SENATE BUILDING

HERITAGE UNIVERSITY KADUNA

ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN

BY

HAMZA BABANGIDA (B.Sc Hons)

A THESIS PRESENTED TO THE POST GRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc) (Arch) DEGREE IN ARCHITECTURE.

DEPARTMENT OF ARCHITECTURE

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY

ZARIA

OCTOBER 1998

DECLARATION

I do hereby declare that the work in this dessertation has not been presented for any other degree, it is the product of my own research, and that all quotations, and sources of informations have be duly acknowledged.

HAMZA BABANGIDA

04/11/1998
Date

D E D I C A T I O N

To my father ALHAJI HAMZA MOHAMMED K-BAY and my Late mother INDO AISHA whose prayers kept me going.

May Almighty ALLAH reward you both with JANNAH, Ameen.

BABANGIDA

C E R T I F I C A T I O N

This Thesis entitled SENATE BUILDING FOR HERITATE UNIVERSITY, KADUNA, ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN, meets the requirements governing the award of the degree of Master of Science (M.Sc Arch) in Architecture of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Chairman, Supervisory Committ	Date
Member, Supervisory Committee	4-11-98 Date
Member, Supervisory Committee	Date
Head, Department of Architecture	Date
Dean, Post Graduate School	22/07/99 Date

AK N O W L E D G E M E N T S

My sincere gratitude goes to my Project Supervisor DR W.B. QURIX for his criticism and advice towards the succes of this dessertation.

I also wish to express my gratitude to the members of my Supervisory Committee i.e Arc ABDULKARIM, (H.O.D), Arc MBINA and Arc A.K. YEBOAH for the advice given to me during the course of this project.

Special thanks goes to the Administrative Staff of the Heritage University Planning Secretariat, Kaduna, for the assistance rendered to me towards the success of this project.

My deep appreciation also goes to the staff of the ABU, Senate building, and University of Lagos Senate House who were kind enough to supplied me with the necessary plans for my case studies.

Friends and class mates also helped in one way or another towards the success of this work, these are; SHAMSUDDIN GIWA, HARUNA LAWAL, ABUBAKAR SADEEQ YUSUF, MANSIR M., RUKAYYA TUKUR, TIJJANI M. MODI SULE ZANGO, KUFUNG-R

and host of others too numerous to mention, the last but not the least is Mr ZAKARI M.J. KUCHA of the Department of Architecture who did the excellent job of typing the manuscript.

I say a big "thank you" to my brothers for the support in one way or another especially DR AHMED TIJJANI HAMZA, Mal. ABDULKADIR HAMZA and Engr. KABIR HAMZA.

BABANGIDA

A B S T R A C T

Solar Radiation incidant on a building causes great discomfort especially here *in* the tropic, due to the transmission of the solar energy in form of heat through the external walls and openings by the process of conduction.

As a result of the Above, Architects employed means of controlling this problem through the use of active elements of design, e.g use of Air conditioners to control neat gain by cooling the interior, the use of artificial lighting when a deep planning concept is adopted etc,

However, the aim of this dissertation is to explore and evolve means of controlling this and other forms of energy e.g Wind, Sound, etc which affect building "Architecturally". By using and employing passive elements, i.e choice of plan shapes, forms, type of materials, choice of finishing construction techniques, use of building components, orientation of the building to the sun and to the wind, percentage openings (Fenestrations), landscaping, and choice of a suitable sun shading devices that will serve the purpose on Shadiag as well as to enhance the elevations..

TABLE OF CONTENTS

Contents		Page
Title page	....	i
Dedi[illegible]	....	ii
Declaration	....	iii
Certification	....	iv
Aknowledgements	....	v
Abstract	....	vi
Table of Contents	....	vii
List of Figures	....	viii
List of Plates	....	ix
List of Tables	....	x
CHAPTER ONE		
1.0 INTRODUCTION	....	3
1.1 Research area: achieving control of energy through Architectural design	..	4
1.2 Motivation	....	5
1.3 Aims and Objectives	.....	6
1.4 Scope/Design Task	.....	8
1.5 Research Methodology	.....	8
1.6 Research Constraint	.....	10
CHAPTER TWO		
2.0 REVIEW OF RELEVANT LITERATURE	.....	13
2.1 University education and its economic relevance to Nigerian development	.....	16
2.2 Administrative Structure of Nigerian Universities	....	17
2.2.1 The Visitor	....	18
2.2.2 The Chancellor	....	19
2.2.3 Pro-Chancellor	....	19
2.2.4 The Vice Chancellor	.....	20
2.2.5 Deputy Vice Chancellor	.....	21
2.2.6 The Registrar	....	22

2.2.7 The Bursar 22
2.2.8 The Librarian 22
2.2.9 University Organogram 23

2.3.0 ADMINISTRATIVE BODIES OF NIGERIAN UNIVERSITIES

2.3.1 The Council 24
2.3.2 The Senate 25
2.3.3 Faculty Board 26

2.4.0 ADMINISTRATIVE STRUCTURE OF HERITAGE UNIVERSITY, KADUNA

2.4.1 The President 27
2.4.2 The Registrar 27
2.4.3 The Financial Controller 28
2.4.4 The Librarian 28
2.4.5 Dean Students Affairs 28

2.5 MISSION OF HERITAGE UNIVERSITY, KADUNA

2.5.1 Aims and Objectives 29

2.6 CLASSIFICATION OF NIGERIAN UNIVERSITIES

2.6.1 Conventional Universities 30
2.6.2 Federal/States Universities 31
2.6.3 Federal Universities of Agriculture 31
2.6.4 Military Universities 31

2.7 PLANNING CONCEPTS IN NIGERIAN UNIVERSITIES

2.7.1 Close Knit Concept 32
2.7.2 Loose tie Concept 34
2.7.3 Ring Concept 34
2.7.4 Segregated type concept 39
2.7.5 Campus Systems Operated by Nigerian Universities 36
2.7.6 City-Heart Campus System 36
2.7.7 Multy-Campus System 36
2.7.8 Sub-Urban Campus System 37
2.7.9 Urban Campus System 37

2.8 THE SENATE BUILDING IN NIGERIAN UNIVERSITIES

2.8.1 Location 38

2.9 ENERGY IN BUILDINGS

2.9.1 Energy control policy in France 41
2.9.2 Energy control policy in Italy 42
2.9.3 Nigeria's position on Energy control 43

3.0 CASE STUDIES AND PHYSICAL CHARACTERISTICS OF STUDY AREA

3.1 INTRODUCTION 48
3.2 AHMADU BELLO UNIVERSITY, ZARIA 48
3.2.1 Location (Senate) 49
3.2.2 Design Appraisal 50
3.2.3 Design Criticism 52

3.3.0 ENERGY CONSIDERATION .....
3.3.1 Solar Energy 53
3.3.2 Wind Energy 54
3.3.3 Sound Energy 55
3.3.4 Electrical Energy 55
3.3.5 Mechanical Energy 57

3.4 ABUBAKAR TAFAWA BALEWA UNIVERSITY, BAUCHI

3.4.1 Location 61
3.4.2 Design Appraisal 62
3.4.3 Design Criticism 62

3.5 ENERGY CONSIDERATION .....
3.5.1 Solar Energy 64
3.8.7 Temparature sun shine 85
3.8.8 Wind 88
3.8.9 Relative Humidity 89

3.9 SITE ANALYSIS ....
3.9.1 Site selection 91
3.9.2 Accessibility 91
3.9.3 Other services 92
3.9.4 Microclimate 95
3.9.5 Topography 95

3.9.6 Vegetation 45
3.9.7 Source of noise 96
3.9.8 Orientation 96
3.9.9 Sun path and traces winds 96

4.0 ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN .....
4.1 INTRODUCTION 101
4.2 ENERGY (Concept) 102
4.2.1 Sources of Energy 103
4.3 TYPES OF ENERGY AND THEIR EFFECTS ON BUILDINGS
4.3.1 Electrical energy 105
4.3.2 Wind energy 112
4.3.3 Sound energy 119
4.3.4 Solar energy 125
4.3.5 Human energy .... [illegible]
4.3.6 Mechanical energy ..... [illegible]

4.4 PASSIVE DESIGN CONSIDERATIONS FOR ENERGY CONTROL ....
4.4.1 Siting and orientation of buildings 135
4.4.2 Building shape 138
4.4.3 Nature of envelope 141

4.5 BUILDING COMPONENTS USED FOR ENERGY CONTROL ....
4.5.1 Window Treatment 145
4.5.2 Insolation .... [illegible]

4.6 ENERGY CONTROL EQUIPMENTS IN BUILDINGS
4.6.1 Electrocomp energy computer ..... [illegible]
4.6.2 Fuel cells .... [illegible]
4.6.3 Energy monitors (Electric) ..... [illegible]
4.6.4 Heat Detector .... [illegible]

CHAPTER FIVE

5.0 THE DESIGN PROPORSAL AND REPORTS .....
5.1 PLANNING CONCEPT 154
5.2 SITE ZONING CONCEPT 156

5.2.1 Based on Accessibility 155
5.2.2 Based on Noise Control 155
5.2.3 Based on Functionality 156
5.3 DESIGN BRIEF 156
5.3.1 Office of the President 158
5.3.2 Office of the Registrar 158
5.3.3 Office of the Finance Officer 159
5.3.4 Senate Chamber 159
5.4 SCHEDULE OF ACCOMMODATION .....
5.4.1 Office of the President 159
5.4.2 Office of the Registrar 160
5.4.3 Office of the Finance Officer 161
5.4.4 Senate Chamber 162
5.5 DESIGN CONCEPT ....
5.5.1 Plan concept 162
5.5.2 Elevational concept 165
5.6 DESIGN PROPORSAL (Report) 168
5.6.1 Block 'A' 168
5.6.2 Block 'B' 170
5.7 DESIGN PHILOSOPHY (Energy control measures considered) .....
5.7.1 Solar energy 172
5.7.2 Wind energy 175
5.7.3 Sound energy 176
5.7.4 Electrical energy 176
5.7.5 Mechanical energy 177
6.0 CONCLUSION/RECOMMENDATION. 201
BIBLIOGRAPHY 203

LIST OF FIGURES

3.0	Master plan of Ahmadu Bello University Zaria, showing buildings and road network	49
3.1	Ground floor plan of ABU Senate building	53
3.2	Section of ABU Senate building	54
3.3	First floor plan of ABU Senate building	56
3.4	Second floor plan of ABU Senate building	57
3.5a	Third floor plan of ABU Senate building	58
3.5b	Fourth floor plan of ABU Senate building	58
3.6a	Seventh floor plan of ABU Senate building	60
3.6b	Eighth floor plan of ABU Senate building	60
3.7	Master plan of ATBU Bauchi showing buildings and road network	61
3.8a	Ground floor plan of ATBU Administrative building (VC's Block)	61
3.8b	The front of the VC's block of atbu Administrative building	63
3.8c	The Rear elevation of the VC's block of ATBU Administrative block	63
3.8d	First floor plan of ATBU Administrative building	64
3.9	Master plan of University of Lagos Senate House	67
3.9a	Section through the Senate House University of Lagos	69
3.9b	Section through the Bursary	70
3.9c	First floor plan University of Lagos Senate House	71
3.9d	Second, third, and fourth (typical) floor plans of Unilag Senate House	72
3.9e	Nineth to twelth floor plans of Unilag Senate House	74
3.9f	The last floor University of Lagos Senate House....	76

LIST OF PLATES

3·0	The Approach of ABU Senate building, Zaria	61
3.1a	The Approach of ATBU Administrative building	63
3.1b	The Rear of ATBU Administrative building	63
3·2	The Approach of University of Lagos Senate House	68
3·3	University of Lagos Senate building from parking Area,	73
3·4	Road leading to the site Area.	92
3.5	Railway line from Kano which passes close to the Site	93
3.6	High Tension National Grid line which passed close to the Site	94
3.7	Double carriage road linking the site area to the main Kaduna expressway	95
3.8	Vegetation type of the site	97
3.9	Part of the road that lead to the site	97
4·0	Active control and Generation of Energy in a Nuclear station	100
	Fuel cell used for providing energy requirements of Building	
4·4	Solar Glass wall to regulate solar Radiation	151
4·5	Tapes of Heat energy defector in Buildings	151

LIST OF TABLES

2.0	Percentage distribution of education to GDP in Nigeria (1962 - 1980)	18
2.1	Nigeria's University (system) Organogram	25
3.0	Table Showing Total (average) Annual Rainfall of Kaduna.	84
3.1	Table showing mean temparature and sun shine hours of Kaduna.	86
3.2	Table showing the prevailing wind directions in Kaduna.	88
3.3	Table showing mean Annual Relative Humidity (%) for Kaduna	90
4.0	Energy flow chart of Mechanical Plant Capacity.	112

CHAPTER ONE

"ARCHITECTURE IS A COMPLEX UNDERTAKING INVOLVING TECHNICAL, SOCIAL AND UTILITARIAN AND CULTURAL PROBLEMS. IN SHORT, IT IS THE SYSTEMATIC ARRANGEMENT OF KNOWLEDGE, IT INVOLVES THE MAKING OF BEAUTIFUL FORMS, ORDERING SPACE IN A COHERENT MANNER, USE OF MATERIALS IN A FUNCTIONAL AND KNOWLEDGE-ABLE WAY AND PROVIDING COMFORT AND CONVE-NIENCE FOR ITS CLIENTS AND THEIR ACTIVITIES"

C. McDONALD

Chapter One

1.0 INTRODUCTION

Since independence, the Federal Government has been shouldering responsibility of establishing Universities as well as funding them, with few enceptions where State Governments established their own States University, some of which the Federal Government took over as a result of the State inability to fund them adequetly.

The Federal Government thus acquired more Universities than it can adequately cater for financially, hence the government call for direct and full participation of the private sector in the development of high quality Higher Education in the country.

As a result of the above call, and in line with the provisions of the Decree No. 9 of January 1993 and taking into consideration the National University Commission (NUC) and Federal Government of Nigeria (FGN) Guide lines, some public spirited and concerned Nigerians are proposing a first privately owned, run, and maintained conventional university to be known as Heritage University, Kaduna. The university is to be located in Kaduna, Kaduna State.

The university is at the planning stage, now its successful growth, will no doubt depends on the efficiency of its administrative system. This efficiency can only be

achieved within a suitably organised environmental setting thus it has become necessary to have a Senate Building for the Administrative staff.

The Senate Building is to be the seat of the Administrative unit of the University and the Governing Council, it is also seen as a common property for the academic components of the University, with each unit or department looking up to it for the solution of one problem or another.

1.1 RESEARCH AREA:- ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN

When the technology of using energy in buildings was discovered, Architects and Designers developed the ability to house people and activities in a different way, to that before the energy was available; in that, problems of heat loss, solar heat gain, lighting, cooling, vertilation etc were overcome through the use of mechanical, electrical, and other forms of energy by

In Nigeria. However, it is becoming increasingly difficult to maintain and man the major source of our electricity power i.e the Kainji Installation, due to that

there has always been epileptic supply of this energy, hence reliance of electric energy for comfort of office users is no longer realistic

The solar radiation, which causes great discomfort in a building envolope, the menance of wind energy, on our buildings especially the roof, coupled with a lot of other problems on the use of the energy both within and building fabric has actually called for a review of these designs.

In this regard, energy conscious design have become imperative to the Architects for prospective clients, this research aims therefore at proposing a an energy conscious design of the Senate Building, which will not rely on active elements for comfort both withing and without the structure.

1.2 MOTIVATION

Architects are increasingly employing the concept of deep planning in their designs i.e design that work or rely wholly on the use of active elements e.g Artificial lighting, Air conditioning, and a lot of others, this concept is alien to Nigeria, hence it causes serious hardship to the occupants, which sometimes lead to either

vacating of the building when in use e.g Kashim Ibrahim Library (KIL), Ahmadu Bello University (ABU), Zaria, where there is no light or even a complete abandonment of the building.

These hardships are generally in the form of finance, especially now that there is astronomical increase in power bill, not many people can afford to buy the mechanical gadgets to keep them cool, or warm, in addition to what one pays as rent.

Also, our limited technology to man these energy sources and distribution has also contributed to the motivation of this research. Nigeria is not technologically advanced as to be able to employ other sources of energy.

In essence, the above factors gave rise to the choice of this research topic, with a view to reviewing these designs to achieve comfort as much as possible naturally, through Architectural design.

1.3 AIMS AND OBJECTIVES

The primary aim of this project is to evolve a design that will provide the desired comfortability within

the building envelope, using, i.e through natural means.

The Senate Building of this University has been chosen for this purpose because of its position as enumerated earlier. In addition to the highlighted points, Senate is also meant to:

i. To provide for office accommodation for the Administrative staff of the University.

ii. This office will be a monumental complex beffiting the University, since it is expected to extend the image and the position of the University to the larger community.

iii. To enhance mutal interaction and unity among the workers.

iv. To provide other accommodation to meet present and future needs of the University.

v. To suggest ways of improving the efficiency of these energy supply system within the building envelop.

The main objective hence is to provide an

efficient and standard Administrative building that will facilitate the speedy growth of the University.

1.4 SCOPE/DESIGN TASK

As stated earlier, the Senate Building proposal is to accommodate the administrative core of the University this include:

i. The Presidents' Office (referred to as Vice - Chancellor in Public University).

ii. The Registrars' Office which includes registry for general administration of the University.

iii. Senate Chamber, where meetings of the University's Senate will be taking place.

iv. The Finance Officers' office (Bursar), and the general finance offices for the day-to-day account of the University.

1.5 RESEARCH METHODOLOGY

Most of the text books consulted provided general information about energy, but Journals on building technology are more specific about energy in building, hence

materials used were mainly through library research and field work, these are as follows:

i. Text books

ii. Journals, and Seminar papers

iii. Encyclopedia of Energy

iv. Case studies of existing senate building

v. Personal observations/discussions with Authorities of the University.

The library research includes as explained, where through books, literature review, Architectural Journals, papers etc while personal observation include a critical appraisal of senate building of some Nigerian Universities. This is with the aim of understanding the design concept and approach in regard to energy consideration by the Architects.

Analysis of environmental climatic data's was carried out to abreast the author with the prevailing Micro and Macro level of the site, this will go a long way to shaping the form, and concept of the design.

Questionnaire was not used because it is not required in this context since the design proposal is on the pipeline hence there is no need to sample opinions.

1.6 RESEARCH CONSTRAINT

Problem was encountered in securing a foreing case study of design on senate building, However, the three case studies obtained in Nigeria were enough for the thesis design criticism and appraisal considering their design concepts and energy considerations.

C H A P T E R T W O

"ARCHITECTS NEED TO DEVELOP IN A SIMILAR MANNER. A MANIPULATIVE ABILITY OF THE CONCEPTS OF ENERGY (CONTROL) IN ORDER THAT THEY INCLUDE THE CONCEPTS IN THE BASIC EQUATION OF THE DESIGN, RATHER THAN REGARD THEM AS A SUBJECT WHICH CAN BE APPLIED TO THE END PROCESS OF A DESIGN.

C. McDONALD

Chapter Two

2.0 REVIEW OF RELEVANT LITERATURE

The demand for a University education in Nigeria started long before Independence. In the 1930s, from the African intellectuals and forefront nationalists. The colonialist would not budge until 1934 when they establish the first Institution of Higher Learning in the country, i.e the Yaba College of Technology.

This college either deliberately or otherwise failed to serve the purpose of which it was established hence the yearnings for a full fledge University continued, increasing daily from different quarters.

The above demand was resposbile for the setting up of a panel called elliot Commission to study the possibility of setting up a University by the colonial masters. However, the commission was to report back to the colonialist their findings

The commission presented a repoer in favour of establishing a University, hence the colonialist, upgraded the Yaba College of Technology to, a University college Ibadan. The University was later to become fully autonomous as a result of its initial relationship with University of London.

The establishment of this University triggered another series of calls, for creation of more Universities immediately after Independence (1962), but this time it was from the Nigerian people to there political leaders. They were calling for a balanced distribution of University in the country so that no part of the country is left behind in terms of educational development. A permanent commission was then created called National Universities Commission to coordinate, and ensure a balanced developments and growth of the University education in Nigeria.

The civil war of Nigeria between 1967 and 1970, lead to the creation of more states in the coutnry, as it was meant to, the states so created helped to develop the areas very rapidly, but this development was realised can only be possible if the people of the area are educated, this realisation tend to or demands of more Institutions of higher learning so as to help train indegenes of the area. This saw the establishment of University of Benin in 1970, Bayero University, Kano, University of Calabar, University Iloring, Unimaid, Unijos, and Usman Danfodio University, Sokoto (1975)

The above Universities came much later after the establishment of the first Generation of Nigerian

Universities, which are University of Nigeria Nsukka (1960), University of Lagos (1962), Ahmadu Bello University, Zaria (1962) and the University of Ife in 1962

The oil boom of the 1970s, and the need for skilled and professional manpower lead the Federal government's decision to create seven more Universities of Technology, and spread them evenly in the country, these Universities include:- Federal Universities of Technology; Bauchi, Makurdi and Owerri (1980) Yola, and Akure (1981), Abeokuta and Minna (1983),

State governments with a very large number of students, and who can afford to established their own States Universities, with the sole aim of catering for their own candidates. These states include:- River State University of Technology, Imo State University, Bendel Ondo, Ogun, Lagos, and Cross River States Universities.

A military training institution was converted to a full fledge degree awarding University, in the late 1980s. This is solely responsible for the training of junior officers, that graduate with a rank of a degree equivalent i.e the second leiutenant (2nd Lt), the University is located in Kaduna and is called the

Nigerian Defence Academy (NDA).

2.1 UNIVERSITY EDUCATION AND ITS ECONOMIC RELEVANCE TO NIGERIA'S DEVELOPMENT.

University education in any economy especially a developing economy like Nigeria has positive economic relevance especially in the development of Human and Natural resources, and even boost national income which is normally represented by the Gross Domestic Product (GDP) of a country.

A study was carried out on fourth national development Plan, for the Federal Government of Nigeria by the Federal Ministry of Finance to assess and to establish the level of contribution of University education in terms of GDP from 1960 to 1980s bearing in mind that this was the period that witness the establishment of most of Nigerias Universities.

Year	1962-70	Year	1971-80
1962/63	2.7	1971/72	2.6
1963/64	2.7	1972/73	2.5
1964/65	3.0	1973/74	2.3
1965/66	2.9	1974/75	2.6
1966/67	3.1	1975/76	2.9
1967/68	3.0	1976/77	3.2
1968/69	3.0	1977/78	3.6
1969/70	3.0	1978/79	4.0
1970/71	3.1	1979/80	4.4

Table 1: Percentage contribution of education to GDP in Nigeria 1962 - 1980

Source: FGN Fourth National Development Plan Vol.I pp.11-62 1981

From above we can see that the highest GDP recorded was in the year 1979/80 with a value of 4.4 while the least was in the year 1973/74 with a GDP value of 2.3

Apart from the above, the other figures do not show any significant difference, or any improvement over time, this is an indicator that more efforts need be put to enhance or improve what was recorded earlier. This effort basically should be in terms of funding; and private participation which is why some concerned Nigerians are proposing a privately run and funded University, i.e Heritage University, Kaduna.

Another way of measuring the imput into the economy of the University education is to consider the total output in terms of earnings of the educated and relate it to the yearly tern over from other sectors, this will help to conclude and establish the economic importance of the University education in contemporary Nigerian economy.

2.2 ADMINISTRATIVE STRUCTURE OF NIGERIAN UNIVERSITIES

Generally, the federal and states universities have the same administrative structure. The following officers are involved in the administration of a University.

the State Governor, or Administrator of the State i.e the chief executive of the State.

iii. By virtue of their positions, they automatically assume the leadership (ceremonial) of the University.

iv. The visitor make or confirm appointments of the Chancellor, Pro-Chancellor, and Vice Chancellor after due consultations.

2.2.2 The Chancellor

i. Traditional rulers (mostly first class) are normally appointed as Chancellor of the University.

ii. Main function, is to preside over ceremonial occassions e.g convocations, orientations etc.

iii. As explained earlier, he is normally appointed by the visitor of the University.

2.2.3 Pro-Chancellor

i. The main function of the Pro-Chancellor is to serve as the Chairman of the University's Council, which is the highest ruling body of the University.

ii. Appointed by the visitor of the University.

iii. Pro-Chancellor is normally an eminent figure

i. The Visitor

ii. The Chancellor

iii. The Pro-Chancellor

iv. The Vice Chancellor

v. The Deputy Vice Chancellors:

(a) Academic

(c) Administration

vi. The Registrar

vii. The Bursar

viii. The Librarian

Source: KABIR, B. (1997)

The first three officers perform ceremonial duties to a University, while the others are directly involved in the day-to-day administration of a University.

The following are duties and responsibilities of the above officers:

2.2.1 The Visitor

i. The visitor to a Federal University is the President, Head of State, or Head of Government of the Federal Republic of Nigeria.

ii. The visitor to a State University is

who has contributed toward upliftment of education in one way or another.

2.2.4 The Vice Chancellor

i. He is in charge of the general administration of the University.

ii. He is responsible to the Senate, of the University, he is expected to report to it at regular interval.

iii. Presides over the Senate meeting

iv. Appointed the visitor to head the University, after due consultation with the Council and the Senate.

2.2.5 Deputy Vice Chancellor

i. DVC Academic

The above assist the Vice Chancellor on academic matters of the University, he can act for and on behalf of the Vice Chancellor on academic matters of the Institution.

ii. DVC Administration

The DVC Administration assist the Vice Chancellor in the general administration of the Univeristy, he can act for and on behalf of the Vice Chancellor on administrative matters.

Both are appointed by the Council.

2.2.6 The Registrar

i. Assist the Vice Chancellor in the daily happenings of the University, e.g appointments, resignations, recruitments etc.

ii. He is also the Secretary of the Senate and the University's Council.

iii. Also appointed by the Council.

2.2.7 The Bursar

i. Responsible for financial matters of the University.

ii. Report to the Vice Chancellor for the financial status of the Institution.

iii. Also appointed by the Council of the University.

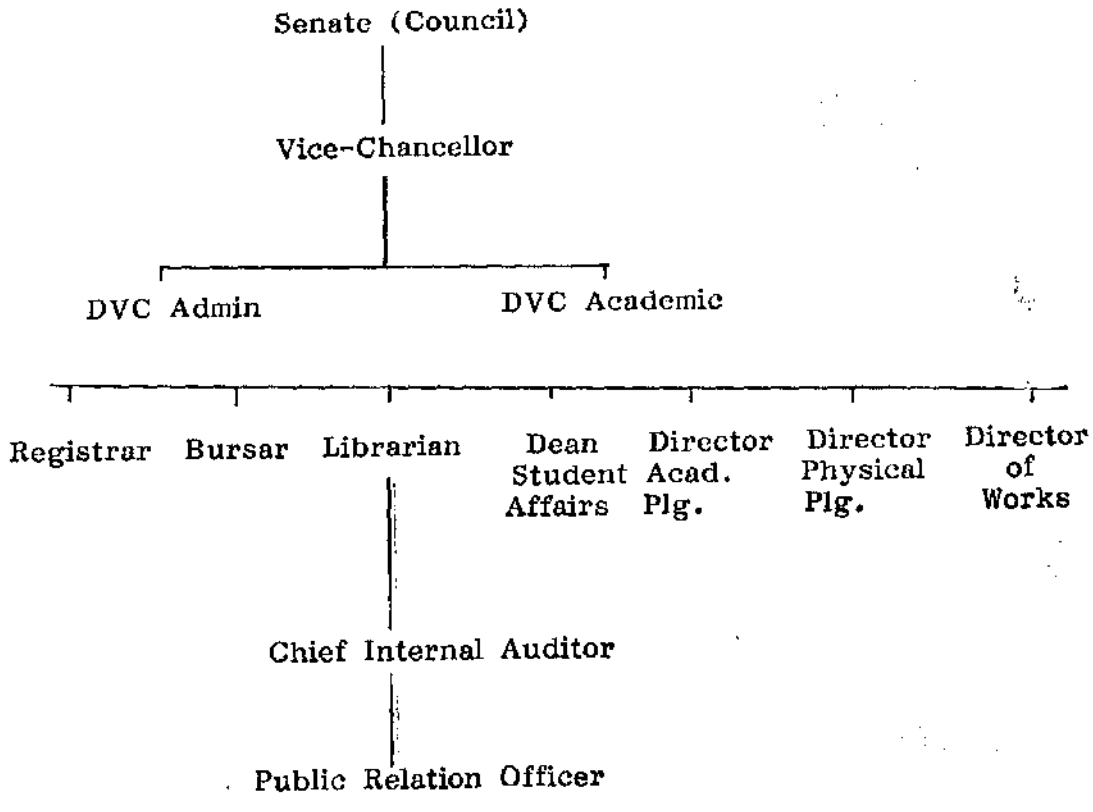
2.2.8 The Librarian

i. Responsible to the Vice Chancellor on library matters.

ii. In charge of day-to-day happenings in the library.

iii. Appointed by the University's Council

NIGERIA'S (SYSTEM)
UNIVERSITY ORGANOGRAM



Source: KABIR, B. (1997)

Table 2.1

2.3 ADMINISTRATIVE BODIES OF NIGERIAN UNIVERSITIES

To simplify the general administration of the University, there are bodies responsible for decisions taking on different matter; these bodies are:

(a) The Council

(b) The Senate

(c) Faculty Boards

2.3.1 The Council

This is the highest ruling body of a University system. It conprise of eminent personalities representing the general public interest and also notable officials of government agencies and ministries, selected across the country in case of Federal University. The functions performed by the Council include:

i. It take decisions of policy on the University, this could be financial or administrative.

ii. General management decisions of the University.

iii. Decisions on the control of the property and general expenditure of the University.

iv. It has power to decide on all issues not otherwise provided for by the law of the University.

v. It has power to decide on thedaily activities of the University e.g regulation and conduct of the University.

