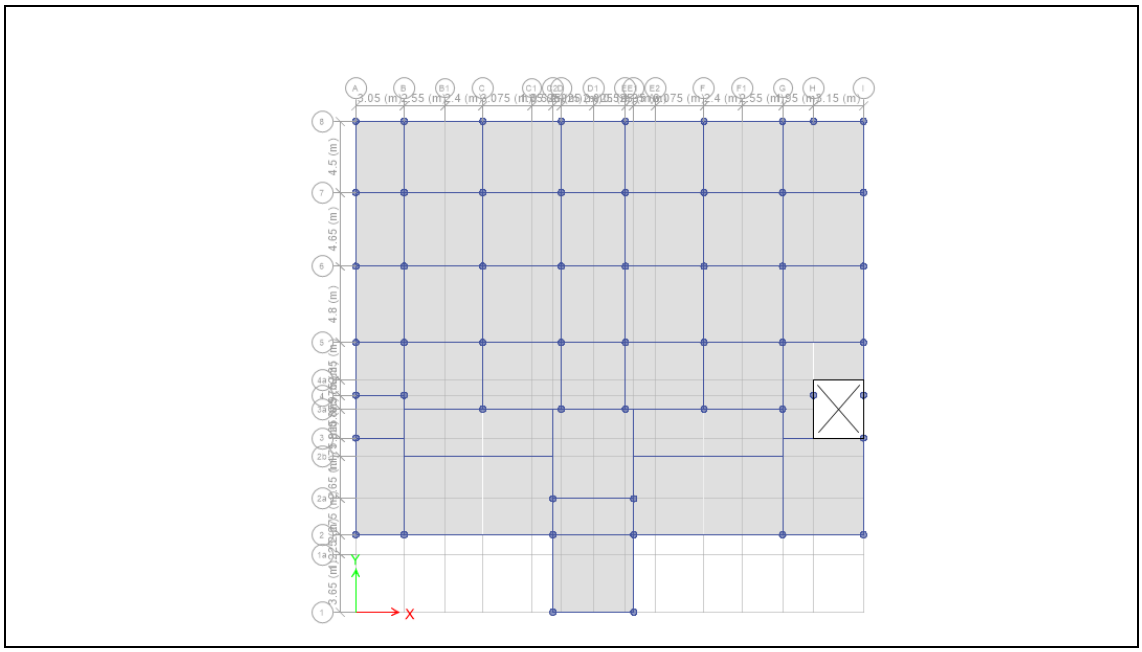


Figure 9-3: First floor column /beam layout. Similar column layout at the basement level

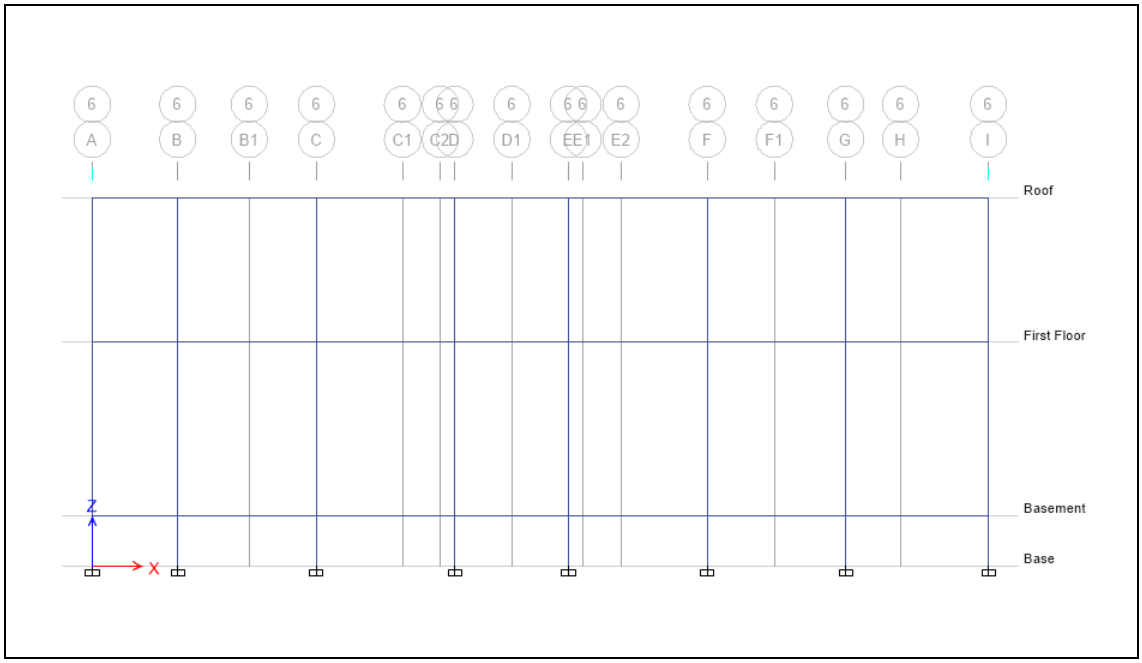


Figure 9-4: Typical frame on gridline 6

9.3 Control Design

The control design aimed to check the adequacy and safety of the structural system and elements based on the information obtained during the investigation phase. The structural safety assessment was based on the Limit State concept – Ultimate Limit State (ULS) and Serviceability Limit State (SLS). The control design was based on gravity loads only (dead and live) using the four loading scenarios in **Table 9-5**

The elements considered for the structural safety assessment included slabs, beams, and columns. ETABS (version 18) was used for the analysis and control design of the structure. Verification included checking for stability, robustness, strength, and serviceability requirements to ensure that the performance of the structural system and elements was within acceptable limits as required by the relevant design codes and standards. Manual checks were also performed on critical members to cross-check the results from the computer model.

9.4 Verification of Analysis Results

The verification was done under each of the loading scenarios. A typical storey of the 3D model and a frame on gridline 6 were verified in detail. The findings from the verification of the analysis and control design are indicated below.

- **Loading scenario 1** – only the self-weight (DL) of the structure was considered in this scenario (LC 1: 1.35 DL). The structural capacity is represented with cyan, green, yellow, purple and red colour coding as shown in **Figure 9-5**. Cyan colour coding means structural capacities have not reached 50%, yellow means capacities ranges from 70-90% and red colour coding means structural capacities have exceeded 100% indicating the members have failed. With reference to **Figure 9-5**, about 80% of the members hard reached structural capacity between 30-45%; however, three of the columns had reached over 70% of their structural capacity and a few of the beams had exceeded their structural capacity indicating failure. Verification of a typical frame on gridline 6 (**Figure 9-9**) further underscored that beams on grid 6/H-I at the first floor and roof levels have reached over 60% of their structural capacity, which is not acceptable under only self-weight verification.

- **Loading scenario 2** – under this loading scenario the self-weight (dead load – DL) of the structured and superimposed dead load (SDL) of finishes were applied (LC-2: 1.35DL + 1.35 SDL). It was observed that significant number of members have cyan, yellow and red colour coding (see **Figure 9-6**). Members with cyan colour coding means structural capacities have not reached 50%, yellow means capacities ranges from 70-90% and red colour coding means structural capacities have exceeded 100% indicating the members have failed. Under this loading scenario, over 50% of the columns had reached 55-70% of their structural capacity, 5 columns had reached 80% of their structural capacity and 4 columns were overstressed indicating they had exceed their structural capacity indicating failure. Additionally, about 40% of the first floor beams had reached 80% of their

structural capacity whilst about 20% had exceeded their structural capacity indicating failure. Verification of a typical frame on grid line 6 (**Figure 9-10**) further revealed that six (6) of the basement columns have exceeded 55% of their structural capacity, and most beams at the first and roof levels (yellow colour) have reached 80% of their structural capacity. It was also observed that two beams (red colour) were overstressed (O/S) indicating they have exceeded their structural capacity. Again, this was not expected because the structure was only loaded with self-weight and floor finishes hence the capacities were not expected to exceed 50%.

- **Loading scenario 3** – under this scenario, self-weight (DL), superimposed dead load (SDL) of floor finishes and live load (LL) based on the use and occupancy were applied (LC3: 1.35 DL+ 1.35 SDL + 1.5 LL). As shown in **Figure 9-7**, members with yellow colour coding indicate structural capacities between 70-90%, purple colour means structural capacities ranges from 90-100% and red colour coding means structural capacities have exceeded 100% indicating the members have failed. It was observed that about half of the columns had reached 80% of their structural capacity. Over 50% of the first floor beams and few of the columns were overstressed (O/S) indicating their structural capacity had been exceeded and such members had failed. Verification of a typical frame on grid line 6 (**Figure 9-11**) further revealed that four (4) of the basement columns (yellow colour) have reached 80% of their structural capacity, and most beams at the first and roof levels (red colour) have exceeded their structural capacity indicating they have failed.

- **Loading Scenario 4** – under this scenario, self-weight (DL) of the structure, floor finishes (SDL), live load (LL) and block walls on the peripheral beams and beams on gridline 3a were applied (LC4: 1.35 DL+ 1.35 SDL +1.5 LL). It was observed that significant number of columns had yellow and red colour coding (see **Figure 9-8**). About 80% of the columns had exceeded 80% of their structural capacity out of which about 50% of such columns were overstressed indicating the members had failed. Similarly, about 80% of the beams were overstressed indicating they had failed. Verification of a typical frame on grid line 6 (**Figure 9-12**) further revealed that four (4) of the basement columns (yellow colour) have reached 80% of their structural capacity and two columns (red colour coding) have exceeded their structural capacity. Further, it was observed that about 80% of the beams at the first floor and roof levels have exceeded their structural capacity by over 40% indicating they have failed. Under loading scenario 4, some

beams and columns had exceeded over 50% of their structural capacity – this is very critical and can lead to catastrophic collapse of the structure.

9.5 Summary of findings

The analysis and control design were based on *four (4) loading scenarios*. Scenario 1 was based on the self-weight of the structure only; scenario 2 was based on self-weight plus floor finishes; scenario 3 was based on self-weight, floor finishes plus live loads; and scenario 4 was based on self-weight, floor finishes, live load plus block walls on the perimeter beams, and beams on grid line 3a only.

Verification of the analysis and control design revealed that the structure lacks adequate capacity even under self-weight only because some of the beams were overstressed under this loading scenario, indicating failure. Verification under loading scenario 2 revealed that over 50% of the columns had reached 55-70% of their structural capacity, and approximately 40% of the first floor beams had reached 80% of their structural capacity, with few of the columns and beams overstressed (failed). Verification under loading scenario 3 also revealed that approximately half of the columns had reached 80% of their structural capacity; and over 50% of the first floor beams and a few of the columns were overstressed (failed). Verification under loading scenario 4 further revealed that approximately 80% of the columns had exceeded 80% of their structural capacity out of which approximately 50% of such columns were overstressed (failed), and approximately 80% of the beams were also overstressed (failed). Overall, under loading scenario 4, some beams and columns exceeded 50% of their structural capacity, which is critical and can lead to a catastrophic collapse of the structure.

The extent of failure of the structural members considering the loading scenarios was progressive; that is, the number of members that exceeded their structural capacity (failed) increased with an increase in loading. The columns failed primarily due to inadequate longitudinal reinforcing steel, and the beams failed due to inadequate longitudinal and shear reinforcing steel provided. *It is important to note that the above results were based on gravity loads only (dead and live loads), and the extension works on the existing structure (i.e. 20 rooms apartment) were not considered in the analysis*. It is also worth noting that even without lateral loads (wind and seismic loads) verification, the structure lacks adequate capacity under gravity loads, and this suggests that the strength and stability of the structure were dependent on over-strength factor owing to the non-linearity of the materials. This implies that any additional load may lead to a structural collapse. This further suggests that the

addition of the 20 rooms apartment (comprising a lot of blockwork) caused virtually all members to exceed their structural capacity by worsening the situation of an already “weak structure” leading to collapse of the building.

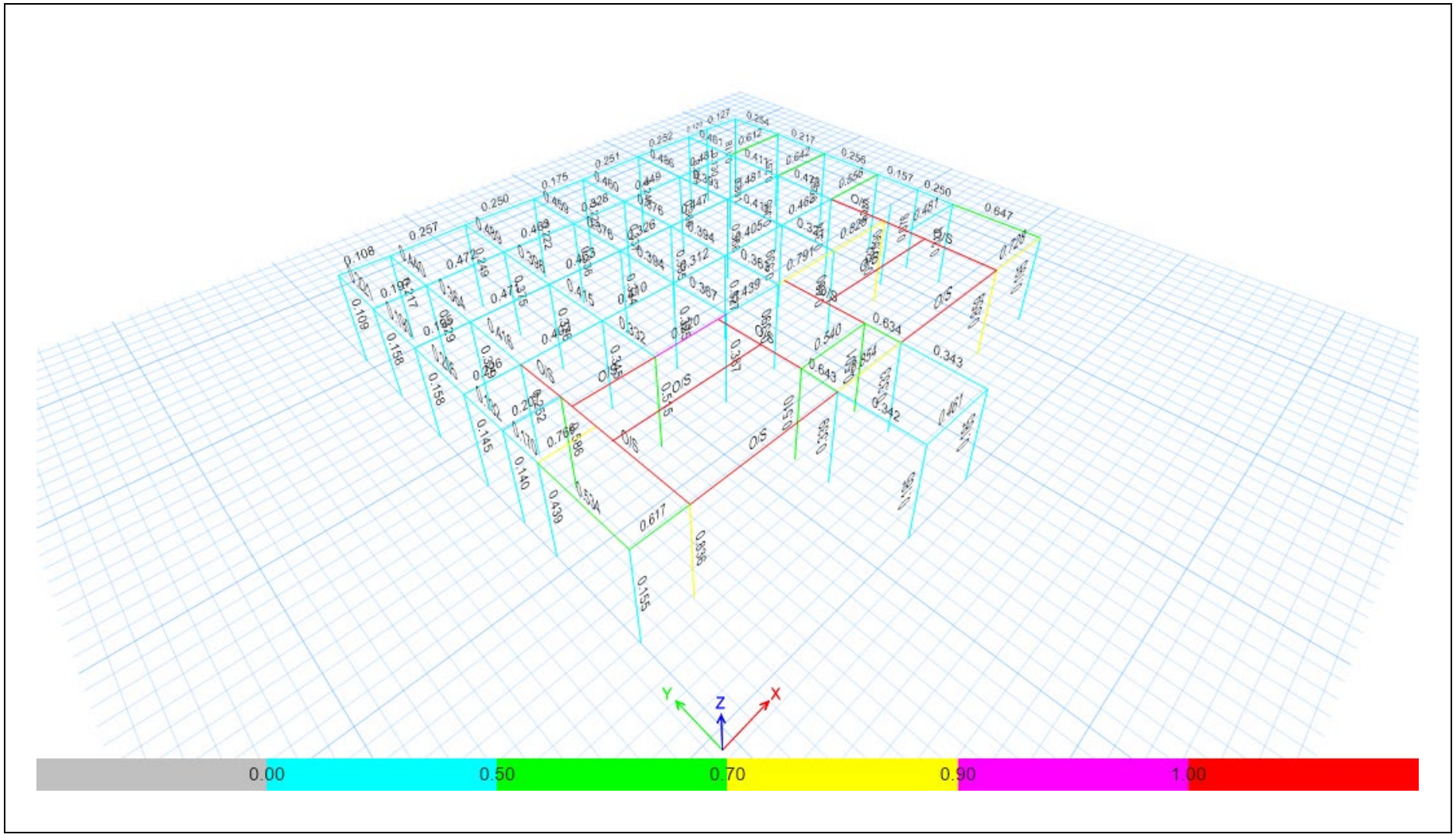


Figure 9-5: Structural capacity ratio (D/C ratio) for columns at the basement floor level (basement – 1st floor level) and first floor beams under loading **scenario 1.**

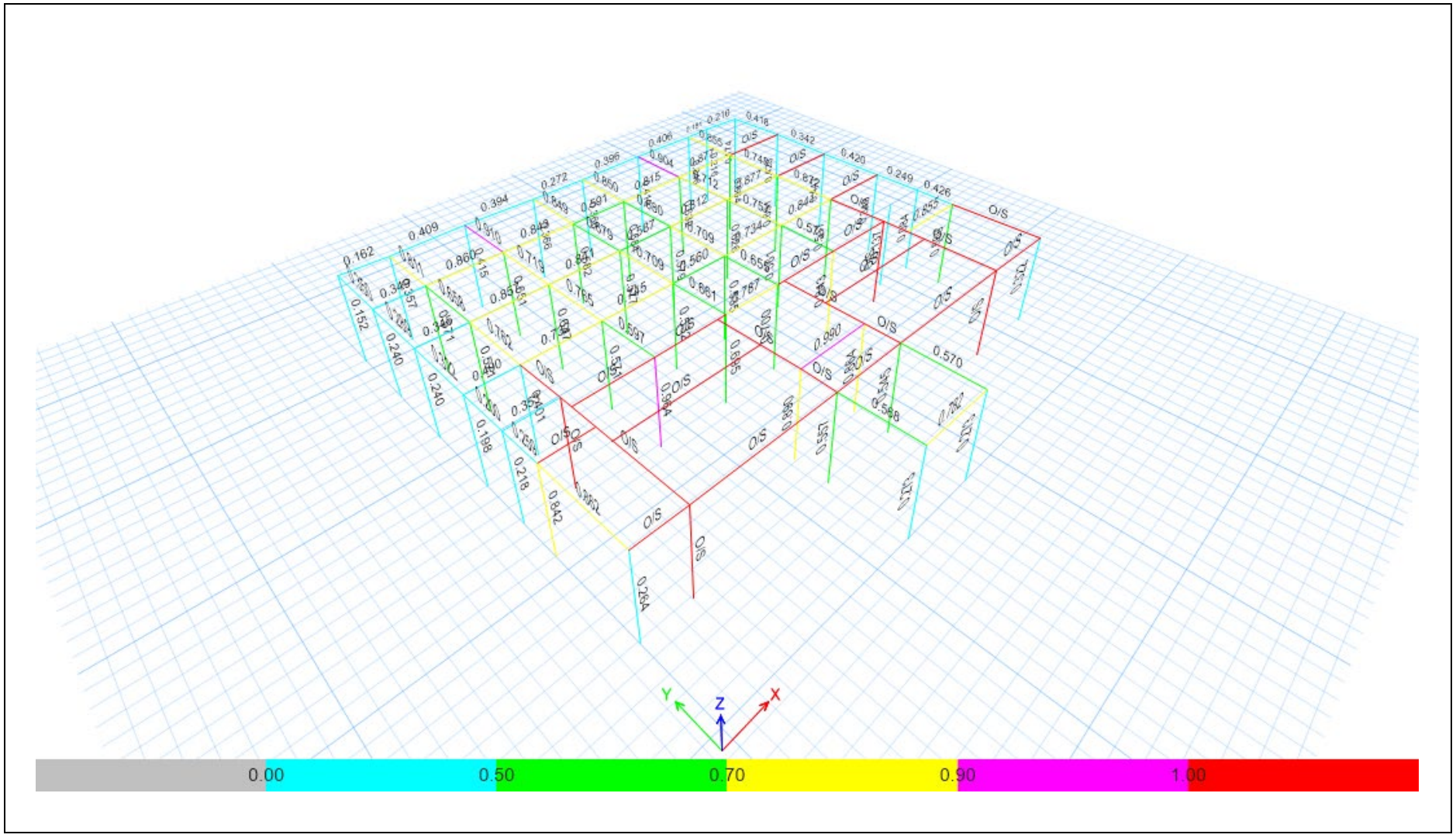


Figure 9-6: Structural capacity ratio (D/C ratio) for columns at the basement floor level (basement – 1st floor level) and first floor beams under loading **scenario 2.**

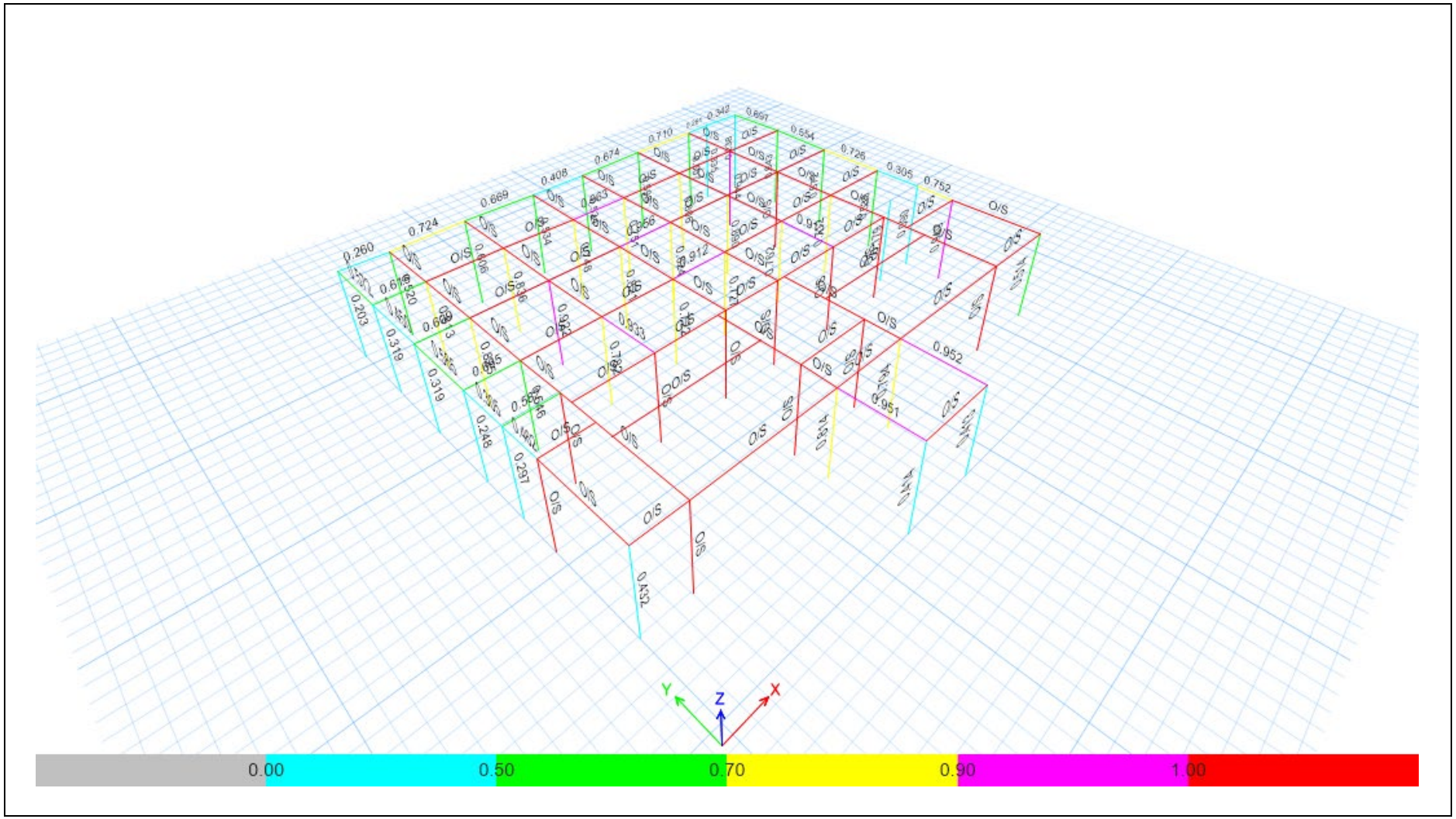


Figure 9-7: Structural capacity ratio (D/C ratio) for columns at the basement floor level (basement – 1st floor level) and first floor beams under loading **scenario 3.**

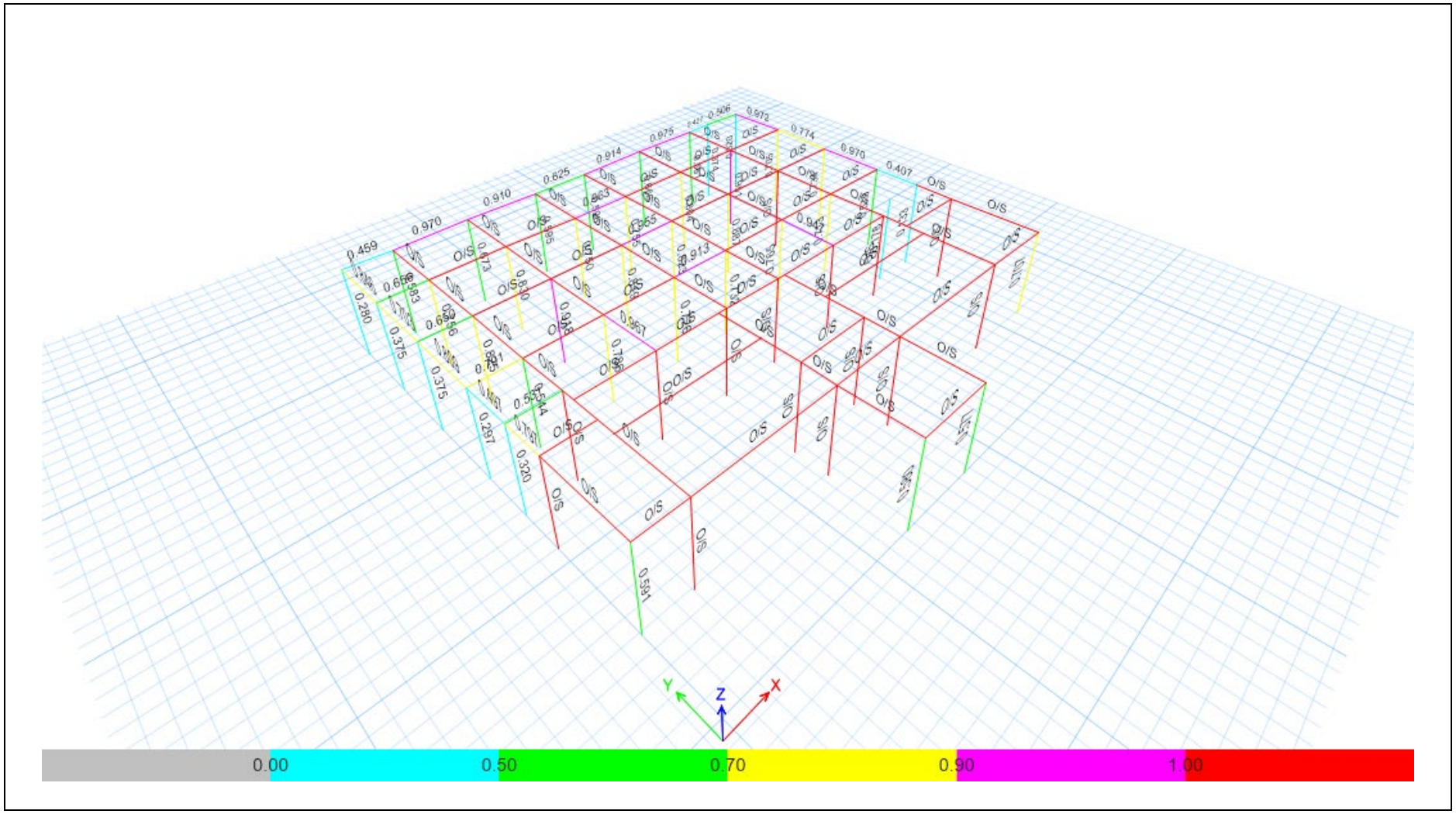


Figure 9-8: Structural capacity ratio (D/C ratio) for columns at the basement floor level (basement – 1st floor level) and first floor beams under loading **scenario 4.**

