KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ARCHITECTURE AND PLANNING

FACULTY OF ARCHITECTURE AND BUILDING TECHNOLOGY

DEPARTMENT OF ARCHITECTURE

KNUST

TITLE: STOCK EXCHANGE BUILDING – RIDGE, ACCRA.

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AFUA OFEIBEA DADE (BSC. ARCHITECTURE)

JUNE, 2009

STOCK EXCHANGE BUILDING,
ACCRA

KNUST

BY

AFUA OFEIBEA DADE (BSC. ARCHITECTURE)

A design thesis report submitted to the Department of Architecture , Kwame Nkrumah University of Science and Technology in partial fulfilment of the requirements for a

POST-GRADUATE DIMPLOMA IN ARCHITECTURE

JUNE, 2009

DECLARATION

STUDENT

I declare that I have personally undertaken this study under supervision

..... 18th September, 2009

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SUPERVISORS

I confirm the student's declaration with regard to the undertaken of this study. I further declare that I have supervised the student and he therefore has my permission to submit it.

..... 18th Sept. 2009

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CERTIFIED BY

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PROF. G. W. K. INTSIFUL **DATE**

(HEAD OF DEPARTMENT)

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DEDICATION

I dedicate this thesis to God Almighty and also to my mother. I owe my life to God, for seeing me through six years of architecture school, through every step of the way. To my beloved mother, Miss Beatrice Mochiah, you are the queen of my heart and I am blessed to have you as a mother and best friend.

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ABSTRACT

Asked about the Ghana Stock Exchange, and most Ghanaian have no idea what it is and its operation. This is simply because the Ghana Stock Exchange is hiding at the 5th and 6th floors of the Cedi House at Ridge, Accra. Talk of the London Stock Exchange, New York Stock Exchange, Amsterdam Stock Exchange, Nigeria Stock Exchange, America Stock Exchange and Johannesburg Stock Exchange. All these exchanges have well built facilities that can be identified with them, not only to stand as the economic hub, but also to create the awareness of their existence in their various countries.

It is not the same story in Ghana, the exchange, though young, is in an era of high economic competition across the world. Ghana cannot afford to lay back while the rest of the world is at top speed.

Therefore, there is the need for a well designed building for the exchange to make it prominent and create an economic hub for Ghana, and this is what this design thesis seeks to achieve.

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CHAPTER ONE

INTRODUCTION

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CHAPTER ONE: INTRODUCTION

1.0: INTRODUCTION

In the past, trading was done in Africa by buying and selling food staff, textiles, slaves and etc, between various countries directly. In recent times, trading in Africa is in goods and services. The trading of these goods and services are by companies and corporations which are owned by the government, individuals, and groups of individuals. These companies and corporations generate more income for their businesses by floating shares to the general public; that is giving others the opportunity to become part owners of these companies and corporations by putting money into the businesses, thereby gaining any profit that comes and loss that is incurred. These shares are traded by the stock exchange; that is the stock exchange is the mediator between the companies and the prospective buyers which may be individuals, groups of people, and other companies who may be interested in buying shares of another company.

In Ghana, the stock exchange has been in existence since 1971 and named the **Ghana Stock Exchange**. It is currently located at the 5th and 6th floors of Cedi House, Ridge Accra. It has 16 brokerage firms listed. It has the following types of securities listed, which are all in Ghana:

Table 1.1: Types of securities and their number at the Ghana Stock Exchange

Type of security	Number
Ordinary shares	34
Preference shares	1
Debt securities – corporate	3
Government bonds – 2 years	58
3 years	49
5 years	2

All these shares and bonds are only from Ghana and all the listed brokerage firms are also in Ghana. The Ghana Stock Exchange needs to open up to the rest of West Africa and Africa as a whole. It has started by automating its operations to the Johannesburg Stock Exchange. This

means opening up the market to South Africa, and it is a step in the right direction. This shows that the Ghana Stock Exchange will soon open up its market to the rest of Africa soon. Therefore, this will necessitate bigger office spaces, trading floor and other facilities that will allow the exchange to accommodate the new developments.

With the up and coming common monetary policy on its way in West Africa, it will be in the right dimension if there is a stock market that will allow for easy trading throughout the sub region, in which it can even interconnect to the other stock exchanges of the other sub regions. Also, the coming of the oil industry boom in Ghana will have companies and corporations springing up and so the more companies in Ghana, the bigger the money market will be.

This will allow for trading in stocks of small, medium and large corporations in Ghana and the sub region by all manner of investors in Africa, to be administrated by the Ghana Stock Exchange. That is to say that any investor in, for example Nigeria, can buy and sell stocks of corporations in either Ghana or the Gambia or Liberia through the Ghana Stock Exchange. This will help develop the economy of Ghana, the West African economy itself and Africa as a whole.

1.1: PROBLEM STATEMENT

A stock market for the West Africa, administrated by the Ghana Stock Exchange is timely for the diverse and rapid economic development invoke in the sub region. With the primary aim to reach a middle income class on the world market, West Africa must have a common stock market that will allow for the booming of its money market to be competed on the world market. So there is the need to open up the Ghana Stock Exchange to pave a wider platform where buying and selling of stocks is done for the various growing corporations in West Africa and Africa. The proposed money market will cater to all the stock trading needs of Ghana and the West African market.

1.2: JUSTIFICATION

- A stock market for West Africa by the Ghana Stock Exchange is necessary to support in the development of small and promising corporations in Ghana and West Africa - for example I.C.T. - to compete with the rest of the world.
- Also, a country cannot be isolated in terms of its economy, so if all other countries pull their resources together it will help to develop the individual countries. This goes with the trade liberalization in question.
- The training institution which is to be attached to the stock market to train brokers, dealers, specialist and others will develop and improve the human resource in Ghana to be able to take this larger market.
- Such a market will make Ghana's economy stable and help it to grow, so that before any person or group of persons pick up arms to destabilize a country, they will count the cost of loosing out in the common economic market.
- The facility will also provide networking to other stock markets of the other sub regions of Africa, as the Ghana Stock Exchange has started with Johannesburg Stock Exchange.
- In short, a stock market for West Africa, by the Ghana Stock Exchange is timely and vital to the economic development of the sub region.

1.3: OBJECTIVES

- To expand the Ghana Stock Exchange to cater to the West African market and to be interconnected to the rest of Africa.
- To create a learning environment for the human resource in Ghana.
- To create an architectural work that stands out as an economic giant; an economic icon.

1.4: CLIENT

The Ghana Stock Exchange

1.5: FUNDING

The project will be funded by the client with support from the Government of Ghana, ECOWAS, and interested investors.

1.6: SCOPE

The Ghanaian money market - Ghana Stock Exchange, West Africa, Africa and the rest of the world.

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1.7: TARGET GROUP

- Investors in Ghana, West Africa, and the rest of the world.
- Business students who are studying to become brokers, dealers, and administrators.
- Brokerage firms in Ghana and West Africa..
- Financial institutions.
- Other offices and firms.
- The general public.
- Business executives.

1.8: LOCATION AND SITE

Ridge, Accra: the site is located along the Independence Avenue and the Libya Road, specifically opposite the Efua Sutherland Children's Park and adjacent to the SSNIT building – the Victor Morrison building.

1.9: PHILOSOPHY

AN ARCHITECTURAL ICON THAT SHOWS THE EMERGING ECONOMY OF GHANA

1.10: ARCHITECTURAL STYLE

THE INTERNATIONAL STYPE OF ARCHITECTURE.

1.11: CONCEPTS

- **Technology:** A high – tech building equipped with modern building and ITC technology (an intelligent building), with state – of – the – art facilities.
- **Sustainability:** the use of sustainable energy – use of building integrated photovoltaic, social sustainability – comfort and organization internal space.
- **Diversity:** A multi – purpose building providing various economic facilities – spacial and visual diversity – varied building heights.
- **Prominence:** A building that stands out from the rest visually and that which provides unique economic facilities for the people.

1.12: BRIEF

- Administration – over seeing and monitoring the stock market
- The trading floor itself with spaces for brokers, dealers and the specialists. Position of the screens to be easily visible by all.
- Office spaces for the brokerage firms
- Office spaces to let to financial institutions like banks, insurance companies and other offices.
- Business and media centre – to have conference rooms for official occasions.
- Training centre with lecture rooms and a library (to train brokers, dealers, specialists and over-the-counter brokers and other allied professionals).
- Executive suites for business men/women.
- Restaurant
- Parking

CHAPTER TWO

LITERATURE REVIEW

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CHAPTER TWO: LITERATURE REVIEW

2.0: OVERVIEW OF THE STOCK EXCHANGE

Stock Exchange is an organized market for buying and selling financial instruments known as securities, which include stocks, bonds, options, and futures. Most stock exchanges have specific locations where the trades are completed. For the stock of a company to be traded at these exchanges, it must be listed, and to be listed, the company must satisfy certain requirements. But not all stocks are bought and sold at a specific site. Such stocks are referred to as unlisted. Many of these stocks are traded *over the counter*—that is, by telephone or by computer.

Stock exchange transactions involve the activities of brokers and dealers. These individuals facilitate the buying and selling of financial assets. Brokers execute trades on behalf of clients and receive commissions and fees in exchange for matching buyers and sellers. Dealers, on the other hand, buy and sell from their own *portfolios* (inventories of securities). Dealers earn income by selling a financial instrument at a price that is greater than the price the dealer paid for the instrument. Some exchange participants perform both roles. These dealer-brokers sometimes act purely as a client's agent and at other times buy and sell from their own inventory of financial assets.

2.1: IMPORTANCE OF THE STOCK EXCHANGE

- They encourage investment by providing places for buyers and sellers to trade securities.
- Stock exchanges essentially function as **secondary markets**. By providing investors the opportunity to trade financial instruments, the stock exchanges support the performance of the primary markets. This arrangement makes it easier for corporations to raise the funds that they need to build and expand their businesses.
- The price of a company's stock in the secondary market influences the amount of funds that can be raised by issuing additional stock in the primary market.

- The secondary markets affects the financial wealth of the corporation's owners—the **stockholders.** If the price of the stock rises, then the stockholders become wealthier.
- Stock exchanges protect investors by upholding rules and regulations that ensure buyers will be treated fairly and receive exactly what they pay for.
- Exchanges also support state-of-the-art technology and the business of brokering. This support helps traders **buy and sell securities quickly and efficiently.**

2.2: HISTORY AND THE DEVELOPMENT OF STOCK EXHANGE

In 11th century **France** the *courtiers de change* were 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.**

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 opened in 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.

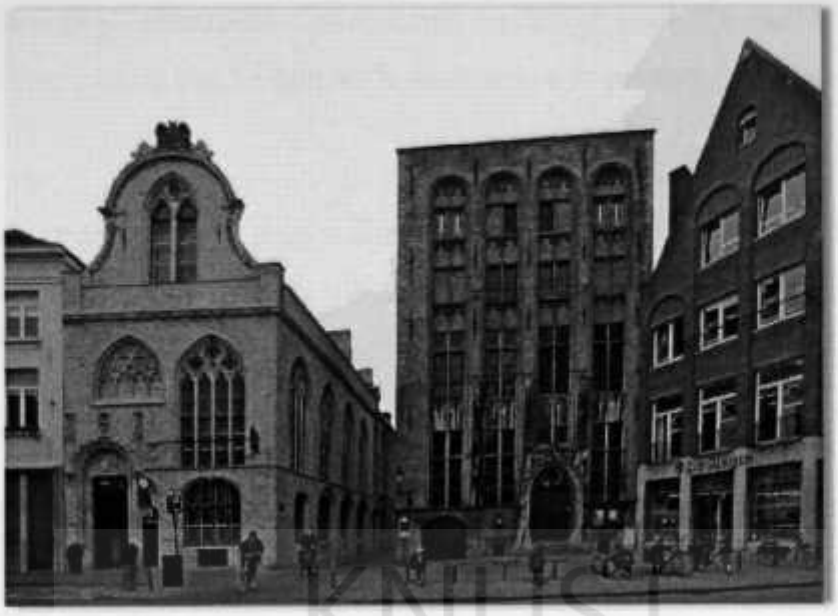

Figure 2.1: House *Ter Beurze* in Bruges, Belgium.

On May 17, 1792, twenty-four supply brokers signed the Buttonwood Agreement outside 68 Wall Street in New York underneath a buttonwood tree. On March 8, 1817, properties got renamed to New York Stock & Exchange Board. In the 19th century, exchanges (generally famous as futures exchanges) got substantiated to trade futures contracts and then choices contracts. There are now a large number of stock exchanges in the world.

2.3: THE FUTURE OF THE STOCK EXCHANGES AND ITS IMPACT ON DESIGN

The future of stock trading appears to be **electronic**, as competition is continually growing between the remaining traditional New York Stock Exchange specialist system against the relatively new, all Electronic Communications Networks, or *ECN*s. ECNs point to their speedy execution of large block trades, while specialist system proponents cite the role of specialists in maintaining orderly markets, especially under extraordinary conditions or for special types of orders. This means the more space for computers and network devices on the trading floor and the building as a whole. This will also require server rooms, offices for network specialists, and other auxiliary facilities.

Historically, the 'market' (which encompasses the totality of stock trading on all exchanges) has been slow to respond to technological innovation, thus allowing growing pure speculation to

continue. Conversion to all-electronic trading could erode/eliminate the trading profits of floor specialists. Also more trading can be done in a short time and prevent the brokers and specialist from cheating.

ECNs have changed ordinary stock transaction processing (like brokerage services before them) into a commodity-type business. ECNs could regulate the fairness of initial public offerings (IPOs), measure the effectiveness of securities research and use transaction fees to subsidize small- and mid-cap research efforts.

Some, however, believe the answer will be some combination of the best of technology and "upstairs trading" — in other words, a **hybrid model**. Such hybrid model trades will require more space than the individual traditional trade and electronic trade.

2.4: SPATIAL CONSIDERATIONS OF A STOCK MARKET

- The limited number of seats for a brokerage firm to be allowed in the market and the limited number of brokerage firms.
- The number of specialist
- The number of stocks to be traded
- How many people are involved in a trade at a time and the amount of space required
- The size of the administration of the market in question and the detail of a stock exchange's administration.
- Other activities relating to a stock market, in terms of screens, those who monitor the screens – their spatial requirements.
- Security apparatus used in a stock exchange building.
- Training centre.
- Services – I.T. server room, A.C. plant room and chiller tower, power house, water pumps room, solar batteries room, lift motor rooms, stand-by generators, sanitary sevice ducts, inspection chambers, etc.

2.5: THE GHANA STOCK EXCHANGE

2.5.1: HISTORY

The idea of establishing a Stock Exchange in Ghana lay on the drawing board for almost two decades prior to its implementation. In February 1989, the issue of establishing a stock exchange moved a higher gear when a 10 - member National Committee, under the Chairmanship of Dr. G.K. Agama, then Governor of the Bank of Ghana, was set up by the Government.

The work of the committee was to consolidate all previous work connected to the Stock Exchange project and to fashion out modalities towards the actual establishment of the Exchange. As a result of the work of the committee, the Stock Exchange was established in July 1989 as a private company limited by guarantee under the Companies Code, 1963. It was given recognition as an authorized Stock Exchange under the Stock Exchange Act of 1971 (Act 384) in October 1990. The Council of the Exchange was inaugurated on November 12, 1990 and trading commenced on its floor the same day. The Exchange changed its status to a public company limited by guarantee in April 1994.

The Ghana Stock Exchange is a private sector initiative and is not funded by government but has enjoyed the support of the Government of Ghana.

2.5.2: Landmarks

	Pearl report by Commonwealth Development Finance Co. Ltd recommended the establishment of a Stock Exchange in Ghana within in two years and suggested ways of achieving it.
	Various committees established by different governments to explore ways of bringing into being a Stock Exchange in the country.
1971	The Stock Exchange Act was enacted
1971	The Accra Stock Exchange company incorporated but never operated.

Feb, 1989	PNDC government set up a 10-member National Committee on the establishment of the Stock Exchange under the chairmanship of Dr. G.K. Agama, the then Governor of the Bank of Ghana.
July 1989	Ghana Stock Exchange was incorporated as a private company limited by guarantee under the Companies Code 1963
Oct, 1990	Executive Instrument No. 20 giving recognition to Ghana Stock Exchange as authorized Stock Exchange signed.
Nov.1990	Council of the Exchange adopted operational regulations namely, GSE Membership Regulations L.I. 1510, Listing Regulations L.I 1509 and Trading and Settlement Regulations.
Nov, 12, 1990	First Council of the Exchange with Mrs. Gloria Nikoi as Chairperson inaugurated.
Nov, 12, 1991	Trading commenced on the floor of the Exchange
Jan, 11, 1991	Ghana Stock Exchange was officially launched
Sept. 1993	The Exchange moved to its present offices, 5th Floor, Cedi House, Liberia Road, Accra
April 1994	A resolution passed at the AGM changed the Exchange from a private company limited by guarantee to that of a public company limited by guarantee under the Company Code 1963 (Act 179)

2.5.3: MEMBERS OF THE EXCHANGE

The Ghana Stock Exchange as a public company limited by guarantee has no owners or shareholder as such, but members who are either corporate bodies or individuals.

There are two categories of members: - **Licensed Dealing Members** and **Associate Members**. A Licensed Dealing Member is a corporate body licensed by the Exchange to deal in listed securities. An Associate Member is an individual or corporate body, which has satisfied the

Exchange's membership requirements, but is not licensed to an act as a stockbroker on the Exchange. Currently, there are **sixteen** stock broking firms licensed to deal on the exchange.

2.5.4: LOCATION OF THE EXCHANGE

The Ghana Stock Exchange is located on the fifth and sixth floors of the Cedi House at Ridge, Accra. The Cedi House is an evidence of a tropical building. It has a simple rectangular form and vertical and horizontal elements on the facade as shading devices. These form of shading devices help to conserve energy in terms of the use of air conditioning and artificial lighting. The shading devices also help to prevent glare. This building is therefore said to be a sustainable building.

Figure 2.2: Cedi House, Ghana Stock Exchange

Figure 2.3: Building heights of Ridge, Accra

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2.5.5: LAYOUT OF G.S.E. AFTER THE AUTHOMATION

The Exchange is at the 5th and sixth floor of the Cedi House.

