

REPORT ON DESIGN OF GHANA STOCK EXCHANGE

By

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KNUST

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of

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Architecture and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Stock exchanges over the world are used as the engine for economic and industrial development. They offer a suitable platform for diverse people to contribute their varying funds to the development of corporate establishments. This offers a drive to help improve the economy and grow funds in such a way as to ensure that funds are not left idle but continuously put into the growth of the economy. This therefore brings to the fore the need to develop the Ghana Stock Exchange into a more strategic economic component to help achieve the millennium development goals. In this regard the development of a purpose built building for the Ghana Stock Exchange is in the right direction. This design report enumerates and discusses the processes in the development of an architectural design proposal for the construction of a Ghana Stock Exchange building. It documents all studies carried out to help the design process and explains the process and design of the final proposal.



Praise and honour be unto the Almighty God for being a blessing and guardian throughout the entire period of the study and writing of this thesis. The completion of this thesis is not by my own might but by your sustaining grace upon me.

My sincere regards and gratitude are given to my lecturer and supervisor, Mr. Samuel Amadi.

Also, you have been my physical guide and help and I thank you for all the time you spent out of your busy schedule to go through my design and read this report and help me make the necessary corrections. My regards also go to all my relatives in the department of architecture.

DEDICATION

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As a student of architecture, I extend my heartfelt gratitude and appreciation to

This design is dedicated to my beloved parents MR. and MRS. TAKPO NA WIDAANA II

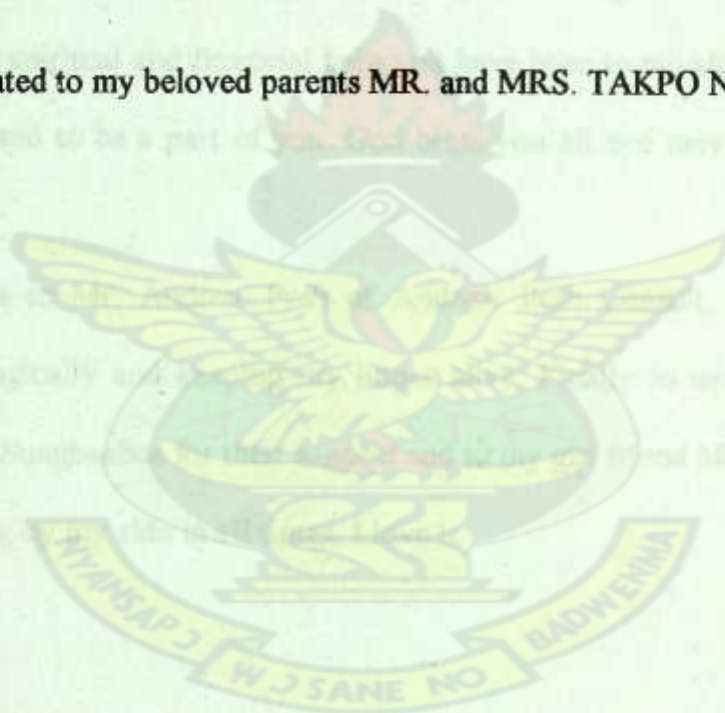
For this, I am truly blessed to be a part of this institution and all the love and support you have given me.

My gratitude also goes to Mr. Samuel Amadi, Lecturer in Architecture, for being of

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for always being there for me in all my needs.



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Praise and honour be upon the Almighty God for being a blessing and guardian throughout the entire period of the study and writing of this thesis. The completion of this thesis is not by my might but by your unrelenting grace upon me.

My sincere regards and gratitude also goes to my lecturer and supervisor, Mr. Samuel Amos-Abanyie, you have been my physical guide and help and I thank you for all the time you took out of your busy schedule to go through my designs and read this report and help me make the necessary corrections. My regards also goes to all my lecturers in the department of architecture, KNUST, for lecturing me and my class throughout all these years.

My entire family has been a blessing on me. I extend my heartfelt gratitude and appreciation to all of you for the moral spiritual and financial help you have been to me all the years of my life to date. I am truly blessed to be a part of you. God bless you all and may all your life wishes come to pass.

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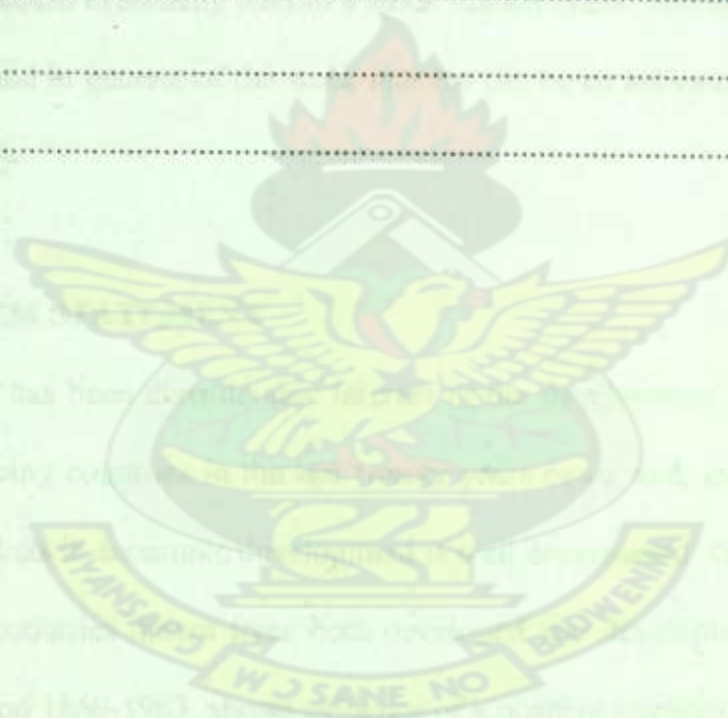
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1.0 CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE

At the stock exchange, share prices rise and fall in a trend depending largely, on market forces or the economic environment. Share prices tend to rise or remain stable when companies and the economy in general show signs of stability and growth. An economic recession, depression, or financial crisis such as witnessed in the later part of 2008 to date could eventually lead to a stock market crash. Therefore the movement of share prices and in general of the stock indexes can be an indicator of the general trend in an economy.

1.2 PROBLEM STATEMENT

There has been considerable interest in the development of capital markets in many developing countries in the last twenty years or so, and, evidence of the role of financial markets in economic development is well documented. Goldsmith (1969), in a study of 36 countries drawn from both developed and developing countries over the 100-year period 1860-1963, shows evidence of a positive relationship between the ratio of financial institutions' assets to gross national product (GNP) and output per person. Goldsmith presented data showing that (with some exceptions) periods of more rapid growth in the economy have been accompanied by an above average rate of financial development.

Other researchers, including Barro (1989) and Romer (1989), have used cross-country data spanning several years to show very significant differences in per capita output growth rates and financial market development. Levine (1990) shows that stock markets accelerate growth by;

- (1) Facilitating the ability to trade ownership of firms without disrupting the productive process occurring within firms, and
- (2) Allowing investors to hold diversified portfolios.

Having demonstrated the role stock markets play in economies and more so as the Ghanaian economy, we turn our attention to the space in which the entirety of trading goes on. The Ghana Stock Exchange is currently housed on the sixth and fifth floor of Cedi House in Accra which has proven to be insufficient in terms of size and space configuration for the normal handling of business and for the future computerization and automation of processes. This therefore brings the need for a purpose designed building in line with the short term future aspiration of the Ghana Stock Exchange to accommodate its development and evolution.

1.3 OBJECTIVES

- To provide appropriate business spaces for stock trading
- To achieve a sustainable architectural design through the optimization of materials, environmental control, resource conservation and reduced life cycle cost.
- To improve urban land utilisation and densities to maximize resource returns.

1.4 JUSTIFICATION

The role that stock markets play in economies cannot be over emphasized. It is one of the statues of strong economic development by way of mobilising funds which would perhaps have been left idle to accelerate development. By so doing, funds are raised to provide capital for companies to grow and at the same time facilitate the redistribution of wealth as a result of the varied share holding. This ensures that dividends are distributed over wide range of share holders with small and large holdings in companies. Because of the varied ownership of companies corporate management of companies is improved in order to satisfy the demands of these shareholders and the more stringent rules for public corporations imposed by public stock exchanges and the government. Governments also use stock markets to raise funds through bonds to finance social projects in the country.

Due to the trend of stock exchanges towards automation through information communication technology, it has become imperative for more specialised buildings which will take into consideration the varied implications of this technology and its future. This is very essential to ensure the continued development of the stock market and to continue to attract foreign direct and indirect investment as well as local investors to project our economy into our visions and dreams.

To enhance the image of the country and to boost pride in citizens the nation by way of infrastructure need to have landmarks which are worthy to enhance the reputation of the country. Such landmarks can be physically embodied in important buildings as stock markets which play important roles in national development.

1.5 SCOPE OF THE STUDY

The thesis will include a detailed architectural design of an office block suitable for the business of stock trading including all facilities required for its efficient performance.

1.6 TARGET GROUP

- Ghana Stock Exchange(GSE)
- Securities and Exchange Commission(SEC)
- Stock Brokerage Firms
- Banks and Financial Institutions
- Other Corporate Firms

1.7 CLIENT

The Ghana Stock Exchange and the Securities and Exchange Commission.

1.8 CLIENT'S BRIEF

GHANA STOCK EXCHANGE OFFICES

- trading floor
- Conference room
- Seminar hall
- Trading and clearing department offices
- Information department offices
- Finance and data analysis offices

- GSE securities depository department offices
- General offices
- Library and archives
- Luxury offices for managers
- Board room

SECURITIES AND EXCHANGE COMMISSION OFFICES

- Board room
- Chairman's office
- Personal offices
- General office

LETTABLE OFFICES

SHOPPING AREA

POST OFFICE

CLINIC

CHILD CARE AREA/ SCHOOL

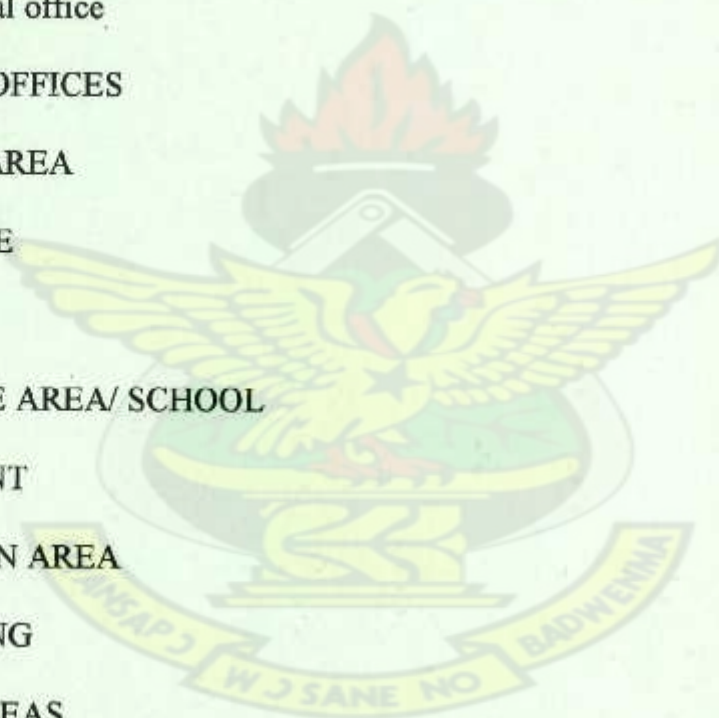
RESTAURANT

RECREATION AREA

CAR PARKING

SERVICE AREAS

SANITARY AREAS



1.9 FUNDING

The funding for the project will be provided in part by the Ghana Stock Exchange and the Securities and Exchange Commission and part funded through a mutual fund opened to the public.



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2.0 CHAPTER TWO

LITERATURE REVIEW

2.1 WHAT IS STOCK EXCHANGE

Wikipedia online free encyclopaedia defines a stock exchange, securities exchange or (in Europe) bourse is a corporation or mutual organization which provides "trading" facilities for stock brokers and traders, to trade stocks and other securities. Stock exchanges also provide facilities for the issue and redemption of securities as well as other financial instruments and capital events including the payment of income and dividends.

The securities traded on a stock exchange include: shares issued by companies, unit trusts and other pooled investment products and bonds. The securities traded in the stock exchange are only those that have listed on it. It is considerable for a stock exchange to have centralized trading clearing and book keeping and this has received serious innovation in information technology making it possible electronically and thereby increasing speed of transaction and reduced handling cost. Trade on an exchange is by members only. The initial offering of stocks and bonds to investors is by definition done in the primary market and subsequent trading is done in the secondary market. A stock exchange is often the most important component of a stock market. Supply and demand in stock markets is driven by various factors which, as in all free markets, affect the price of stocks.

2.2 HISTORY OF STOCK EXCHANGES

In 11th century France the *courtiers de change* was concerned with managing and regulating the debts of agricultural communities on behalf of the banks. As these men also traded in debts, they could be called the first brokers.

Some stories suggest that the origins of the term "bourse"(another name for stock exchange in Europe) come from the Latin word *bursa* meaning *a bag* because, in 13th century Bruges, the sign of three purses hung on the front of the house where merchants met to trade in stocks.

However, it is more likely that in the late 13th century commodity traders in Bruges gathered inside the house of a man called Van Der Burse, and in 1309 they institutionalized this until now informal meeting and became the "Bruges Bourse". The idea spread quickly around Flanders and neighbouring counties and "Bourses" soon sprung up cities in as Ghent and Amsterdam.

In the middle of the 13th century, Venetian bankers began to trade in government securities. In 1351, the Venetian Government outlawed spreading rumours intended to lower the price of government funds. There were people in Pisa, Verona, Genoa and Florence who also began trading in government securities during the 14th century. This was only possible because these were independent city states ruled by a council of influential citizens, not by a duke.

The Dutch later started joint stock companies, which let shareholders invest in business ventures and get a share of their profits (or losses). In 1602, the Dutch East India Company issued the first shares on the Amsterdam Stock Exchange. It was the first company to issue stocks and bonds. In 1688, the trading of stocks began on a stock

exchange in London. The trade in shares in London began with the need to finance two voyages: The Muscovy Company's attempt to reach China via the White Sea north of Russia, and the East India Company voyage to India and the east. Unable to finance these costly journeys privately, the companies raised the money by selling shares to merchants, giving them a right to a portion of any profits eventually made.

2.3 ROLE OF STOCK EXCHANGES IN ECONOMIES

2.3.1 Mobilising savings for investment

The intelligent investing public is always on the lookout for better avenues for getting higher profits. When they draw their savings from institutions like Commercial Banks, and amount kept as idle deposit and invests more prudently in shares, such money goes to promote business activity. The economic sectors that are in dire need of resources, like commerce and industry and agriculture get their demands, paving way for higher productivity and growth.

2.3.2 Raising capital for growth

Business means opportunities; business means timing, making the right move at the right time. In this era of industrial and internet revolution, decisions to expand and change the production lines, acquisition of necessary business assets, takeovers and mergers will have to be taken fast. The share market makes it possible for the businessman to grow through fusion or acquisition.

2.3.3 Redistribution of wealth

This establishment is not founded to felicitate redistribution of wealth. But this consequential action just happens. The investors share the wealth of dividends declared and increase in the prices of shares which will result in capital gains. They get their portion of wealth of the profitable businesses.

2.3.4 Corporate governance

Companies listed on the stock exchange have varied share holders and thereby generally lead to an improvement in the management of these companies to satisfy the demands of these share holders. This leads to the general assertion that public listed companies tend to perform better than privately owned companies due to diverse share holding

2.3.5 Creating investment opportunities for small investors

The future of the small investors is more or less safe, if they are guided properly. Such guidance is neither costly nor it is far to seek. Buying shares depends upon one's affordability and as such it is the convenient mode. You have the freedom to invest. With no differentiation between the small and big investors, this is a place where justice to the investors is assured.

2.3.6 Capital-raising for government projects

Towards creating a welfare society, the first duty of the Government is to create infrastructure. Sewage and water treatment plants, housing projects are financed by floating bonds. The public lends money to the government through the medium of

Exchange. The bonds apparently offer tax concessions to the investing public, but in reality they do not seem to provide the actual relief in the over all context. Sooner or later, the government will tax the citizens to repay the bonds on redemption and the expenses devolved in managing the issue of bonds together with interest. It is just like "rob Peter to pay Paul."

2.4 MAJOR STOCK EXCHANGES GLOBALLY

Region	Stock Exchange	Market Value (trillions of US dollars)	Total Share Turnover (trillions of US dollars)
Africa	JSE Securities Exchange	0.940	0.349
Americas	NASDAQ	4.39	12.4
Americas	São Paulo Stock Exchange	1.40	0.476
Americas	Toronto Stock Exchange	2.29	1.36
Americas/ Europe	NYSE Euronext	20.7	28.7
Asia-Pacific	Australian Securities Exchange	1.45	1.00
Asia-Pacific	Bombay Stock Exchange	1.61	0.263
Asia-Pacific	Hong Kong Stock Exchange	2.97	1.70
Asia-Pacific	Korea Exchange	1.26	1.66
Asia-Pacific	National Stock Exchange of India	1.46	0.564
Asia-Pacific	Shanghai Stock Exchange	3.02	3.56
Asia-Pacific	Shenzhen Stock Exchange	0.741	1.86
Asia-Pacific	Tokyo Stock Exchange	4.63	5.45
Europe	Frankfurt Stock Exchange (Deutsche Börse)	2.12	3.64
Europe	London Stock Exchange	4.21	9.14
Europe	Madrid Stock Exchange (Bolsas Mercados Españoles)	1.83	2.49
Europe	Milan Stock Exchange (Borsa Italiana)	1.13	1.98
Europe	Moscow Interbank Currency Exchange (MICEX)	0.965	0.488
Europe	Nordic Stock Exchange Group OMX1	1.38	1.60
Europe	Swiss Exchange	1.33	1.58

Table 2.1 *Twenty Major Stock Exchanges in the World: Market Capitalization & Year-to-date Turnover at the end of October 2007* —source: World Federation of Exchanges.

2.5 GHANA STOCK EXCHANGE

The Ghana Stock Exchange (GSE) is the principal stock exchange of Ghana. The exchange was incorporated in July 1989 with trading commencing in 1990. It currently has around 30 listed companies and 2 corporate bonds. All types of securities can be listed. Criteria for listing include capital adequacy, profitability, spread of shares, years of existence and management efficiency.

2.5.1 History and operations

Since its inception, the GSE's performance has varied considerably. All listings are included in the main index, the GSE All-Share Index. In 1993, the GSE was the 6th best index performing emerging stock market, with a capital appreciation of 116%. In 1994 it was the best index performing stock market among all the emerging markets, gaining 124.3% in its index level. 1995's index growth was a disappointing 6.3%, partly because of high inflation and interest rates. Growth of the Index for 1997 was 42%, and at the end of 1998 it was 868.35. As of October 2006 the market capitalization of the Ghana Stock Exchange was about (\$11.5bil) 111,500bil Cedis. As at December 31 2007, the GSE's market capitalization was 131,633.22bil Cedis. In 2007 the index appreciated by 31.84%.

The manufacturing and brewing sectors currently dominate the exchange. A distant third is the banking sector while other listed companies fall into the insurance, mining and petroleum sectors. Most of the listed companies on the GSE are Ghanaian but there are some multinationals.

Although nonresident investors can deal in securities listed on the exchange without obtaining prior exchange control permission, there are some restrictions on portfolio investors not resident in Ghana. The current limits on all types of non-resident investor holdings (be they institutional or individual) are as follows: a single investor (i.e. one who is not a Ghanaian and who lives outside the country) is allowed to hold up to 10% of every equity. Secondly, for every equity, foreign investors may hold up to a cumulative total of 74% (in special circumstances, this limit may be waived). The limits also exclude trade in Ashanti Goldfields shares.

There is an 8% withholding tax on dividend income for all investors. Capital gains on securities listed on the exchange will remain exempt from tax until 2015. The exemption of capital gains applies to all investors on the Exchange. There are no exchange control regulations on the remittance of original investment capital, capital gains, dividends, interest payments, returns and other related earnings.

Potential changes at the exchange include the introduction of automated trading and the listing of some of the state banks. The Bank of Ghana plans the development of mutual funds, unit trusts and municipal bonds later. These changes are aimed at making the exchange more relevant, more efficient and more effective. The Exchange was also involved in the preparation of the draft law on collective investment vehicles.

2.5.2 Membership

There are two categories of members, namely Licensed Dealing Members (LDMs) and Associate Members. An LDM is a corporate body licensed by the Exchange to deal in all securities. An Associate member is an individual or corporate body, which has satisfied the Exchange's membership requirements but is not licensed

to deal in securities. A Government Securities Dealer is a corporate body, which is approved by the Bank of Ghana and registered by the Exchange to deal only in government securities.

2.5.3 Regulatory Framework

GSE operates within a set of Rules, including membership, listing, trading & settlement. These are collectively referred to as the GSE Rule Book.

2.5.4 Listing Regulations

These prescribe, among others, criteria for listing securities (local and external), continued obligations of the listed companies as well as Take-over and merger procedures.

2.5.5 Regulations Affecting Foreign and Non-Resident Investors

Exchange Control permission was given in 1993 to non-resident Ghanaians and non-resident foreigners to invest through the Exchange without any prior approval. However, each non-resident foreign portfolio investor may not hold more than 10% of a listed company's total issued shares while total holdings of non-resident foreigners in any one listed security is limited to 74% unless with prior exchange control approval from the Bank of Ghana.

2.5.6 Trading Method

GSE uses the Continuous Auction Trading system on the floor of the Exchange. This system is currently not automated but action has been initiated towards automated

trading to complement the Central Securities Depository established by the Bank of Ghana.

2.5.7 Trading Days

The exchange has pre-market sessions from 09:30am to 10:00am and normal trading sessions from 10:00am to 12:00noon on all days of the week except Saturdays, Sundays and holidays declared by the Exchange in advance.

2.5.8 Clearing & Settlement

Settlement of trades is manual but centralized (Settlement takes place on the floor of the Exchange at specified times). Settlement occurs three business days after the trade date (T+3). Settlement is by Delivery Versus Payment (DVP). An automated clearing and settlement of listed securities would become operational in 2006.

2.5.9 Surveillance

The Securities and Exchange Commission (SEC) carries out regular inspection of Licensed Dealing Members' operations and books. Brokers are also required to submit returns to GSE. Listed companies are required to submit annual and quarterly financial statements to SEC and the GSE.

2.5.10 Listing

GSE has three categories of listing. These are the 1st, 2nd, and 3rd. The three categories are currently being reviewed. GSE has put in place a set of guidelines to

allow small companies and SOE's for divestiture to list in two stages - provisional and formal.

Types of Securities that can be listed include shares or equities and Debt-in the form of corporate bonds (and notes), municipal bonds (and notes), & government bonds (and notes) close-end unit trusts and mutual funds

2.5.11 Market Index

The Exchange publishes the GSE All-Share Index, which comprises all listed equities on GSE. It has its base as the average capitalization for the period covering November 12, 1990 to December 31, 1993. The base is 100.

2.5.12 Regulations Affecting Foreign And Non-Resident Investors

Exchange Control permission has been given in given to non-resident Ghanaians and non-resident foreigners to invest through the Exchange without any prior exchange control approval. However, one external resident portfolio investor (whether individual or institutional) can hold only up to 10% of any security approved for listing on the Exchange. Furthermore, the total holdings of all external residents in one listed security shall not exceed 74% except with prior exchange control approval. Ghanaians externally resident and foreigners resident in Ghana, though, may invest without any limit. The limits do not also apply in the case of AGA, CPC, TBL and PBC shares.

There is free and full foreign exchange remit ability for the original capital plus all capital gains, and related earnings. There is a 10% withholding tax (which is also the final tax on dividend income) for all investors, both resident and non-resident. Capital

gains on listed securities are exempt from tax until November 2005. An application has been made to the Minister of Finance for a waiver for a further period 5 years after November 2005.

Custodial services for non-resident investors are provided by Barclays Bank of Ghana Ltd. Head Office, P. O. Box 2949, Accra, Tel: 233-21-664901/4, Merchant Bank (Ghana) Ltd and Stanbic Bank Ghana Ltd.

2.5.12 Investor Protection Provisions

The Exchange has various provisions in its rules which have been designed to protect the investor in addition to what the securities regulator provides.

Under the SECURITIES INDUSTRY LAW PNDCL 333 (1993), as amended, the apex regulatory body in the securities market is the Securities and Exchange Commission and its functions include;

- Maintaining surveillance over the securities business to ensure orderly, fair and equitable dealing in securities
- Registering, licensing, authorizing, a Stock Exchange, investment advisors, securities dealers, etc.
- Protecting the integrity of the securities markets against any abuses arising from the practice of insider trading.

2.6 THE FUTURE OF STOCK EXCHANGES

Internet plays the dominant role as for the future of stock exchanges. The changes in the system have wiped out the traditional modalities of buying and selling of

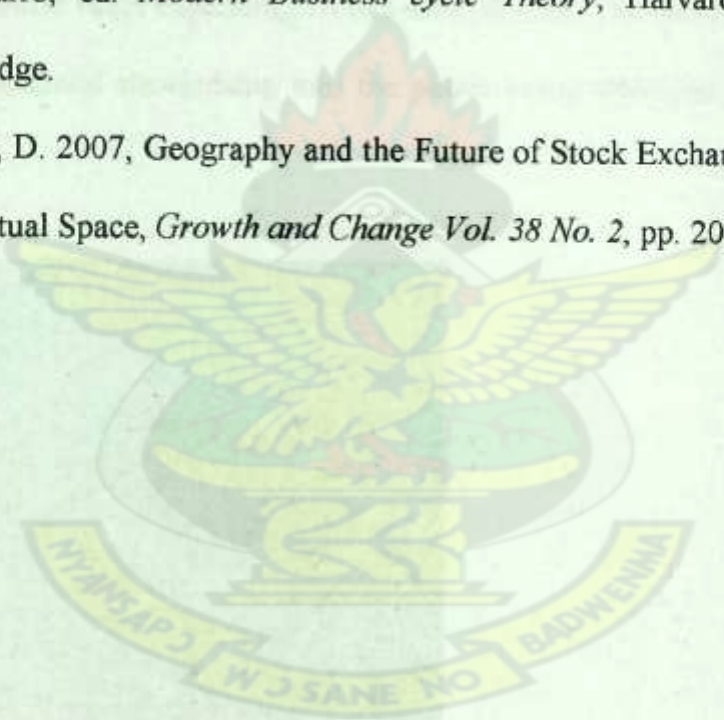
shares. Electronic networks are dominating the scene. The investment activities have multiplied. The day to day volume of the operations has reached staggering heights with corresponding increase in the number of brokers. The dealings have turned out methodical, systematic and instant access has rendered the verifying procedures easy. Gain or loss, an investor can deal confidently and will know his position with the click of the mouse.