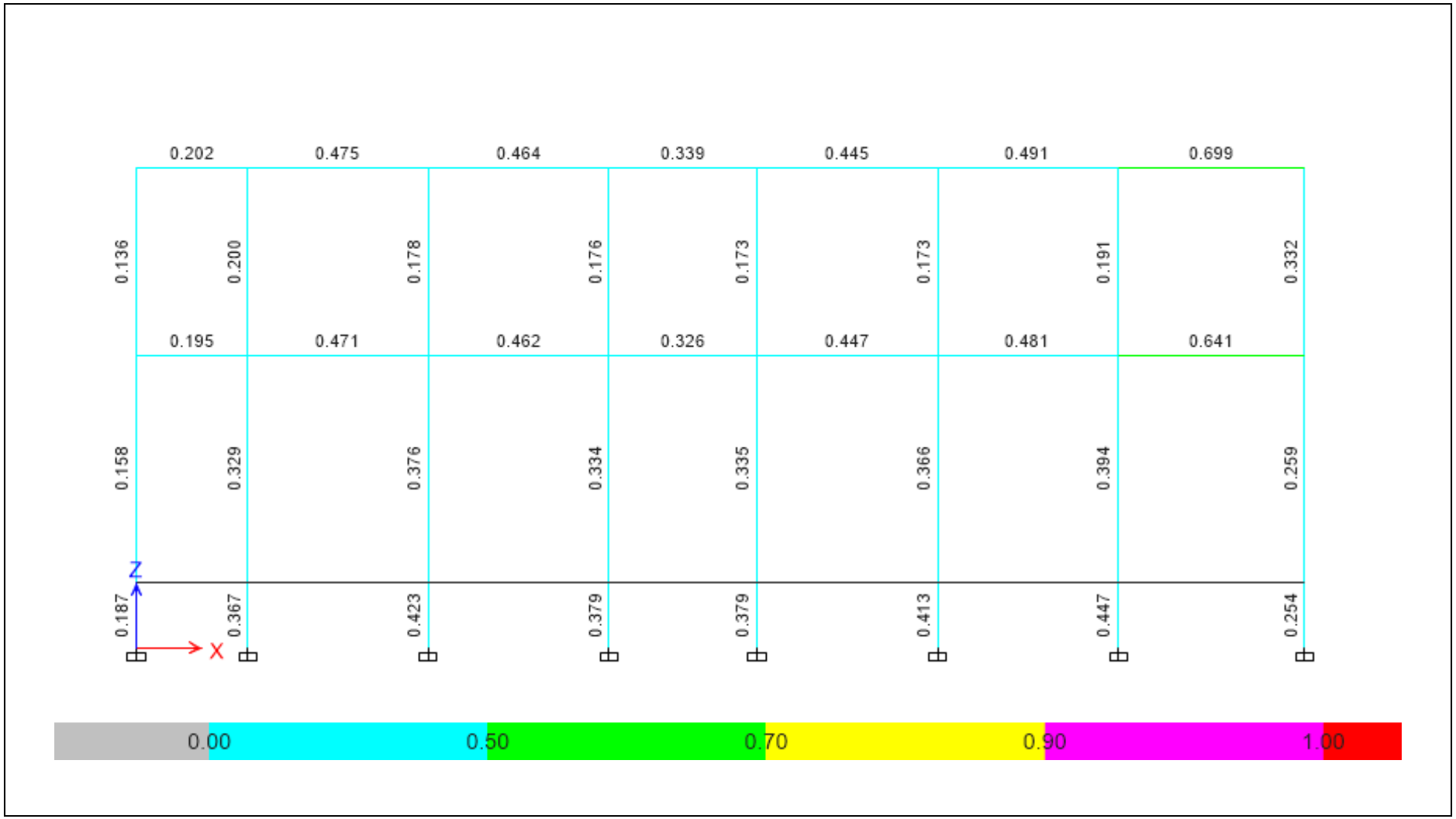


Figure 9-9: Structural capacity ratio (D/C ratio) for columns and beams on gridline 6 under loading **scenario 1.**

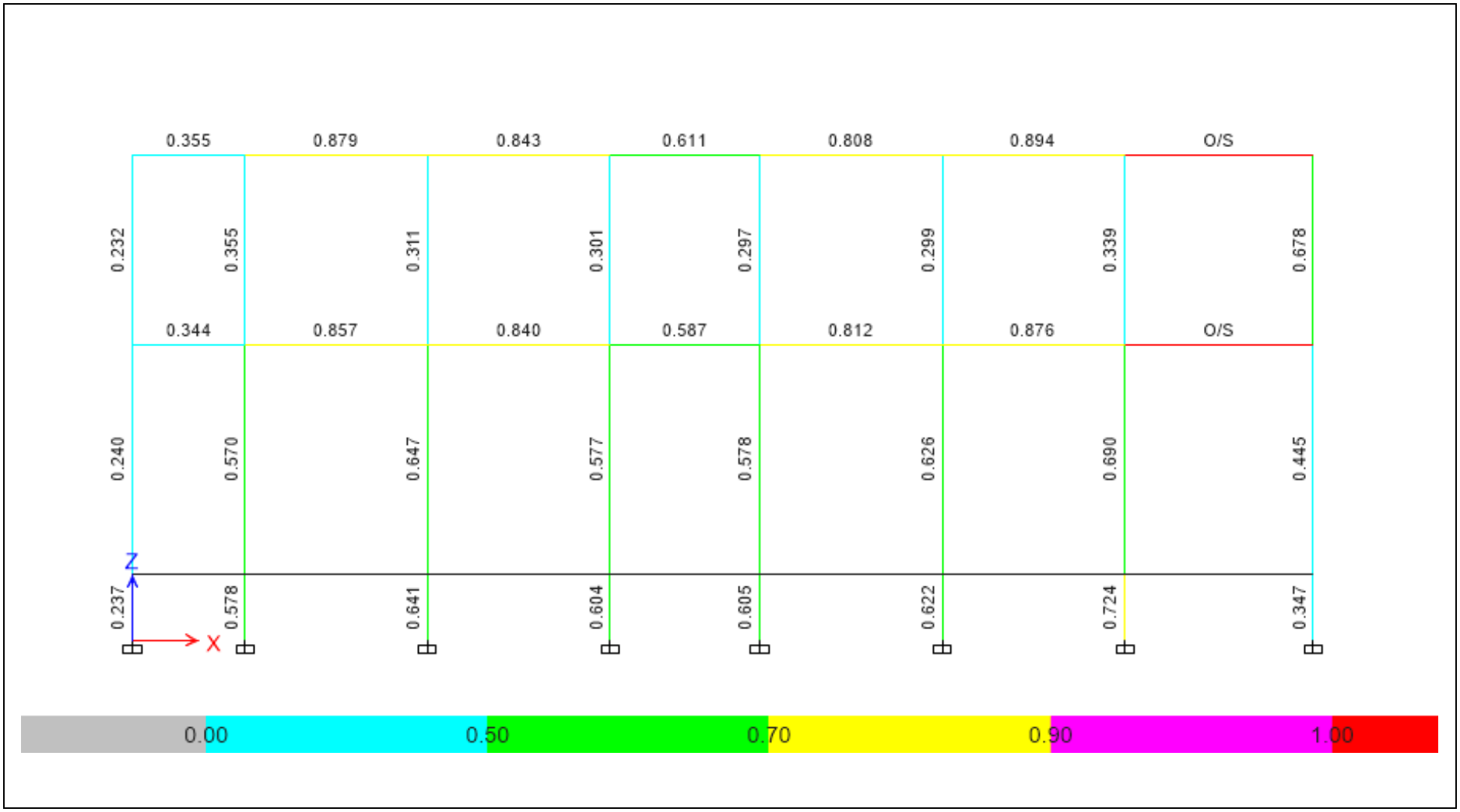


Figure 9-10: Structural capacity ratio (D/C ratio) for columns and beams on gridline 6 under loading **scenario 2.**

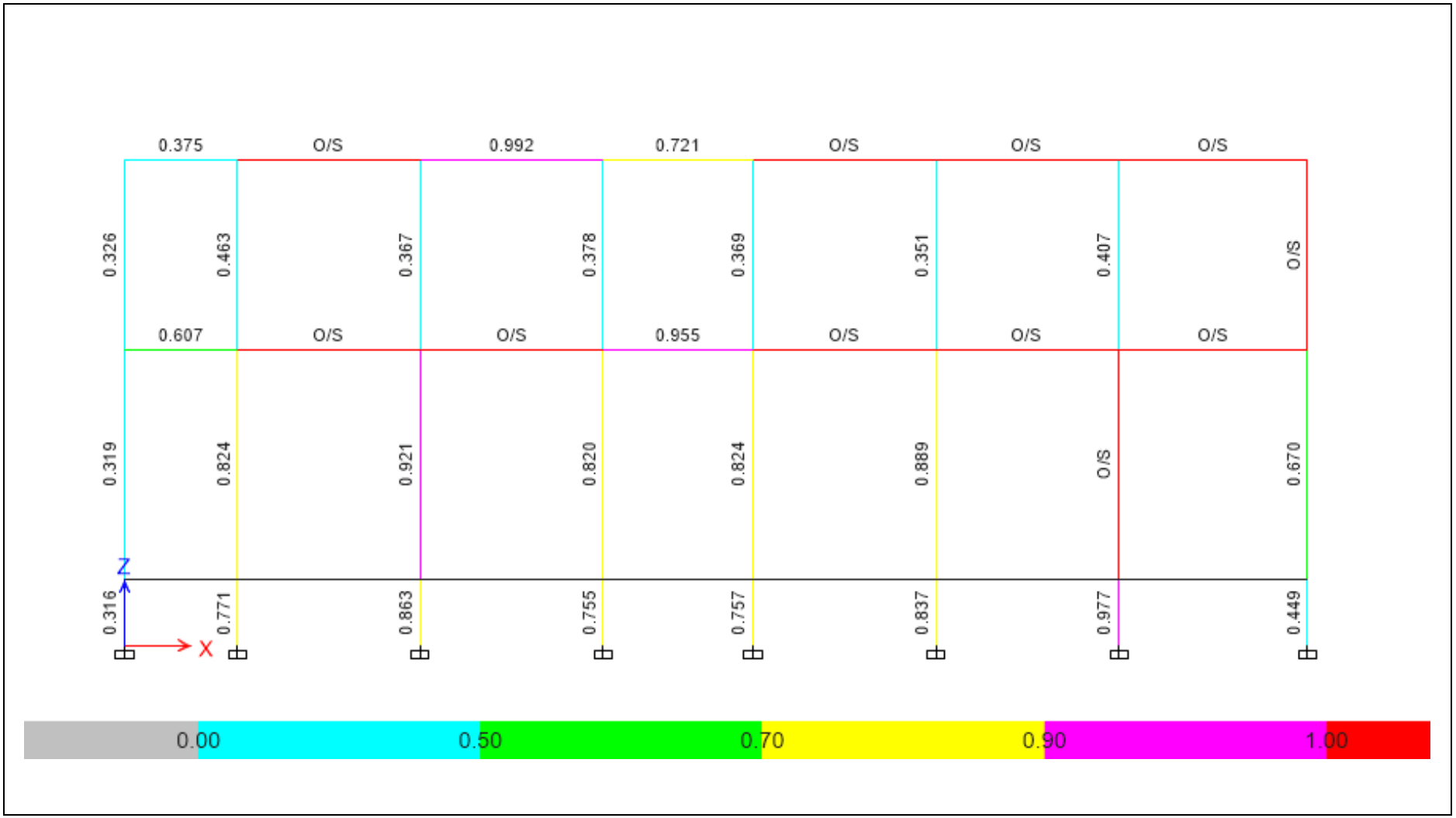


Figure 9-11: Structural capacity ratio (D/C ratio) for columns and beams on gridline 6 under loading **scenario 3.**

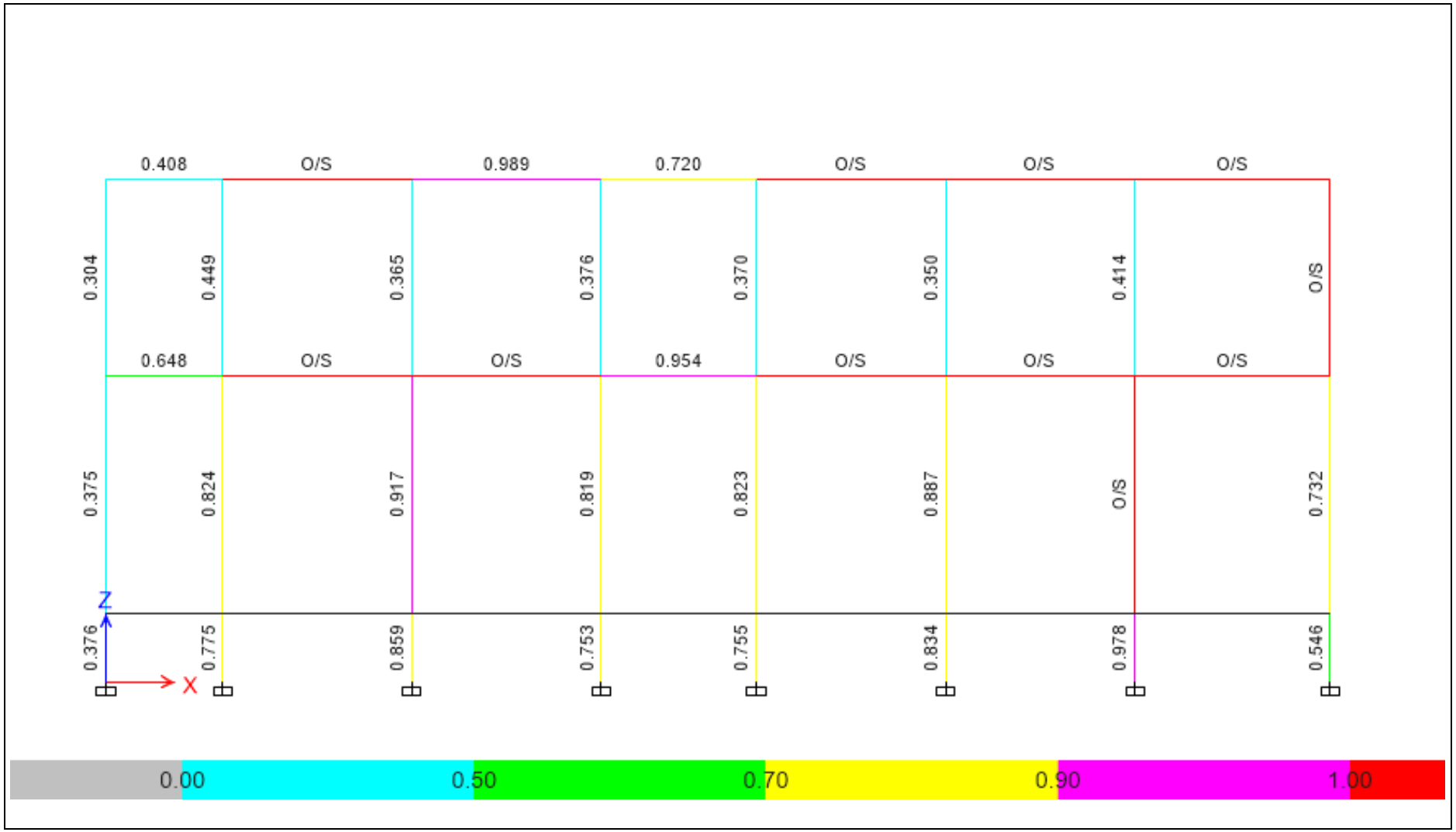


Figure 9-12: Structural capacity ratio (D/C ratio) for columns and beams on gridline 6 under loading **scenario 4.**.

10.0 FINDINGS

Key findings from the investigations are summarized below:

- The architectural design was not performed by a competent and licensed architect. The architectural design and drawings were done by a draughtsman; the drawings were characterised by errors and lacked adequate details to be used for construction purposes; and contravene the provisions of the Building Regulations 2022 (LI 2465) (see Appendix D).
- The structural design was not performed by a competent and licensed structural engineer, and the structural drawings were conceived and produced by a draughtsman who lacked basic competency in structural engineering. The structural drawings were not standard and lacked adequate details for construction purposes. For example, no concrete grade, concrete cover, reinforcing steel type, or structural notes/specifications were provided. Similarly, there were no general arrangements/ layout drawings or cross-sectional details of beams and columns nor bending schedules for beams, slabs and columns (except for stairs). (see Appendix D).
- No geotechnical investigations were conducted at the site before the design and construction of the structure.
- The Ga South Municipal Assembly issued permit for the construction of the collapsed chapel building.
- The construction work was not supervised by competent construction professionals, and there was a lack of proper quality control measures during construction.
- It was observed that both the architectural and structural drawings were endorsed by a registered Architect with Reg. No. 633.
- It was noted that the Assembly inspected the facility on 9th May 2022 upon application by the church for gazetting of the premises to “officiate marriages”. The inspection report from the assembly indicated that they noticed some variations of the as-built structure compared to the original permit drawings, and requested the church to provide architectural and structural drawings of the as-built structure including a structural integrity report before the permit could be granted. (See Appendix D for further details).

- It was noted that there were some extensions to the existing structure during the physical observation of the collapsed structure. Interviews with the developer and other stakeholders confirmed that there was an extension (of 20 rooms apartment) on the last floor (RC roof) intended to be used as accommodation for congregants who travel from remote areas to attend church programmes.

- Poor workmanship, incorrect arrangement of reinforcement and inadequate reinforcing steel were provided in the structural elements of the as-built structure. The construction works were also not supervised by competent construction professionals. From the interviews with the stakeholders, it was revealed that the Pastor (i.e. the building owner/ developer) supervised and managed the construction works, although he had no relevant education or professional training/qualification in construction technology, and did not have a licence to practice.

- The average in-situ compressive strength of concrete recoded based on a digital Schmidt Hammer test conducted on selected beams and columns was C12/15 (cylinder/cube strength). This grade of concrete is of poor quality and falls short of the recommended grade C20/25 for reinforced concrete structures by design codes and standards.

- It was noted through the review of documents and interviews with stakeholders that the design, construction, and supervision of the structure was done by artisans and unqualified persons who claimed to have knowledge in construction but had no proof of educational or professional training.

- The analysis and control design were based on *four (4) loading scenarios*. Scenario 1 was based on the self-weight of the structure only; scenario 2 was based on self-weight plus floor finishes; scenario 3 was based on self-weight, floor finishes plus live loads; and scenario 4 was based on self-weight, floor finishes, live load plus block walls on the perimeter beams, and beams on grid line 3a only. The structural analysis revealed that the building lacked sufficient structural capacity under its own weight and gravity loads, and the addition of an apartment (20 rooms apartment) worsened the situation of an already “weak structure” leading to the structural collapse.

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

In conclusion, based on the results and findings of the investigation, the following conclusion can be made

- The developer failed to engage qualified professionals at the pre-contract and post-contract stages of the development.
- The Assembly did not undertake due diligence to verify the set of drawings submitted by the developer before issuing the permit, and the drawings were not critically assessed to determine their buildability, as per the provisions of the Building Regulations 2022 (LI 2465). Further, there were no evidence of inspection records by the Municipal Assembly of the stages of work after the permit was issued. This suggests that the Municipal Assembly lacks adequate built environment professionals to inspect ongoing projects once permit is granted.
- The average in-situ compressive strength of concrete recoded based on a digital Schmidt Hammer test conducted on selected beams and columns was C12/15 (cylinder/cube strength). This grade of concrete is of poor quality and falls short of the recommended grade C20/25 for reinforced concrete structures by design codes and standards.
- Verification of the analysis and control design results revealed that the structure lacked adequate structural capacity under both self-weight and gravity loads (dead and live loads). Verification of the structure for gravity loads (dead and live loads) revealed that approximately 80% of the columns exceeded 80% of their structural capacity, of which approximately 50% of such columns were overstressed, indicating that the members had failed. It is worth noting that the analysis and verification were based on the 2-storey existing structure, and that the additional apartment was not considered in the analysis due to lack of available details.
- Based on the findings from the physical observations, interview with stakeholders and structural analysis, it can be concluded that the existing structure lacked adequate structural capacity for its intended purpose, and the addition of the 20 rooms apartment further worsened the situation of an already “weak structure” leading to collapse of the building.

11.2 Recommendations

Based on the results and findings, and the conclusions, the following are recommended to the Government, the Municipal Assembly, the professional bodies, prospective developers, the public and the media.

11.2.1 Recommendation to the Government

- The government should ensure that all existing laws and regulations regarding infrastructural development in Ghana, including bye-laws at the Metropolitan, Municipal, and District Assemblies (MMDAs) are strictly enforced.
- The central government, the Ministry of Local Government and Rural Development, and the MMDAs should develop *e-permit systems* to ensure that human interference in the permit process is brought to the nearest minimum, and to improve proper record keeping and assessment.
- Design review of all developmental projects by qualified and licensed built environment professionals must be mandatory and an integral part of the permit process. The MMDAs must have independent representatives from the various built environment Professional Bodies to assist with the processes of reviewing, inspecting and approving infrastructural development projects.
- The Ministry of Local Government and Rural Development should establish an independent unit to monitor the operations of various Metropolitan, Municipal, and District Assemblies (MMDAs) as a check on the system for granting development and operating permits.
- The government should enforce all-risk insurance for all public building projects from the construction to habitation stage in the process of acquisition of permits. Approval agencies should ensure that all developmental projects are insured before granting the permits. Once Insurance Companies are brought into the process, they will be interested in the entire construction process thereby ensuring quality work.

11.2.2 Recommendations to the Ga South Municipal Assembly

- The Municipal Assembly should provide adequate resources for Planning and Building Inspectorate Divisions to enable them undertake periodic post-permit inspections and supervision.
- The Municipal Assembly should ensure that all permit processes and inspections

carried out at the pre- and post-permit stages are well documented and filed. Where space is a constraint, the assembly should consider the use of spreadsheets or cloud space for record keeping.

- The Municipal Assembly should undertake regular public education on the importance and benefits of securing permits before undertaking physical development.
- Structural integrity assessment should be conducted on the remaining L-shaped building under construction on the church premises (built along the fence wall) to ascertain its structural adequacy and safety.
- The draughtsman who produced the 'structural drawings' for the collapsed church building claimed he has designed over 20 buildings, which had been built, including a 10-storey building that has been built at Adenta. It is recommended that the Municipal Assembly should trace all such structures and order for structural integrity assessment (particularly 2-storey buildings and above) to ascertain the structural adequacy and safety of such structures.
- The Assembly should consider establishing a verification process for checking the authenticity of stamps and signatures of professionals on development drawings before approval and issuance of permits.
- The Municipal Assembly must ensure that built environment professionals are co-opted onto the Spatial Planning Committees (SPC) of District Assemblies for them to make inputs on permitting decisions as per the provisions of section 37, sub-sections 3 and 4 of the Land Use and Spatial Planning Act 2016 (Act 925).
- The work of the built environment professionals at the Municipal Assembly should be focused on inspection of structures under construction among other related areas, but not revenue generation only. To this end, it is recommended that a separate committee/unit be formed by the Assembly to take up the task of revenue generation.

11.2.3 Recommendations to the Professional Bodies

- Professional Bodies should collaborate with the Ministry of Local Government and Rural Development to develop a digital platform to regulate projects in the country by ensuring that only licenced and qualified professionals in good standing are engaged in construction/developmental projects.

- The Professional Bodies should form a Regulatory Board (consisting of representatives from various professional bodies) that will collaborate with the government in the monitoring of developments in the country and make recommendations from time to time to help reduce unqualified personnel handling projects.
- Professional Bodies should develop a simple checklist for private and corporate developers who want to engage the services of any of the built environment professionals. The various professional bodies should also have an up-to-date website to provide information on all members in good standing and include the link (or website address) in the checklist.
- Professionals should take interest in reporting ill-conditioned and unsafe structures likely to pose danger to the public to the MMDAs within such jurisdiction for necessary remedial actions to avoid future collapse and casualties.
- Professionals should take interest in and time to critically vet or review designs/drawings before approval.
- The public should be educated to engage the services of built environment Professionals not only to design their buildings but also to supervise the construction to avoid the unfortunate occurrence of the collapse of buildings.
- The Profession Bodies should create a portal to bring all construction industry workers under one umbrella for the purposes of regulation and training through regular continuing professional development (CPD) programmes for all members of the industry.
- The Professional Bodies and the various Councils are to ensure strict adherence to the Building Regulations, Codes and Standards in the built environment by the MMDAs and the public.
- Construction professionals should be sensitised to focus on their niche areas (areas of specialty) of practice as required by their code of practice.

11.2.4 Recommendations to the Building Owners/Developers

- Developers are advised to engage the services of licenced professionals in the built environment at the design, construction and facility management stages and avoid engaging services of “quack professionals”.
- Corporate institutions and private individuals are advised to engage competent

engineers to assess integrity of structures they wish to rent or purchase to ascertain the adequacy and safety of using such structures.

- The process of Procuring Contractors to execute any project must be done transparently to ensure that the best-evaluated Contractor with capacity in terms of equipment and personnel is engaged in any project.
- Quality assurance processes must be adhered to during the execution of construction projects. Adherence to contractual specification is paramount.
- Developers should desist from engaging direct labour to execute projects without the supervision from qualified construction professionals. Engaging unlicensed persons without the capacity to execute any construction project is dire because this leads to poor quality work and no entity will be available to be held responsible should the unfortunate occur.