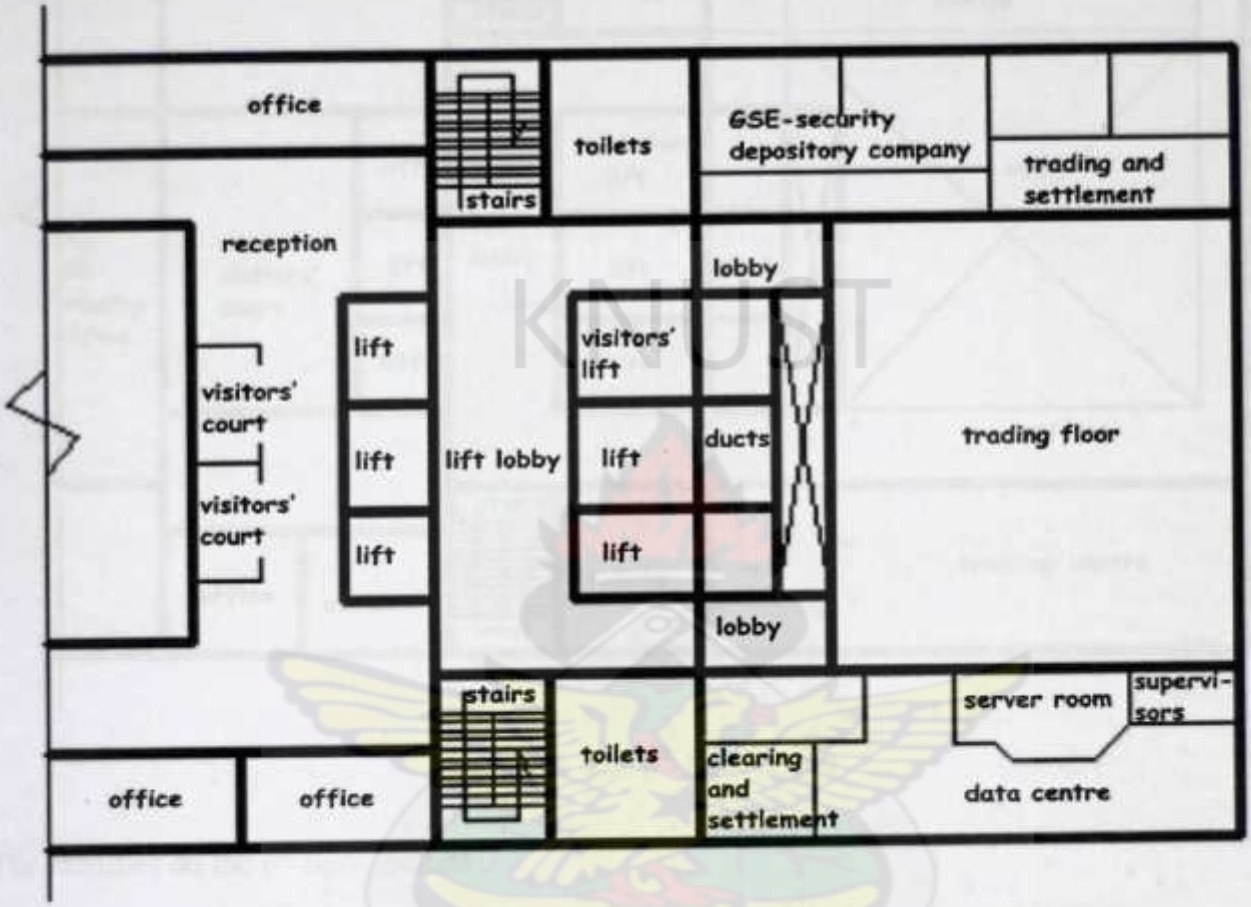

Figure 2.4: The 5th floor layout

The facilities on the 5th floor include:

- Reception
- Visitors' court
- The trading floor
- Offices for GSE Securities and Depository Company, Trading and Settlement department, Clearing and Settlement department, Supervisors, server room and Data Centre, and other offices.
- Washrooms

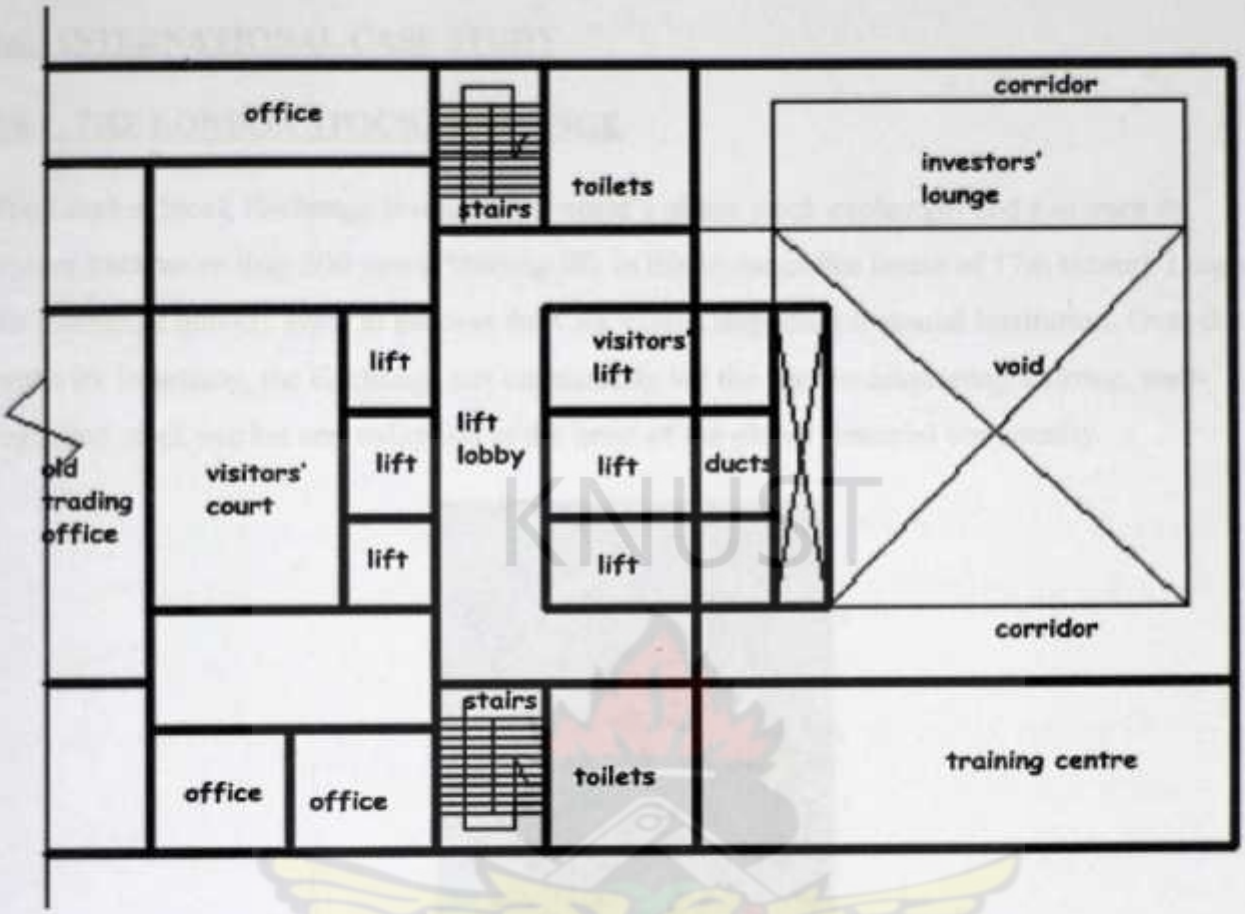

Figure 2.5: The 6th floor layout

The facilities on the 6th floor include:

- Open offices
- Investors' lounge
- Training room
- A gallery to the trading floor
- washrooms

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2.6: INTERNATIONAL CASE STUDY

2.6.1: THE LONDON STOCK EXCHANGE

The London Stock Exchange is one of the world's oldest stock exchanges and can trace its history back more than 300 years. Starting life in life in the coffee house of 17th century London, the Exchange quickly grew to become the City's most important financial institution. Over the centuries following, the Exchange has consistently led the way in developing a strong, well-regulated stock market and today lies at the heart of the global financial community.

Figure 2.6: The building of the London Stock Exchange

Figure 2.7: London Stock Exchange building in context with surrounding buildings

2.6.1.2: OTHER FACILITIES AVAILABLE IN THE EXCHANGE

2.6.1.3: The Media and Business Complex

The innovative concept of combining broadcasting and event space is unique to the exchange.

The Media & Business Complex is the Exchange's purpose-built, broadcast and event venue. It is situated on the first floor of the premises in Paternoster Square. The Media Complex offers both companies and the media a dynamic environment for conducting effective business communications.

With the studios as a backdrop, blue-chip companies and other professional organizations can hire the facilities to host meetings, conferences and receptions in the variety of contemporary event spaces.

In the four specially-designed studios, a variety of global broadcasters report on the day's business and market news. Companies also benefit from the media services and utilise the studios for filming corporate videos, media training or interviews.

2.6.1.4: LESSONS FROM THIS STUDY

- Location of the Exchange is at the heart of the city of London. Location of a stock exchange of any country is very important; it should usually be in the Central Business District of the city and accessible to all.
- Though the building is old, it is competing with its surrounding buildings in terms of the height and the building character in general. Although old, it is fitting in perfectly with the rest and has sustained its building character throughout the years.
- The building height is acceptable in modern terms – it is one of the tall buildings in London, and serving as a vista in the city. Also the building height gives prominence to the purpose of the building.
- The building is multi-purposed with facilities including a Business and Media Centre that has conference rooms to host business meetings and conferences, and also a TV and FM studios for broadcasting business news, filming corporate videos, media training, etc.

2.6.2: AMSTERDAM STOCK EXCHANGE

The Amsterdam Stock Exchange was designed by H. P. Berlage in 1896. It is sited at Commercial Amsterdam. The building represents the city itself – a version of the city's self image. It is one of the strongest exchanges in Europe. It represents a frank recognition of the importance of trade to the existence of the city; it is a building synonymous with the wealth which founded the city and consequently with the city itself.

Figure 2.9: The Amsterdam Stock Exchange building

2.6.2.1: SPECIAL FEATURES

- The building is massive with brick cladding on the exterior which makes the building self sustaining. There are no curtain walls and the windows are recessed to shade them.
- Three great halls form its core and are each devoted to commodities, corn and stock exchange.
- The huge hall of commodities exchange is the heart of the building.

- The halls accommodating the exchanges were required to create an imposing and impressive effect as they were to house great civic functions, official ceremonies and meetings.
- The hall is lit by a glazed room which is supported on a series of brightly painted delicate icon trusses.
- The use of grid - each space is based on a given number of squares within the grid.
- The building is adored within the sculptures, relief works and paintings which are characteristics of the Art and Craft ideal.
- The monumental, heavy effect which defines the exterior is absent in the interior – in the interior the building appears light, bright, and airy.
- Other facilities in the building include offices for the brokers, chamber of commerce, restaurant, post office, telephone exchange, and a strong room below the structure.

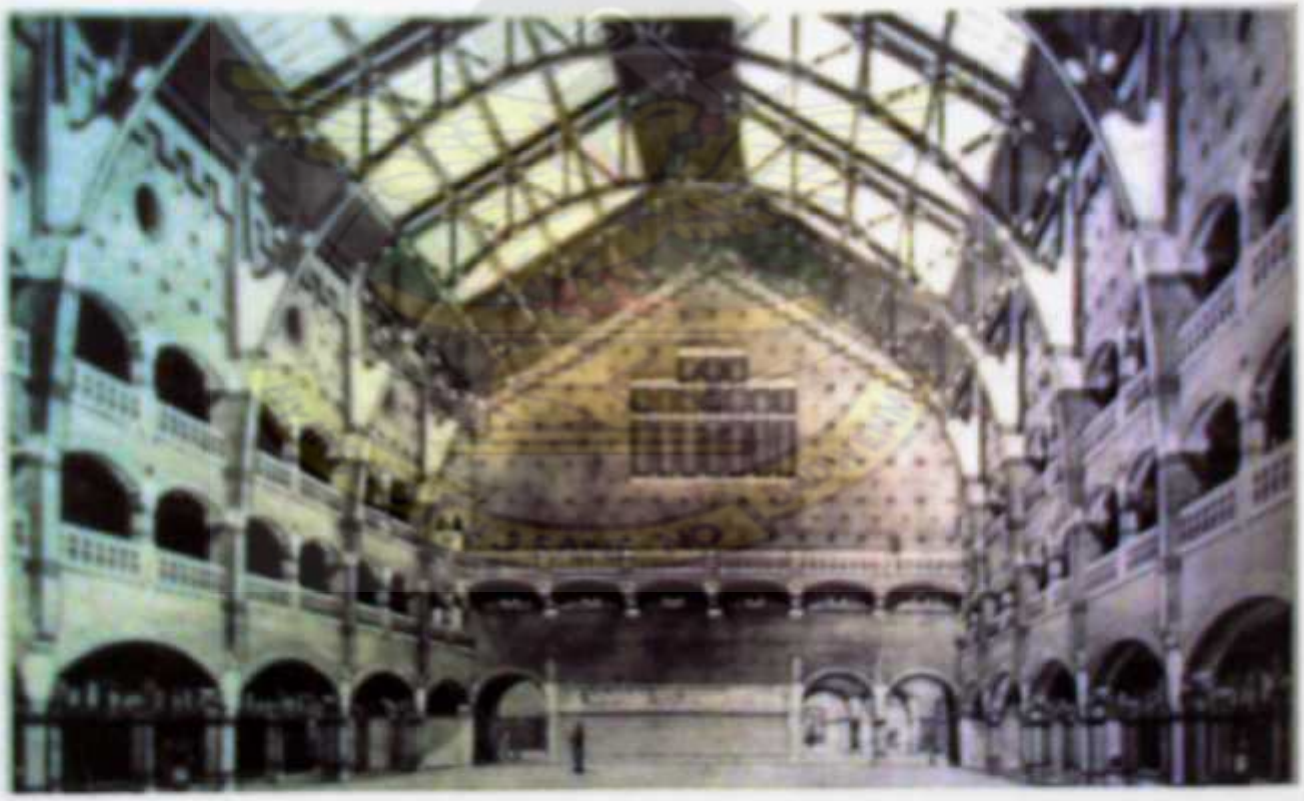

Figure 2.10: The Amsterdam Stock Exchange Trading Floor

2.6.2.2: LESSONS FROM THIS STUDY

- Location of the exchange is at Commercial Amsterdam.
- The halls accommodating the exchanges are multi-purposed; for civic functions, and official meetings.
- The building is the image of the city that is its wealth and the recognition of trade in the city.
- The building is both backward and forward looking, an example of the Art and Craft Ideal – which is evident with the heaviness of the interior and the lightness and airy nature of the interior.

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2.6.3: NEW YORK STOCK EXCHANGE

The New York Stock Exchange (NYSE), nicknamed the "Big Board," is a New York City-based stock exchange. It is the largest stock exchange in the world by dollar volume and, with 2,764 listed securities. Its share volume was exceeded by that of NASDAQ during the 1990s. It was considered the second biggest stock exchange in the world in terms of company listings only next to NASDAQ with 3,200 companies, before Bombay Stock Exchange (BSE) of India, consolidated this position as the biggest stock exchange in the world with a company listing of 4,800 as of August 2007. Nonetheless, the NYSE constitutes the most crucial financial hub of the world, along with Tokyo Stock Exchange and London Stock Exchange. As of December 31, 2006, the combined capitalization of all New York Stock Exchange listed companies was $25.0 trillion.

The New York Stock Exchange building was design by George B Post, Pediment by JQA Ward and Paul Bartlett in 1903. It is located at the 8 Broad Street, between Wall Street and Exchange Place.

2.6.3.2: LESSONS FROM THIS STUDY

- The location of the exchange is at the Wall Street which is the economic heart beat of the United States of America.
- The trading floor is of high volume and is able to accommodate a lot screens and networking elements.
- Trading floor seats are collapsible to allow for more space around when not in use.
- All the network cables are within the steel frames above the trading floor below the ceiling connected to each circle on the floor. There are market screens mounted around each circle. The exchange has a high level of sophistication in terms of networking on the trading floor.

Figure 2.14: Trading floor collapsible seats

2.7: SPECIAL STUDIES

2.7.1: BUILDING INTEGRATED PHOTOVOLTICS – BIPV

This system is basically the introduction of solar panels to generate electricity for a building. The design proposal is to incorporate the use of solar generated electricity for the building. This is because Ghana's energy supply is not reliable for the survival and sustainability of such a building design. Also, solar energy is cheaper and long lasting and with such abundance of sunlight in the region, it is only wise to take advantage of it to run such an intelligent building without any disruptions.

Building-integrated photovoltaics (BIPV) are photovoltaic materials that are used to replace conventional building materials in parts of the building envelope such as the roof, skylights, or facades. They are increasingly being incorporated into the construction of new buildings as a principal or ancillary source of electrical power, although existing buildings may be retrofitted with BIPV modules as well. The advantage of integrated photovoltaics over more common non-integrated systems is that the initial cost can be offset by reducing the amount spent on building materials and labour that would normally be used to construct the part of the building that the BIPV modules replace. In addition, since BIPV are an integral part of the design, they generally blend in better and are more aesthetically appealing than other solar options. These advantages make BIPV one of the fastest growing segments of the photovoltaic industry.

Due to specific task cooperation of many different experts, such as architects, civil engineers and PV system designers, is necessary according to how and where such systems are built, whether into the facade or in the roof, the following BIPV systems are recognized:

Facade or roof systems added after the building was built,
Facade integrated photovoltaic systems built along with an object,
Roof-integrated photovoltaic systems built along with an object,
"Shadow-Voltaic" - PV systems also used as shadowing systems, built along with an object or added later.

In the case of facade or roof systems the photovoltaic system is added to the building after it was built. These low powered systems of up to some 10 kW are usually integrated into the south

facade. Facade integrated photovoltaic systems could consist of different transparent module types, such as crystalline and micro-perforated amorphous transparent modules. In such case a part of natural light is transferred into the building through the modules. Solar cells are available in different colours; therefore, there is no limitation for imagination of the architect or the designer. We can say that such constructed buildings give the term architecture a completely new meaning.

Roof-integrated photovoltaic systems are integrated into the roof; the roof is covered with transparent photovoltaic modules, or they are added to the roof later. Such systems are added to a flat roof or on a tilted roof usually only if the building is small. It is possible to use tiles, which integrate solar cells.

Photovoltaic systems could be used for shadowing, where photovoltaic modules serve as Venetian blinders. In some of such cases photovoltaic modules tilt angle could be adjusted manually or automatically allowing for shadowing the building and/or photovoltaic module efficiency optimization. Such systems are also known as "Shadow-Voltaic" systems. The best results and efficiency can be reached with systems, which are tightly integrated into the passive solar buildings; however, the use of active solar systems is an additional possibility. This is where the modules are partially transmitting allowing natural light to penetrate the building. Undoubtedly, such systems challenge even the best of architects. High level of expertise is required for successful BIPV systems planning, not only in regard to architecture, but also to civil and photovoltaic engineering. The projects realized in the past show that successful BIPV systems designing are based heavily on technical experience and knowledge. Poorly designed systems usually have to be redesigned or repaired later, consequently swelling maintenance costs and lowering system efficiency rate.