Two committees are most important in the Council i.e the Finance Committee and the General Purpose Committee. These committees are normally responsible for the execution of the Councils' decisions.

2.3.2 The Senate

The Senate is second to the University's Council, it is generally concerned with academic matters. The Senate is responsible to the Council on the above matter.

The Senate comprise of many boards comprising of students welfare board, appointments and promotions board, etc. Hence, it is responsible for the following:

i. It is responsible for taking decisions of policy affecting organisation and control of all academic activities of the University,

ii. It coordinates recommendations from the various faculties and departments.

iii. It approves appointments and promotions of workers especially the academic staff.

Members of a University Senate include the Vice-Chancellor, as the Chairman, the Deputy Vice-Chancellors, the entire Professors and heads of departments, the University Librarian and other academic and non-academic staff drawn from the University.

2.3.3 Faculty Board

Some of the duties of a Faculty Board are:-

i. Organise and control academic programmes of the faculty but it is subject to the Senate approval, this include decision on examinations, screening of students etc.

ii. Faculty Board is responsible to the University's Senate. TEchnical details are taken care of at this level for onward submission to the Senate for its approval.

The Dean of the Faculty is the Chairman of the Faculty Board. Other members include the Vice-Chancellor, the Deputy Vice-Chancellors, and all Heads of Deaprtments under the Faculty.

2.4 ADMINISTRATIVE STRUCTURE OF HERITAGE UNIVERSITY.

The administrative structure of Heritage University is to a great extent similar to that used in public Universities. The difference is basically in form of nomenclature only, i.e instead of Vice-Chancellor in the public University, the nomenclature is different, it is called the President. The two Deputy Vice Chancellors are refered to as First Vice-President

and Second Vice-President respectively. The Bursar is refered to as Financial Controller.

Despite the fact that the nomenclature is different, but they perform the same functions. The following are the key officers of the Heritage University and their responsibilities.

i. The Oresidents office
ii. The Registrars office
iii. The Financial Controller
iv. The Librarian
v. Dean Student Affairs
vi. Director Physical Plannings
vii. Director Academic Plannings
viii. Director of Works

2.4.1 The President

The President is responsible for day-to-day general administration of the University, two other offices of Vice-Presidents are attached to this office. First of the Vice-President is to assist the President on administrative matters; while the Second Vice-President is to assist him with academic matters.

2.4.2 The Registrar

As explained in public Univerisities, the function

of a Registrar is to deal with matters such as appointments, resignations, contracts, supplies, legal and property, the office also provide Secretariat for the Council and the Senate.

2.4.3 The Financial Controller

The Financial Controller shall be solely responsible for financial matters of the University and he is responsible to the Vice-Chancellor on such issues as it involves financies of the Instituttion.

2.4.4 The Librarian

Is solely responsible for the day-to-day running of the University's library.

2.4.5 Dean Students Affairs

The Dean shall be responsible for the general welfare of all the students.

2.5 MISSION OF HERITAGE UNIVERSITY, KADUNA

i. To supplement the efforts of both the Federal and States governments in the area of providing qualified Nigerian children access to tertiary level of education; and

ii. To provide an avenue for the much advocated

direct and full participation of the private sector of the economy in the development of high quality Higher education in the country:

2.5.1 Aims and Objectives of Heritage University

The main objective for setting up the Institution is therefore to provide more access to high quality University education and service, comparable to that obtaining any where in the world, to qualified Nigerian children who want it, and who can afford it. It is also to assist the nation advance technologically, the University will place more emphasis on the science - based disciplines. The University will accord priority considerations to providing adequate laboratory and workshop facilities, with particular emphasis on the provision of up to date teaching and research equipment. Furthermore, and in line with government policy, in combating unemployment, the University will provide such training as would prepare its products for the challenges in the employment market. Emphasis will be placed on areas suitable for gainful self-employment creation and others where manpower demand is high in order to minimise the prevailing problems of graduate unemployment.

Specifically, the objective os the University are to:-

(j) . Provide greater access to qualitative University education in a most cost effective manner.

(ii) Improve the quantity and quality of students graduating in the science-based disciplines, thereby assisting the nation in meeting the 60:40 science : arts enrolment mix.

(iii) Attract and retain well - motivated, highly qualified and skilled staff.

(iv) Provide an environment to qualified academic staff, for the pursuit of excellence in teaching, research and community services.

(v) . Promote International cooperation and understanding through linkages in academic pursuits including research, as well as staff and students exchanges.

2.6 CLASSIFICATION OF NIGERIAN UNIVERSITIES

Nigerian Universities, both federal and states owned universities and classified according to the area of specialisation and emphasis of courses and disciplines.

2.6.1 Conventional Universities

These are universities that offers both Arts, Sciences, and Technology in its curriculum. There is no particular emphasis of one of the above or another except perhaps the recently 60:40 Science:Arts ratio of students enrolments.

Examples of such universities are: ABU, Zaria, University of Ibadan, BUK, Kano, University of Calabar etc. Heritage University when fully operational will fall within this class.

2.6.2 Federal/States Universities of Technology

These are Universities whose curricular has more emphasis on the Technological development, the emphasis is on practical Technological application of knowledge through the use of mechines, etc.

They were established with the sole aim of enhancing the nations technology. They are namely; Bauchi, Yola, Minna, Owerri, Akure.

2.6.3 Federal Universities of Agriculture

To enhance food production and research in that area, the government decided to convert two Universities to universities of agriculture namely: Federal University of Agric Makurdi, and Benue State University of Agriculture.

2.6.4 Military Universities

As explained earlier, Nigeria Defence Academy (NDA) has been coverted to a full fledge degree awarding university in the 1980s.

2.7. PLANNING CONCEPTS IN NIGERIAN UNIVERSITIES

Studies on planning concepts adopted in Nigerian Universities have shown that they fall within these four main concepts, each bearing in mind and taking cognisance of the four constituents of a University system; namely, the Central Administration, (Senate Building), Academic Core (teaching/research areas). Accommodation for both staff and students, and lastly the Recreational Areas.

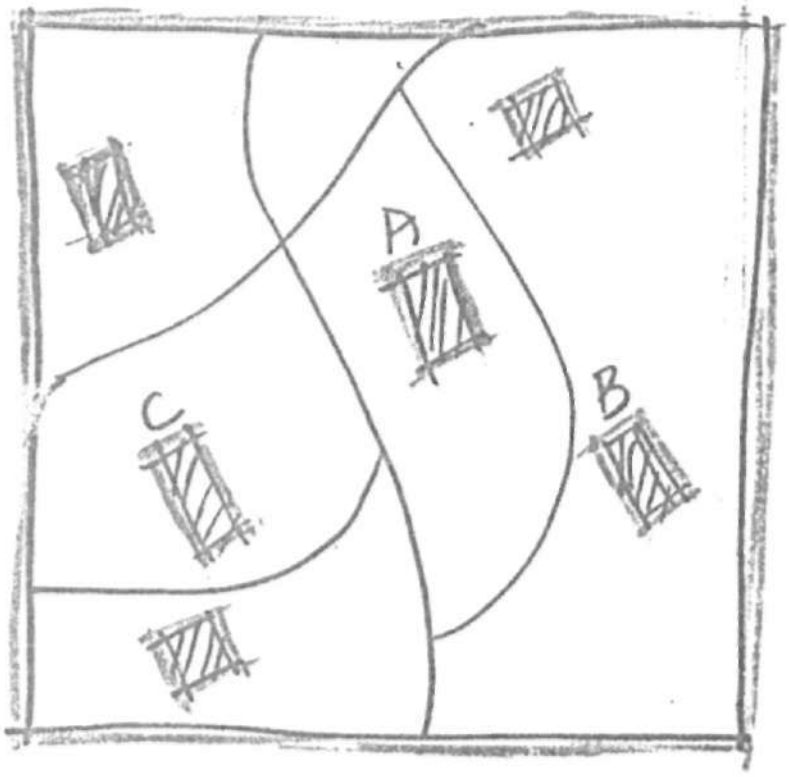
Other important factors that determine the overall campus form, include, size of the site, accessibility to basic amenities, circulation, services, functional relationships, and the expected interaction among the users of the facilities.

2.7.1 Close Knit Concept

In this concept, Schools or Faculties are located at different places within the town of the Universities location. This is typical of Nigerian Universities, because of inadequate structural infrastructure, the Universities could not concentrate in one area, but rather utilise what ever infrastructure given to it within the town to use temporarily, e.g ABU, where we have Congo Campus, Main Campus, and Faculty of Agriculture at Shika - Funtua road.

CLOSE KNIT

SCHOOLS ARE LOCATED AT DIFFERENT PLACES WITHIN THE TOWN OF THE UNIVERSITIES LOCATION



A-
B-
C-
} FACULTIES / SCHOOLS IN DIFFERENT LOCATIONS IN THE SAME TOWN.

SOURCE: HAMZA B (1998)

2.7.2 Loose Tie Concept

In this concept, each of the constituents is independent of one another, but located in one place.

It allows for expansion of each unit, the central administration is normally placed at the centre in between the academic core and accommodation of staff and students. This is to ensure a fair proximity from all parts of the University. However, its major disadvantage is the long distances that may be created between activity areas, due to expansion etc.

2.7.3 Ring Concept

In this, all the constituents are arranged in a ring form, i.e formed around one another.

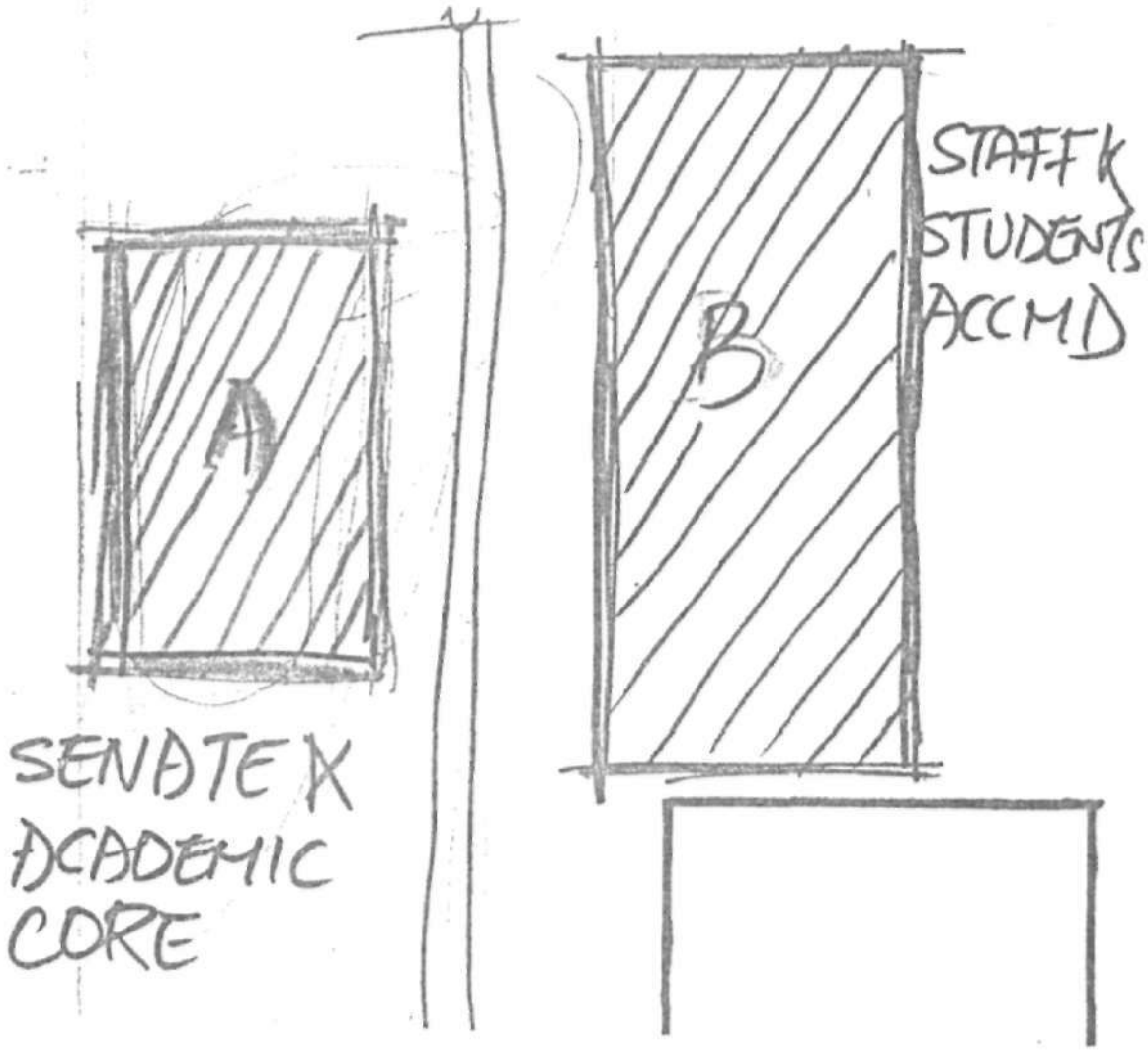
The central administration is normally placed at the centre and surrounded by Academic Core, which in turn is surrounded by housing areas for students and staff. Interaction is enhanced among members of the university community. Distances between units is greatly reduced. This concept because of its simplicity and its advantages is the most widely used concept in planning of Nigeria's Universities.

2.7.4 Segregated Type of Concept

This concept promotes strong relationship between

SEGREGATED.

IN THIS CASE. THE SENATE AND THE ACADEMIC CORE ARE LOCATED TOGETHER WHILE STAFF AND STUDENTS ACCM ARE PLACED AT OPP SIDES



SOURCE: HAMZA. B (1998)

the campus planning elements, on spatial relationship.

In this case, the central administration and the academic core are fused or located together while the students and staff accommodation facilities placed at opposite sides.

Expansion may be difficult for the central administration unless of cause provision have been made from the initial planning for its expansion.

2.7.5 Campus Systems Operated by Nigerian Universities

Generally, four systems are being operated by our universities. A University could have one or even combine the systems at the same time. These systems are:

2.7.6 City-Heart Campus System

This campus system has its campus located right inside the city, e.g of this, is BUK Kano. Expansion normally is a major problem with this system, except it is a new city.

2.7.7 Multi-Campus System

Ahmadu Bello University is an example of this type of campus system. It tend to

have sub-compuses which are in one way or another connected, each campus however, is self sufficient in terms of aminities. They are normally compact e.g Congo Campus, and hence allow for expansion.

The major advantage of this campus system is that it reduces the concentration of the activities at a place, hence reduce congestion.

2.7.8 Sub-Urban Campus System

The university campus is normally located some kilometers away from the city centre, e.g University of Abuja, and Usman Danfodio University.

2.7.9 Urban Campus System

In this, the University campus is located close to the city centre. Infact, presence of the campus can influence the growth of the city itself. Basic amenities are shared between the University community and the city. One of such university for example is the Ladoke Akintola University.

2.8 THE SENATE BUILDING IN NIGERIAN UNIVERSITIES

Senate building of any University is primarily to provide office accommodation to the administrative staff of the University as well to provide for a suitable area or place for meetings of the University Councils

This name Senate Building/House derives its name as a result of the provision of the Senate Chamber meant to be used for the meetings and delibrations of the Councils, and the academic body of the University in the Senate. As explained in the chapter earlier, the Senate is the sole academic body of any University, it therefore, is respossible for taking decisions about matters concerning the academics of the University.

The University Council also meets and delibrate in this Chamber, its decisions involves the general administration of the University; it could be seen hence that the Senate is solely an administrative building of a University.

2.8.1 Location

The location of a University Senate is of utmost importance. The location of this building has consistently been centralised with a University as could be

seen in case studies carried out in chapter three.

The central location of this building is recommeded because of the following reasons:

(i) Accessibility:- This building is supposed to be easily accessible to all segments of the University, i.e the Academic core, the accommodation area etc. This will also ensure easy proximity from the main entrance for visitors.

(ii) Its Position of Seat of Power:- This building accommodate the offices of the highest officers of the University, hence it serves as the highest policy formulating body of the University.

(iii) Serves as a part of call for solutions of one problem or another from other departments of the University.

(iv) Senate building also is the main facilitator of the growth of a University, hence its central position is like a centre of a circle to which all lines radiates from.

2.9 ENERGY IN BUILDINGS

The use of energy in buildings become an issue

in the early 1970s as a result of the energy source crisis in Enrope and America.

Several factors were actually responsible for the crisis involved in energy supply and use, these are:

(i) The world population which is steadily increasing, this means that demand will also increase world wide.

(ii) Social, economic, and political pressures for economic expansion continued in the industrilised countries, this will definately require more energy input.

(iii) The developing countries are becoming more industrilised than expected 10 - 15 years ago, and are also becoming aware that their economic position could be improved by increased energy utilisation.

(iv) Pricing policies and power to alter or revise the price of oil by members of OPEC which greatly affect the western countries.

(v) Non utilisation of energy intensive materials, this lead to over utilisation of materials that could not save energy used in any form.

The above problems posed great threat to the sources of these energies and their supply, especially the electricity, supplied through the use of fossil fuel.

To arrest the situation and to ensure the optimum utilisation of these energies in buildings, some countries adopted policies to control the use of the energy with a view to eliminating wastage.

2.9.1 Energy Control Policy in France

The energy crisis of the 70s lead to the formation of a semi - private organisation called Agency for Economics in Energy (AEE) with a singular aim of achieving at least 45 tonnes of equivalent oil consumption in 11 years.

For easy operation, the committee splitted its work into three:

(i) Industry and Agriculture

In this area, the organisation eexercise control through taxation legislation on the cost of fule, control of loans and grants, in addition minimum thermal insolation was reviewed for factories.

(ii) Transportation

The organisation here regulated vehicel speed

limits, petrol pricing etc.

Residential and Commercial Buildings

This was where the organisation recorded its greatest success through the following measures:

(a) Space temparature during the heating season which was restricted to 20°C

(b) In multi-dwelling buildings, individual energy metering of each unit becomes compulsory.

(c) Thermal insolation and control system were installed to existing buildings.

The Achievement recorded through the use of these policies resulted in energy economics of 13,700 tonnes, equivalent of oil per annum. - AEE (Associationof Energy Economy)

2.9.2 Energy Control Policy in Italy

The energy control policy adopted by Italy is the most recent to come out in Europe, and a great extent represent a general trend in Europe.

Article 4-6 of the above set-out the documenta-

tion form required to obtain approval of a design proposal like:

i. The heat producing plants, and equipments, burners steam generators, boilers etc.

ii. The type and components of the astomatre control systems, and heat metering equipments.

iii. Detail of heat enchangers, cabrifiers, circulation, pumps etc.

Articles 12 gives the thermal insolation of pipe work based on tube diameter, also

iv. The thermal characteristics of insolants and location in the building is given.

The above are some of the regulations on building to control energy as used by Italy and most of European states.

2.9.3 Nigeria's Position on Energy Control

To appreciate this concept in Nigeria, it is important to know the energy sources:

(i) Traditional

This significantly is in a form of wood which

is generally used in rural areas.

(ii) Conventional

These are categorised basically into three, coal, hydro electricity, oil and gas.

(iii) Alternative sources are, solar, wind, tidal, etc However, Nigeria do not have the technology to develop and use these energy sources.

The realisation that Nigeria is a vast emporter of energy had made it difficult to embark on a policy of energy control. But it should be realised that Nigeria is at the moment generating four less (power) than it required. Hence, the only policy is to explore ways of generating energy needed by employing other sources apart from the hydro electricity presently in use.

But generally, building patterns and planning in Nigeria complement control, this is so because the shapes, forms and functions are traditional (especially in the rural areas). Also, buildings are still built using clay mud (in these areas) which cools the building in the hot season and warms it in cold season.

Presently consultants in Nigeria are embarking on energy control measures in buildings through:-

(a) Demanding of Architectural elevations that will reduce the heat gain in buildings, so that a simple form of cooling system can be used.

(b) Sometimes specify separate a/c units in office building for each floor so that the energy can be controled per floor area.

(c) Also gone to the extent of using extractor fans which supplies fresh air intake into a building at low level, and exhaust fan which enpels hot air at a high level without the need for cooling.

Chapter Two

REFERENCES

1. Nigeria Universities Commission (1979) Standard Guide for Universities.

2. Kabir, B. (1997) Senate Building for ATBU Bauchi An Unpublished M.Sc Thesis (1997) ABU Zaria

3. OVE, A. (1980) Building Design for Energy Economy, Construction Press London.

4. Seymour, J. (1980) The Architects Guide to Energy Conservation, Kingsport Press, London.

5. Encyclopedia Brittanica (1992) McGraw Hill, USA.

6. Encyclopedia Brittanica (1978) Inc Vol.12 London.

CHAPTER THREE

"BUILDINGS DIFFER FROM ONE ANOTHER PHYSICALLY, ARE ERECTED IN MANY LOCATIONS, AND ARE BUILT AT VARIOUS TIMES DESPITE THESE VARIABLES, THE DESIGN PROCESS BY WHICH STRUCTURES ARE CREATED FOLLOWS A FAIRLY CONSTANT PATTERN. THIS SIMILARITY MAKES IT POSSIBLE TO OUTLINE WAYS IN WHICH CONTROL TECHNIQUES CAN BE INCORPORATED INTO THE BUILDING PROCESS THROUGHOUT A VARIETY OF SITUATIONS"

S. JARMUL

Chapter Three

3.0 CASE STUDIES AND PHYSICAL CHARACTERISTICS OF STUDY AREA

3.1 INTRODUCTION

To achieve a functional and adequate office complex for Heritage University, a similar existing complex as needed to be studied with a view to assessing functional lapses so as to produce a more effective office complex.

The case studdies were aimed out on three existing Senate Buildings, these are:-

i. Ahmadu Bello University Senate Building
ii. Abubakar Tafawa Balewa Administrative Building.
iii. University of Lagos Senate House.

3.2 AHMADU BELLO UNIVERSITY SENATE BUILDING

The senate building was built in the early 1980s by the then civilian administration of Alhaji Shehu Shagari, principally to accommodate the administrative staff of the Institution because of the inadequacy of the former administrative building. It is located at the Samaru Main Campus. It is an eight floor affair with first

two floors as open plaza and six storey tower with the Senate Chamber in-between the podium x tower.

3.2.1 Location

The senate is located in the mids of the academic core of the university, i.e bounded by SGRS Library on the south, the Convocation Square on the north, the Assmebly Hall to the west and the old Administrative block on the east. The location could be siad to be strategic because of its direct access to the main gate, i.e the access from the main gate is easy.

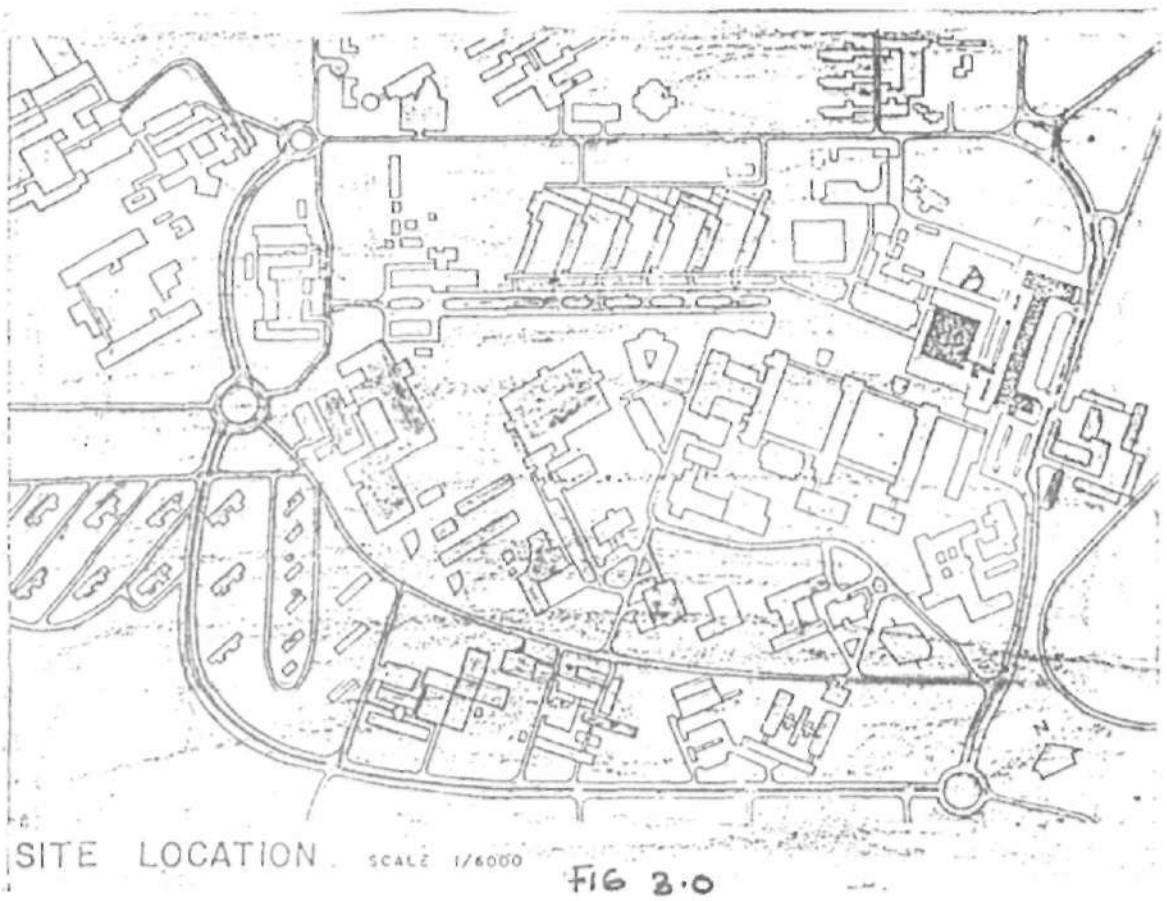


FIG 3.0

GENERAL LAY-OUT OF A·B·U SHOWING THE POSITION OF THE SENATE (A).

3.2.2 Design Appraisal

i. The desing has clearly identified itself as a seat of power for the university because of its elegance, and domination over all the buildings surrounding it.

ii. The design is well befitting for a university of Ahmadu Bello status.

iii. The building has succeeded in providing adequate accommodation to the administrative staff of the university.

iv. Each of the functional spaces/offices was clearly defined and easily accessible.

v. The structure has successfully taken care of human traffic within the building, because of the provision of enough vertical and horizontal transportation systems, and placement of functions most frequented by people on the ground floor.

vi. Adequate services has been provided in form of toilets, where two sets of toilets was provided for each floor.

vii. Good quality construction and durable

material finish.

(viii) Simplicity of design and construction.

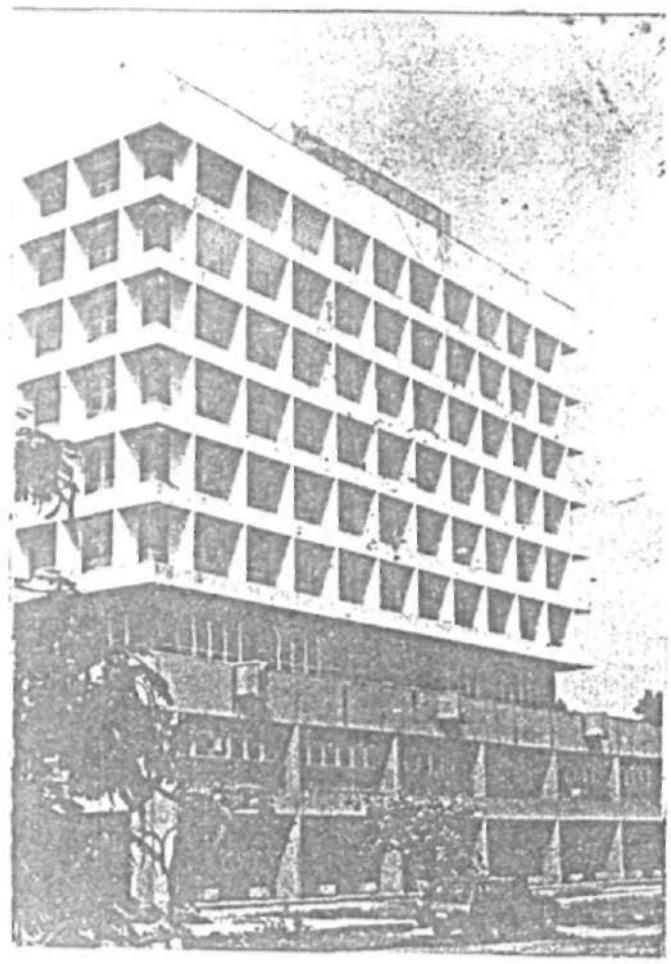


Plate 3.0

SENATE BUILDING OF: A·B·U.
ZARIA.