11.2.5 Recommendation to the General Public

- Developers without expertise in construction and engineering should desist from acting as construction professionals by designing and supervising construction projects.
- The public is advised to engage registered built environment professionals in their private, residential, commercial, industrial, and sacral projects.
- The public is advised to seek the opinions of licensed built environment professionals about the adequacy and safety of structures before renting, purchasing or using them.
- The public is advised against wilful and false use of a name, title, or addition, implying a qualification to practise as an engineer, architect, surveyor, or planner, including other titles of built environment professionals without being registered. Further, persons who practice or profess to practise as an engineer, architect, surveyor, planner, etc.; designs, draws, or prepares construction documents; approves or certifies construction works; or operates a firm in the built environment without a registered practitioner in partnership; and that such persons commit an offence liable to a fine and/or imprisonment or both.
- In accordance with the Building Regulations 2022 (LI 2465), design of a building or group of buildings with an aggregate floor area in excess of 120 square metres, and of two stories and above in height shall be designed by an architect, civil

engineer, structural engineer, or professional builder (but excludes draughtsman, a licensed building surveyor, and a building technician with a qualification lower than the higher technician diploma).The public must note that it is again illegal to engage the services of a draughtsman for design of buildings exceeding 120 square meters.

- The public is advised to report any structural defects or distress (such as cracks) or “unsafe” buildings to the MMDAs, the Professional Bodies, or the media.

11.2.6 Recommendation to the Media

- The media should collaborate with the Government and the Built Environment Professionals to deliver a safer environment for all through the production of ‘build it right’ programmes to propagate through all social media handles.
- The media is also advised to seek professional opinion on issues related to the built environment to avoid speculations and/or ill-education of the public.
- The media is advised and encouraged to focus on monitoring (investigative journalism) and quickly report any structural defects or distress (such as cracks) observed by it or communicated to the media by third parties for immediate action.

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APPENDICES

Appendix A : SCHMIDT HAMMER TEST RESULTS

PROJECT: THE WORD IN ACTION CHURCH BUILDING COLLAPSE INVESTIGATIONS

CLIENT: WORD IN ACTION CHURCH

SCHMIDT HAMMER TEST RESULTS **TEST DATE: 30TH MAY 2022** **SCHMIDT HAMMER TYPE: GTJ-HT225**

Element	Location	ID	Hammer Orientation		Rebound Number (R_i)															Average	Compressive Strength (fcu)
Column																					
	Ground Floor	C1	HOR	20	23	26	25	21	26	24	25	22	26	22	20	21	20	22	23	45.8	14.2
	Ditto	C2	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Ditto	C3	HOR	22	24	26	22	21	24	24	25	22	25	22	23	22	24	25	27	45.8	14.9
	Ditto	C4	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Ditto	C5	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Ditto	C6	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Beam	Floor Beams	B1	HOR	47	54	49	42	54	55	52	52	48	54	48	51	46	53	53	50	51	17.0
	Ditto	B2	HOR	20	23	25	23	21	26	22	25	22	24	22	20	21	20	22	23	45.8	12.4
	Ditto	B3	HOR	23	24	26	22	22	24	24	25	22	25	22	26	22	24	25	27	45.8	15.9
	Ditto	B4	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Ditto	B5	HOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Slab	-	There was no access to test the slabs																			

NOTE: Schmidt Hammer tests were not performed on members which have visual cracks on the surface and detached from the original position or structure

Tale C1 – Estimating characteristic in-situ compressive strength of concrete in existing structures. Based on BS EN 13791 (2007)

Approach A (n ≥ 15)	**Approach B (3 ≤ n < 15)**
$f_{ck,is}$ is the lowest value of A_1 or A_2 : $f_{ck,is} = f_{m(n),is} - k_2 \times s \quad \ldots\ldots (A_1)$ $f_{ck,is} = f_{is,lowest} + 4 \quad \ldots\ldots (A_2)$	$f_{ck,is}$ is the lowest value of B_1 or B_2 : $f_{ck,is} = f_{m(n),is} - k \quad \ldots\ldots (B_1)$ $f_{ck,is} = f_{is,lowest} + 4 \quad \ldots\ldots (B_2)$
Where: $f_{ck,is}$= characteristic in-situ compressive strength $f_{m(n),is}$ = mean in-situ compressive strength of *n* test results $f_{is,lowest}$ = lowest in-situ compressive strength test result *s* = standard deviation of test results or 2.0 N/mm^2, whichever is the greatest k_2 = coefficient, the recommended value is 1.48 *k* = margin associated with a small number of test results (see **Error! Reference source not found.**) *n* = number of test results Note : the strength estimate should be based on cores from the same test region (i.e. one or more structural elements from the same population)	

Table C2 - Margin k associated with small numbers of test results (BS EN 13791, 2007)

Number of Test Results (n)	**Associated Margin (k)**
10 to 14	5
7 to 9	6
3 to 6	7

Table C3 – Assessment of In-situ Compressive Strength by indirect Methods (BS EN 13791 (2007))

The in-situ characteristics compressive strength of the test region is the lower of	$f_{ck,is}$ is the lowest value of *a* or *b* : $f_{ck,is} = f_{m(n),is} - 1.48 \times s \quad \ldots\ldots (a)$ $f_{ck,is} = f_{is,lowest} + 4 \quad \ldots\ldots (b)$

Appendix B : MEMBERSHIP OF THE INVESTIGATION COMMITTEE

Appendix B: List of Investigations Committee Members

S/N	Name	Professional Body	Specialty	Position
1.	Ing. Sampson Agudze	Ghana Institution of Engineering (GhIE)	Structural Engineer	Chairman
2.	Arc. Freeman Kwame Agbomanyi	Ghana Institute of Architects (GIA)	Architect	Member/ Secretary
3.	Surv. Ian Agbenyega	Ghana Institution of Surveyors (GhIS)	Quantity Surveyor	Member
4.	Ing. David Dzitse-Awuku	Ghana Institution of Engineering (GhIE)	Geotechnical Engineer	Member
5.	Pln. Eugene Nyansafo	Ghana Institute of Planners (GIP)	Planner	Member
6.	Surv. Dr. Benjamin Armah Quaye	Ghana Institution of Surveyors (GhIS)	Valuation and Estate Surveyor	Member
7.	Surv. Naa Ayele Beatrice	Ghana Institution of Surveyors (GhIS)	Land Surveyor	Member

Appendix C : SITE PHOTOGRAPHS





Schmidt Hammer test on columns -1





Schmidt Hammer test on columns -2





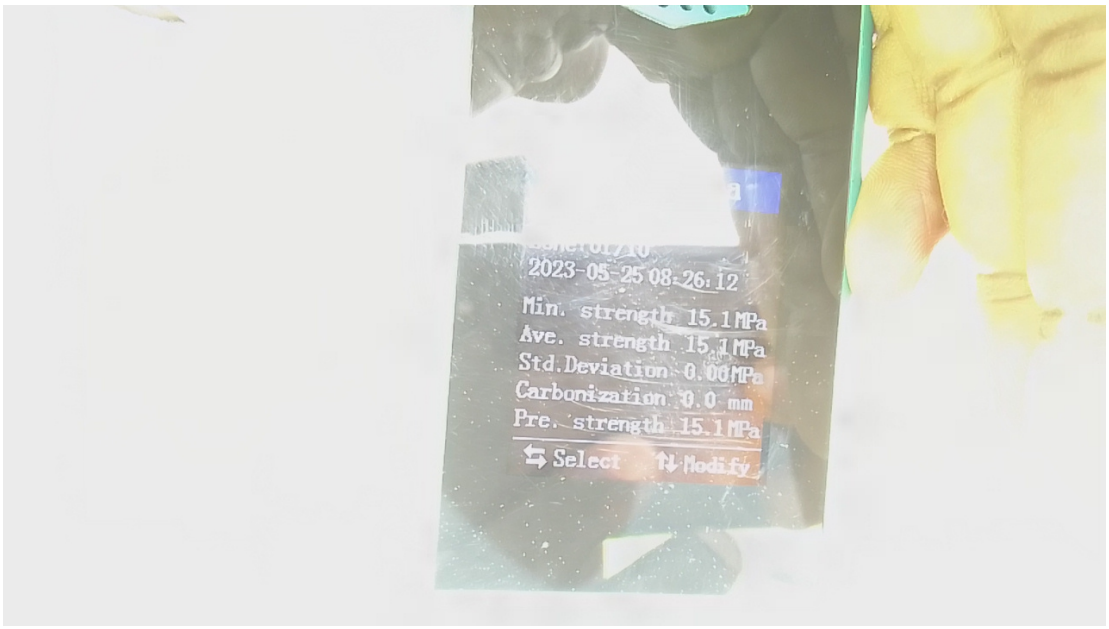
Schmidt Hammer test on beams - 1





Schmidt Hammer test on beams -2





Schmidt Hammer and sample test readings

Appendix D : EXISTING DOCUMENTS

GA SOUTH MUNICIPAL ASSEMBLY

Ngleshie Amanfro

BUILDING PERMIT

GA SOUTH MUNICIPAL ASSEMBLY BUILDING (BYE-LAW AND ACT 936)

B. P. No. GSMA | BORT/M020-0518 | 157

Permit No. 0000583

.....20.....

THE WORD IN ACTION CHURCH

of P. O. BOX

having applied for permission to.....

CONSTRUCT A TWO (2) STOREY COMMERCIAL CHURCH BUILDING WITH BASEMENT, FENCE WALL ON HIS PLOT OF LAND.

ORIGINAL

AT BORTIANOR - ACCRA.

Permission is here by granted, under the provision of Ga South Municipal Assembly Bye- Laws and Acts 936 for the erection of the said building in accordance with the particulars herein set forth and the plans hereto attached.

This permit shall be valid until 18TH day of JUN. 2023 or until such later date and subject also to such conditions as may be endorsed hereon from time to time by the Municipal Assembly and such subject also to the building being commenced within six month from the date on this permit.

This permission does not confer any right or little to the above premises, lands or building.

Dated this 18TH day of JUNE 20 18

.....

.....

APPROVED
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFRO

18/06/2018

V. K. Shenaw
Municipal Engineer

DESCRIPTION OF MATERIAL, ETC. TO BE USED IN THE WORK

All Plans must be full Dimensioned

DESCRIPTION

FOUNDATION:	Material
	Proportions
WALLS:	Material
	Proportions
FLOORS:	Material
	Proportion
	Joists Dimensions
	Joists Spacing
	Covering Thickness
WINDOWS:	Type
	Dimensions
DOORS:	Type
	Dimensions
ROOF:	Type
	Covering
	Spacing of Trusses
STEPS AND STAIRS:	Material
VERANDAHS:	
	Material
FENCING:	Material
	Height
YARDS:	
OUT BUILDING:	
VERANDAHS:	

DESCRIPTION OF MATERIAL, ETC. TO BE USED IN THE WORK

All Plans must be full Dimensioned

DESCRIPTION

FOUNDATION:	Material
	Proportions
WALLS:	Material
	Proportions
FLOORS:	Material
	Proportion
	Joists Dimensions
	Joists Spacing
	Covering Thickness
WINDOWS:	Type
	Dimensions
DOORS:	Type
	Dimensions
ROOF:	Type
	Covering
	Spacing of Trusses
STEPS AND STAIRS:	Material
VERANDAHS:	
	Material
FENCING:	Material
	Height
YARDS:	
OUT BUILDING:	
VERANDAHS:	

THE WORD IN ACTION CHURCH

BORTIANOR – ACCRA – *0249584584*

6th January, 2022

GA SOUTH MUNICIPAL ASSEMBLY
RECEIVED
10 JAN 2022
NGLESHIE AMANFRO

THE MUNICIPAL CHIEF EXECUTIVE
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFRO

Dear Sir,

APPLICATION FOR GAZETTING OF CHURCH PREMISES

We wish to apply for the gazetting of our church premises to officiate marriages.

The Word in Action Church is located at Bortianor Ajasco junction, off Bojo Beach - Kokrobite Road.

We humbly invite your team to arrange for inspection of the premises for your necessary action.

We look forward to your favourable response and would appreciate if all details are communicated to us for adequate preparation.

Counting on your usual co-operation.

Thank you.

Ofn
Pls liaise with METO
8/2/2022

Yours faithfully

JAMES KABU NARTEY – OMAN
For: PASTOR MARK MINTAH
GENERAL OVERSEER

METO/GSMA
Pls inspect & Town.
18/01/22.

PLAN OF LAND

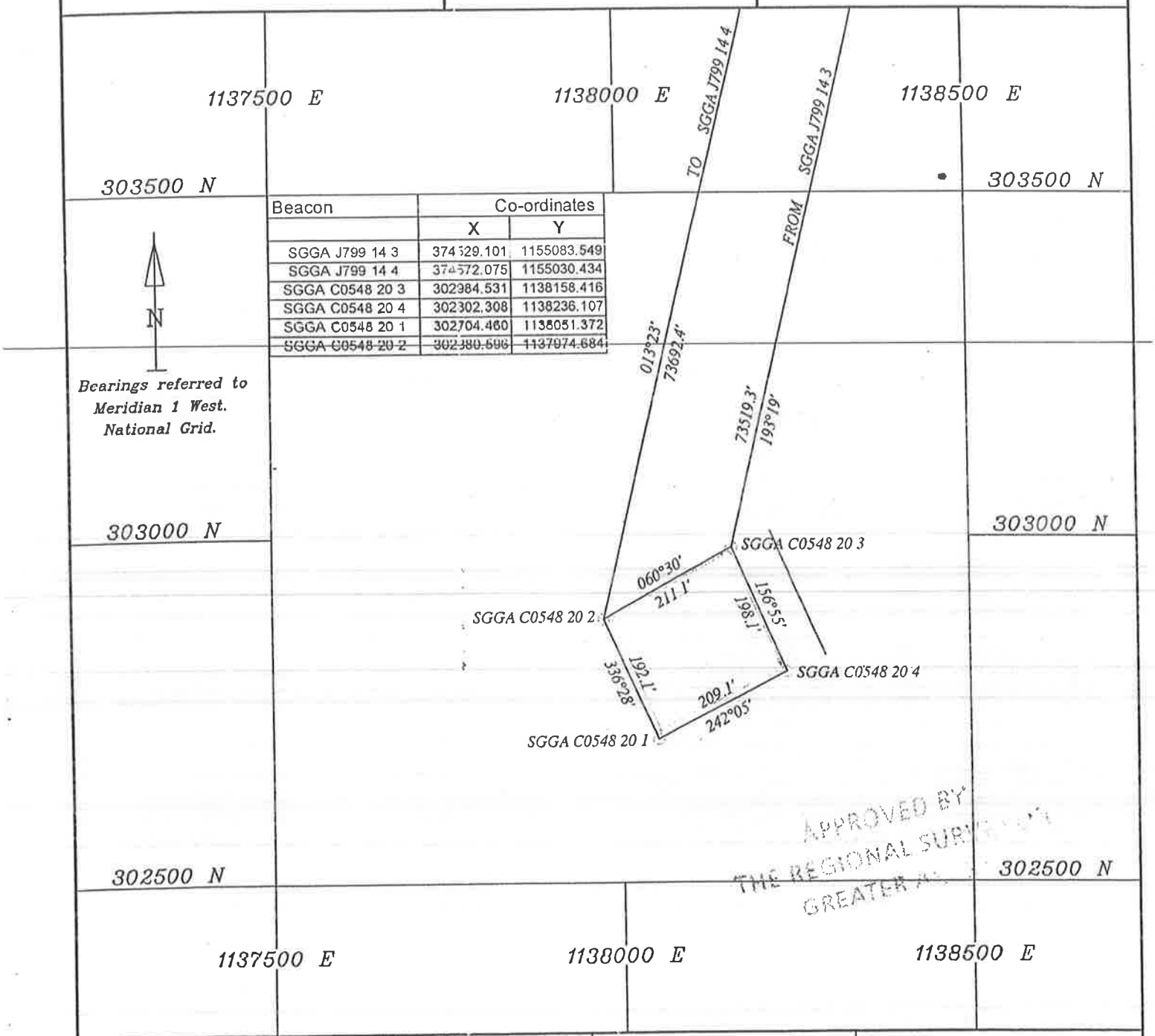
for: MARK AFRIFA MINTAH & ERNESTINA AFRIFA MINTAH

— Shewn Edged Pink —

Scale 1 : 2500

Area = 0.94 Acres (0.38 Ha.)

LOCALITY	DISTRICT	REGION
BORTIANOR	GA - SOUTH	GREATER ACCRA



Beacon	Co-ordinates	
	X	Y
SGGA J799 14 3	374329.101	1155083.549
SGGA J799 14 4	374572.075	1155030.434
SGGA C0548 20 3	302984.531	1138158.416
SGGA C0548 20 4	302302.308	1138236.107
SGGA C0548 20 1	302704.460	1138051.372
SGGA C0548 20 2	302980.596	1137974.684

Bearings referred to Meridian 1 West. National Grid.

APPROVED BY THE REGIONAL SURV... GREATER A...

I, K.N. ARKU LAWSON, Licensed surveyor, certify that this plan is faithfully and correctly executed and accurately shows the land within the limits of the description given to me by my client.

Date: 10-08-2020

Licensed Surveyor No. 358

Approved Seal

for: Director of Surveys
Regional Surveyor(GAR)
Date:.....

18 AUG 2020

PLAN OF LAND

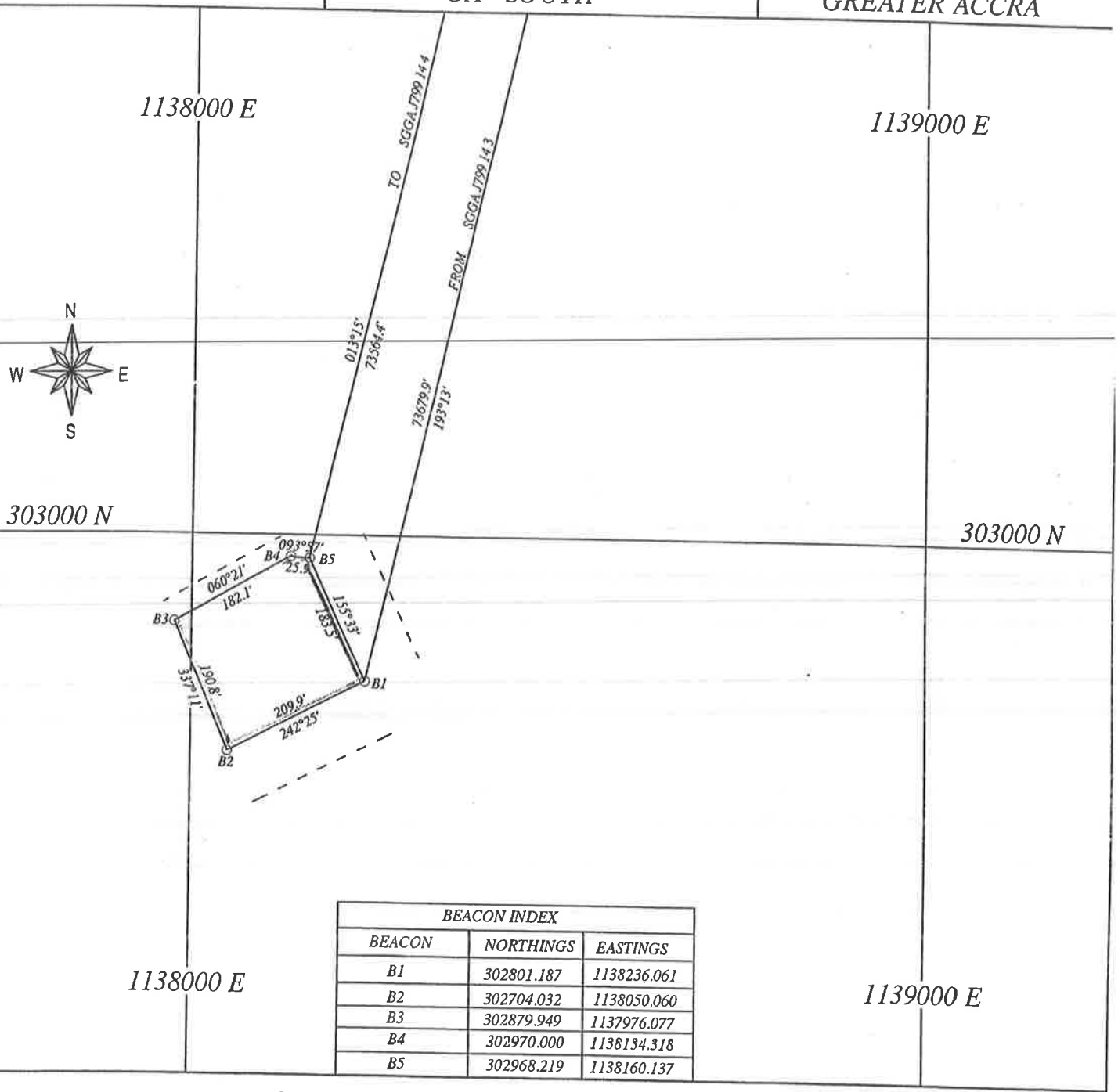
FOR: MINTAH MARK AFRIFA & MINTAH ERNESTINA AFRIFA

- Shewn Edged Pink -

Scale: 1:2500

AREA= 0.92 Acre(0.37 Ha)

LOCALITY	DISTRICT	REGION
BORTIANOR	GA - SOUTH	GREATER ACCRA



BEACON INDEX		
BEACON	NORTHINGS	EASTINGS
B1	302801.187	1138236.061
B2	302704.032	1138050.060
B3	302879.949	1137976.077
B4	302970.000	1138134.318
B5	302968.219	1138160.137

I,.....A....N....ASHIE.....,Licensed Surveyor certify that this plan is faithfully and correctly executed and accurately shows the land within the limits of the description given to me by my client.

Date: 29-11-18

LICENSED SURVEYOR. No. 303

SCHEDULE

ALL THAT PIECE OR PARCEL OF LAND situate lying and being at Bortianor in the Ga-South District of the Greater Accra Region aforesaid and bounded on the North by the Headlessor's property measuring Two Hundred Feet more or less on the East by a proposed road measuring Two Hundred and Ten Feet more or less and on the West by the Headlessor's property measuring Two Hundred Feet more or less covering an approximate area of Nought Point Nine Six (.96) acres more or less.

SIGNED Sealed and Delivered by The

Within –Named Assignor **KAY YAAKOR KWAO-SIMMONDS)** ----------

In the Presence of:

Witness:

Name: GIFTY A. BONSU

Address: P.M.B CT 410, CANTONMENTS – ACCRA

Signature: Adubuna

Date: 14TH JANUARY, 2019

Signed by the Within –Named Assignees

REV. MARK & MRS. ERNESTINA AFRIFA MINTAH)

1ST ASSIGNEE

2ND ASSIGNEE

In the Presence of:

Witness:

Name: ESSEL REGINALD

Address: P.O. BOX DC 21 DANSOMAN - ACCRA

Signature:

Date: 15/10/2019

OATH OF PROOF

I .....GIFTY A. BONSU..... of Accra make oath and say that on the .....14TH.....day of .....JANUARY.....2019, I was present and saw **KAY YAAKOR KWAO-SIMMONDS** herein duly execute the instrument now produced to me and that the said **KAY YAAKOR KWAO-SIMMONDS** can read and write.

Sworn at Accra This 8th]

Day of Sept 2019 20]

.....

Deponent

Before Me

.....

Commissioner for Oaths

REGISTRAR
HIGH COURT
LAW COURT COMPLEX - ACCRA

CERTIFICATE OF PROOF

On the 8th day of September 2019 20 at 1 O'clock in the forenoon this instrument was proved by the within-named to have duly executed by the within-named **KAY YAAKOR KWAO-SIMMONDS.**

.....

Registrar of Deeds

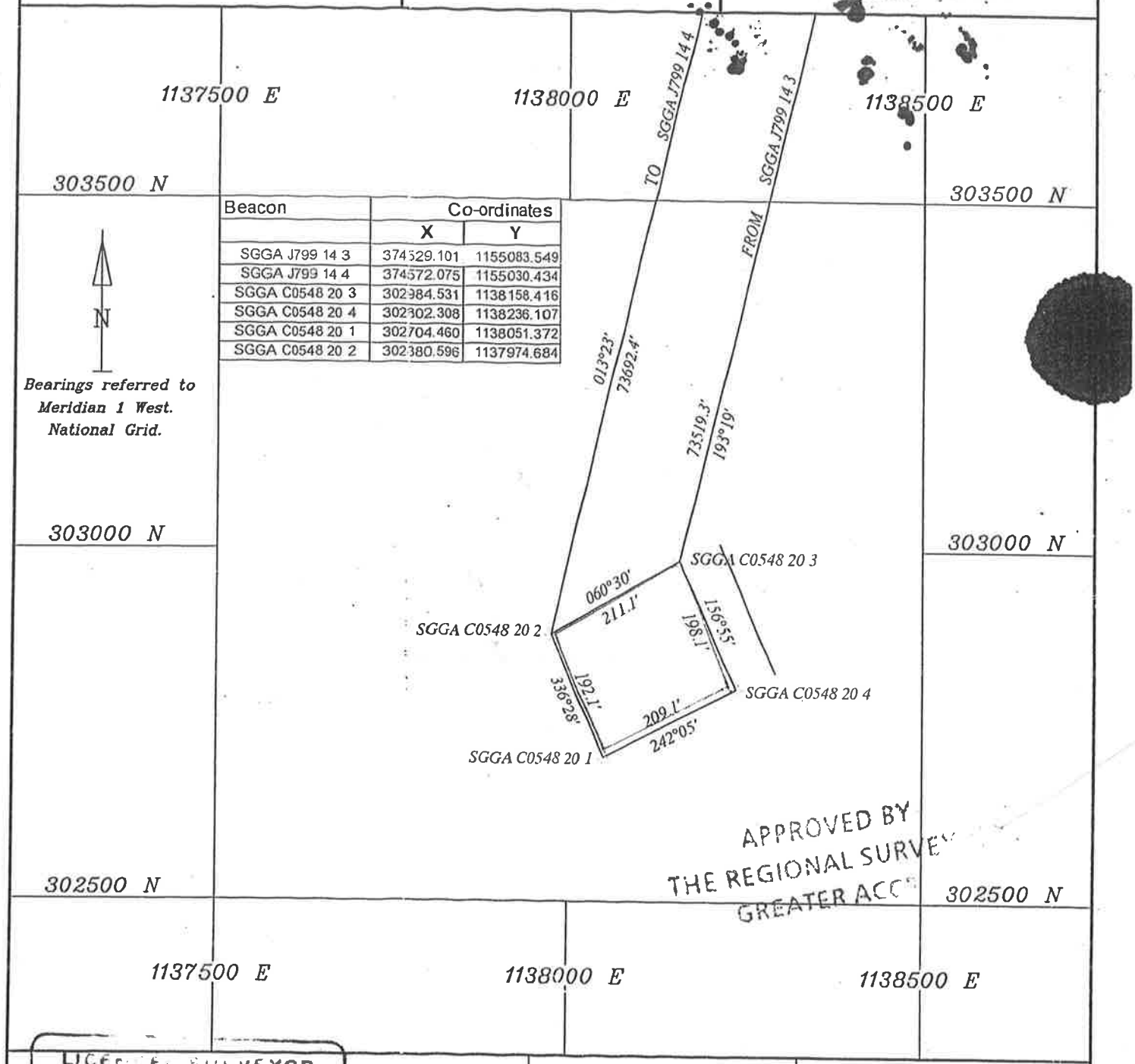
REGISTRAR
HIGH COURT
LAW COURT COMPLEX - ACCRA

PLAN OF LAND
for: MARK AFRIFA MINTAH & ERNESTINA AFRIFA MINTAH
— Shewn Edged Pink —

Scale 1 : 2500

Area = 0.94 Acres (0.38 Ha.)