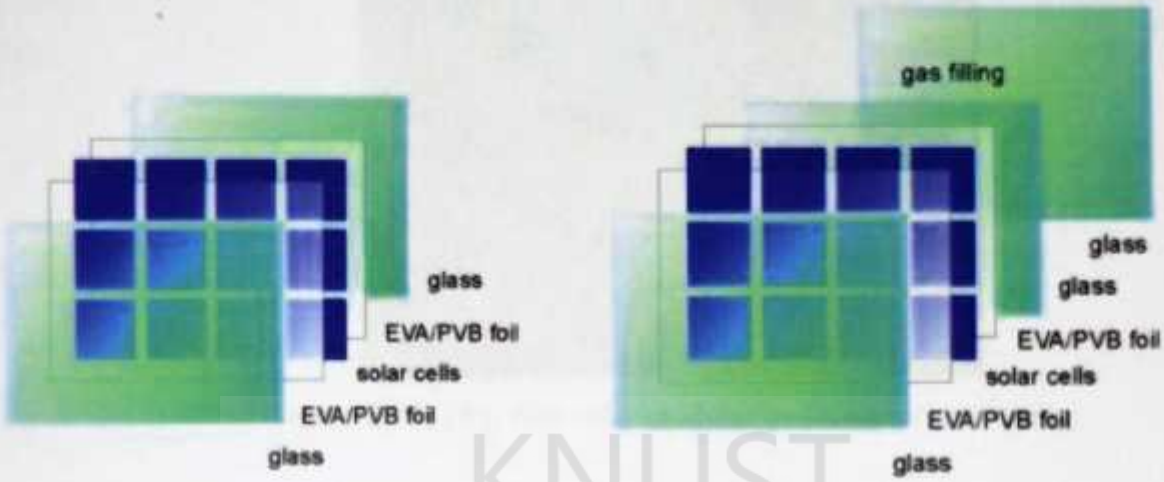

Figure 2.15: Glass/glass and isolation glass/glass laminates with solar cells

Types:

Figure 2.16: Large transparent module - glass/glass laminate

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Figure 2.17: Thin film solar modules as facade or roof cover

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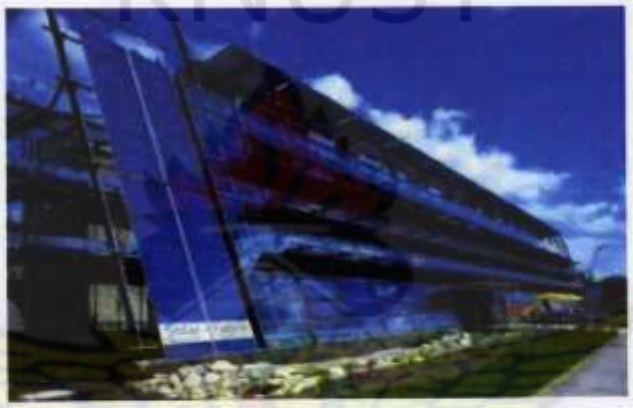

Figure 2.18: Solar fabric, Freiburg facade with transparent modules and shadowing modules

Problems related to BIPV systems:

Exact shadowing analysis should be made before the system is constructed, high temperature conditions should be avoided by crystalline modules (decreased efficiency).

Examples:

Figure 2.19: Photovoltaic system on the roof - "Les Corsaires" 7.7 kW in Switzerland

Figure 2.20: Roof integrated photovoltaic system with transparent solar modules in Switzerland

Figure 2.21: Transparent photovoltaic system in Weiz, Austria.

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2.8: ROOF GARDENS

History:

The concept of roof gardens and roof cultivation had already been exploited by the Babylonians in biblical times by 600 BC. In Berlin, in 1890, farm house roofs were covered wirh a layer of soil as a means of fire protection, in which vegetation seeded itself. Le Corbusier was the first in our century to rediscover the almost forgotten green roof.

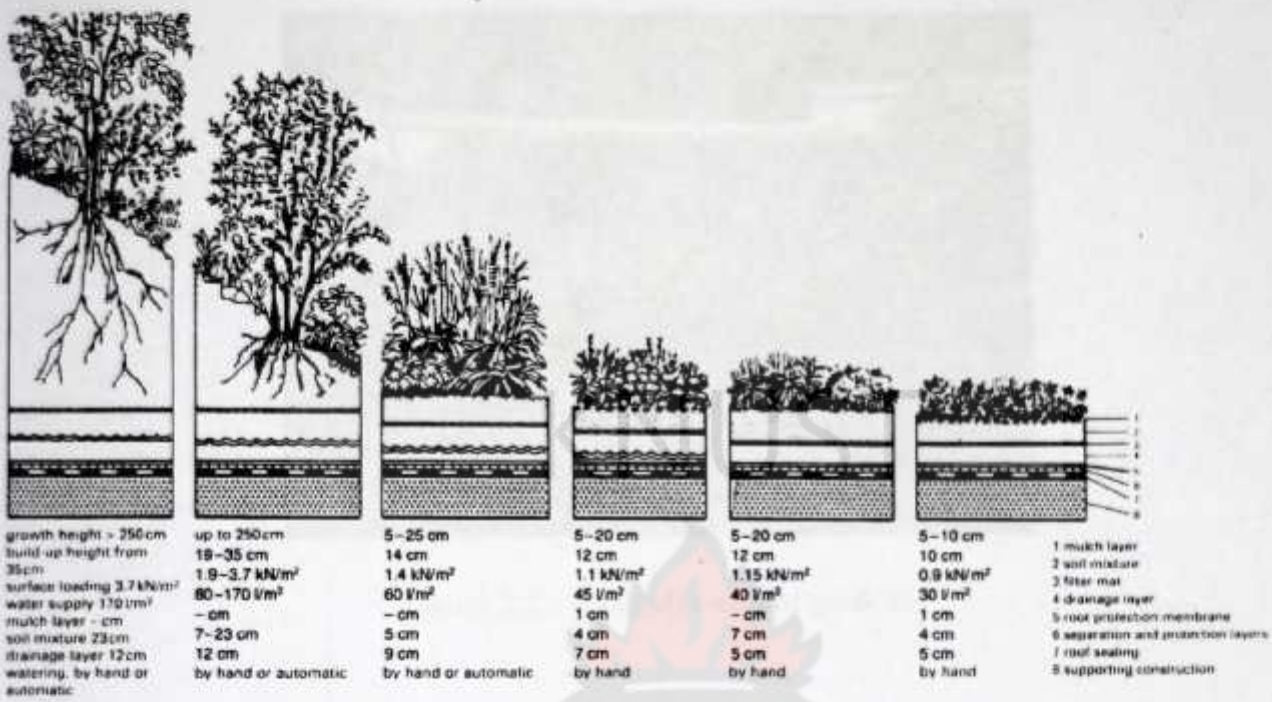
Advantages:

- Insulation by virtue of the layer of air between blades of grass and through the layer of soil, with its root mass containing microbial life processes.
- Sound insulation and heat insulation potential.
- Improvement of air in densely populated areas.
- Improvement of microclimate.
- Improves town drainage and water balance of the countryside.
- Advantageous effect of building structure: UV radiation and strong temperatures are prevented due to the insulation grass and soil layers.
- Binds dust.
- Part of the building design and improves quality of life.
- Reclamation of green area.

Slope of roof gardens:

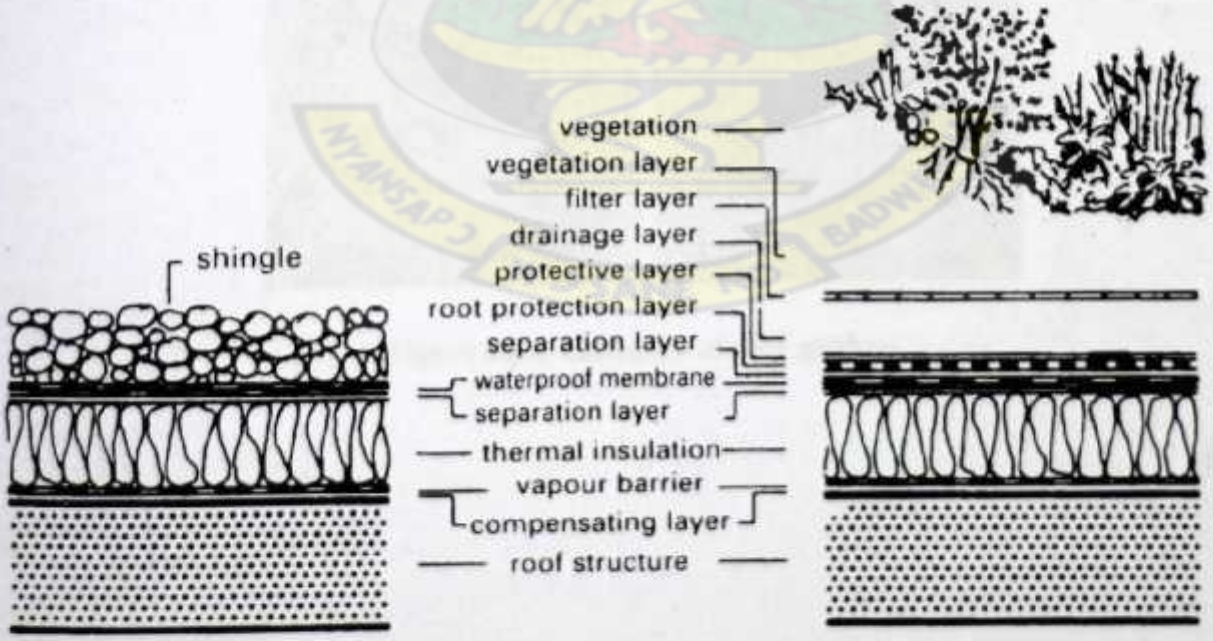
The slope of a double pitch roof should not be greater than 25°. Flat roof should have a minimum slope of 2 -3%.

Types of roof gardens:



Various types of roof cultivation

Construction of roof gardens:



Examples of buildings with roof gardens:

Figure 2.22: Examples of r[illegible]gardens

Figure 2.23: Examples of roof gardens

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CHAPTER THREE

METHODOLOGY

CHAPTER THREE: METHODOLOGY

3.0: METHODOLOGY

The information used to write this thesis was acquired through the adoption of a number of tried and tested research methodologies. These research methods made the acquisition of information very easy as explained below. The information gathered was carefully evaluated to ensure that only the one that would aid the execution of the task was collected. Interviews, Journals, magazines, literature reviews, personal observations, photographic recordings, case study as well as the World Wide Web research were the research methods employed.

- Literature Reviews

Published and unpublished literature on the topic was reviewed. This involved the examination of written material such as books and journals, business news on air and on the television. A lot of literature was also gathered from various web sites associated with the history and design of stock exchanges around the world.

- Internet Searches

The World Wide Web, a giant library with extensive information, was greatly used in the research. It provided a lot of examples of stock exchanges around the world. It also provided answers and clues to some problems encountered whilst undertaking the project.

- Case Study

The Ghana Stock Exchange which serves the functions of the project in Ghana was studied to enable the author know the operation of the exchange and draw conclusions on design decisions to be taken in tackling the scheme.

- Photographic Recordings

Photographs of critical and important facilities and activities that will aid the completion of the project at hand were taken. Also photographs of the proposed site was taken to give a good impression on what is currently existing on the site and around the site, which was necessary because the building character of the site location was important to realize to achieve the task ahead.

- Interviews

Basically the officials of the Ghana Stock Exchange were interviewed to know in detail the operations of the stock exchange and the comfort and efficient use of the present space in the Cedi House. Other people who were interviewed were some architects who have worked and designed some of the major high rise office buildings in Accra, especially at Ridge. This was to help the author get a lot of information on the design issues to be considered, such as the services available and the building regulations at Ridge, Accra. Others information from the architects included land value of Ridge, parking statistics at Ridge and Accra in general.

- Personal Observations

Some of the information used came about through careful personal observations made by the author.

3.1: METHOD OF DATA ANALYSIS

Tables were employed to analyze the data collected for this research. Another method used was to simulate the collected data into meaningful discussions.

3.2: LIMITATIONS

- My colleagues and I were not given the opportunity to explore the offices of the Ghana Stock Exchange to our full benefit. As a result the all inclusive operation of the exchange is superficial.
- We were not allowed to take pictures at the exchange but we took them anyway without the knowledge of the officials of the exchange and then explained to them later that it was for academic purposes.
- It was also difficult to get an appointment to meet the general manager of the exchange; we had to call in some favours.
- There was only one book that I personally came across concerning stock exchange buildings.

CHAPTER FOUR

FINDINGS AND DISCUSSIONS

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CHAPTER FOUR: FINDINGS AND DISCUSSIONS

4.0: SITE LOCATION OPTIONS:

Stock Exchange locations around the world are basically at the commercial centre of the capital city of the country or at the commercial center or the Central Business District of a city. The Ghana Stock Exchange at the moment is at the 5th and 6th floors of the Cedi House at Ridge in Accra. Ridge in Accra has grown over years to become a corporate commercial and civic center in Accra and with the existing location of the exchange already there, it is only appropriate to have the proposed exchange at this location.

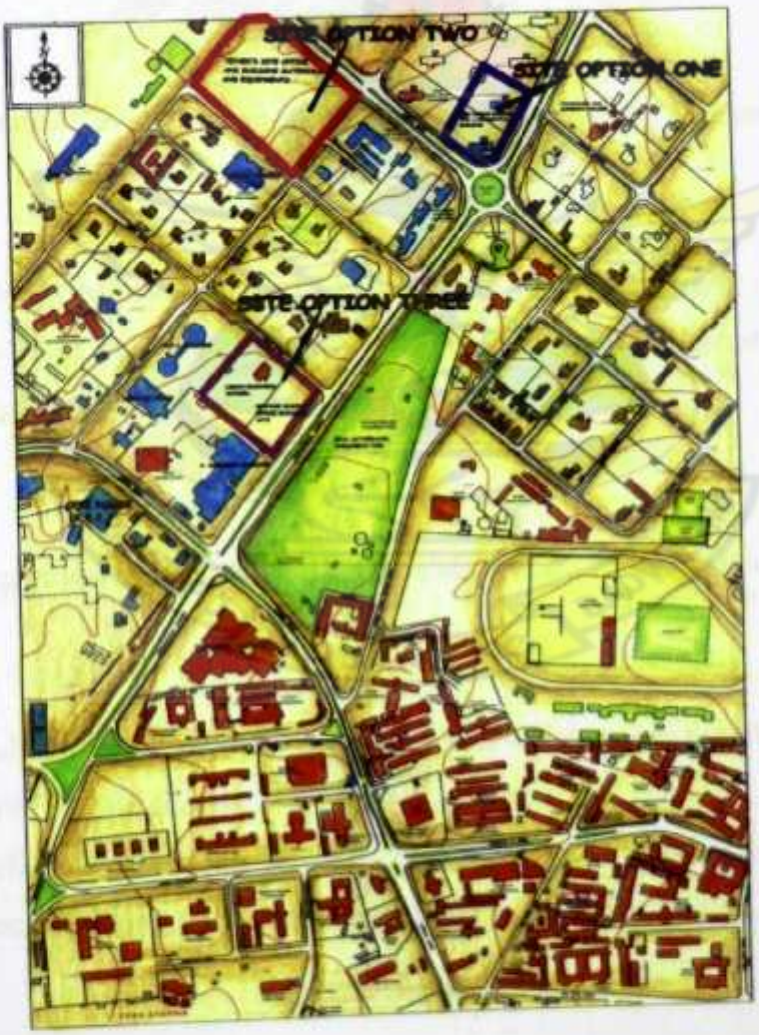

Figure 4.1: Location of site selection options at Ridge, Accra.

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4.1: SITE SELECTION OPTIONS:

4.1.1: OPTION ONE:

Figure 4.2: Location of site option 1 – PURC building site and a residential building.

Site location:

The site is adjacent to the Ministry of Works and Housing which is currently under construction. It is along the Castle Road and the Independence Avenue and near the Liberation Circle. It is also opposite the Physicians and Surgeons College.

Site conditions:

The existing building on the site are the P.U.R.C. building and a residential building.

Merits:

- There is good transportation route around the site, which makes the site easily accessible.
- The location of the site is at the city center of Accra.
- There are well laid out building services around the site like sewage lines, electricity and telecommunication lines, good drainage systems, good street lighting, etc.

Demerits:

- There is intense vehicular traffic around the site that does not allow for easy and safe access to the site.
- The size of the site will cause parking restrictions.

4.1.2: OPTION TWO:

Figure 4.3: Location of site selection option two – the Teysec site office and storage and mixing building materials and storing building equipment for the SSNIT multi-storey car park under construction.

Site location:

The site is bounded by the Castle Road, the 6th and 7th Avenue and the Sudan Road. It is opposite Ridge Hospital and adjacent to VALCO Trust House.

Site condition:

The site currently has the Teysec site office and storage and mixing of building materials and storing building equipment for the SSNIT multi-storey car park under construction.

Merits:

- There are good transportation routes around the site and less vehicular traffic away from the Castle Road.

- The location of the site is at the city center of Accra.
- There are well laid out building services around the site like sewage lines, electricity and telecommunication lines, good drainage systems, good street lighting, etc.

Demerits:

- There is limited site access to peripheral roads.
- There is intense vehicular traffic around the site that does not allow for easy and safe access to the site.
- The size of the land is too expensive to buy and have a toll on the budget for the building.

4.1.3: OPTION THREE:

Figure 4.4: Location of site option three – the Legon business school and the proposed site for the GLICO office building.

Site location:

The site is bounded by the Independence Avenue and the Libya Road. It is opposite the Efua Sutherland Children's Park and adjacent to the V. Morrison building.

Site condition:

The site currently houses the Legon Business School and the wholesale outlet of FUDI.

Merits:

- There are good transportation routes to the site and away from the traffic on the Castle Road.
- The site is nearer to the Cedi House, compared to the previous options.
- The location of the site is at the city center of Accra.
- There are well laid out building services around the site like sewage lines, electricity and telecommunication lines, good drainage systems, good street lighting, etc.

Demerits:

- There is limited access to the site from the peripheral roads.

4.2: THE THIRD SITE OPTION IS THE SELECTED OPTION:

The site houses the Legon business school and the wholesale outlet of FUDI. The total area of the site is 12951.47 meter square. It is bounded by the Independence Avenue and the Libya Road and it is opposite the Efua Sutherland Children's Park.

4.2.1: S.W.A.T. ANALYSIS OF SELECTED SITE:

Strengths:

- There are good transportation routes to the site and away from the traffic on the Castle Road.
- The site is nearer to the Cedi House, compared to the previous options.
- The location of the site is at the city center of Accra.

- There are well laid out building services around the site like sewage lines, electricity and telecommunication lines, good drainage systems, good street lighting, etc.
- Large enough to support such a facility.
- The site has good soil for landscaping.
- The site is easy to locate.