SOURCE: HAMZA·B (1998)

3.2.3 Design . Criticism .

i. Undefined parking spaces. The scattered parking provided was grossly inadequate.

ii. The stair cases provided for vertical transportation is hidden and dark.

iii. Interruptions by colums has in some office reduce the useful working area.

iv. The toilet facility provided in the ground floor is well hidden and accessibility is difficult since it is placed behind lifts.

3.3. ENERGY CONSIDERATIONS

i. The discussion will be restricted to those energies as explanned in the earlier chapters, that affect buildings. These are:-

ii. Solar energy

iii. Wind energy

iv. Sound energy

v. Electrical energy

vi. Mechanical energy.

These energies are hereby examined to see how they affect the building, and profer possible solutions on how it could be taken of in future.

3.3.1 Solar Energy

(a) Shape:

Because of the square shape adopted, there is less absorbtion of solar energy. Squared shaped plans absorbs less insolation than rectangles, which in turn absorbs less than a circular shaped plan.

Inference: the sun-shading devices (both horizontal and vertical is proving to be effective.

This could be enhanced by the use of appropriate external wall finish, e.g white paint which reflect solar insolation.

(b) It could also be controlled through the use of a heavy walls both external and internal. Heavy wall is a wall that has about eight hours time lag minimum.

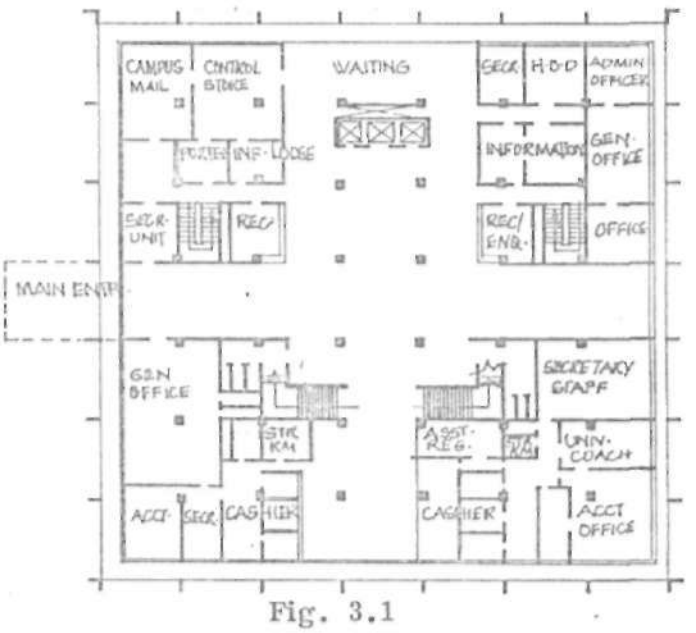


Fig. 3.1

GROUND FLOOR PLAN. SQUARE FORM WHICH ABSORBS LESS SOLAR ENERGY.

3.3.2 Wind Energy

i. The use of concrete roof has greatly reduce the risk of the roof being blown away.

ii. The sun shading devices also help to control the wind going into the offices in the last six floors of the tower.

iii. The use of trees around the building served as a buffer for the first two floors i.e podium.

iv, The orientation was influenced by the direction of wind, depending on the location of the site, this is in order to achieve optimum natural ventilation. There is also an efficient application of stack effect by creating a gap between podium x tower.

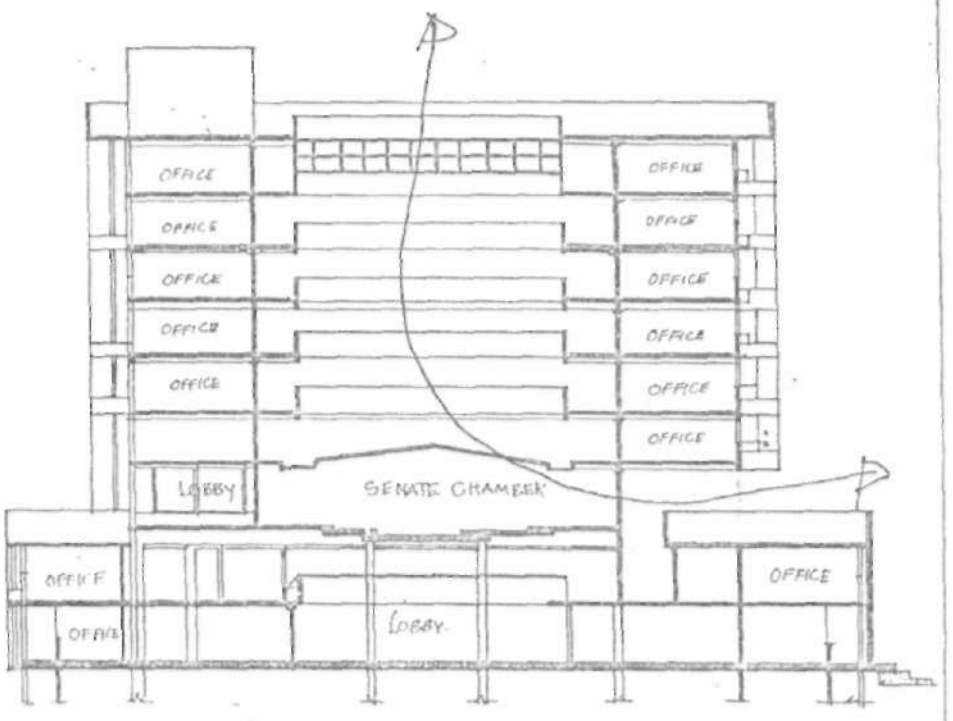


Fig. 3.2

SECTION THROUGH SENATE SHOWING HOW STACK EFFECT WAS USED TO ENHANCE VENTILATION

3.3.3 Sound Energy

i. The sound that could come from noises of people has been taken care of through design, i.e by placing those offices that are frequented by people at the ground level. Hence human traffic is reduced.

ii The use of single banking in the corridors of the last six floors will go a long way in reducing the noise coming from people because of the use of central core in the tower.

3.3.4 Electrical Energy

The use of electrical energy is mostly in the form of lighting and the operation of mechanical gadgets and machineries.

i. As a result of the concept of deep planning employed in the design of the podium, especially the mezzanine floor, this floor will require a great deal of artificial lighting especially the circulation areas which were sandwitched between offices.

ii. The lighting requirements in the offices in these floor will need the use of artificial lighting.

iii. The stair cases will no doubt require the use of artificial lighting, because of its design. It is hidden, and there is basically little consideration given to natural lighting of the stair case, especially mezzanine floor.

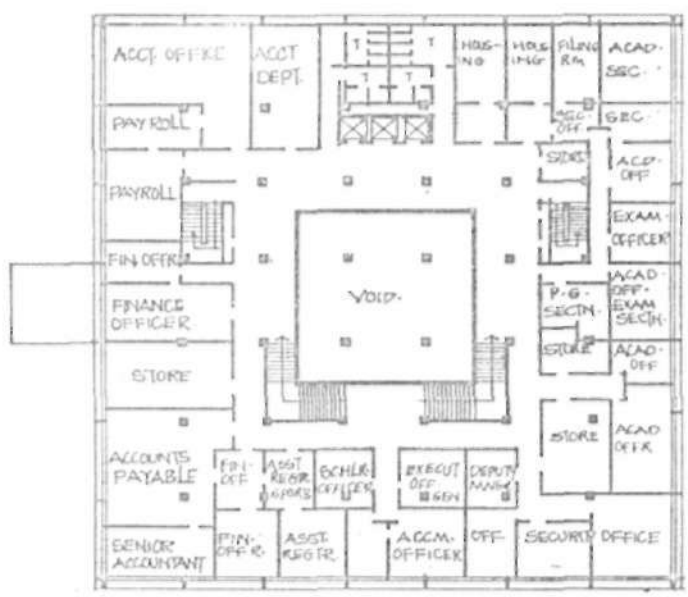


FIG 3.3

FIRST FLOOR PLAN 1:400
SHOWING THE SQUARED SHAPED PLAN.

iv. The offices at the last six tower floors of the tower require less use of artificial lighting, because of the use of single banking, and the use of central core.

v. The Senate Chamber requires the use of

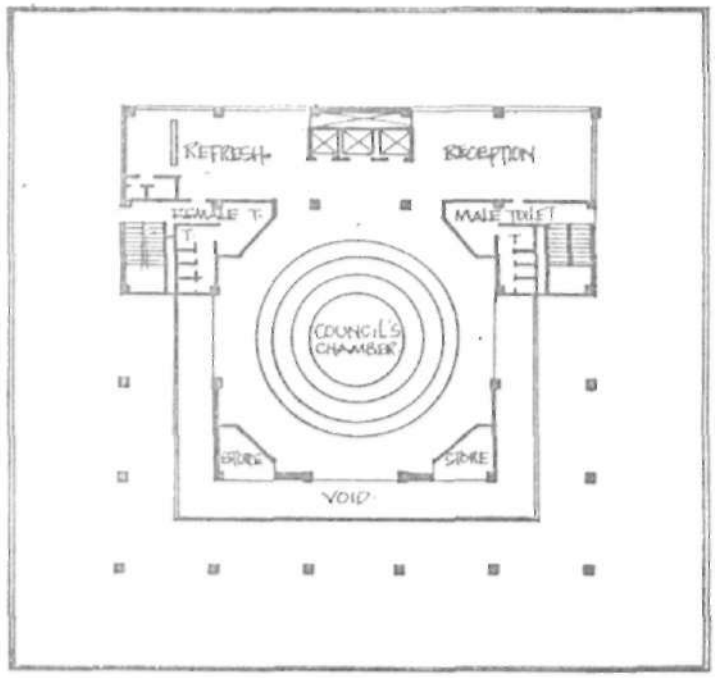


Fig. 3.4

SECOND FLOOR PLAN SHOWING THE SENATE CHAMBER 1:400

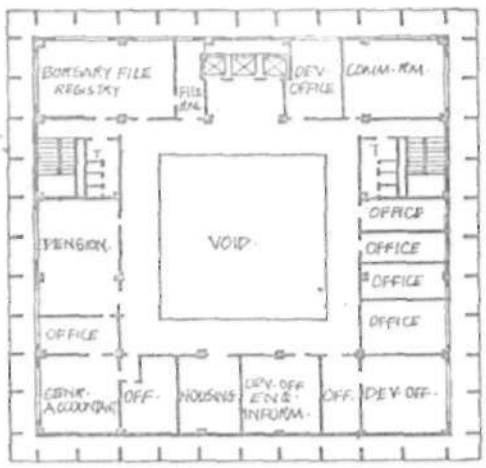


Fig. 3.5a

FOURTH FLOOR PLAN

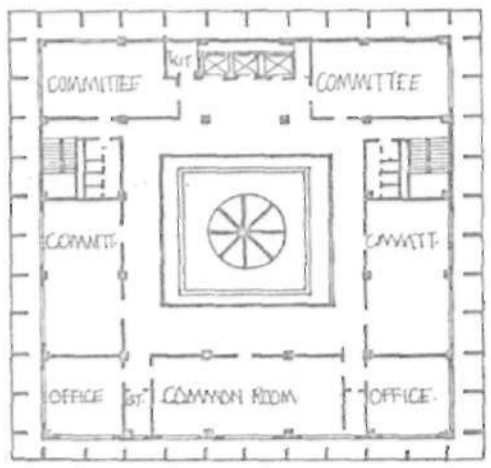


Fig. 3.5b

THIRD FLOOR PLAN 1:400

artificial lighting.

Inference: The reliance on artificial lighting in the mezzanine floor will cause a lot of inconviniences.

If there is no light, the spaces will be dark even during the day. Hence this will no doubt cause a heavy financial burden on the users/clients of these buildings.

3.3.5 Mechanical Energy

i. The use of Air Conditioners in this building will greatly consume a lot of energy, but of cause this will be converted into heat energy.

ii. Since the concept of deep planning was used in the ground and mezzanine floors, there is need for the use of air conditioners to enhance ventilation.

iii. The use of air conditioners in the top offices is actually unneccessary because there is the provision of natural ventilation as a result of the central core and use of single banking.

Inference: The use of mechanical gadgets to achieve the desired goal of design e.g air conditioner, and others should not be

of priority, rather passive means should be evolved.

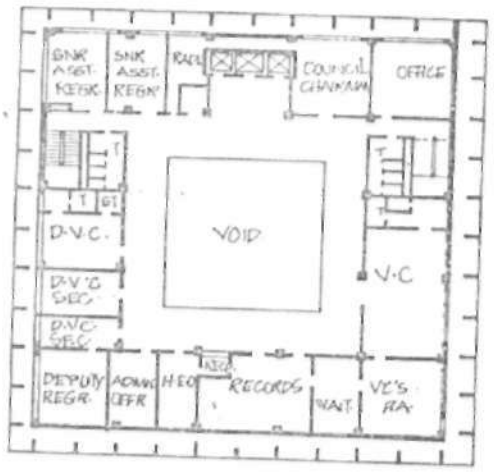


Fig. 3.6 EIGHT FLOOR PLAN 1:400

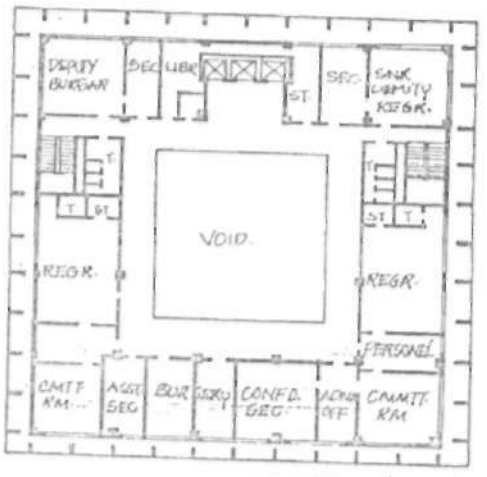


Fig. 3.6a SEVENTH FLOOR PLAN 1:400

FLOOR PLANS FOR A·B·U SENATE BUILDING.

3.4 ABUBAKAR TAFAWA BALEWA UNIVERSITY, BAUCHI - ADMINISTRATIVE BUILDING

The Administrative Building occupied by the staff of this University was not originally designed as a Senate Building. It was designed as a class-room block, however, as a result of lack of office accommodation, the class-room was modified to serve as the Administration block.

3.4.1 Location

The administrative block was located at about the centre of the University (Yelwa Campus), it is located at a place almost equidistance from the various academic cores.

The location is appropriate, being in the centre, and approximately equel distance from other areas.



(A - SENATE BUILDING)
MASTER PLAN OF THE UNIVERSITY SHOWING THE SENATE IN RELATION TO OTHER BUILDINGS.

Fig 3.6b

3.4.2 Design Appraisal

The design is simple rectangular form, this makes it easier to construct. Simple materials also used in the construction.

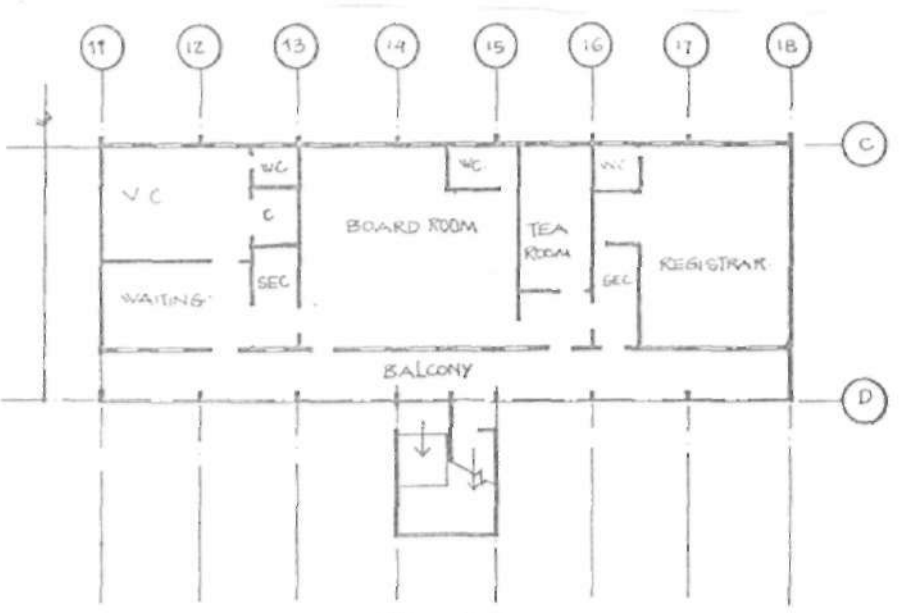


Fig. 3.8
VCS BLOCK (FIRST FLOOR PLAN) 1:100
SHOWING THE SIMPLICITY OF THE FLOOR PLAN.

3.4.3 Design Criticism

The University's administrative block has:

i. No defined parking space.

ii. Inadequate office accommodation.

iii. The building do not portray its position as a seat of power for a University.

3.4.2 Design Appraisal

The design is simple rectangular form, this makes it easier to construct. Simple materials also used in the construction.

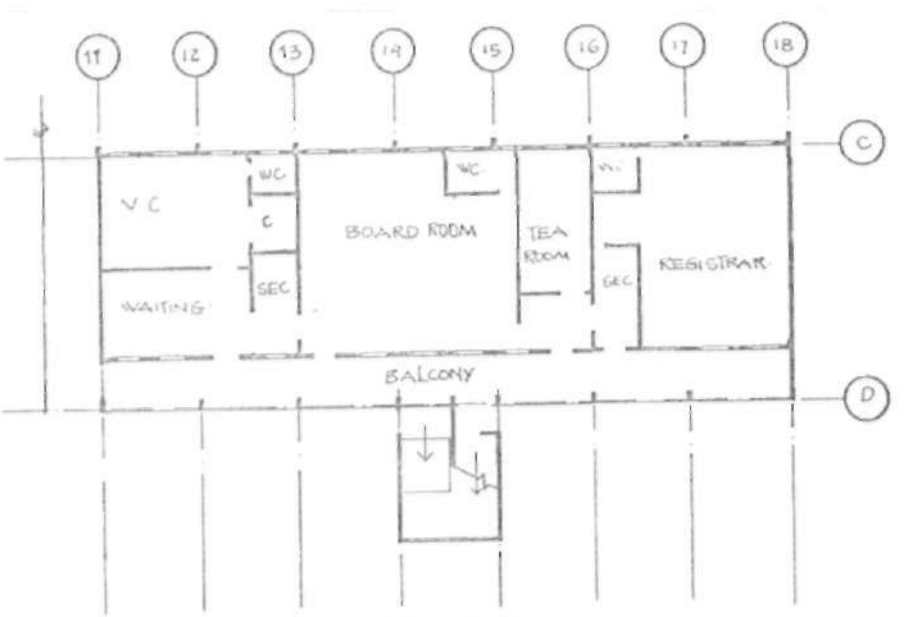


Fig. 3.8
VCS BLOCK (FIRST FLOOR PLAN) 1:200
SHOWING THE SIMPLICITY OF THE FLOOR PLAN.

3.4.3 Design Criticism

The University's administrative block has:

i. No defined parking space.

ii. Inadequate office accommodation.

iii. The building do not portray its position as a seat of power for a University.



Plate 3.1 9

APPROACH ELEVATION OF A·T·B·U SENATE SHOWING THE UNDEFINED AND INADEQUATE PARKING SPACES.



THE REAR OF THE BUILDING SHOWING INADEQUATE S·S·D.

Plate 3.2b

3.5 ENERGY CONSIDERATION

3.5.1 Solar Energy

The building being rectangular in shape, is bound to absorb more solar Insolation than a square shape, this will lead to the transmission of heat through conduction into the inside of the building.

This calls for more sun-shading device on the building, here a combination of vertical and borizontal sub-shading devices.

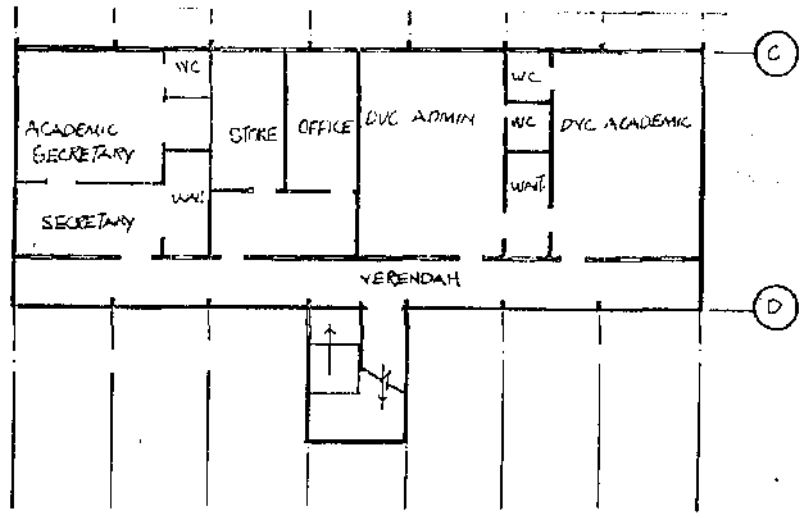


Fig. 3.8d
VC'S BLOCK (GROUND FLOOR PLAN) 1:100
SHOWING RECTANGULAR SHAPE OF THE PLAN.

3.5.2 Wind Energy

The wind energy is likely to affect the roof

more in this case than any other part of the building. Monopitch was used falling to the rear.

However, good workmanship, and use of trees will ensure control of this form of energy should it exceed the normal velocity.

3.5.3 Sound Energy

Rectangular shape of the building ensures a good sound distribution. However, distraction can be caused since it is singly banked and opened to the outside.

3.5.4 Electrical Energy

The use of electrical energy for lighting is very minimal, i.e optimum day lighting is achieved because of the single banking used.

3.5.5 Mechanical Energy

There was the use of Air Conditioners to enhance ventilation, this is unnecessary because the building has been properly oriented to achieve cross-ventilation.

3.6 UNIVERSITY OF LAGOS SENATE HOUSE

The University of Lagos Senate House was built as the same time with the Ahmadu Bello University Senate Building in the 1980s. They were both funded by the Federal Republic of Nigeria.

The Senate House is a 12-story structure consisting of plaza of three stories, where the Bursary and general accounts offices were located.

Registry and the Vice Chancellors office were placed in the high tower, employing the same method of reducing human traffice as in the case of ABU Senate.

There is an inter-play of horizontal as well as vertical elements of design. The Senate Chamber however, was designed using circular form, and projects outwards at the approach.

3.6.1 Location

The Senate House is located at the centre of the academic core because it was bounded by the Arts Lecture Theatre to the west, Advanced Legal Studies to the north, and the old Administrative building and Auditorium to the east.

It is directly accessible from the main gate, which is situated on the western side of the campus.

The senate location could be said to be appropriate since it is supposed to be a part of call to all, hence its central position is appropriate.

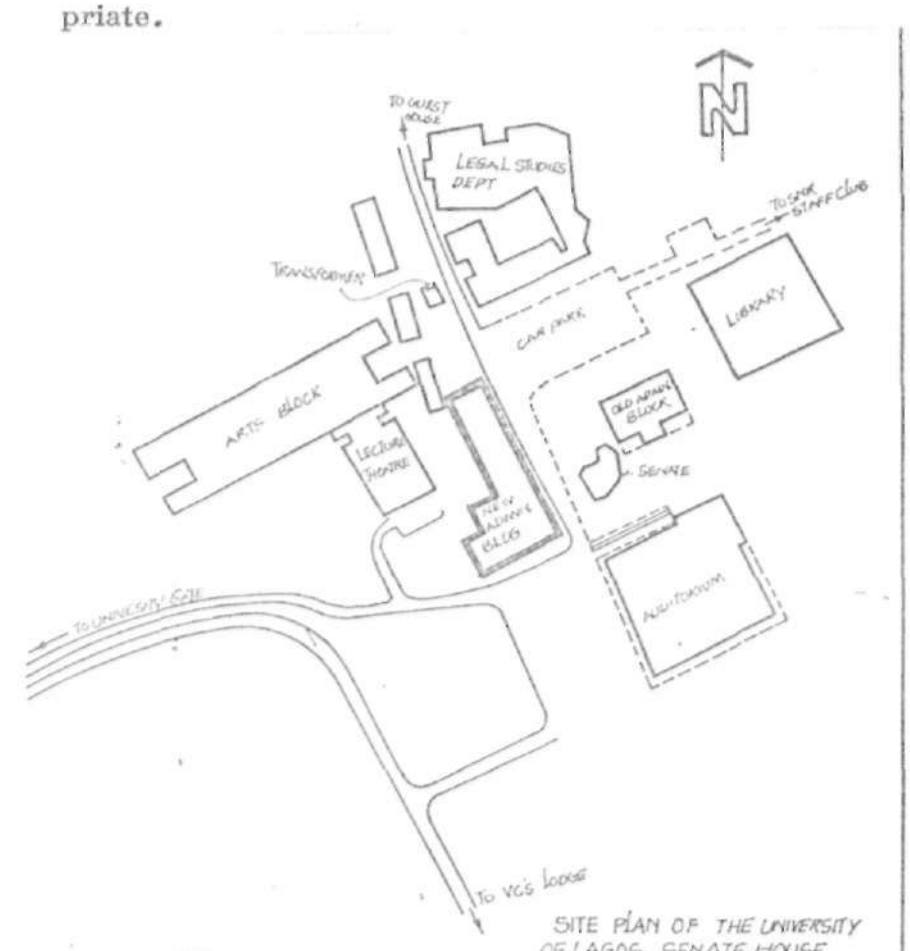


Fig. 3.9

3.6.2 Design Appraisal

The desing obviously stood out, as a magnificents structure, as a seat of power for the university.

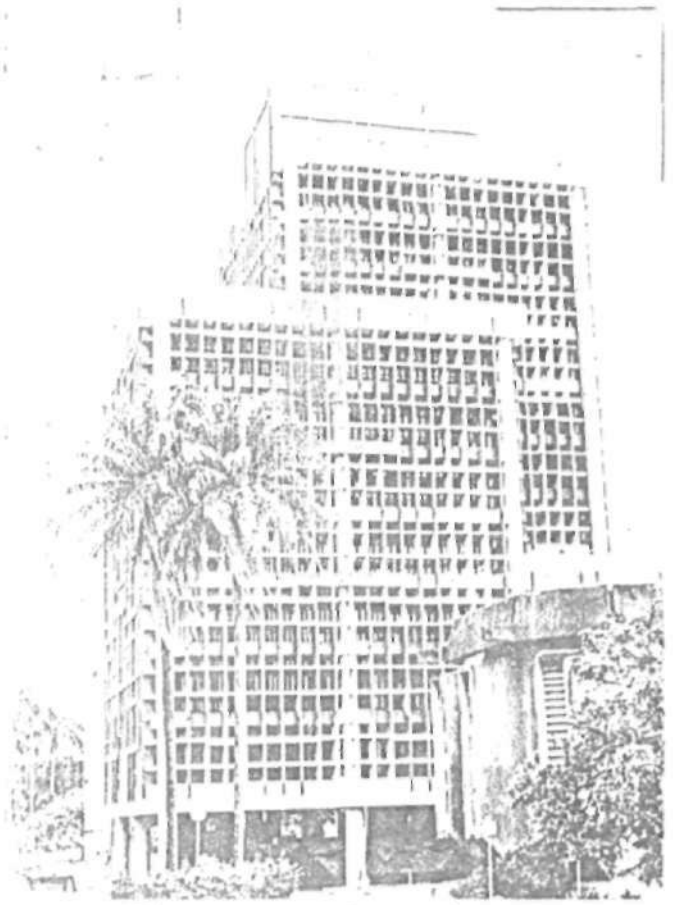
(ii) The structure is well befitting for the university.

(iii) The office accommodation which is the primary aim of the senate is adeqaute, and enough to accomodate the administrative staff of the university.

(iv) There is a delibrate attempt to reduce human traffic as one goes up, this was achieved by locating offices most frequented by people at the lower floors.

(v) The parking provided is defined and adequate.

(vi) The circulation around the building is also effective for both vehicular and pedestrian.