LOCALITY	DISTRICT	REGION
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SGGA C0548 20 3	302984.531	1138158.416
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SGGA C0548 20 1	302704.460	1138051.372
SGGA C0548 20 2	302380.596	1137974.684

APPROVED BY THE REGIONAL SURVEYOR GREATER ACCRA

LICENSED SURVEYOR K.N. LAWSON

I, K.N. ARKU LAWSON, licensed surveyor, certify that this plan is faithfully and correctly executed and accurately shows the land within the limits of the description given to me by my client.

Date: 10-08-2020

Licensed Surveyor No. 358

Approved Seal

for: Director of Surveys
Regional Surveyor (GAR)
Date: 18 AUG 2021

INSPECTION REPORT ON CHURCH GAZETTING FOR THE WORD IN ACTION CHURCH

1.0 Background

On Monday 9th May 2022 Officers from Works Department embark on an inspection of the above church at Ajasco junction off Bojo beach Kokrobite road.

We visited the church premises called The Word In Action Church.

The name of the pastor: Mark Mintah

2.0 Findings

- The church building is a Two (2) Storey building with basement occupying a land size of about 4 plot of land.
- The structure has capacity of about 450 congregations.
- The church premises have children block 150 congregation within the building.
- The church has a building permit (permit No /Bort/ mo2o-0518/157) dated 18th June 2018.
- The composition of the building does not comply with the permit that was issued.
- There was an extension of additional offices, wash rooms, hall, bedrooms and staircase at the ground and first floor.
- It was also found out that two (2) storey apartments of seven rooms was built on existing fence wall.

3.0 Recommendation

We proposed to the church (The Word in Action Church) to produce both the architecture and structural drawing to suit the design on site and structural integrity report before granting approval.

Attached are pictures of the church.

4.0 Inspection team

Name	Signature
Ing Emmanuel Dowuona	..... 09/05/22
Ing Joseph Ofori	..... 09/05/22

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PROPOSED RESIDENCE

FOR:

THE WORD IN ACTION CHURCH

AT:

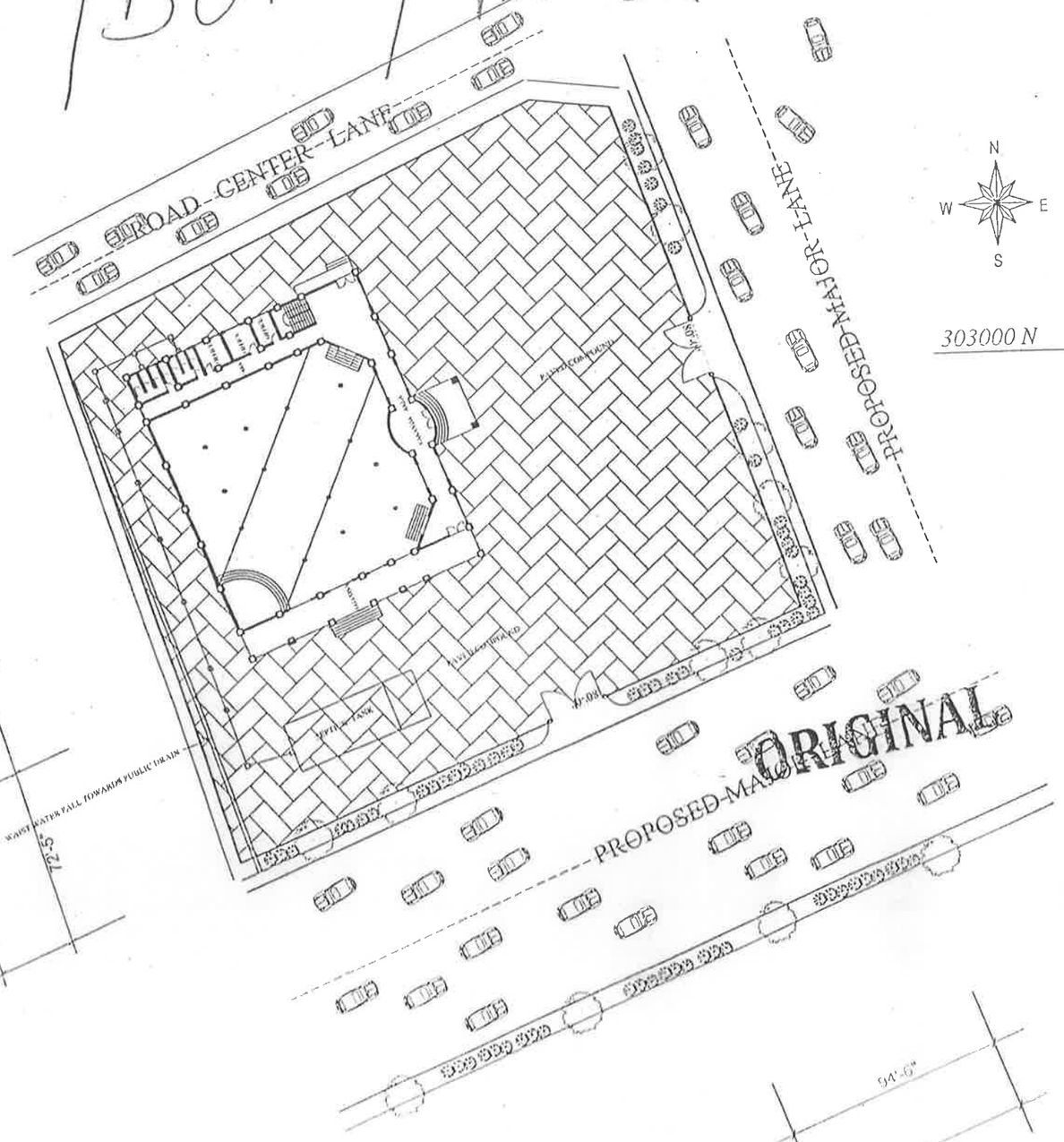
BORTIANOR - GREATER ACCRA

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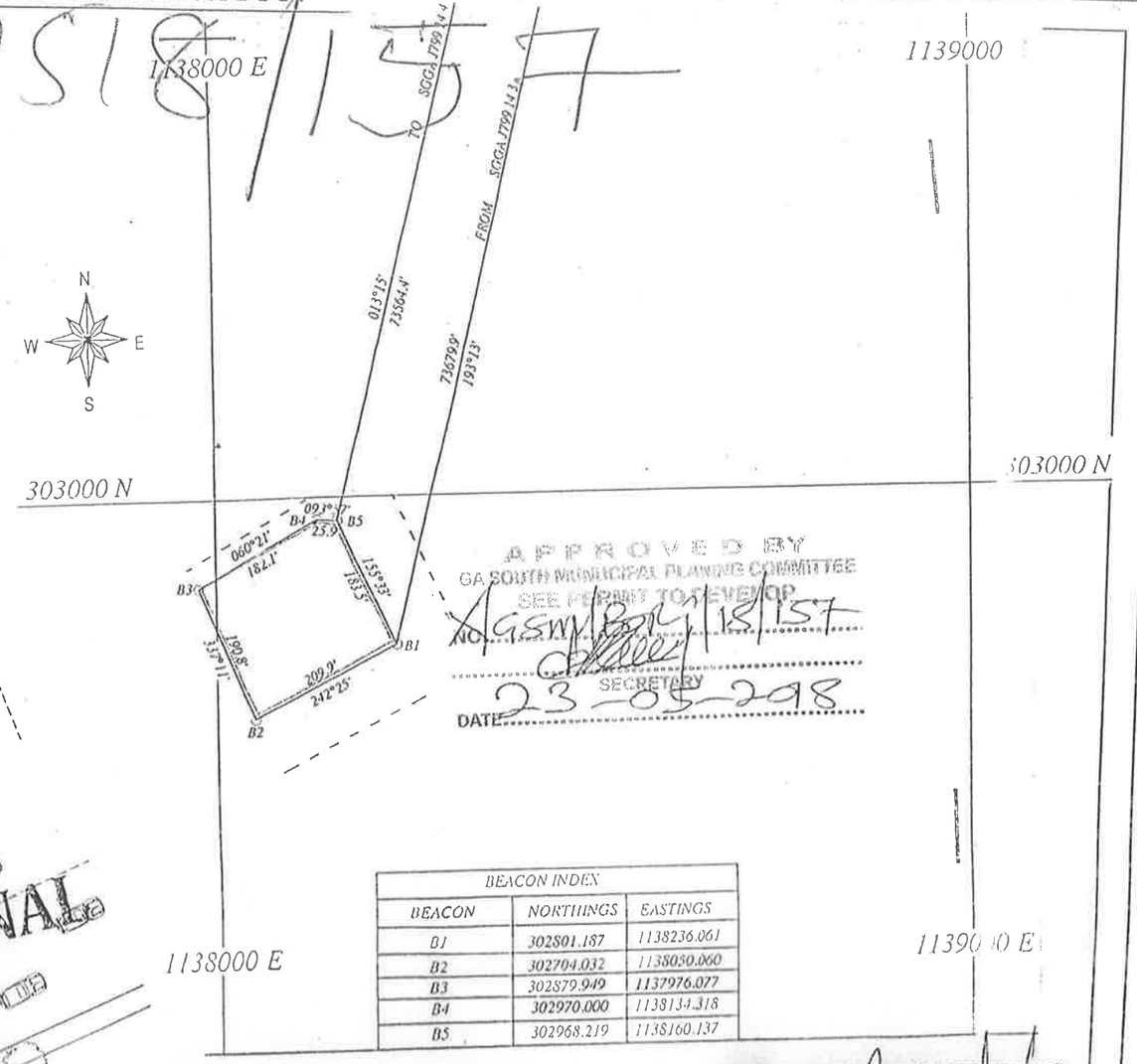
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BLOCK : Scale: 1:16 = 1'-0"



BEACON INDEX		
BEACON	NORTHINGS	EASTINGS
B1	302801.187	1138236.061
B2	302704.032	1138050.060
B3	302879.949	1137976.077
B4	302970.000	1138134.318
B5	302968.219	1138160.137

SITE PLAN : Scale: 1:16 = 1'-0"

APPROVED BY
GA SOUTH MUNICIPAL PLANNING COMMITTEE
SEE REVERSE FOR CONDITIONS TO DEVELOP
NO. GSMA/BORT/157
SECRETARY
DATE 23-05-2018

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

CHARLES YAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 533 Date 3/12/18
Signature

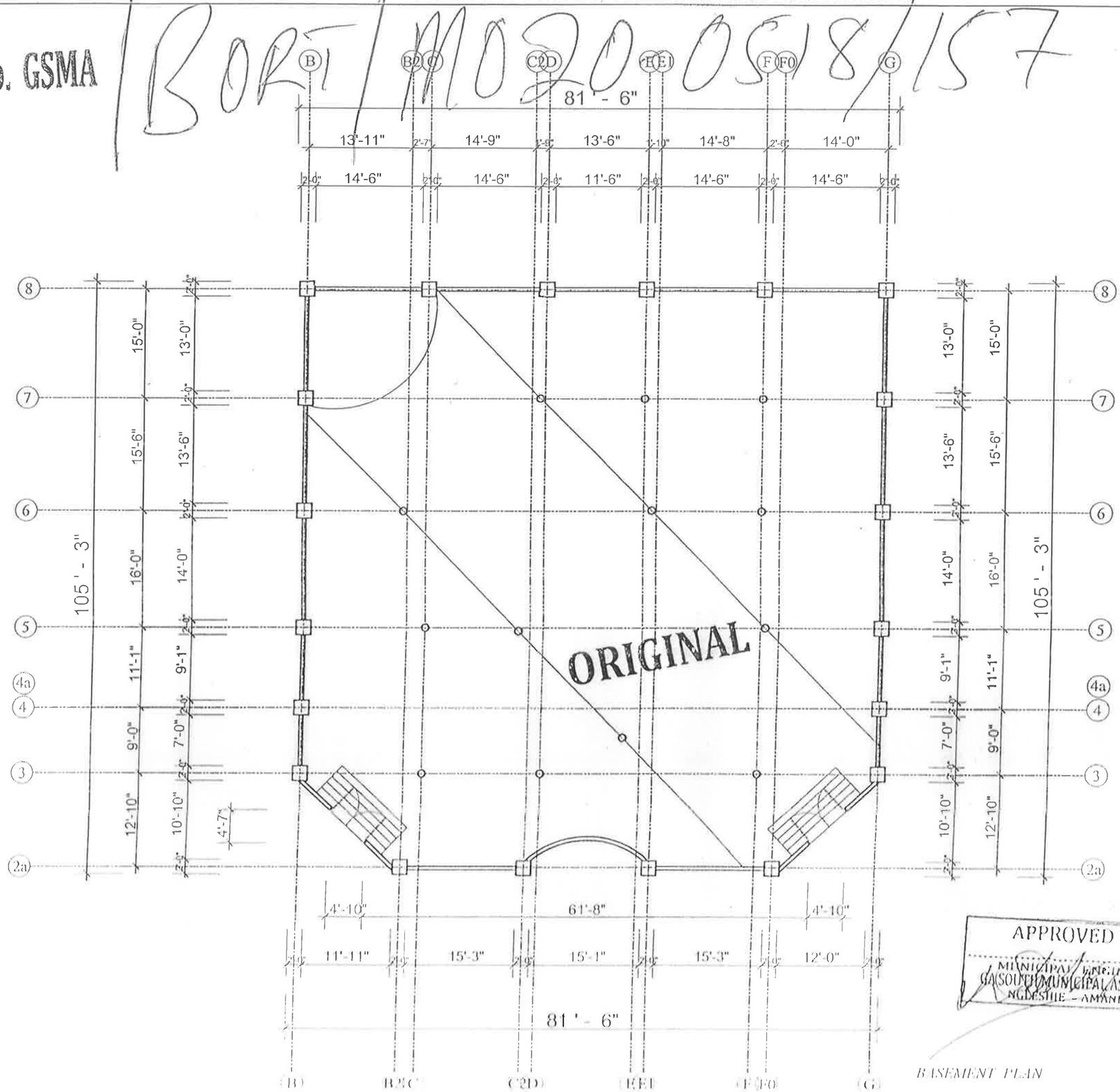
Project: PROPOSED BUILDING
client: THE WORD IN ACTION CHURCH
Loca: BORTIANOR - GREATER ACCRA

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Design by:	FELIX BUABENG - FORUE
Drawn by:	FELIX BUABENG - FORUE
Chec'ked by:	
Date:	NOVEMBER '2017
	Drawing No: 1/01

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BASEMENT PLAN

NOTES

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SECRETARY
DATE 23-05-2018

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

CHARLES AGATTA DAWSON, AGIA
ARCHITECT
Reg. No. C53 Date. 5/12/18
Signature

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Tell no: 0244548896 /0277678867
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Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

Scale	1/8" = 1'-0"
Design by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked by	
Date	NOVEMBER 2018
Drawing No.	A 1/0

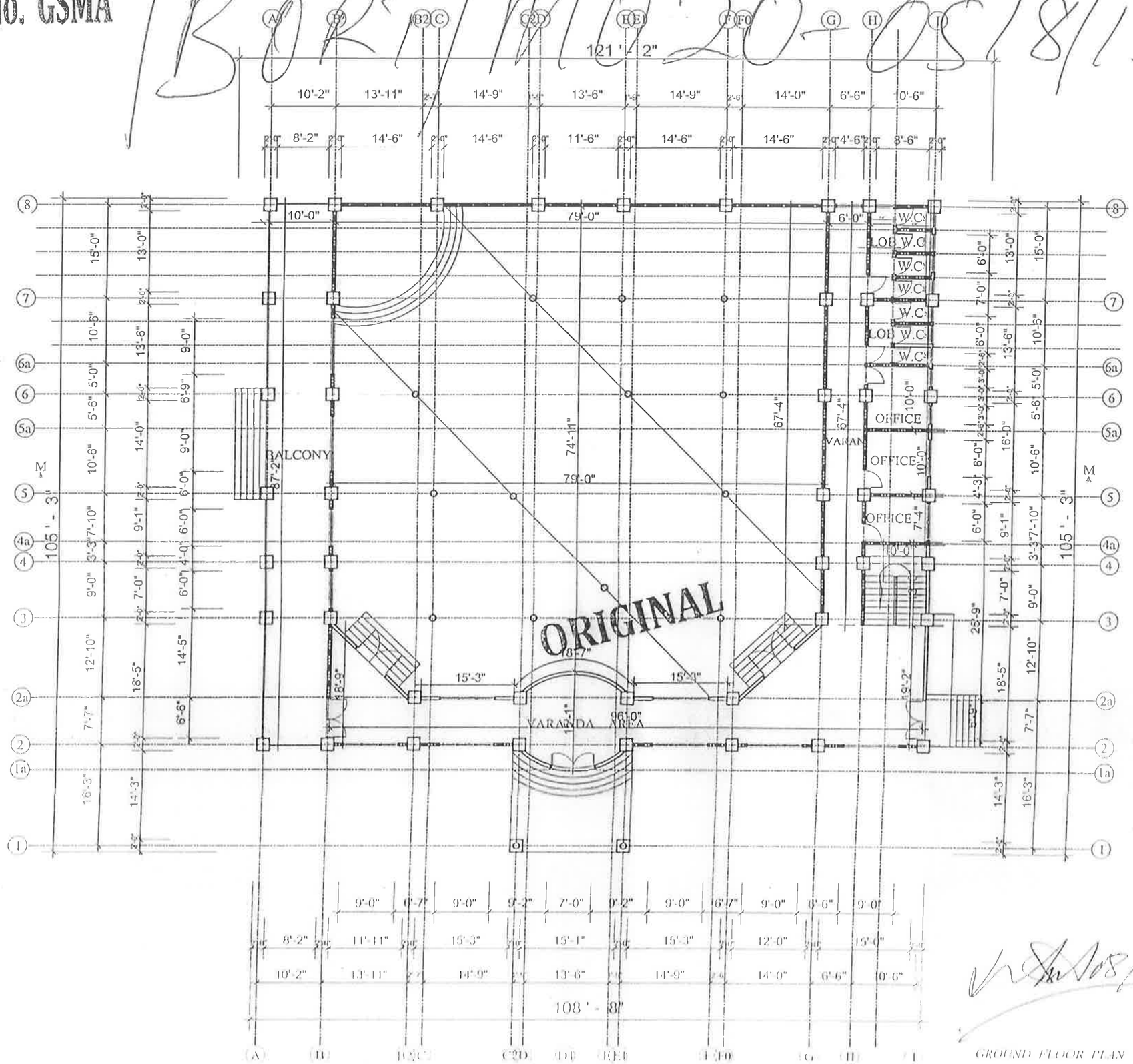
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B.P. No. GSMA

BORT/M20-0518/17



GROUND FLOOR PLAN

NOTES

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PERMIT TO DEVELOP
GSMA/21/18/157
SECRETARY
DATE 23-05-2018

CHARLES YAO-AYTA DAWSON, AGIA
ARCHITECT
Reg. No. 633 Date 5/18
Signature

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Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

Scale	1/8" = 1'-0"
Design by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked by	
Date	NOVEMBER '2018
Drawing No	A/03

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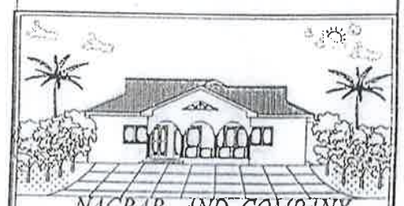
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GA SOUTH MUNICIPAL PLANNING UNIT
SEE PERMIT TO DATE
NO. GSMA/BOR/1815/17
SECRETARY
DATE 23-05-2018

CHARLES YAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 033 Date 5/10/18
Signature



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Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

Scale	1/8" = 1'-0"
Design by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked by	
Date	NOVEMBER '2018
Drawing No.	A/04

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

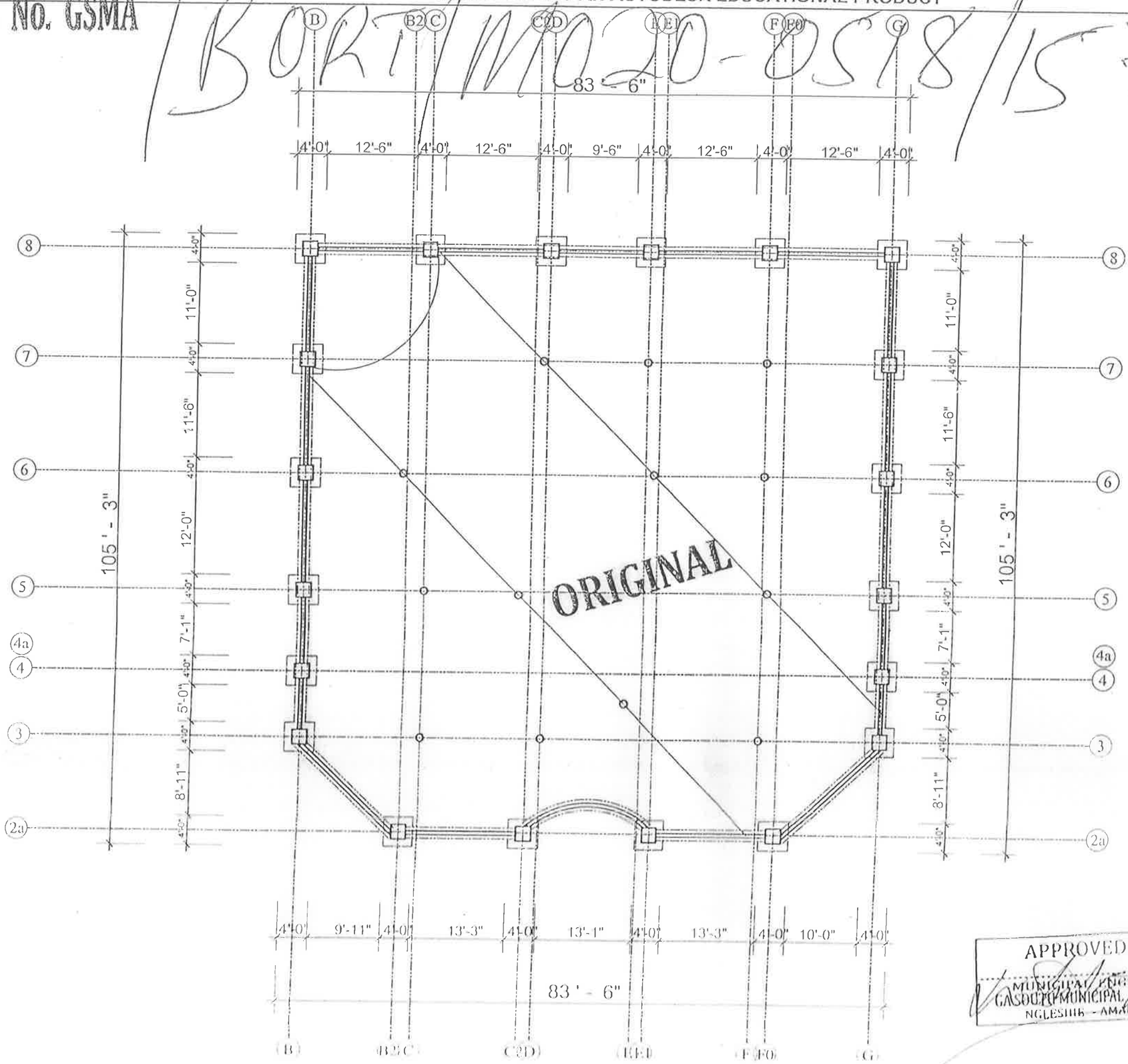
FIRST FLOOR PLAN

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B.P. No. GSMA

BORT/MO 20-0518/157



FOUNDATION PLAN

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DATE 23-05-2018

CHARLES YAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 533 Date 8/10/18
Signature

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Project: PROPOSED BUILDING
client: THE WORD IN ACTION CHURCH
Local: BORTIANOR - GREATER ACCRA

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MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