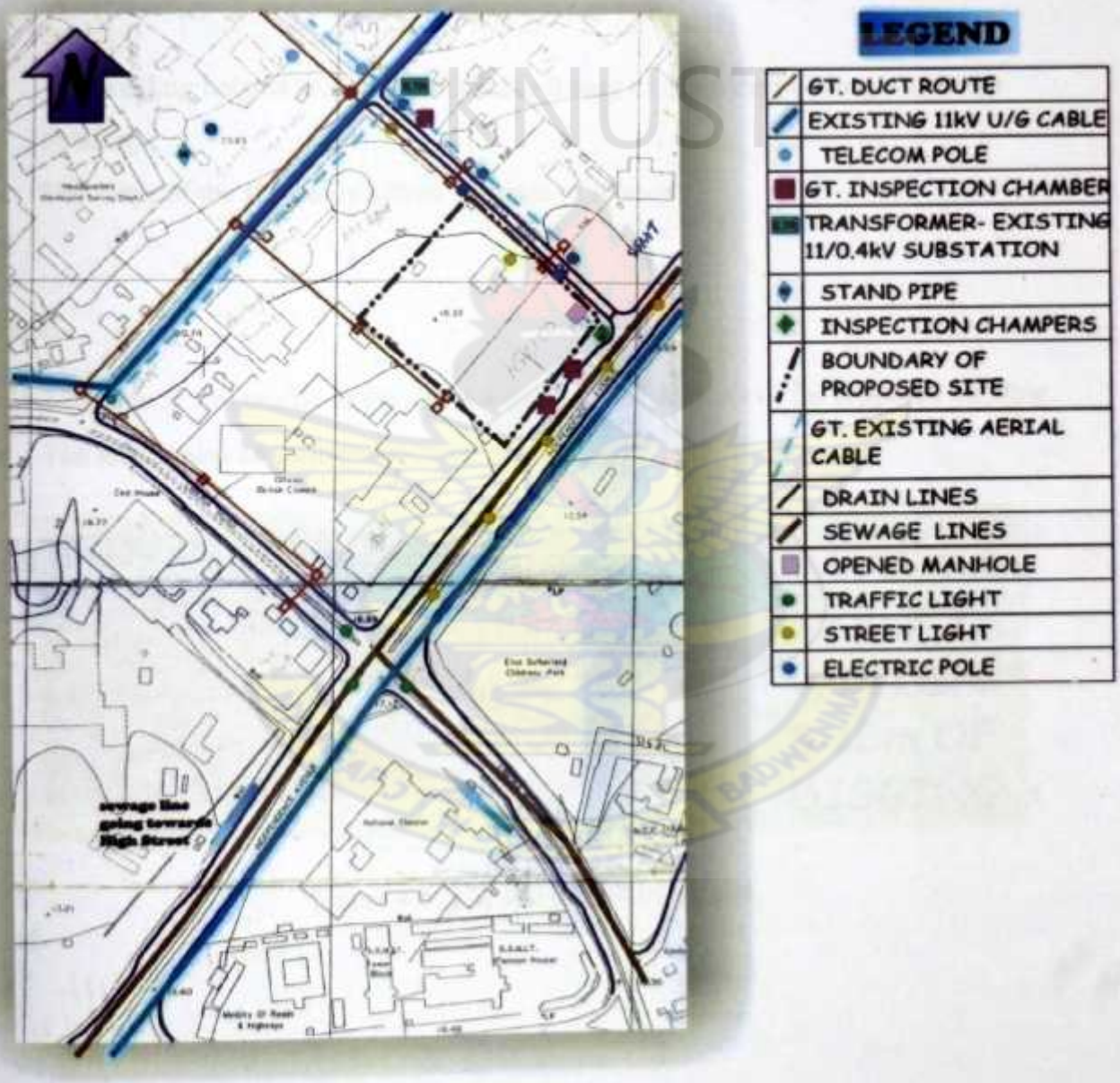

Figure 4.5: Existing services layout around the site.

Weaknesses:

- There is limited access to the site from the peripheral roads.

Opportunities:

- Soil supports good landscaping.
- The existing well laid out services around the site makes bringing services to the site easy.
- The building heights around the site make it easy to make the building a high rise building.
- The slope of the site easily allows drainage of sewage.

Threats:

- The general soil profile of the site is a threat to the structure of the proposed building.
- The area is also an earthquake prone zone.

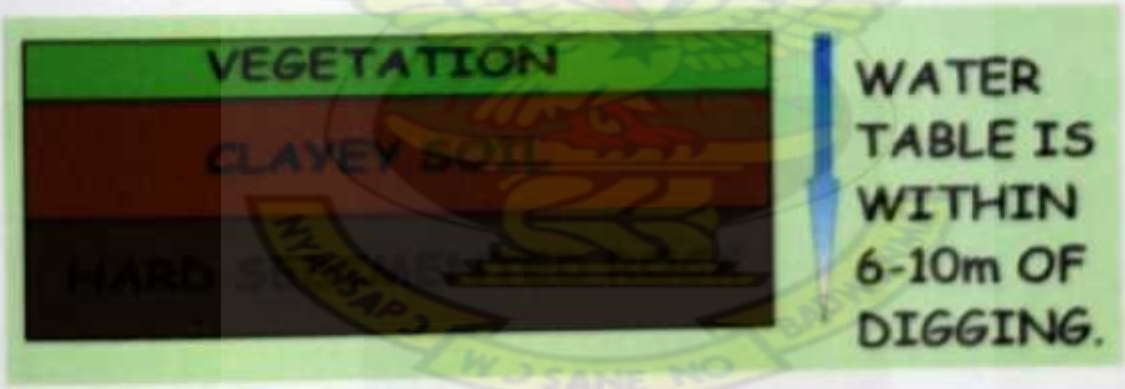

Figure 4.6: The soil profile of the site.

4.3: SITE FEATURES:

- The Legon business school: the north – west part of the site houses the Legon Business School.
- The FUDI wholesale outlet: the south – east part of the site houses a wholesale outlet for FUDI. This part of the site is a proposed site for the GLICO office building.
- The site is along the Independence Avenue which is a dual carriage road and the side road is the Libya Road.

Figure 4.7: The Legon Business School

Figure 4.8: The FUDI wholesale outlet.

Figure 4.9: the Independence Avenue

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- The general site condition can support this facility. The soil is good for landscaping and also with the right foundation the soil can support a high rise building.

Figure 4.10: The soil condition on the site.

4.3.1: CLIMATE:

Ghana is in the tropics and experiences dry and rainy seasons. The general average daily temperature in Accra ranges from 23° to 31°. The mean annual rainfall of Accra ranges from 750 to1000 mm. The wind direction on the site is from the south-west and the west side of the site has the highest amount of sunlight.

4.3.2: TOPOGRAPHY:

The site slopes towards the south-western part of the site and also toward the south-eastern part of the site.

4.3.3: GEOLOGY:

The soil profile of the site is such that the water table is after 6m to 10m of digging and it is made up of clayey soil and hard sediment rock.

4.3.4: VEGETATION:

The vegetation on the site is such that the Legon Business School has large trees and the proposed GLICO site has dry short dry grass.

4.3.4: LAND VALUE:

The land value for Ridge, Accra is generally $1.5 million to $2 million per acre.

4.4: ACCOMMODATION SCHEDULE:

Building component	Space required (sq. meters)
Stock exchange administration	
Reception	25
Visitors' court	
Office space for administration workers (75 workers)	3000
Trading floor	
Wash rooms	50
Archive room	
Printing and photocopying	10
Storerooms	
Total	**3770**

A bank	
Banking hall	1200
Front desk	12
Back office (70 workers)	1000
Tellers	20
Wash rooms	50
Archive room	20
Kitchenette	15
Strong room	20
Conference room	50
A.T.M.s	12
Total	2399
Business center	
Conference rooms	5000
Wash room	50
Business center administration	30
Store for P.A. systems	20
Total	5100
Training center	
Lecture rooms (200 students)	5000
Library	1000
Training center administration	30
Wash rooms	50
Lecturers' lounge / offices	50
Printing and photocopying	10
Total	**6140**

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Restaurant	
Dining hall	2000
Service lift	4
Cold store	20
Dry store	20
Empties room	20
Wash room	100
Changing room	65
Bar	30
Kitchen	250
Waste chute	2.25
Kitchen yard	50
Total	**2561.25**
Executive suites	
Reception	8
Visitors' court	18
Executive suite administration	30
Wash rooms for workers / visitors	50
Kitchenette	70
Suites (30)	3000
Service lifts	12
Bar	60
Dining room	500
Total	**3748**
Open offices to let	
Office space	2000 x 21 = 42000
Wash room	50 x 21 = 1050

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Kitchenette	15 x 21 = 315
Total	43365
Building's administration	
Offices for building administration	30
Laundry	18
Cleaners' changing room	100
Electricians / store	20
Plumbing / store	20
Bell boys/ valets / maids to the executive suites	100
Postal / mail room	70
Wash rooms	50
Server room	20
Total	428
Service floor / rooms	
Water pumps room	50
Power room	50
A.C. plant room	50
Stand-by generator	50
Garbage room	50
Solar batteries room	20
Service floor to upper floor	1000
Total	1270
Security post / entrances / exit / vertical circulation	
Security posts	40
Lifts	530
Stairs	1440
Total	2010

Parking

Parking statistics of buildings at Ridge Accra:

Buildings with specific components:

Component required	Area – (sq. meters)	No. of cars
Banking	1000	20 – 40
Office	1000	10 – 15 – 25
Restaurant	1000	25 – 35 – 60
Executive suites	1 suite	1
Higher education	5 seats	1

So therefore, for:

Component	No. of parking to be provided
Banking	91
Offices	677
Restaurant	90
Executive suites	30
Training centre	40
Total	**928**

11600

So, this facility will be able to reasonably provide for 464 cars.

Grand total 82396.25

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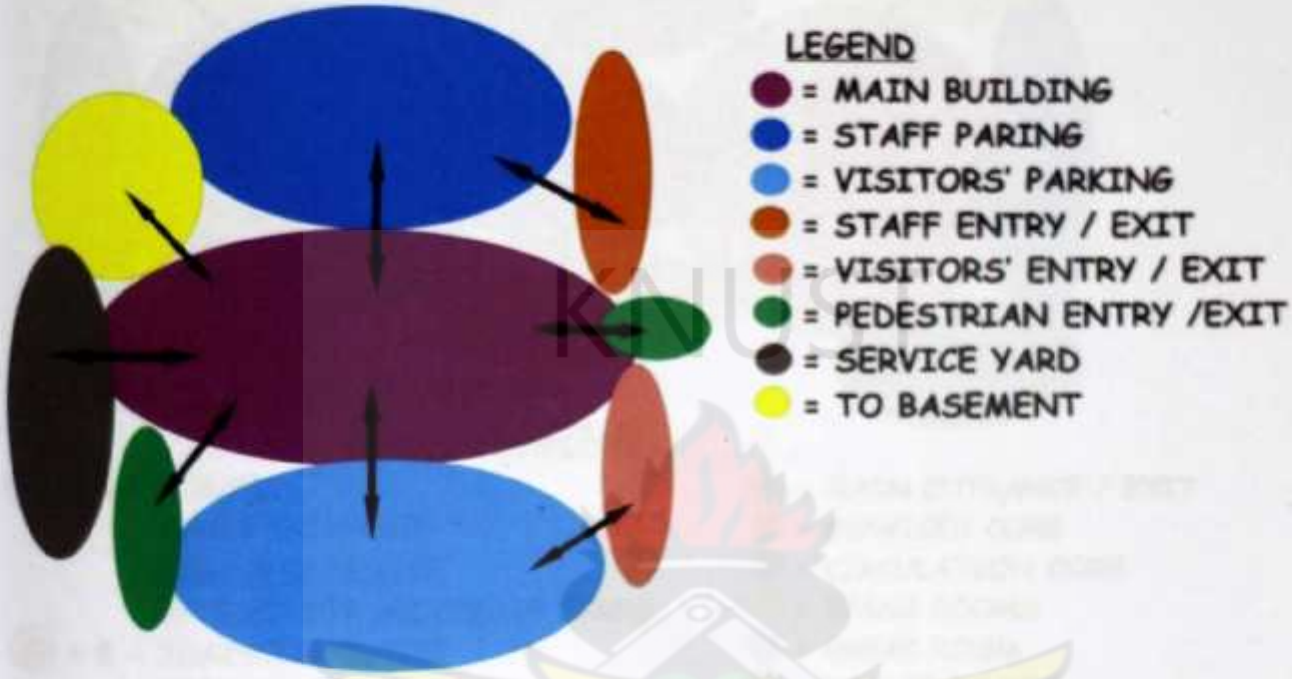
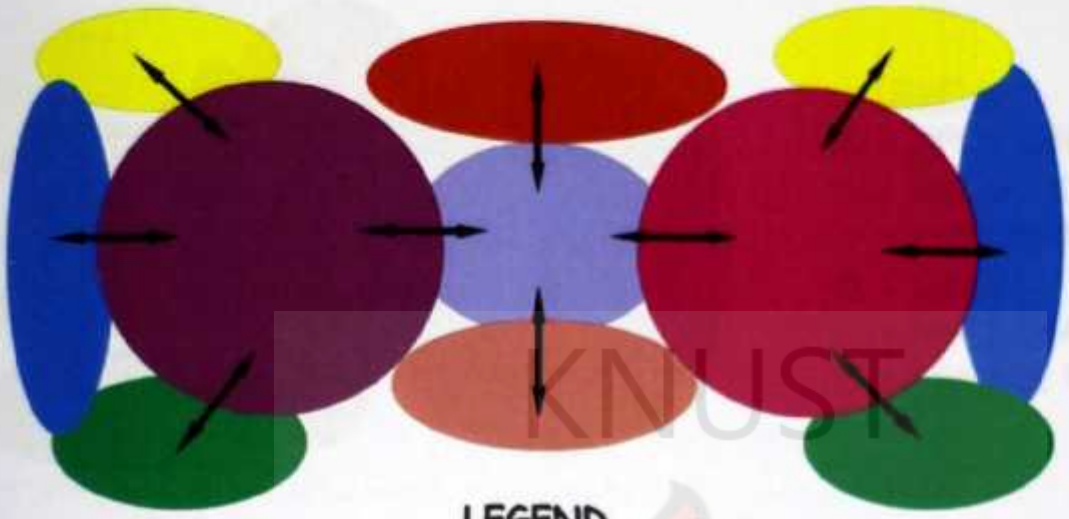
4.5: FUNCTIONAL FLOW DIAGRAM:

4.5.1: SITE FLOW DIAGRAM:



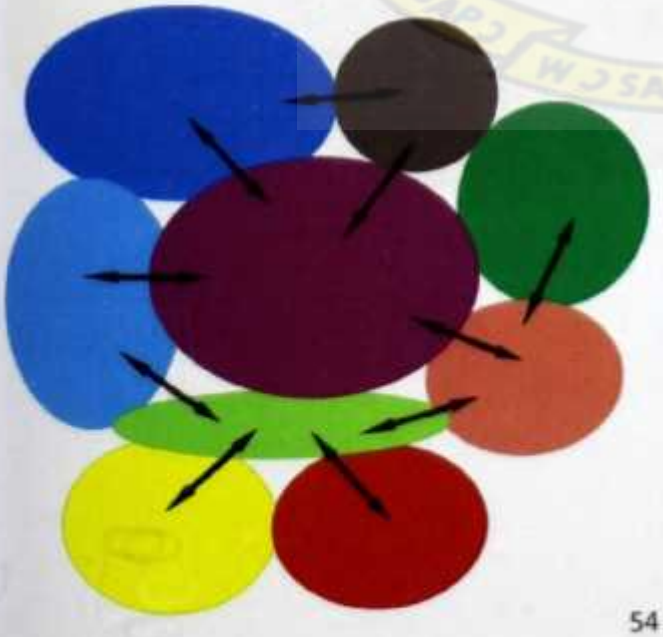
4.5.2: BUILDING'S FLOW DIAGRAM:



LEGEND

- = A - A BANK
  STOCK EXCHANGE
  BUSINESS CENTRE
  OFFICES FOR BROKERAGE FIRMS
- = B - TRAINING CENTRE
  RESTAURANT
  BUILDING'S ADMINISTRATION
  OPEN OFFICES TO LET
  EXECUTIVE SUITES
- = MAIN ENTRANCE / EXIT
- = SERVICES CORE
- = CIRCULATION CORE
- = WASH ROOMS
- = BREAK ROOM
- = ESCAPE STAIRS

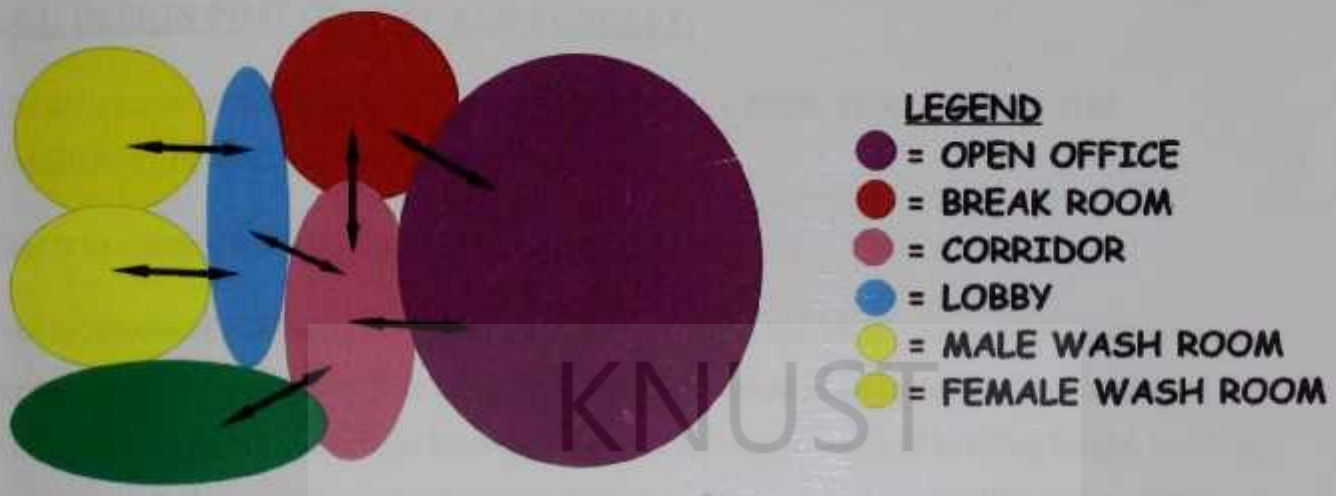
4.5.3: STOCK EXCHANGE FLOW DIAGRAM:



LEGEND

- = TRADING FLOOR
- = RECEPTION
- = VISITORS' COURT
- = CORRIDOR
- = JOURNALISTS' LOUNGE
- = INVESTORS' LOUNGE
- = GENERAL OFFICE
- = EXECUTIVE OFFICES
- = ARCHIVES

4.5.4: OPEN OFFICE FLOW DIAGRAM:



4.5.5: EXECUTIVE SUTES FLOW DIAGRAM:

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4.6: THE DESIGN

4.6.1: DESIGN PHYLOSOPHY AND CONCEPT:

The philosophy of this design is "AN ARCHITECTUAL ICON THAT SHOWS THE EMERGING ECONOMY OF GHANA".

This is to identify the following:

"An architectural ICON……" – an icon is a symbol that is universally recognized to be a representative of something. The design is to use architecture as an **economic icon** in Ghana. The design is meant to stand out from the rest in all aspects, in terms of building height, building technology, building services, landscaping, human comfort, ease of workability and aesthetics. The design is to be a symbol of the future of the economy of Ghana in terms of trade. It to show to Ghanaian and the rest of the world that the economy of Ghana is moving from one step to another, hence "….. EMERGING ECONOMY OF GHANA" – emerging here means to arise, appear or occur or to move from one stage to another. The economy of Ghana since independence has evolved from one point to another. The design is showing this fact with the use of the principle of the stairs; the stairs work by moving from one height to another and the heights between all the steps are equal. So the design has one part of it being 10 floors, the next being 15 floors and the last being 20 floors. This shows a definite difference of 5 floors, evident of growth – from one stage to the other.

4.6.1.1: THEMES USED FOR THE DESIGN:

Diversity: This is shown with the use of the varied height of the building, from 10 floors to 15 to 20 floors. Also the use of diverse building materials like concrete and steel and building technology, the use of vertical and horizontal elements in the façade design and the various facilities available in the building.

Prominence: This is shown by the height and mass of the building. It is to stand out from the rest in all aspects. It is to be the tallest building in Accra. This is show the power of wealth, the power of money, the power of the money market – the stock exchange.

Sustainability: This design is to survive the test of time on its own, that is, it should be energy efficient and not depend on outside help for energy and water. In this sense, there is the use of building photovoltaic to produce electricity for the building and the harvesting of rain water and wells to provide water for the building.