Electronic Communication Networks (ECNs) have reduced the possibility of front running. The lightening speed with which the transactions take place, without any manual intervention, has made it virtually impossible for the traders to acquire prior knowledge of customer's incoming orders and do the balancing act. The future of the stock exchanges is bright, as they have multiple roles to play in the economy.



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3.0 CHAPTER THREE

DESIGN STUDIES

3.1 CASE STUDY 1- HEIFER INTERNATIONAL HEADQUARTERS

Located next to the Clinton Presidential Library, the Heifer International Headquarters is in walking distance of a bus station, a new light-rail system, and a pedestrian entertainment district.

Part of a four-phase master plan, the Headquarters building was conceived as a series of concentric rings expanding from a central core. The building was designed to expand environmental stewardship into the public realm while serving as a beacon of hope.



FIG 3.1- *Heifer International Headquarters, Arkansas.* -source: ASHRAE

A restored wetland that wraps around three sides of the building collects stormwater for reuse as irrigation water. Rainwater collected from the roof is stored in a five-story water tower wrapped with a fire stair. Gray water collected from sinks and drinking fountains, condensate from outside air units, and rainwater from the water tower are reused in the toilets and cooling tower. Moisture removed from the building as condensate is reused to cool the building. Waterless urinals and low-flow toilets and lavatories further reduce potable water use.

The narrow, semicircular floor plan provides daylight and views for all employees. The majority of open offices in the building offer river views and northern light, and all major gathering spaces access the exterior: five balconies on each floor, designed as outdoor conference rooms, hang over the wetland and act as sunscreens. The building was designed to use up to 55% less energy than a conventional office building and to last for at least 100 years. Materials were selected for their durability, maintainability, low toxicity, recycled content, and regional availability

3.1.1 Gray water recycle system

The architect asked for a system to provide 60 gallons a minute of filtered and sterilized recycled water to flush toilets in a building. A Filter Jet-series reclaim system with onboard ozone disinfection capable of 100 gallons per minute was delivered to Heifer International Headquarters in Little Rock, Arkansas. The system is used to filter, disinfect and pressurize water for their gray-water system.

The excess capacity is also used for the make-up water in the cooling towers, reducing blowdown and decreasing the amount of city water needed to cool the

building, saving water and electricity. The ozone disinfects the cooling tower water, preventing legionella and other pathogens from infecting the system. Ozone is three molecules of oxygen held together by an extra electron, it is non-toxic and non-carcinogenic and is created naturally by lightning.



FIG 3.2- *Water Tower Collector*.- source: ASHRAE

1. Rainwater is collected from the tower collector (in fig3.2). The tower collector works like a large funnel that collects and stores water like a water tower without a lid. A spiral staircase enclosed in a glass tower wraps around the tower's large cylindrical vertical column.
2. Gravity pulls the water down into a reclaim tank in the basement where it is ozonated.

3. The ozone quickly reacts with any contaminants in the water and the freed electron then bonds to any particulate matter in the water, creating a type of static cling which brings smaller particles together into larger and more filterable clumps.

4. The ozonated water is then pulled in to the filtration system where a 7.5 HP pump pushes it through a 25 micron stainless steel filter element, removing all particles larger than 25 microns, approximately the size of a white blood cell.



FIG 3.3- 7.5 HP pump providing 60 psi of water for the building at 100 gallons per minute. - source: ASHRAE

5. The 7.5 HP pump provides 60 psi of water for the building at 100 gallons per minute. If the tower collects too much water, it overflows into the moat surrounding the building and out to the marshland where the building is situated. If there is not enough rain, then a city water valve opens allowing the temporary use of city water in the building.

3.1.2 Lighting

Although only 40 percent of the headquarters' envelope is glass, the interior feels bright, in part because of the innovative placement of the building's three staircases. Instead of hiding them inside, they are individually articulated and wrapped in glass. Two float over the wetland. With air openings at ground level and five stories up, convection pulls cool air off the water, helping to keep the unconditioned spaces comfortable year-round. The third wraps around the water tower. Five balconies on each floor create additional opportunities to step outside.

3.1.3 Air conditioning

The design team solicited proposals from three manufacturers who furnished price, performance and maintenance data. A life-cycle cost analysis was performed on the three proposals. One of the bid alternatives, a centrifugal compression chiller uses HFC-134a with a limited mass flow in pump energy equation was selected. Its efficiency was enhanced with a series of flow flat plate heat exchanger leading to about 72.6% in energy savings.

3.1.4 Raised access floor

The design met the requirements for optimizing comfort, flexibility and sustainability by the use of raised access floors. Several raised floor systems were evaluated and a steel and concrete composite system was selected with an 18in clear space below the floor with great care taken during construction to minimize air leakage within the floor system

3.2 CASE STUDY 2-PEARL RIVER TOWER, GUANGZHOU, CHINA

The Pearl River tower, in Guangzhou has been designed to be the most energy efficient of all the worlds' super tall structures. Although the design team's original goal of constructing a net zero-energy building that would sell its excess power to the local electrical grid is unlikely to be achieved, the structure is expected to consume nearly 60% less energy than traditional building of similar size and could serve as a model for future carbon-neutral towers.

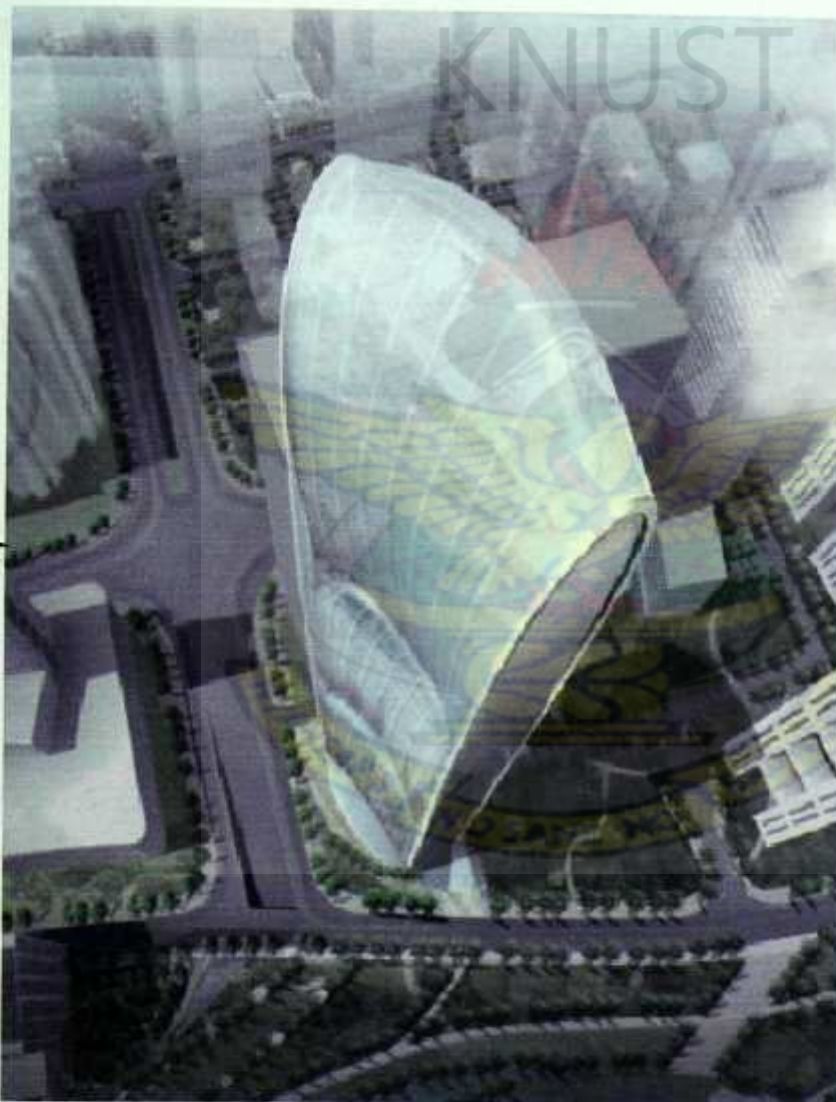


FIG. 3.4- *Pearl River Tower, in Guangzhou.* -source: CTBUH

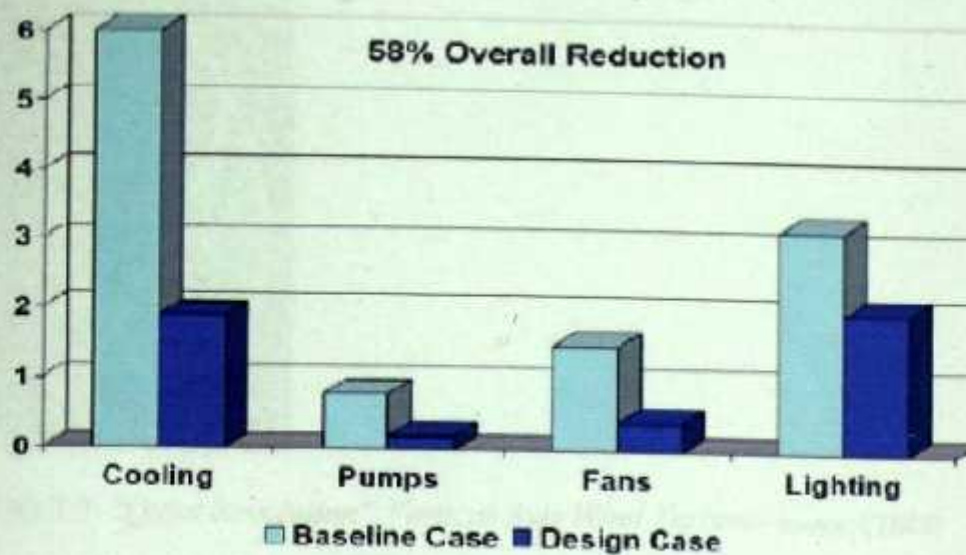


FIG 3.5- Pearl River Tower Annual Energy Consumption.- source: CTBUH

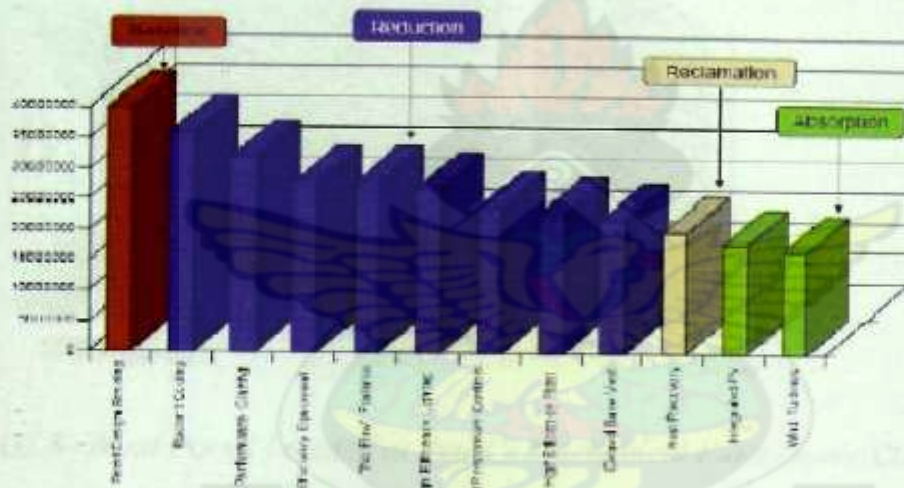


FIG 3.6- Overall Energy Savings for Sustainable Strategies.- source: CTBUH

3.2.1 Building integrated power generation

The building integrates wind and photovoltaic energy generation in the building fabric. It has four openings on the facade which houses small turbines generating up to 15 times more than a typical stand alone wind generator. We= 10,000kwh/ year



FIG 3.7- "Quiet Revolution" Vertical Axis Wind Turbine- source: CTBUH



FIG3.8- Wind Portal Located at Pearl's Mechanical Floor- source: CTBUH

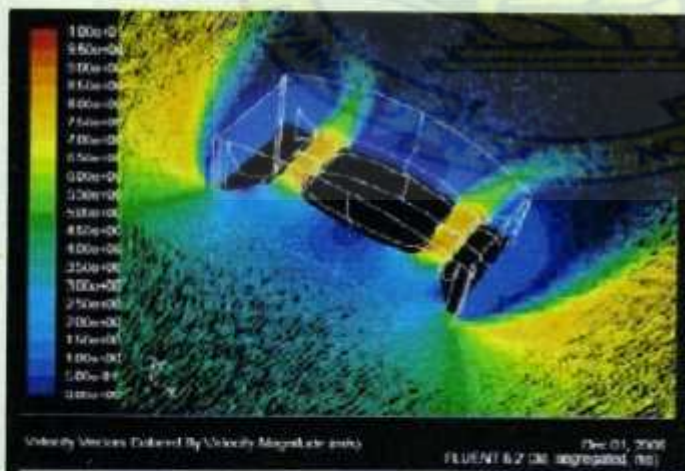


FIG3.9-Wind Velocity Vectors at Pearl's Mechanical Floor- source: CTBUH



FIG3.10- *Building Integrated Photovoltaic's.*- source: CTBUH

The building takes advantage of the tropical sun using two kinds of solar electric panels on the east and west facades. At the crown of the tower, the design integrates more than 15,000m² of pv in the facade glass. It also adds another 15,00m² of pv on the fixed shading feature on the west facade. $P_{ve} = 300,000 \text{ kwh/ year}$.

3.2.2 Multi propose double facade.



FIG3.11- *High Performance Active Façade Detail.*- source: CTBUH

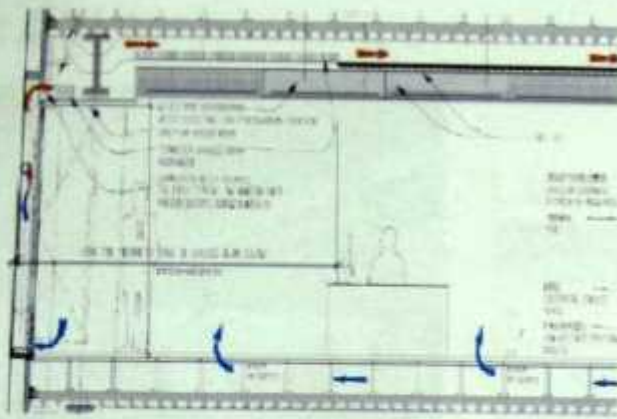


FIG3.12- Exterior Wall Air Flow Diagram. - source: CTBUH

With 71 floors of glass exposed to the tropical sun, one key element to reducing cooling load and the energy associated with it is the facade itself. The tower integrates a double facade consisting of an external insulated double layer of glass and an inside layer of single glass with an air space sandwiched in between the two layers. When heat from the sun warms the air in the space it is vented out before it can radiate into the interior by fans drawing air from a slot at the bottom of the glass on each floor. This air is used to draw humidity out of the building with a heat exchanger.

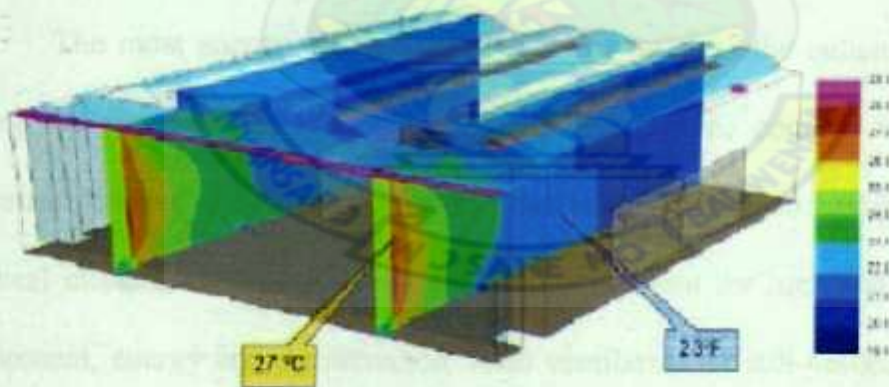
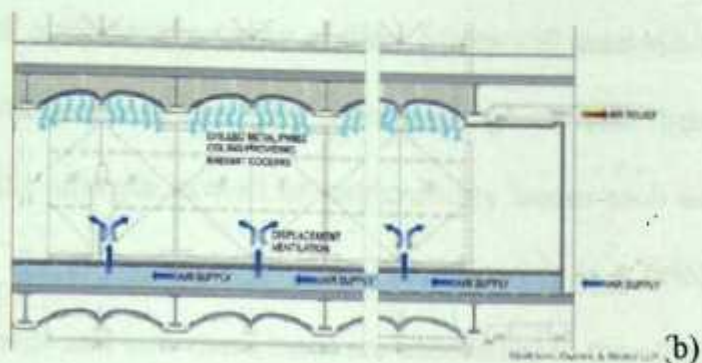


FIG3.13- Air Temperature Cross Section at Perimeter Zone. - source: CTBUH

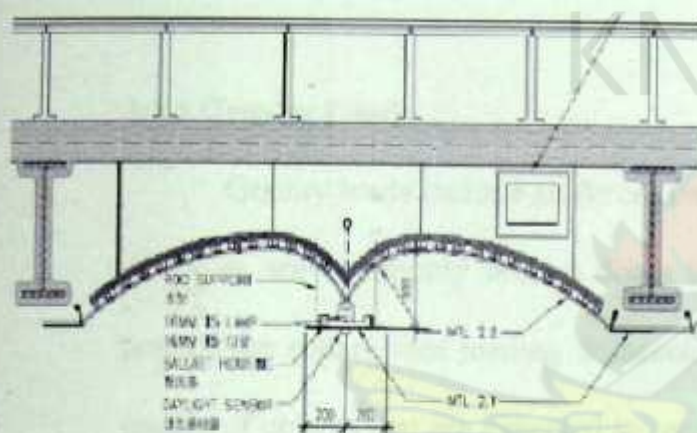
3.2.3 Radiant panel cooling system



(a)



(b)



(c)

FIG 3.14- Radiant Chilled Ceiling Panel. - source: CTBUH

The most energy efficient system in the tower is the radiant cooling panels in which water flows through ceiling panels and provide cooling needs of the space. Because cooling is delivered by water instead of air and no heating is necessary for tropical climate, the system does not need equipment for such and saves cost for the equipment, energy and maintenance. With ventilation air still needed for breathing, the system delivers necessary ventilation underneath floors that are already raised for cabling

3.3 STEEL STRUCTURES

All structures are subjected to forces that are imposed by gravity, wind and seismic events. The combination and anticipated severity of these forces will determine the maximum design force the member can sustain. The structural engineer will then select a member that meets all of the strength as well as serviceability issues such as deflection and/or vibration criteria for any specific project. The following is a brief discussion on each of the types of loads and how these loads are transferred to the other structural components.

3.3.1 Gravity Loads

Gravity loads include all forces that are acting in the vertical plane. These types of forces are commonly broken down into dead loads and live loads in a uniform pounds per square foot loading nomenclature. Dead loads account for the anticipated weight of objects that are expected to remain in place permanently. Dead loads include roofing materials, mechanical equipment, ceilings, floor finishes, metal decking, floor slabs, structural materials, cladding, facades and parapets. Live loads are those loads that are anticipated to be mobile or transient in nature. Live loads include occupancy loading, office equipment and furnishings. The support of gravity loads starts with beams and purlins. Purlins generally refer to the roof while beams generally refer to floor members. Beams and purlins support no other structural members directly. That is to say, these elements carry vertical loads that are uniform over an area and transfer the uniform loads into end reactions carried by girders.

Girders generally support other members, typically beams and/or purlins, and span column to column or are supported by other primary structural members. Girders may support a series of beams or purlins or they may support other girders. Forces imposed on girders from beams, purlins, or other girders are most often transferred to the structural columns. The structural column carries the vertical loads from all floors and roof areas above to the foundation elements.

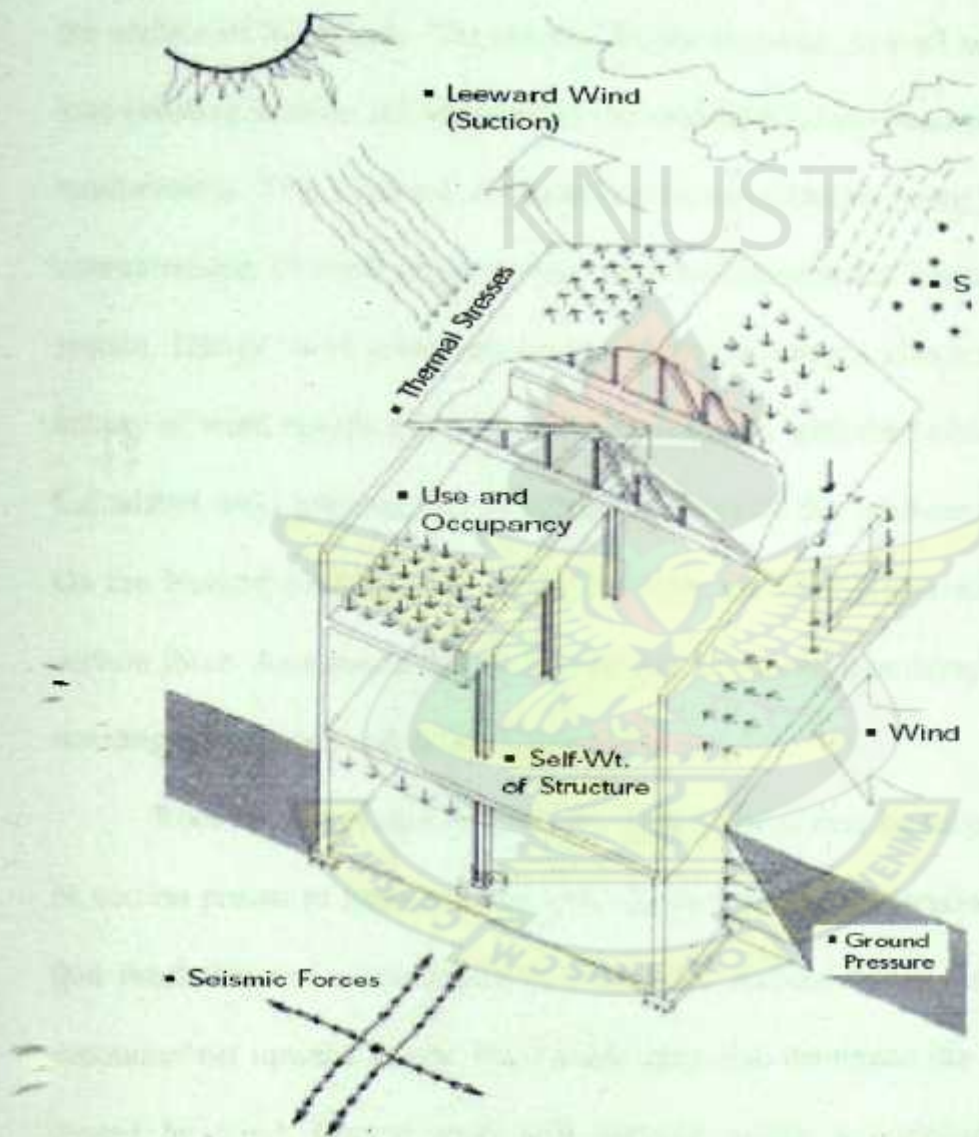


FIG 3.15- *Forces Experienced by Structures.*

3.3.2 Horizontal Loads

Forces created by wind or seismic activity are considered to act in the horizontal plane. While seismic activity is capable of including vertical forces, this discussion will be based only on horizontal forces. The majority of this section will address wind forces and how they are transferred to the primary structural systems of the building. Wind pressures act on the building's vertical surfaces and create varying forces across the surface of the façade. The exterior façade elements, as well as the primary lateral load resisting system, are subjected to the calculated wind pressures stipulated by code requirements. This variation accounts for façade elements being exposed to isolated concentrations of wind pressures that may be redistributed throughout the structural system. Design wind pressures can be calculated using a documented and statistical history of wind speeds and pressure in conjunction with the building type and shape. Calculated wind pressures act as a pushing force on the windward side of a building. On the leeward (trailing) side of the building, the wind pressures act as a pulling or suction force. As a result, the exterior façade of the entire building must be capable of resisting both inward and outward pressures.

Roof structures made up of very light material may be subjected to net upward or suction pressures from wind as well. Roofs typically constructed of metal decking, thin insulation and a membrane roof material without ballast have the potential to encounter net upward forces. Roof shape may also determine the net uplift pressures caused by wind. Curved roofs will actually exhibit a combination of downward pressures on the top portion of the curve and upward pressure on the lower portion of

the curve. This distribution of downward and upward pressures caused by the curve is similar to the principles of air pressure and lift acting on an airplane wing.

As the wind pressures are applied to the exterior of the building, the façade (actually a structural element to some degree), transfers the horizontal pressures to the adjacent floor or roof. As these pressures are transferred, the floor and roof systems must have a means to distribute the forces to the lateral load resisting systems. Floors and roofs that are generally solid or without large openings or discontinuities may behave as a diaphragm. A diaphragm is a structural element that acts as a single plane with the connecting beams and columns. When experiencing a force, this single plane causes the beams and columns to displace horizontally the same amount as the diaphragm. This can be exemplified by a sheet of paper or cardboard that is supported by a series of columns. Should the paper, a flexible diaphragm, be pushed horizontally, all points in contact with the paper will move laterally by the same amount. The metal roof decking on most projects will behave as a flexible diaphragm.

Substituting a piece of cardboard for paper in our example, the paper will behave more like a rigid diaphragm. A typical floor decking and composite structural slab are examples of a rigid diaphragm.