THE FACADE OF UNILAG SENATE

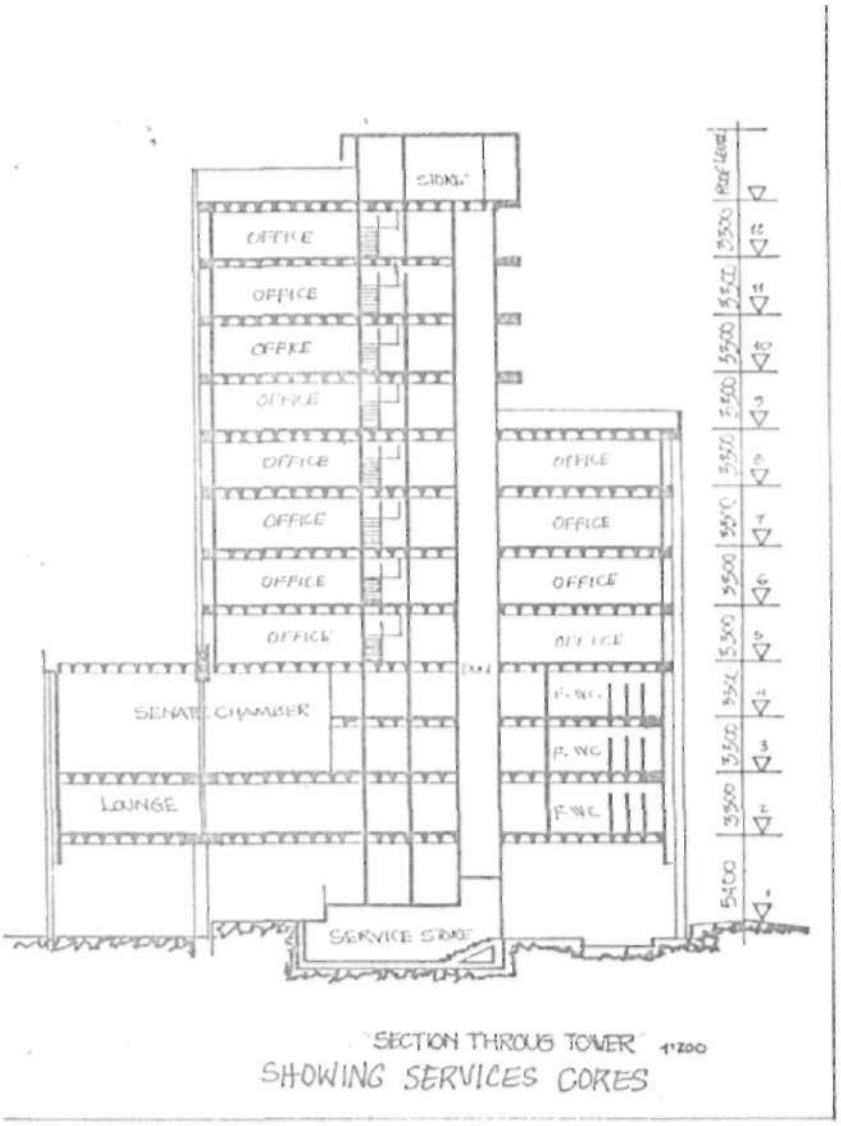


Fig. 3.9a

3.6.3 Design Criticism

i. Because of its height, it will be difficult to reach in the event of fire.

ii. Some of the escape stairs are hidden, this may bring some difficulties in case of fire, the stair cases so hidden are normally dark, because the are enclosed.

iii. There was inappropriate compartmentalisation, emphasis was given to the concept of open office design.

iv. There was a noticeable construction error in the third floor, which showed in a form of buckling.

3.7. ENERGY CONSIDERATION

3.7.1 Solar Energy

i. There is use of vertical and horizontal fins as sub-shading devices. This will check in infiltration of sun through the windows.

ii. The rectangular shape used would have absorbed more solar energy, if it had exposed more skin. It can noticed that the window glazing is recessed hence there is very little skin exposed to insolation.

iii. The use of heavy wall has also checked the heat absorbtion of the building

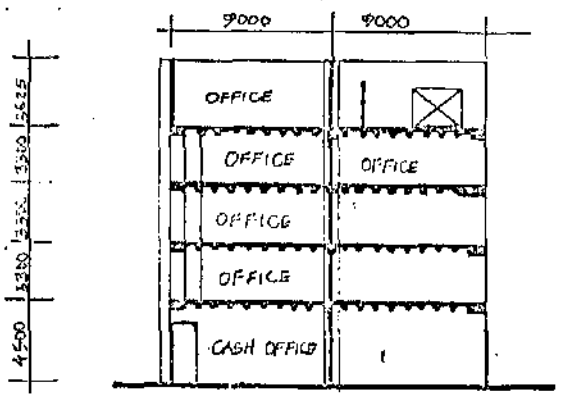


Fig. 3.9b SECTION THROUGH BURSARY.

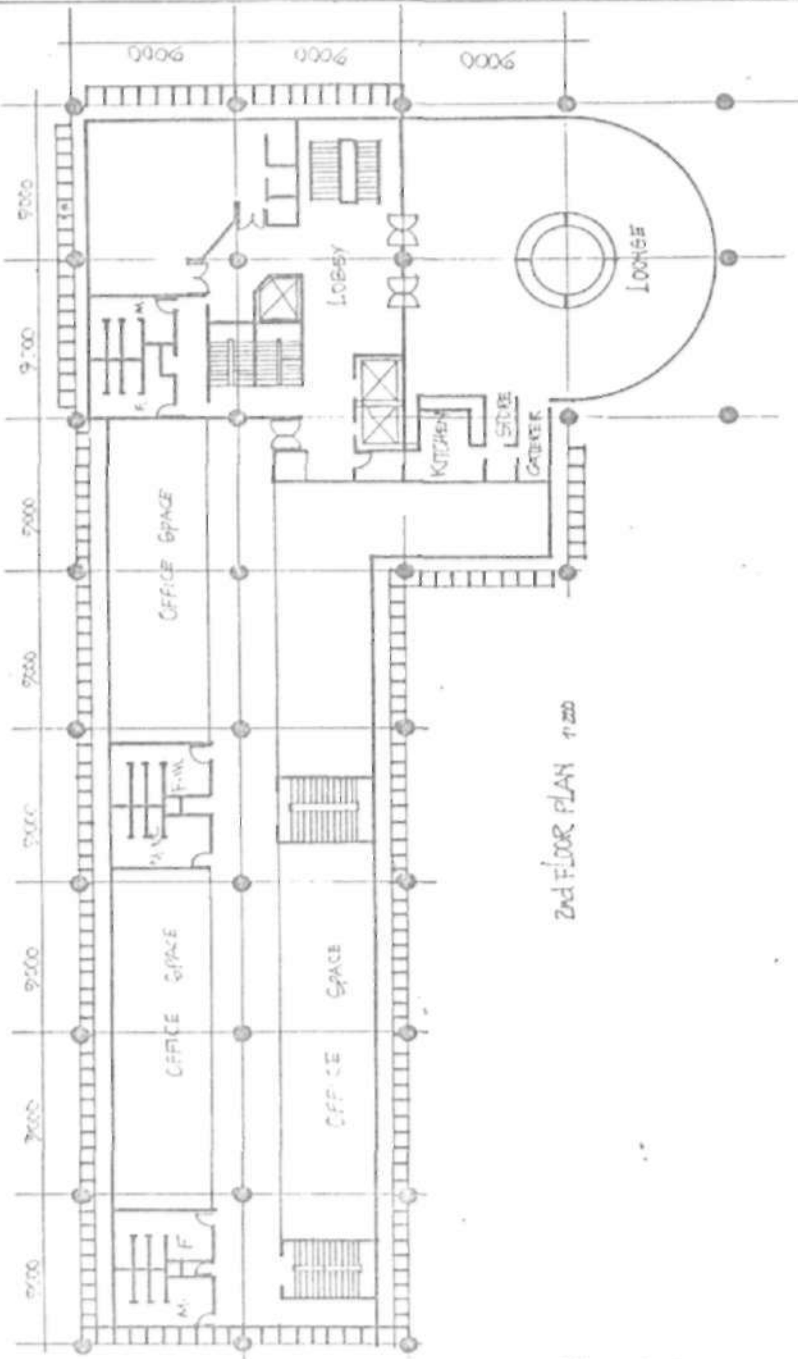
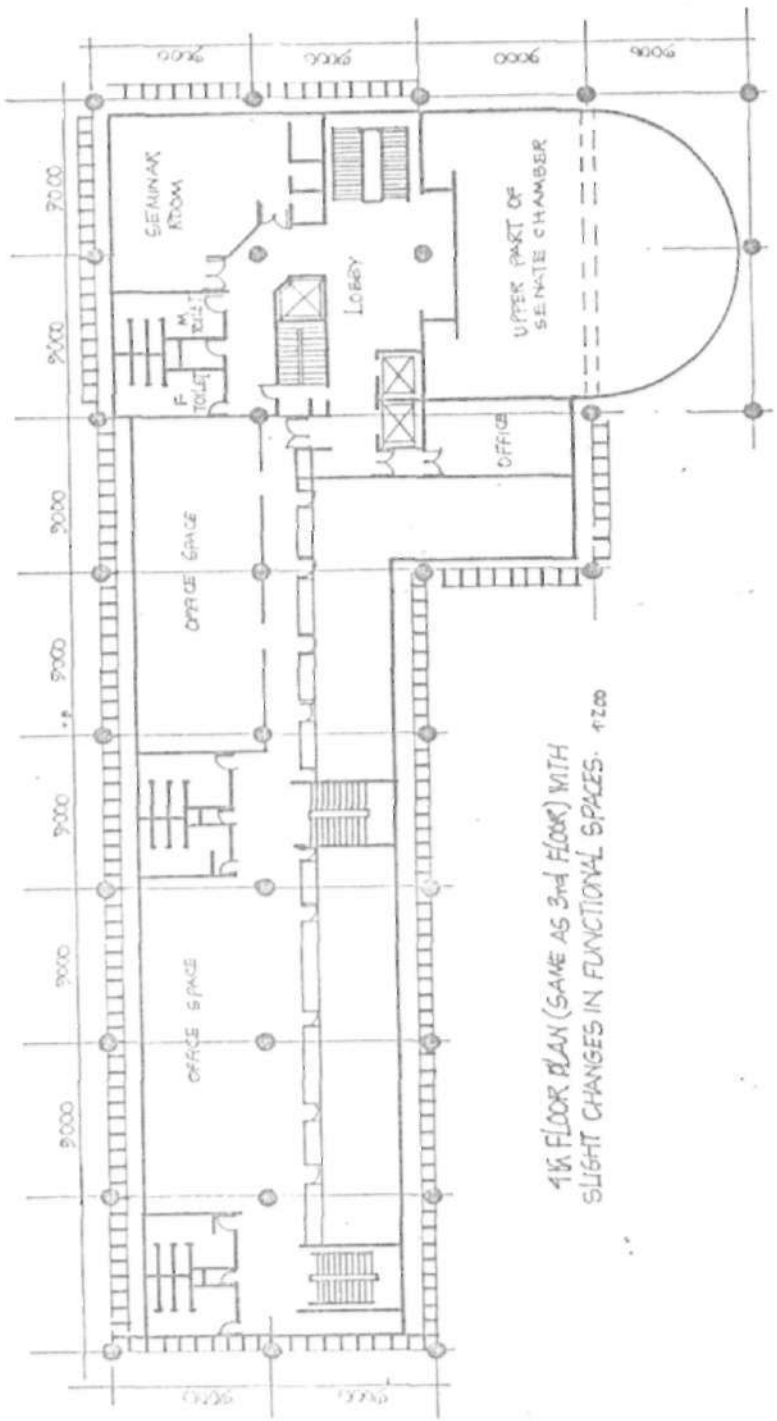
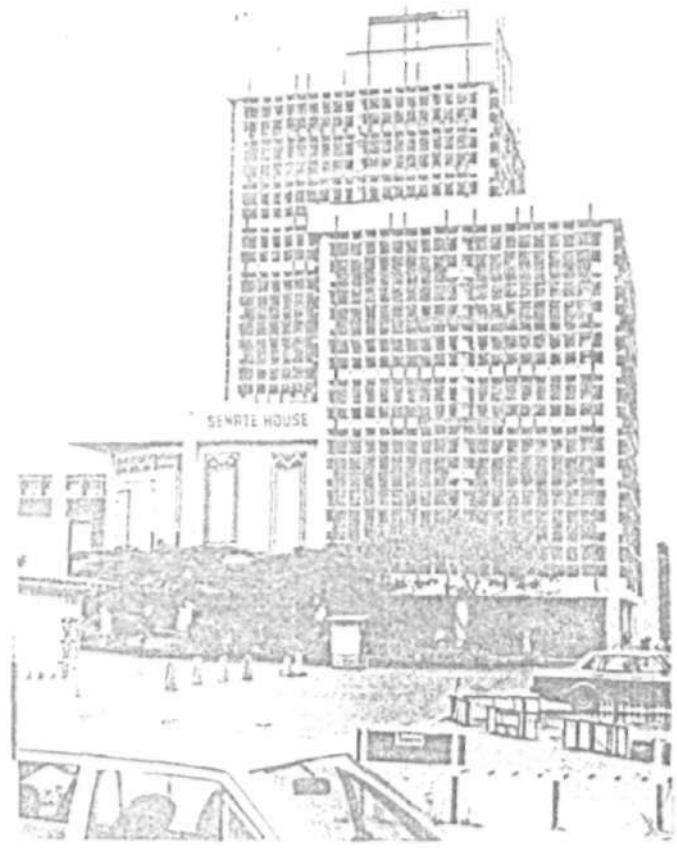

9000
9000
9000
LOBBY
LOUNGE
KITCHEN
STORE
OFFICE SPACE
OFFICE SPACE
2nd FLOOR PLAN

Fig. 3.9c



1st FLOOR PLAN (SAME AS 3rd FLOOR) WITH SLIGHT CHANGES IN FUNCTIONAL SPACES. 1:200

Fig. 3.9d



SENATE HOUSE UNIVERSITY OF LAGOS. NIG.

3.7.2 Wind Energy

The use of concrete roof has greatly reduce the risk of roof being blown away.

The egg-crate sun-shading devices used will help to control excessive wind coming to pass through the building.

The orientation of the building ensures good ventilation by placing the windows on windward side.

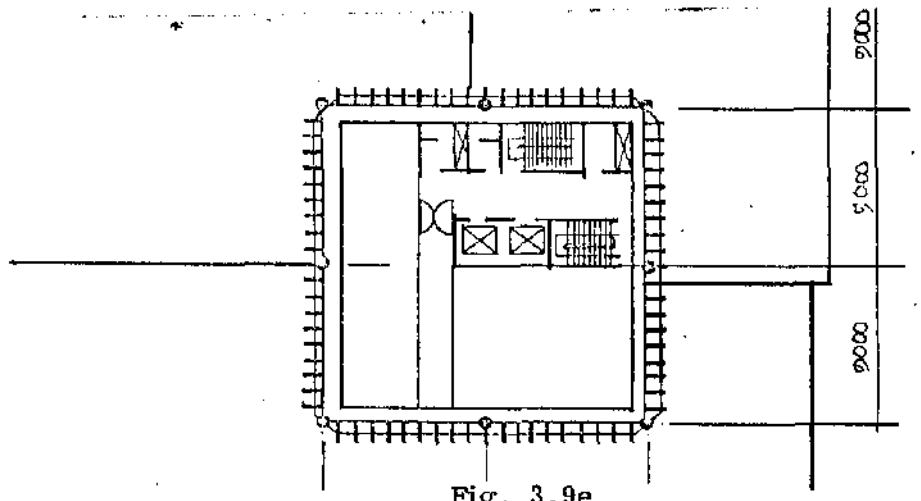


Fig. 3.9e
9-12 FLOOR PLANS 1:200

3.7.3 Sound Energy

i. The sound coming from the noises of people has been taken care of through design, i.e by placing those offices that are most frequented by people at the ground level.

ii. As stated earlier rectangles help in spreading sound, hence this form and shape will reduce the menance of sound energy on the occupant.

iii. The use of circular form in the design of the Senate Chamber was basically to control sound, since it is a very good form for sound distribution and absorbtion.

3.7.4 Electrical Energy

i. The provision of rench windows in the offices has greatly reduce the use of electrical energy in form of lighting, as natural lighting is achieved.

ii. In the lobby and the stair cases however, there is the need of artificial lighting because they are well hidden, and provision of natural lighting through windows or openings was not made.

3.7.5 Mechanical Energy

i. The use of lifts, air conditioners and the services cores will certainly consume a lot of energy.

ii. The use for air conditioners to enhance ventilation may not be neccessary because of the good orientation to both sun, and wind.

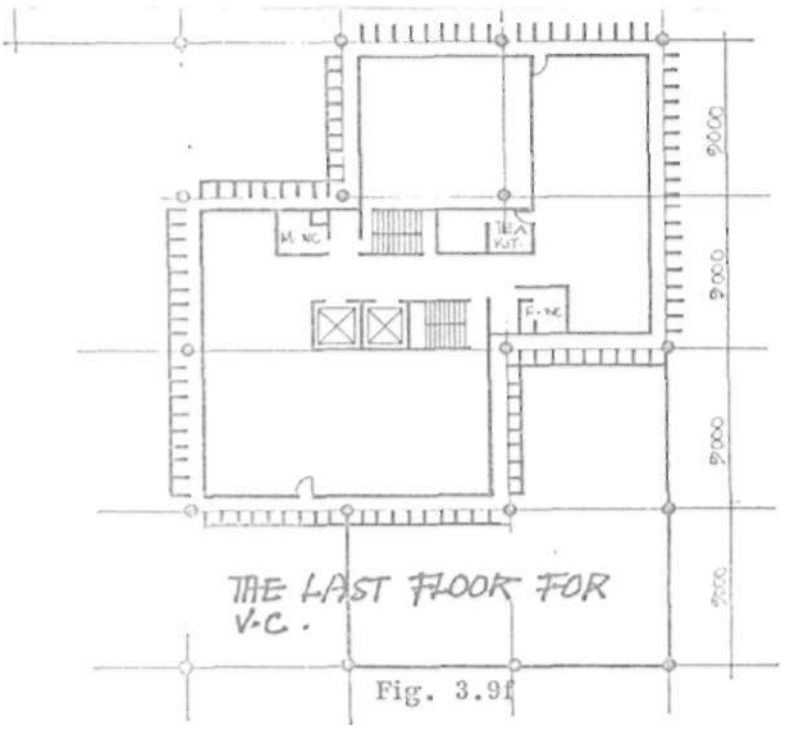
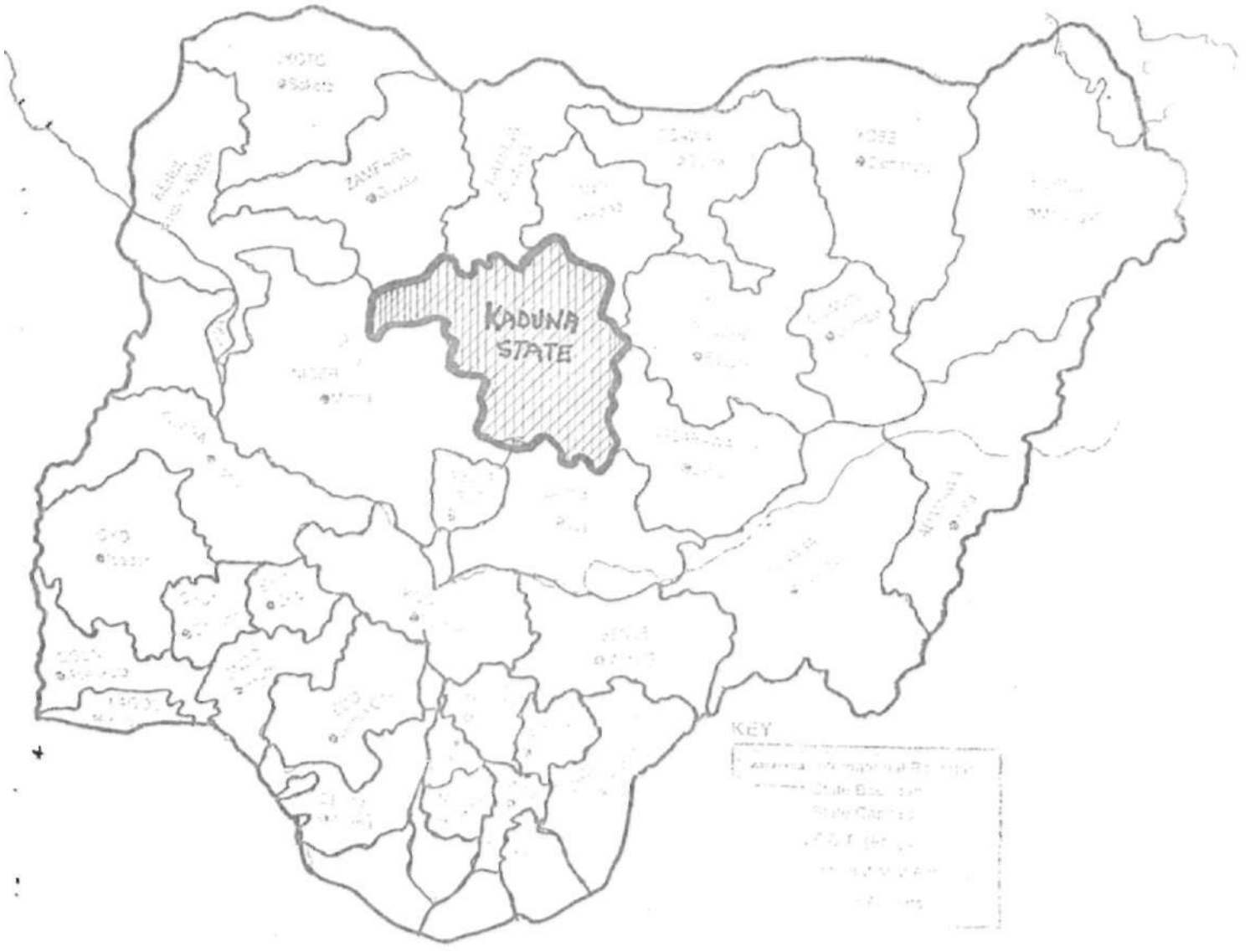


Fig. 3.9f



MAP OF NIGERIA SHOWING THE 36 STATES, WITH THE STUDY AREA SHADED.

SOURCE: NIG. ATLAS (1998)

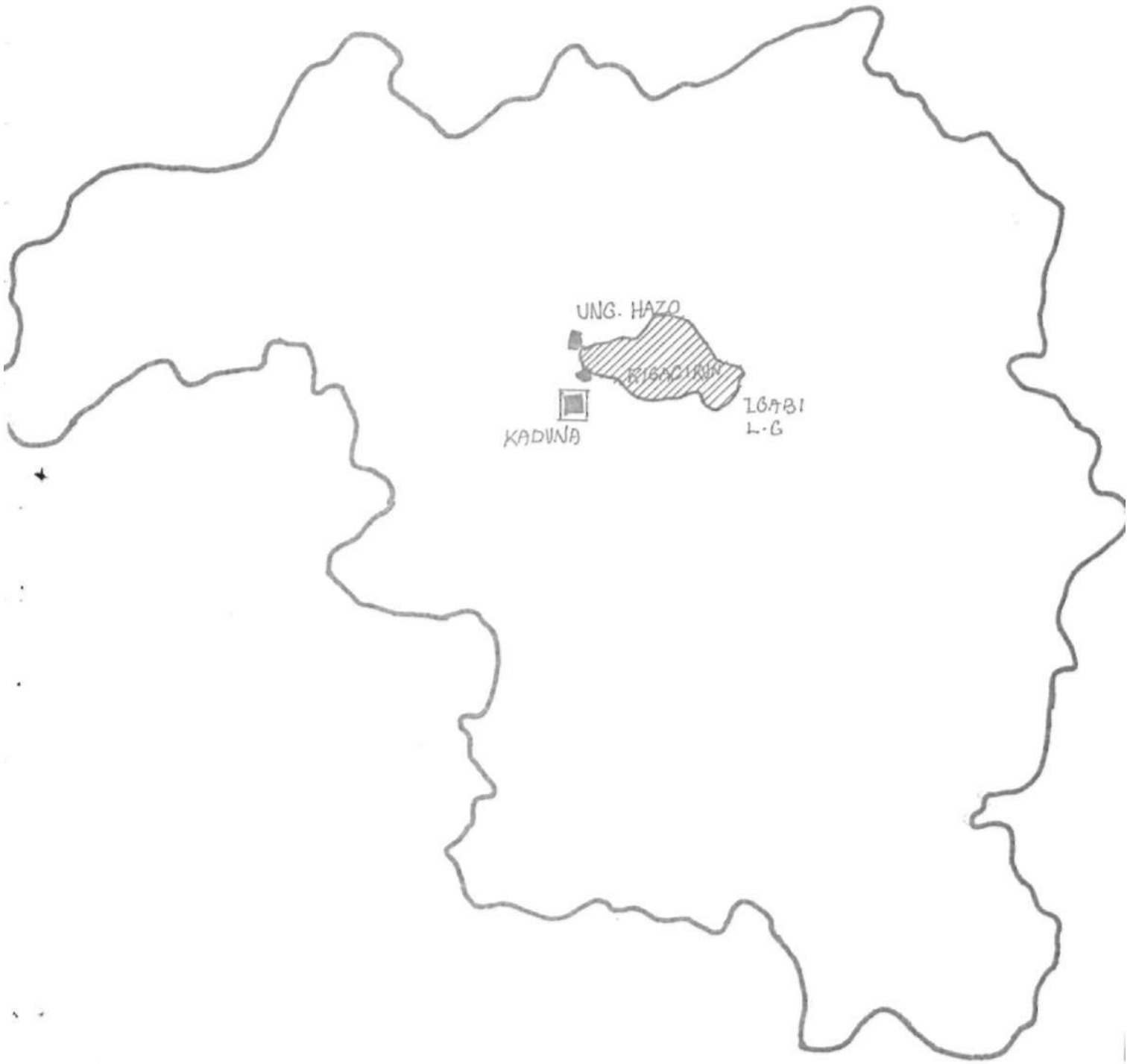
3.8 PHYSICAL CHARACTERISTICS OF STUDY (KADUNA)

3.8.1 Introduction/Location

Kaduna by virtue of its position on the map of Nigeria, i.e its geographical location of longitude 7°27', latitude 10°36', altitude 544.93m is the centre of the northern Nigeria. This strategic location coupled with other reasons of weather conditions lead to its selection by the colonial masters to serve as administrative, and military capital of the then northern protatorate.

It is linked to other major towns in Nigeria by primary roads i.e federal trunk 'A' roads. It is located 239km to the west of Jos, 176km to the south of Kano, etc. It is serving as a junction between the arm of railway strechking from Kano to Lagos, linking the north with the west and the link moving northwards from Port-Harcourt in the east.

Presently, it is a state, i.e one of 36 states in the Federal Republic of Nigeria, with the Kaduna town as its administrative capital.



MAP OF KADUNA STATE SHOWING IGABI LOCAL GOVERNMENT.

Igabi Local Government is one of the 24 local governments in the state, this is where the site is located.

The site is located at Unguwan Hazo from Rigachukum village.

3.8.2 Historical Background of Kaduna

The city of Kaduna served as the Headquarters of the administrative and military capital of what then was called the Northern Protectorate. It was at the centre of the Northern Protectorate, the area it served as the headquarters, it was chosen because of this strategic location.

In between 1956 and 1959, i.e within four years, the still somewhat small garrison outpost of government and growing industry were fitted with the country's parliment and with much needed improvements, this lead to Kaduna was prepared and equipped to take up position of greater responsibility as a capital of the north, within the newly created Independent Federation of Nigeria in the 1960s.

It remained the capital of the north Central States after the creation of first twelve states

in 1967 when later more states were created it became the capital of Kaduna State.
The word Kaduna was a plural of Kada (i.e Crocodile) in Hausa language which formed the major tribe of this state.

By virtue of its position as the first capital of the north, it attracted almost every tribal group within Nigeria, this made Kaduna a cosmopolital city.

In 1978, the United Nations development project estimated the city's population to be 528,000 - civilians with a growth rate of 8.6%, this was the highest in all the states of the federation at that time. Kaduna population is expected to reach at least two million by the year 2000, by UNDP projections.

3.8.3 Topography

Kaduna topography comprises of rolling park line terrain typical of the northern states, with little relief high about 100ft above and below 200ft countour line. There is the presence of granite inselbergs that rises sporadically like domes as high as a thousand feet above

the general level of the plain which is to the east - and south-eastwards from Kaduna ends in escapement to the Jos Plateau.

Soil can be identified generally to the content of clay which determine the classification of the soil as clay (where it has over 30% clay), clay-loam between 20 - 30%, loamy sand less them 20% and sandy loam less than 15%.

These soils generally are coarse and to an extent textured, they are a well drained but with finer texture poorly chained. Covered with iron-stones in some places, these soils are moderately suitable for dry farming (fadama) and easy to cultivate.

3.8.4 Geology

The Geological structure comprised of mines of streaked granite, rocks in parts with darker softer bands and varied in colours. Over most of the area, the surface is the upper part has decomposed to laterite.

Erosion is mainly by small streams that cut deep gullies leaving behind the residual laterite caps that are gradually eaten away at the edges by naturally forces of rain, wind,

and vegetation.

The water table is usually high, so that wells are sunk to a comparatively shallow bore depth of about 50ft.

3.8.5 Vegetation

Kaduna falls within Guinea Zine, which is characterised by a relatively thicker wood vegetation than the Sudan Savannah, this is generally of orchard bush.

Modifications over centuries by cultivation, bush burning, and grazing, lead to the places becoming open like grasslands.