Technology: This building is an intelligent building so it will be equipped with the modern security apparatus. Also modern communication and transportation media will be employed.

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4.6.2: ARCHITECTURAL STYLE USED:

THE INTERNATIONAL STYLE OF ARCHITECTURE WAS USED.

4.6.2.1: CHARACTERISTICS OF THE INTERNATIONAL STYLE:

- **Expression of volume rather than mass:** this is portrayed in the design by the use double and triple volumes of voids. Also the ground floor's room height is higher than the rest of the building. Also the ground floor of the part of the building that is 20 floor is raised on stilts and the space used as a terrace car park.
- **Balance rather than preconceived symmetry:** this is shown by the used of different heights in definite order, that is from 10 floors to 15 to 20 floors in order. This shows balance in the design. The treatment of the façade has the core being different from the rest and the other two parts being treated the same.
- **Expulsion of applied ornament:** there are no ornamental design on the exterior, just horizontal and vertical design elements and transparent glass windows and curtain walls.

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4.6.2.2: EXAMPLES OF THE USE OF THE INTERNATIONAL STYLE:

Figure 4.11: Villa Savoye, by Le Corbusier

Figure 4.12: The Glass Palace, a celebration of transparency, in Heerlen, The Netherlands (1935)

Figure 4.13: The Philadelphia Saving Fund Society Building

4.7: SITE CONCEPTUALS PLANNING

Option 1:

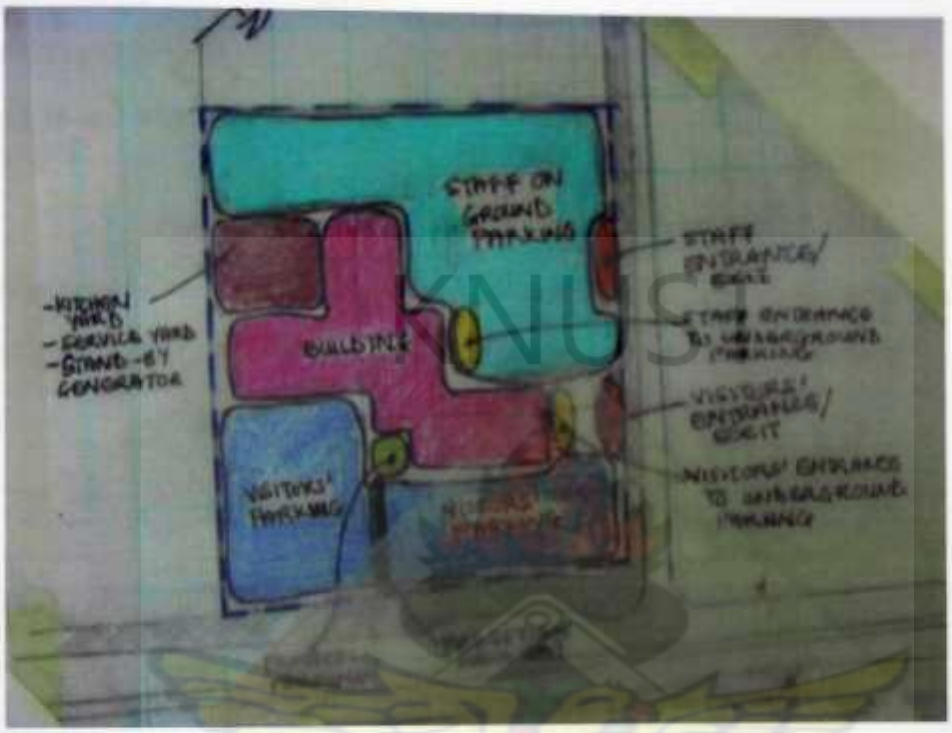

Figure 4.14: Bubble diagram of site conceptual option 1.

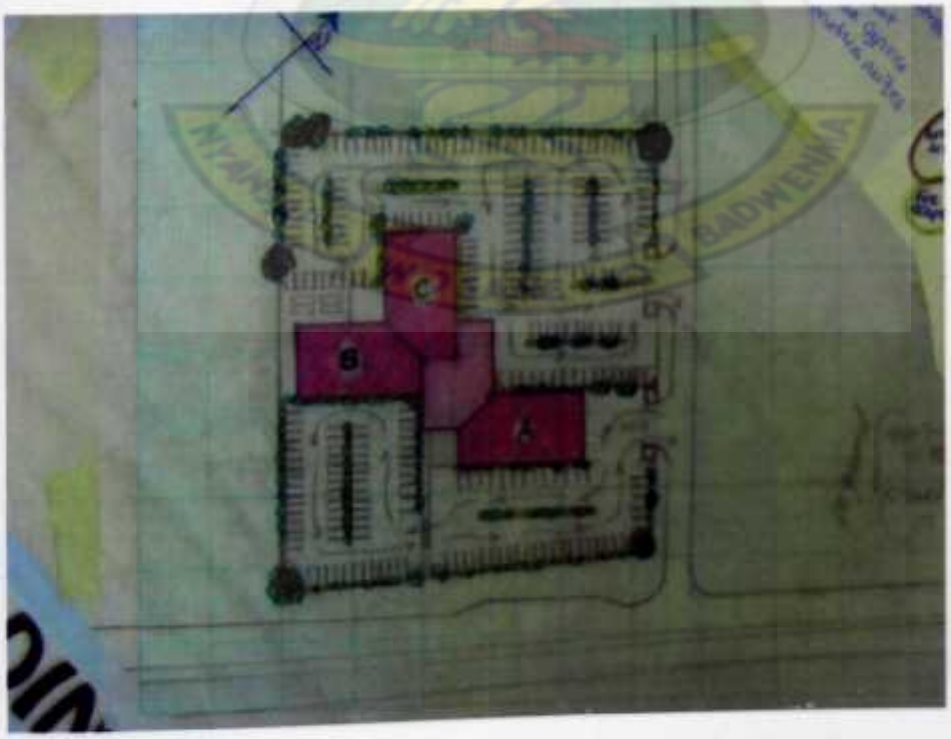

Figure 4.15: Massing of site conceptual option 1.

Merits:

- Separate parking for staff and visitors.
- Security post for staff and visitors.
- Screened service yard.
- Parking is one way to avoid traffic.

Demerits:

- Building is taking more space and there will not be enough space for future expansion.
- Pedestrian walkway will disrupt vehicular traffic and may cause accidents.

OPTION 2:

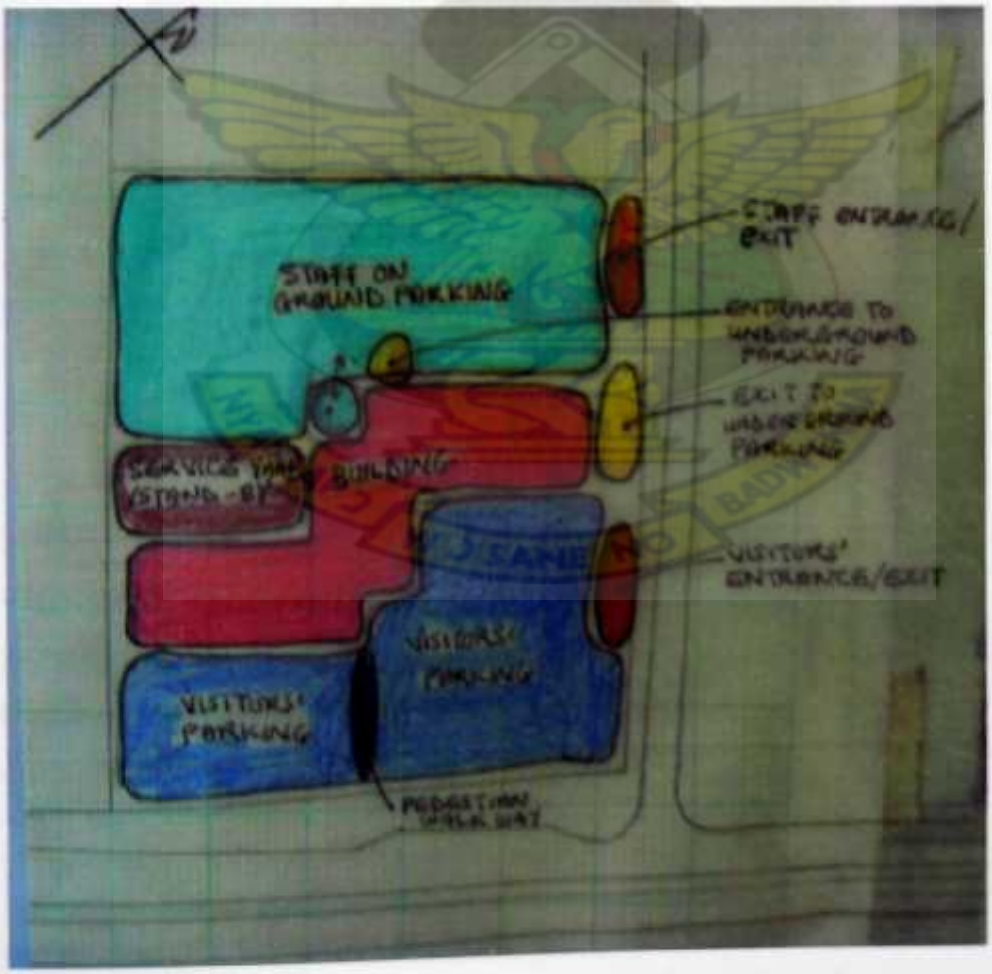

Figure 4.16: Bubble diagram of site conceptual option 2.

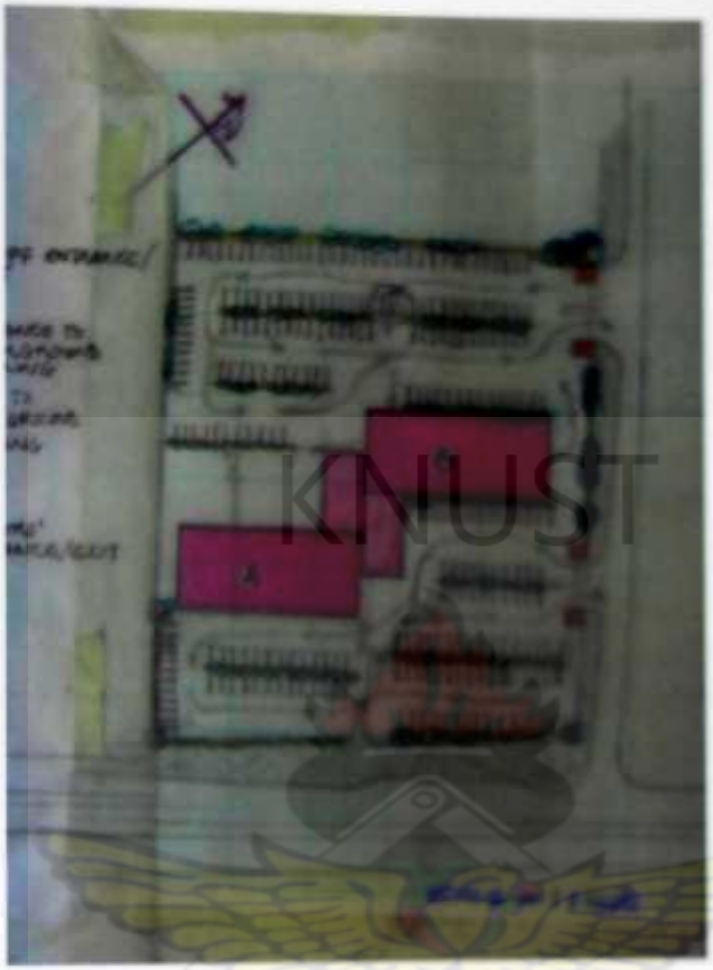

Figure 4.17: Massing of site conceptual option 2.

Merits:

- Separate parking for staff and visitors.
- Security post for staff and visitors.
- Large service yard.
- Parking is one way to avoid traffic.
- Separate entrance and exit to basement or terrace parking.

Demerit:

- Pedestrian walkway will disrupt vehicular traffic and may cause accidents.

4.8: TYPOLOGY:

OPTIONS:

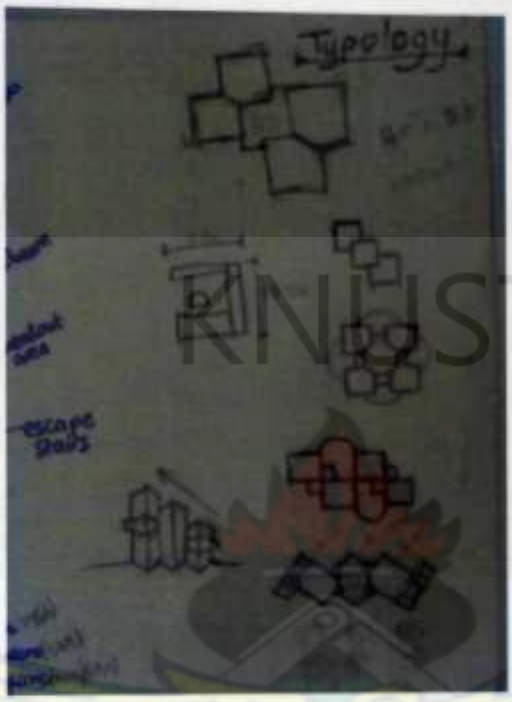

Figure 4.18: Sketches of typology options

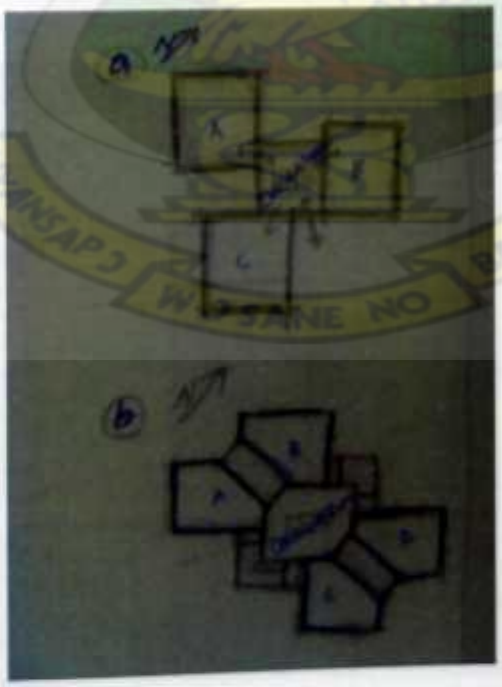

Figure 4.19: Sketches of typology options

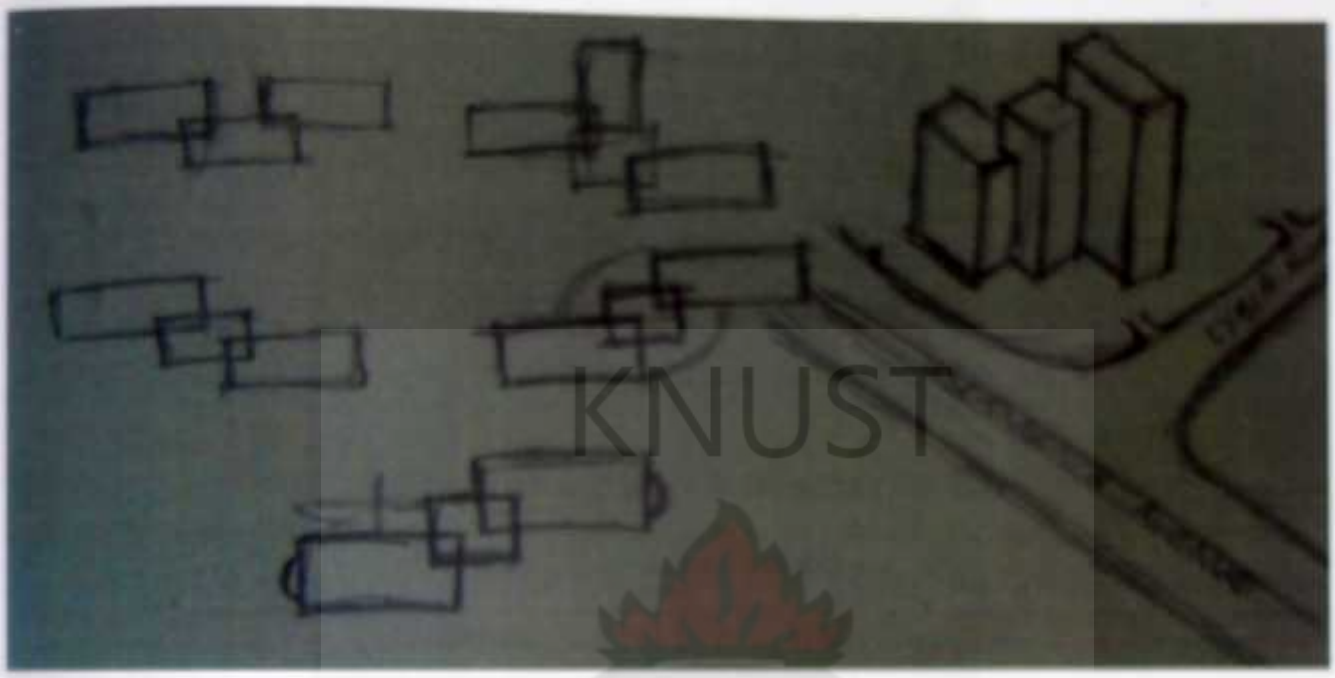

Figure 4.20: Sketches of typology options.

4.9: MASSING OPTIONS:

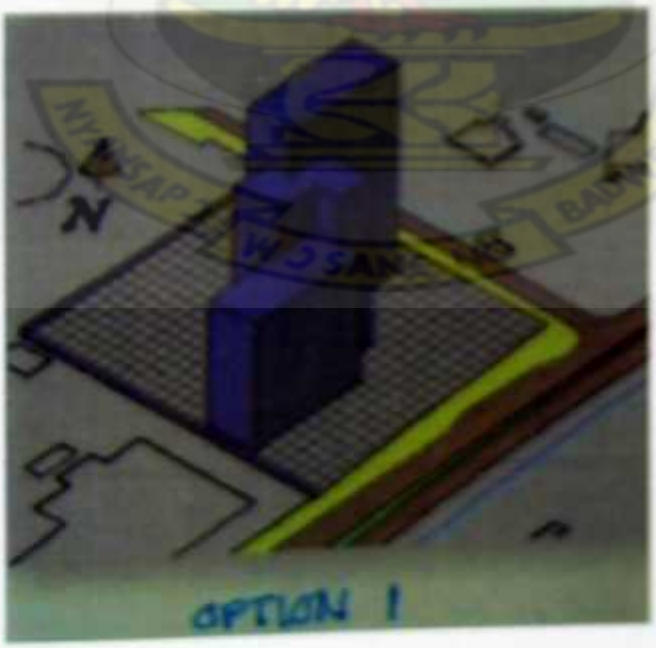

Figure 4.21: Massing option1

Figure 4.22: Massing option 2

Figure 4.23: Massing option 3

Table 4.1: The merits and demerits of the massing options:

	Merits	Demerits
Option 1	• The varying heights explain the design philosophy well. • There is a definite height from one to another. • The core is well connected to the parts of the building.	• The core is slimmer and not large enough and might look out of place in relation to the rest. •
Option 2	• The core is large enough and relates well with the rest.	• The varied heights is not definite in terms of the distance between, hence this massing defeats the philosophy.
Option 3	• The varying heights explain the design philosophy well. • There is a definite height from one to another. • The core is large enough and relates well with the rest. • The highest part of the building is raised on stilts to show prominence and also to exhibit the architectural style use.	• The raised stilt may cause security problems.