Horizontal diaphragms are an efficient means to transfer the horizontal loads at each level of a building to the lateral load resisting systems. Should large openings, such as atriums, skylights, raised floors or other discontinuities exist to interrupt the diaphragm, the lateral or horizontal loads may not flow easily to the lateral load resisting systems. As a result, the structural engineer will investigate the need for a horizontal truss system utilizing the floor beams and/or girders as chord members.

Secondary web members will be added to complete the truss concept. This is particularly common in roof areas where there may be very long continuous skylights on a relatively narrow or long roof area.

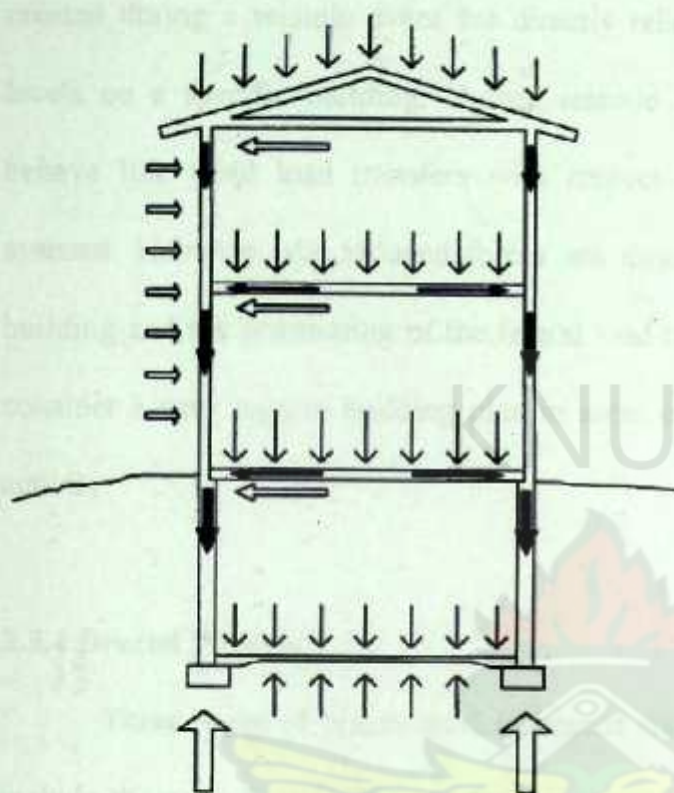


FIG 3.16- Gravity and Wind Loads.

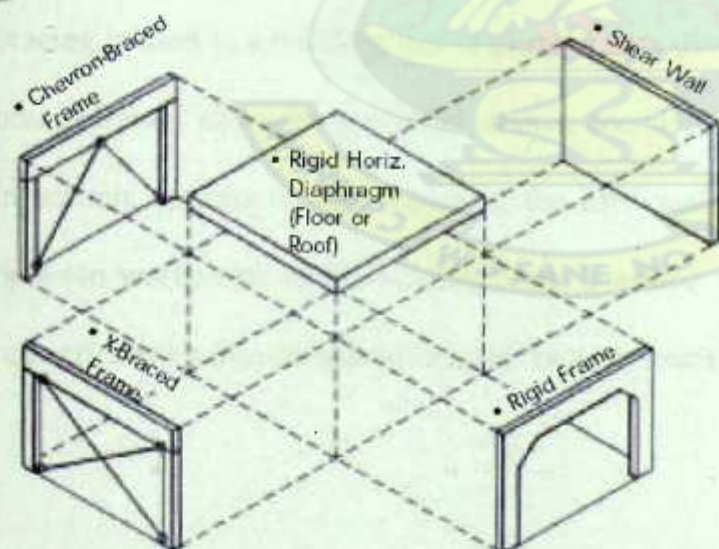


FIG 3.17- Horizontal Diaphragm/ Lateral Load Resisting Interface

3.3.3 Seismic

Seismic activity induces horizontal forces, and at times, vertical loads. The discussions will focus on horizontal forces imposed during seismic activity. Forces created during a seismic event are directly related to weight or mass of the various levels on a specific building. During seismic activity horizontal diaphragms which behave like wind load transfers with respect to the primary lateral load resisting systems. However, the induced forces are much more sensitive to the shape of the building and the positioning of the lateral load resisting systems. It is advantageous to consider a very regular building plan in areas of the country with significant seismic activity.

3.3.4 Braced Frames

Three types of braces used in braced frames typically seen in buildings today include the cross brace, Chevron (or inverted V) and eccentric brace. Cross bracing is often analyzed by the structural engineer as having tension only members. Chevron bracing is used in a building that requires access through the bracing line. Eccentrically braced frames allow for doorways, arches, corridors and rooms and are commonly used in seismic regions to help dissipate the earthquake energy through the beam/girder between workpoints of the bracing/beam interface. Braced frames are generally more cost-effective when compared to rigid frame systems.

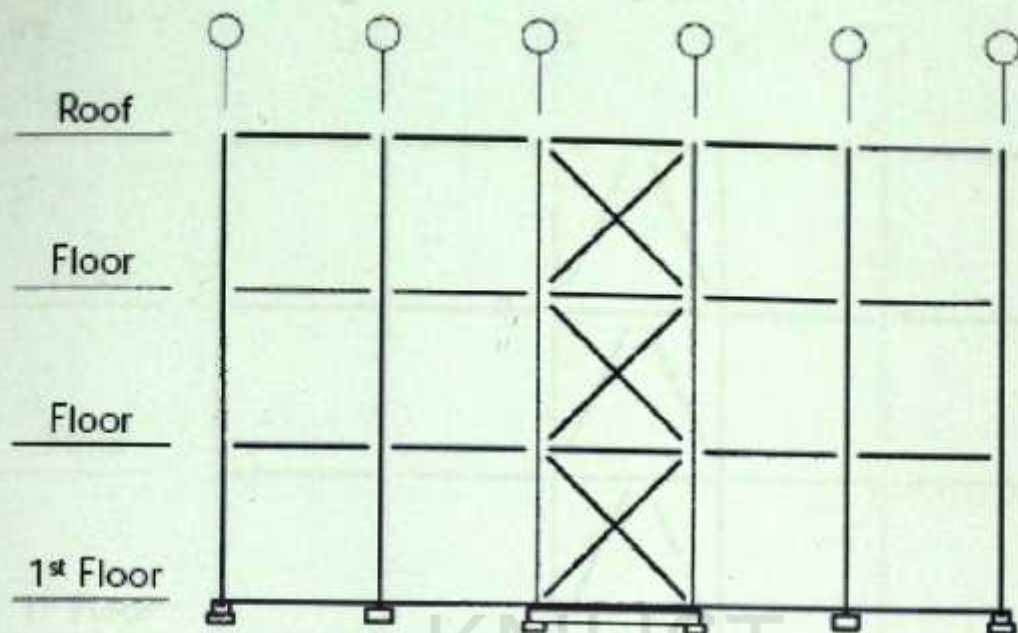


FIG 3.18- *Crossed Braced Building Elevation.*

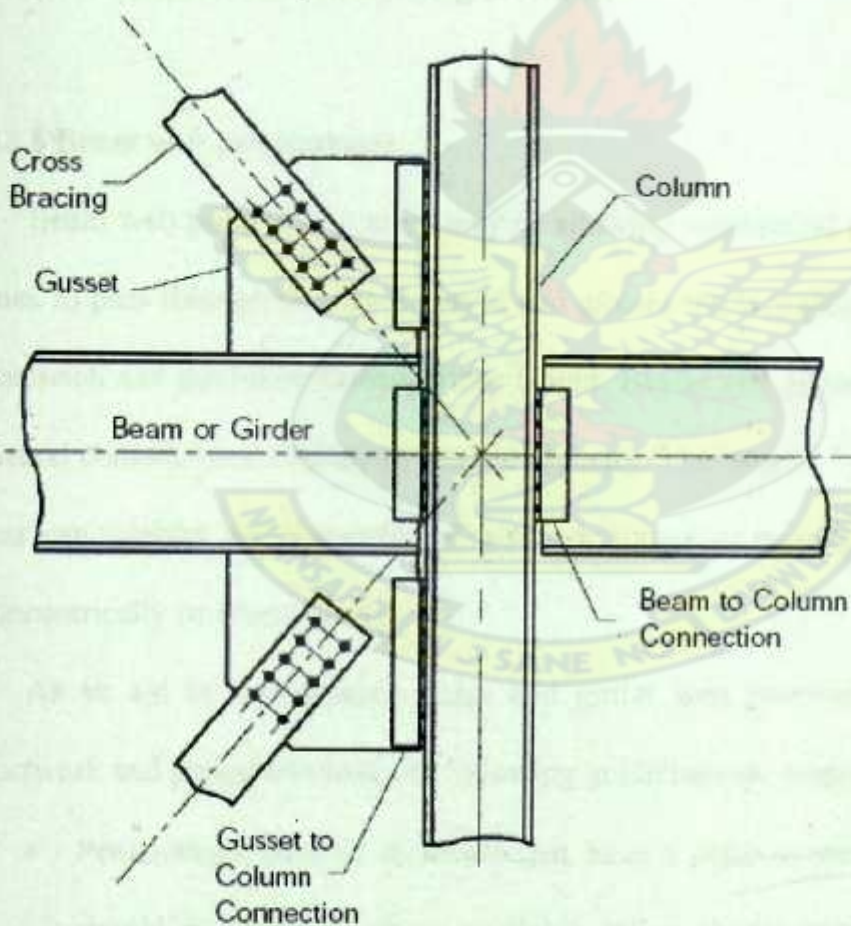


FIG 3.19- *Typical Beam to Column Braced Connection*

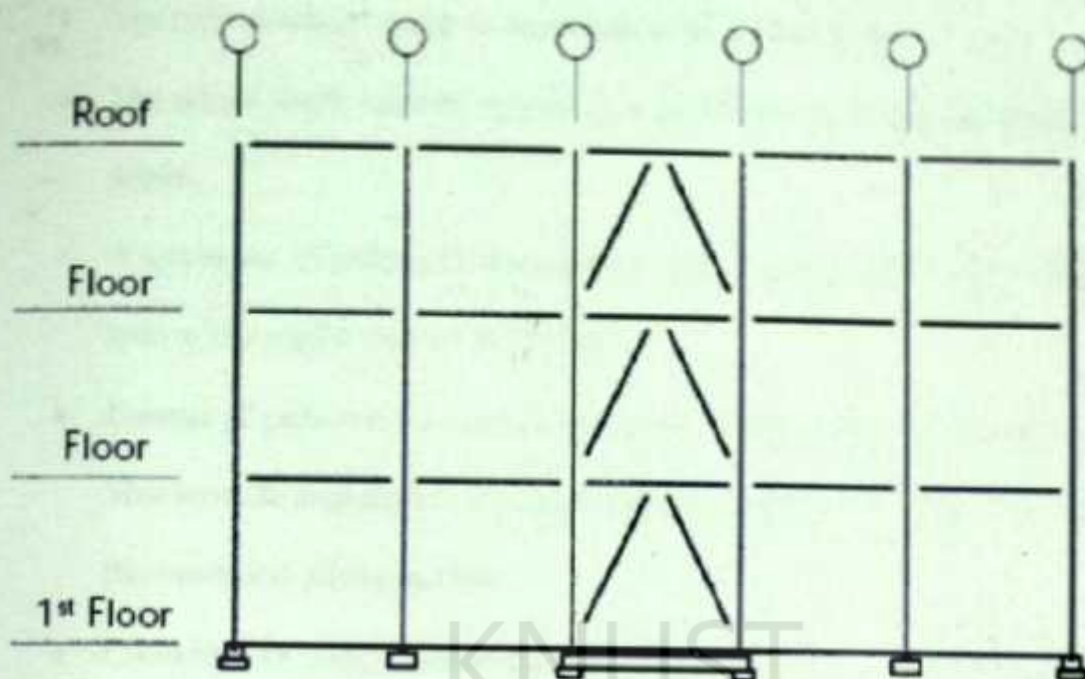


FIG 3.20- *Chevron Braced Building Elevation*

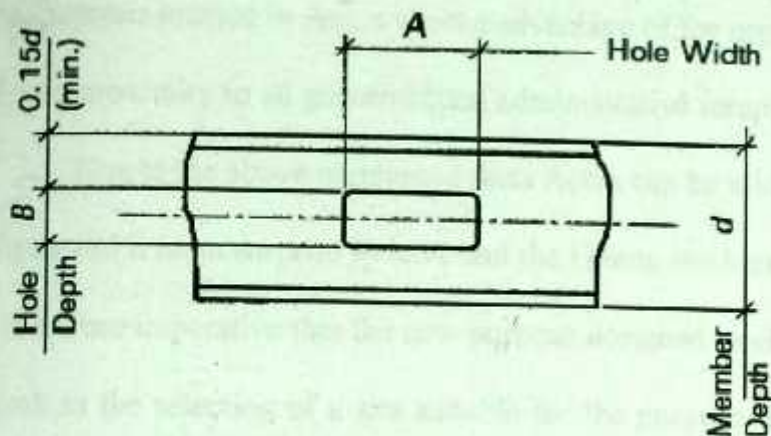
3.3.5 Beam web penetrations

Beam web penetrations are a way of allowing mechanical ductwork and plumbing lines to pass through structural beams and girders while maintaining a shallow ceiling sandwich and minimum floor-to-floor height. Beams and girders in buildings have, by natural consequence, regions of reserve capacity. The length of the member offers areas that can tolerate the placement of a round, square or rectangular penetration, either concentrically or eccentrically.

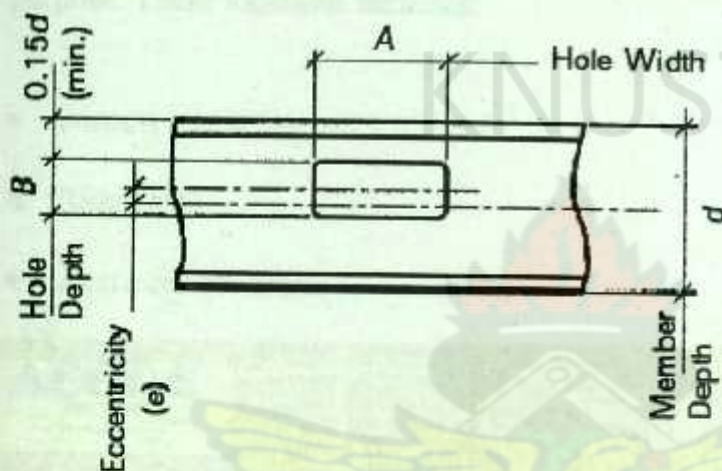
As an aid in coordinating beam and girder web penetrations with the building ductwork and piping services, the following guidelines are suggested:

- Penetrations through members that have a depth-to-web thickness, $d/t_w > 75$ should be avoided. Some available rolled shapes generally fall outside this criterion.

- The ratio of whole length to depth should be limited to 2.5.
- The whole depth must be limited to a maximum of 70 percent of the member depth.
- A minimum 15 percent of the member depth must remain from the edge of the hole to the outside face of the flange.
- Corners of penetrations must be made with a radius of approximately one inch. This must be considered in determining the size of penetration to accommodate ductwork and piping services.
- Concentrated loads from beams and column transfers must not be made within the length of the hole.
- Multiple holes should have a minimum two times the hole length between hole edges.
- Beams are to be laterally supported by the floor/roof construction.
- Penetrations in members that are at or near deflection limits or that have sensitive vibrations should be avoided.
- All penetrations must be investigated by a qualified structural engineer to insure the structural integrity of the member.



CONCENTRIC WEB PENETRATION



ECCENTRIC WEB PENETRATION

FIG 3.21- Concentric and Eccentric Web Penetration.

3.4 SITE STUDIES

3.4.1 Site selection

Accra is the national capital of Ghana and the largest city in the country with about 3 million people. All aspects of the economy of the country is controlled from Accra and given that it host the only international airport and the major sea port in the country makes it very attractive to business. Most prime business therefore have their

headquarters located in Accra to take advantage of the opportunities available by virtue of easy proximity to all governmental administrative setups.

Due to the above mentioned facts Accra can be said to be the financial capital of Ghana and it is no surprise to have had the Ghana stock exchange located in the city. It is therefore imperative that the new purpose designed stock exchange will be located in Accra. In the selection of a site suitable for the purpose of a stock market, three main locations were chosen for initial survey to determine which will be more suitable for the purpose. These locations included;

- Airport city area
- Ridge area
- Accra central area



FIG 3.22- Map of Accra

3.4.2 Airport city area

Airport city as the name depicts is within close proximity of the Kotoka International Airport and forms a part of the airport commercial area. It is a specially zoned area to be developed to compliment the airport.

Merits;

- Airport proximity
- Has complimenting facilities as hotels, shopping malls etc
- Promising architectural character
- Good access to public utilities

Demerits

- High vibration and noise from the airport

3.3.3 Ridge area

The ridge area has been mainly a residential area with government bungalows spread about most of the site. It has now been rezoned as mainly a civic area with planning regulations emphasizing the development of multi-storey buildings at least 5 levels as part of the new building standard for the zone. It now has several tower blocks ranging from 7 levels to 17levels

Merits

- Most financial institutions have their head offices in and around the area
- Good access roads and minimal traffic
- Good access to public utilities

- Good proximity to government agencies and administrative setup

Demerits

- Falls within a seismic activity zone
- High water table

3.4.4 Accra central area

Accra central is the central business district of the city. It has a thriving commercial activity and has a very dense population during working hours. It is marked with a lot of human and vehicular traffic during the day and a lot of squatters during the night.

Merits

- Good proximity to government agencies and administrative setup
- Good access to public utilities

Demerits

- High incidence of traffic
- Poor architectural character of area

After the initial survey of these areas the ridge area was realised would be the location to situate such building since it offers more opportunities and even takes advantage of the Accra central area due close proximity.

3.5 SITE LOCATION

The site is located in the ridge area on the independence avenue junction with Libya road. It is bound to the North West and north east by undeveloped sites, to the

south west by Libya road and to the south east by the independence avenue. Opposite the site across the independence avenue is Efua Sutherland children's park and across the Libya road is the university of Ghana business school administration block.



FIG 3.23- Ridge area map (site edge shown red)

3.6 SITE INVENTORY

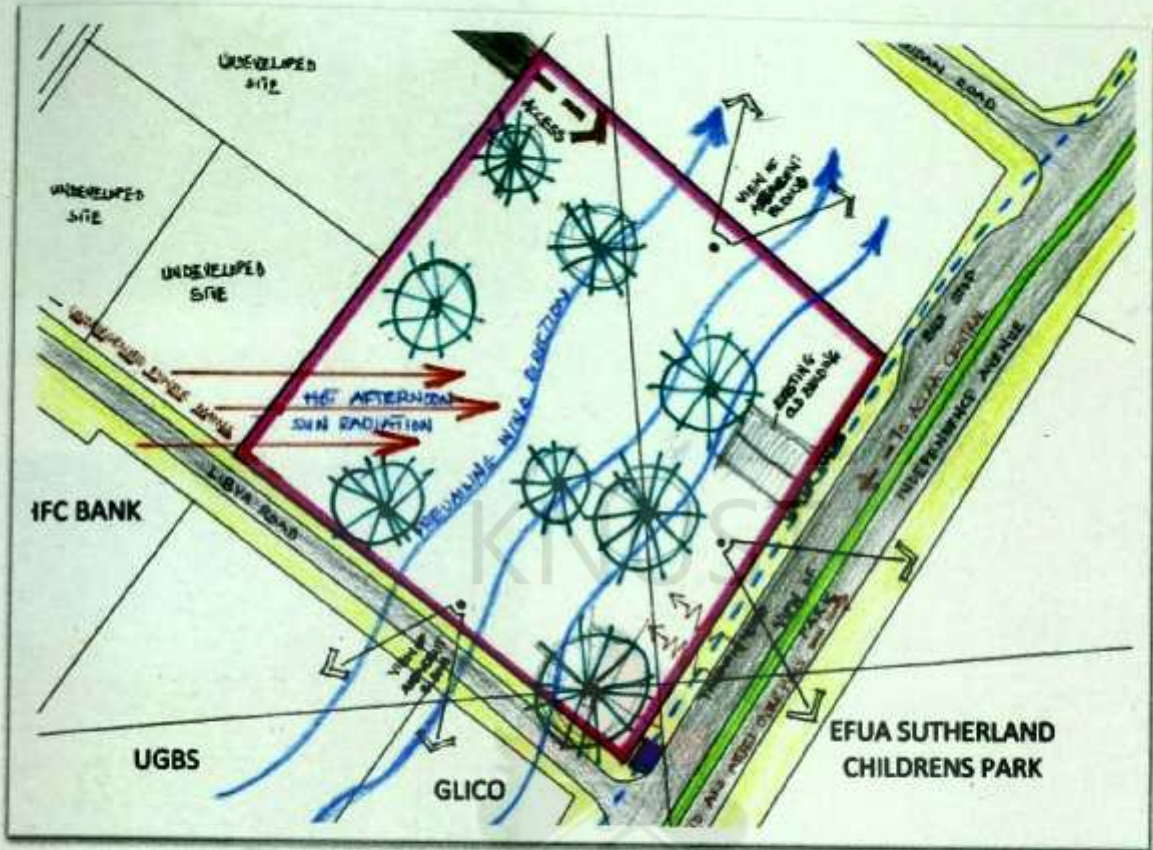


FIG 3.24- *Site inventory map*

The site has a few trees mainly mango and neem located sparsely around the site. There exists an old house on the site currently being occupied by squatters. The foundation of an old building is still visible on the ground. The site generally occupied by short weeds with few areas of overgrown weeds. There is a barbed wire fencing around the perimeter of the site. Water mains line runs along its south east boundary on the independence avenue with a hydrant at the junction between the boundary roads. Drainage sewers also run alongside the water line with inspection points evenly placed along its length. Electrical supply in the area is mainly underground and can be tapped on the Libya road.



FIG 3.25- view of site showing existing building.



FIG 3.26- view of site from children's park.



FIG 3.27- view of site with trees.



FIG 3.28- *view of site with ground cover.*

3.7 SITE ANALYSIS

Given the extent of activity on the independence avenue it will be prudent to allow vehicular access of the site from Libya road and 1st sixth avenue close maintain the later for service access. By locating the services access from the 1st sixth avenue close the service area of the site should located close to the access to optimize circulation. Pedestrian access will be possible from the walkway of the independence avenue and that of Libya road. The view of the children's park provides a visual harmony and beauty. The boundaries to the North West and north east should be secured with a good security wall to prevent activity spillage from the adjacent site and also good clearance should be given to ensure the connection of public utilities to the site service area on those boundaries.

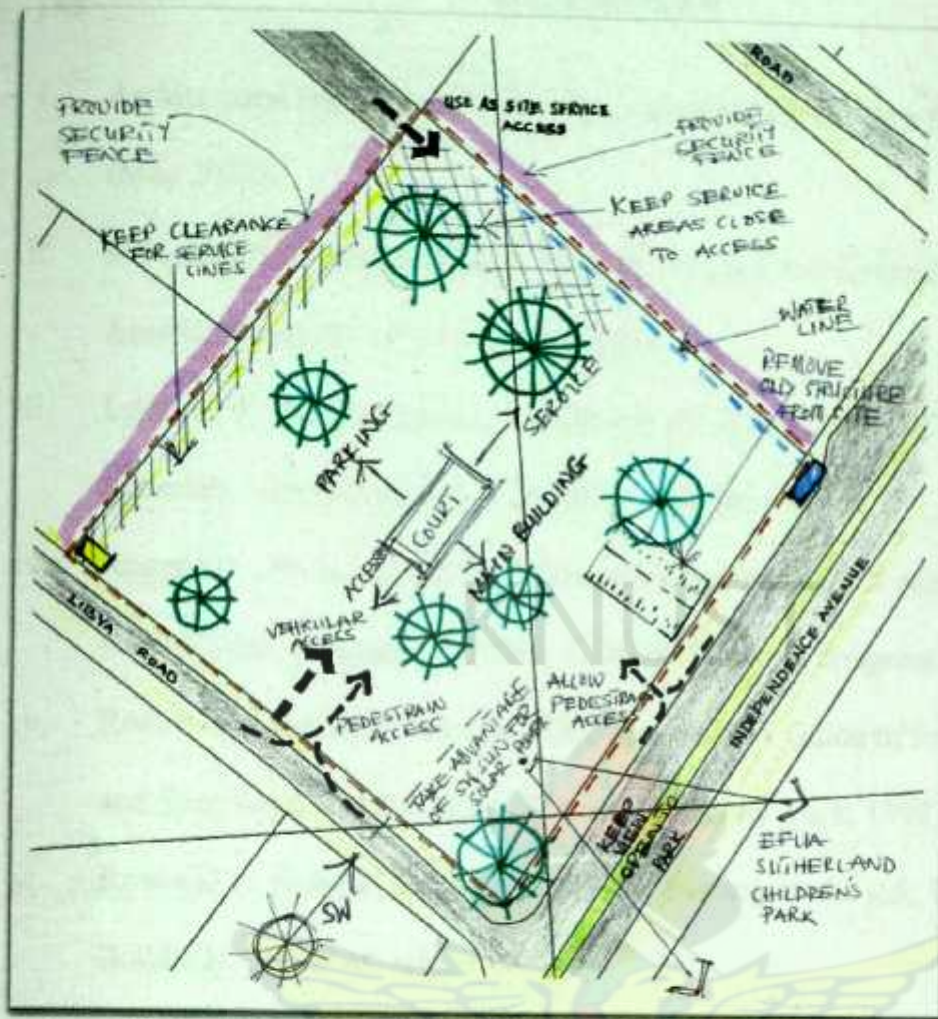


FIG 3.29- Site Analysis.

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4.0 CHAPTER FOUR

PLANNING AND DESIGN

4.1 BRIEF DEVELOPMENT

By carefully studying the task of the design with respect to a consultative process and a study of similar and existing office buildings and stock exchanges, analysing the various needs of the client and the target group accompanied by an in-depth research on the design task and site considerations has resulted in the development of the client's brief.