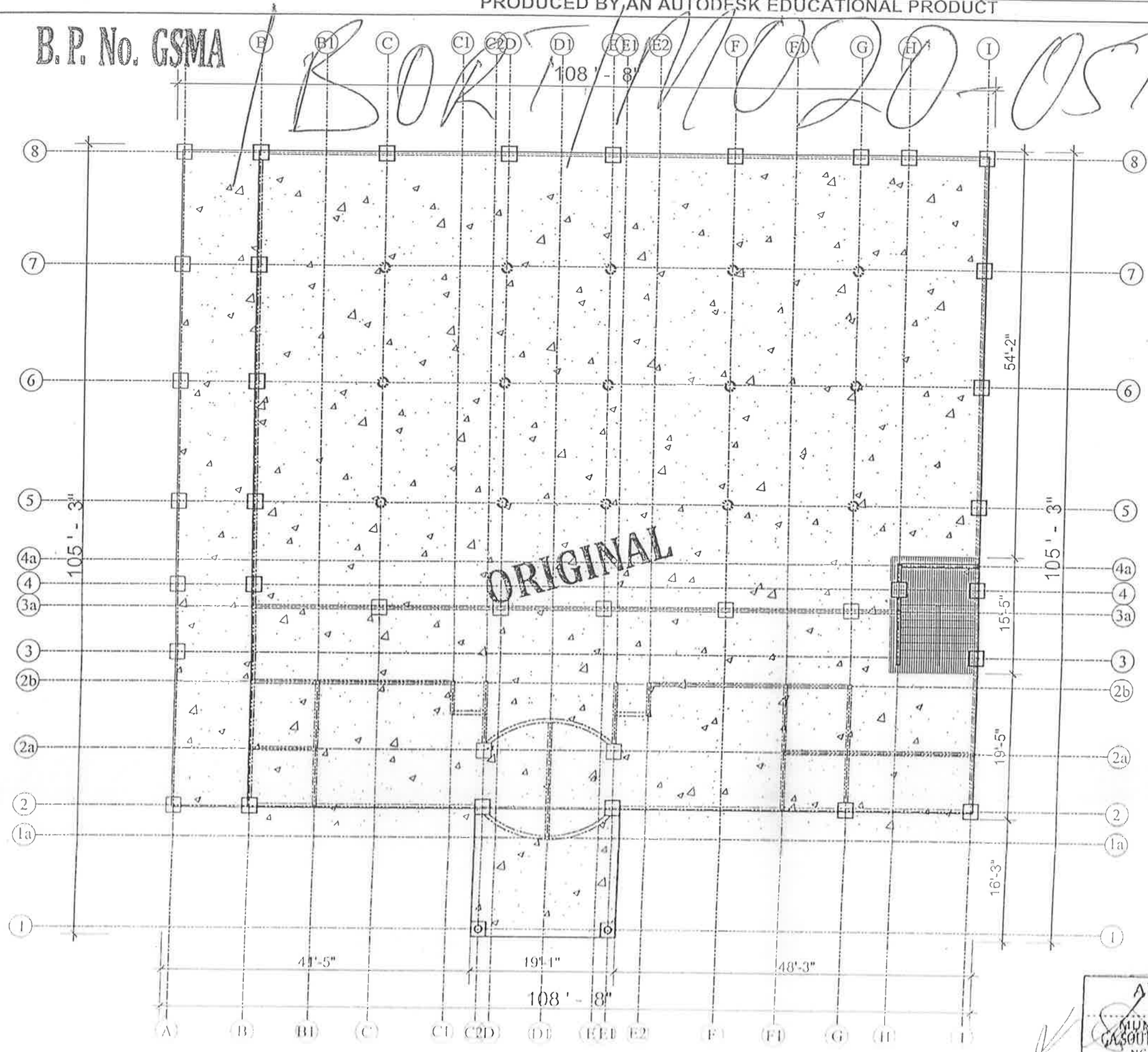
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Date	NOVEMBER 2015
Drawing No.	A/05

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CONCRETE ROOFING PLAN

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GA SOUTH MUNICIPAL PLANING COMMITTEE
SEE PERMIT PROVISO/OP
GASM/BAC/18/157
SECRETARY
DATE 23-05-2018

CHARLES YAO-ATTA DAWSON AGIA
ARCHITECT
Reg. No. 133 Date: 5/12/18
Signature



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Tell no: 0244548896 /0277678867
location: Opp korlebu police syation
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

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MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

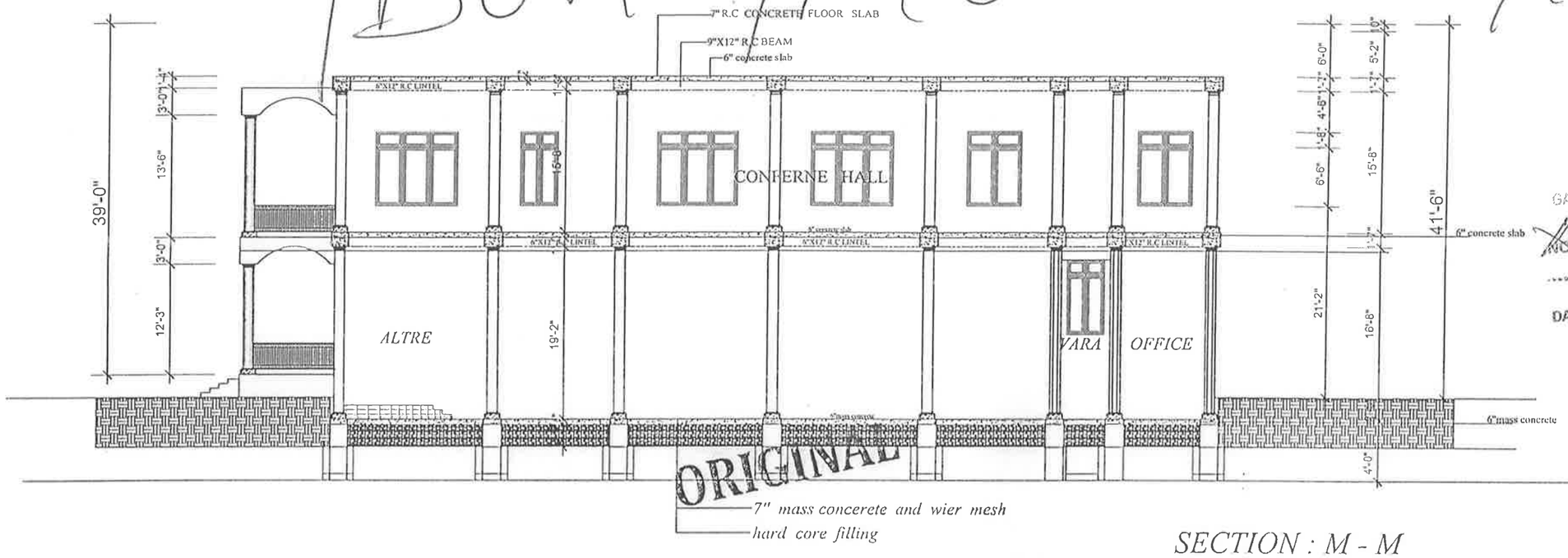
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Date	NOVEMBER '2015
Drawing No	A/06

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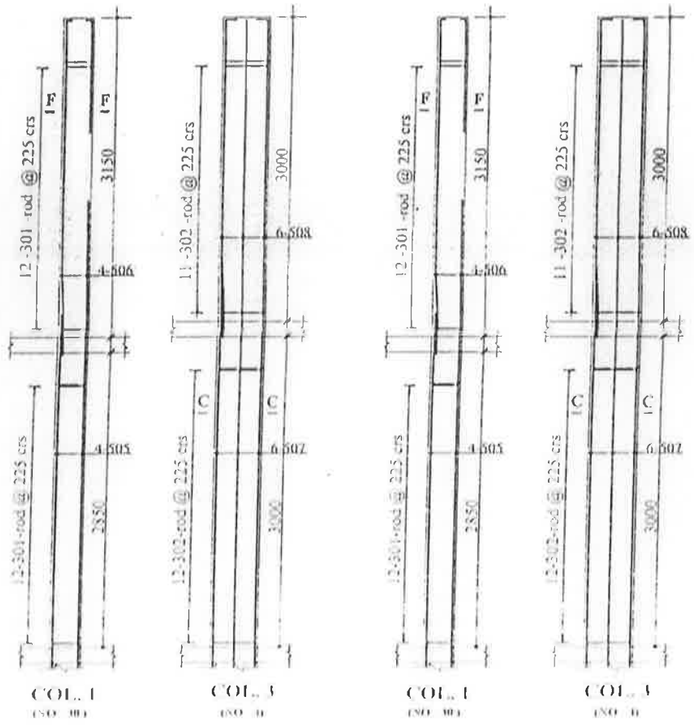
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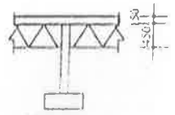
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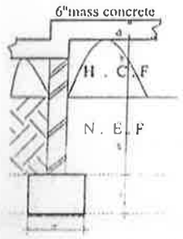
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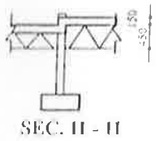
CHARLES YAO-ATTA DAWSON AGIA
ARCHITECT
Reg. No. [illegible] Date 5/10/18
Signature

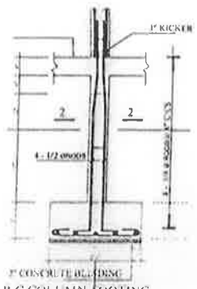


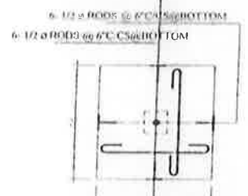




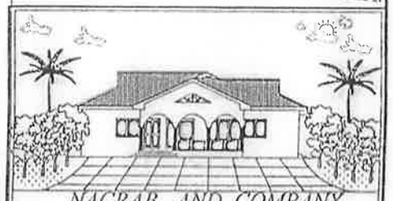
FOOTING DETAIL : 3 - 3







R.C APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NELESTINE AMANEBU



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location: Opp korlebu police syation
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Project : PROPOSED BUILDING
client: THE WORD IN ACTION CHURCH
Loca: BORTIANOR - GREATER ACCRA

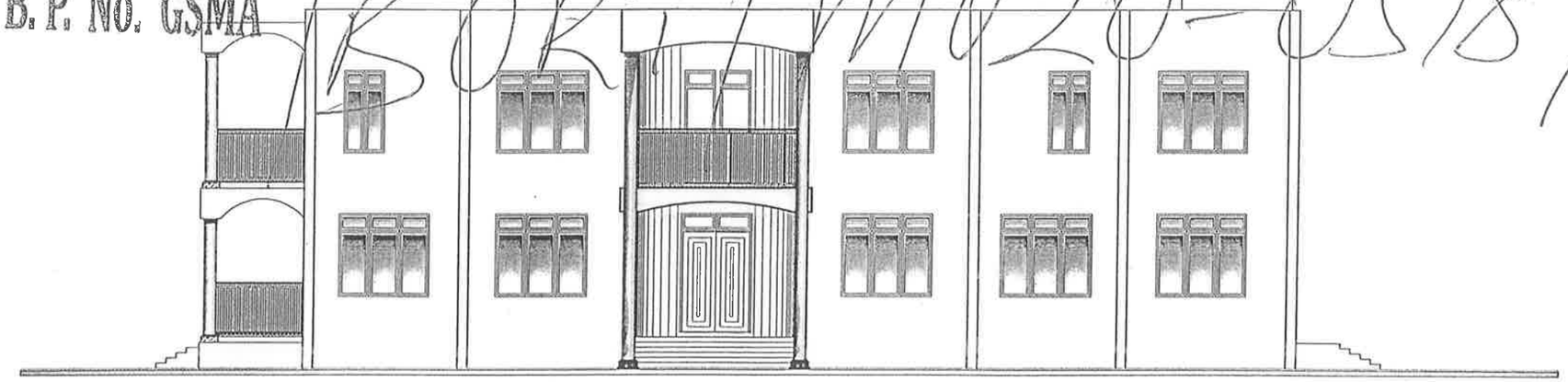
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Design by	FELIX BUABENG POBEE
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Date	NOVEMBER 2018
Drawing No.	A/07

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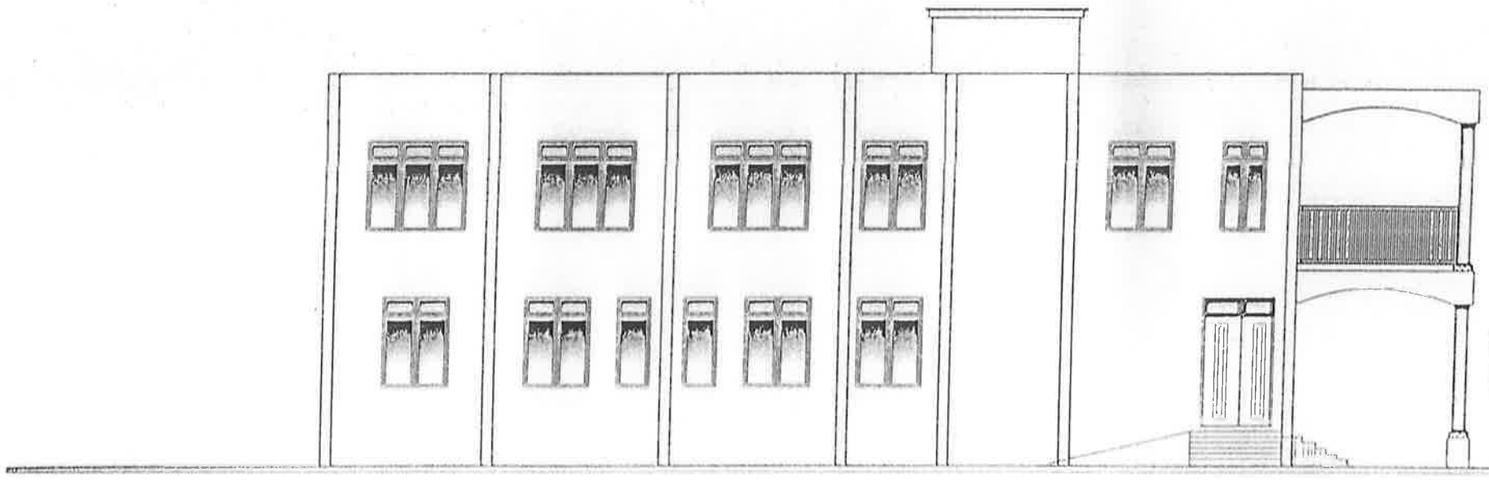
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FRONT VIEW

ORIGINAL



RIGHT SIDE VIEW

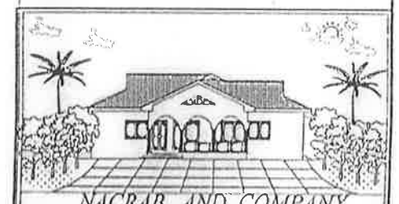
APPROVED BY
GA SOUTH MUNICIPAL PLANNING COMMITTEE
SEE PERMIT TO BUILD
NO. GSM/BP/ 1718157
SECRETARY
DATE 23-05-2018

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NGLESHIE - AMANFRO

NOTES

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CHARLES YAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 033 Date 5/12/18
Signature



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Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

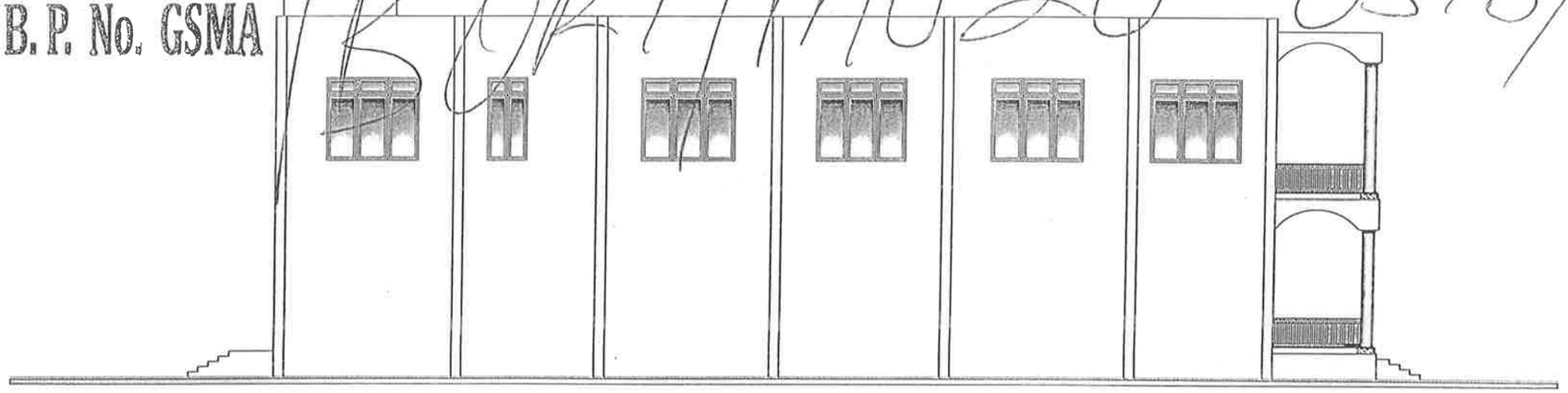
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Date	NOVEMBER '2018
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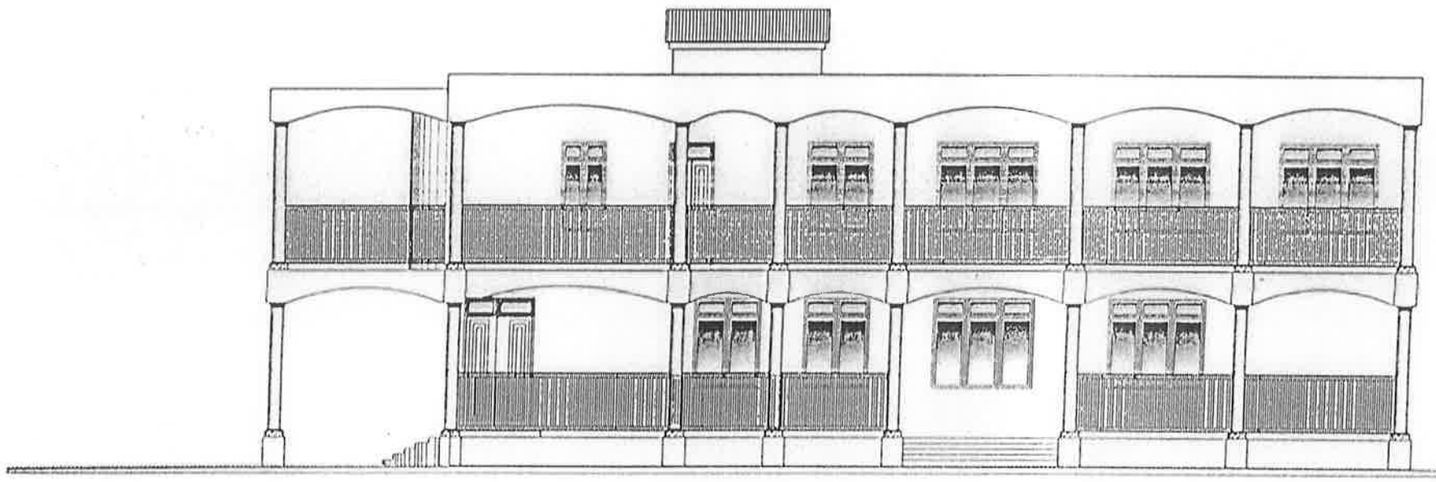
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BACK VIEW

ORIGINAL



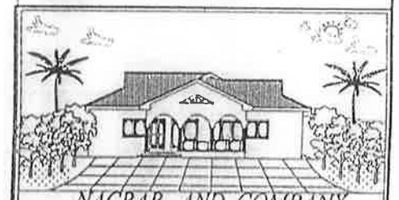
LEFT SIDE

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SECRETARY
DATE 23-05-2018

CHARLES NAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 873 Date 5/12/18
Signature



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Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFORO

Scale	1/8" = 1'-0"
Design by	FELIX BUAHENG POBEE
Drawn by	FELIX BUAHENG POBEE
Checked by	
Date	NOVEMBER '2018
Drawing No.	A09

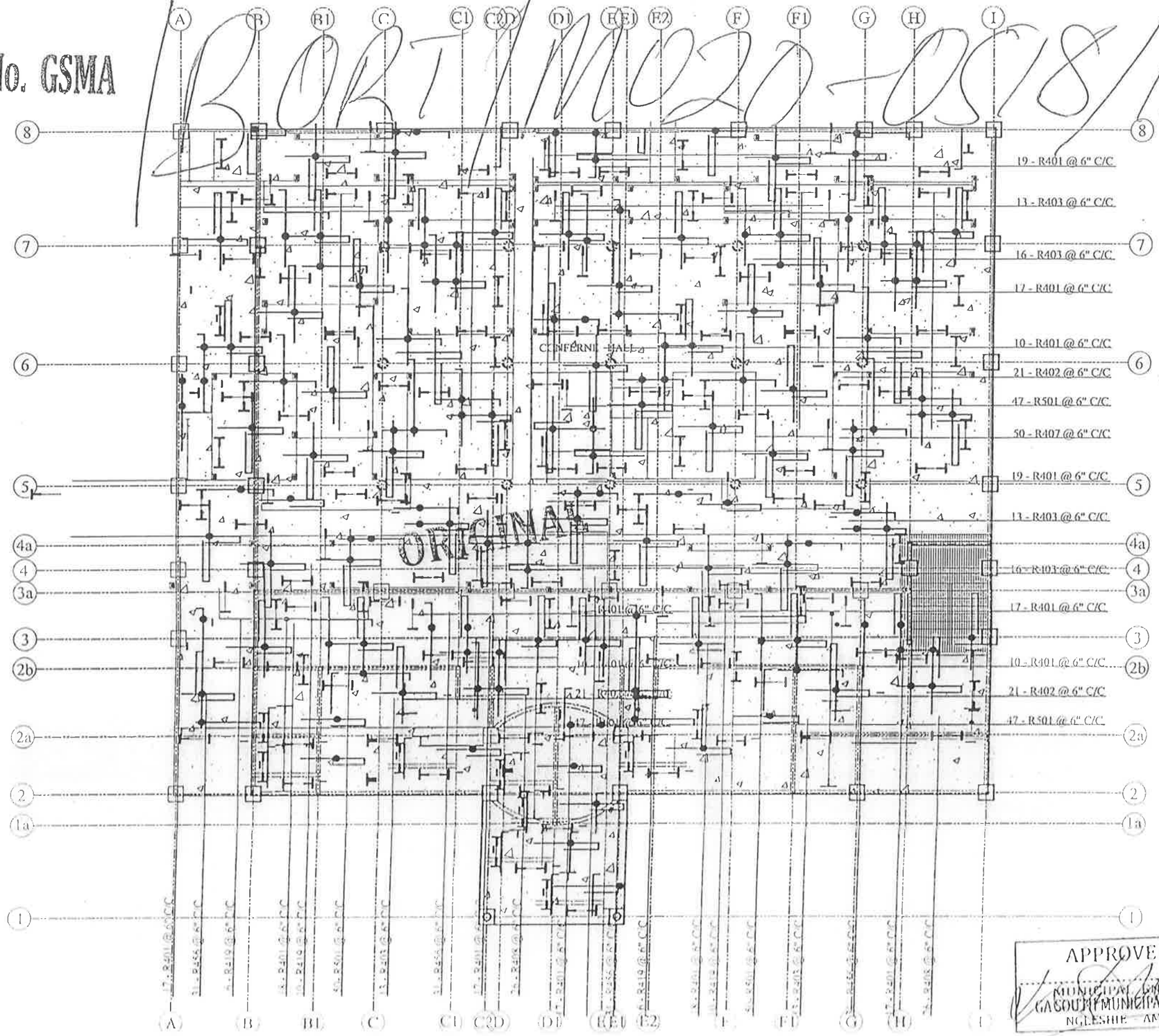
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BORT/M020-0518/17



R. C. FLOOR PLAN

(SCALE - 1/8")

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CHARLES YAO-ATTA DAWSON, AGA
ARCHITECT
Reg. No. 1833 Date 12/18
Signature

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Project : PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFRO

Local: BORTIANOR - GREATER ACCRA

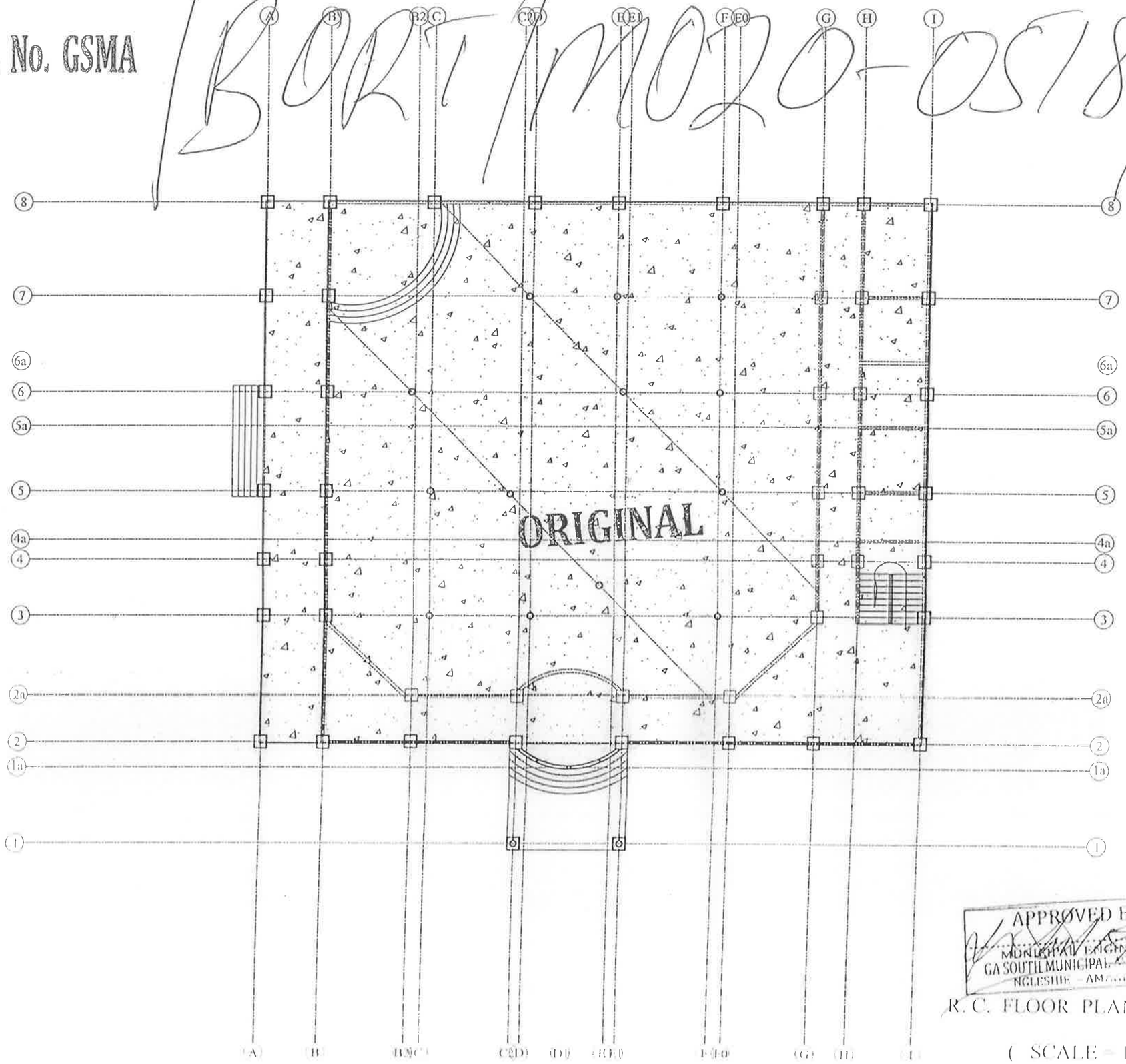
Scale	1/8" = 1'-0"
Design by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked by	
Date	NOVEMBER, 2018
Drawing No.	A/10