Option 3 was chosen and the design sketches are below.

4.10: DESIGN SKETCHES AND BUBBLE DIAGRAMS:

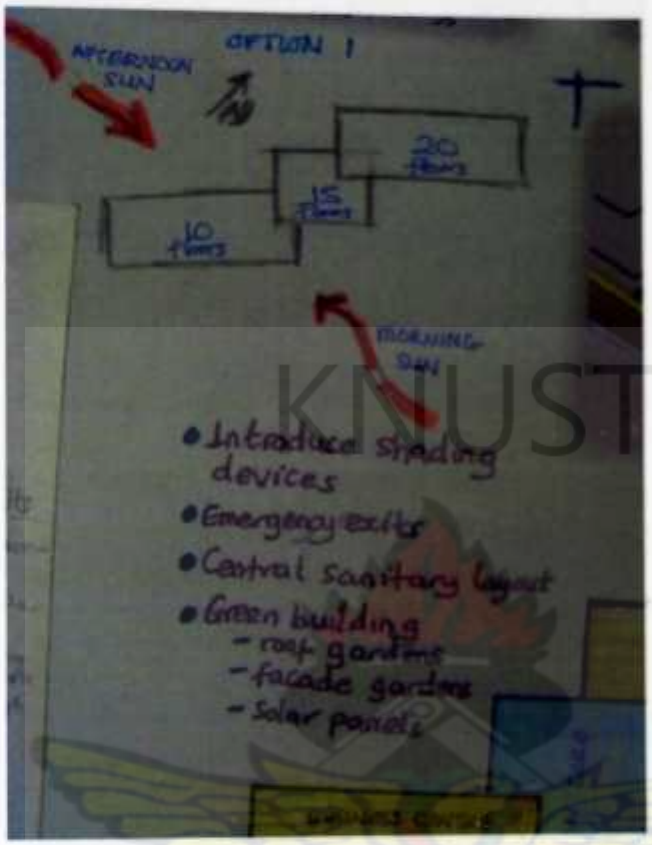

Figure 4.24: Sketches of typology options 1

Figure 4.25: Sketches of typology options 2

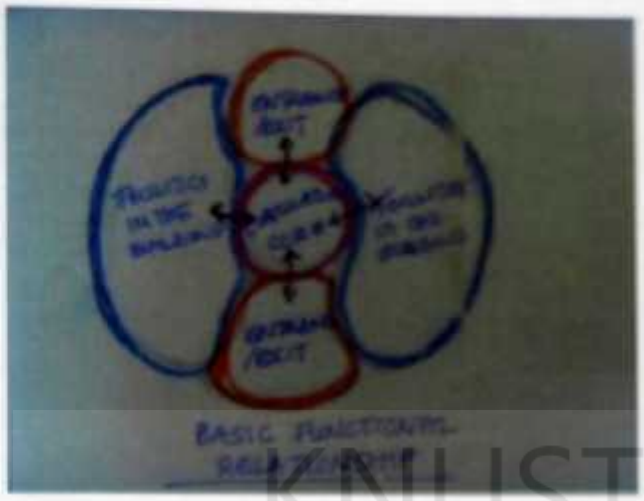

Figure 4.26: Sketches of circulation 1

Figure 4.27: Sketches of circulation 2

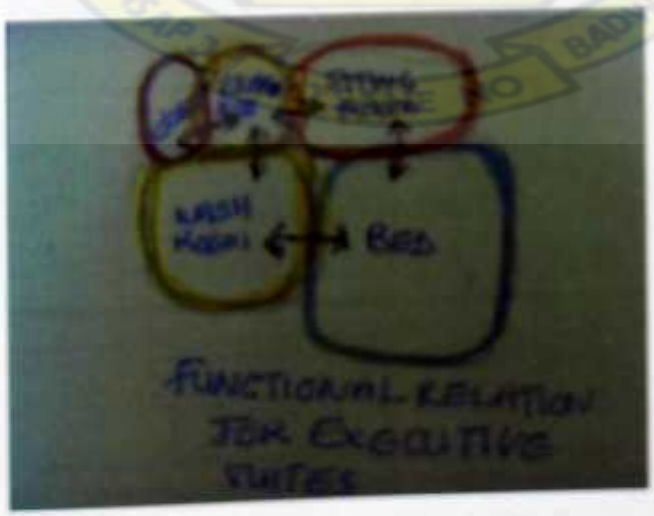

Figure 4.28: Sketches of circulation 3

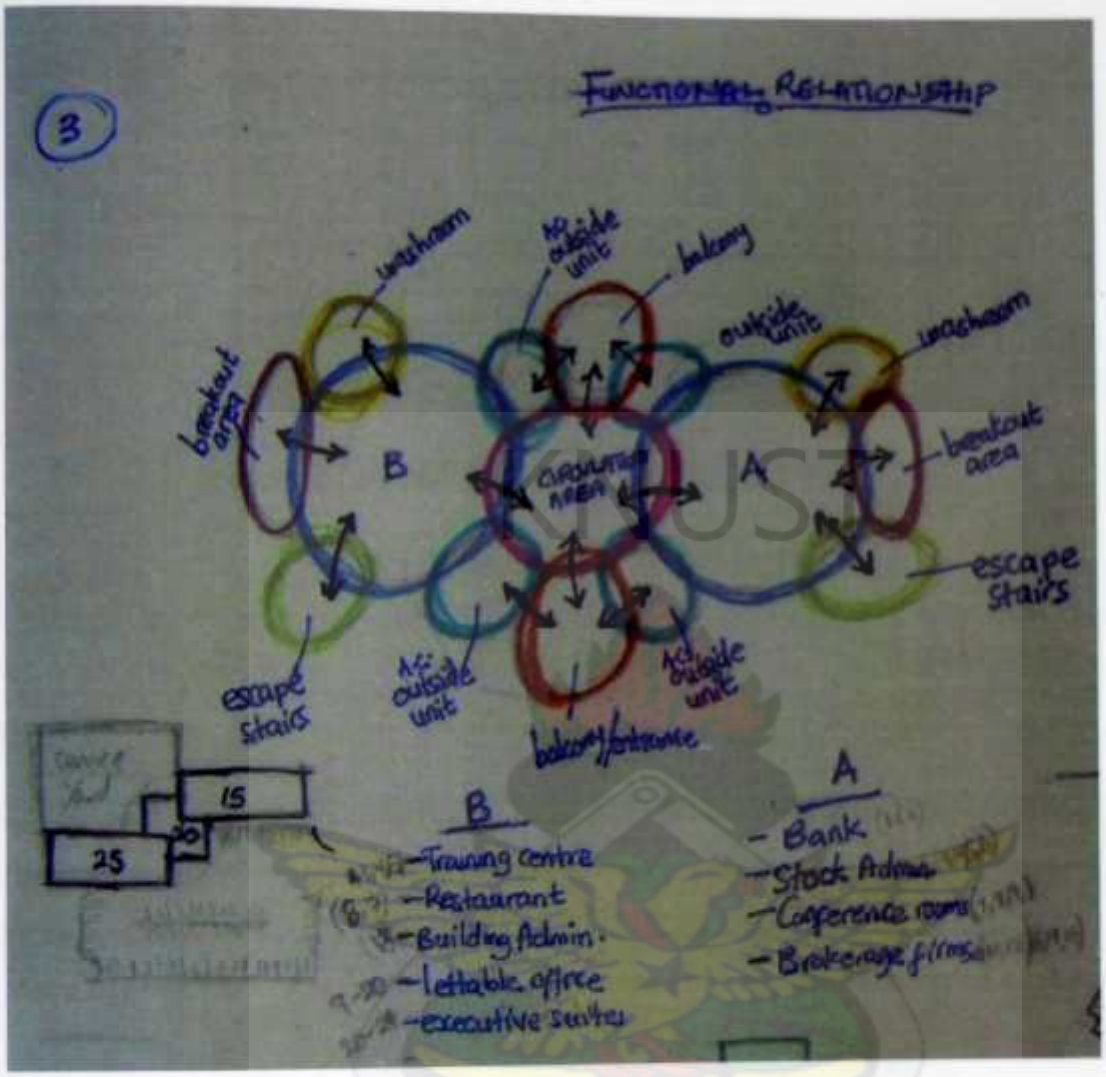

Figure 4.29: Sketches of the design 1

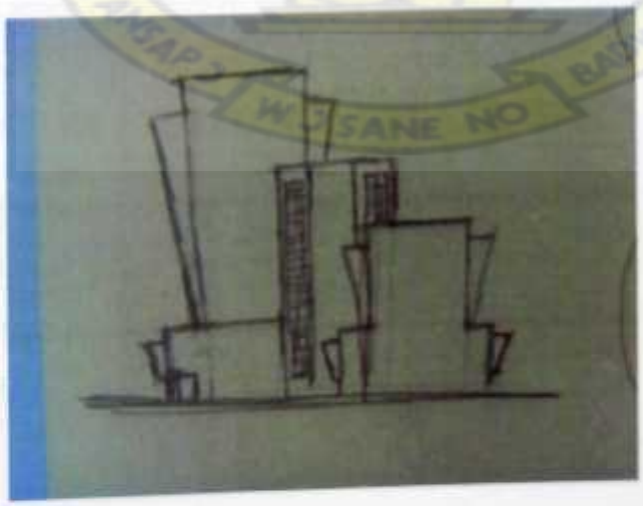

Figure 4.30: Sketches of the design 2

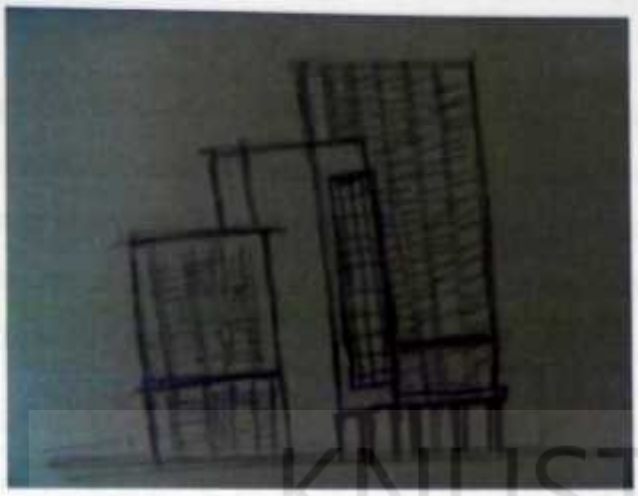

Figure 4.31: Sketches of the design 3

4.11: THE DESIGN

The design is based on the philosophy that evolved from the emerging economy of Ghana. That is from independence to date, the economy of Ghana has grown from one stage to the other. Hence the philosophy, "*AN ARCHITECTURAL ICON THAT SHOWS THE EMERGING ECONOMY OF GHANA*". The facility is to be a financial hub for the evolving economy of Ghana.

The design is basically an office building for the Ghana Stock Exchange. It has been designed with the basic needs of a stock exchange in mind and other auxiliary facilities. The main parts are the trading floor, offices for the exchange's administration, offices for brokerage firms, a training centre, a bank, offices to let and executive suites.

The facility being a multi-storey building has three main things that were addressed; **form**, **structure** and **services**. Other issues that were considered in the design are circulation, human comfort, sun shading devices, sustainable energy and water supply, security, available building materials and landscaping.

4.11.1: THE FORM:

The form of the building evolved from the philosophy that is the simple steps to an emerging economy. Steps have definite distances between each other, from one level to the other. This phenomenon was chosen to show that the economy of Ghana and for that matter the Ghana Stock Exchange has grown from one step to the other. This is shown as the building designed to be three different heights, from 10 floors to 15 to 20 floors.

The building was designed to stand out from the rest; that is it being imposing and prominent from the rest. The proposed building will be the tallest building at Ridge, for that matter Ghana. This was to make the building the commercial hub of Ghana and as such it should stand out from the rest.

Figure 4.32: front view of the proposed Ghana Stock Exchange

south-east elevation

north-west elevation

north-east elevation

south-west elevation

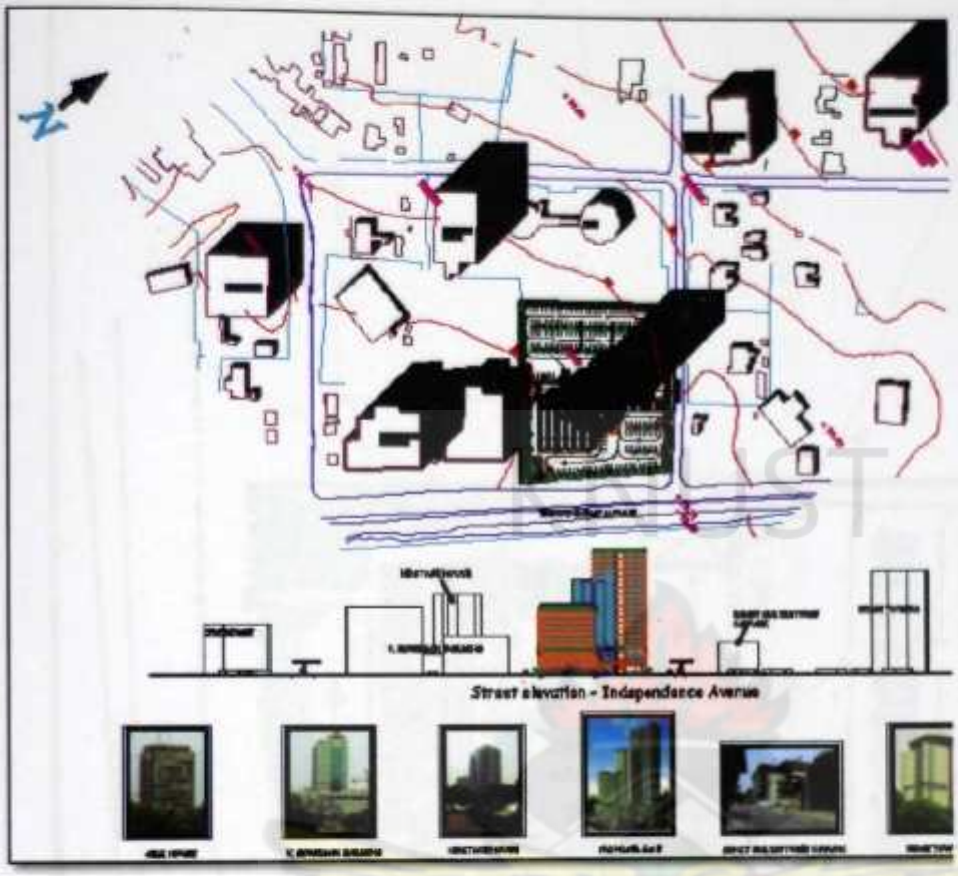

Figure 4.33: Building height compared to the other high rise buildings at Ridge.

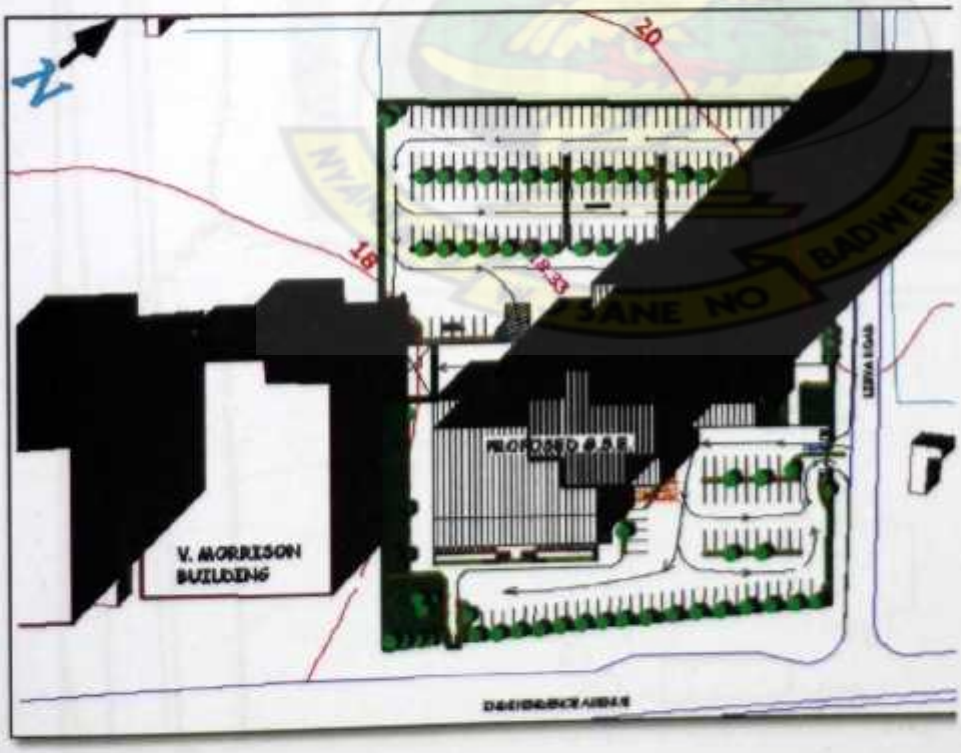

Figure 4.34: Block plan

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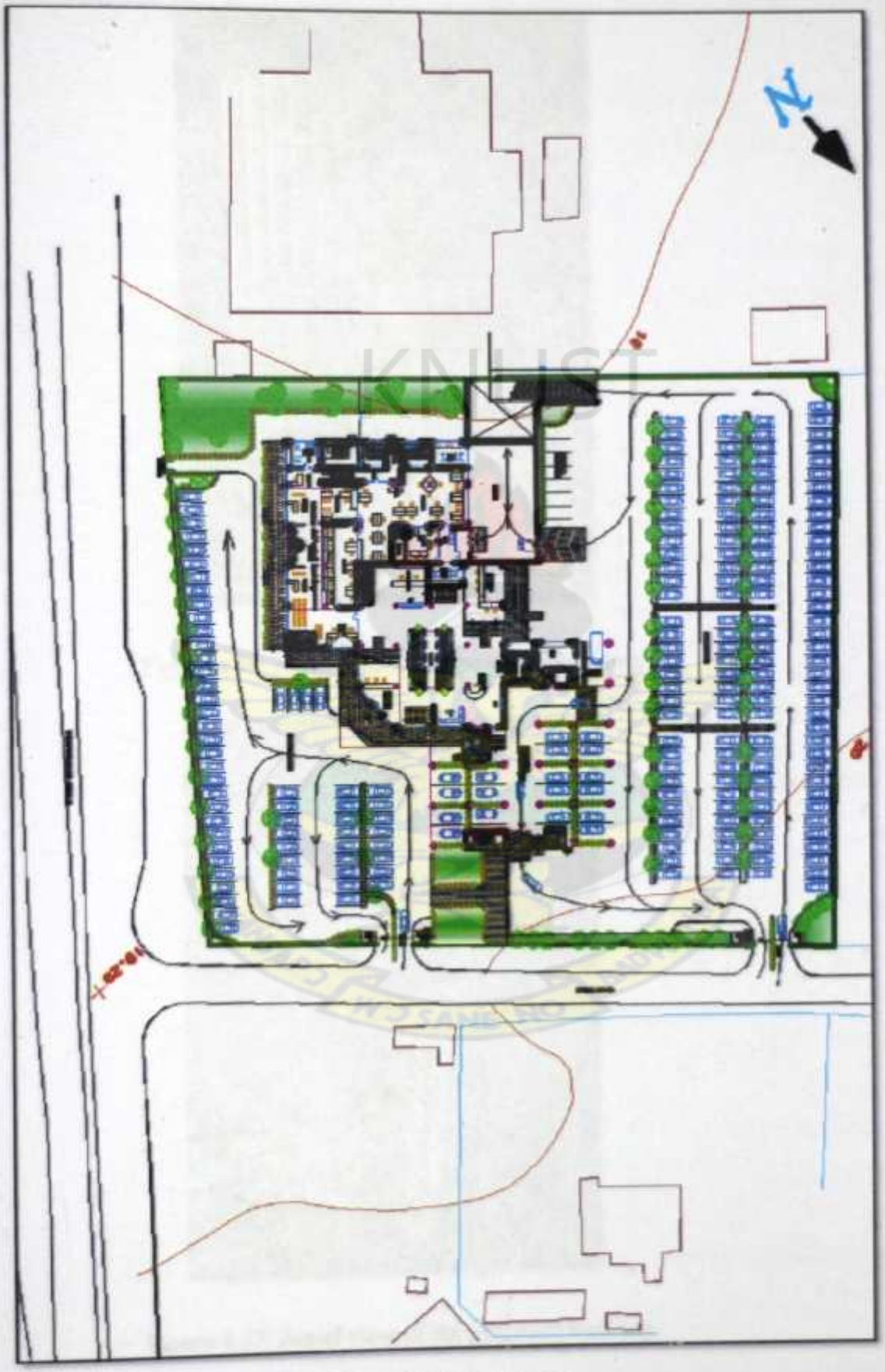