1. Sub-basement
 - Service room
 - Storage for shops
 - Banks
 - Post office
 - Security monitoring office
2. Ground floor
 - Shops
 - Banks
 - Main food servery
 - Security monitory room
 - Main server room
 - Facilities management office
 - sanitary
 - Offices to let (small units)
 - Eating area
 - Sanitary area
3. First floor
 - Shops
4. Second floor
 - Offices to let
 - Banks
 - Clinic
 - Gymnasium
 - Child care centre
 - Restaurant

- Sanitary
5. Third floor
- Reception
 - Trading floor
 - Conference room
 - General office (GSE)
 - Library
 - Sanitary
6. Fourth floor
- Trading and clearing department office
 - Information department office
 - Finance and data analysis office
 - GSE securities depository company office
 - Seminar hall
 - Sanitary
7. Fifth floor
- Board room (GSE)
 - Office of the managing director
- Office of the marketing manager
 - Office of the finance manager
 - Office of the administration manager
 - Office of the corporate affairs manager
 - Archives
 - Publication centre
 - Gymnasium
 - Sanitary
8. Sixth floor
- Board room (SEC)
 - Chairman's office
 - Supervisors offices
 - General offices
 - Offices to let
 - Sanitary
9. Seventh floor to twenty first floor
- Offices to let
 - Sanitary
10. Twenty second floor (recreation)
- Tennis

- Badminton

- helipad

- Gardens

4.2 SCHEDULE OF ACCOMMODATION

BRIEF	AREA (m ²)
<i>1. Sub-basement</i>	
• Service room	700
• Storage for shops	500
<i>2. Ground floor</i>	
• Shops	900
• Banks	800
• Main food servery	200
• Security monitory room	50
• Main server room	100
• Facilities management office	100
• Sanitary	90
<i>3. First floor</i>	
• Shops	1050
• Banks	800
• Post office	100
• Security monitoring office	50
• Offices to let (small units)	200
• Eating area	100

• Sanitary area	90
<i>4. Second floor</i>	
• Offices to let	650
• Banks	400
• Clinic	200
• Gymnasium	300
• Child care centre	400
• Restaurant	500
• Sanitary	90
<i>5. Third floor</i>	
• Reception	150
• Trading floor	700
• Conference room	120
• General office (GSE)	350
• Library	400
• Sanitary	60
<i>6. Fourth floor</i>	
• Trading and clearing department office	150
• Information department office	180
• Finance and data analysis office	180
• GSE securities depository company office	180
• Seminar hall	150

• Sanitary	60
<i>7. Fifth floor</i>	
• Board room (GSE)	70
• Office of the managing director	100
• Office of the marketing manager	100
• Office of the finance manager	100
• Office of the administration manager	100
• Office of the corporate affairs manger	100
• Archives	75
• Publication centre	70
• Gymnasium	80
• Sanitary	60
<i>8. Sixth floor</i>	
• Board room (SEC)	60
• Chairman's office	100
• Supervisors offices	100
• General offices	250
• Offices to let	600
• Sanitary	60
<i>9. Seventh floor to twenty first floor</i>	
• Offices to let	16300
• Sanitary	900

10. Twenty second floor (recreation)	
• Tennis	250
• Badminton	160
• Gardens	400
• Service area	70
• helipad	180

TABLE 4.1- *Schedule of Accommodation*

4.3 CONCEPT AND PHILOSOPHY OF DESIGN

Modern office design shows that much more flexibility and cost savings can be made by adopting design themes that ensure openness and barrier free spaces. This also contributes greatly to worker interaction, equity and supervision leading to an improvement in the productivity of workers.

In the design of this stock exchange, a lot of consideration has been given to the realization of worker productivity and welfare and thus the design philosophy chosen for the realization of this set target is based on **visibility, safety and openness**.

In order to achieve this design philosophy, the design will seek to reduce the use of visual and physical barriers and promote open office floors.

4.4 CONCEPTUAL SITE PLANNING

The conceptual layout arises from a careful analysis and consideration of the relationships between facilities. The size and shape of site and nature of surroundings

influenced the arrangements of the various facilities on the site. The planning configuration and orientation of buildings was carefully done to enhance view of environment, reduce solar heat gain, and maximize day lightening to reduce energy cost.

Option 1

A- MAIN BUILDING

B- CAR PARKING

C- LANDSCAPING AND EXTERNAL CIRCULATION

D- SERVICE AREA



FIG 4.1- Option 1 Site Conceptual Plan

Merits

- View of the children's park is emphasized
- Ground floor area of main building is maximized
- Screened parking

- Enhanced security and enclosure
- Responds to corner nature of site and improves views of the environment

Demerits

- Prevents the public use of car park which will compromise on security in the court yard
- Reduced car parking area

Option 2



FIG 4.2- Option 2 Site Conceptual Plan

A- MAIN BUILDING

B- CAR PARKING

C- LANDSCAPING AND EXTERNAL CIRCULATION

D- SERVICE AREA

Merits

- View of main street and the children's park is emphasized
- Public access to car park is enhanced without interruption
- Car park area is enlarged
- Court yard is opened and encourages interaction between people and the building

Demerits

- Ground floor area of main building is reduced

Option 2 was chosen to be developed further since it solved the demerits of the first option and the reduction in the ground floor area of the main building can be compensated for easily by height. It will be further developed closely with building massing to enhance site optimization.

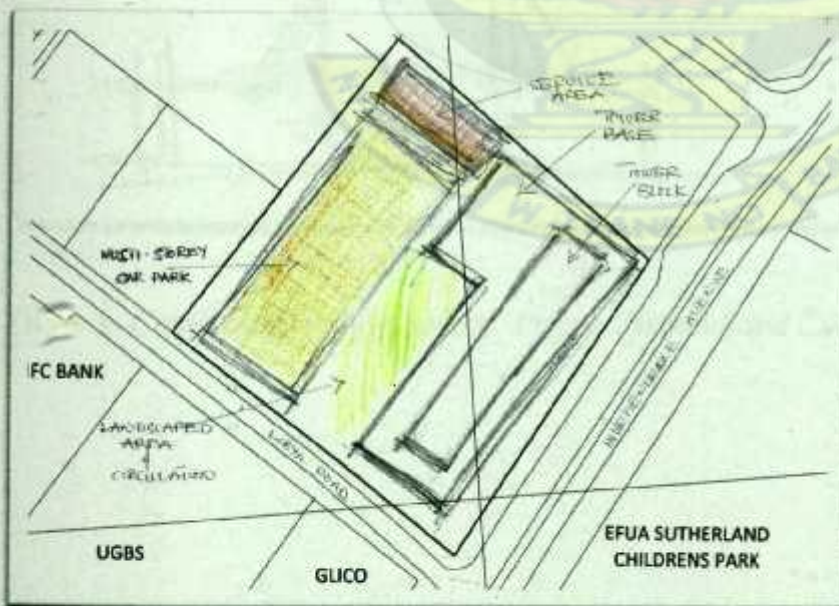


FIG 4.3- Option 2 Site Arrangement

4.5 DESIGN PLANNING AND MASSING

The site layout was planned to integrate a multi-storey office block, a multi-storey car park and a service area. The massing of the building is a combination of pyramid which depicts stability in form, a prism which maximizes floor area and a cuboid base further enhances the stability of the structure. This combination of basic geometric form is what I refer to as a *Based Pris-Pyramid*.

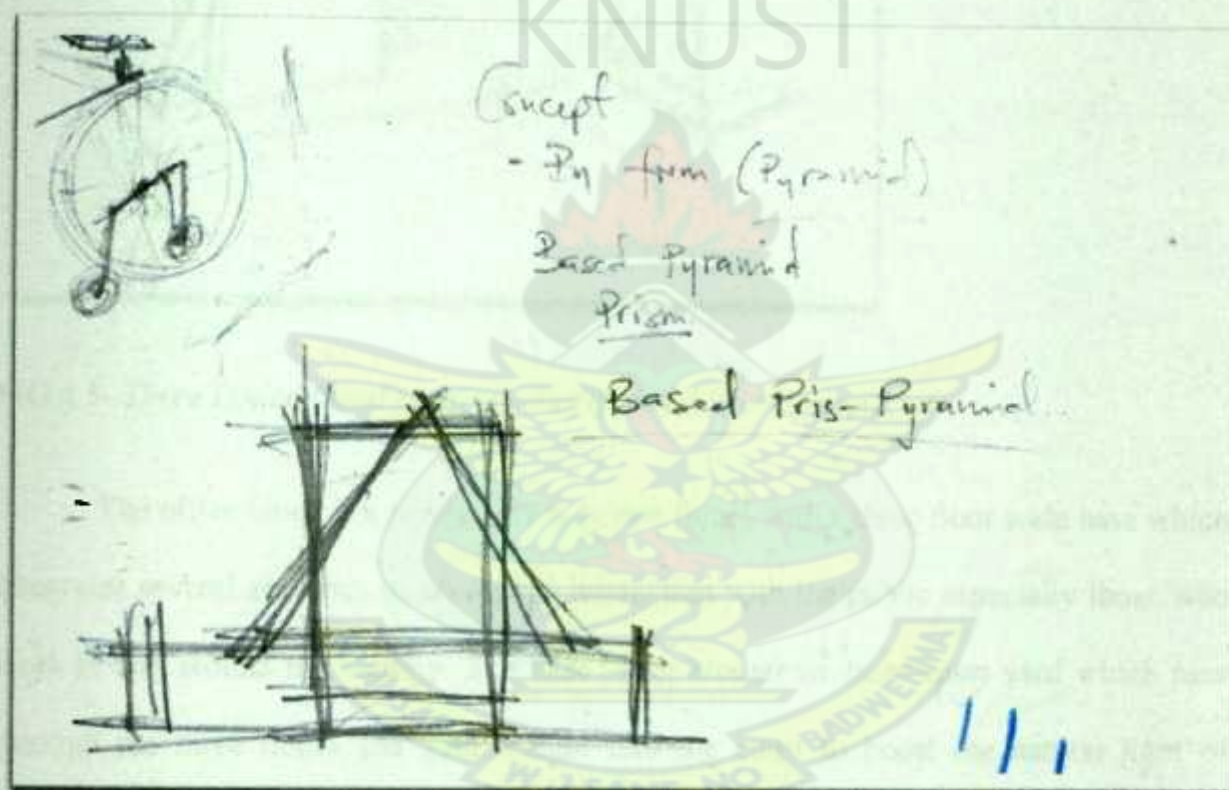


FIG 4.4- Combination of Geometric Prism, Pyramid and Cuboid.

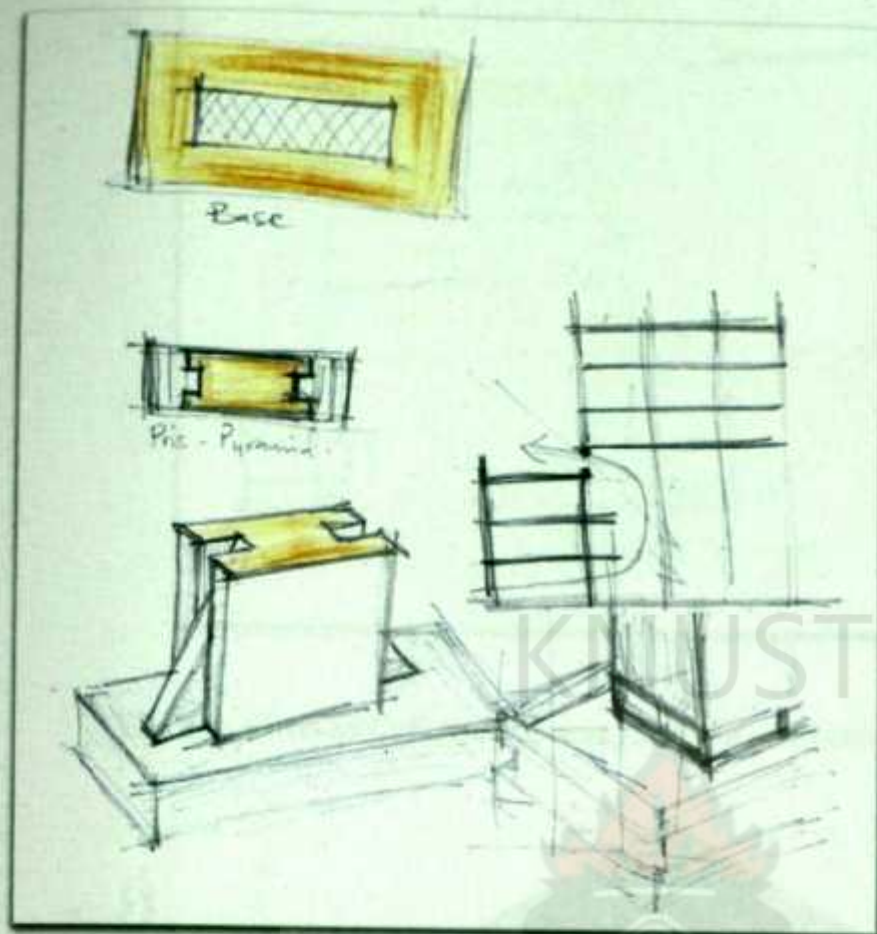


FIG 4.5- *Three Dimensional Impression of a Based Pris-Pyramid.*

The office block is a tower of twenty two floors with a three floor wide base which integrates several activities to encourage interaction with the public especially those who work in and around the vicinity. The base is set around an inner court yard which runs through the three floors and admits light into the court to boost the natural light of peripheral spaces from within. This also enhances ventilation of the court which will serve as a social space within the block.

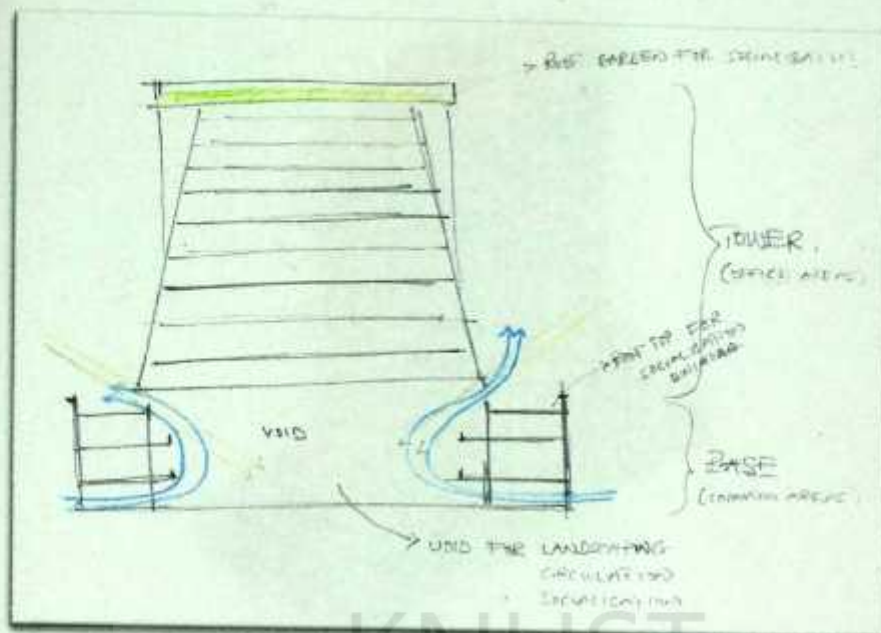


FIG 4.6- Covered Courtyard System for Light and Ventilation Admission.

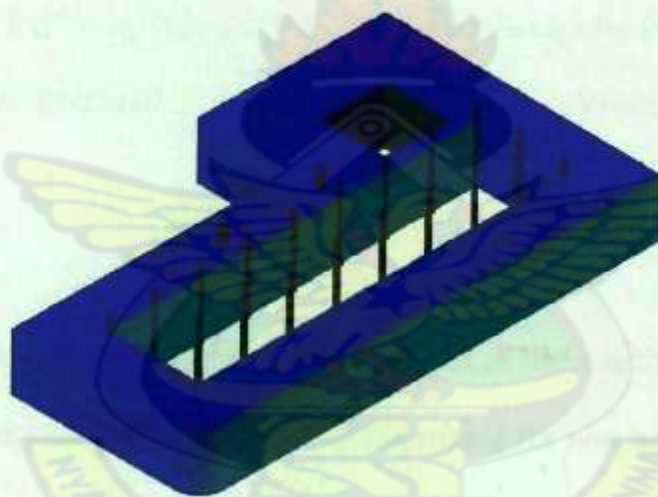


FIG 4.7- Base of Office Block with Court Yard.

The tower block which is set above the court yard of the base and is raised by a floor height to enhance the admission of light and ventilation air into the court yard. The tower block contains the trading floor and offices of the **Ghana Stock Exchange** and the **Securities and Exchange Commission** with provision of offices spaces to let for especially financial, brokerage and insurance companies.

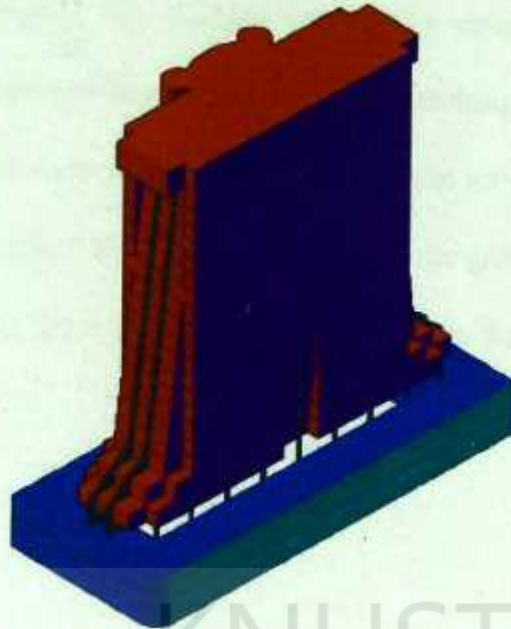


FIG 4.8- *Three Dimensional Impression of Office Block.*

The multi-storey car park is positioned to enhance shared usage by inhabitants of the main building and by others who work in other office blocks in the vicinity.

4.5.1 SHOPS

Shops are provided on the ground and first floor of the ease the burden of shopping by workers and in the vicinity. There are no shops around the area and thus cause workers to rely on house-helpers to render them such services. By bringing shopping closer to these workers, they will be helped to do shopping easily and as often as they wish. The car parking constraints in relation to this provision is eased by the multistory car park.

4.5.2 BANKS

Banking is one of the prime activities of firm and individuals especially those who work within the area. Thus the provision of banks will enhance the interaction of the

building with people and serve the working community extensively. Each bank has an average of 400m² floor area and handles all aspects of banking from customer banking to executive banking. Bullion vans access the banks from the service entry which is secured and well monitored by security. Banks on floors except the ground floor are served with a micro lift which transports money and other security notes from the ground floor to the back office.

4.5.3 MAIN SERVERY

An established restaurant will cook and supply food to the main servery located on the ground floor. This space has facilities to ensure storage and finishing of food preparation to serve workers and the restaurant. The servery will be linked to other smaller serveries on the first and second floors by a service lift to transport food to the restaurant.

4.5.4 CLINIC

With a building of such capacity, it is prudent to have a place to handle health emergencies. The clinic which is located on the second floor has a reception, consultation room, pharmacy and personal wards for executives.

4.5.5 CHILD CARE

The child care unit is to help parent workers who need to have special care for their babies and kids who require serious monitoring. This unit will ensure that the heavy burden of dropping off babies and kids to nurseries and picking them up later after work

will be drastically reduced. The unit has areas for baby courts and activity areas for toddlers with sanitary and eating areas.

4.5.6 GYM

The gym is located on the second floor and will cater for the physiotherapy needs of workers in the building. It has integrated sanitary and washroom facilities to ensure worker can shower and change for office after exercise.

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4.5.7 POST OFFICE

Correspondence and parcel delivery service is a need in official work. Thus, with the provision of a post office in the building companies and individuals can send and pick up mail without much trouble.

4.5.8 TRADING FLOOR

The trading floor is a significant aspect of the stock exchange. That is where the prime activity of trading in the stock market takes place. Located on the third floor it has a floor area of 700m² and a double room volume. A long gallery overlooks the floor from the fourth floor where supervisors, executives and visitors can observe the proceedings on the floor. The floor has a workstation arrangement towards the centre of the floor where large screens display state of trading of the various stocks and the major figures and prices of stocks. Because of the openness of the trading floor and the access floor system integrated into the floor slab, flexibility in workstation arrangement is achieved.

4.5.9 RECREATIONAL AREAS

Recreational areas are provided on the roof of the second floor, and the twenty second floor. These act as key places for recreation, leisure and sports for the workers in the building. The roof of the second floor will be able to host parties and receptions as well as places where workers can meet for lunch instead of the restaurant or have a drink.

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5.0 CHAPTER FIVE

SERVICES

5.1 WATER SUPPLY

Water supply shall be from two main sources namely the city water supply system and rain water harvesting and supply system. The water from the utility company lines shall be directed to an underground storage facility which is then pumped to a water cistern on the roof and then distributed by gravity to outlets in sanitary areas as potable water. The rain water harvesting system shall collect rain water from roof and surface drains and channeled to a rain water reservoir. This is filtered, cleaned and stored in another reservoir from where it is also supplied to water closets in sanitary areas by gravity form an overhead water cistern. This ensures the utilization of rain water and minimizes dependence on city water supply.

5.2 DRAINAGE

Roof drainage is through down pipes in column jackets all the way down into the the rain water harvesting system for utilization. Run off and surface water shall be collected by covered drains and also directed into the rain water harvesting system with an integrated overflow into the sewer line on the independence avenue.

5.3 ELECTRICITY

A dedicated transformer will be situated on site in the service area of the site. This transformer will supply step down power voltage to the building by underground cables to the electric control room. An emergency automatic switch over power generator shall compliment the city supply especially during power outages and shall have an underground fuel reservoir to ensure good interval between refills. The tower shall receive electric distribution cables through a centrally placed access duct from where power shall be tapped into ceiling and access floor spaces. Each floor shall have a control room with a five hour rated openings where all power control installation for that particular floor shall be located.

With significant sun shine on the south east façade of the tower, solar panels are placed to harvest this energy to optimize electric consumption of the building. This power shall be applied for low power emergency systems such as lamps in circulation areas, security installations and alarm systems to ensure that power outages during emergency period do not lead to excessive loss of lives and property.

5.4 SWITCHES AND SOCKETS

British standard switches and sockets shall be provided. There shall be 13amp sockets in for low power installations and equipment and 15amp sockets for special equipment

5.5 FIRE ALARM SYSTEMS

Automatic smoke and heat detectors with audible warning throughout the buildings shall be provided. Water hose will be located at various points within circulation areas and fire extinguishers within offices. All circulation areas and offices shall be fitted with sprinkler systems to ensure the heat reduction during excessive burning. In addition, fire hydrants shall be located at vantage locations to help fire fighting by the fire service.

5.6 TELECOMMUNICATIONS

Every facility has communications requirements that need to be connected to the Information infrastructure. These communications requirements encompass not only basic telephone service, but local area network/data communications (LANs), video/television, paging, and security and fire sensing and alarm systems.

Separate, dedicated telecommunications space will be provided to satisfy the immediate and planned future telecommunications needs.

5.7 SOFT LANDSCAPING

Landscaping is prime in the design. A lot of green will be incorporated into the site layout to promote urban forestry. All non circulation ground area shall be either planted or covered with a lawn. In addition above ground recreational area shall all be planted to ensure that besides the decorative benefit, roof plantings may provide green, temperature control, architectural enhancement, habitats for wildlife and recreational opportunities. Available gardening areas in the city are often seriously lacking, which is the key impetus for the roof garden.

5.8 HARD LANDSCAPING

Easy maintenance, durability and aesthetic appeal shall be considered in my choice of hard paving elements. Drive ways, car park and pedestrian walks shall be finished with interlocking concrete paves interspersed with grass. The pavers shall blend with the rest of the landscape in both colour and texture. This is aimed at reducing heat loads, glare and by the principle of rhythm and repetition to achieve a better design.



6.0 CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The Ghana Stock Exchange has been designed to be a landmark on the landscape of Accra and Ghana as a whole and will act as such given its bold expression on the prominent independence avenue will add stature and prominence to the Ghana Stock Exchange and place it on a pedestal for a higher achievement locally and internationally. It add to the statement of the development of the economy and give meaning to its strategic position in the advancement of businesses and industries to push the country into middle income status.

The building has been organised to enable vertical and horizontal interaction and to bring users closer to their immediate needs in the work environment so as to provide a productive focused environment. By providing the needed facilities and places within the building, it saves user time and worries thereby resulting in a much more focused workforce that is highly productive. open floors provides the flexibility of a work environment to be managed and changed to suit the needs of users at any time.

Finally, the building has been integrated in photo voltaic panels and equipment to produce solar energy to offset demand from the national grid. The building is designed to harvest rain water for use in washrooms in a bid to reduce consumption from the water company. This thus make the building self reliant to such an extent that conserve resource consumption and promote sustainability in the long term.

6.2 RECOMMENDATION

From the experience of the design it is very important to involve all stakeholders in the project from conception to completion. This will ensure that all concerns of all the stake holders will be raised and satisfactorily dealt with to ensure the project achieves its set quality target and delivered within the time schedule. For such a complex high-rise building, the management of all the processes and coordination of all the actors is supreme to achieving the best results.