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R.C. FLOOR PLAN

(SCALE - 1/8")

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GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

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CHARLES YAO ATTA DAWSON, ARCHITECT
Reg. No. 333 Date: 5/12/18
Signature

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Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Local: BORTIANOR - GREATER ACCRA

Scale	1/8" = 1'-0"
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Drawn by	FELIX BUAHENG POBEE
Checked by	
Date	NOVEMBER 2018
Drawing No.	A/1/1

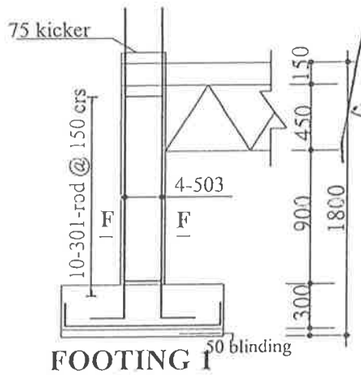
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

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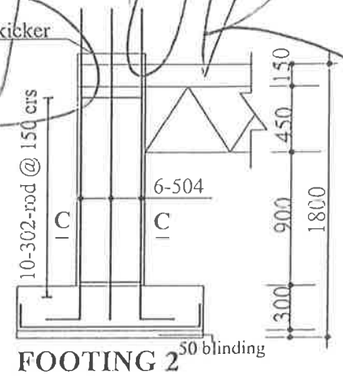
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

B.P. No. GSMA

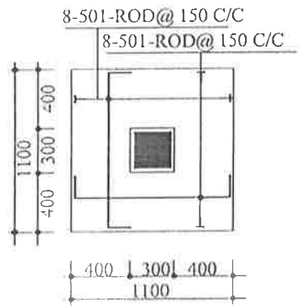
ORIGINAL



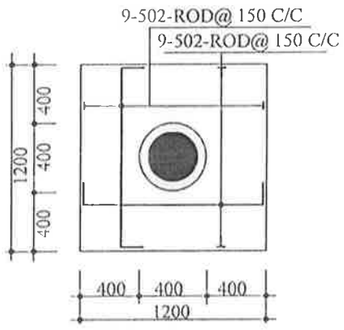
FOOTING 1



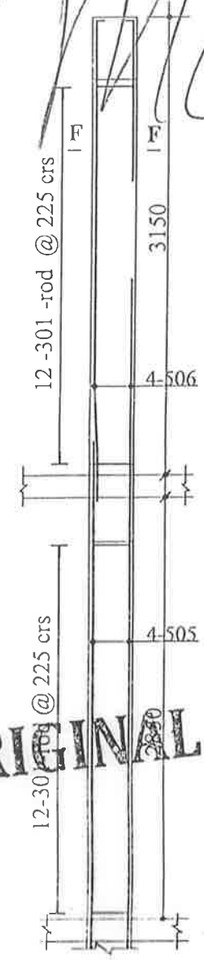
FOOTING 2



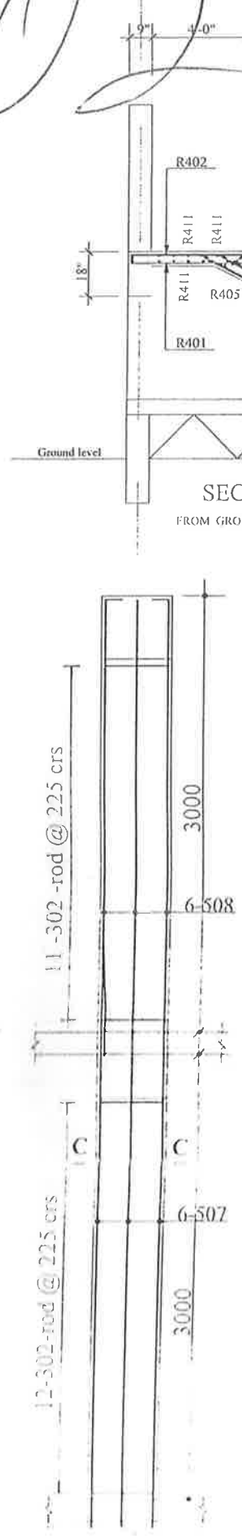
COLUMN BASE
(NO - 31)



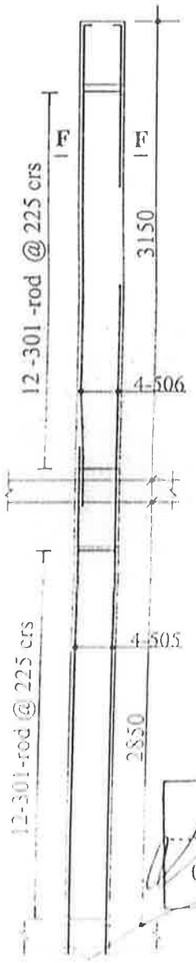
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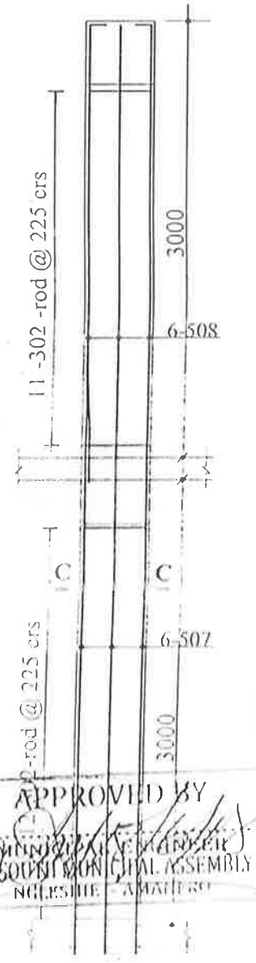
COL. 1
(NO - 30)



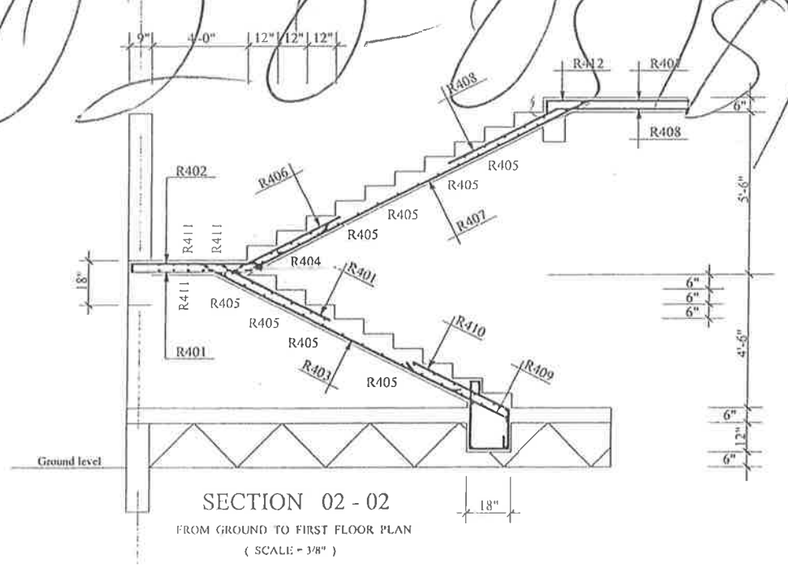
COL. 3
(NO - 4)



COL. 1
(NO - 30)

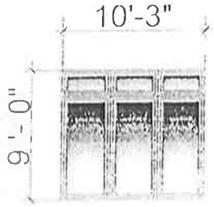


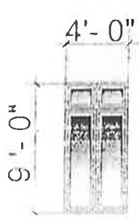
COL. 3
(NO - 4)

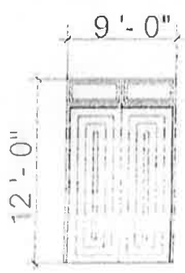


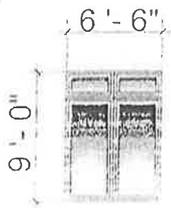
SECTION 02 - 02
FROM GROUND TO FIRST FLOOR PLAN
(SCALE - 3/8")

DOOR & WINDOW SCHEDULES

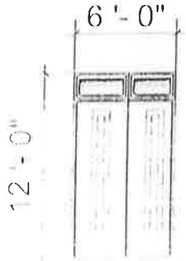








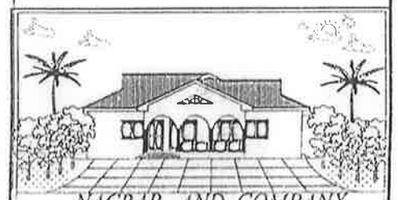




NOTES

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* *ALL DIMENSIONS MUST BE RECHECKED BEFORE COMMENCE ON THE CONSTRUCTION.*

CHARLES YAO-ATTA DAWSON AGIA
ARCHITECT
Reg. No. 833 Date 8/12/18
Signature



NACRAB AND COMPANY
CONSTRUCTION CO.LTD.
P.O.Box 14714 Accra
Tel no: 0244548896 /0277678867
location: Opp korlebu police syation
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING
client: THE WORD IN ACTION CHURCH
Loca: KOKROBITE - GREATER ACCRA

APPROVED BY
MINISTRY OF ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

Scale:
Design by:
Drawn by:
Checked by:
Date:

ELTA BUABENG FORBE
ELTA BUABENG FORBE

NOVEMBER 2018

A1/P

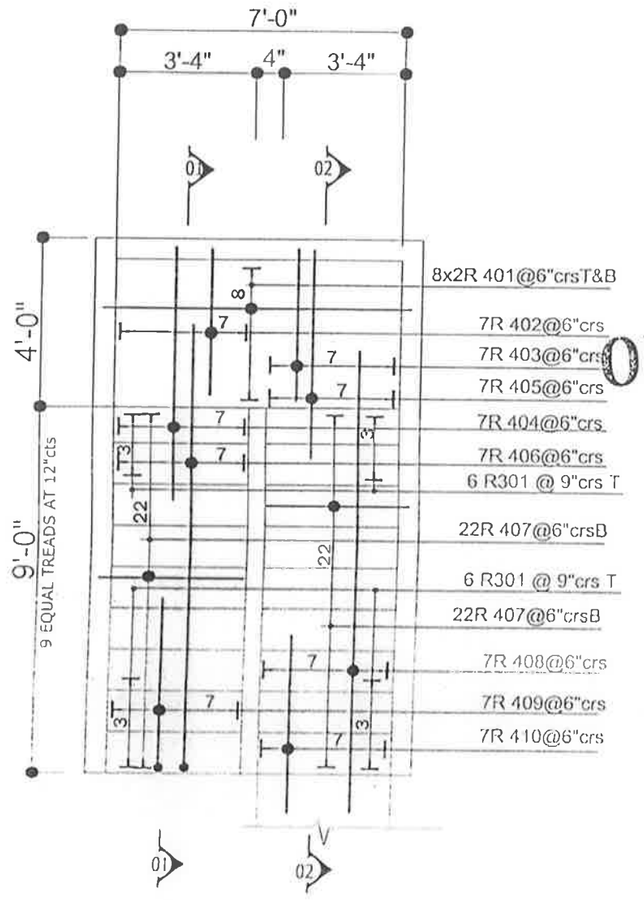
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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

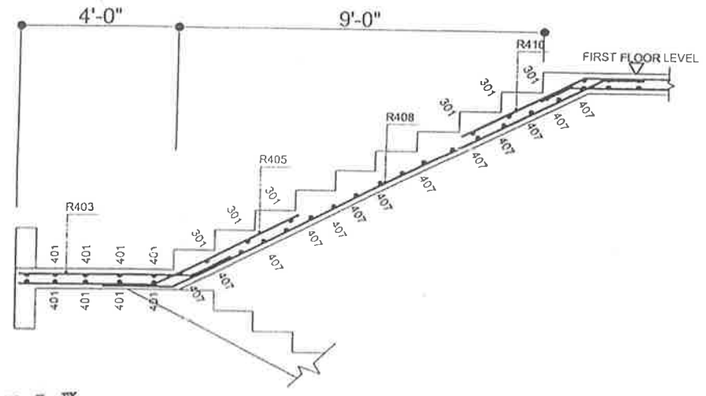
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

B.P. No. GSMA /BORT/M020-0518/15

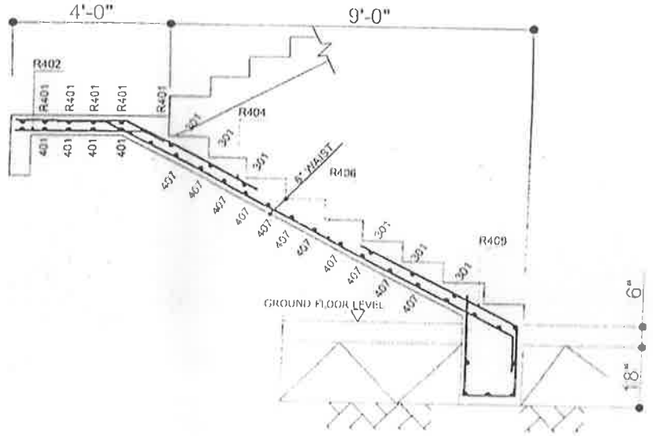
BENDING SCHEDULE				
No	DIA	LENGTH	QTY.	SHAPE
301	3/8"	3'-0"	12	STRAIGHT
401	1/2"	7'-4"	16	STRAIGHT
402	1/2"	4'-6"	7	3'-6" 12"
403	1/2"	5'-6"	7	4'-6" 12"
404	1/2"	7'-0"	7	3'-0" 4'-0"
405	1/2"	7'-6"	7	3'-6" 4'-0"
406	1/2"	15'-4"	7	2'-4" 12'-0" 12"
407	1/2"	4'-0"	44	STRAIGHT
408	1/2"	14'-8"	7	2'-4" 2'-4" 12'-0"
409	1/2"	10'-2"	7	2'-4" 3'-6" 3'-0" 16"
410	1/2"	7'-0"	7	3'-6" 3'-6"



R.C STAIRCASE PLAN DETAIL



02 - 02



STAIRCASE SECTIONAL DETAIL 01 - 01

ORIGINAL

CHARLES YAO ATTA DAWSON AGIA
ARCHITECT
Reg. No. 033 Date 5/12/18
Signature

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFRO

Project PROPOSED BUILDING
client THE WORD IN ACTION CHURCH
Local KOKROBITE - GREATER ACCRA

Scale	1/4" = 1'-0"
Designed by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked by	
Date	NOVEMBER '2015
Drawing No.	A / 5

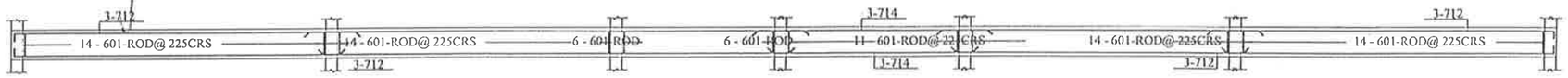
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

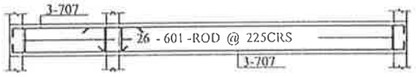
B. P. No. GSMA BOA/MA0020-0578/15



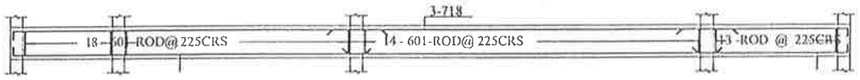
BEAM ON GRID 2- 2



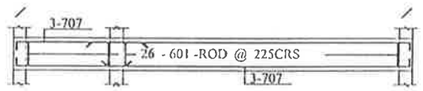
BEAM ON GRID C2 - C2



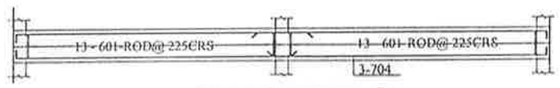
BEAM ON GRID E1 - E1



BEAM ON GRID 2a - 2a

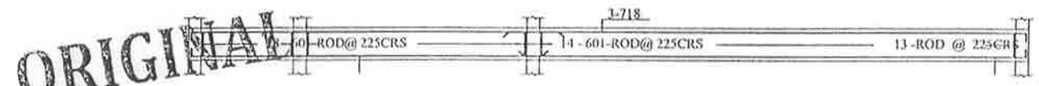


BEAM ON GRID 5 - 5

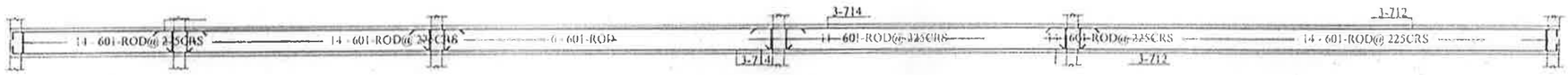


BEAM ON GRID B1 - B1

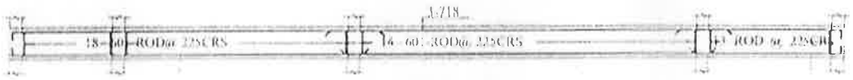
ORIGINAL



BEAM ON GRID 2a - 2a



BEAM ON GRID 3a - 3a



BEAM ON GRID B1 - B1



BEAM ON GRID E1 - E1



BEAM ON GRID A - A

NOTES

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CHARLES YAO-ATTA DAWSON, AGIA.
ARCHITECT
Reg. No. [illegible] Date 12/18
Signature

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE AMANFRO

NACRAB AND COMPANY
CONSTRUCTION CO.LTD.
P.O.Box 14714 Accra
Tell no: 0244548896 /0277678867
location: Opp korlebu police syation
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Loca: KOKROBITE - GREATER ACCRA

Scale	1/8" = 1'-0"
Design by	FELIX BUABENG POBEE
Drawn by	FELIX BUABENG POBEE
Checked By	SENE TOH
Date	NOVEMBER 2018
Drawing No	A/14

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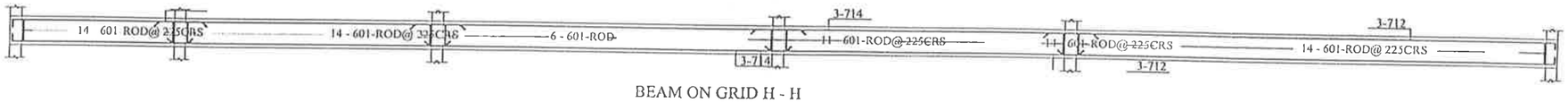
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B.P. No. CSM/A

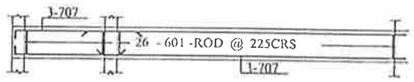
BOARD APPROVAL



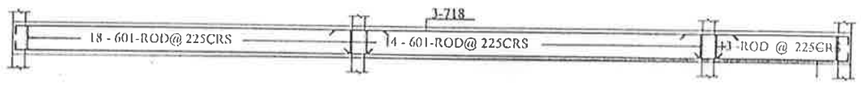
BEAM ON GRID I - I



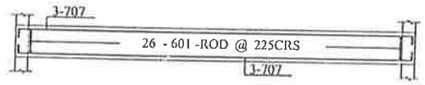
BEAM ON GRID H - H



BEAM ON GRID E1 - E1

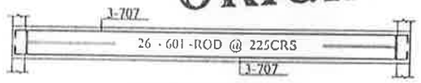


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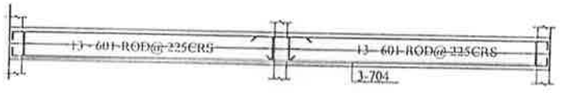


BEAM ON GRID 5a - 5a

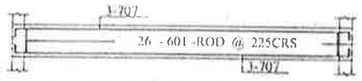
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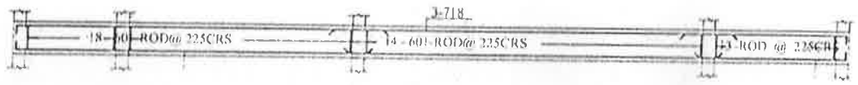
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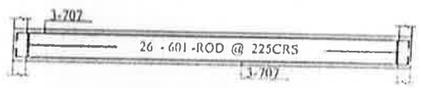
BEAM ON GRID E1 - E1



BEAM ON GRID
6a-6a



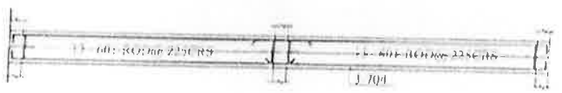
BEAM ON GRID E1 - E1



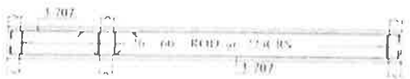
BEAM ON GRID 4a - 4a



BEAM ON GRID 5 - 5



BEAM ON GRID E1 - E1



BEAM ON GRID B1 - B1



BEAM ON GRID D - D



BEAM ON GRID G - G

NOTES

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CHARLES NAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 633 Date 5/12/18
Signature

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CONSTRUCTION CO.LTD.
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Tell no: 0244548896 /0277678867
location: Opp korlebu police syation
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING

client: THE WORD IN ACTION CHURCH

Town: KOKROBITE - GREATER ACCRA

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NGLESHIE - AMANFRO

Drawn	
Checked By	
Date	

SCALE	1:50
FELIX BUBUNG PORLE	
FELIX BUBUNG PORLE	
SIGNATURE	
NOVEMBER '17	
Drawing No.	A / 0

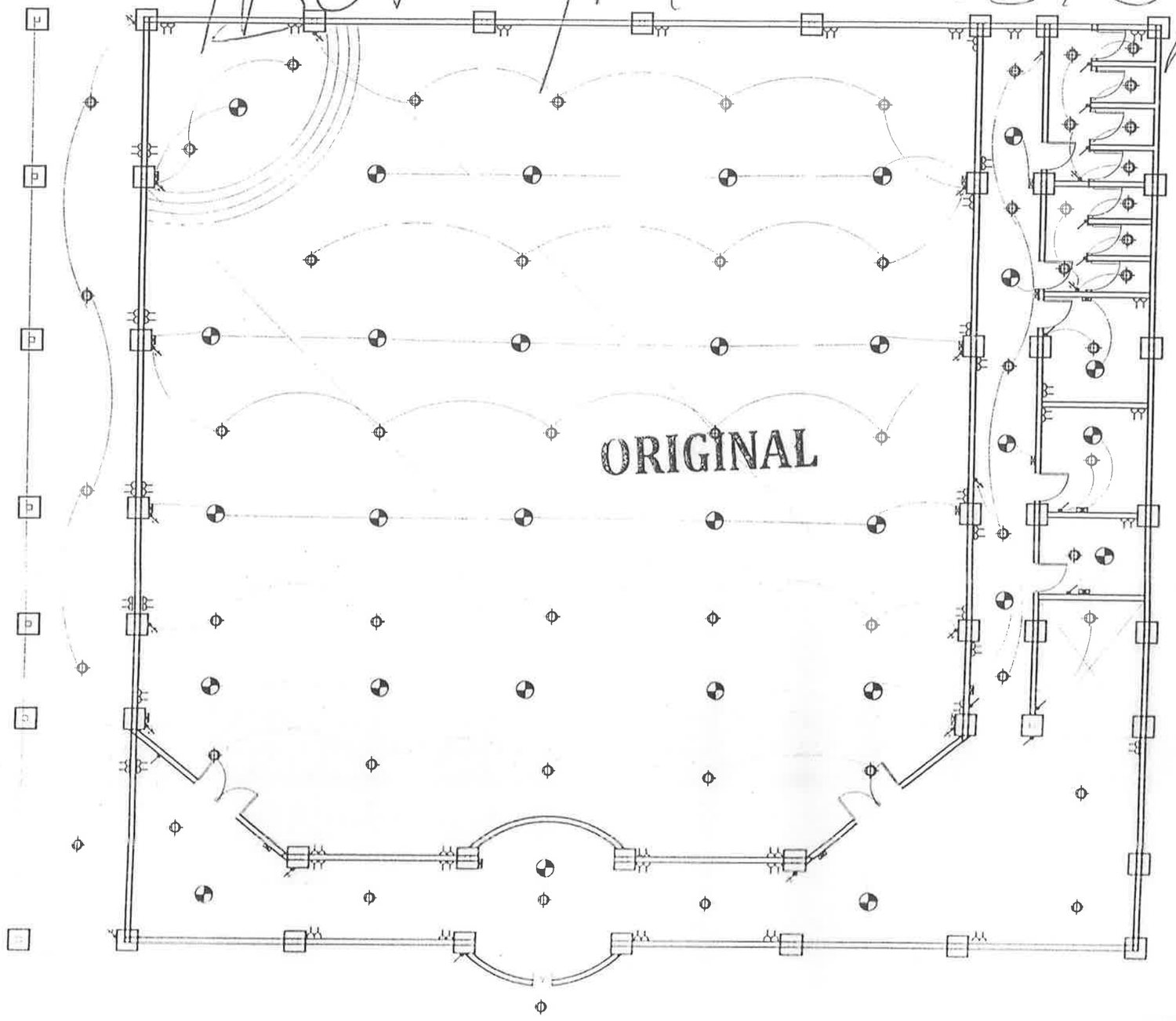
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B.P. No. GSMA

BORT/M020-0518/15



GROUND FLOOR PLAN

LEGEND

SYMBOL	DESCRIPTION
	20A DOUBLE POLE SWITCH WITH FLEX OUTLET
	15A A/C SWITCH SOCKET OUTLET
	13A SINGLE SWITCH SOCKET OUTLET
	13A TWIN SWITCH SOCKET OUTLET
	CEILING FAN REGULATOR
	TPN DISTRIBUTION BOARD
	METER BOARD

SYMBOL	DESCRIPTION
	10A 1WAY 1GANG SWITCH
	10A 1WAY 2GANG SWITCH
	10A 2WAY 1GANG SWITCH
	10A 2WAY 2GANG SWITCH
	2x20W FLUORESCENT FITTING
	2x40W FLUORESCENT FITTING
	CEILING MOUNTED LIGHTS
	WALL MOUNTED LIGHTS
	CHANDELIER LIGHTS
	CEILING FAN