Figure 4.35: Site layout

Figure 4.36: Night view of the proposed building

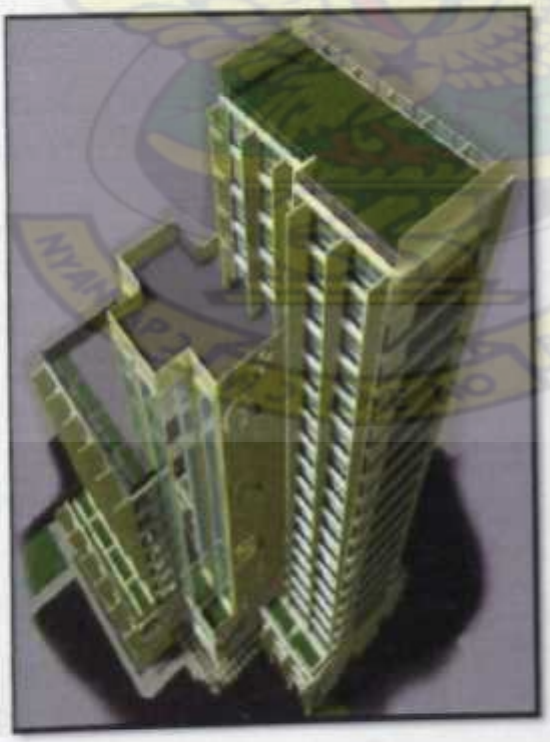

Figure 4.37: Aerial view of the proposed building

4.11.2: THE STRUCTURE:

Structural type: The structure is a simple post and beam form of building structure. It is the skeletal form of structure where by the columns reduces in diameter from height to height at 6670mm centre to centre and 7500mm centre to centre.

Structural material: The material used for the structure is reinforced concrete. The columns start 1000mm diameter from the basement and ends at 400mm diameter at the top most floor. The beams dimensions are 400mm by 750mm including the floor slab.

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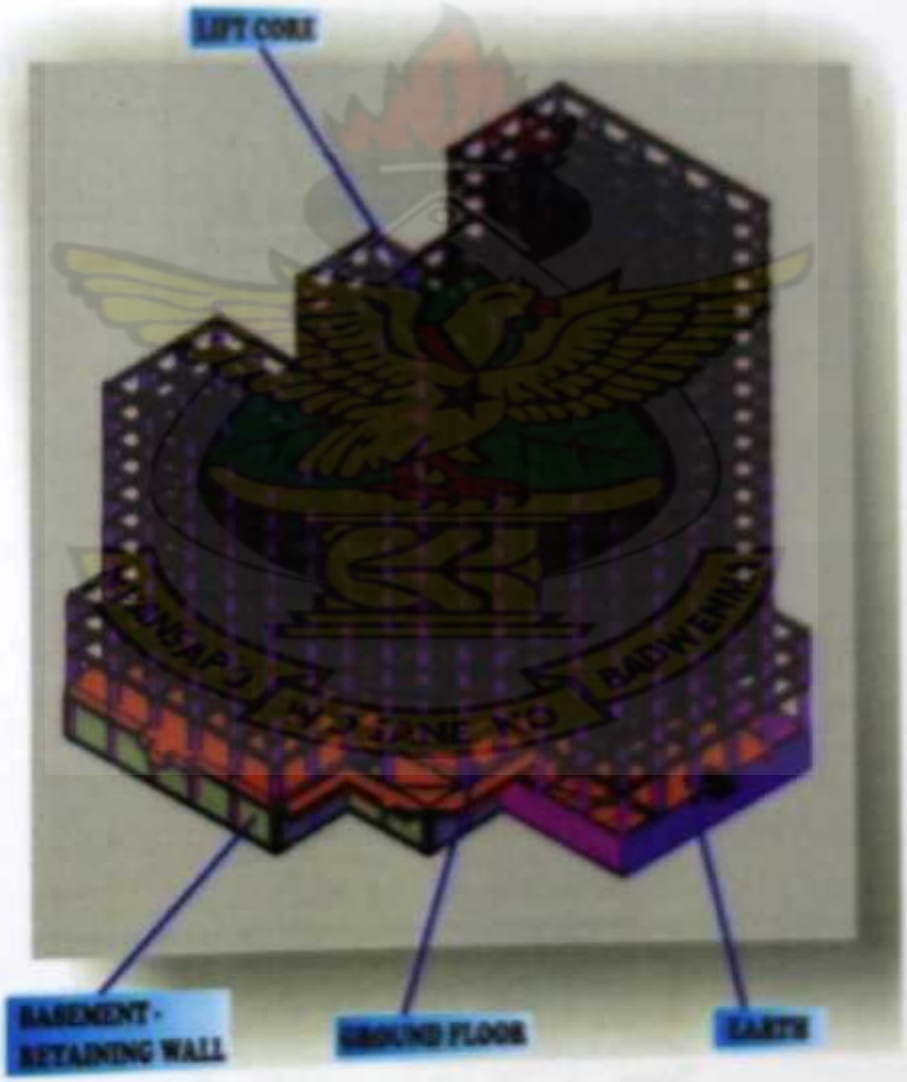
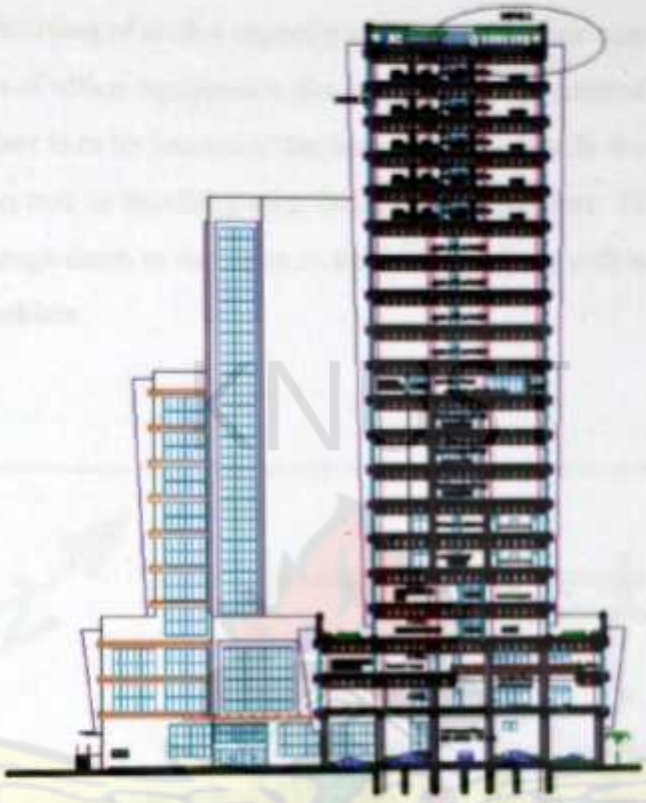


Figure 4.38: 3D of the structure

section x-x

section y-y



section z-z

4.11.2: THE SERVICES:

The services core of the building is located at the basement of the building. It has the following:

- Central air conditioning plant room
- Air conditioning chillers room
- Underground water storage
- Water pumps room
- Life motor rooms
- Electricity control room
- Solar batteries room
- A vault for the bank
- Stand-by generators

The services involved in the design of this building are:

Air conditioning: An office building of such a capacity and status need air conditioning for human comfort and protection of office equipments like computers. The central air conditioning system was employed. The plant is to be located at the basement along with the chillers and each floor of the building has one to two air handling units located at the lift core. These handling units distribute chilled air through ducts to the vents in the ceiling, along with network cables, electricity cables and fire sprinklers.

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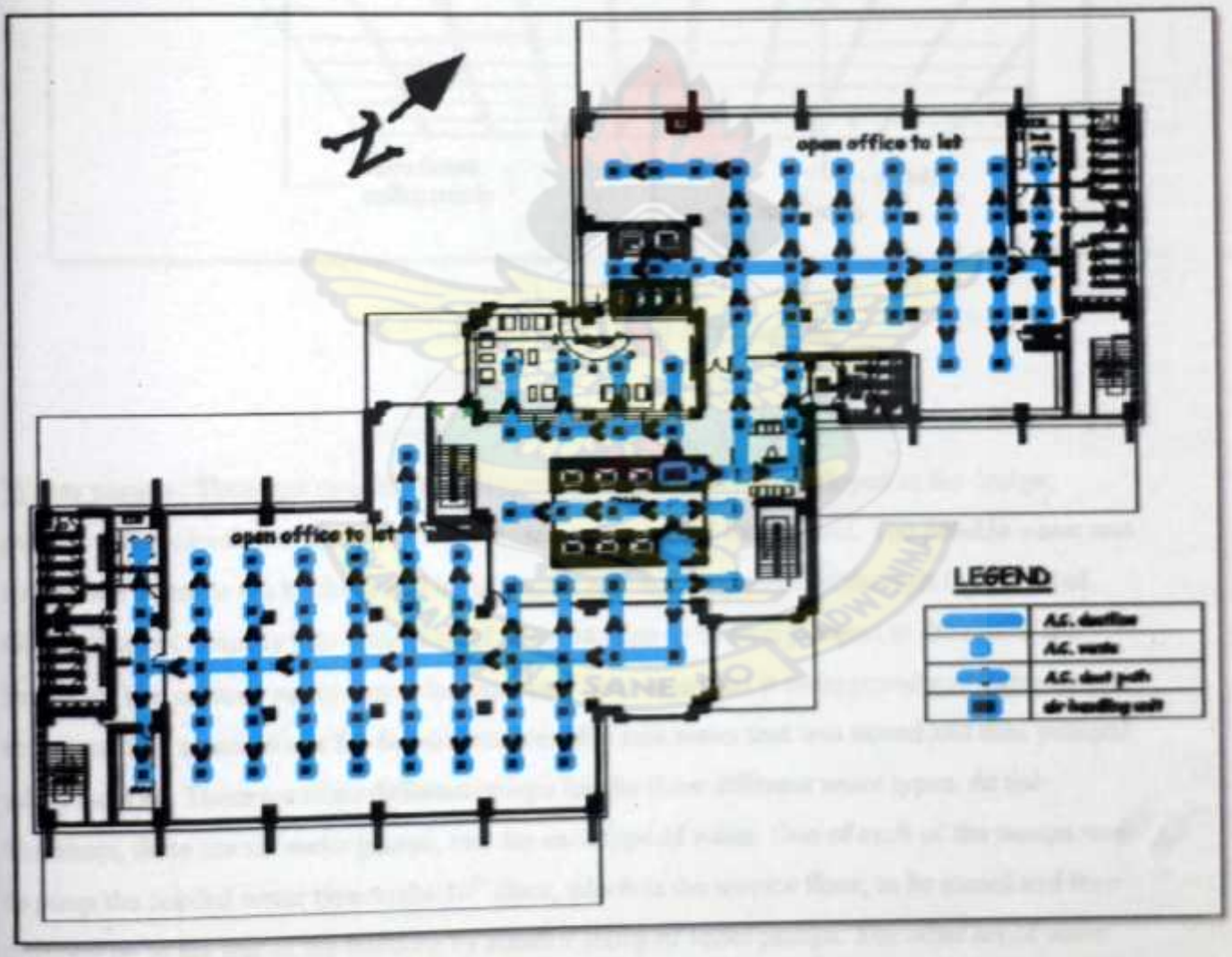

Figure 4.39: Typical plan showing air conditioning distribution layouts

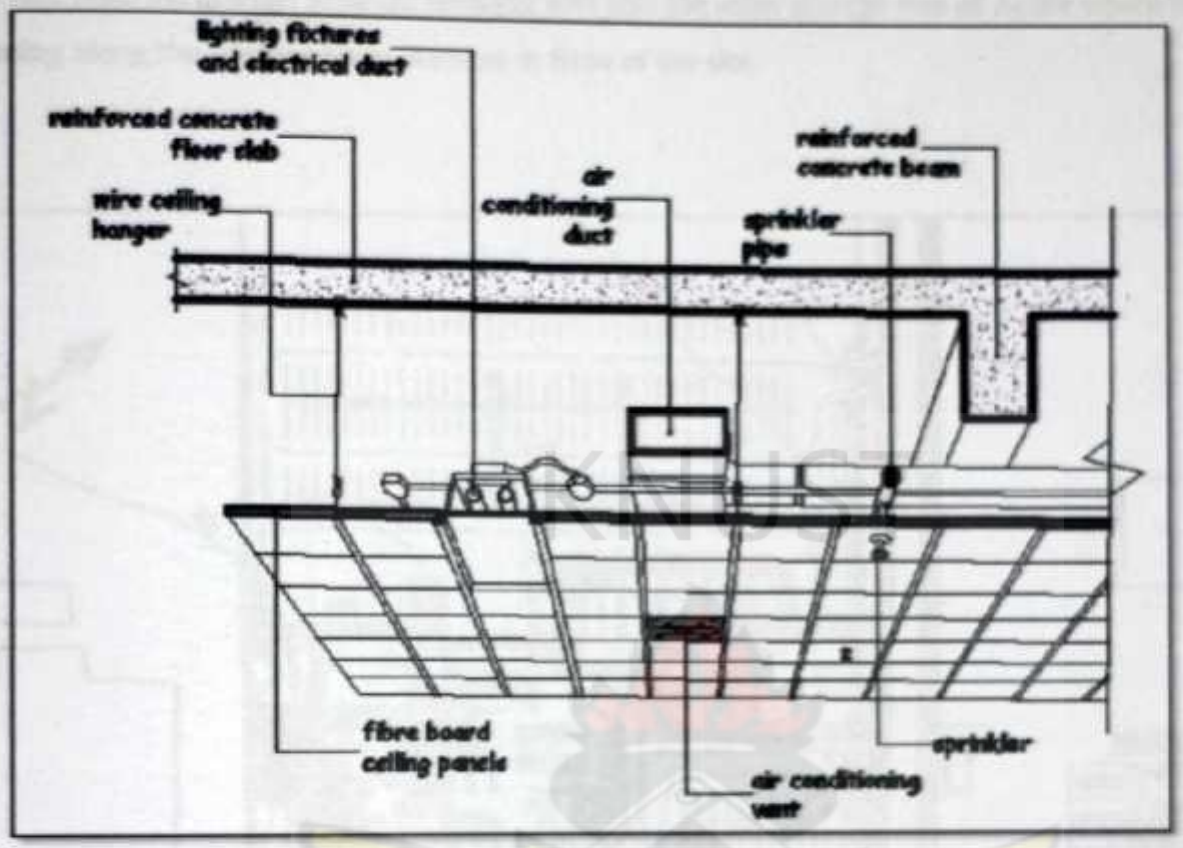

Figure 4.40: Detail of the ceiling

Water supply: There are three different types of water that were employed in the design; potable water (drinkable water), sanitary water and water for fire control. The potable water was to provide water to the kitchens and break rooms and this was supplied through the mains of Ghana Water Company into underground water storage to be then pumped to the rest of the building. The sanitary water was to be harvested rain water that is to be stored and then pumped to the sanitary areas. Water for fire control was also rain water that was stored and then pumped when need be. There are three different pumps for the three different water types. At the basement, there are six water pumps, two for each type of water. One of each of the pumps was to pimp the needed water type to the 10th floor, which is the service floor, to be stored and then pumped up to the rest of the building by another group of water pumps. The other set of water pumps at the basement is to pump the needed water to the first 10 floors of the building. Also, over head water storage is also employed.

Waste water and sewage: Waste water from the building is going to join the main drains around the site. Also the sewage from the building will join the main sewage line of Accra which in running along the Independence Avenue in front of the site.