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LIBYA ROAD

CHINA STREET

KNUST

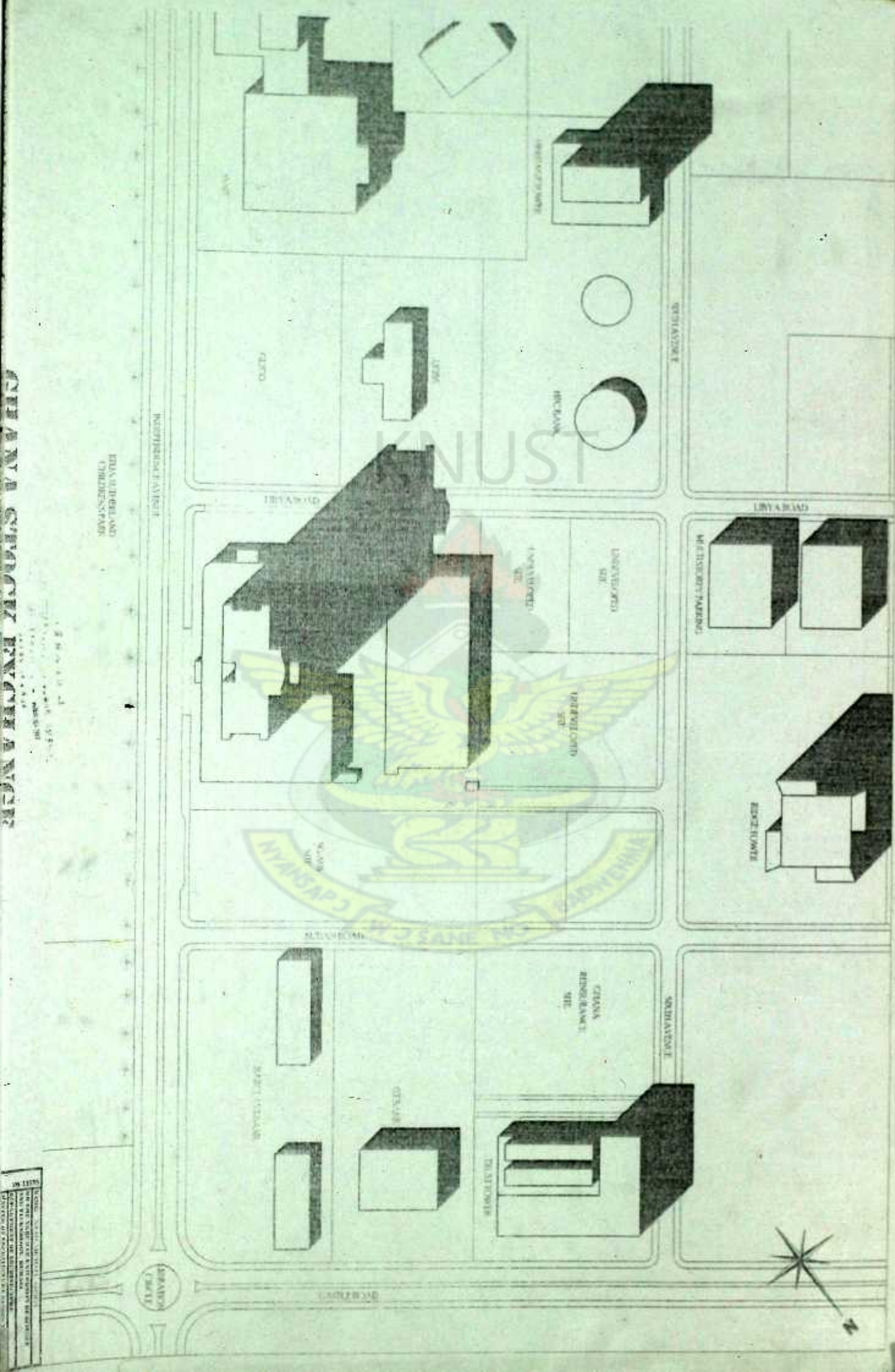
REST

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Sheet 1 of 1

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SUB-BASEMENT PLAN



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INSTITUTION: INSTITUTE OF ARCHITECTURE

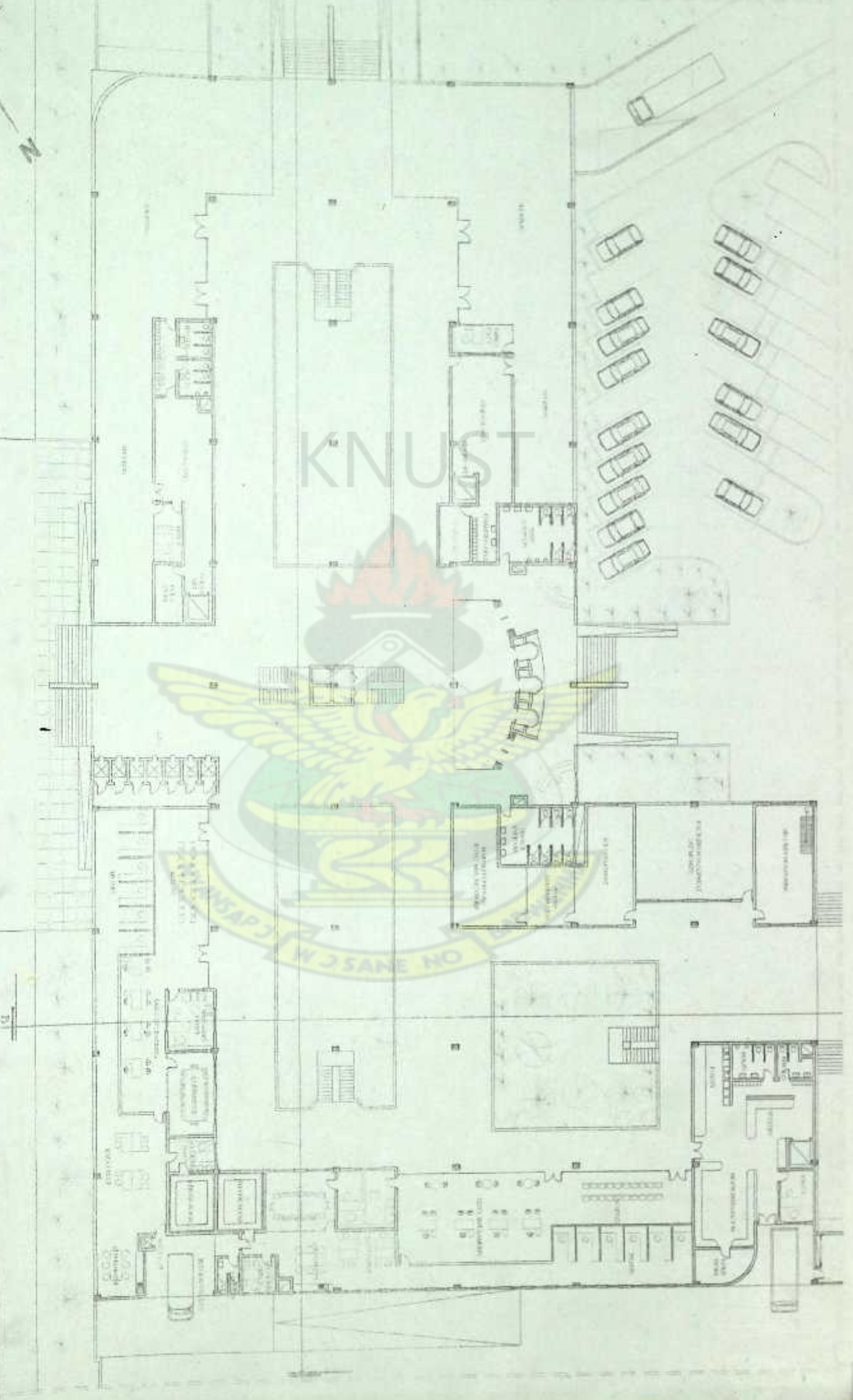
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OFFICE OF ARCHITECTURE DESIGN THRU 2000



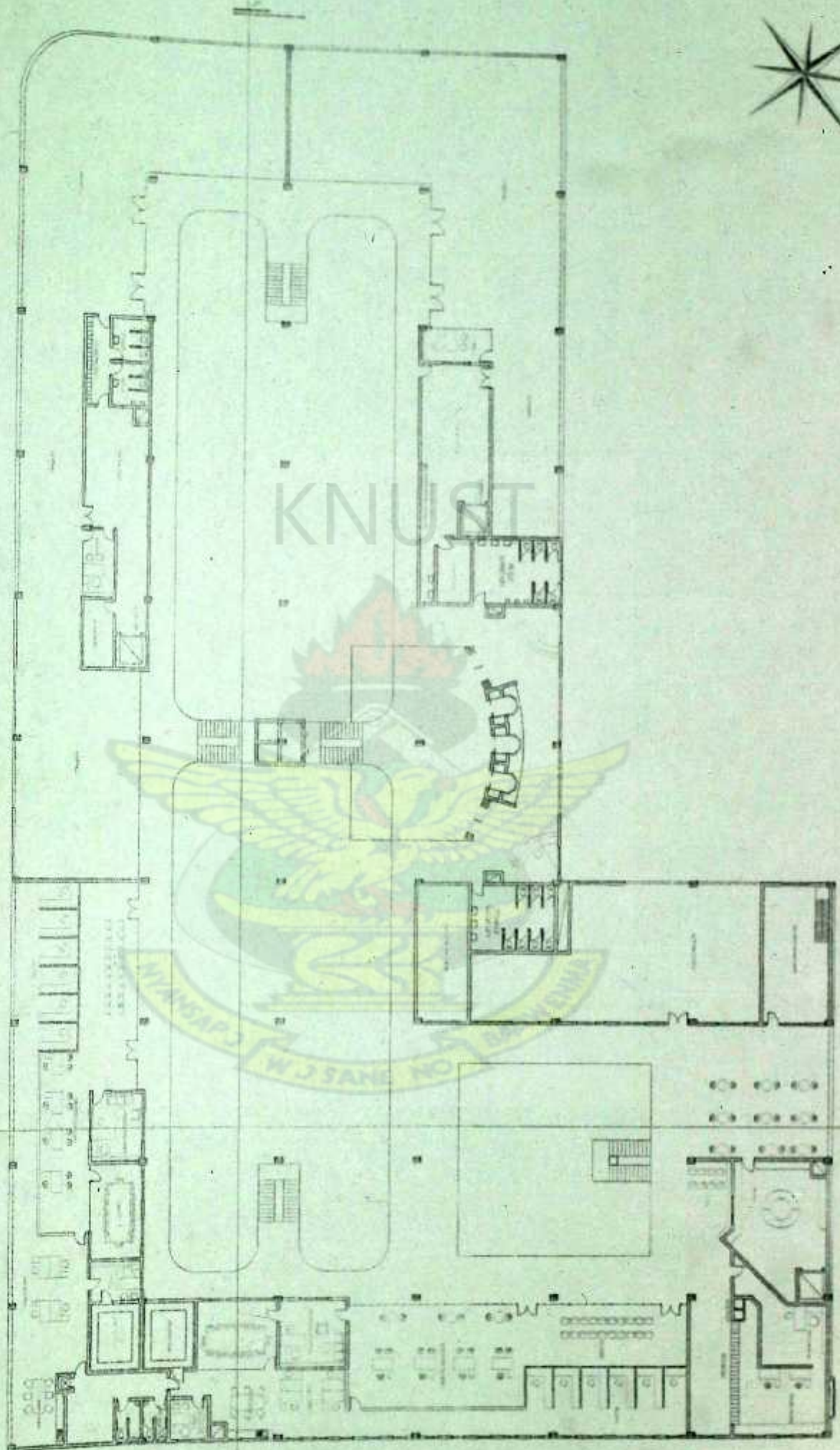
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LOCATION: KNUST
DATE: 1998

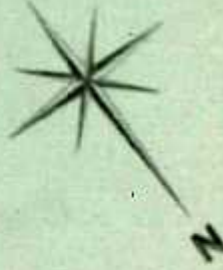


CHANA STOCK EXCHANGE

FIRST FLOOR PLAN

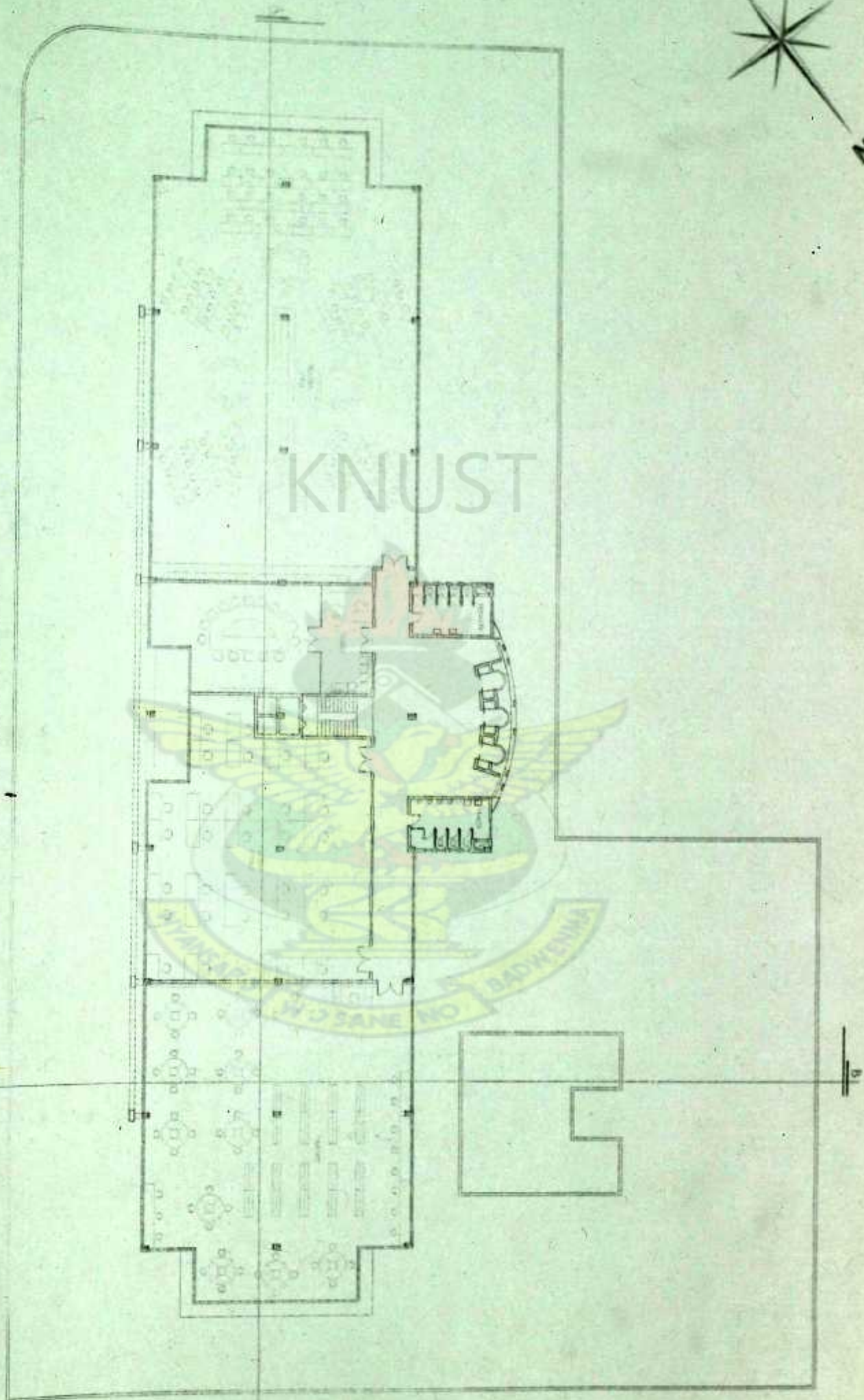


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MASTER OF ARCHITECTURE DESIGN THESIS 2005	
FIRST FLOOR PLAN	SCALE: 1/200



KNUST

THIRD FLOOR PLAN



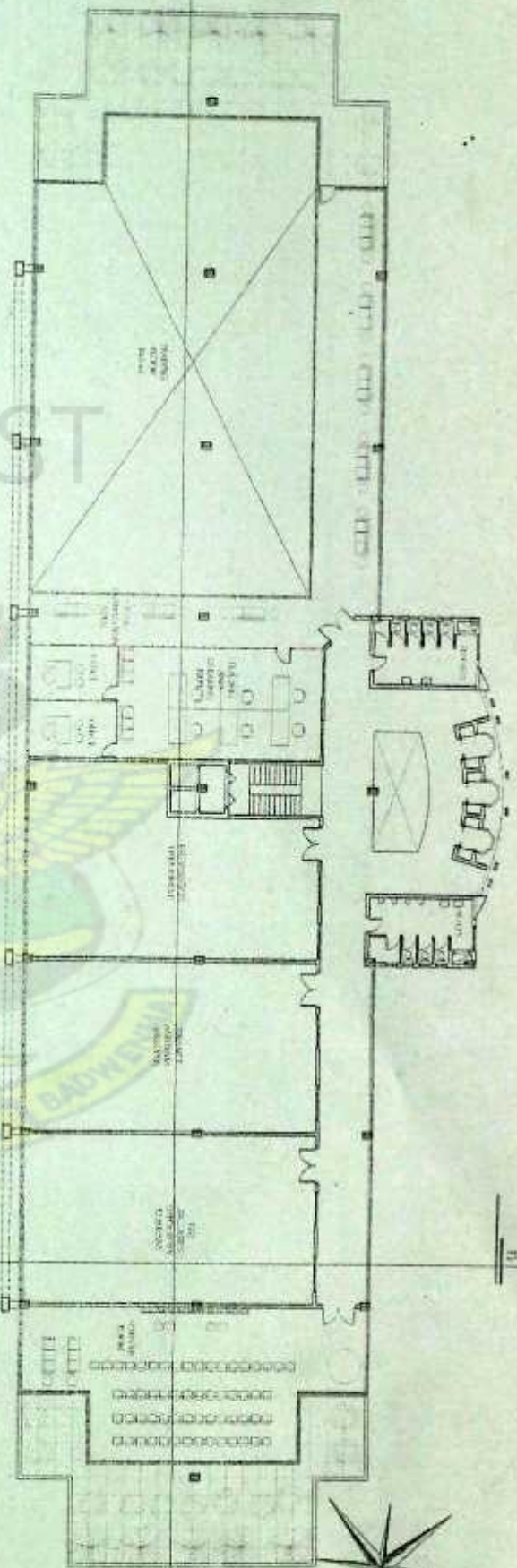
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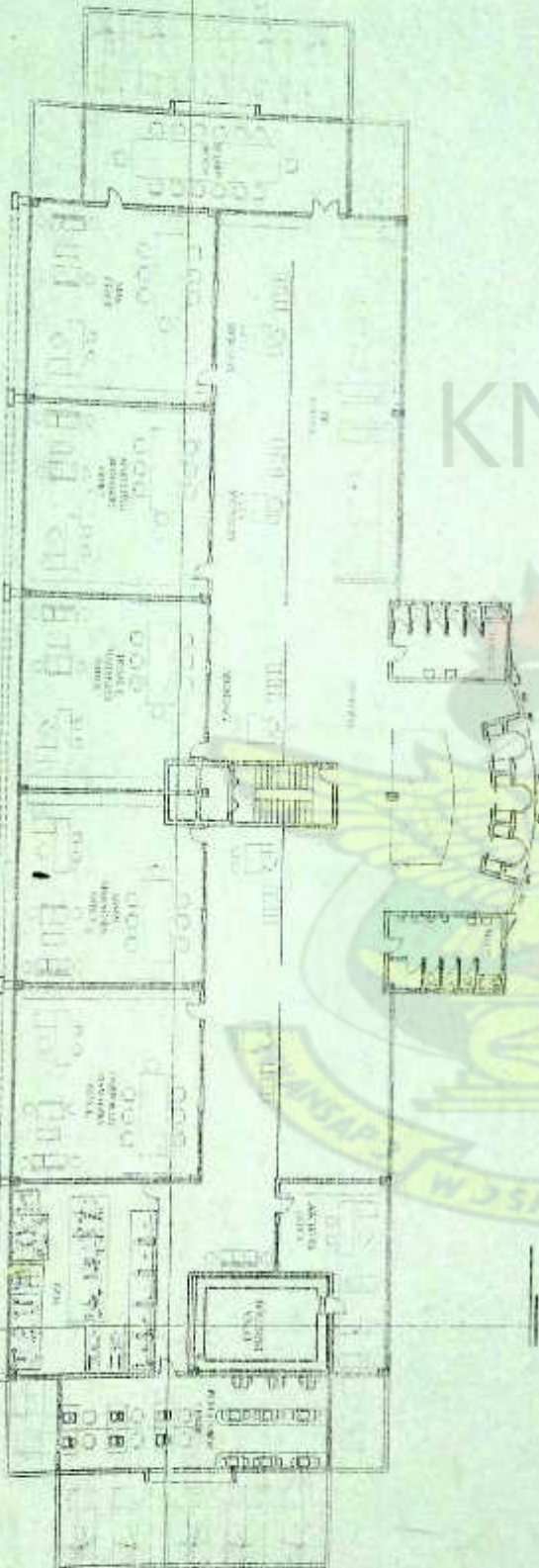
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FOURTH FLOOR PLAN



FIFTH FLOOR PLAN



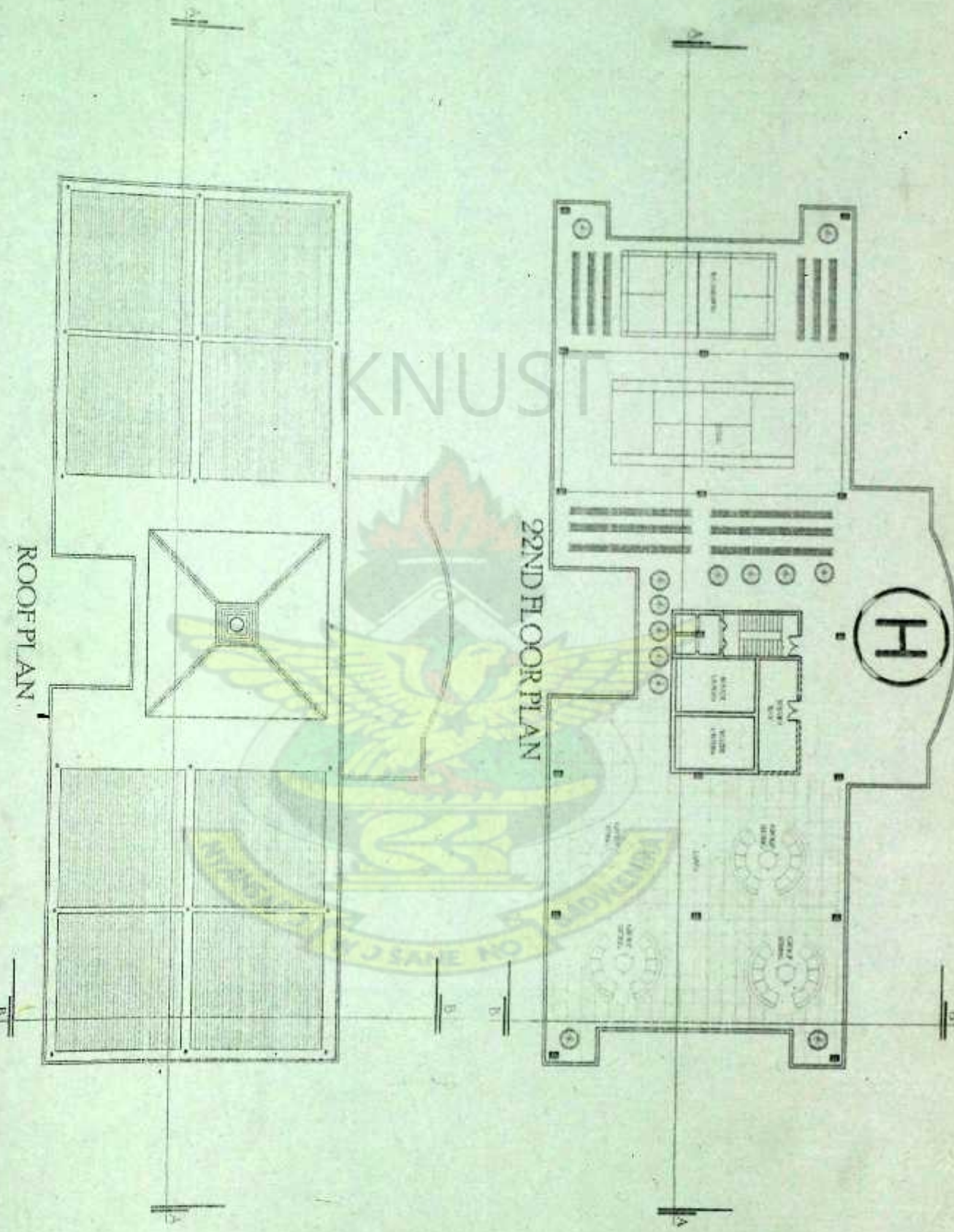
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GHANA STOCK EXCHANGE