The greatest threats to the vegetation is in the cutting of these trees by people to be used as fire wood, and recently bush burning.

CLIMATIC DATA OF THE SITE

The site is located at Unguwan Hazo, Riga-chukum, a village six kilometers to Kaduna going to Kaduna from Zaria, the site lies at approximately at 45° to the central Kaduna area.

3.8.6 Rainfall

Rainfall normally comes between the months of April to ending of September, with the highest normally recorded in July - August.

Considering the chart of rainfall for a particular year drawn - fig It can be seen that the highest recorded was in the month of August with about 600mm, and the lowest value recorded was in January.

Kaduna can be said to have at least five months of rainfall in a year with a varying degree of intensity.

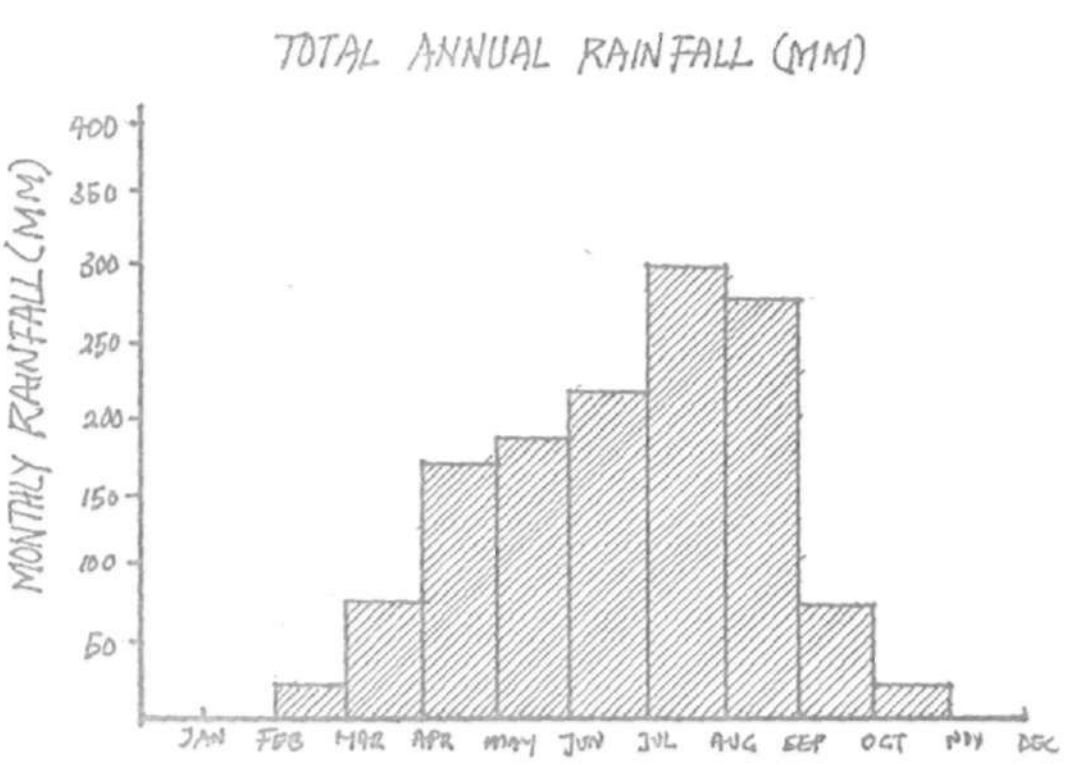


Table 3.0

SOURCE: I.A.R, A.B.U ZARIA

Inference: The above values of rainfall, and the time duration will influence design in the following ways:

i. Slope of a roof, i.e the angle at which a roof is placed will be steeper there in Kaduna than other places with less amount of rainfall record.

ii. Provision of covered walkways is recommended in a design, especially considering the length of rainfall in a year.

iii. Adequate drainage for rainwater is to be provided in form of roof gutter if flat roof is to be used etc.

iv. The external finishes of the building will also be affected i.e water proof paints to be used for external walls etc.

3.8.7 Temperature/Sun Shine

The average sun-shine hours recrded in this area is between 7 - 8 hours a day, sometimes the temperature reaching up to 36°C. In the month of March.

The least recorded temperatue in this area was in the month of July with about 25°C.

Comfort of occupants of a building depends on orientation of the building to the sun. Normally, the west wall receives intense heat from the rays of the sun striking at low angles in the afternoon. As soon as the sun gets lower rays will now penetrate any window on this side thereby causing discomfort.

The short wave radiation from the sun is changed to long wave radiation from the wall. This is stored during the day and given off during the night which penetrate the skin. Thereby making the roof very hot and uncomfortable at night especially in the month of April when the temperature is highest.

Based on this, the knowledge will now assists us to determine;

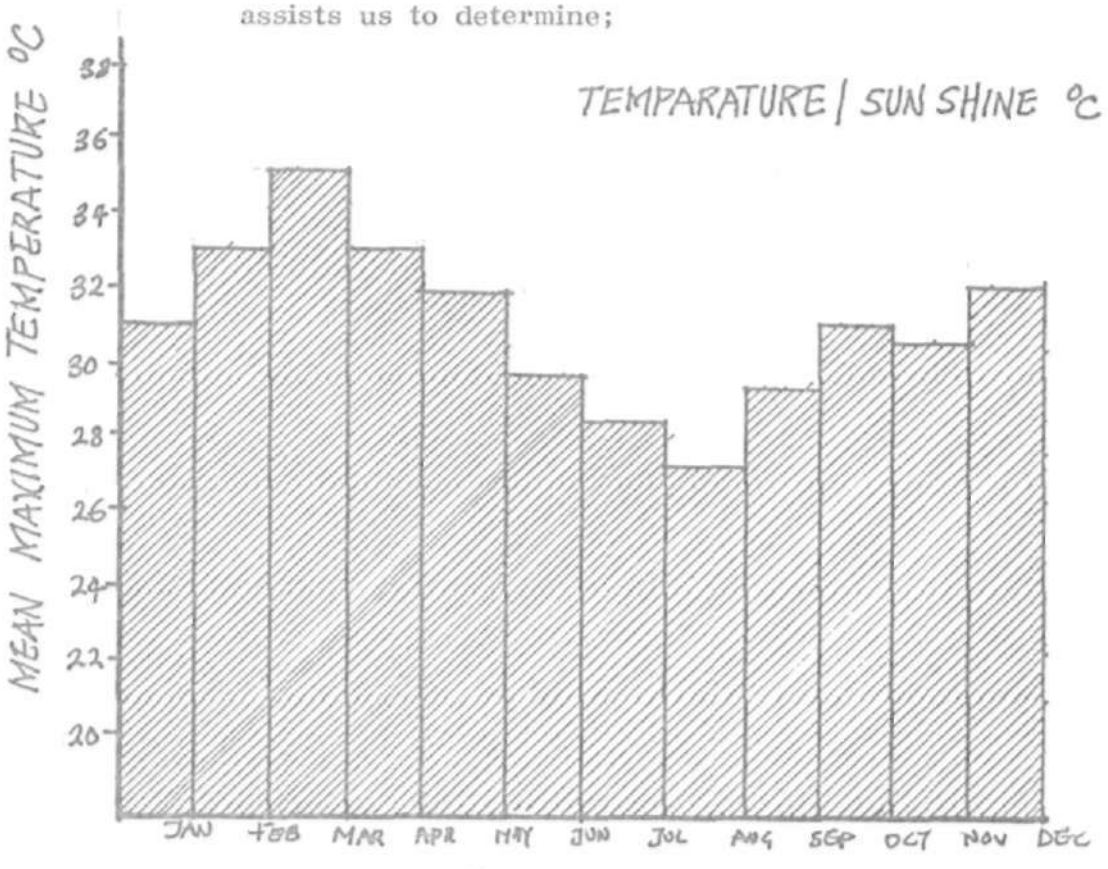


Table 3.1

Inference:

i. Types of walls to be used for the construction of the building. In this case, heavy walls and roofs with at least eight hours time lag is recommended.

ii. Penestrations should be avoided on the western side of the building.

iii. Windows should be medium on the walls i.e between 20 - 40% of the wall area.

iv. These windows are recommended in the North and South walls at body height on wind ward side.

v. Extensive paved surfaces are to be avoided near pedestrian areas.

vi. Shaded pedestrian areas modify intense heat in the sun.

vii. External finishes of the wall should also be such that they reflect the sun instead of absorbing it.

viii. Most importantly, it determines the type of sun - shading device to be used externally.

3.8.8 Wind

The wind comes in two ways, one, during the harmattan season from November to March, the winds are dry, cold and often strong and blows coming from North-east straight of the Sahara regions.

The second one comes in form of rainstorms, which usually violent with thunder and lighting preceded by driving winds coming from the South-east.

The highest wind speed recorded was 75km h-1 i.e 20m5[1], in the month of April, and the lowest in the month of October with a value of 20km h-1. This knowledge will help in determining:

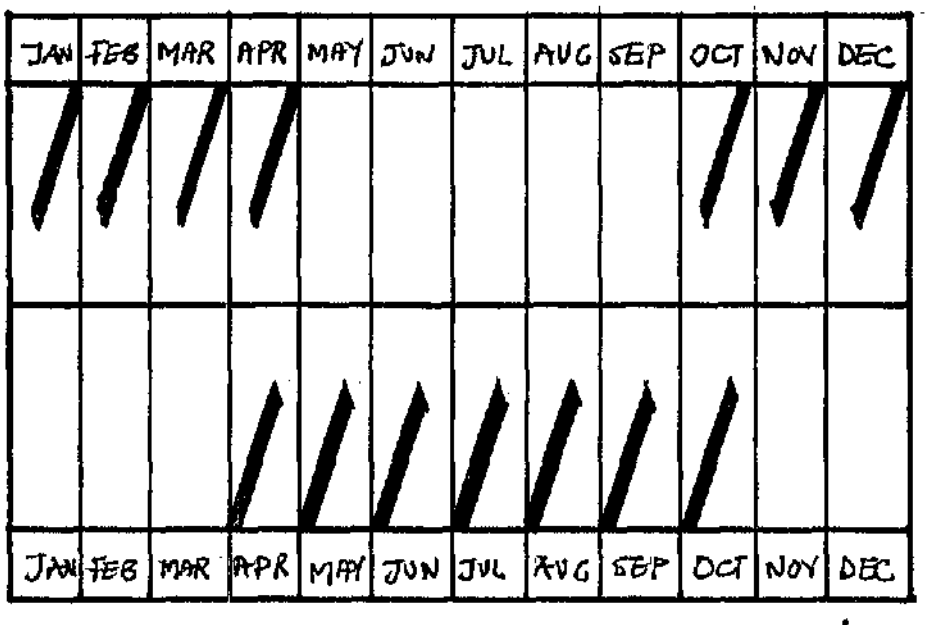


Table 3.2 WIND DIRECTION IN A YEAR.
SOURCE: I·A·R, ABU ZARIA

Inference:

i. In structural design, it should be made in such a way that the building behaves as a single unit; design for reversal of stress, avoidance of electricity in attachment.

ii. Design of roofs for internal as well as external pressure.

iii. Orientation to the wind to achieve optimum cross ventilation could be achieved, in this case the orientation of windows should be in such a way that cross ventilation is achieved in the Nourth - South axis.

iv. Use of dust barriers in the form of ever green trees and to act as buffer.

v. Provisions should be made to enclude sunlight.

vi. Opening especially windows should not exceed 20 40% of the total wall area.

3.8.9 Relative Humiditv(%)

The value of relative humidity is normally high in the mornings and low in the afternoons. The mean maximum relative humidity recorded was in August with about 80% value, this is

ofcouse due to the consistent rainfall in the month.

The lowest RH recorded however was in the months of December and January with 43 - 60% value. In the afternoon of these months a value of less than 30% have been registered.

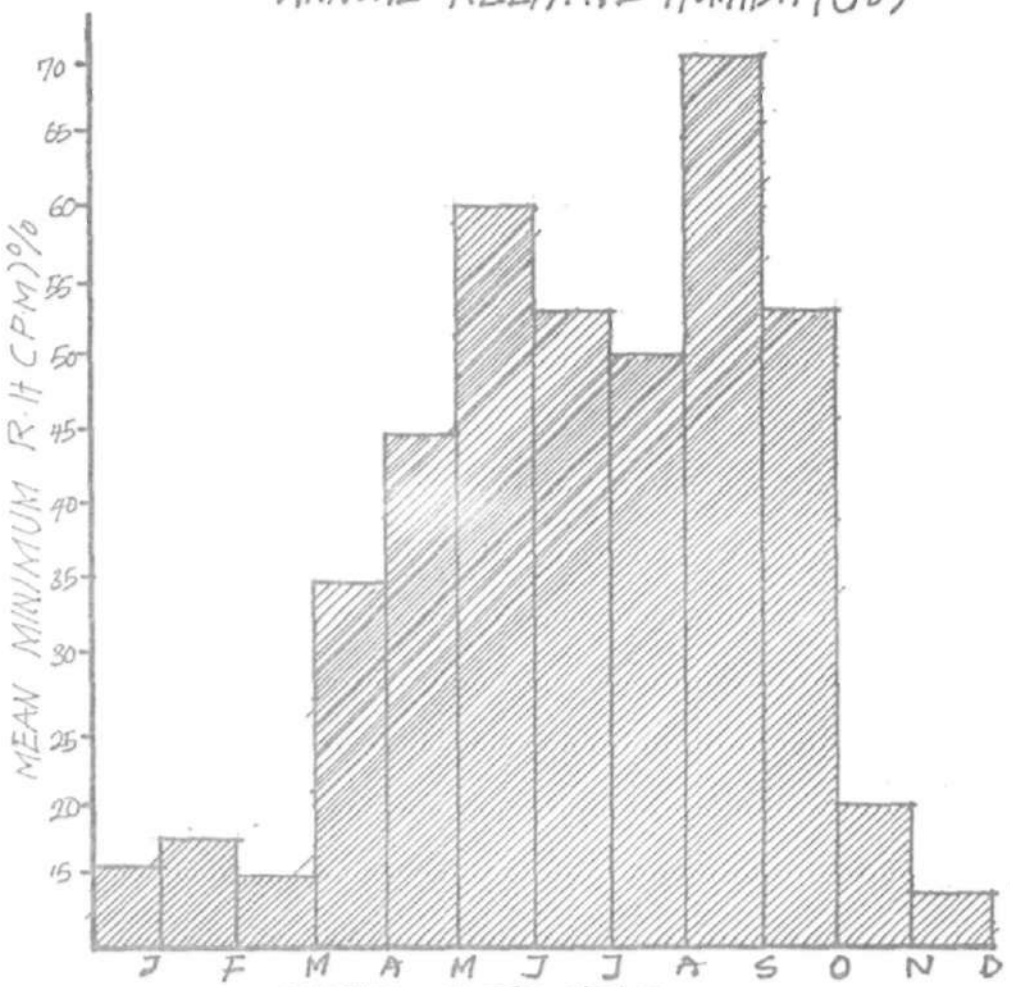


Fig. 3.3

Inference:

- Positioning of water bodies e.g artificial dam in the path of North-east trade winds; this will cause evaporation and helps to increase humi-

dity during the dry season.

ii. Sizes of penestrations can also be determined by a value of humidity, this is in order to achieve proper lighting and cross ventilation.

iii. Type of banking systems to be used. In this area to achieve optiman cross ventilation single banking is recommended.

3.9 SITE ANALYSIS

As explained earlier in the preceeding chapter the site is located at Unguwan Hazo, in Rigachukum are of Igabi Local Government of Kaduna.

The site is located six kilometers away from Kaduna town, and just a kilometre to the new permanent site of Trade Fair Complex.

3.9.1 Site Selection

The site could be said to be well selected for this project simply because of the ease of accessibility, services, e.g power lines that passed close to the site, the railway line etc.

3.9.2 Accessibility

The accessible road to the site is through an untarred road that linked the main double

carriage way going to Kaduna. However, the untarred road leading to the site needed to be upgraded and tarred to serve the expected increased traffic to be expected from and to the university.



Plate 3.4

ROAD FROM DOUBLE CARRIAGE EXPRESS WAY OF KADUNA, LEADING TO THE SITE.

SOURCE: HAMZA .B (1998)

3.9.3 Other Services

Other services advantage to the site are, the National grid - National Electric Power Autho-

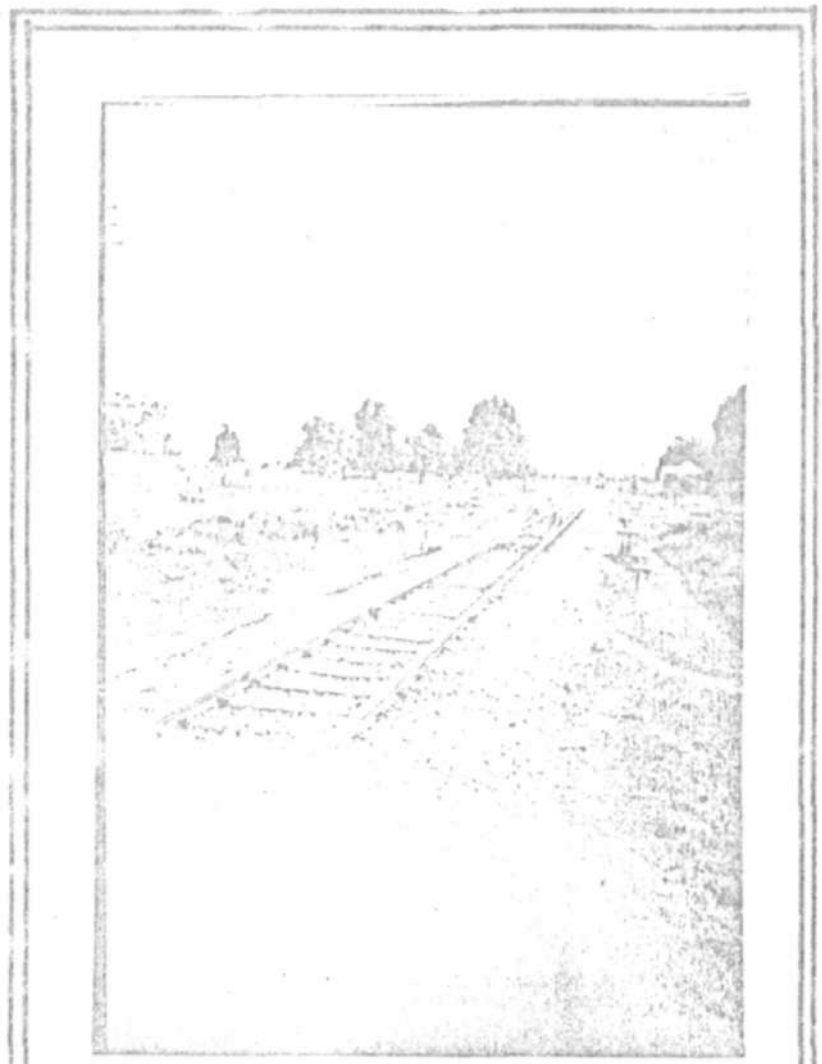


Plate 3.5

RAILWAY LINE, COMING FROM KANO TO THE SOUTH IT PASSES SOME KILOMETERS FROM THE SITE.

SOURCE: Hamza-B (1998)



Plate 3.6

HIGH TENSION NATIONALGRID N·E·P·A THAT PASSED AND COULD BE USED FOR POWER FOR THE UNIVERSITY..

SOURCE : HAMZA·B (1988)

rity, and the railway line that will supplement the road transport system to the University.

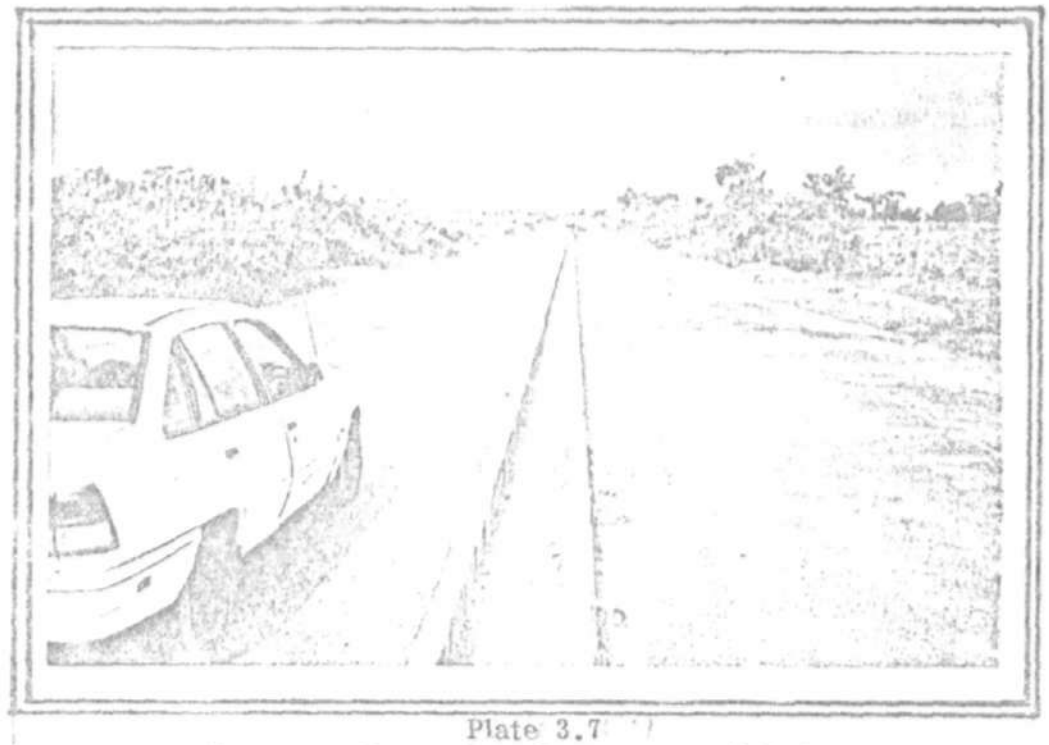


Plate 3.7

TARRED ROAD LINKING THE EXPRESS-WAY TO THE UNTARRED ROAD GOING TO THE SITE.

SOURCE: HAMZA. B (1978)

3.9.4 Micro - climate of the site:-

3.9.5 Topography

The site as seen in the section is generally flat with a very slight slope to the North west.

3.9.6 Vegetation and Climate

The vegetation is typical of Guinea Savannah with shrubs and scattered trees.

3.9.7 Source of Noise

The main source of noise is expected from the major road to the site.

3.9.8 Orientation

The site is located at approximately 45° to the Northern position.

3.9.9 Sun-path and Trade Winds

The sun passes the site from the east side of the site to the west at approximately right angle, i.e horizontally.

The North-east trade wind that is most prominant between November to February, crosses the site at right angle, this wind is cold, dry, and dusty.

The South-west trade wind is most prominent between the months of March to September. This wind is wanted and required. It is cold, moist, and good for ventilation.

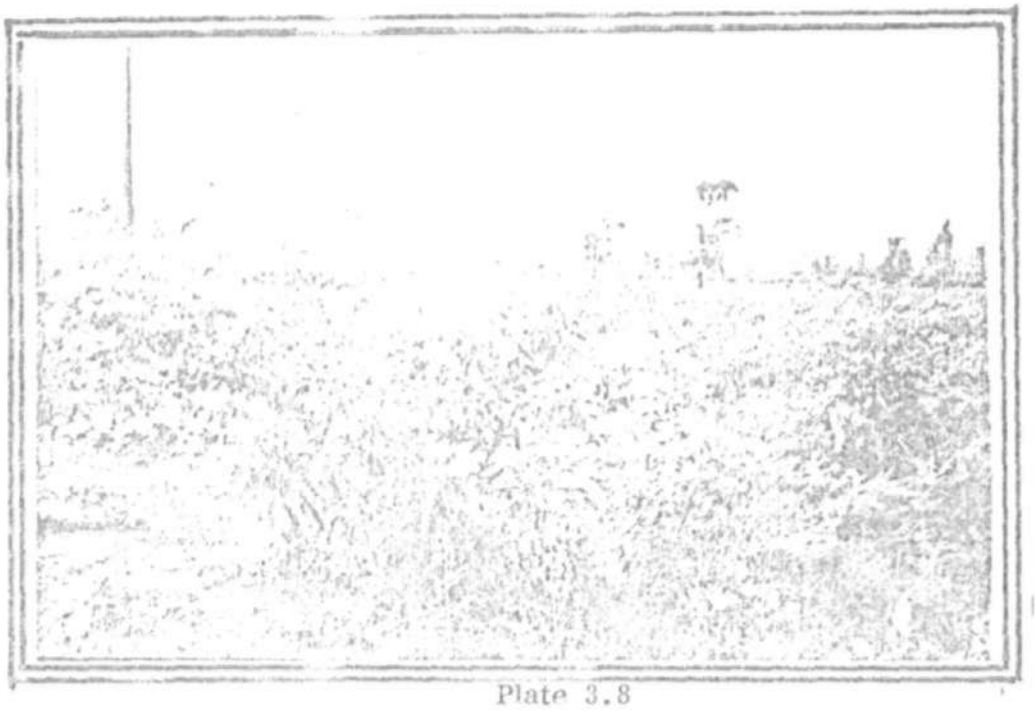


Plate 3.8

SITE AREA SHOWING VEGETATION. TYPICAL OF GUINEA SAVANNAH. I.E SHRUBS AND TREES



Plate 3.9

PART OF ROADS LEADING TO THE SITE, NOTICE THE TYPE OF VEGETATION.

SOURCE: HAMZA · B (1998)

Chapter Three

REFERENCES

1. Nigerian Universities Commission: Standard Guide for Universities.

2. Ahmadu Bello University's Master Plan (1965) ABU Press

3. Kabir, B. (1997) Senate Building for ATBU Unpublished M.Sc Thesis, ABU Zaria on

4. Doi, J.A. (1988) Islamic Institute of Research and Islamic Studies, Unpublished M.Sc Thesis, ABU Zaria.

5. Idowu, I. (1994) Senate Building LAVECH Ogbomoso, Unpublished M.Sc Thesis, ABU Zaria.

6. Kaduna State Government Press, (1970) Kaduna Town Master Plan (1970-90)

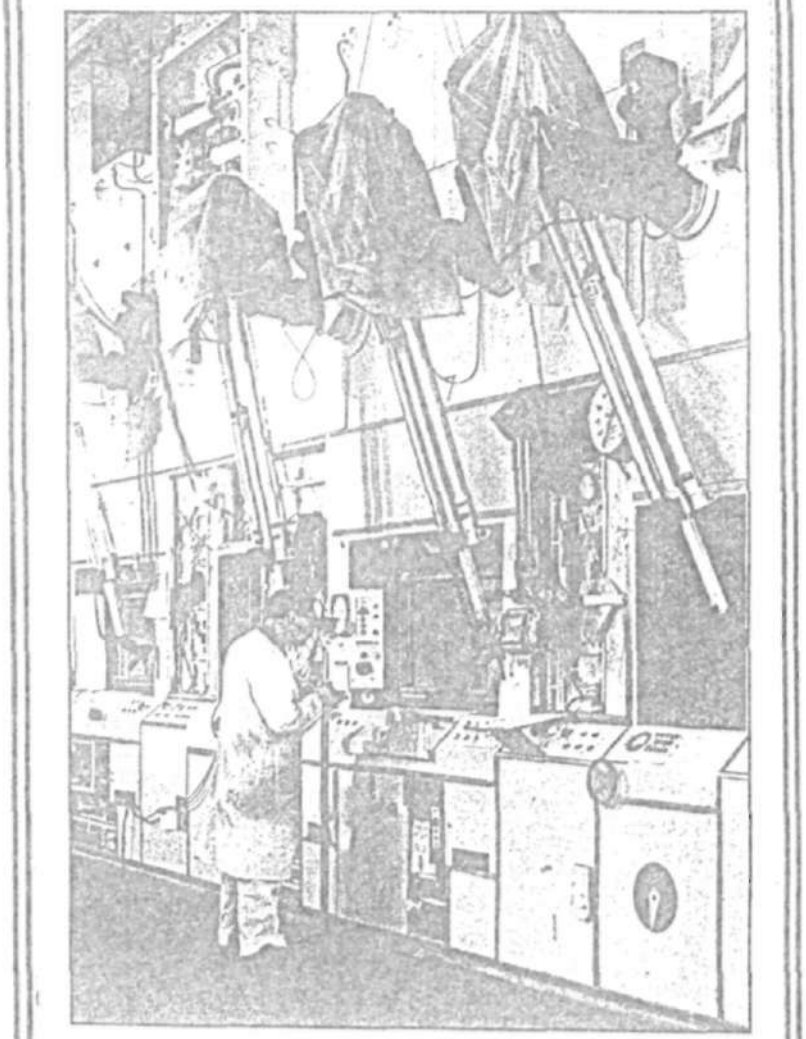
7. OGUNSOTE, O.O. (1994) Introduction to Building Climatology, ABU, Press, Zaria.