CHARLES YAO-ATTA DAWSON AGIA
ARCHITECT
Reg. No. 033 Date 5/12/18
Signature

NACRAB AND COMPANY
CONSTRUCTION CO,LTD.
P.O.Box 14714 Accra
Tell no: 0244548896 /0263600310
location: Opp korlebu police station
Email: nattoah@yahoo.com;nattoah@hotmail.com /www.nacrab.com

Project: PROPOSED BUILDING
Client: THE WORD IN ACTION CHURCH

Town: BORTIANOR
GREATER ACCRA

ELETRICAL LAYOUT

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY

Designed By:
Drawn By:
Checked By:
Date: NOVEMBER '2018

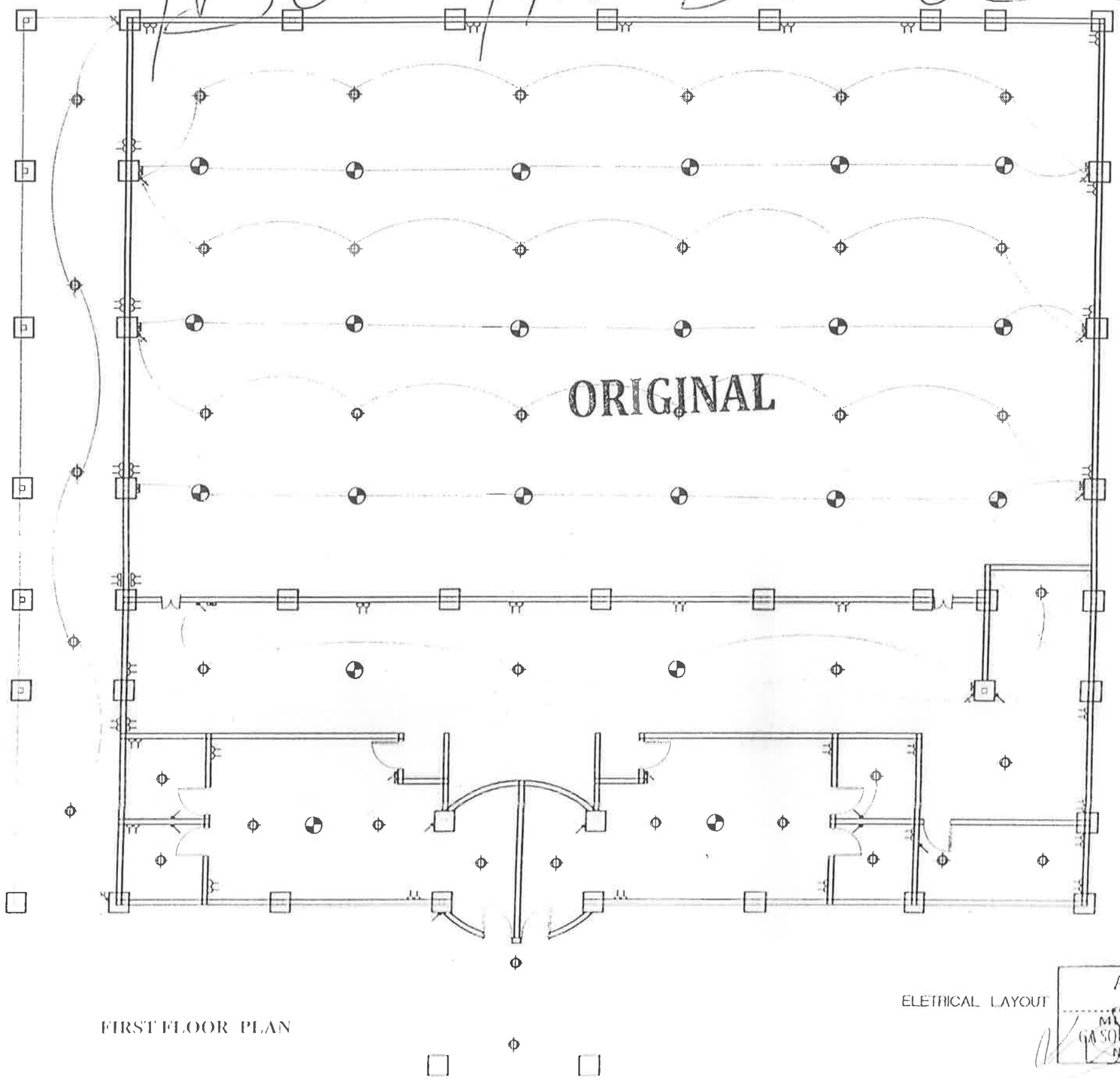
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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

B.P. No. GSMA

BORT/M020 0818/17



FIRST FLOOR PLAN

ELETRICAL LAYOUT

LEGEND

SYMBOL	DESCRIPTION
	20A DOUBLE POLE SWITCH WITH FLEX OUTLET
	15A A/C SWITCH SOCKET OUTLET
	13A SINGLE SWITCH SOCKET OUTLET
	13A TWIN SWITCH SOCKET OUTLET
	CEILING FAN REGULATOR
	TPN DISTRIBUTION BOARD
	METER BOARD

SYMBOL	DESCRIPTION
	10A 1WAY 1GANG SWITCH
	10A 1WAY 2GANG SWITCH
	10A 2WAY 1GANG SWITCH
	10A 2WAY 2GANG SWITCH
	2x20W FLUORESCENT FITTING
	2x40W FLUORESCENT FITTING
	CEILING MOUNTED LIGHTS
	WALL MOUNTED LIGHTS
	CHANDELIER LIGHTS
	CEILING FAN

CHARLES KWAO-ATTA DAWSON, GIA
ARCHITECT
Reg. No. 633 Date 5/12/17
Signature

NACRAB AND COMPANY
CONSTRUCTION CO,LTD.
P.O.Box 14714 Accra
Tell no: 0244548896 /0265600310
location: Opp korlebu police station
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING
Client: THE WORD IN ACTION CHURCH
BORTANOR
GREATER ACCRA

APPROVED BY
MUNICIPAL PLANNING OFFICER
GA SOUTH MUNICIPAL ASSEMBLY
NGEGBE - AMANFO

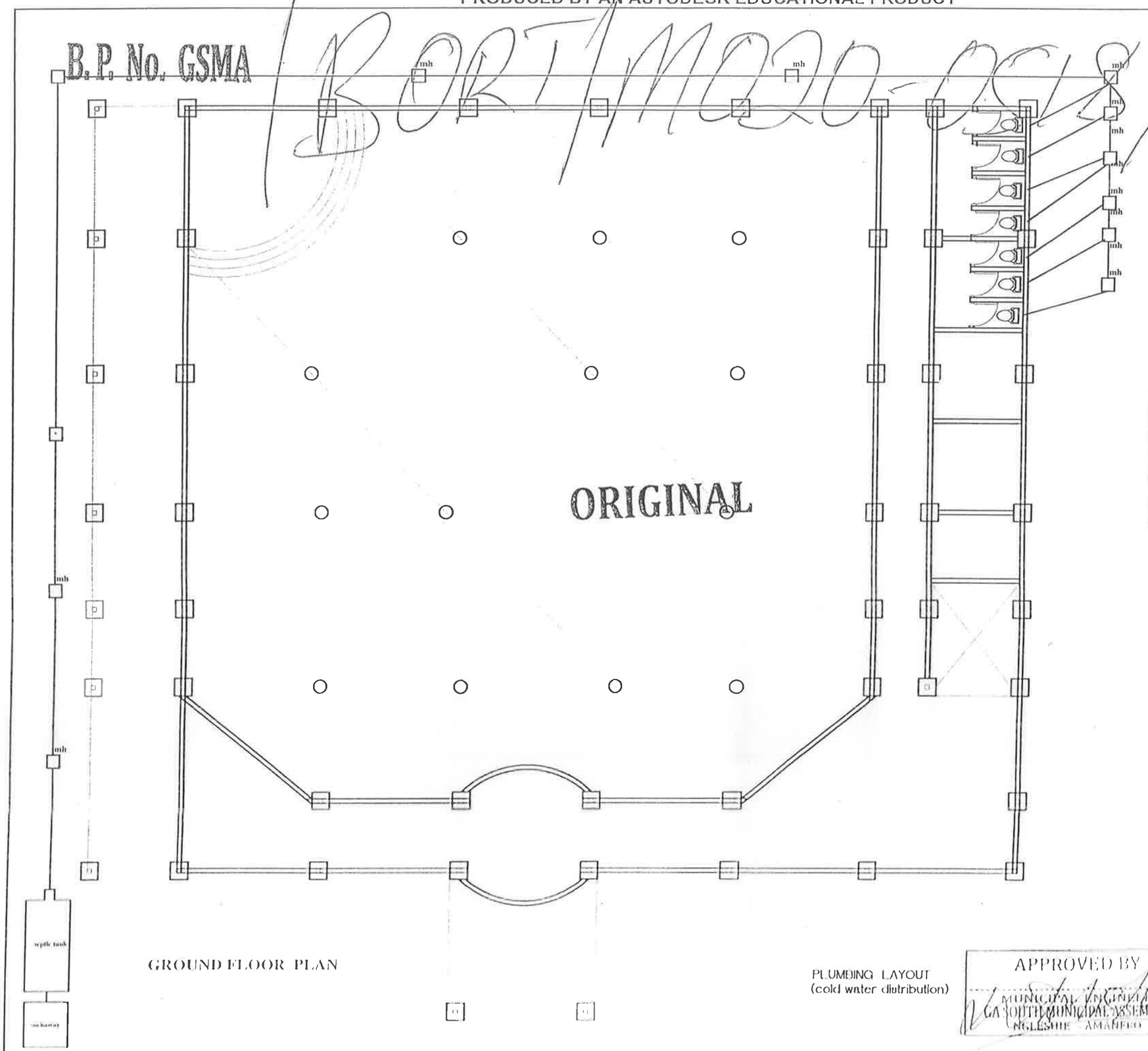
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B.P. No. GSMA /BORT/M020-0515

ORIGINAL



GROUND FLOOR PLAN

PLUMBING LAYOUT
(cold water distribution)

LEGEND

SYMBOL	DESCRIPTION
	COLD WATER PIPE
	STOP VALVE
	W. C. BOWL
	WASH HAND BASIN
	SHOWER TRAIL

CHARLES KAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 03[illegible] Date 23/12/18
Signature

NACRAB AND COMPANY
CONSTRUCTION CO.LTD.
P.O.Box 14714 Accra
Tell no: 0244348896 /0265600310
location: Opp korlebu police syation
Email: nittoah@yahoo.com,nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING
Client: THE WORD IN ACTION CHURCH
Local: BORTIANOR GREATER ACCRA

Scale	1:50 / 1:100
Design by	EETIA BUAHENG POBEE
Drawn by	EETIA BUAHENG POBEE
Checked by	
Date	NOVEMBER 2015
Drawing No.	L/1S

APPROVED BY
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NG.LESHIE AMADEO

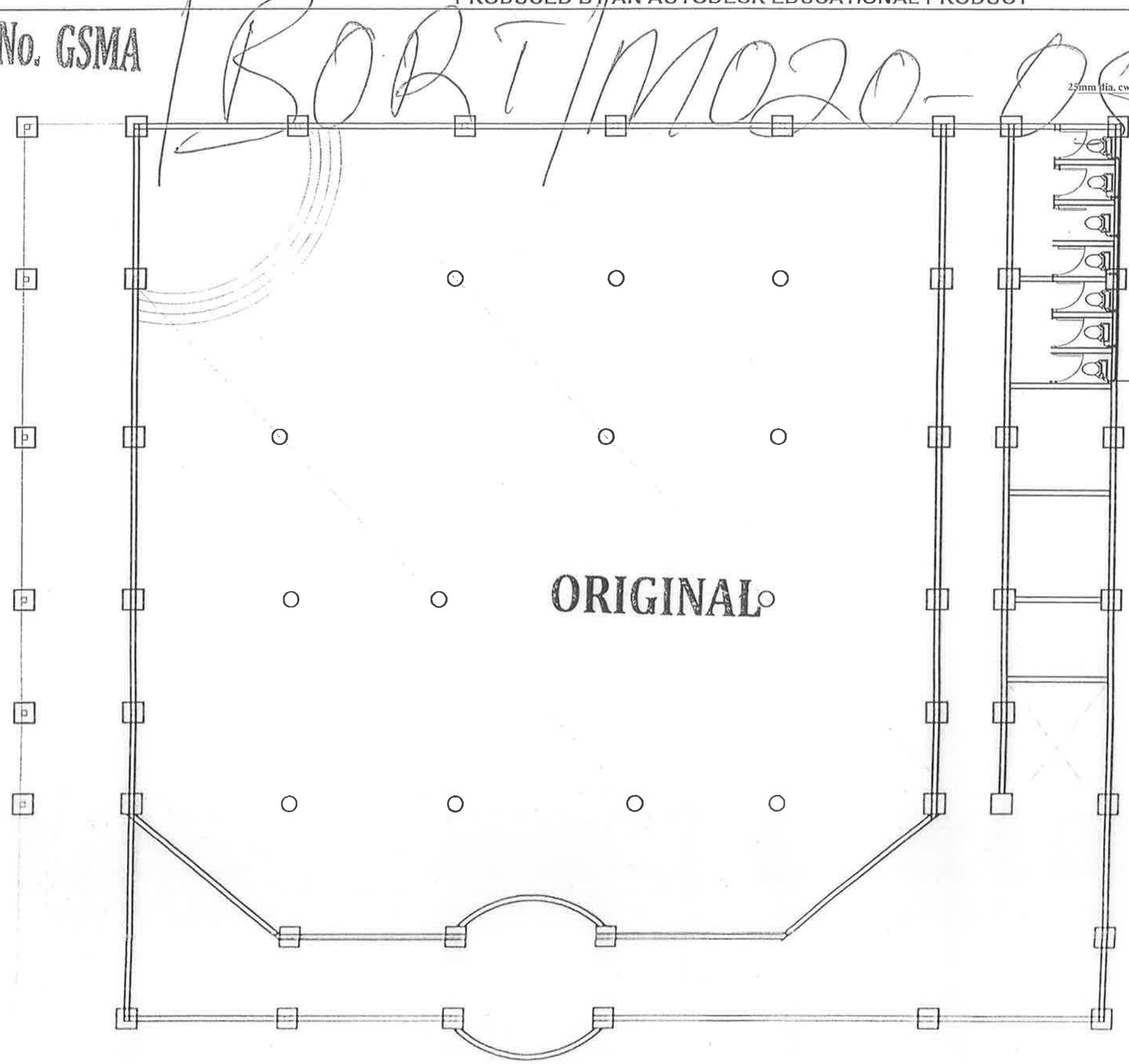
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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

B.P. No. GSMA /BORT/M020-0278

ORIGINAL



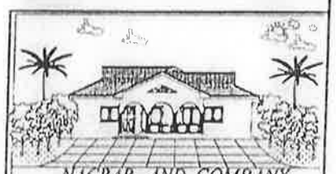
GROUND FLOOR PLAN

PLUMBING LAYOUT
(cold water distribution)

LEGEND

SYMBOL	DESCRIPTION
	COLD WATER PIPE
	STOP VALVE
	W. C. BOWL
	WASH HAND BASIN
	SHOWER TRAIL

CHARLES YAO-ATTA DAWSON, AGIA
ARCHITECT
Reg. No. 533 Date 8/12/19
Signature



NACRAB AND COMPANY
CONSTRUCTION CO.LTD.
P.O.Box 14714 Accra
Tell no: 0244548896 /0265600310
location: Opp korlebu police station
Email: nittoah@yahoo.com;nittoah@hotmail.com /www nacrab.com

Project: PROPOSED BUILDING
Client: THE WORD IN ACTION CHURCH
Area: BORTIANOR GREATER ACCRA

Scale	AS SHOWN
Drawn by	FELIX BOATENG PORBLE
Traced by	FELIX BOATENG PORBLE
Checked by	
Date	NOVEMBER 2019
Drawing No.	1/9

APPROVED BY
Cold water pipe from ground tank
MUNICIPAL ENGINEER
GA SOUTH MUNICIPAL ASSEMBLY
NOLESHIE AMANTSO

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

DATED THIS 14TH **DAY OF** JANUARY **2019**

DEED OF ASSIGNMENT

BETWEEN

KAY YAAKOR KWAO-SIMMONDS
P.O. BOX OS 048
OSU – ACCRA

AND

REV. MARK & MRS ERNESTINA AFRIFA MINTAH
18735 FORESTDEER RD, HOUSTON,
TX 77084, USA

ROBERT KINGSLEY YEBOAH, ESQ.
LLB (GH) BL
SOLICITOR/BARRISTER

SOLICITOR OF THE SUPREME COURT

LMDGHS1286744T2C21

DEED OF ASSIGNMENT

THIS DEED OF ASSIGNMENT is made this day of January Two Thousand and Nineteen (2019) BETWEEN KAY YAAKOR KWAO SIMMONDS of P.O. BOX OS 048 Osu – Accra in the Greater Accra Region of the Republic of Ghana (hereinafter called "The Assignor")of One part and REV. MARK & MRS ERNESTINA AFRIFA MINTAH both of 18735 Forestdeer Rd, Houston, TX 77084, USA (hereinafter called "The Assignees") pf the other part.

WHEREAS:

a) By a Statutory Declaration (hereinafter called "THE DECLARATION") dated 22nd November, 1977 and stamped as No. 12194B/77 and registered at the Deeds Registry as No. 5/1978 at the Lands Commission, Accra made by Nii Kwei Arku IV the Head and lawful Representative of Nii Kwei Arku Family of Bortianor the land and hereditaments described in the Declaration was declared as belonging to the said family and vested in Nii Kwei Arku IV for and on behalf of the Nii Kwei Arku Family.

b) By a Lease (hereinafter called "the Lease") dated 10th June, 1998 and registered as No. 3327/99 at the Lands Commission, Accra the parcel of land referred to in the schedule hereunder was leased by Nii Akotey IV in his capacity as the Head and lawful representative of the Nii Kwei Arku Family of Bortianor (therein referred to as "the Lessor") of the one part to Unique Guest House Limited (therein referred to as "the Lessee") of the other part for a term of Ninety-Nine (99) years commencing on 1st June, 1999.

c) By an unregistered Deed of Assignment dated 30th May, 2017 made between UNIQUE GUEST HOUSE LIMITED of the one part and KAY YAAKOR KWAO-SIMMONDS (the Assignor herein of the other part), the land subject matter of this assignment was granted to the Assignor herein for the residue of the unexpired term granted SUBJECT to the payment of the rent and performance and observance of the covenants and conditions thereof.

d) IN Pursuance to the Contract of Assignment dated 13th November, 2018 and made between the parties herein the Assignor agreed to assign all her interest in the Property described in the Schedule hereto (hereinafter called "the Property") to the Assignees for the residue of the unexpired term granted.

NOW THIS DEED WITHNESSETH as follows:

In consideration of the sum of..... paid by the Assignees to the Assignor (the receipt whereof the Assignor hereby acknowledges); the Assignor as beneficial owner hereby ASSIGNS unto the Assignees all that piece or parcel of land and hereditaments thereon known as the Property and demised by the Lease TO HAVE AND TO HOLD the same unto the Assignees all that piece or parcel of land containing an appropriate area of 0.96 Acres for the residue of the unexpired term granted by the said Assignor SUBJECT to the payment of the rent and performance and observance of the covenants and conditions on the part of the Lessee therein contained.

THE ASSIGNEES COVENANTS WITH THE ASSIGNOR as follows:

1) To pay the rent reserved and henceforth to observe and perform all the covenants, conditions and stipulations in the Lease which are capable of assignment.

2) To indemnify the Assignor fully against any liability the Assignor may incur as a result of any breach by the Assignees of any of the provisions in the Lease which run with the Property after this assignment.

THE ASSIGNOR COVENANTS WITH THE ASSIGNEES as follows:

1) To give vacant possession of the Property to the Assignees on the due date.

2) That all the rent reserved under the Headlease had been paid and the covenants, conditions and stipulations contained in the said Lease had been performed or observed up to the date of assignment.

IN WITNESS WHEREFORE the parties hereunto have set their respective hands and names the day first above written.

Appendix E : PERMIT PROCEDURE

PRE-PERMIT – DISTRICT ASSEMBLY

	Documents Required	Remarks by District Assembly	Means of Verification	Reviewer's Comments
A	**Submission of Application to the Physical Planning Dept (Secretariat of SPC)**			
A1	Site Plan (Local Plan Extract)		Local Plan	Conformity of zoning to approved Local Plan
A2	Architectural Drawings		A2	Signed by appropriate professional
A3	Structural Drawings		A3	Signed by appropriate professional
A4	Proof of Ownership		Land certificate, title deed, indenture	
A5	Geotechnical Report		A5	Signed by appropriate professional
A6	Traffic Impact Assessment (TIA)		A6	Signed by appropriate professional
A7	Environmental Impact Assessment (EIA) permit		A7	Issued by EPA
A8	Fire Safety Report/Certificate		A8	Issued by GNFS
A9	Others		A9	
**	*L.I. 2384 - 44(3a-f) 7 days*			*General comments*
B	**Review of Applications for Physical Development and Joint Site Inspection by Technical Sub-committee (TSC)**			
	Architectural Drawings		Minutes of Technical sub-committee. Joint Site Inspection Report	Verify **quorum** (6 out of 11 members). *L.I. 2384 – 7(3-4)* **1. Physical Planning Department head** **2. District Development Planning Officer** **3. Works Department Head** 4. NADMO head **5. Representative from Lands Commission** **6. Representative from EPA** **7. Head of Roads Unit or Urban Roads Dept.** 8. District fire officer 9. District Health officer 10. Two co-opted members one should be chair of urban council or sub-metro Check schedule for any specific comments on the application
	Structural Drawings			
	Proof of Ownership			
	Geotechnical Report			
	Traffic Impact Assessment (TIA)			
	Environmental Impact Assessment (EIA) permit			
	Fire Safety Report/Certificate			
	Others			
**	*L.I. 2384 - 44(7a-f) 14 days*			

	Documents Required	Remarks by District Assembly	Means of Verification	Reviewer's Comments
C	**Spatial Planning Committee (SPC) meeting for consideration of development applications**			
	Site Plan (Local Plan Extract)		Minutes of Spatial Planning Committee	Verify **quorum** (9 out of 15 members) *L.I. 2384 – 7(1-2)* **1. District Chief Executive** **2. District Coordinating Director** **3. Physical Planning Department head** **4. District Development Planning Officer** **5. Works Department Head** **6. NADMO head** **7. Representative from Lands Commission** **8. Representative from EPA** **9. Head of Roads Unit or Urban Roads Dept.** 10. Chairperson of Development Planning sub-committee 11. Chairperson of Works sub-committee 12. Representative from Traditional Council 13. Representative from Lands Commission 14. Two (2) elected Assembly members. Check schedule for any specific comments on the application
	Architectural Drawings			
	Structural Drawings			
	Proof of Ownership			
	Geotechnical Report			
	Traffic Impact Assessment (TIA)			
	Environmental Impact Assessment (EIA) permit			
	Fire Safety Report/Certificate			
	Others			
**	*L.I. 2384 - 44(8, 9,) 21 days*			
D	**Issuance of permit**			
	Architectural Drawings		Permit documents which is a copy of all that was submitted	The assigned individuals have duly signed the documents. **1.** District Physical Planning Officer **(ask if he is a member of a professional body)** **2.** Works Engineer **(ask if he is a members of a professional body)**
	Structural Drawings			
	Proof of Ownership			
	Geotechnical Report			
	Traffic Impact Assessment (TIA)			
	Environmental Impact Assessment (EIA) permit			
	Fire Safety Report/Certificate			
**	*L.I. 2384 - 44(10) 30 days*			

POST PERMIT – DISTRICT ASSEMBLY

	Documents Required	Remarks by District Assembly	Means of Verification	Reviewer's Comments
E	**Issuance of Certificate of habitation**			
1	Application **FORM 43D** from L.I. 2384		**FORM 43D**	Check for any specific comments on the state of the completed building in relation to the approved permit. Check for pictures
2	Inspection by Planning and Building Inspectorate (Section 158 of Act 925)		Inspection Report of the Planning and Building Inspectorate	
3	Certificate of habitation **FORM 43E**		**FORM 43E**	
**	*L.I. 2384 – 45 (15,16,17) 14 days*			

***NOTE: Number of days are cumulative**

Required documents

1. Permit application documents
    a. Architectural Drawings
    b. Structural Drawings
    c. Proof of Ownership
    d. Geotechnical Report
    e. Traffic Impact Assessment (TIA)
    f. Environmental Impact Assessment (EIA) permit
    g. Fire Safety Report/Certificate
    h. Any other requested by the Assembly
2. Minutes of Technical sub-committee including schedule of applications in connection with the proposed development application
3. Joint Site Inspection Report of the Technical Sub-committee on the site of the proposed development
4. Minutes of Spatial Planning Committee at which a decision on the proposed development was made
5. Copy of approved permit documents
6. Application for certificate of habitation **FORM 43D** from L.I. 2384
7. Inspection Report of the Planning and Building Inspectorate Unit (Section 158 of Act 925)
8. Certificate of habitation **FORM 43E** from L.I. 2384

Appendix F : TERMS OF REFERENCE (TOR)

TERMS OF REFERENCE

FOR

THE ADHOC COMMITTEE TO INVESTIGATE COLLAPSE OF BUILDINGS IN THE GREATER ACCRA AND NORTHERN REGIONS OF GHANA

Under the Auspices of

Ghana Institute of Planners (GIP)

Ghana Institute of Architects

Ghana Institution of Engineering

Ghana Institution of Surveyors

MAY 10, 2022

1. Background

Within a space of two weeks, about four storey buildings under construction have collapsed with some resulting to death and injuries across the country, and particularly in the Greater Accra Region and the Northern Regions. In the Greater Accra Region, there has been a coincidence of three-storey buildings collapsing at Nanakrom in the Adentan Munipality, West Adenta in the La Nkwantanang Madina Municipality and Old Bortianor in the Ga South Municipality. In the Northern Region, a six-storey building under construction at the University for Development Studies, City Campus in Sagnarigu is reported to have collapsed after a rainstorm on Saturday 6th May 2023.