22ND FLOOR PLAN

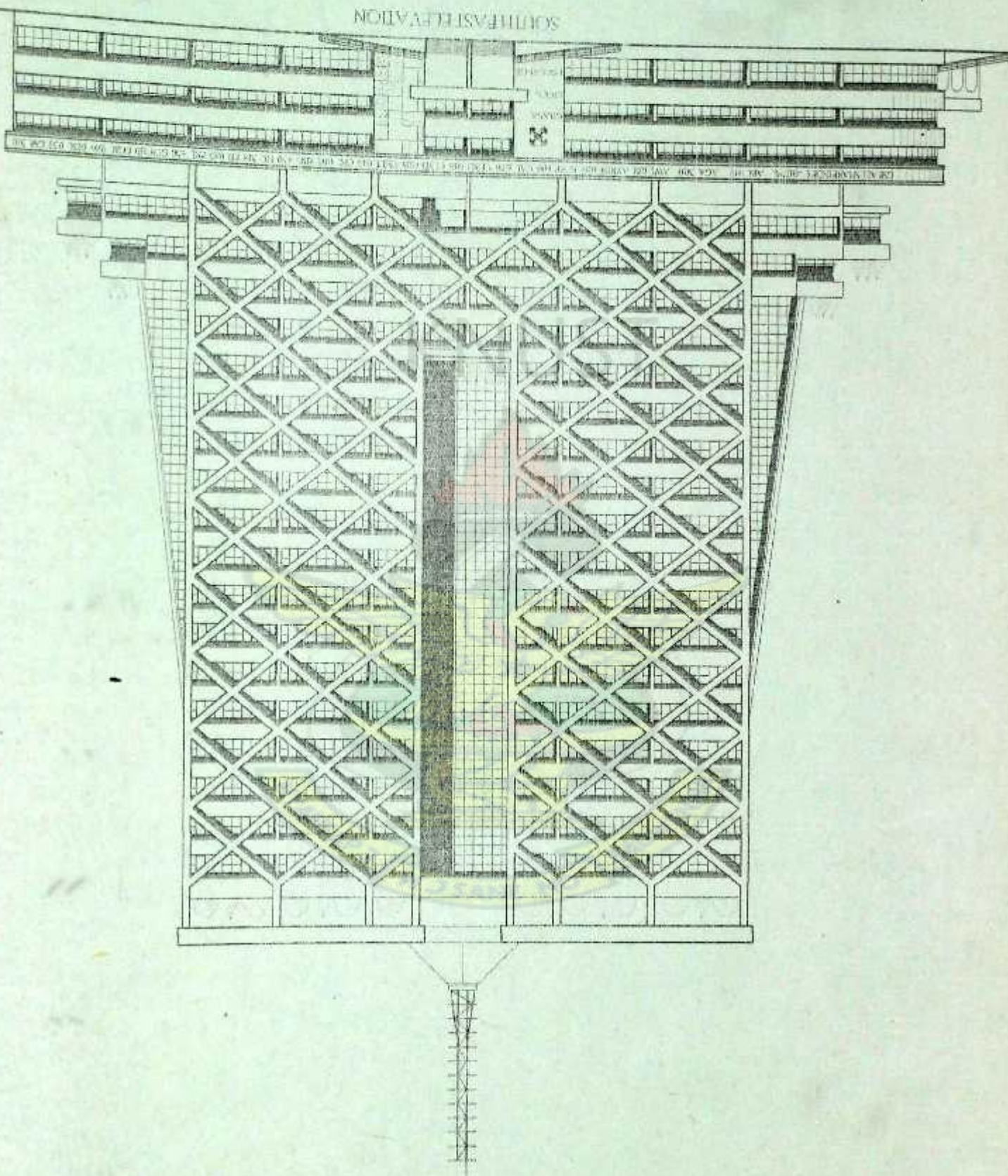
ROOF PLAN



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GHANA STOCK EXCHANGE

SOUTHEAST ELEVATION

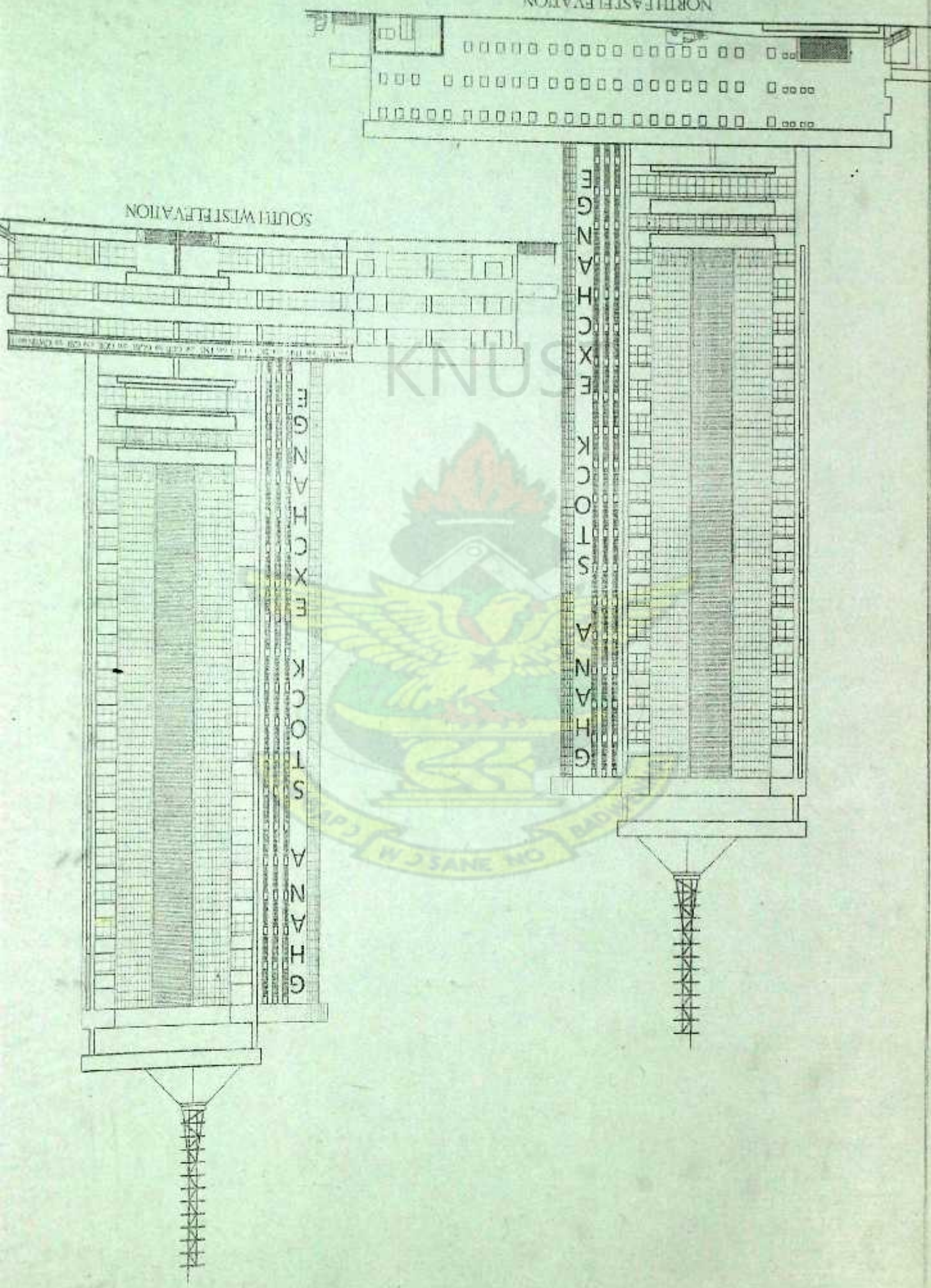


GHANA STOCK EXCHANGE
STREET NO. 10, ACCRA
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STOCK EXCHANGE
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GHANA STOCK EXCHANGE

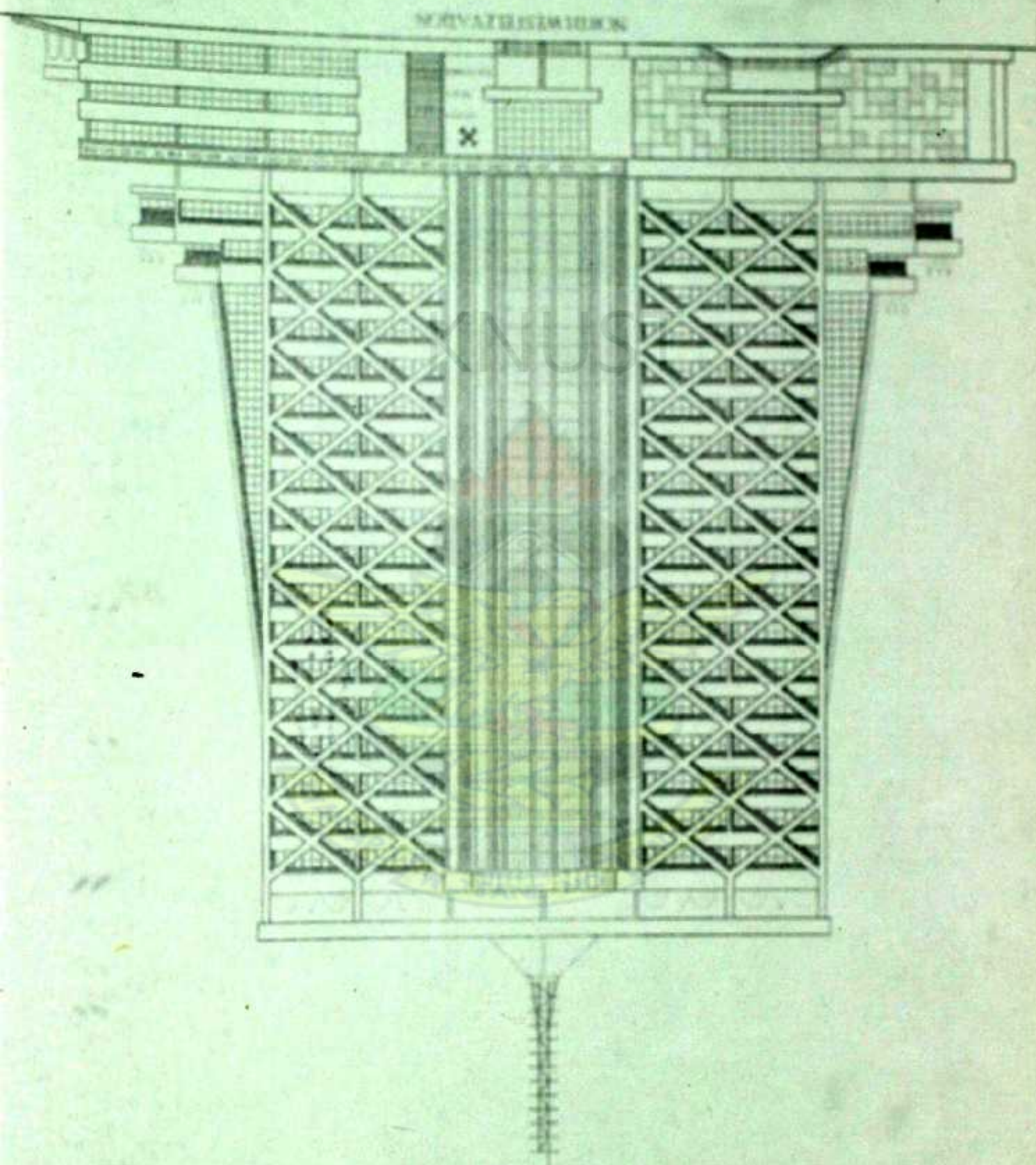
NORTH EAST ELEVATION

SOUTH WEST ELEVATION



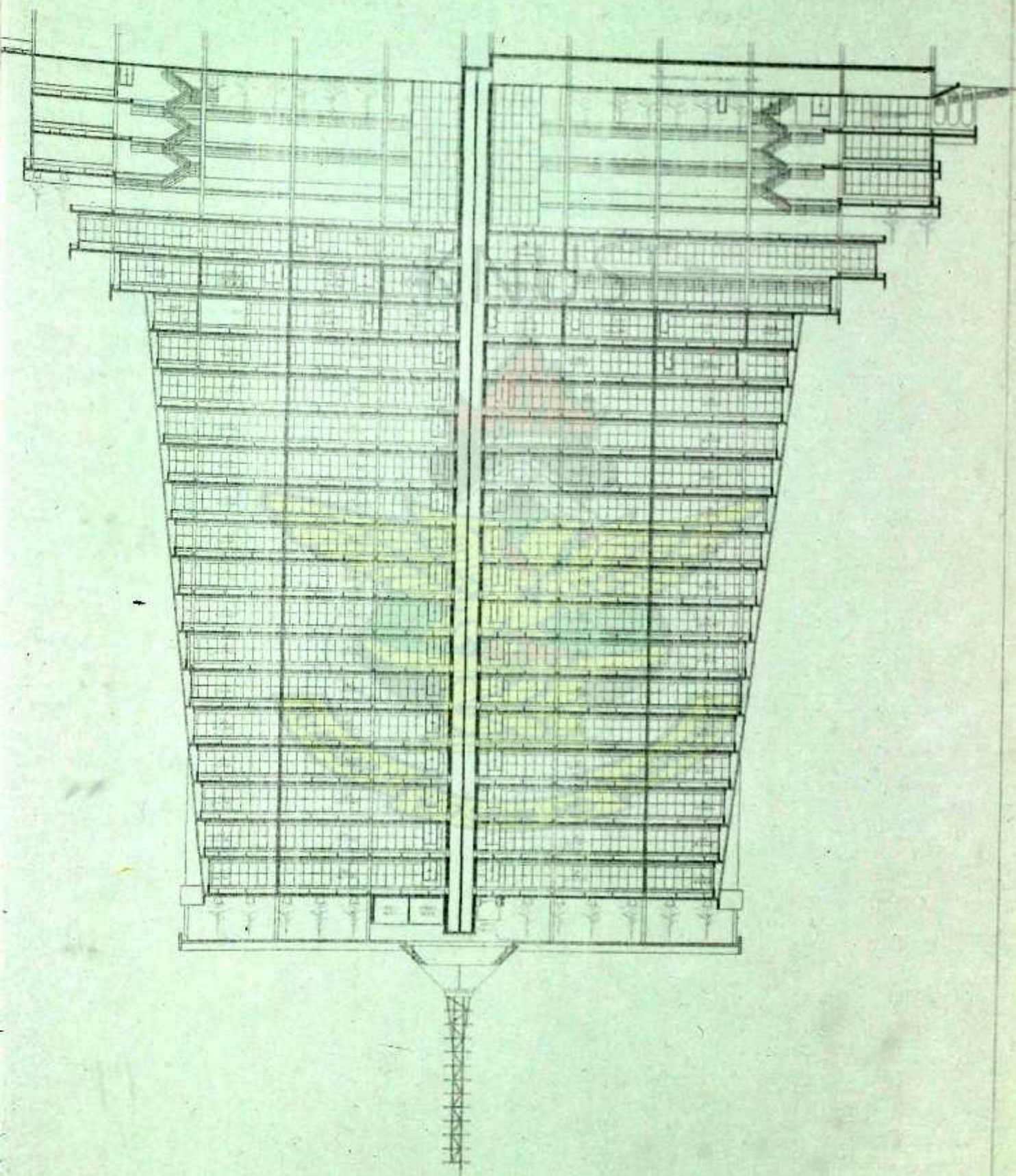
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2. FINANCIAL STATEMENTS
3. MANAGEMENT INFORMATION
4. ADDITIONAL INFORMATION



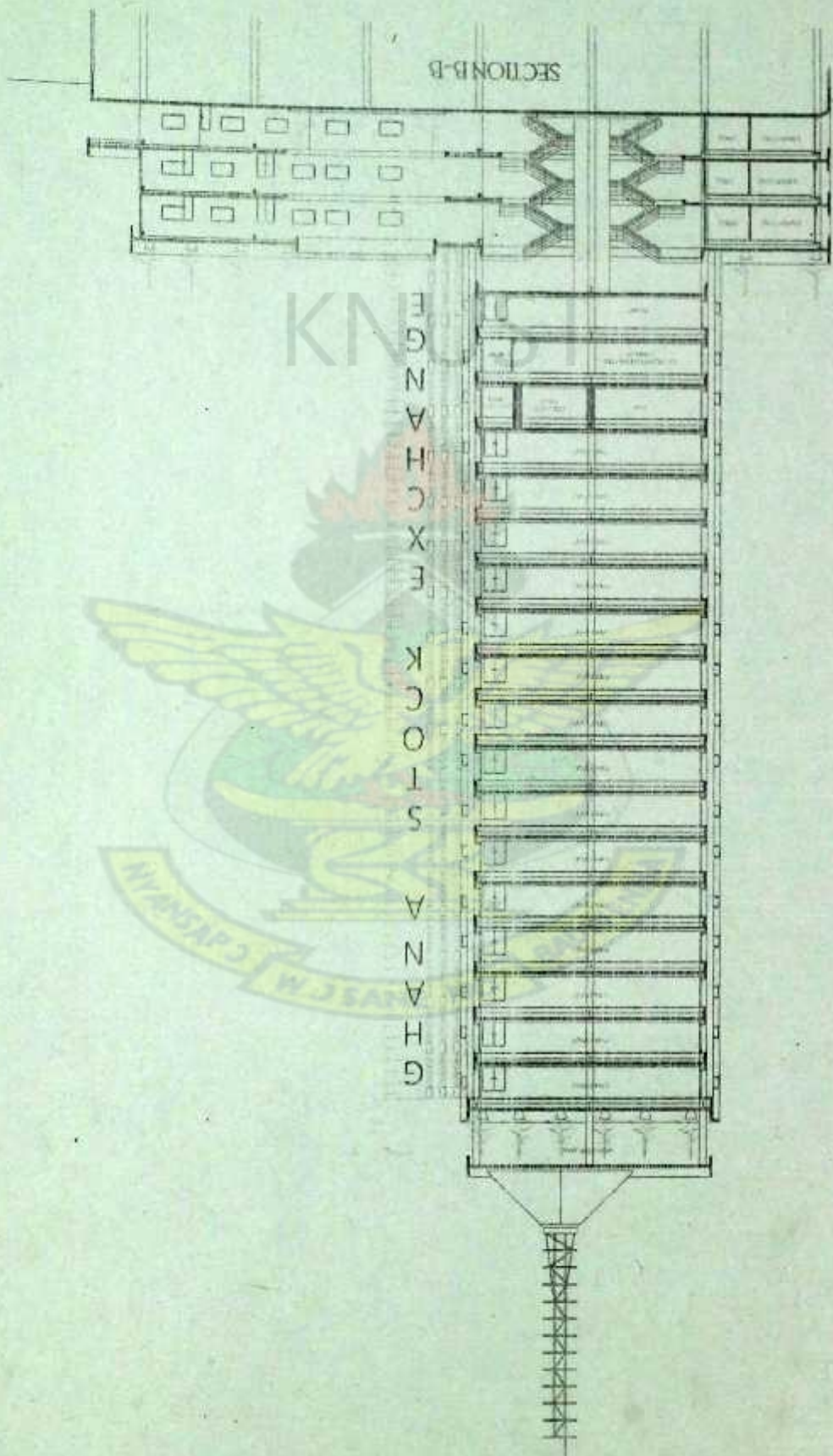
GHANA STOCK EXCHANGE

THE GHANA STOCK EXCHANGE
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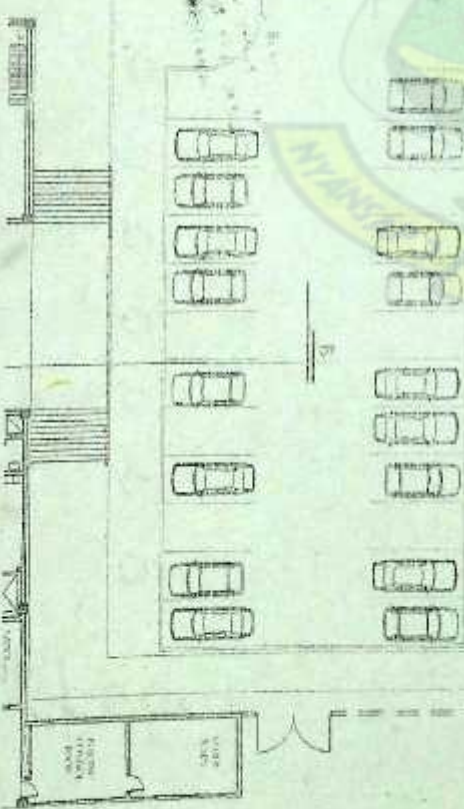
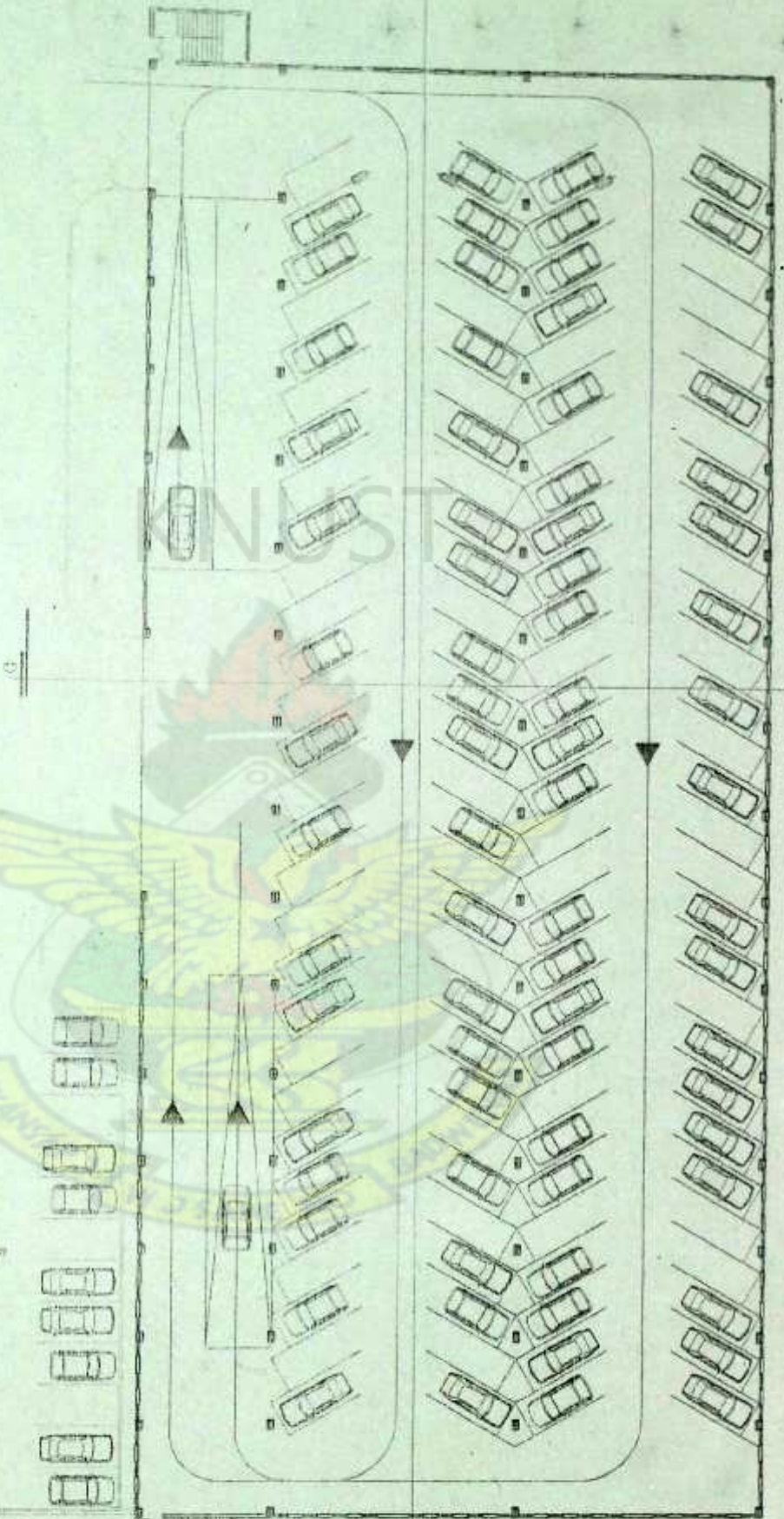
KENNEDY
 ARCHITECTS
 100, MARKET STREET, ACCRA
 GHANA
 TEL: 222222
 FAX: 222222





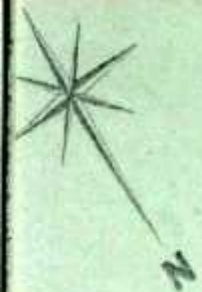
GROUND FLOOR PLAN- CAR PARK

GHANA STOCK EXCHANGE



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GROUND FLOOR PLAN- CAR PARK SCALE: 1:200

GHANA STOCK EXCHANGE



FIRST TO THIRD FLOOR PLAN

SHEET NO.	NAME: NATH MOHAMED AHMED
IN CHARGE: NATH MOHAMED AHMED	IN CHARGE: NATH MOHAMED AHMED
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UNIVERSITY OF ARCHITECTURE, KUMASI	UNIVERSITY OF ARCHITECTURE, KUMASI



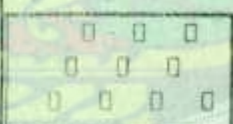
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ELEVATION B

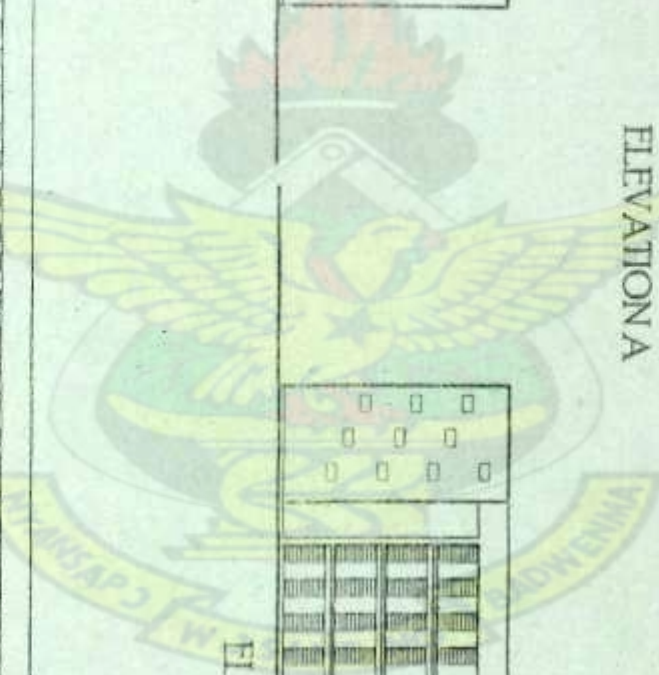


ELEVATION C



ELEVATION D

GHANA STOCK EXCHANGE



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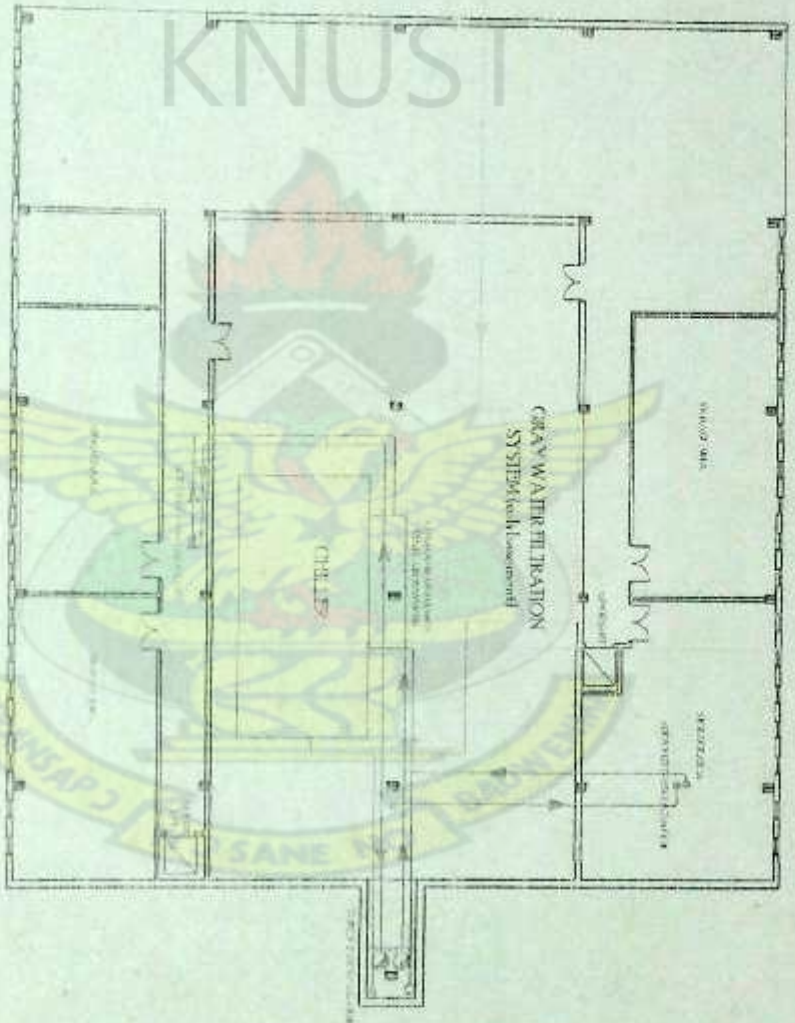
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	STUDYING IN A FOREIGN COUNTRY - YES
	DATE OF BIRTH - 1990