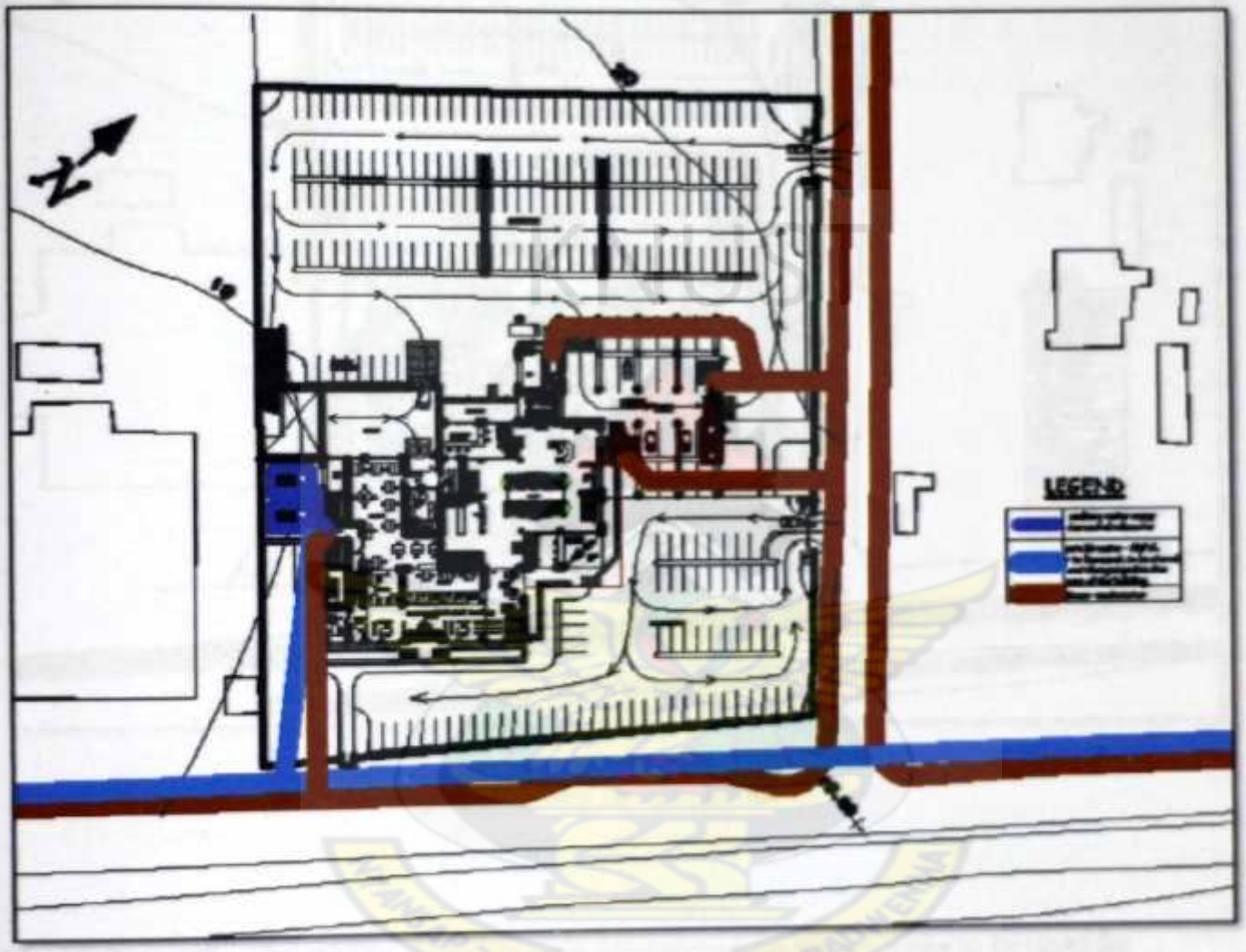

Figure 4.41: Water supply and waste water layout

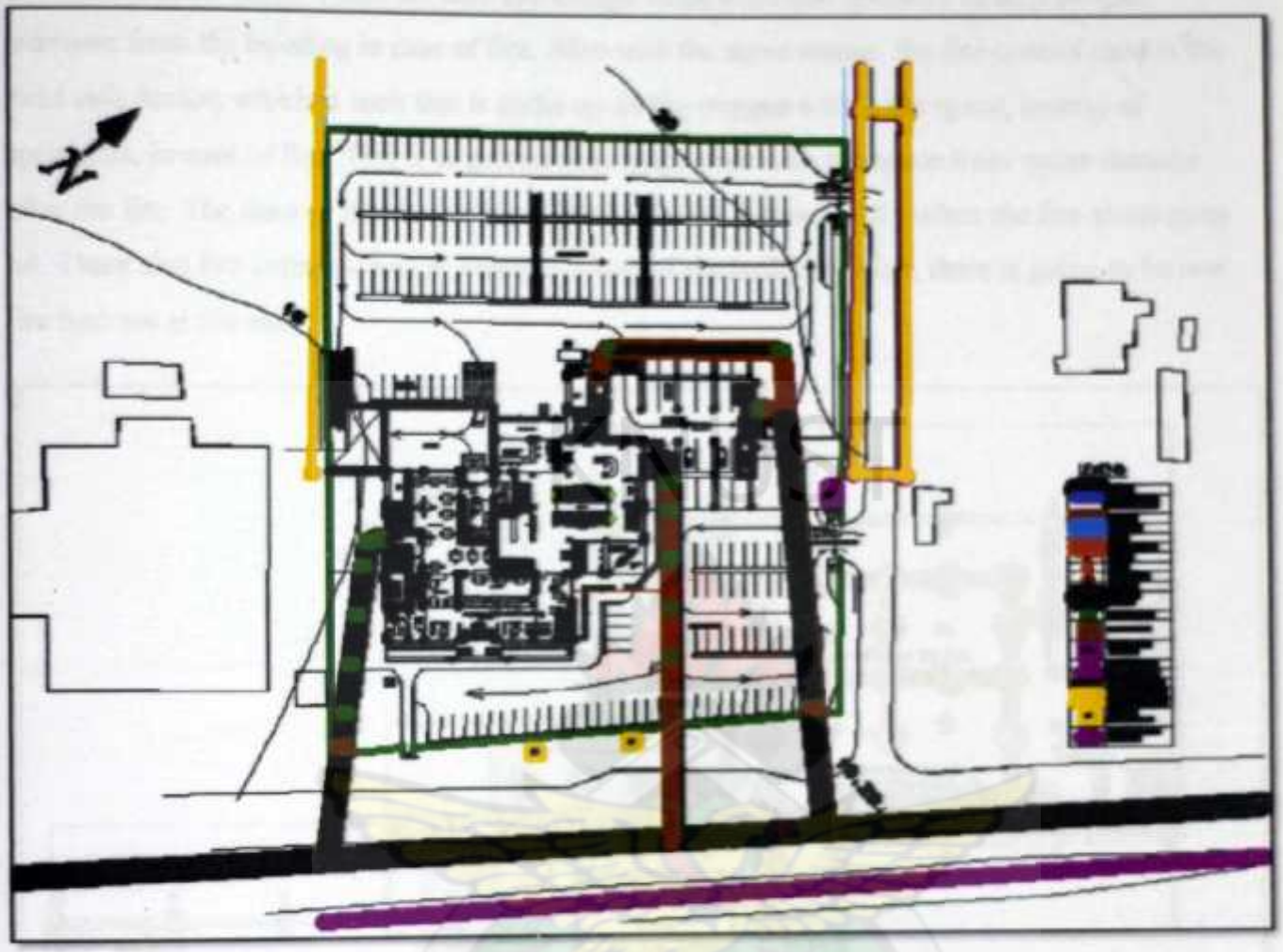

Figure 4.42: Site services layout

Electricity supply: The existing electricity main lines around the site are going to be taped for the building. There will be a transformer installed for this building alone. Also available to the building will be stand-by generators which are sited in front of the basement to control noise from the generators and vibration. To make the building a sustainable building, the author has employed the use of Building Integrated Photovoltaic (BIPV) to generate electricity for the use of the building. The main electricity control plant is located at the basement of the building and there are two electricity control duct rooms on each floor of the building.

Fire protection: Some of the fire protection mechanisms used include fire rating doors with 2 hours fire protection capacity. Also there are fire sprinklers laid out through the ceiling to be triggered by the fire and smoke alarms. There are also two fire hoses on each floor of the

building. There are two fire escape stairs on each floor and the doors open automatically at the sound of the fire alarm. There are also fire escape voice activated speakers to help people evacuate from the building in case of fire. Also with the serve rooms, the fire control used is the field safe device, which is such that it sucks up all the oxygen within the space, instead of sprinklers, in case of fire. This is to protect the equipments with the space from water damage after the fire. The door to the service room is also closed automatically when the fire alarm goes on. There also fire extinguishers at vantage points of the building. Also, there is going to be one fire hydrant at the site.

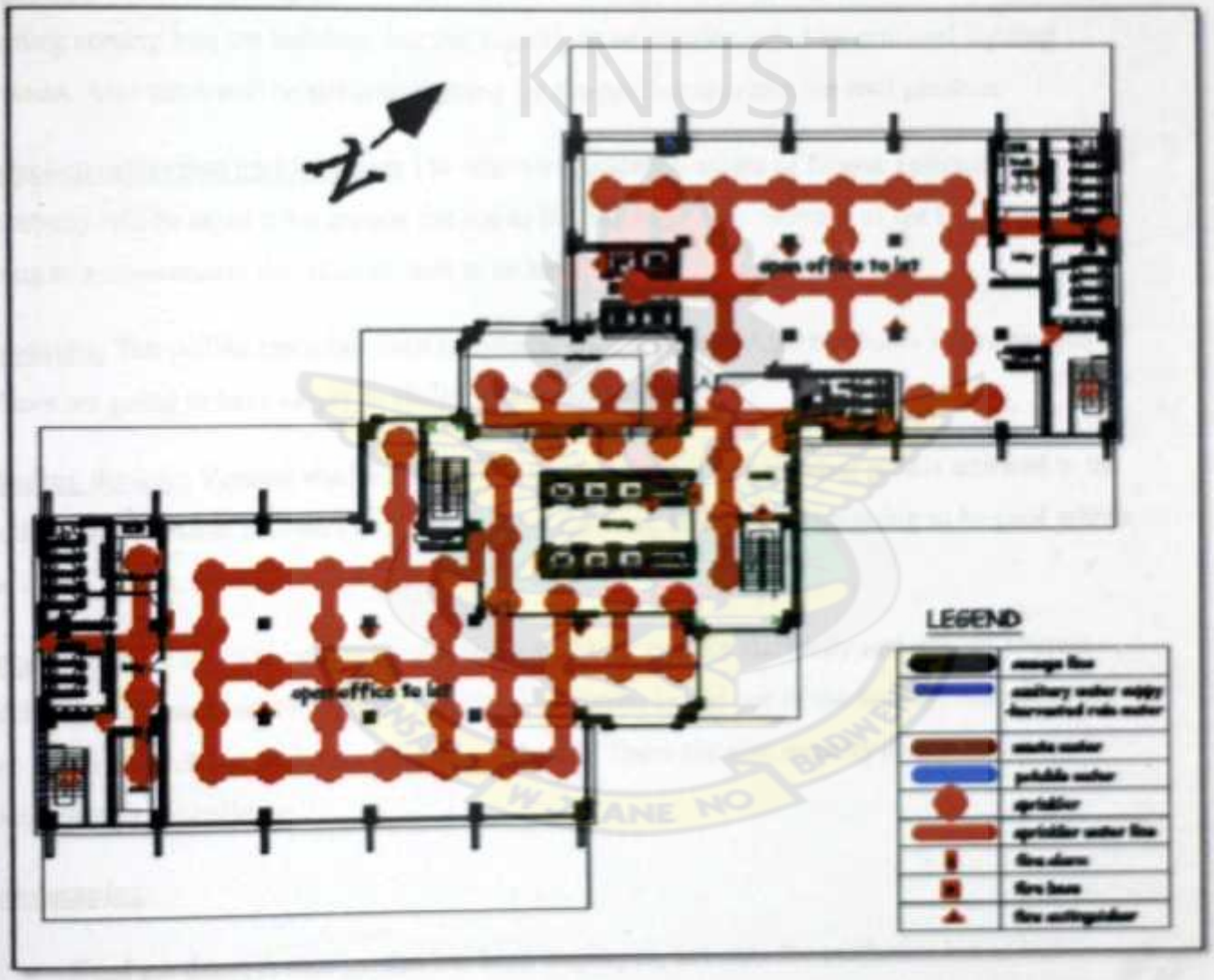

Figure 4.43: Fire control layout

Vertical circulation system: Lifts and stairs are basically used for vertical circulation within the building. There six main lifts at the core of the building to take staff and visitors of the building from one level to the other. There are also two lifts to the executive suites and two lifts for services. All these lifts have their motor room at the basement. There is a lift to the vault of the bank within the building and its motor room is at the 2nd floor. All these lift are hydraulic lifts. There are two main staircases and two fire escape stairs.

Lighting: With the glazing on the façade of the building, there is going to be a lot of natural lighting coming into the building, but this is going to be supplemented by artificial lighting systems. Also there will be artificial lighting for the parking area and the roof gardens.

Telecommunication and internet: The telecommunication mains of Ghana Telecommunication Company will be taped from around the site to the building. Also the roof of the building is going to accommodate the internet mast to be installed.

Acoustics: The ceiling materials used is acoustic ceiling panels. Also the floors of the various offices are going to have carpet to absorb and control sound.

Shading devices: Vertical shading devices have been used. They are steel panels screwed to the wall and are between 1000mm to 2500mm from the wall. Blinds are also going to be used within the office spaces.

Security: There are two main entrances to the building, one for staff only and one for visitors. Each entrance has a security post to monitor who comes in and out of the facility. Also there are two security check points for both staff and visitors. There are also security doors to various spaces within the building.

Landscaping:

- **Roof gardens:** A roof garden has been employed, not only for aesthetics but to also insulate the roof slab and to create a garden feel at the top of the building for leisure.
- **Car park:** The car park is well designed with shading trees and shrubs for aesthetics. Also, there are street and garden lights on the car park.

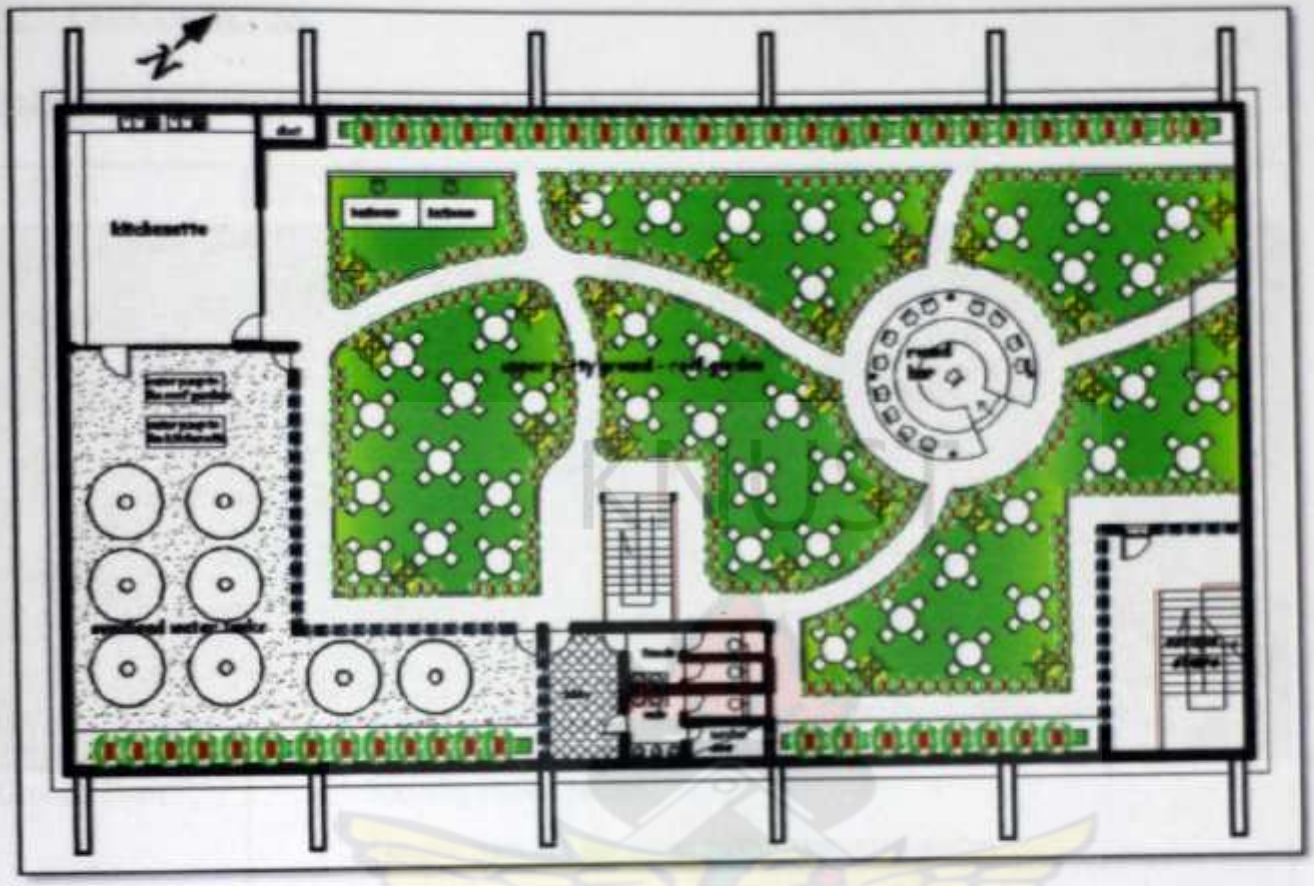

Figure 4.44: Plan of the roof garden.

4.12: CIRCULATION:

Table 4.2: Facilities on each floor of the building:

FLOOR	FACILITY
Basement	• Central air conditioning plant room • Air conditioning chillers room • Underground water storage • Water pumps room • Life motor rooms • Electricity control room • Solar batteries room • A vault for the bank • Stand-by generators
Ground floor	• Security check points • Terrace parking for guest to the executive suites • Main reception • Commercial/ Retail bank
1ST	• Excel corporate bank • G.S.E. trading floor • Offices for the exchange
2ND	• Building's administration • Security cameras control room • Offices for the exchange • Investors' lounge • Journalists' lounge

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3RD	• Offices for the exchange • Visitors' court • Convenient shop • Training centre – 3 lecture rooms, lecturers lounge, training centre administration office
4TH	• Offices for the exchange • Training centre – 5 lecture rooms, lecturers lounge
5TH	• Restaurant with a kitchen • Training centre – 2 lecture rooms, lecturers lounge, library
6TH	• Executive restaurant with a kitchen • Business centre – 2 conference rooms, 5 executive conference rooms, business centre administration office
7TH - 9TH	• Open offices to let • Offices for brokerage firms
10TH	• Service floor – water tanks with pumps, electricity control room, air conditioning plant and chillers rooms, office for engineers.
11TH -14TH	• Coffee bar • Open offices to let
15TH – 19TH	• Executive suites with kitchenettes
20th	• Roof garden restaurant or party ground with a bar, kitchen and washrooms. • Overhead water tanks with pumps

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CHAPTER FIVE

RECOMMENDATIONA AND CONCLUSION

CHAPTER FIVE: RECOMMENDATIONA AND CONCLUSION

5.0: RECOMMENDATIONS:

- Putting up such a building require a lot of funding so it is recommended that the listed companies and individual investors should come on board to invest in this building to their own benefit of profit.
- The energy requirement for such buildings are so much that it is recommended that sustainable energy sources like Building Integrated Photovoltaic (BIPV) should to incorporated into the design of such building in Ghana.
- Also the Ghana Stock Exchange should have other auxiliary facilities as it has been proposed to generate more income for the exchange.

5.1: CONCLUSION:

The proposed building when built is going to put the Ghana Stock Exchange on the world business map, thereby bringing more investors into the country. It will also serve as a sense of economic security and a hub of growing business mind in Ghana.

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- **Wikipedia – the free Encyclopaedia**
- **Bank Builders by Edwin Heathcote**
- **Architect' Data, by Ernst and Peter Neufert - third edition**
- **www.gse.com.gh** - The website for Ghana Stock Exchange
- **www.londonstockexchange.com** - The website for London Stock Exchange
- **www.nyse.com** - The website for New York Stock Exchange
- **www.pvresouce.com** - The website for the Building Integrated Photovoltaic (BIPV)

APPENDIX

Securities: They are financial instruments used to trade on the stock market.

Bonds: Bonds provide a way for companies to borrow money. Companies obtain funds when they initially issue bonds. As with the initial issue of stocks, companies use the services of investment banks in primary market transactions for bonds. Once issued the bonds are then traded in secondary markets or on exchanges and the company is no longer directly involved.

Stocks: Stocks are shares of ownership in companies. People who buy a company's stock may receive dividends (a portion of any profits).

Brokers: A stockbroker is an employee of a brokerage firm. The individual investor contacts his or her stockbroker and provides the stockbroker with the details of the transaction the investor wants to complete. Stockbrokers, however, are more than order takers or sales representatives for their firms; they frequently provide advice to the investor. They may have their own client list and call clients when they see transactions that will fit the client's investment objectives. Stockbrokers almost always have certification from, or registration with, a state government agency or an exchange or both. For this reason they are sometimes referred to as registered representatives.

Specialists: They are coordinators on the trading floor of the exchange.