In all these cases, initial information from media sources suggest that the developers do not have permit to build. Meanwhile, the public are deeply concerned that poor supervision on the part of the district assembly authorities is the main course of these disasters (Daily Graphic, Monday 8th May 2023, page 13).

Although the cause of these incidents appear to directly relate to structural failure, there are indications that other indirect causes related to institutional and procedural lapses as well as capacity challenges on the part of both the local planning authorities and the developers. Irrespective of the causes of this disaster, it is concerning that these disasters could recur and endanger public safety, cause loss of lives, property and livelihood if not checked. Unearthing the cause(s) of these disasters could help improve the existing development permitting and development control processes. It will also help create public awareness about the need to follow due processes and take steps to enhance existing capacity deficits on the part of officers responsible for permitting construction activities and prevent or minimize the reoccurrence of these disasters.

In line with the investigative powers conferred on the built environment professional institutions this terms of reference aims at providing guidance for investigations into circumstances leading to the collapse of the storey buildings under construction at the Old Bortianor, Adentan and La Nkwantanang Madina municipalities of the Greater Accra Region and the UDS Campus in the Sagnarigu Municipality of the Northern Region.

2. Composition of the Committee

Four different Adhoc Committees with representatives from the Ghana Institute of Planners, Ghana Institute of Architects, Ghana Institution of Engineering and Ghana Institution of Surveyors shall undertake this assignment. Each of the four Adhoc

Committees shall comprise:

- 1 Architect (GIA),
- 1 Structural Engineer(GhIE),
- 1 Geotechnical Engineer (GhIE),
- 1 Planner (GIP) and
- 1 Member Surveyor (GhIS)

Each of the 4 adhoc committees shall choose their own chairpersons and rapporteurs.

3. Scope of Work of the Committees

Each of the four Committees shall be responsible for investigating into circumstances leading to the collapse of the structure. The Committee shall specifically:

i. Ascertain whether the developers involved have acquired the requisite permit prior to commencement of development/construction.
ii. Assess the professional capacities of the professionals involved on both the side of the developer and the Municipal Assemblies.
iii. Assess the adequacy of existing institutional arrangements and procedures for review and approval of permits for construction as well as conduct of construction supervision and occupancy.
iv. Systematically collect data for analysis to determine the cause of the collapse based on initial observations, witness account and available records of the building construction.
v. Conduct structural assessment of the collapsed building and any available records of the building construction.
vi. Identify any liability based on the findings including designs, construction and supervision. and building code violation.
vii. Prepare report including conclusions and recommendations.

4. Deliverables

The Committee shall be required to deliver a report outlining the methodology for the investigations, key findings and recommendations for policy consideration.

5. Duration of Mandate

The Committee shall work from May 22, 2023 to June 05 2023 per the following schedule.

18th May, 2023: Official inauguration of the 4 adhoc Committees (Press Conference)

22nd May, 2023: Commencement of work by the 4 Adhoc Committees

5th June, 2023: 3 Completion of work and submission of report by the 4 Adhoc Committees.

6. Reporting Structure

- The Committees shall submit their respective reports through the built environment professional coordinating group to the Ministers responsible for Local Government and Works and Housing
- The Committee members shall not speak to the media and other external stakeholders on contents of the report.
- On 6th June 2023, the findings of these investigations shall be disclosed as a short press briefing

7. Composition of Adhoc Committees

a. Old Bortianor (Ga South Municipal Assembly)

1. Arc. Freeman Kwame Agbomanyi, 024.087.6610, 020.824.9461
2. Pln. Eugene Nyansafo, 020.356.8526
3. Surv. Ian Agbenyega (Quantity Surveyor), 024.461.0299
4. Surv. Naa Ayele (Land Surveyor), 054.528.6752
5. Surv. Dr. Benjamin Armah Quaye (Valuation and Est. Surveyor), 050.132.2686
6. Ing. Sampson Agudze (Structural Engineer), 024.131.4109
7. Ing. David Dzitse-Awuku (Geotechnical Engineer), 024.448.0893

b. **Nanakrom** (Adenta Municipal Assembly)

1. Arc. Justice Kwame Offei-Nketiah, 024.236.3298
2. Pln. Dr. Benedict M. Arkhust, 020.148.3068
3. Surv. Benjamin Kwasi Larbi (Quantity Surveyor), 024.452.3474
4. Surv. Franklin Liggie-Kudonoo (Land Surveyor), 024.025.9270
5. Surv. Edem Feglo (Valuation and Estate Surveyor), 024.851.8947
6. Ing. Joshua Allotey (Structural Engineer), 024.424.1296
7. Ing. Kweku Solomon (geotechnical Engineer), 054.886.7345

c. **West Adentan** (La Nkwantanang Madina Municipal Assembly)

1. Arc. Chezrie Degraft Takyi, 024.420.2241
2. Pln. Felix Ofei, 020.055.0000
3. Surv. Ruweida Ibrahim Adam (Quantity Surveyor), 024.901.0770
4. Surv. Jacob Kwame Boateng (Land Surveyor), 020.791.4472
5. Surv. Jefferson Zumegah (Valuation and Estate Surveyor), 054.437.3366
6. Ing. Obeng Afari (Structural Engineer), 020.871.5557
7. Ing. Joseph Oddei (geotechnical Engineer), 024.472.6164

d. University of Development Studies, Sagnarigu Campus

1. Arc. Desmond Opoku, 024.402.9103
2. Pln. Sylvester Yinubah Gyogluu, 020.333.0453
3. Surv. Roland Kambase (Quantity Surveyor), 020.879.3706
4. Surv. Robert Clottey (Land Surveyor), 024.473.2372
5. Surv. Samuel Atta Gyarten (Valuation and Estate Surveyor), 020.024.0100
6. Ing. Francis Suglo (Structural Engineer), 024.099.6831
7. Ing. Fred Owusu Nimo (Geotechnical Engineer), 054.333.3174

NOTE: Each Adhoc Committee will appoint a Chairperson and a Secretary.

Appendix G : STRUCTURED INTERVIEW QUESTIONS

Building Owner/Developer

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions:

Section A. General Questions

1. When did the construction works commenced; when was it completed; and when was it commissioned?

   (a) Commencement date _____

   (b) Completion date _____

   (c) Commissioning date _____

2. The building structure was how many stories? _____

   Composition: Basement ☐ Ground Floor ☐

   First Floor ☐ Second Floor ☐

3. What was the actual use of the building? _____

4. Indicate the specific use of the following floors:

   ☐ Basement _____

   ☐ Ground Floor _____

   ☐ First Floor _____

   ☐ Second Floor _____

5. Does the church has a Building Committee or Project Committee?

   Yes ☐ No ☐

6. Did the church acquired building permit?

   Yes ☐ No ☐

   If Yes, provide date/name of Assembly _____

7. Did the construction works started before the permit was granted?

   Yes ☐ No ☐

   If Yes, indicate stage of construction _____

8. What was the original number of stories submitted to the assembly for the permit? _____

9. Was the structure built in accordance with the original drawings approved by the assembly without any changes?

   Yes ☐ No ☐

   If No, briefly explain changes made during construction

   _____

   _____

10. Was the design of the building awarded to any consultant/ building professional?

    Yes ☐ No ☐

    Is yes, provide name of consultant/professional _____

    _____

    If No, why? _____

11. Was the construction project awarded to any contractor?

    Yes ☐ No ☐

    If Yes, provide name of consultant _____
    If No, why? _____

12. Was the construction works supervised by consultants/ certified construction professionals?

    Yes ☐ No ☐

    If Yes, provide name of the consultant _____

    If No, who supervised the construction? _____

13. Are [is] the supervisor(s) certified construction professionals?

    Yes ☐ No ☐

    If yes, provide profession _____

    If No, provide profession _____

14. Which criteria was used to certify the quality of work done before approval?

    _____

    _____

15. Were there any tests performed on the materials during the construction phase?

    Yes ☐ No ☐

    If yes, provide list of tests _____

16. Did you observed (or did the workers reported) any issue of ground water encountered during the excavation works at the construction stage?

Yes ☐ No ☐

17. Were there any visible warning signs or structural issues (e.g. cracks) observed prior to the collapse?

Yes ☐ No ☐

18. Were there any ongoing repairs or renovations or additional works on the building prior to the collapse?

Yes ☐ No ☐

19. Were there any previous structural assessments or inspections conducted on the building prior to the collapse? If so, when and by whom?

Yes ☐ No ☐

If yes, when and by whom? _____

20. Were there any reports of unusual noises, cracks, vibrations or signs of distress observed in the building prior to the collapse?

Yes ☐ No ☐

If yes, briefly describe _____

_____

_____

21. Did you receive any warnings or concerns from church members about the structural safety of the building?

Yes ☐ No ☐

If yes, briefly describe _____

_____

22. Does the church experience occasional flooding on the premises after every heavy downpours?

Yes ☐ No ☐

If yes, how many times does it usually occur in a year, and when was the last time this occurred? _____

23. What is the purpose of the wells/sumps and pumps situated on the church compound?

_____

_____

_____

24. Were there any emergency response plans in place for the building?

Yes ☐ No ☐

If yes, briefly describe _____

_____

25. Does the church has any insurance policy for the building or congregants?

Yes ☐ No ☐

If yes, kindly provide name of insurance company and type of insurance

_____

_____

_____

Section B. Pre-Permit

26. What documents did the Assembly require you to submit for your permit application?

(a) Architectural Drawings ☐

(b) Structural Drawings ☐

(c) Proof of Ownership ☐

(d) Geotechnical Report ☐

(e) Traffic Impact Assessment (TIA) ☐

(f) Environmental Impact Assessment (EIA) permit ☐

(g) Fire Safety Report/Certificate ☐

(h) Any other requested by the Assembly specify ☐

_____

_____

27. Did the Joint Technical Sub-committee conducted any inspection of your site?

Yes ☐ No ☐

28. What kinds of fees were you required by the Assembly to pay?

(a) Processing fee ☐

(b) Permit fee ☐

(c) Others specify ☐_____

29. How long did it take for the church to secure the development permit? _____

30. How did the Assembly communicated its decisions to the church (e.g. example through text message, phone calls, etc.)? _____

Section C. Post-Permit

31. Did the Assembly visited the site during the construction phase?

    Yes ☐ No ☐

    If yes, how many times and at what stages? _____

    _____

32. Did the planning and building inspectorate offer the church any advice during their visit to the site?

    Yes ☐ No ☐

    If yes, indicate specific advice _____

33. Did the church apply for a certificate of habitation upon completion of the construction from the Assembly?

    Yes ☐ No ☐

    If yes, was it granted and how was the decision communicated to you?

    _____

    _____

34. Has the Assembly demanded from the church to provide certificate of habitation?

    Yes ☐ No ☐

    If Yes, any basis for the demand? _____

    _____

    _____

    _____

35. Did the church had any plans to make any extension/renovations to the structure by increasing the number of stories?

    Yes ☐ No ☐

    If yes, how many stories did you intended to add? _____

36. Did the church applied to the assembly for any extension/renovation works, and was the permit granted?

    Yes ☐ No ☐

    If No, why was the permit not granted? _____

37. Did the church applied to the assembly to grant permit for gazetting the premises for marriages?

Yes ☐ No ☐

38. Was the application for the gazetting granted?

Yes ☐ No ☐

If yes, which date was it granted? _____

If No, why was the permit not granted? _____

_____

_____

_____

Section D: Conclusion

39. In your view, do you think a quality work was done during the construction?

Yes ☐ No ☐

40. In your view, what do you think was the probable cause of collapse of the building?

_____

_____

_____

41. What will you do differently if you are given the opportunity to rebuild or if you have the opportunity to build another structure?

_____

_____

_____

42. Do you have any additional information you wish to share with the Committee?

Yes ☐ No ☐

If Yes, kindly share _____

_____

_____

_____

_____

_____

Ga South Municipal Assembly:

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Are you [interviewee] a member of any professional body and what is your area of specialisation?

   Yes ☐ No ☐

   If yes, name of professional institution _____

   Area of specialisation _____

2. Is the Works Engineer a member of any professional body, and what is his area of specialisation?

   Yes ☐ No ☐

   If yes, name of professional body _____

   Area of specialisation _____

3. Is the District Physical Planning Officer a member of any professional body, and what is his area of specialisation?

   Yes ☐ No ☐

   If yes, name of professional body _____

   Area of specialisation _____

4. Kindly briefly explain the basic steps followed by the Ga South Municipal Assembly in granting a development permit (i.e. brief permit procedure).

   _____

   _____

   _____

   _____

   _____

   _____

   _____

5. What documents did the Assembly requested to be submit for the permit application?

   (a) Architectural Drawings ☐
   (b) Structural Drawings ☐
   (c) Proof of Ownership ☐
   (d) Geotechnical Report ☐
   (e) Traffic Impact Assessment (TIA) ☐
   (f) Environmental Impact Assessment (EIA) permit ☐
   (g) Fire Safety Report/Certificate ☐
   (h) Any other requested by the Assembly specify ☐

   _____

   _____

   _____

6. Did the Joint Technical Sub-committee conducted any inspection of the site prior to the approval of the permit application?

   Yes ☐ No ☐

7. What kinds of fees were the developer required to pay upon submission of the application?

   (a) Processing fee ☐
   (b) Permit fee ☐
   (c) Others specify ☐_____

8. As per the documents provided by the Assembly, the permit was granted on 18th June 2018 and expires on 18th June 2023. Is that Correct?

   Yes ☐ No ☐

9. In your estimation, how long did it take the assembly to issue the permit after the application by the church? _____

10. How did the Assembly communicated its decisions to you church after the approval? _____

11. Did the Assembly visited the site during the construction phase?

    Yes ☐ No ☐

    If yes, how many times and at what stages? _____

    _____

    _____

_____

12. Did the Assembly noticed any non-compliance issues during the site visits and what was recommended?

Yes ☐ No ☐

If yes, indicate non-compliance issue detected and the recommendation

_____

_____

_____

_____

13. Did the church applied for certificate of habitation upon completion of the construction works?

Yes ☐ No ☐

If Yes, was it granted? _____

_____

_____

14. From the existing documents provided by the Assembly to the Committee, we noticed that the church applied for gazetting of the premises for marriages on 6th January 2022. Following this request, officers from the assembly, on 9th May 2022 carried out the inspection. We noticed that it took about 5 months before the assembly visited the site to carry out the inspection. That was quite a long time – Is that the usual practice?

Yes ☐ No ☐

Is No, what is the usual practice? _____

_____

_____

_____

15. With reference to the inspection report for the gazetting, the Assembly recommended that the church should produce as-built architectural and structural drawings, and a structural integrity report? Was these recommendations officially (through writing) communicated to the church?

Yes ☐ No ☐

If Yes, has the church provided the documents? _____

_____

_____

16. Has the assembly received any complaints from the church or the public with regard to the structural safety of the church building?

Yes ☐ No ☐

If Yes, briefly describe the concerns raised? _____

_____

_____

17. Do you have any additional information you wish to share with the Committee?

Yes ☐ No ☐

If Yes, kindly share _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Foreman

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Was your company/firm responsible for construction of the building?

   Yes ☐ No ☐

2. Kindly provide the following details of your company/firm.

   Name of company _____

   Classification of Company _____

   Year of registration _____

   Number of years of operation _____

3. Are you a construction professional? Kindly provide the following details.

   Yes ☐ No ☐

   Name of professional body _____

   Area of specialisation _____

   Number of years of experience _____

4. How did you [or your company] procure the contract? Can you briefly explain?

   _____

   _____

   _____

   _____

5. What was the duration of the contract? _____

6. Were you provided with the approved construction drawings and other documents for the construction works?

   Yes ☐ No ☐

   If yes, kindly provide list of the documents received _____

   _____

   _____

   _____

_____

7. Did you requested for other relevant documents that were not provided?

   Yes ☐ No ☐

   If yes, provide list of documents requested_____

   _____

   _____

   _____

   _____

8. Can you provide the Committee with copies of the contract/construction documents?

   Yes ☐ No ☐

9. When did the construction works commenced and completed?

   Commencement date _____

   Completion date _____

10. Can you provide the list of professionals in your company who were directly engaged in the construction works?

    Yes ☐ No ☐

    If yes, provide list of professionals' _____

    _____

    _____

    _____

11. What is the name, area of specialisation and number of years of experience of your site supervisor/ foreman who supervised the project?

    Name of site supervisor/foreman _____

    Area of Specialisation _____

    Number of years of experience _____

12. Did you conducted any tests on the materials during the construction phase?

    Yes ☐ No ☐

    If yes, provide list of tests _____

13. Were there any variations from the approved construction plans?

    Yes ☐ No ☐

If yes, briefly explain _____

_____

_____

_____

14. Did the construction team encountered any structural challenges or issues during construction?

Yes ☐ No ☐

If yes, what were the challenges and were they addressed?

_____

_____

_____

15. Were there any changes made to the building design during construction, and were these changes properly reviewed and approved?

Yes ☐ No ☐

If yes, what kind of changes?_____

_____

_____

16. Do you have as-built/outline drawings of the structure?

Yes ☐ No ☐

If yes, can you provide us with copies? _____

17. Kindly provide the following information of your steel bender who worked on the project

Name of steel bender _____

Number of years of experience _____

Membership of professional body _____

18. Can you give us the size, type and depth of the foundation?

Yes ☐ No ☐

If yes, Size, type and depth? _____

19. In your view, do you think a quality work was done during the construction?

Yes ☐ No ☐

20. In your view, what do you think was the probable cause of collapse of the building?

_____

_____

_____

21. What will you do differently if you [or your company] are given the opportunity to reconstruct the building or if your company is awarded another contract in the future?

_____

_____

_____

_____

22. Do you have any additional information you wish to share with the Committee?
Yes ☐ No ☐

If Yes, kindly share _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

The Structural Draughtsman:

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Are you a member of any professional association/institution?

   Yes ☐ No ☐

   If yes, kindly provide name of the association/ grade of membership

   _____

   _____

2. What is your area of specialisation?

   _____

   _____

3. Were you the design Engineer for the structure?

   Yes ☐ No ☐

   If yes, indicate area of specialisation _____

4. Do you have a license to practice?

   Yes ☐ No ☐

   If yes, indicate specialised area for which the license was granted _____

   _____

5. Kindly provide us with list of initial documents provided for the design.

   _____

   _____

   _____

6. Did you requested for other relevant documents that were not provided?

   Yes ☐ No ☐

   If yes, provide list of documents requested_____

   _____

_____

7. Kindly provide details of the following with regard to the design:

   Intended use of the structure _____

   Live load used for the design _____

   Concrete and rebar grade _____

   Bearing capacity for foundation design _____

   Analysis/design software used _____

   Was lateral loads (wind and seismic) considered in the design? _____

   Design codes adopted for the design _____

8. Did you provided standard structural drawings for the construction works?

   Yes ☐ No ☐

   If No, why _____

9. Did you supervised the construction works?

   Yes ☐ No ☐

10. Did you conduct any inspections or site visits during the construction phase as the designer?

    Yes ☐ No ☐

    If yes, any concerns raised or areas of non-compliance? _____

    _____

    _____

    _____

11. In your view, what do you think must have led to the collapse of the building?

    _____

    _____

    _____

12. What will you do differently if you are given the opportunity to redesign the building or if you have another job in the future?

    _____

    _____

    _____

13. Do you have any further information you would like to share with the Committee?

    Yes ☐ No ☐

If yes kindly share_____

_____

_____

_____

_____

Endorsing Architect:

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Are you a member of any professional association/institution?

   Yes ☐ No ☐

   If yes, kindly provide name of the association/ grade of membership

   _____

   _____

2. What is your area of specialisation?

   _____

   _____

3. Were you the architect engaged for the works?

   Yes ☐ No ☐

4. Were you the one who produced the architectural drawings?

   Yes ☐ No ☐

   If No, who produced the drawings? _____

5. Did you stamped, signed and approved the architectural drawings?

   Yes ☐ No ☐

   If yes, did the drawing met the minimum requirements? _____

6. Were you the one who produced the structural drawings?

   Yes ☐ No ☐

   If Yes, was the structured designed and to what standard? _____

   _____

   If No, who designed and produced the drawings? _____

   _____

7. Did you stamped, signed and approved the structural drawings?

   Yes ☐ No ☐

8. Do you have license to stamp, sign and approve structural drawings?

   Yes ☐ No ☐

   If No, why did you stamped and signed the structural drawings?

   _____

   _____

9. What criteria (or checklist) was use to ascertain the correctness of the structural drawings?

   _____

   _____

   _____

10. Did you supervised the construction works?

    Yes ☐ No ☐

11. Did you conduct any inspections or site visits during the construction phase as the designer?

    Yes ☐ No ☐

    If yes, any concerns raised or areas of non-compliance? _____

    _____

    _____

    _____

12. In your view, what do you think must have led to the collapse of the building?

    _____

    _____

    _____

    _____

13. What will you do differently if you are given the opportunity to redesign the building or if you have another job in the future?

    _____

    _____

    _____

14. Do you have any further information you would like to share with the Committee?

    Yes ☐ No ☐

If yes kindly share_____

_____

_____

_____

_____

_____

The Architectural Draughtsman:

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Are you a member of any professional association/institution?

   Yes ☐ No ☐

   If yes, kindly provide name of the association/ grade of membership

   _____

   _____

2. What is your area of specialisation?

   _____

   _____

3. Were you the draughtsman engaged for the works?

   Yes ☐ No ☐

4. Were you the one who produced the architectural drawings?

   Yes ☐ No ☐

   If No, who produced the drawings? _____

5. Did you conducted any site inspection before producing the drawings?

   Yes ☐ No ☐

   If yes, what specific things did you check during the site visit and what were your findings? _____

   _____

   _____

   _____

6. Who stamped, signed and approved the architectural drawings for you?

   Yes ☐ No ☐

If yes, did the drawing met the minimum requirements? _____

7. Were you the one who produced the structural drawings?

   Yes ☐ No ☐

   If Yes, was the structured designed and to what standard? _____

   _____

   If No, who designed and produced the drawings? _____

   _____

8. Who stamped, signed and approved the structural drawings?

   Yes ☐ No ☐

9. Did you supervised the construction works?

   Yes ☐ No ☐

10. Did you conduct any inspections or site visits during the construction phase as the designer?

    Yes ☐ No ☐

    If yes, any concerns raised or areas of non-compliance? _____

    _____

    _____

    _____

11. In your view, what do you think must have led to the collapse of the building?

    _____

    _____

    _____

    _____

12. What will you do differently if you are given the opportunity to redesign the building or if you have another job in the future?

    _____

    _____

    _____

13. Do you have any further information you would like to share with the Committee?

    Yes ☐ No ☐

    If yes kindly share_____

    _____

Block Factory

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. In which year was the block factory established at the current location?
   _____
2. Was the block factory established before the church building was constructed?
   Yes ☐ No ☐

   If Yes, id the factory supplied any materials during the construction?

   _____

   _____
3. Did the factory supplied any materials during the construction?
   Yes ☐ No ☐

   If Yes, what materials were supplied? _____

   _____

   _____
4. Did you witnessed the structure when it was collapsing?
   Yes ☐ No ☐

   If Yes, kindly briefly share your experience/observations _____

   _____

   _____
5. Do you have any video footage during the collapse that you will like to share with the Committee?
   Yes ☐ No ☐
6. How many equipment/ plant do you have on this premises? _____
7. Can you provide us with the details of the equipment or plant?

Yes ☐ No ☐

If Yes, can you provide us with details of the equipment/plant?

_____

_____

8. Has the church reported any issue concerning some vibrations they usually experience on their premises?

Yes ☐ No ☐

If yes, what have you done to mitigate the vibrations reported to you?

_____

_____

_____

_____

9. Is it possible to take the team round to inspect the machines?

Yes ☐ No ☐

10. Do you have any other information or concerns you would like to share with the Committee?

Yes ☐ No ☐

If Yes, kindly share your _____

_____

_____

_____

_____

_____

_____

_____

The Caretaker

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Were you [or are you] the Caretaker of the church and for how long?

   Yes ☐ No ☐

   Period in years _____

2. Do you have any knowledge in construction?

   Yes ☐ No ☐

3. Were you involved in the construction of the building?

   Yes ☐ No ☐

   If yes, what was your role? _____

4. Did you witnessed the construction stage of the building?

   Yes ☐ No ☐

   If yes, observations _____

   _____

   _____

   _____

   _____

5. Can you take us through a virtual tour through interior part of the building?

   Yes ☐ No ☐

   Keynotes _____

   _____

   _____

   _____

6. Have you seen and/or reported any incidence of cracks or other defects observed to the Pastor?
   Yes ☐ No ☐

   If Yes, briefly describe_____

   _____

   _____

   _____

   _____

7. Have you observed and/or reported any issue of vibrations in the building to the Pastor?
   Yes ☐ No ☐

   If Yes, briefly describe_____

   _____

   _____

   _____

8. Did you witnessed the collapse of the building?

   Yes ☐ No ☐

   If Yes, briefly describe_____

   _____

   _____

9. Do you have any video footage of the collapsed building during collapse?
   Yes ☐ No ☐

   If Yes, can you share a copy? _____

   _____

   _____

10. Do you have any additional information you wish to share with the Committee?

    Yes ☐ No ☐

    If Yes, kindly share _____

    _____

    _____

    _____

    _____

    _____

    _____

Some Selected Church Members:

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Did you notice any signs of deterioration, structural issues, or maintenance problems in the building?

   Yes ☐ No ☐

   If Yes, briefly describe your observations

   _____

   _____

2. Were there any unusual events or occurrences in the building before the collapse that might be relevant?

   Yes ☐ No ☐

   If Yes, briefly describe_____

   _____

3. Were there any concerns raised to the pastor/ authorities (Municipal Assembly) regarding the building's safety?

   Yes ☐ No ☐

   If Yes, briefly explain _____

   _____

4. Do you have any additional information or concerns you will like to share with the Committee?

   Yes ☐ No ☐

   If Yes, kindly share _____

   _____

   _____

   _____

   _____

Eye Witnesses / Nearby Residents

Interviewee details

Name of Interviewee: _____

Date of interview : _____

Time of interview : _____

Questions

1. Did any witnesses or nearby residents observe or capture any footage or photographs of the collapse?

   Yes ☐ No ☐

   If Yes, can you provide us with the evidence? _____

   _____

2. Do you have any concerns you want to share?

   Yes ☐ No ☐

   If Yes, kindly share your concerns _____

   _____

   _____

   _____

   _____

   _____

   _____