Chapter Four

ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN

"THE DESIGNERS PHILOSOPHY MUST BE TO DESIGN FOR ENERGY CONTROL IN A COMPREHENSIVE MANNER TAKING ACCOUNT OF ALL THE MULTIVATIOUS ASPECTS OF HIS ART. HE MUST EXPLORE NEW TECHNOLOGY AND TAKE ACCOUNT OF PAST TECHNOLOGY. BUT ALWAYS APPLY THE RESULTS IN A MANNER WHICH PRODUCES A COHERENT WHOLE".

C. McDONAL



CONTROL OF ENERGY THROUGH ACTIVE MEANS IN A NUCLEAR STATION.

Plate 4.0

SOURCE: HAMZA·B (1996)

Chapter Four

4.0 ACHIEVING PASSIVE CONTROL OF ENERGY THROUGH ARCHITECTURAL DESIGN

4.1 INTRODUCTION

Many buildings today have a common characteristics of being high energy consumers (especially electrical). Energy was used, as it was then inexpensive to over come problems of heat loss, solar - heat gain, lighting, cooling etc.

Few architects and infact society in general were not particularly aware of the serious implications of resource consumption, while it is reasonable to question why society as a whole was short-sighted, it must not be forgotten that buildings of this era represented the general social concerns of their time. In doing so they have solved many of the social and technical problems of our age, and still continue to do so. Designers developed the ability to house groups of people and activities in a way which we now take for granted.

Looking at bukdings designed before energy became plentiful, and easily distributed, as well as buildings from cultures where energy, as we use it, was not available.

Designers of these buildings over come many of the problems we face by the manipulation of such things as thermal mass, shading, orientation, wind, sun, etc. In addition, these devices have often been instrumental in forming the Architectural vocabulary of the buildings to which they were applied. It is not suggested that these concepts will solve all the problems; however, they must not be disregarded. This is the main aim of this thesis dessertation.

In view of this, Architects should evolve a manipulative of energy control in order that they can include the concepts of passive design in the basic equation of design, rather than regard them as a subject which can be applied to the end process of design.

4.2 ENERGY (Concept):-

Energy is defined by Encyclopedia Brittanica as the ability to do work, this was from the word energia a Greek word meaning 'In work'. One of form of energy can be converted to another form through a process called 'Transformation of energy' e.g Radiant energy from the sun can be converted into heat when absorbed into a body,

or it can be converted directly into electrical energy through the use of solar cells.

The use of energy in buildings become an issue in Nigeria because of the cost of its supply to homes, (electrical energy), and for wind or tidal energy it became a point of concern as a result of destruction caused to roofs of buildings recently.

For solar energy, there is an excess of this form of energy in form of insolation, hence it become of concern to Architects on how to control its menance and reduces its penetration in a building which causes great discomfort.

4.2.1 Sources of Energy

Basically, there are two sources of energy supply that occurs naturally. These are:

i. Renewable sources

ii. Non - renewable sources.

iii. Renewable Sources

These are the sources that occurs naturally and which replenish themselves naturally in a relatively short time, and will therefore be readily available for use; example:

a. Hydro-electric power

b. Ocean thermal

c. Solar energy

d. Fidal energy

e. Wind energy

f. Wood fuel energy sources.

ii. Non - Renewable Source

These sources are of two process, i.e they originate from two different processes, one, photo-sysithesis and fossilation of plants, and animal life, and the process of formation of the earth it-self.

The first process gave rise to source in form of the following:

a. Coal

b. Oil (Petroleum)

c. Natural gas

While the second process gave rise to the following sources in form of fuel for nuclear energy, i.e Uranium. Now a days, some countries have developed a technology to use Neclear stations to generate electricity, using Uranium as raw material.

4.3 TYPES OF ENERGY AND THEIR EFFECTS ON BUILDING FORMS

There are many forms of energies, and their sources as discussed earlier. However, discussion will be restricted to those that affect building either directly or indirectly, within, or without the building envelope, these are:

1. Electrical energy
2. Heat/solar energy
3. Human energy
4. Tidal/wind energy
5. Mechanical energy
6. Sound energy.

4.3.1 Electrical Energy

This is the most utilised form of energy within a building envelope.

Artificial Lighting System Design (Panameters);

This is a complex process and required the services of electrical engineer to specify. However, it is good to introduce some of the basic considerations in the design.

(a) The Lighting Problem

This relates to the function and structure

of the area to be lit. This problem relates to specific tasks to be lighted.

(b) Method of Artificial Lighting:

There are four to be chosen from, these are:

i. General lighting
ii. Angle lighting
iii. Localised lighting
iv. Local lighting

(c) Illumination Value Required:

The amount of the illumination for a task depends on the following;

i. Size of the detail to be seen
ii. Contrast between the object of vision and its background
iii. Reflection factor
iv. Motion of the object.

(d) Types of Fittings;

Factors that influence the choice of fittings;

i. The light distribution
ii. The brightness of fittings
iii. Luminums efficiency
iv. Mechanical characteristics of the fitting.

(e) Types of Lamps:

The choice of lamps depends on the special composition of light, source brightness, source area, and economic factors.

(f) Number and Placing of Fittings

This is determined by the available mounting height and the illumination required. The shape of the room determing the arrangement of fittings.

(g) Maintenance:

The installation of fittings enable flexibility of control and easy access for maintenance.

(h) Lighting Standards:

The day light factor required to provide adequate illumination depends on how much light is available from the sky. This in turn depends on the thickness of cloud cover. Design sky is level of illumination and changes from place (Table

Electric energy is used for many purposes within a building e.g lighting, air conditioning (ventilation) heating, etc.

In an office building however, the highest consumption of electric energy is in form of lighting and enhancing ventilation.

i. Lighting in Buildings

One of the most visible sourcesof energy waste in a building is the traditionally designed lighting system. Excess lighting results in energy was both for lighting itself and in warm weather for the cooling needed to offset the heat created by the lights.

In low-rise buildings without elevators, lighting can consume 60% of the supplied electric power. In hot weather, lighting systems account for one fourth to two-thirds of the cooling load in a typical office building.

Some aspects of the relation between day - lighting and artificial lighting are of interest. Day-lighting does not reduce the amount of artificial lighting that must be installed in a building, since it must be designed for the worst, i.e night condition, it does however, reduce the total consumption of lighting energy for certain areas which receive sufficient national lighting to allow the lights to be turned off for part of the occupied hours.

In any event, areas near windows should have a system of switches that allow the artificial lighting to be turned on and off, or dimmed, according to the amount of daylighting available at a given time.

With respect to artificial lighting, there are basically three approaches to controlling electricity energy:

i. Reduce lighting levels where practical
ii. Turn off lights where possible
iii. Upgrade the efficiency of lighting fortunes.

One of the most important contributions an architect can make is to design space that is light efficient, this could be achieved through:-

a. Room surfaces should have light colours with high reflectance and malte finishes.

b. The wall colours should have a light reflective value of 60% or greater.

c. Ceilings should be white.

d. Desk tops, filing cabinets, and other furnishings within the freed of vision should be light coloured with malte finishes.

e. Open (office) planning permitts the greatest

light flow over a given area.

Switches also affect energy consumption in lighting systems. The amount of energy that switches can save depends on how and what lights the switches control, and whether the switches are organised and located so people can use them easily.

If different areas of the sloor are controlled by separate switches which are then grouped at the door, the chances are that people will switch every thing on as they enter the room, therefore, each switch should be located close to the area it controls

ii. Ventilation (Air Conditioning)

In an office building, ventilation is second to lighting in electric energy consumption.

Air conditioning involves the enhancement of ventilation trough the use of mechanical gadgets.

Air conditioning design is not only a question of building physics and physiological principles, but also a question of analysis of the usage of the space. Cooling loads vary from area to area on a typical floor, depending on the space function and the time of the day.

To save energy and capital cost, we muct aim for minimum plant capacity. This is achieved; if the air flow is reversed from the conventional ceiling to floor to from floor to ceiling, resulting in a possible reduction in capacity.

The average building temperature is allowed to rise during the day.

Energy losses in distribution systems are reduced to the minimum.

The above is shown in the fig below.

Generally, the type of building and air conditioning solution to be used should be able to meet the size criteria of:

(i) Minimum mechanical plant capacity
(ii) Minimum energy cost
(iii) Personal comfort
(iv) Simple design and installation
(v) Air conditioning flexibility
(vi) Easy operation and maintenance.

The above is achieved by having a system that combines central structure temperature, humidity, and dust and odour control working in conjunction with floor standing space cooling or heating booster

units.

The table below shows the process in a schematic form, ove



MINIMISATION OF MECHANICAL PLANT CAPACITY. SOURCE: ARUP (1988)

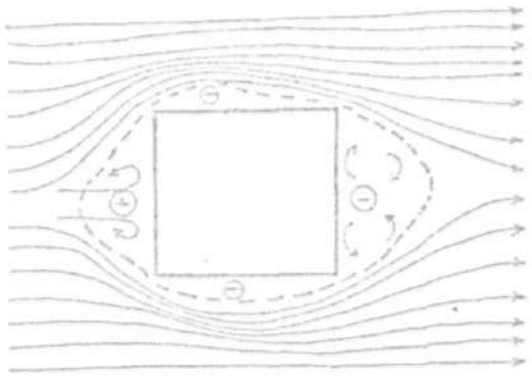
Table 4.0

4.3.2 Wind Energy

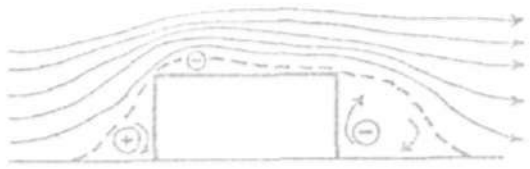
Wind energy in form of rainstorms, and trade winds are significant for building occupant. However, when they exceed the optimum required, it then becames dangerous for the building especially the roof and external finishes of the the building.

i. Wind Effects on Buildings

Wind creates pressure on the wind-ward side of a building and suction on the leeward side. This creates air movement within the building in the direction of the wind. This wind is deflected over the roof and around the sides of the building creating suction. For a wind acting at an angle to a rectangular building, pressure is experienced on a two wind-ward sides, while



Plan



Section

⊕ = pressure

⊖ = suction

where P = wind pressure (N/m^2)

V = wind velocity (m/s)

$$P = 0{\cdot}612V^2$$

Figure 4.1

Wind pressure on buildings

WIND EFFECTS ON BUILDINGS
SOURCE: OGUNSOTE (1994)

suction is experienced on the other two. Suction and pressure on an L-shape building follow the same principles.

Buildings that are positioned perpendicular to the wind direction receives on their exposed side, the full sweel of the velocities. Therefore, the determination of wind loads for roof design should reflect maximum values to avoid blowing of the roofs.

Building rows spaced at a distances equal to seven times their respective heights, secure satisfactory ventilation effect for such units, but the wind has tendency to leap-frog along parallel unit arrangements.

Buildings planned in row arrangement cause a wind shadow over subsequent units, which reinforced for the wind to channel through free spaces and pass by the later units. Staggered arrangement takes advantage of direct flow to subsequent stractures but causes damage to the roof.

ii. Stack Effects

Stack effects refers to the movement of air as a result of difference in air pressure of two bodies of air at different temparatures. Thus when there is a significant difference in the temparature of

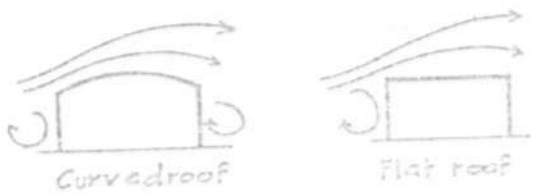
air within and outside a building possesing appropriate air inlets and outlets, air movement results.

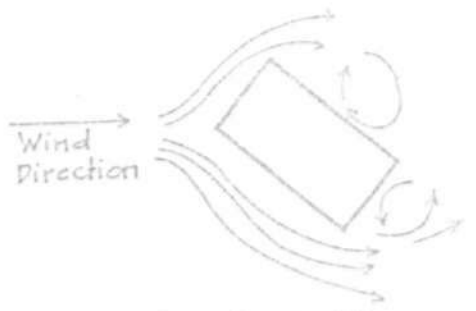
If for example, the temparature outside the building is lower than that inside, then cold air will enter through the lower inlet and warm air will rise and exit through the upper outlet.



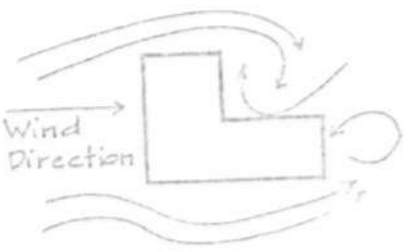
Fig. 4.2
STACK EFFECTS OF WIND
SOURCE: HAMZA (1998)

Stack effect usually produces some air movement even for small differences in temparature and height. In warm humid conditions, such as in Lagos, stack effect cannot be relied upon to provide adequate cooling by air movement, even with large windows. This is due to the low difference in temparature between the inside and the outside. In hot dry climates, stack effects can provide structural cooling at night time especially during the hot season.





Plan : Rectangular building
Wind acting on corner



Plan : L-shaped building

Figure
Wind flow round buildings

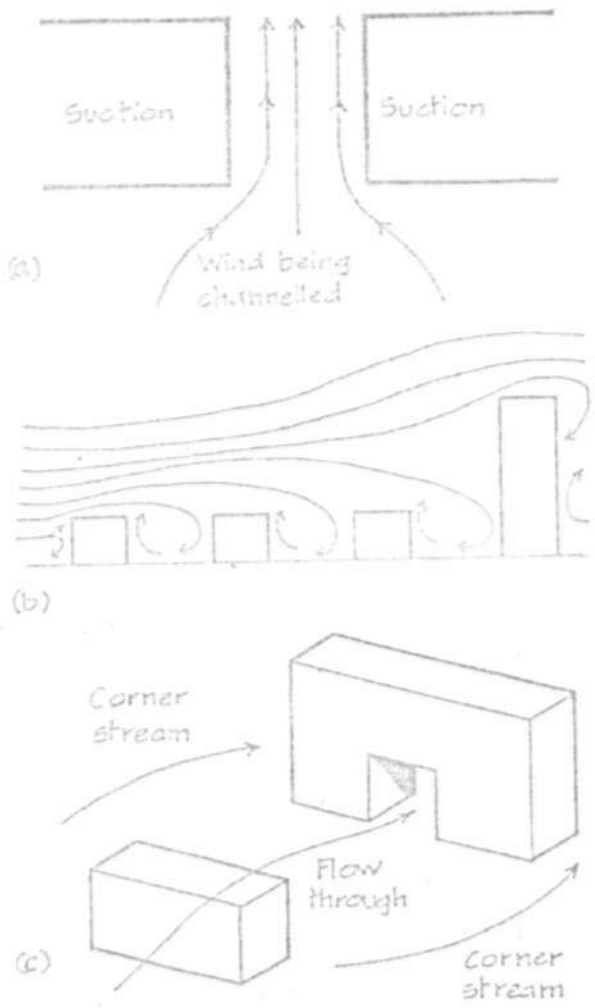


Figure
Effect of neighbouring buildings on windflow
(a) channelling of wind (b) interaction of low and high-rise buildings (c) wind flow around buildings

Fig. 4.2a-c

WIND EFFECTS ON BUILDINGS
SOURCE: OGUNSOTE (1994)

4.3.5 Wind Energy Control Measures

Large air masses can not be altered in their motion which is dictated by differences is air pressure. However, velocities near the living or ground level can be controlled to a certain extent; through the use of the following:

i. Vegetation

The friction drag of vegetation and resistance and obstruction created by trees can cause diversion, in the air flow which may be utilised beneficially.

Besides their aesthetics and shade, giving properties, the value of tree wind breaks lies in there ability to reduce wind velocities. This mechanical effect brings perceptible changes in the temparature and humidity of the air.

A wind breake diverts the air current upward and while they soon turn back and again sweep the ground, an area of relative calm is created near the ground. The most protected part of this area is close to the wind break on the leeward side it become more exposed as the distances increases untill a point is reached where the air have again reach full velocity. There is a smaller calm area, on the windward side especially if the wind break

is quite dense. It is open so that the wind can sweep under the trees, the windward side such openness will result in a smaller protected area located further from the wind break.

ii. Landscaping

The immediate surrounding near a building has an effect on wind velocities. This frees the building to a certain extent from rigid orientation requirements, the landscape design elements including plant materials, trees, and shurbs, walls, and fences creat low pressure which diverse the high wind velocities in a low speed. Care should however, be taken that the arrangement and orientation do not eliminate the desirable cooling breeze during over heated periods as orientation for ventilation might not be suitable for wind control and planting should be designed to direct and accelerate beneficial air movement into the building.

iii. Use of Standard Materials and Good Workmanshp

Use of sub-standard materials used in building and bad work manship also can affect the strengh of the building structure generally.

These materials can not resist wind pressure

which causes sunctian and coupled with bad work manship, the roof ended up blown off.

Where there is a high wind velocities, the spaces between roof members such as rafters, purline etc should be reduced to a minimum so as to make the roof system strong enough to resist the wind pre-suure to prevent against wind damage.

Walls, floors, and roof should be constructed (heavy) i.e with high thermal capacity to present damage caused by wind velocities.

iv. Use of Paradet Wall (As roof)

The use of a parapet wall is also another means of protecting a building especially the roof, this is achieved by wind diversion, thus reducing loads on roof by wind pressure, where the roof is exposed to wind without any obstruction around the building, parapet wall prevent roof from being exposed to wind but increases loads to the building.

4.3.3 Sound Energy

Sound can be defined as a longitudinal waves originating from a source and conveyed through a medium. Sound is the sensation of the medium acting on the ear. The source can be a vibrating

solid body e.g a guitar or membrane of a drum, it can also be vibrating gaseors medium such as air in a whistle, hance the medium can either be a solid or gas fluid.

Amplitude, frequency, wavelength, and velocity are the basic characteristics of sound wave. The sound frequency is defined as the number of waves per unit time, while velocity is the product of wavelength and the frequency. Amplitude indicates the intensity of sound.

i. Types of Sound

These are basically three, they are categorised based on their form of transmission:

a. Structure Borne Sound

This is caused through the vibration of molecules of the barrier which may then re-emit the sound.

b. Impact Sound

This is generated through the use of mechanical means.

c. Air Borne Sound

This form of sound is the type emitted through the air.

Generally, sound may be either;

(a) transmitted

(b) absorbed, or

(c) reflected.

ii. Sources of Sound Energy and Its Control in Buildings

Basically, there are two sources of sound as it affect a building, these are:

iii. Indoor Sources

These are sounds that came from

a. Peoples activities e.g talking, speeches etc.

b. Use of home appliances

c. Use of motorised appliance

d. Office machines.

The above sources of sound can actually be controlled to a bearable proportion theough the use of one or all of the following:-

(a) Reduction at Source

This applies when the noise or sound coming is due to a vibrating machinery: (i) flexible mountings are used to prevent transmission of vibration to the building strcture. In the case of air-borne sound, (ii) an insulating enclosure around the source

is used.

(b) Use of Absorbent Screews and Surfaces:

The use of absorbent materials on critical surfaces of an enclosure can be efficient in reducing reverberant noise when the source of the sound is within the enclosure, basically, there are four types of these absorbent materials used today;

i. Porous absorbents (for high frequencies)
ii. Membrane absorbents (for low frequencies)
iii. Resonants absorbents (Resonators)
iv. Perforated panel absorbents

(c) Insulation:

The transmission of sound between enclosures can be effectively reduced by sound insulation (i) Noisy equipments, such as generators may thus be placed in well insolated enclosures, (ii) Air borne sound can be reduced by air tight and noise insolating constructions, (iii) Structure - borne sound can be reduced by creating sound gaps' separating structures.

(d) Building Design:

Since the noise within a building comes from people, bathrooms, kitchens and appliance, the normal

practice is to:

i. Group noisy zones together, e.g stairs, lifts, corridors, and sometimes kitchens and loundries are grouped together.

ii. The quiete zones are grouped together, e.g study, bedroom and other private careas.

iii. Insolation can also enhance the sound control.

iv. Sizes and shape of an enclosure, e.g large rooms surfaces should be aconstically treated with sound absorbing materials, large corved surfaces tend to focus sound and create an uneven distribution of sound. Thus, high curved ceilings or curved rear walls in a room should be avoided. In general, a room of rectangular shape is preferred.

i. Outdoor Sources;

These are sources of sound that come outside a building, basically, they came from the following sources:

a. Road traffic

b. Railways

c. Air craft

d. Industries.

The above external sources can be controlled through the following ways:

i. Screening

This is mostly used to control sound from traffic, from a high way passing near a building. The screen can be made from walls, hedges, or other barriers.

ii. Planning

Site planning plays important role in noise control viz:

(a) The first rule it to place buildings as far as away as possible from noise sources.

(b) Noise sensitive buildings such as garages, workshops and stores which are placed nearer the noise sources.

(c) Where there are strongly directional sources of sound, noise bands should be avoided in the location of buildings.

(d) Trees and lanscaping are additional tools that may be used.

iii. Insulation

Sound insulation from external sources can be achieved by:

(a) Use of sound insulating materials in external walls and openings.

(b) Increasing the thickness of walls and

(c) Reducing the size of openings in them.

iv. Building DEsign

In this respect, like the indoor noise, it could be achieved by:

(a) Placement of noisy zones such as bathrooms and kitchen near noise source.

(b) The position and orientation of openings should prevent noise penetration.

(c) Use of elements e.g wing-walls, and screens may be used as additional protection.

4.3.4 Solar Energy

The main source of energy on the earth is the sun. This energy comes in form of electromagnetic radiation, the heat flow rate is measured in walts (W) that is Joules per Second (J/S).

However, it is not all the solar radiation coming from the source reaches the outer surface of the earth, for instance assuming the solar radiation reaching the outer surface of the earth as 100%, then 20% is reflected from the clouds, 25% is absorbed

in the atmosphere and 5% is reflected from the ground. Only 50% of the total radiation is thus absourbed by the earth's surface with 23% of this being in the form of diffuse radiation and the remaining 27% as direct solar radiation, this form of radiationalsl called in-coming radiation and it is finally absorbed by the bare soil, hydrosphere, to raise water temparature, and use by marine vegetation.

The earth loses the heat absorbed through long-wave radiation 40% evaporation 40% and convection.

(i) Solar Energy and Its Effects in Buildings:

As explaoned earlier, the only source of solar energy is the sun.

The overall shape of a building affects the amount of solar energy it will consume. In general a configuration that resists unwanted heat gains or losses results in an energy conserving body. To minimise heat transmission for a given enclosed volume, a building should be constructed with minimum exposed surface area. A spherical or round building has less surface hence less heat gain or loss than any other shape for an equal amount of total floor area. A square building has less surface

than a rectangular one of equal area per floor, and so undergoes less thermal transmission loss or heat gain.

The penetration of solar radiation into a building envolope especially in the tropics causes a lot of inconviniences and discomfort for the occupant.

(ii) Solar Radiation Control Measures in and Around Buildings:

Solar control measures that are generally taken are taken to reduce the intensity of the insolation within the building envelope, these are broadly done in two ways:

a. Elements of site control
b. Design (Architectural)

(a) Elements of Site Control

The purpose of site control is to modigy the adverse effect of the solar intensity at a distance before they impact the building. These include:

(i) Shade trees

This is used as form of landscaping to absorb the insolation, this is so because plant absorbs sunlight and yet has lower temparature, because of evaporative cooling which occurs during the trans-

piration of plants. The net heat gain from the sun is rapidly dissipated by the enourmous surface area of the leaves. Very little heat is stored in vegetation because of its minimal mass.

(ii) Ground Surface (Paved and Planted)

This involves the use of light coloured ground surfaces to reflect sunlight on to a building, dark-coloured surfaces to absorb sunlight and raise temparatures, and planted surfaces to both absorb sun light and lower outside temparatures.

Ground reflected light transmitted through windows strikes the ceiling, this is the reason why the paved surfaces should be minimised as much as possible.

(iii) Orientation to the Sun

The general strategy for the placement calls for the largest window area on the side where the sun exposure minimises combined heating and cooling needs.

The percentage of the incident solar energy that a window transmitts for any given day depends on the angle at which rays of sunlight intercepts the window, and for how many hours the window receives the light.

(iv) Orientation to the Wind

When window placement on opposite sides of an interior space is pssible, the building should be slightly askew to the direction of the window. (details on the refer to design conditions for energy control).

(b) Architectural Design

To control solar energy through Architectural design include the use of the following:

(i) sizes of penestrations

(ii) use of solar energy efficient materials and finishes

(iii) use of sun shading devices

(iv) use of verandahs etc.

4.3.3 Human Energy

The most noticeable way of this energy is through the discharge of heat by a body, in form of sweat, and sometimes shivering.

This form of energy within a building is being influenced by basically two factors

(a) Climate

These are major factors which affect thermal comfort, in a design.

i. The air temparature within an enclosure

ii. The air velocity within an enclosure

iii. The relative humidity

a part from the above, others factors that affect human energy in a building include:

iv. Form of clothing

v. Level of activity.

Which Architectural solutions could be profered to the first four of the above, there is little effort one can do about the last two.

b. Architectural Design

In a building, human energy is controlled through the provision of the following:-

i. Use of double volume in places where a gathering of people is expected, and machineries that releases heat to the surrounding.

ii. Circulation system should be souch that it is optimum and properly located. In this respect, stair cases should be placed at a reasonable distance from a functional spaces e.g office, bedroom etc.

Provision of adequate circulation areas by condidering the expected number of users, also these circulation area, their distances should be

minimised as much as possible.

4.3.6 Mechanical Energy

The use of mechanical energy in buildings is in form of machineries, that may require the use of electricity to operate or through mannual means.

Some of these machines and equipments are used to achieve active control of energy in the building, these include:

a, Air conditioners to enhance ventilation

b, Electric fans

c, Mechanical heaters.

There are also equipments, that are used for mechanical transportation systems in a building; these are:

Lifter

Escalators etc.

The above equipments emits heat energy during their operations.

i. Mechanical Energy Control Measures in Buildings

The energy control measures that can be used are two:-

a. Active means

b. Design

a, Active means

In this, the machines and equipments that are to be used are considered and chosen based on:-

i. Minimal mechanical plant capacity that can serve the required purpose.

ii. Easy operation and maintenance

iii. Simple design of plant and easier installation.

In essence, what it means is to enhance the efficiency of the plants.

b, Design

This involves the provision of the following in the Architectural design of the building:

i. Provision of adequate services cores for the machineries and equipment for efficient operation.

ii. The finishing of the spaces provided should conform with the standard.

iii. Appropriate location of the services cores on the floor plan.