KEY	
PERFORATED WALL	
RAIN WATER	
CO. FLOOR DRAIN	
THROTTLE VALVE	
RAINFALL WATER	
PERFORATED	
WATER TREATMENT	
AIR CONDITIONING	

WATER TREATMENT SYSTEM

RAIN WATER STORAGE TANK
Below ground



WATER TREATMENT SYSTEM

SUB-BASEMENT PLAN

GHANA STOCK EXCHANGE

SUBJECT AREA	
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INstitute: NORTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI	INstitute: NORTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI
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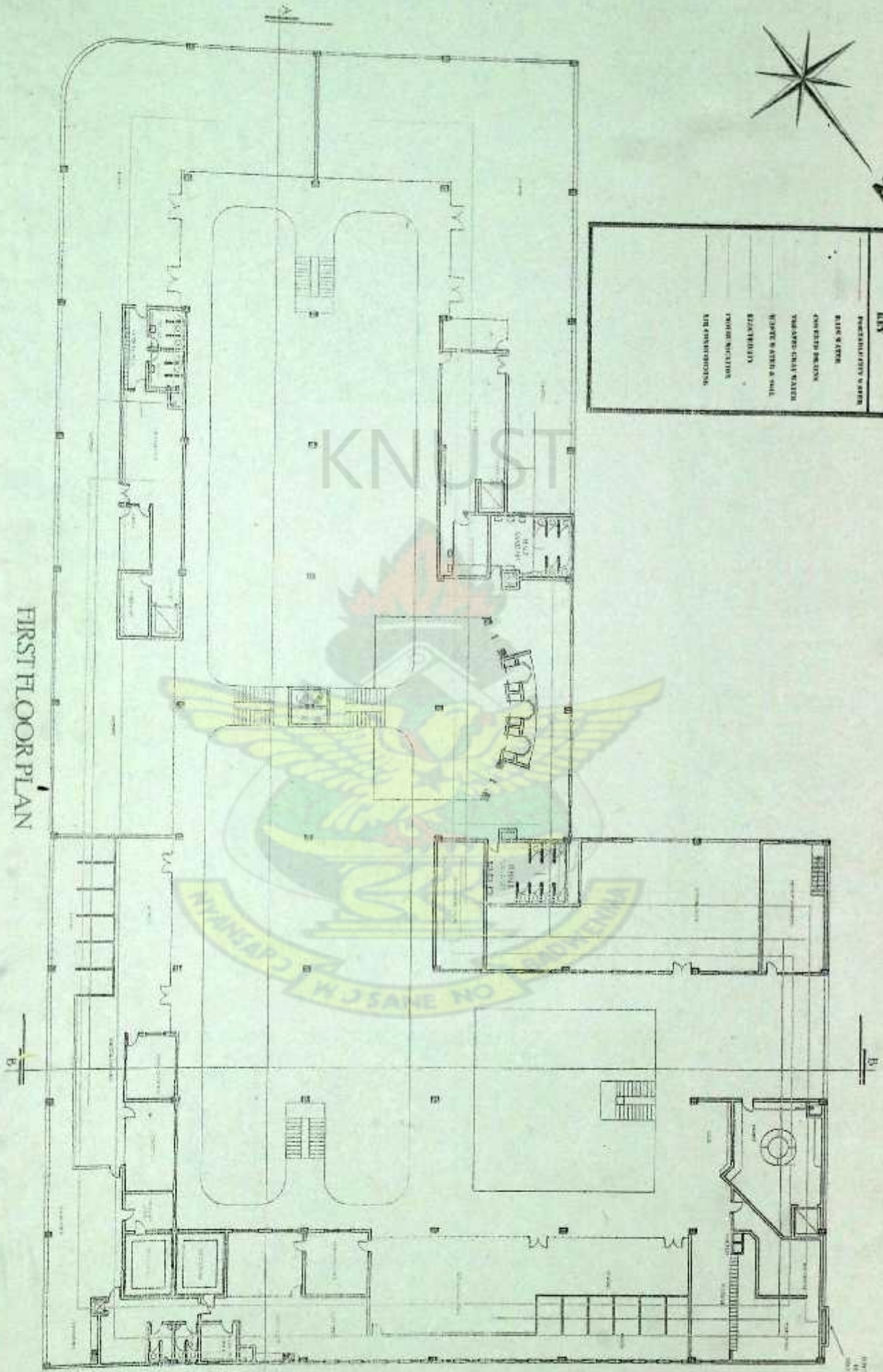


444-223-1074
The Tappan
Hotel & Casino



KEY	
—	PERMANENTLY N. AREA
—	BLK. & AREA
—	CONCRETE PAVEMENT
—	TOILETS & CLO. WATER
—	WATER & AREA & CLO.
—	ELECTRICITY
—	PHONE NO. 1100
—	AIR CONDITIONING

FIRST FLOOR PLAN



GHANA STOCK EXCHANGE

SHEET NO.	NAME, NAAM, NORTLAND ANDIV
DATE, NAAM, NORTLAND ANDIV	DATE, NAAM, NORTLAND ANDIV
DEPARTMENT OF ARCHITECTURE	DEPARTMENT OF ARCHITECTURE
MINISTER OF ARCHITECTURE	MINISTER OF ARCHITECTURE
DATE, NAAM, NORTLAND ANDIV	DATE, NAAM, NORTLAND ANDIV

NAME: MAAL, MICHAEL ANDY
 NAME: NORTHAM UNIVERSITY OF SCIENCE
 AND TECHNOLOGY, AUSTIN,
 TEXAS
 DEPARTMENT OF ARCHITECTURE
 MASTER OF ARCHITECTURE DEGREE THESIS 2009
 STUDY 2: LAYOUT and floor
 SCALE: 1"=6'

Architectural floor plan of the main building at KNUST, Kumasi. The plan shows a large rectangular building with a central corridor and various rooms. A large watermark of the KNUST logo is visible across the center. A legend in the top right corner identifies symbols for: Main Entrance, Main Building, Lecture Halls, Laboratories, Workshops, Stores, and Staff Quarters. A north arrow is located in the top right corner.

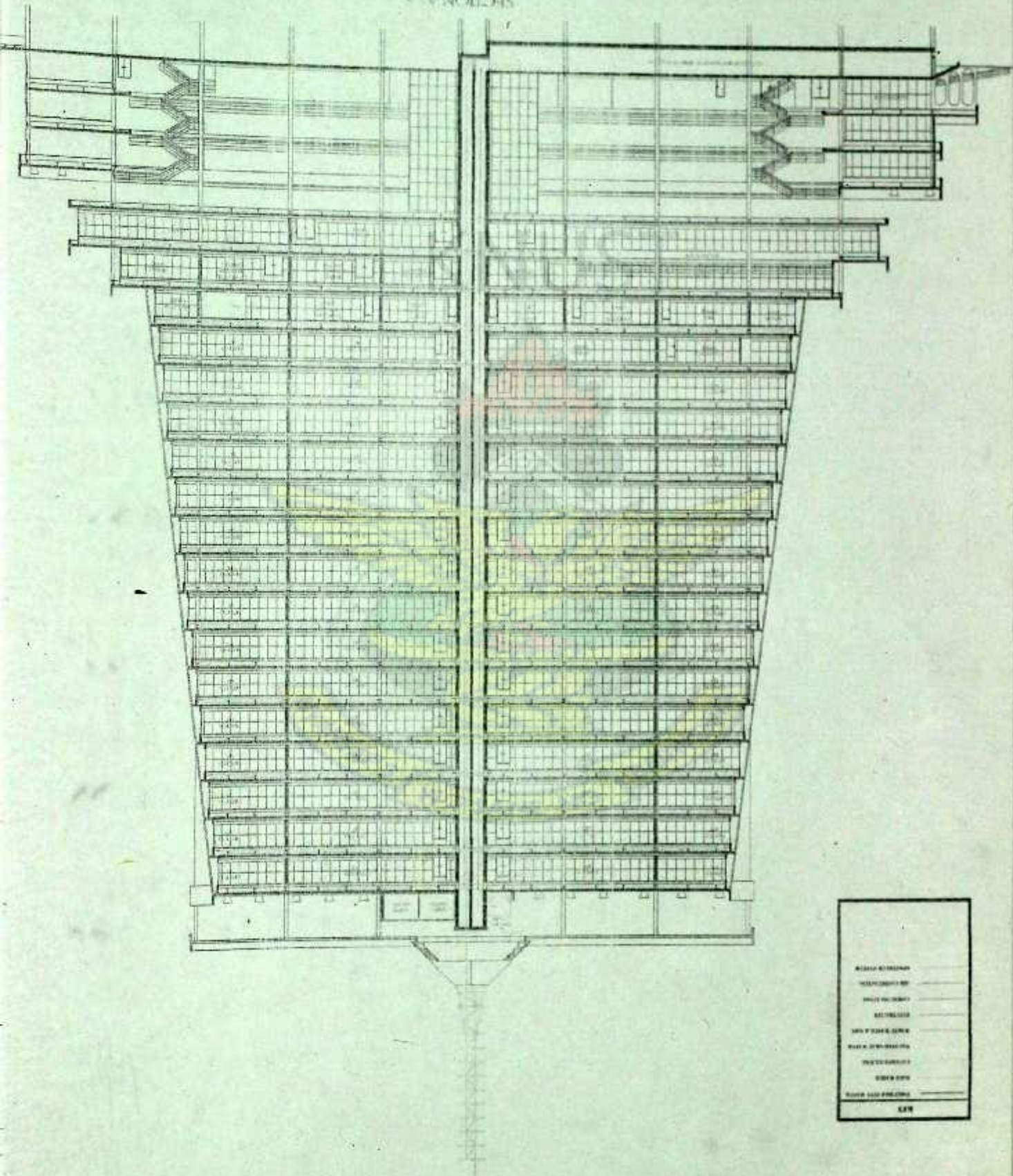
NEW	
POULTRY & EGGS	
MEAT & FISH	
DAIRY PRODUCTS	
BEVERAGES & ICE CREAM	
VEGETABLES & FRUIT	
BAKED GOODS	
DESSERTS	
CONDIMENT & SPICES	
WINE & CIGARETTES	
GENERAL MERCHANDISE	



GHANA STOCK EXCHANGE

DRAWN BY: [illegible]
 CHECKED BY: [illegible]
 DATE: [illegible]
 SCALE: 1/4" = 1'-0"
 SHEET NO. 1 OF 1

SECTION A-A



GHANA STOCK EXCHANGE

DETAIL S3

NAME: NAME OF ARCHITECT
 ADDRESS: ADDRESS OF ARCHITECT
 CITY: CITY OF ARCHITECT
 COUNTRY: COUNTRY OF ARCHITECT
 SCALE: SCALE OF ARCHITECT
 DATE: DATE OF ARCHITECT
 SHEET NO: SHEET NO OF ARCHITECT

SECTION LINE

SECTION LINE

SECTION LINE

SECTION LINE

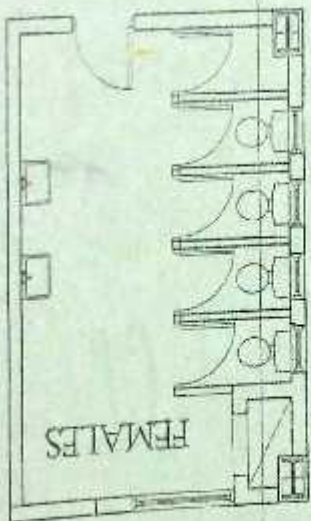
SECTION LINE

SECTION LINE

SECTION LINE

SECTION LINE

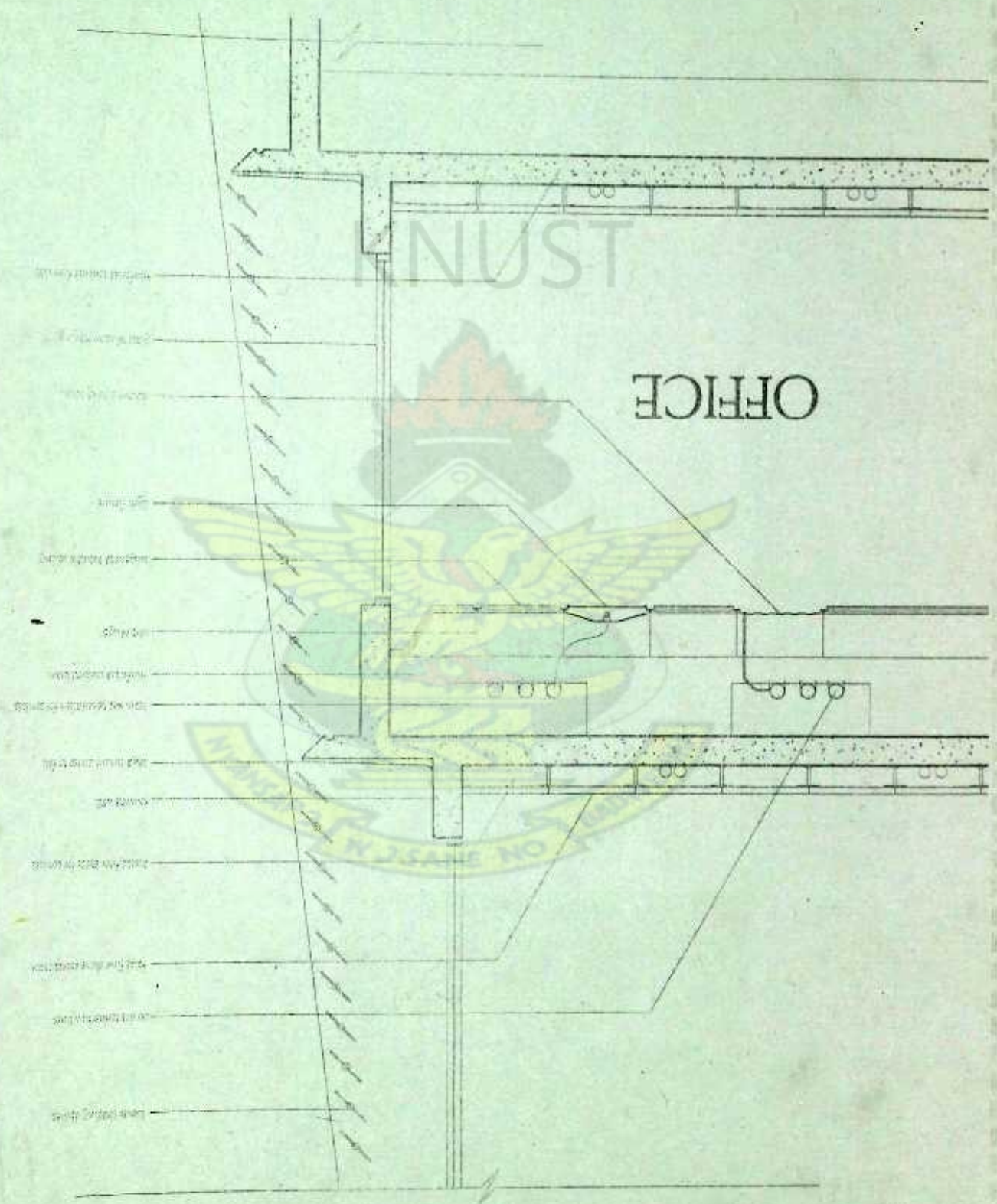
SECTION LINE



S3

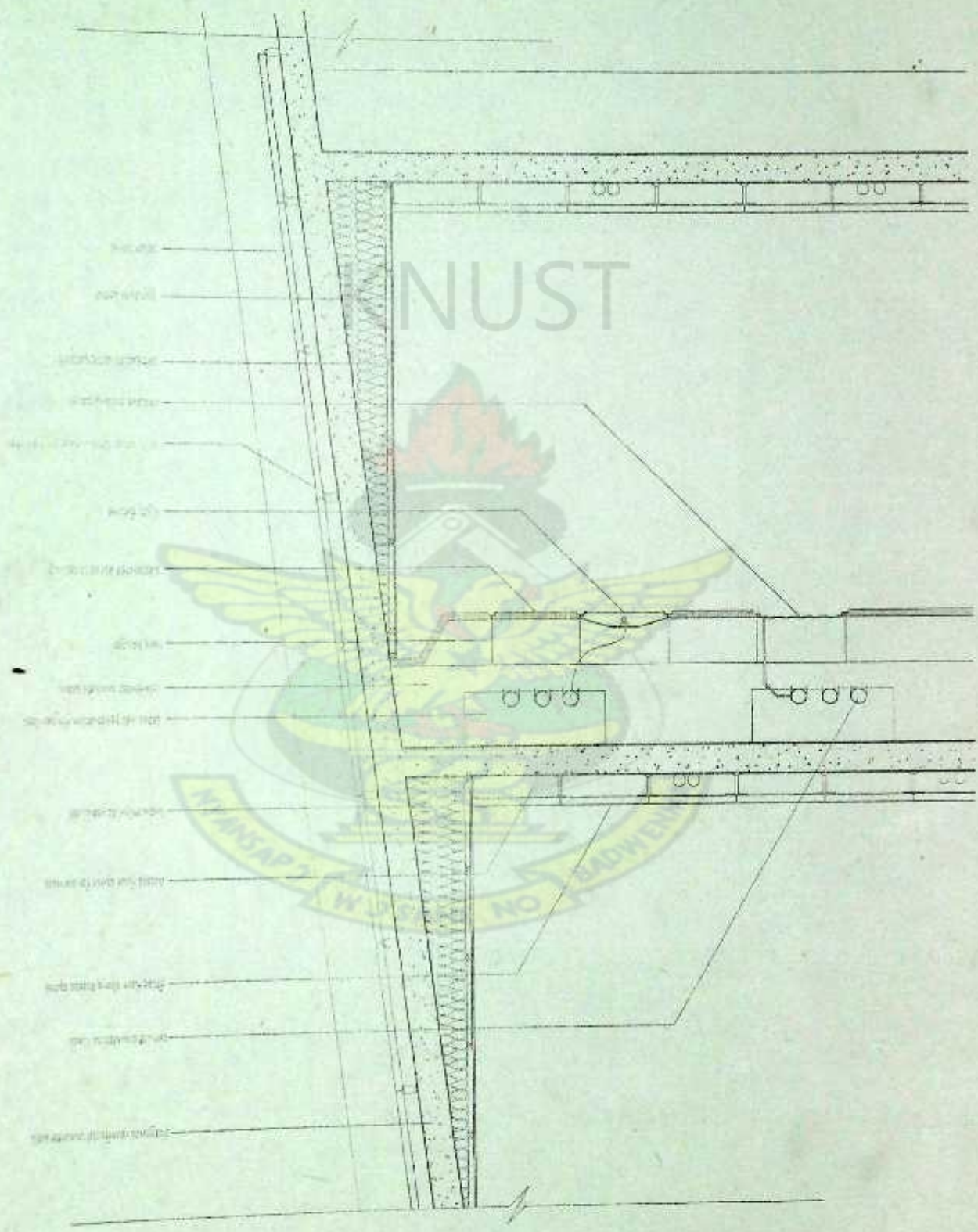
GHANA STOCK EXCHANGE

DETAIL 6/7-A

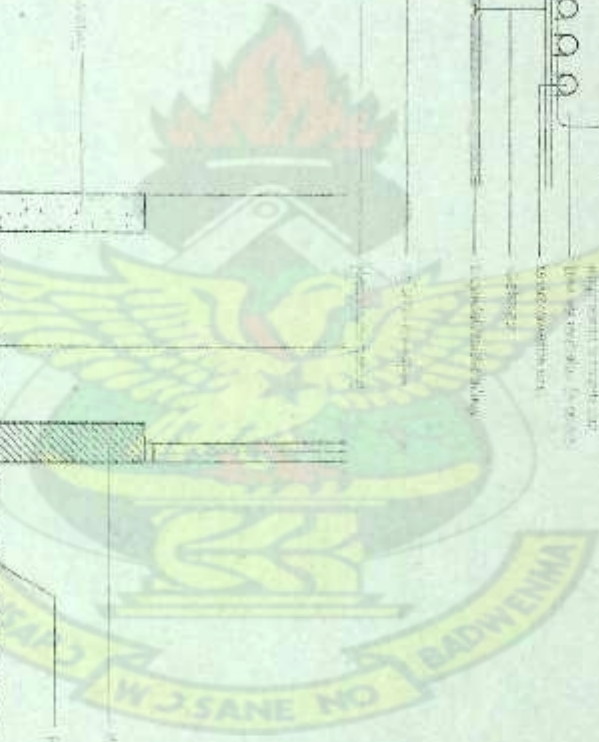
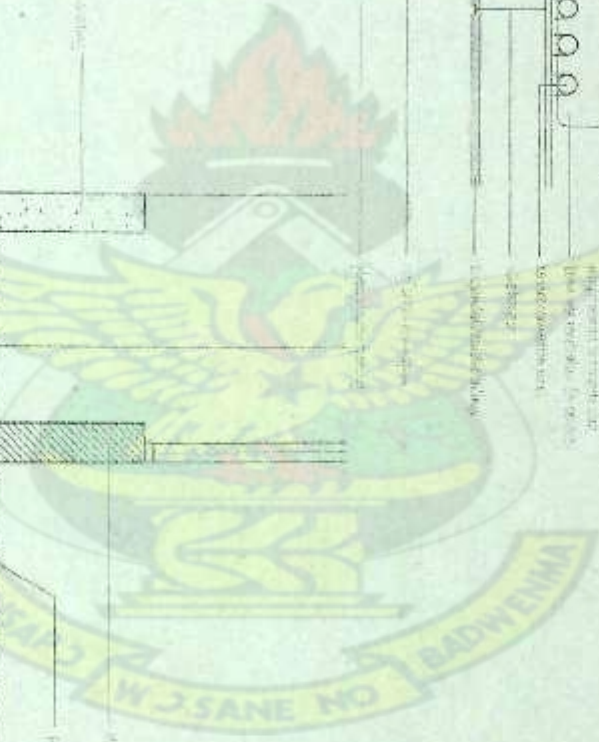


GHANA STOCK EXCHANGE

DETAIL 6/7-B



KNUST



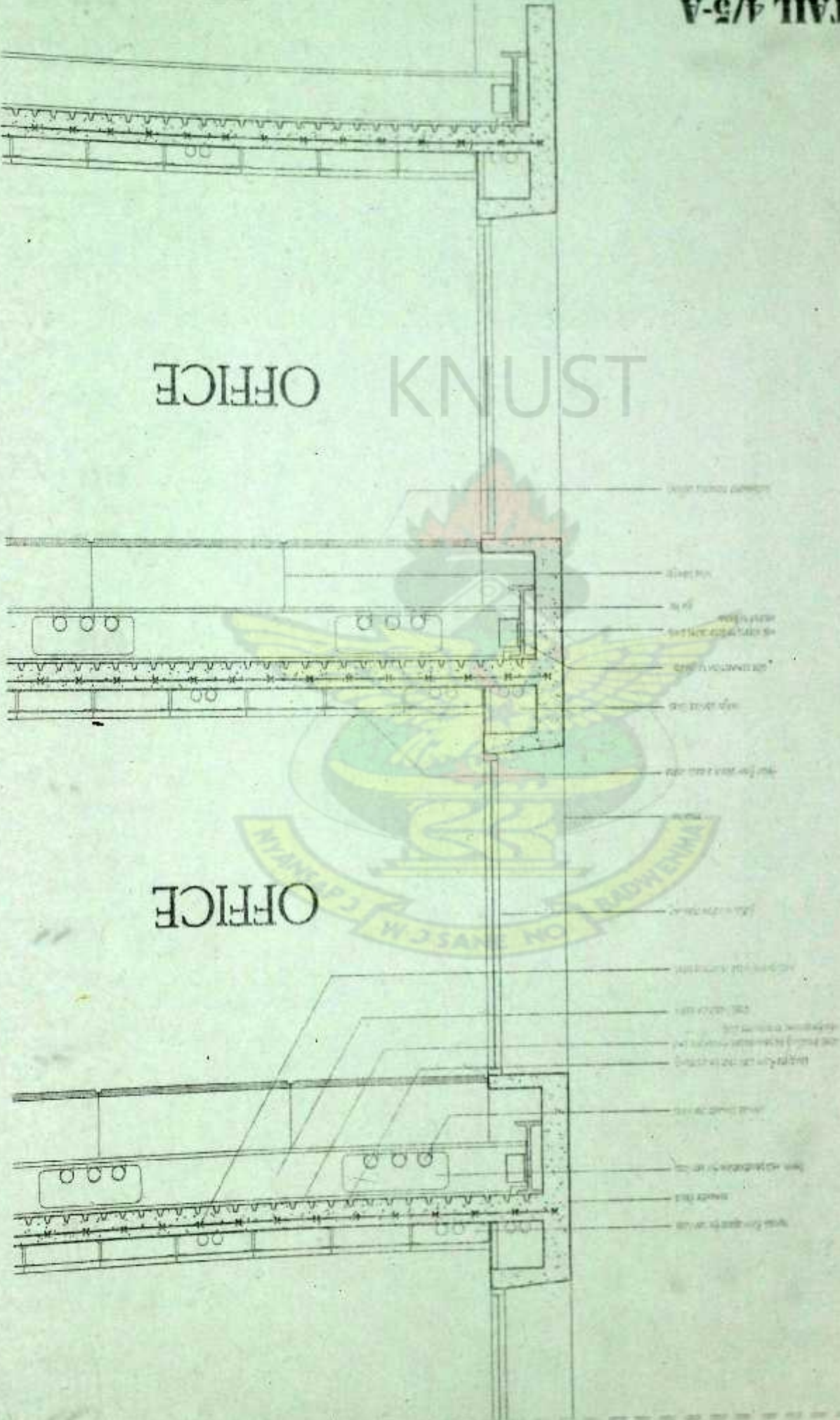
NAME	MAHARAJA ARCHITECT ASSOCIATES
INVOICE NUMBER	MAHARAJA UNIVERSITY OF SCIENCE AND TECHNOLOGY, BOMBAY
DEPARTMENT OF ARCHITECTURE	
MASTER OF ARCHITECTURE DESIGN THESIS	
DATE	15.06.2004
SHEET NO.	19