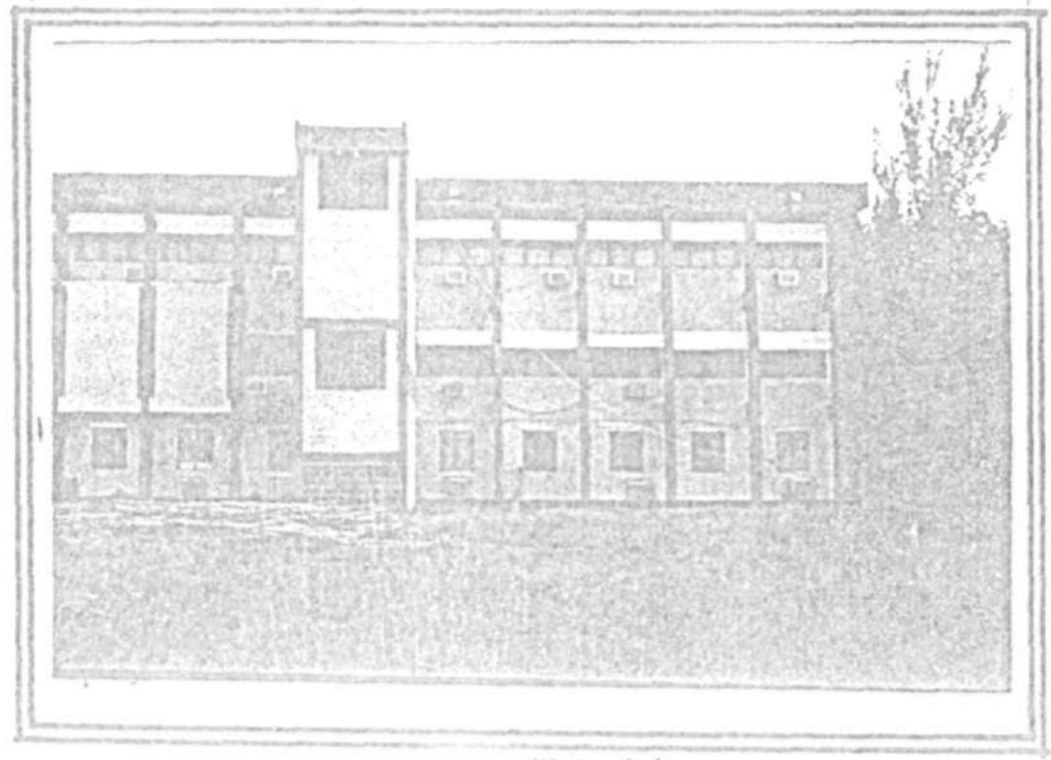
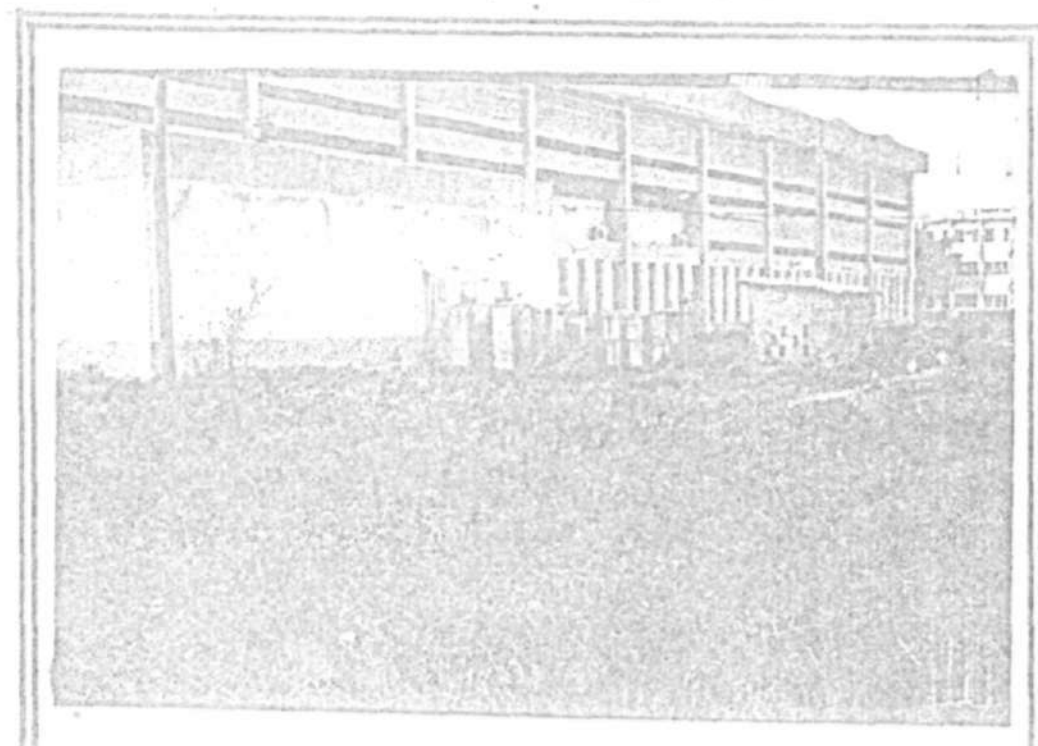


Plate 4.1

RELIANCE ON MECHANICAL COOLING BY USING A·C's



TRANSFORMER HERE USED TO ENHANCE ELECTRICITY SUPPLY

Plate 4.2b

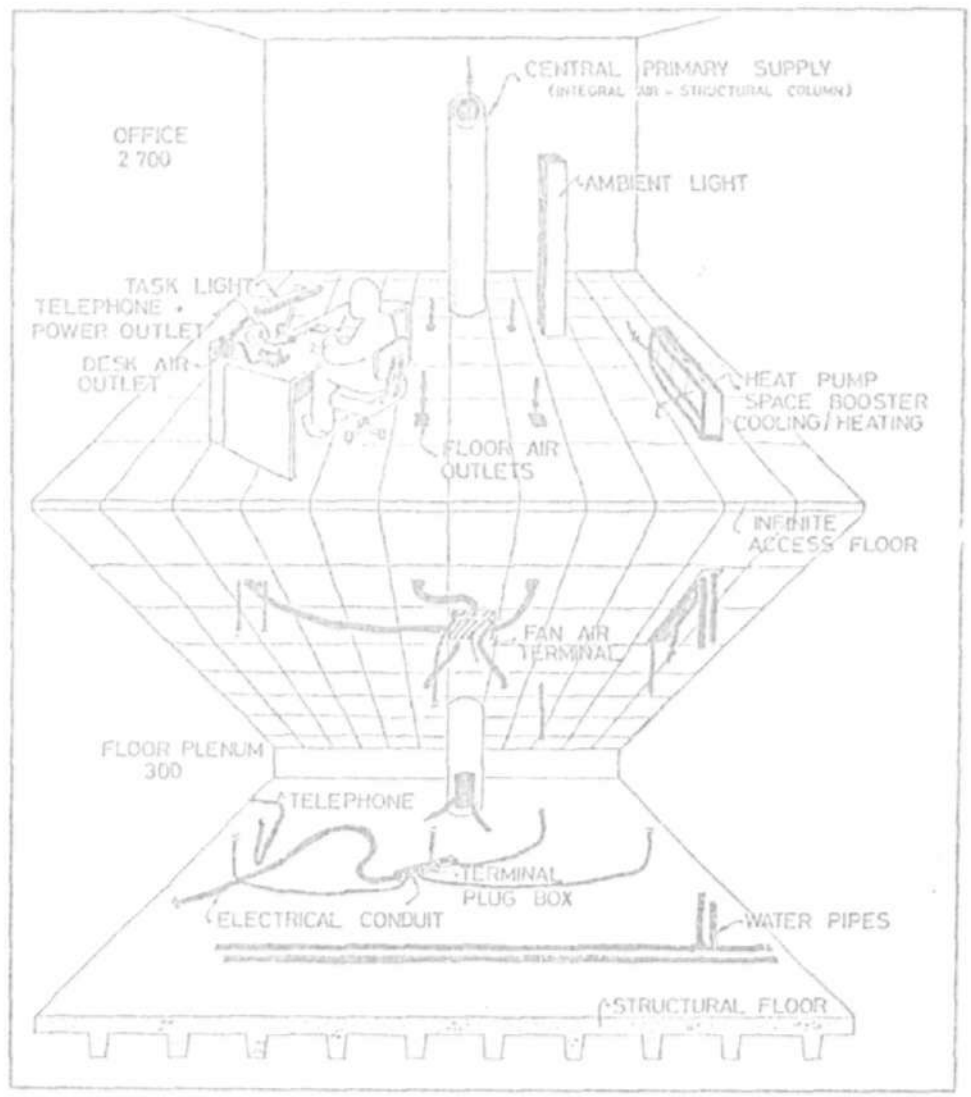


Fig. 4.3

ELECTRICAL AND MECHANICAL INSTALLATIONS INCREASES THE ENERGY NITHING A BUILDING ENVELOPE

SOURCE: ARUP (1988).

4.4 PASSIVE DESIGN CONSIDERATIONS FOR ENERGY CONTROL

Passive design are designs and ways in which buildings reacted to its environment without reliance on mechanical assistance, which in the early times was not available. These considerations included the following;

(i) Siting and orientation

(ii) Building shape

(iii) Nature of envolope.

4.4.1 Siting and Orientation of Building

In actual practice, few architects are offered the luxury of being able to chose a site for a project. In most cases, the client would have gotten his site before approaching the Architect, hence as far as choosing a site is concerned, there is very little an Architect can do.

What an Architect can do is to utilise the site given to him and modify it by using what is called elements of site control, these are;

a. wind breaks

b. shading trees

c. ground surfaces

d. orientation to the sun

e. orientation to the wind.

a) Wind Breaks

This consist of either a fence or row of trees, or shrubs which reduce air infiltration through windows by diminishing the wind pressure. The most effective location for a wind break is upwind a distance of 1½ to 2½ times the height of the building. At this distance, the wind will be deffected up and well over the building reducing the pushing action on the buildings windward side and the pulling action on its loward side.



TREES USED AS WIND BREAK

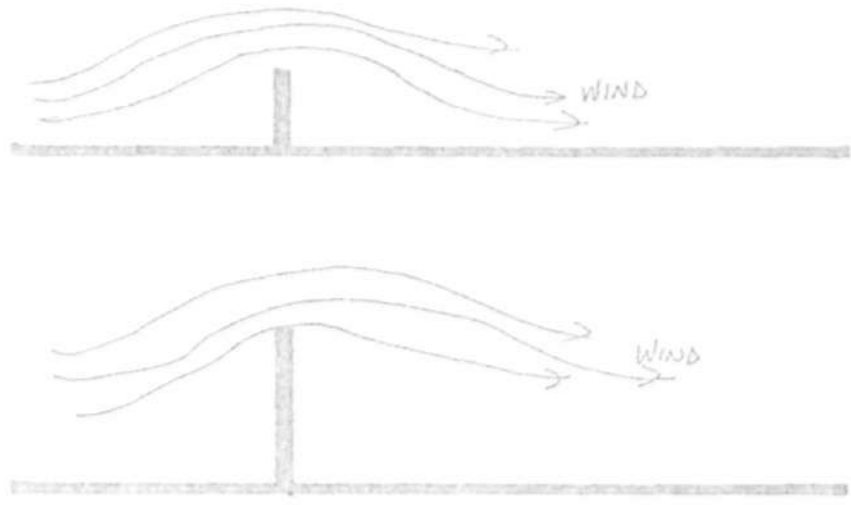


Fig. 4.4a-c
FENCE USED AS WIND BREAK

SOURCE: HAMZA.B (1986)

b, Shading Trees

Trees and shrubs are used around buildings basically for the provision of shades, cooling of the surroundings, and to serve as wind breakers to a strucuure.

c, Ground Surfaces

Use of excessive concrete walk ways, and parings around a building for circulation and other purposes increases the temparature of the area. Hence what is recommended in elements of site controll is, to

(i) reduce the paved surfaces areas as much as possible.

(ii) use shrubs and plants along the pavings to reduce the heat that will be emitted by the paving.

d, Orientation to the Sun

Appropriate orientation to the sun is desired primarily for two reasons, especially in our context;

(i) To avoid direct solar penetration in the buildings through openings. In Nigeria and especially northern part of the country, the recommended orientation is long axis should be along East-west, so that windows should be provided on the North and South direction.

(ii) To reduce the solar energy absorbsion of the building, it is recommended that the orientation follows the above orientation, i.e longer exis along North-east.

a. Orientation to the Wind

As discussed earlier, when window placement on opposite sides of an interior space is possible, the building should be oriented slighted askew to the direction of the wind.

In the illustration below. It will be seen that if the wind encounters an inlet and an outlet in alignment with its outside direction, it will pass through the intervening space in a narrowly defined, high-velocity stream. Very little ventilation will occur beyond that narrowly defined stream. However, if the wind is forced to change direction in transit between inlet and outlet, a turbulence within the room will develop.

4.4.2 Building Shape

To minimise heat transmission for a given enclosed volume, a building should be constructed with minimum exposed surface area. A spherical or round building has less surface and thus less heat gain or loss than any shape for an equal amount

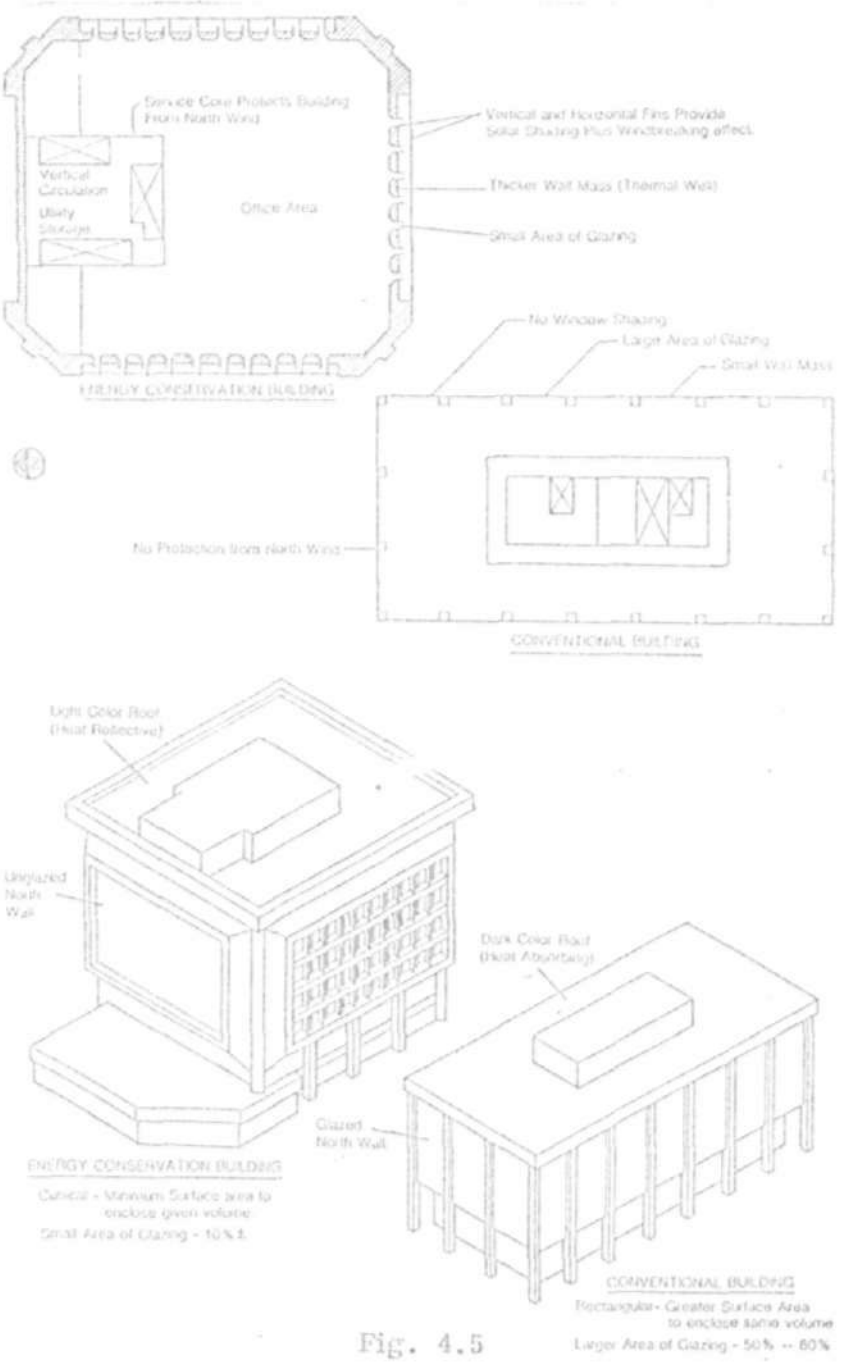


Fig. 4.5

COMPARISM OF BUILDING SHAPES BASED ON ENERGY CONSUMPTION. SOURCE: OVE·A (1988)

of total floor area.

Where a building for example generates large amount of heat from its lighting and computers, the problem may be one of dissipating rather than conserving energy. In this case (depending on the climate) it may be desirable to have as large an amount of building skin as possible in form of volume to facilitate heat dissipation.

To control energy in buildings through its shape, some recommendations are profered:

(i) Tall Buildings

a. They are subjected to greater wind velocities, this increases infiltration and heat hosses, hence provision of exhaust dual systems is required.

b. They have propertionately smaller roof, and hence is less affected by solar gains on that surface.

(ii) Floor-to-Ceiling Height

a. Increased ceiling height improve environmental conditions in summer by allowing heated air to rise.

b, The effects of greater height on energy may be small, although it depends on the thermal characteristics of wall.

(c) Building Forms

i. A dome roof can permit warm air to rise and collect at the top leaving the floor area cooler.

ii. Pyramids, zigzag exterior walls, and other forms can all be used to control the influence of climate on energy.

(d) Exposed Floors

Elevated floors on column or with small first floor areas, and large over hanging upper floors increase heat loss and heat gain because of the extra exposed floor surfaces, this is an advantage in places like the Northern Nigeria.

4.4.3 Nature of Envolope: (Building)

Generally, two aspects of envelope composition are recommended in effort to reduce or control energies particularly the solar energy.

(i) The charge from conventional static envelope designed the concept of modolated construction.

(ii) Consideration of thermal mass.

a. Modolar construction

This form of construction is based on the

supposition that just as different orientations require different treatments, so also different times of the day, or different times of the year. In essence, the building envelope should respond to the change from day to day to night as a flower might open itself up to the sun and then close itself for protection against the cool of the night.

This concept require the use of high technology, some of the ways to be suggest include; flexible wall possibilities:

(i) Walls which slide, horizontally or vertically, fully opening up the facade when desired.

(ii) Walls which slide over glass areas in order to reduce heat loss in winter and heat gain in summer.

(iii) Walls which revolve or rotate in order to exposes an appropriate material to the sun or to the inside.

Experiments on the above concepts have been carried out by Zomeworks, Incorporated, of Albuquerque, USA called Beadwall.

b. Thermal Mass

Mass, the property of density, can have a

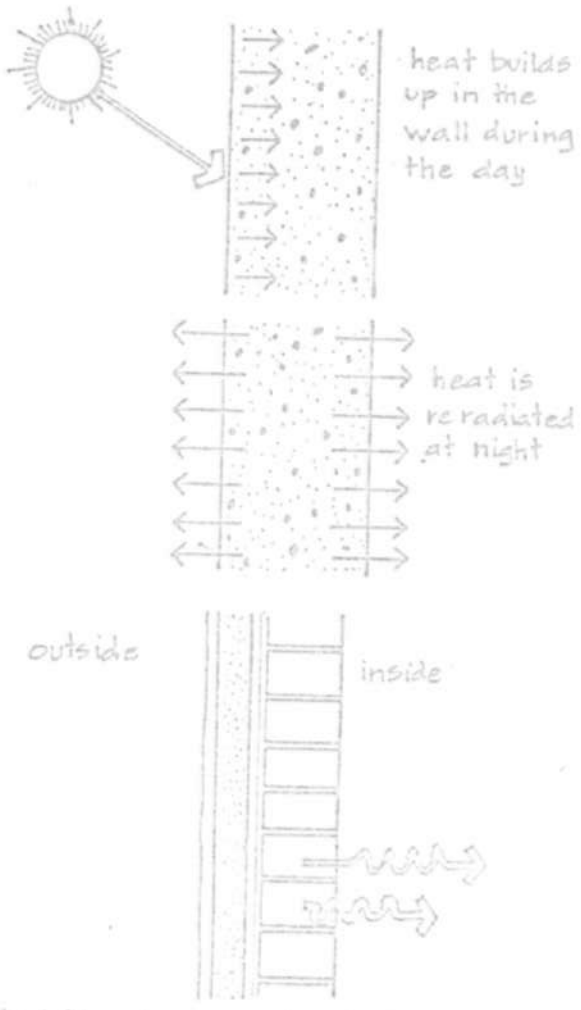


Figure 4.6a
Wall treatment—thermal capacity

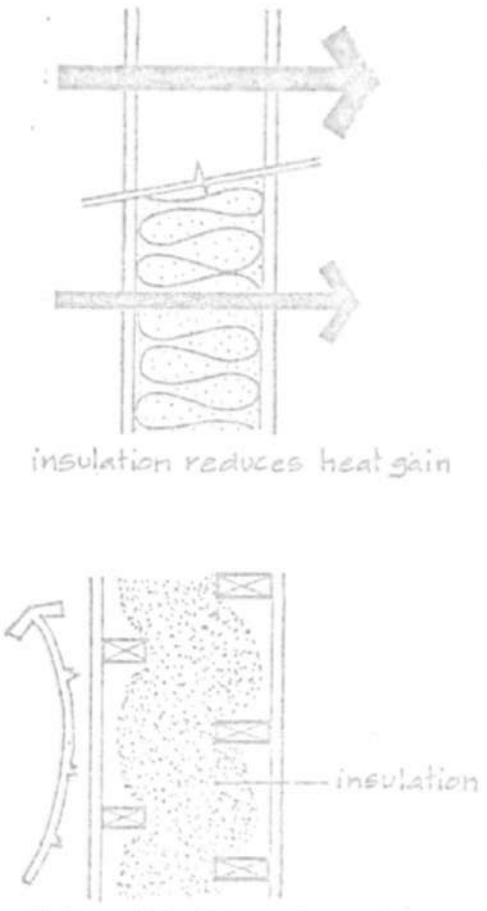


Figure 4.6b
Wall treatment - insulation

SOURCE: OGUNSOTO·O (1994)

great effect on the energy consumption of buildings because it is the ability to store heat and thus delay the effects of the outdoor temparature scale.

Buildings of heavy masonry or in Nigeria, those constructed with mad have a moderating effect of heavy construction, whereas light weight construction of wood or metal does little to delay heat floor, this sometimes makes it necessary to control the flow of energy with insolation.

In a homogeneous wall, the heat flow in and out are equal. But within a wall with exterior insolation, for example, the heat flow becomes more selective, the insolation will now restricts the flow into the massive heat - absorbing material, and therefore more time will elapse before the storage capacity of the massive material is filled increasing the time lag.

4.5 BUILDING COMPONENTS USED FOR ENERGY CONTROL

Apart from the design of the building envelope, another important aspects that where mentioned in the explainations, as party building components also help to control energy in buildings.

Some of the components involve the use of active

element hence they will only be mentioned but will not be discussed since the emphasis is on passive elements of design:

a. window treatment
b. insolation
c. air conditioning
d. ventilating
e. lighting

Only the first two will be discussed in detail, because the others have been covered in the earlier part of the chapter.

4.5.1 Window Treatment

Well designed windows can actually serve in energy control, windows are generally used for the following functions:

(i) Provide year-round lighting
(ii) Provide year-round natural ventilation
(iii) Provide year-round insolation.

Thermal treatment of a window generally used today are to, manipulate light before it hits the window, this involves the use of sun-shade, like overhangs or louvers.

The other treatment is to change the elements

that formed the window.

In the above case glazing could be altered to include multiple glazing, reflective galss, heat absorbing glass, and reflective and absorbtive films.

Changes in the construction of the window frame in frame in response to energy considerations, have resulted in frames which are built of materials that are good insolators.

4.5.2 Insulation

There are many materials that are used to achieve insulation, some of which are:

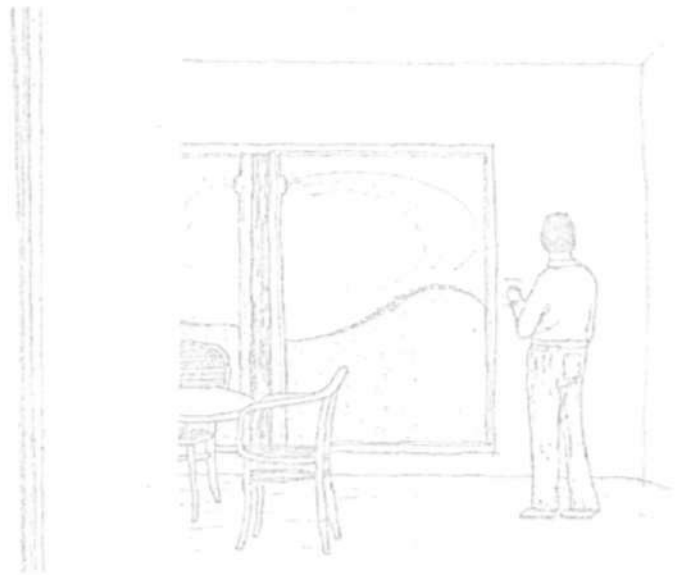
(i) Aluminuim foil

This is a single or multiple parallel layers of foil and kraft paper combinations with an air space. It is a good reflector but poor absorber of radiations.

(ii) Fibre Glass

This is made of fine wool like compressible fibres spun from glass, it can be in loose form, in batts, or faced on one or both sides with paper or foil.

(iii) Cellular Galss



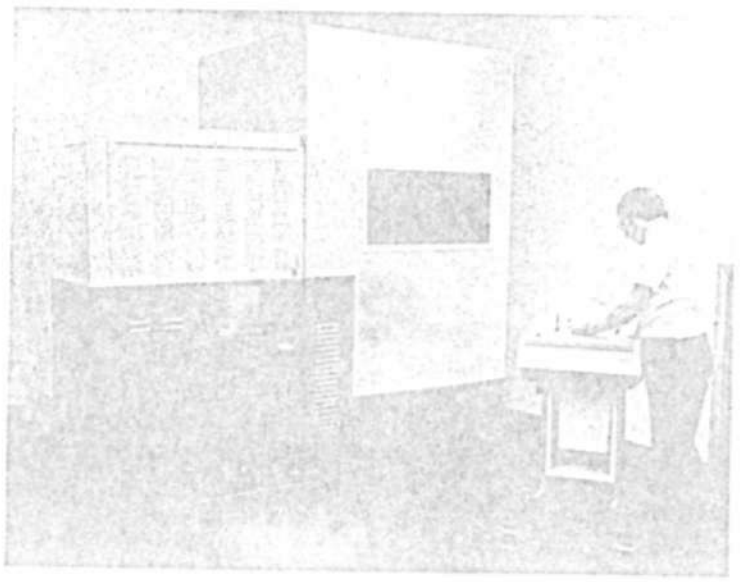
WINDOW INSULATION HELP TO REDUCE HEAT PENETRATION.



SAMPLE OF ROOF INSULATION AGAINST HEAT LOSS

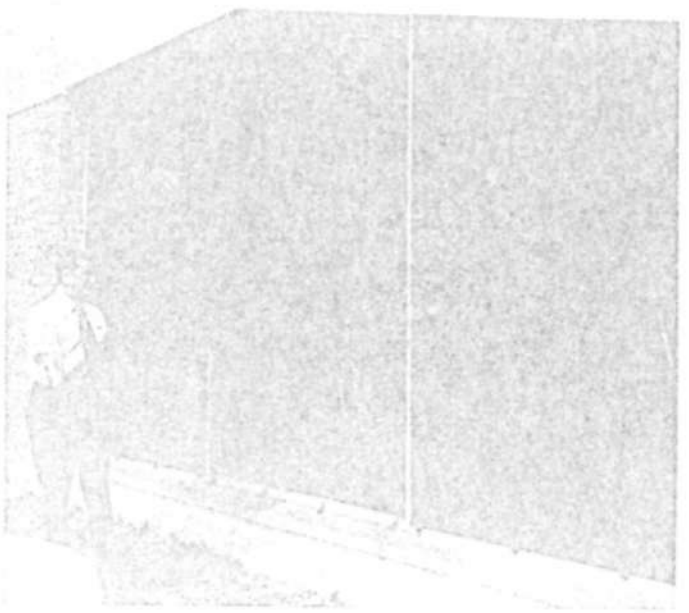
Plate 4.3a-b

SOURCE: JARMUL·A (1988)



FUEL CELL USED TO PROVIDE ENERGY REQUIRMENTS OF BLD

Fig. 4.4a



SOLAR (GLASS) WALL USED TO REGULATE AND CHECK RADIATION.

Fig. 4.4b

SOURCE: ARUP-A (1988)

This composed of a lightweight, rigid insulation composed of millions of completely sealed glass cells.

iv. Expanded Polystryne

This is a polymer that has been impregnated with a foaming agent which, when exposed to heat, creates a uniform closed cell structure highly resistant to heat flow and moisture penetration.

v. Mineral wool

This is made of wool like fibres spun from molten slag and coke similar to fiber glass. This transmits moisture easily.

vi. Solar screew

Designed for installations outside existing windows, these fibre glass screens block out 65 to 75 per cent of the sun-heat, and slare before it reaches the window glass.

Designed primarily to reduce cooling costs, the screens can be removed and stred during winter.

4.6 ENERGY CONTROL EQUIPMENTS IN BUILDINGS

As a result of the awareness of energy utilisation that is gaining grounds a way has to be found

found to know the energy use in buildings, this gave way to the invension of some equipments to help assist in deteromining energy consumption in buildings some of these are:

a. Electro comp energy computer
b. Fuel cells
c. Energy monitors (electric)
d. Heat detectors

4.6.1 Electrocomp Energy Computer

This is a portable computer designed to calculate heat loss and annual heating cost of residences. After feeding in the appropriate building information together with climatic references, a meter immediately indicates the heat loss or the annual operating cost.

4.6.2 Fuel Cells

This is an electric generator that provide a building energy needs while using less fuel than usuall conventional types. Here the fuel cell generates electricity through a chemical reaction in a process that efficient, clean and quiet.

4.6.3 Energy Monitors (Electric)

These are design that measure the electric energy consumption on branch circuits and thus aid in energy audits.

4.6.4 Heat Detector

This is used for heat loss detection it continuously provides a digital printant of the temparature of the surface at which it is pointed, it is in form of a pistol.

HEAT ENERGY DETEC TOR PRINTS TEMPARA TURE ON THE SURFACE

Plate 4.3a



PRESS CAMERA LIKE HEAT DETECTOR SHOWS SPOTS OF COLD AND HOT.

Plate 4.3b

SOURCE: JARMUL A (1986)

REFERENCES

1.	Norbert Lecturer (1994)	Heating, Cooling and Lighting Design Methods for Architects (1992)
2.	Ove A. (1986)	Building Design for Energy economy, The Construction Press, Lodon.
3.	Seymour, J. (1980)	The Architects Guide to energy Conservation, Kingsport Press, London
4.	Brown M. (1993)	Son, wind, and light, Architectural Design Strategies
5.	Hassan, F. (1988)	Natural energy and Vernacular Architecture
6.	Konrja (1994)	Design Primer for Hot Climates
7.	Stein (1994)	Architecture and Energy
8.	Watson (1994)	Designing and Building a Solar House
9.	Anderson, (1994)	Solar Energy: Fundermentals in Building Design.
10.	Olgay and Olgay (1994)	Solar Control and Shading Devices.