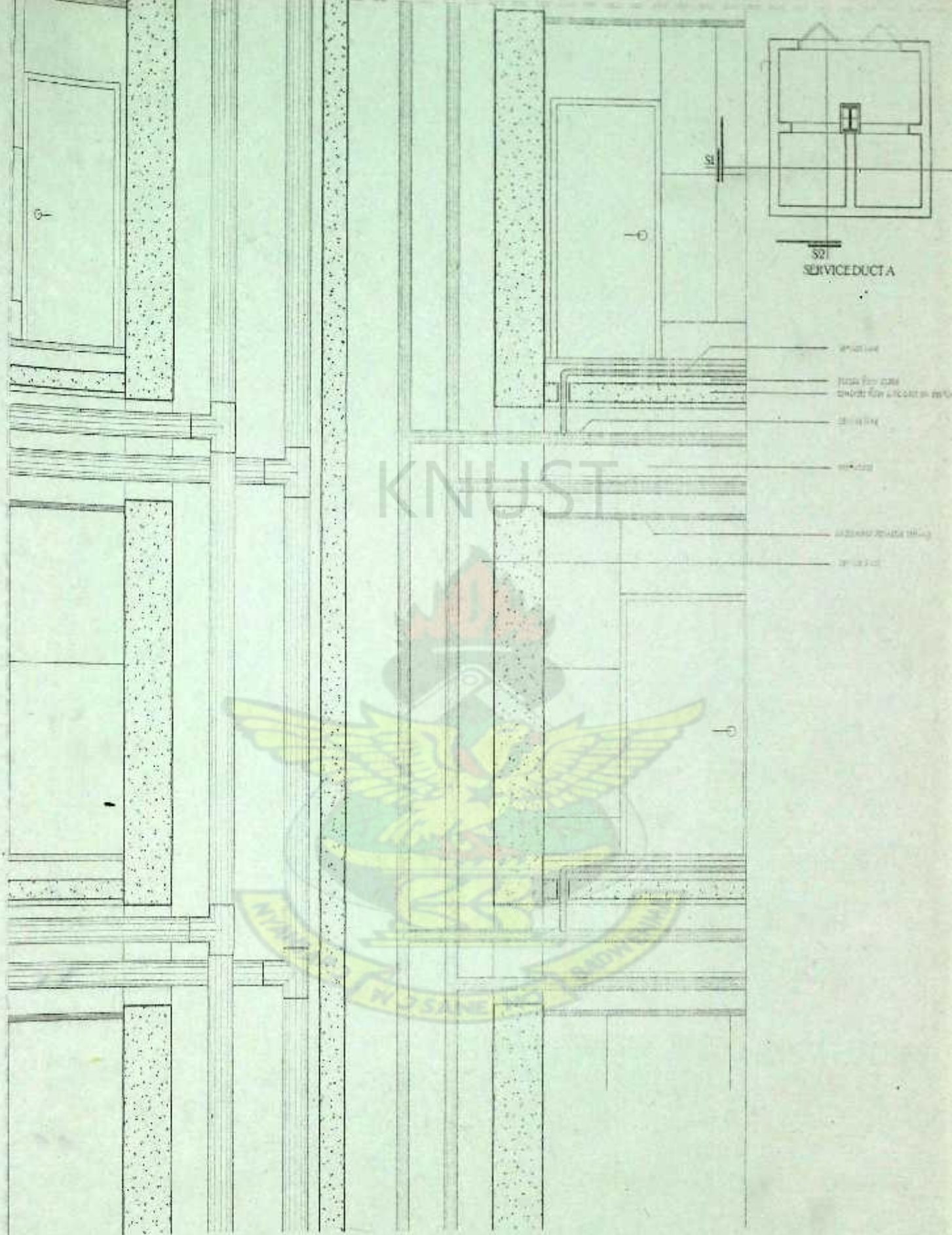
GHANA STOCK EXCHANGE

DETAIL 4/5-A

OFFICE

OFFICE

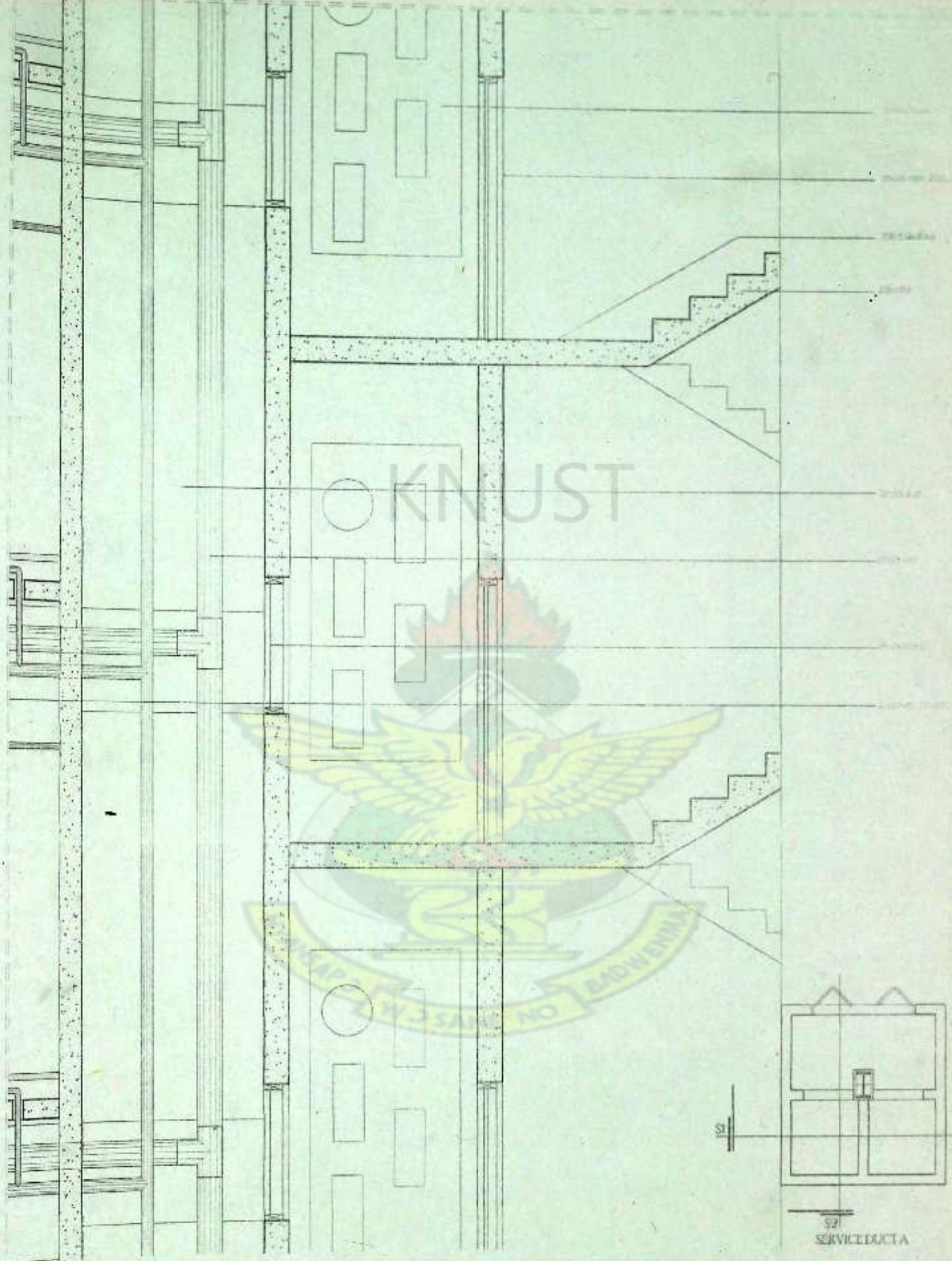




DETAIL S1

GHANA STOCK EXCHANGE

SHEET NO.	NAME: NAHL MICHAEL ANDVI
	KWAME NKRUumah UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI
	DEPARTMENT OF ARCHITECTURE
	MASTER OF ARCHITECTURE DESIGN THESIS 20
	DETAILS-S1
	SCALE: 1:1



DETAIL S2

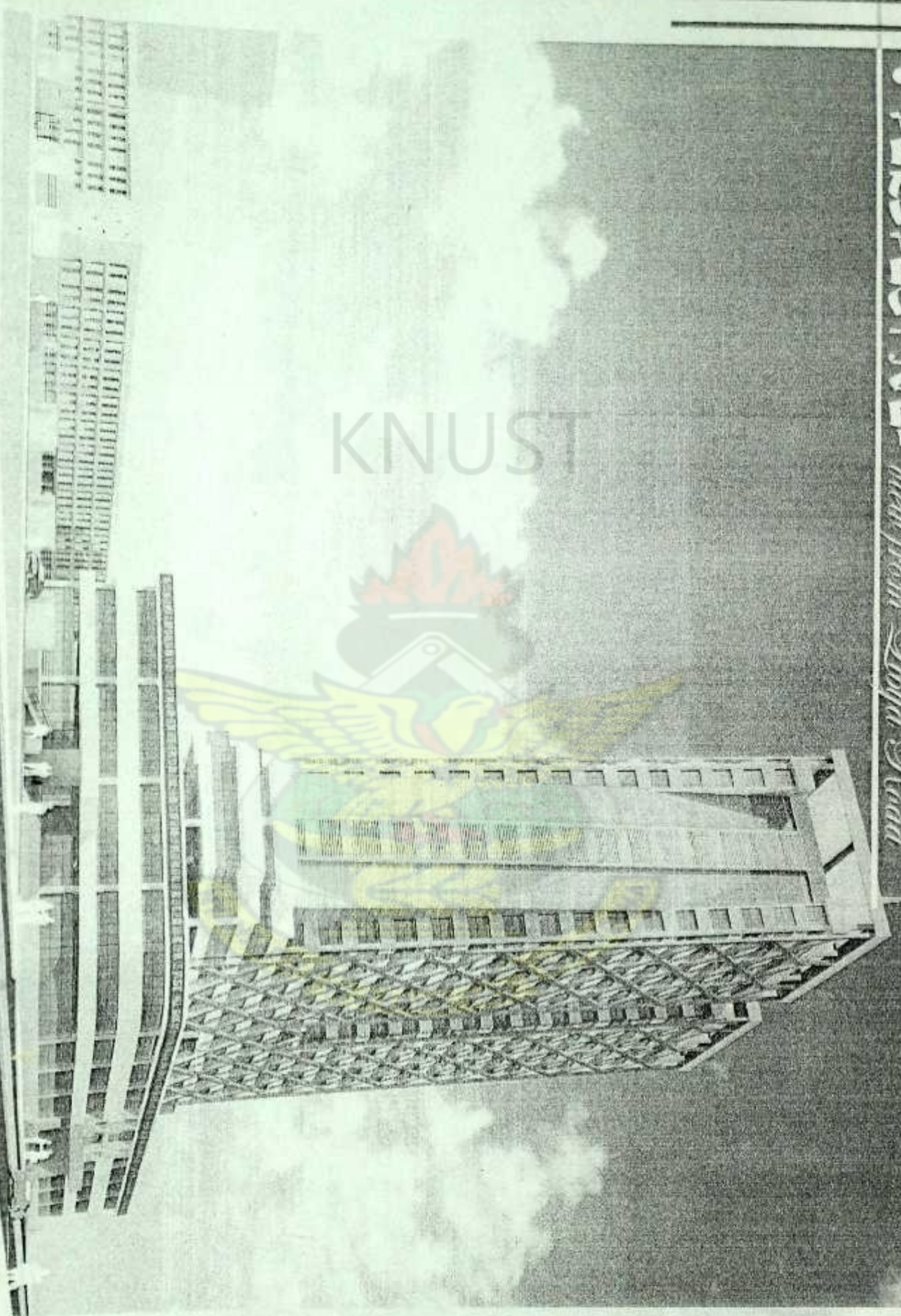
GHANA STOCK EXCHANGE

SHEET NO.	NAME: NANA MICHAEL ANDREY
	KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI
	DEPARTMENT OF ARCHITECTURE
	MASTER OF ARCHITECTURE DESIGN THESIS 2006
	DETAILS-S2

SCALE: 1:20

• PERSPECTIVE- view from *Offiya Road*

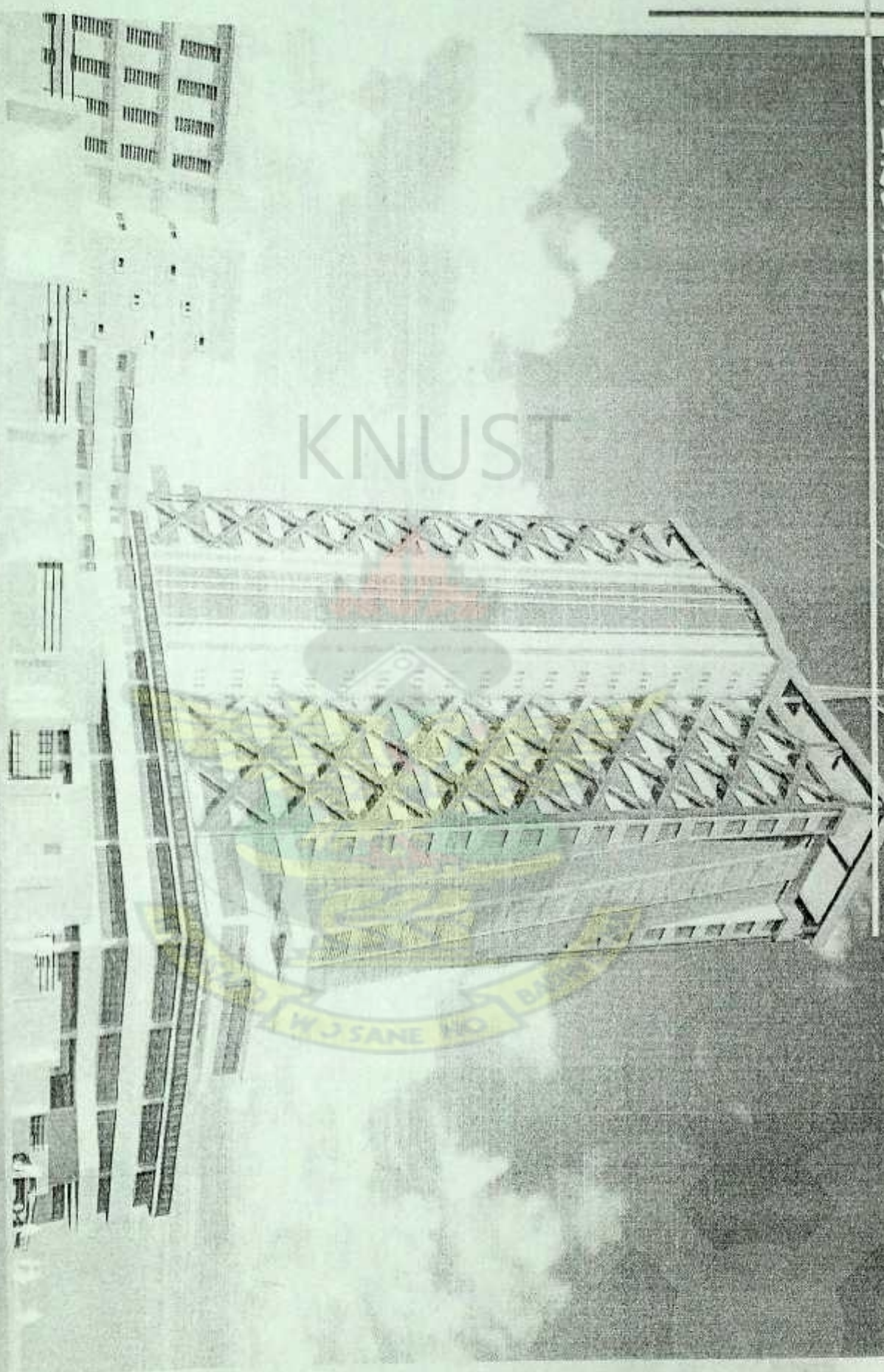
KNUST



GHANA STOCK EXCHANGE

SHEET NO.
NAME: NAME AND TITLE, ARCHT.
OF ARCHT. NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY, ACCRA
DEPARTMENT OF ARCHT. ENGINEERING
MASTER OF ARCHT. ENGINEERING DESIGN PROGRAM 2000

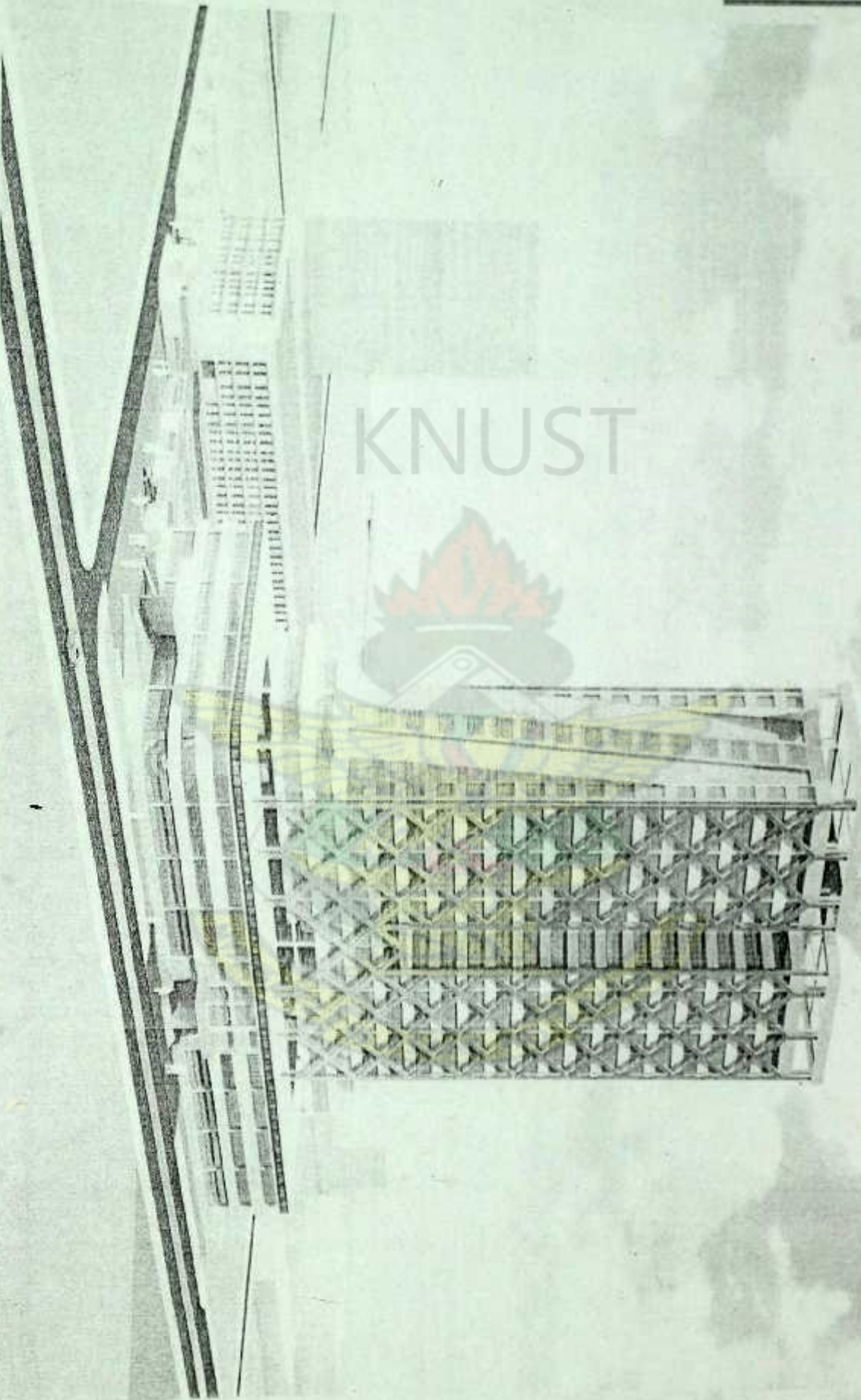
• PERSPECTIVE - view from *Libya Road*



GHANA STOCK EXCHANGE

SHEET NO:	NAME: NANA MICHAEL ANONY
INSTITUTE: KNUST	INSTITUTE: KNUST
DEPARTMENT OF ARCHITECTURE	DEPARTMENT OF ARCHITECTURE
PROJECT: GHANA STOCK EXCHANGE	PROJECT: GHANA STOCK EXCHANGE
PERSPECTIVE	PERSPECTIVE

men from President Johnson



GHANA STOCK EXCHANGE

CONCLUSIONS

NAME: NAEL, MICHAEL ANDY
 WORKING NAME: NAEL UNIVERSITY OF SCIENCE
 AND TECHNOLOGY, KEMASAT.

COMPLETION OF SUBSTRUCTURE

THE WASHINGTON UNIVERSITY OF MEDICAL SCIENCES

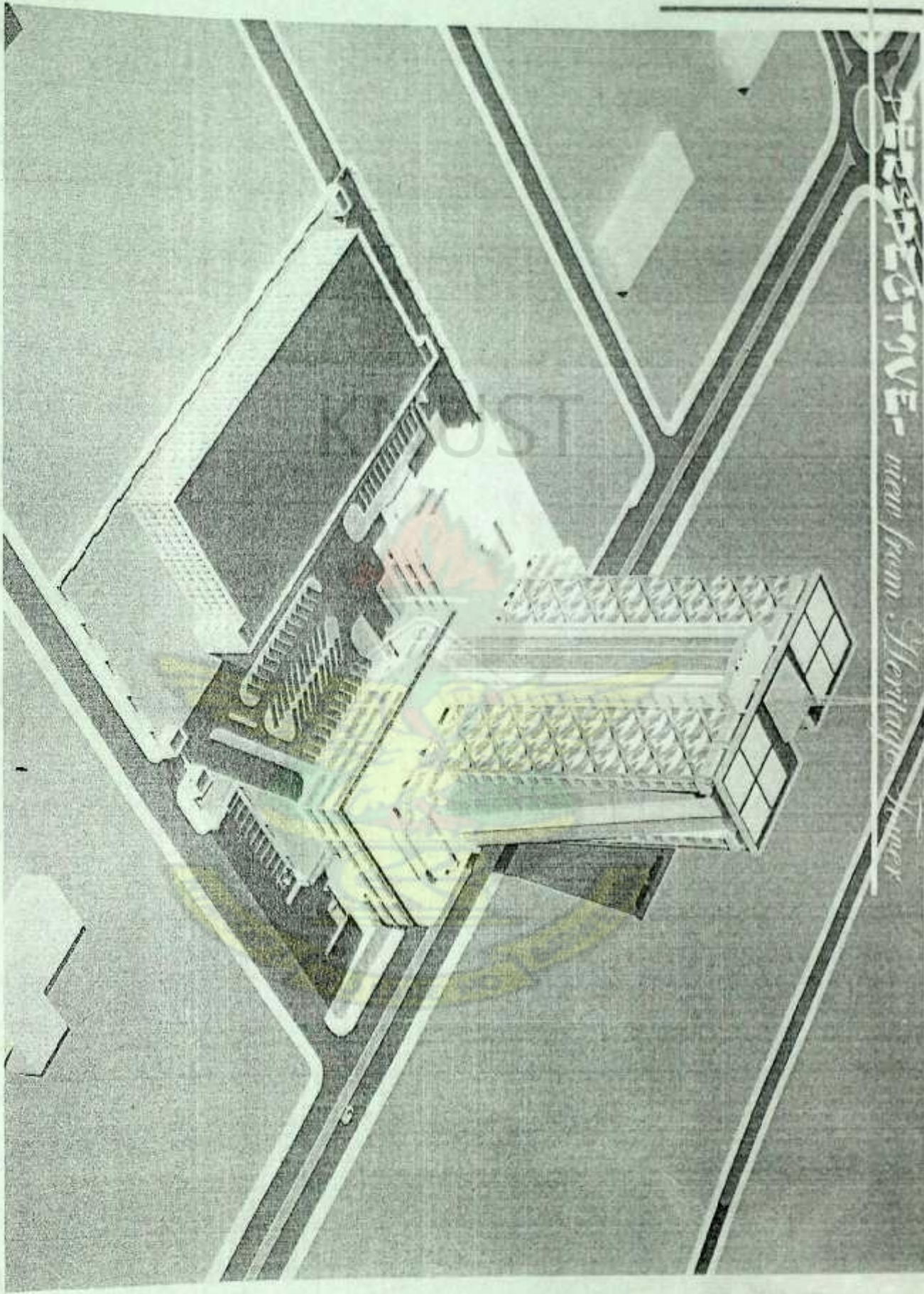
ANNE T. CHANDLER, EDITOR.

CONTEMPORARY OF AMERICAN STRUCTURE

MASTER OF ARCHITECTURE DESIGN DEGREE

ACQUISITION

PERSPECTIVE - view from Heriada Tower



CHANA STOCK EXCHANGE

SHEET NO:	
NAME: NAUL MITAL ANJVI	NAME: NAUL MITAL ANJVI
KVALE NORTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY, KURAST.	
DEPARTMENT OF ARCHITECTURE	
MASTER OF ARCHITECTURE DESIGN THESIS 2001	
PROJECT TITLE	