CHAPTER FIVE

"TRUE REGIONAL CHARACTER CANNOT BE FOUND THROUGH A SENTIMENTAL OR IMITATIVE APPROACH BY INCORPORATING EITHER OLD EMBLEMS OR THE NEWEST LOCAL FASHIONS WHICH DISAPPEAR AS FAST AS THEY APPEAR. BUT IF YOU TAKE FOR INSTANCE THE BASIC DIFFERENCE IMPOSED ON ARCHITECTURAL DESIGN BY THE CLIMATIC CONDITIONS OF CALIFONIA, SAY AGAINST MASSACHUSSETTS, YOU WILL REALISE WHAT DIVERSITY OF EXPRESSION CAN RESULT FROM THIS FACT ALONE..."

WALTER GROPIUS

Chapter Five

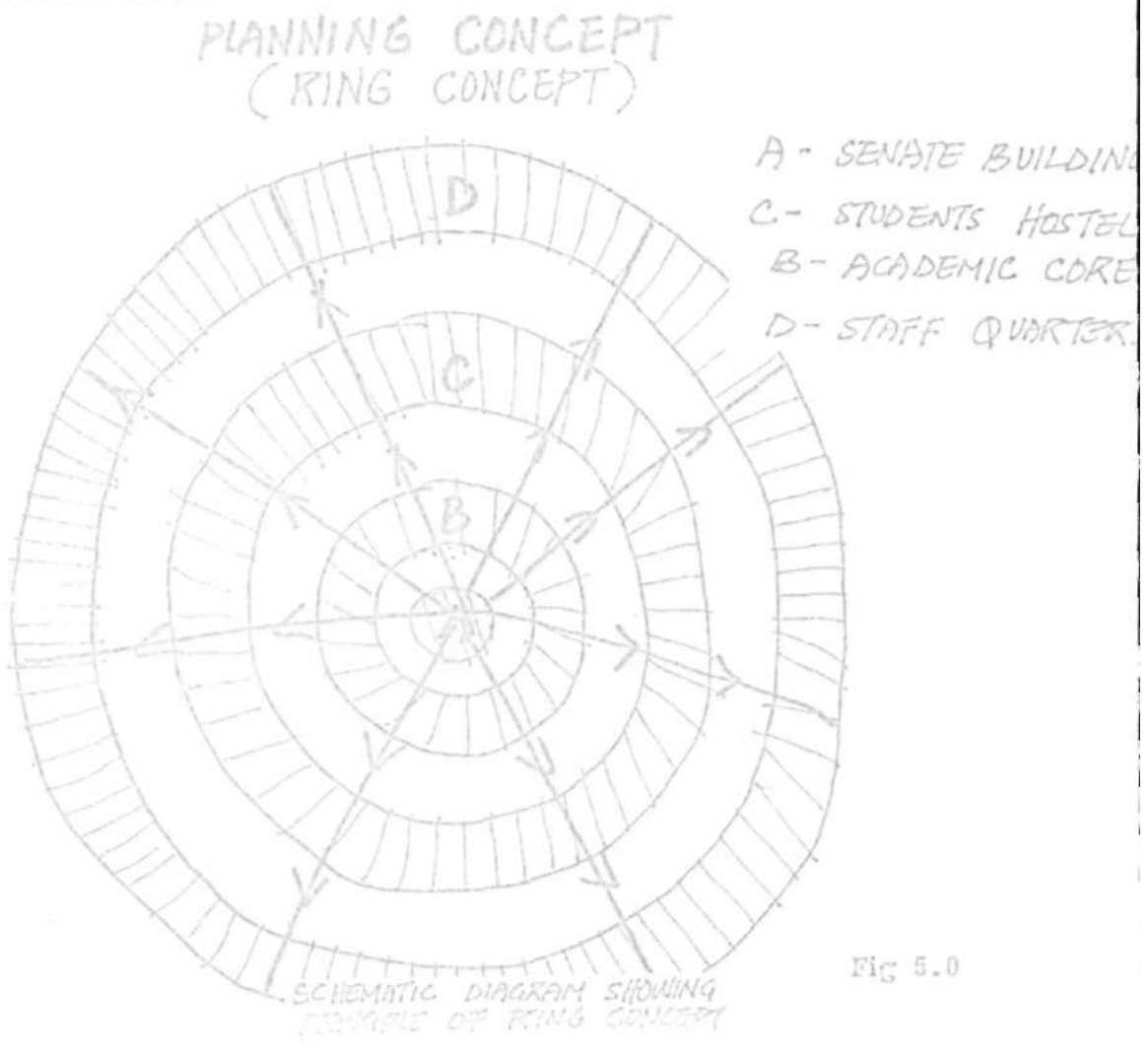
5.0 DESIGN PROPOSAL AND REPORT

5.1 PLANNING CONCEPT (Creteria)

The planning concept recommended for the University is the Ring concept after a thorough study of the variants concepts. (chapter two).

Ring concept has been chosen basically for thefollowing reasons:

(i) The first and foremost is that this concept considers Senate building as its main point of emphasis where all other Departments actually radiates from.



SCHEMATIC DIAGRAM SHOWING EXAMPLE OF RING CONCEPT

Fig 5.0

(ii) In this concept the Senate is placed at the centre, followed by the academic core i.e Academic Departments and Faculties, followed by Students Hostels, followed by Staff quarters, and then other activities, all going in a circular or Ring form.

(iii) In this concept also, interaction is enhanced among members of the University community, because distances are greatly reduced.

5.2 SITE CONCEPT (Zoning)

The site area of the Senate building was based on:

i. Accessibility
ii. Noise control
iii. Functionality

5.2.1 Based on Accessibility

In this case, office to be frequented more especially by students are more accessible, while those officesfor the senior executives are less accessible to people, this help in controlling human traffic.

5.2.2 Based on Noise Control

Those offices like Accounts, both students,

and staff, students registration and accommodation are noisy areas hence are located on the ground and the first floor of the first block.

5.2.3 Based on Functionality

This refers to the strategic location of offices, services cores and other function in the complex.

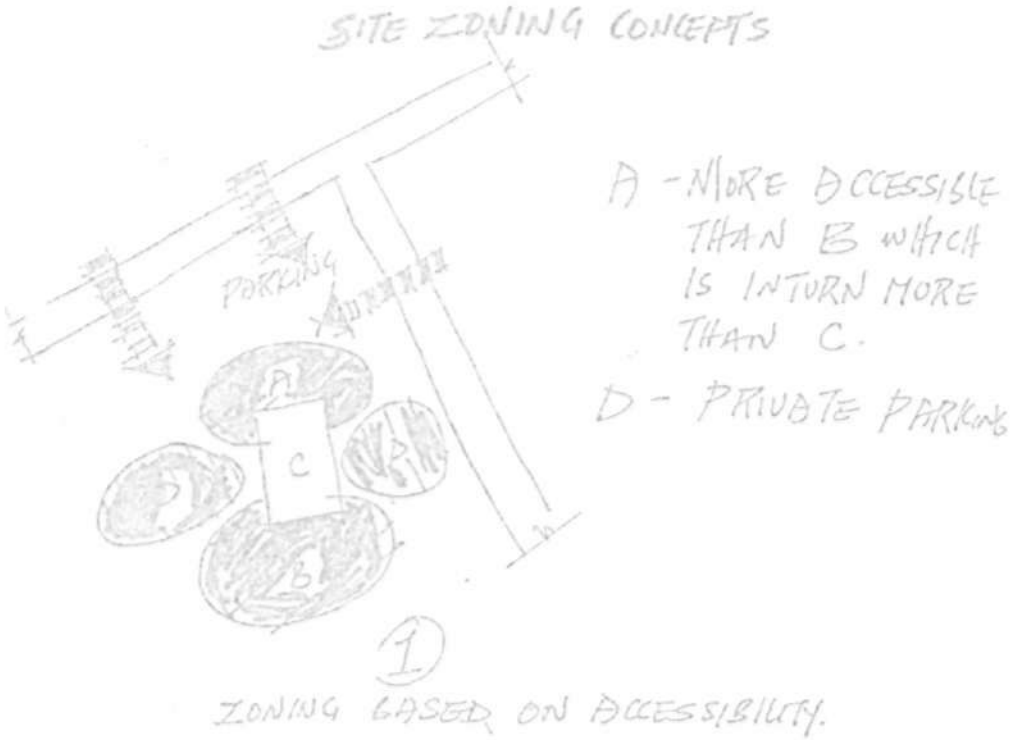


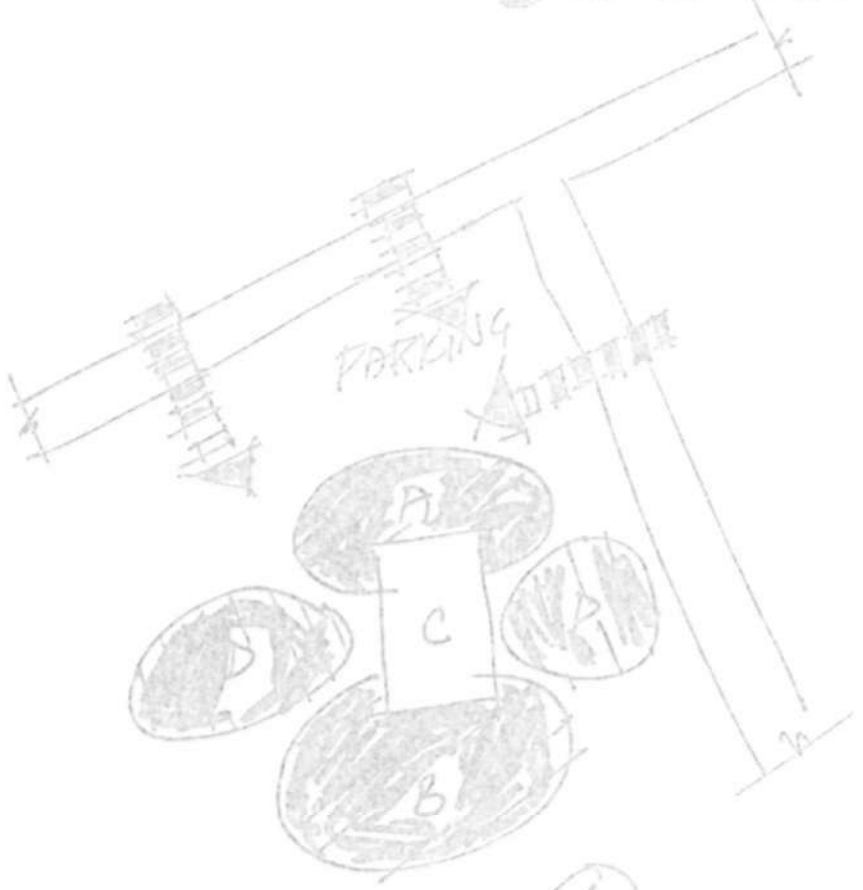
Fig 5.1

5.3 DESIGN BRIEF

As earlier explained, the design scope shall comprise of the following:

(i) Office of the President

SITE ZONING CONCEPTS



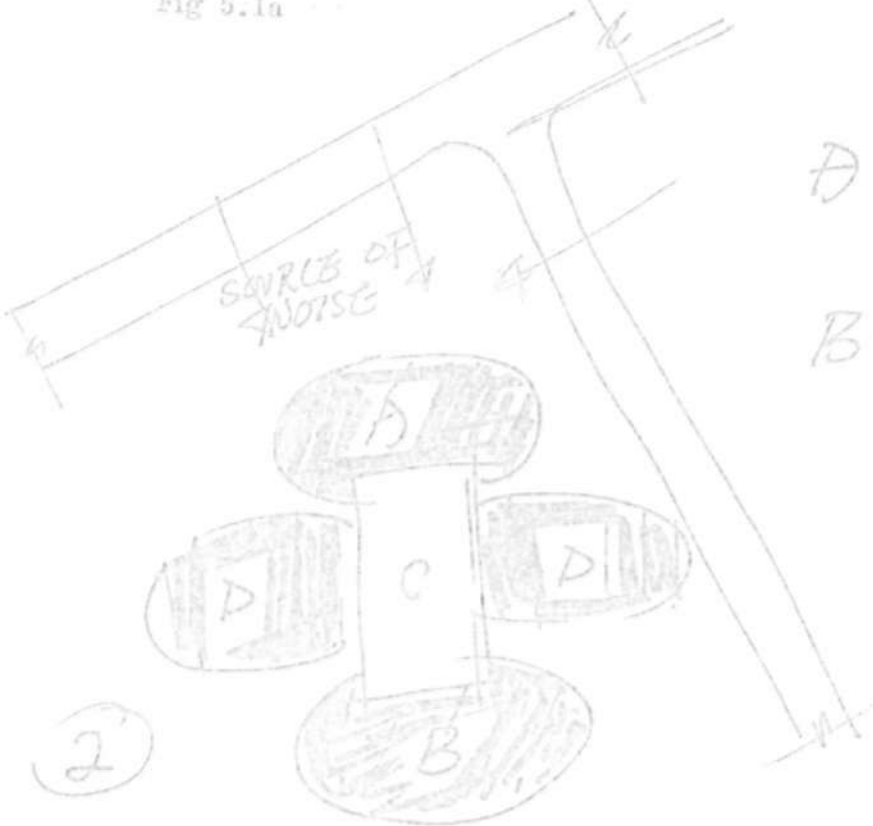
A - MORE ACCESSIB
THAN B WHICH
IS INTURN MORE
THAN C.

D - PRIVATE PARK

1

ZONING BASED ON ACCESSIBILITY.

Fig 5.1a



B - IS NOISY ZONE
(STUDENTS)

B - IS LESS THAN
D, WHICH IS
MORE THAN
C - SENATE

2

ZONING BASED ON NOISE CONTROL

Fig 5.1b

(ii) Office of the Registrar which includes the registry.

(iii) The Finance Officers' office (Bursary)

(iv) The Senate chambers.

5.3.1 Office of the President

The office of the President comprised of the following in this design.

i. Office of the President
ii. Office of the Secretary
iii. General office for other staffs e.g Special
iv. Assistants, etc.
v. First Vice President office
vi. Second Vice President office,
a Secretary.

5.3.2 Office of the Registrar

(i) The Registrar's office
(ii) Secretary
(iii) Committee room
(iv) Dean, Students Affairs
(vi) Secretary
(vii) Academic Secretary
(viii) Establishment.

5.3.3 Office of the Finance Officer

i. Finance Officers' Office

ii. Secretary

iii. Committee room

iv. Students accounts

v. Staffs accounts (payrol) etc.

5.3.4 Senate Chamber

i. Senate chambe for meetings

ii. ...esh area

The above are the spatial requirements considered in the design.

However, it has been expanded as can b... ...edule of accommodation.

5.4 SCHEDULE OF ACCOMMODATION

5.4.1 Office of the President	Floor Area (m^2)
i. Office of the President	54
ii. Secretary	18
iii. General office	24
iv. f... ...e President	36
v. Secretary	12
vi. Second Vice President	24
vii. Secretary	12

5.4.2 Office of the Registrar		Floor Area (m^2)
i.	Registrars' office	36
ii.	Secretary	12
iii.	Committee room	24
iv.	General office	12
	Students Affairs	
i.	Dean of students	16
ii.	Secretarys' office	10
iii.	Committee room	12
iv.	Sports office	12
v.	Academic Secretary	20
vi.	Secretary office	12
vii	Computer room	24
	Examination Office	
i.	University Examinations Officer	16
ii.	Secretarys' office	10
iii.	General exams office	24
iv.	StudentsRecord	34
	Establishment Division	
i.	Senior Assitant Registrar	24
ii.	Secretary officer	12
iii	Housing and Passages	24
iv.	Officer in Charage	12
v.	General office (registry)	24
vi.	Staff officer	16

vii.	Secretary office	10
viii	Intermediate & Junior staff matters	24

Secret Registry

i.	[illegible] Assistant Registrar	16
ii.	General registry	24
iii.	Computer room	24

Admission Office

i.	[illegible]ion officer	12
ii.	Secretarys' office	10
iii.	General office	24
iv.	Asst. Admission officer (accommodation officer)	12

5.4.3 Office of the Finance Officer

i.	Finance officers' office	24
ii.	Secretarys' office	12
iii.	Committee room	24
iv.	General office	12

Students Accounts

i.	Cash office	24
ii.	Senior Accountant	12
iii.	Students accounts	24
iv.	Computer room	24

Staff Accounts

i. Payrol office 12

ii. General and Advances office 24

iii. Accountant 12

iv. Computer room 24

5.4.4 Senate Chamber

i. Meeting chamber 120

ii. Refreshing area 40

iii. Kitchennette etc 24

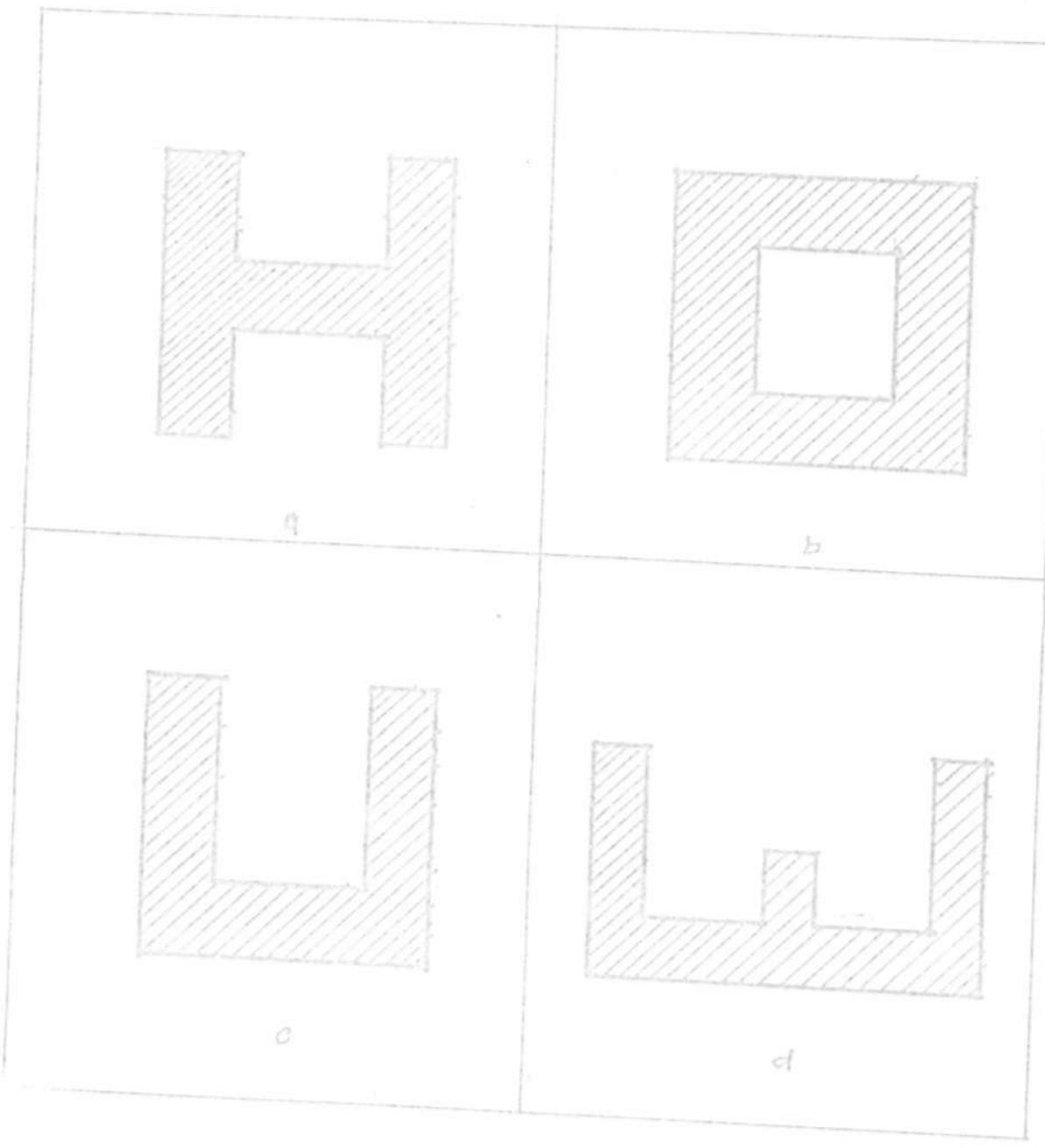
5.5 DESIGN CONCEPT

5.5.1 Plan Concept

To achieve an energy efficient building, studies were carried out on the various plan shapes in relations to energy efficiency (control). In this, it was discaused that various shapes have different energy absorbtion factors e.g a circular shape absorbs less of solar energy than a square which in turn absorbs less than a rectangle.

Regarding energy efficiency, there are basically four plan types that are more energy efficient than others. The plan shapes are energy efficient because of the following reasons:

i. The plans encourages shallow planning.

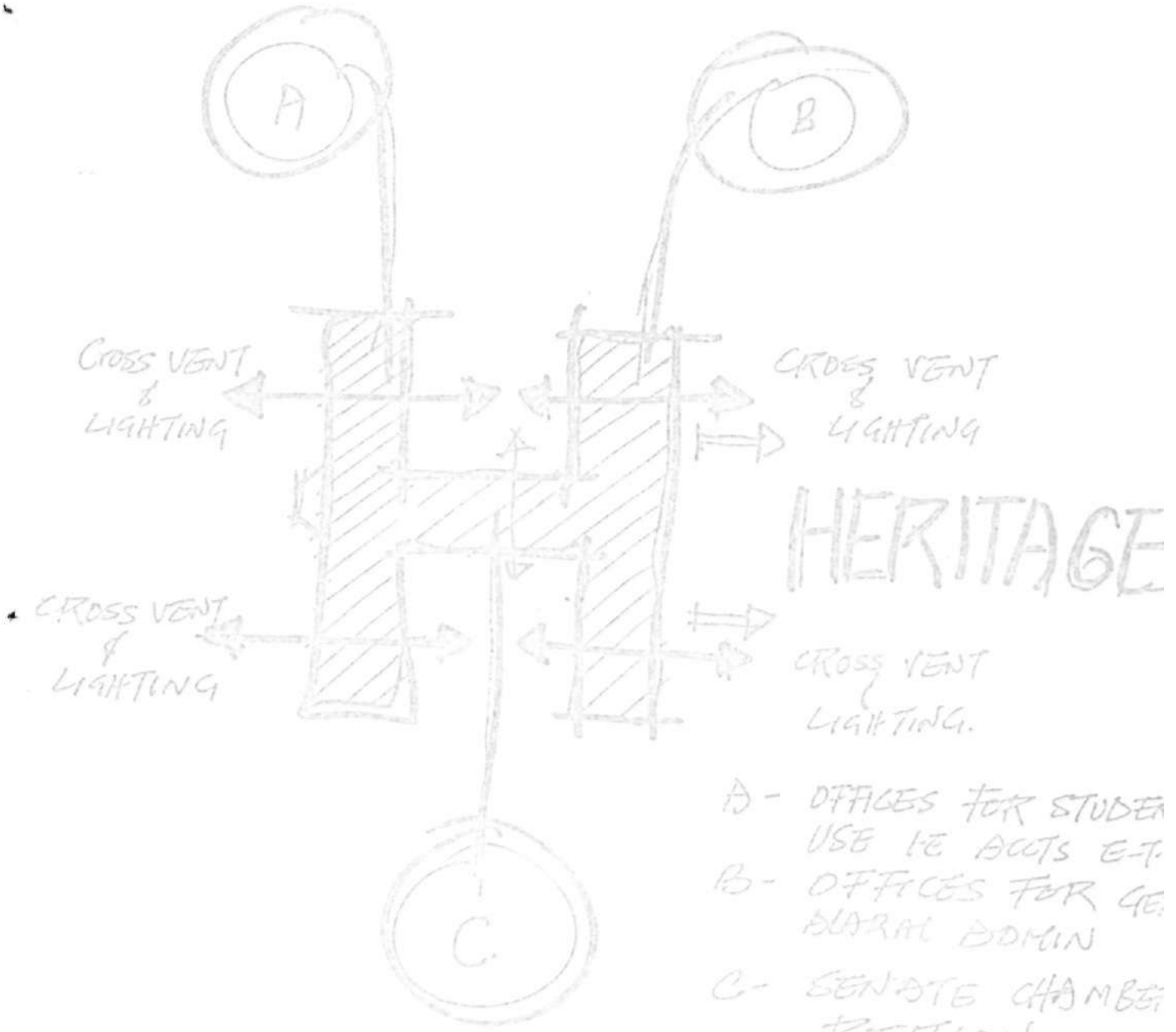


COMMON PLAN SHAPES FOR ENERGY EFFICIENCY.

SOURCE: NORBERT - L (1996)

Fig 5.3

PLANO - CONCEPT



ADOPTED PLAN CONCEPT WHICH SYMBOLISES THE UNIVERSITY'S NAME H - FOR HERITAGE.

Fig 5.4

ii. It is easier to achieve cross ventilation in the offices

iii. It is also easier to daylight the offices inside.

The H - concept has been choosen among the plans shapes because in addition to the above mentioned advantages of their energy officiency, it is, also sysmbolises the word "Heritage" with the capital H letter H - hence it was choosen to be the plan concept and finally adopted.

5.5.2 Elevational Concept:

New Oxford Dictionary defined the word 'HERITAGE' as "that which was or has been passed from Generation to Generation". Hence the elevation tried to portray the meaning of this word Heritage in Architectural way.

Studies was carried out on different Architectural elements and traditional motifs of the region in which the University is to be located, and came out with those element that portray a regional Architecture of this area. The Architectural elements used were:

i. Zanko

ARCHITEC+



SMALL WINDOWS ARC
PS DUE FILTERS INTO
BUILDINGS BECAUSE O
HARSH WEATHR OF



ERN-
NORTH
CITIES



1 Z
2 A
3 D
4 S
5 C
E

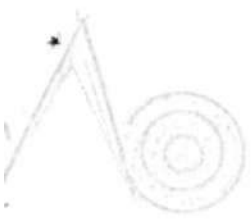
ENTRANCES ARE CELEBRATED
BY PROJECTING A PART OF
STRUCTURE IN FORM OF ZAHED

Fig 5.5

ARCHITEC-

TRADITIONAL

POT ON FIRE









NAME:
HAMZA



Fig 5.6

ii. Dome

And the traditional motif choosen was the 'kobo' literaly means 'coin', but its meaning is means of lively hood, it was used on the facade because education is a means of lively hood.

5.6 Design Proposal (Report)

The design consists of two office blocks, and Senate Chamber in between the two blocks forming the letter H.

5.6.1 Block 'A'

This block of offices consists of offices that are most frequented by students especially, and it is the first block met as one approach the building. It consist of:

i. Ground floor
ii. First floor
iii. Second floor

(i) Ground Floor (Plan)

In this floor, Reception was located where students notices are displayed and used for access to the first and second floors because of the state case located.

The offices located in this floor are basically accounts for both staff and students, this is because;

a. Students are successfully restricted to this floor for their registrations, and for notices.

b. Traffic has been controlled.

(ii) First Floor (Plan)

This floor consist of the following offices for the use of students;

a. Students examinations office
b. Academic Secretary office.

(iii) Second Floor (Plan)

This floor consists of the following offices for the use of students:

a. Dean students affairs who oversees all student affairs.
b. Sports office
c. Admission office etc.

It will be noticed that all the three floors are for the use of students exclusively, this was delibrately done in order to keep them away

from the other block which was for administrative staff.

5.6.2 Block 'B'

This block of offices consist of offices for staff matters, and general University's administration. It consists of the following:

i. General floor
ii. First floor
iii. Second floor
iv. Third floor

(i) Ground Floor (plan)

This floor consist of offices for Intermediate and Junior staff use, the computer room for record keeping and the office of the staff officer who is responsible to them.

(ii) First Floor (plan)

This floor accommodate the information and protocol unit, housing and passages office with the offices in charge i.e the Senior Assistant Registrar.

(iii) Second Floor (plan)

This floors accommondates Senior Executive

Officer and committee rooms for meeting with their unit heads. These are:

a. The Registrar

b. The Fiance Officer

(iv) Third Floor (plan)

This floors accommodate the executive officers of the University, these are:

a. The President

b. The First Vice President

c. The Second Vice President

This block also accommodate an office for security.

5.6.3 Senate Chamber

This is to be used for meeting of the University's council.

5.7 Design Philosophy

The sub-topic for this project is achieving passive control of energy through Architectural design, these energy forms as explained are those that affect building:

i. Solar energy

ii. Wind energy

iii. Sound energy

iv. Electrical energy

v. Mechanical energy

5.7.1 Solar Energy

In tropics, this is the most problematic form of energy, because of the heat it transmits through conduction, convention and radiation, therefore, the main design philosophy centres around how to control this form of energy. This is achieved through the use of sun-shading device.

The control of this energy through the use of this type of sun-shading devices was achieved in this way:

a. it is seen in both plan and elevation that the shading devices used was separated from the main building, i.e standing on its own only linked by beams extending from the floors. this was done so that the heat transmitted by solar radiation to the inside by conduction is reduced or can eliminated completely by creating a vacuum between the shading device and the main building.

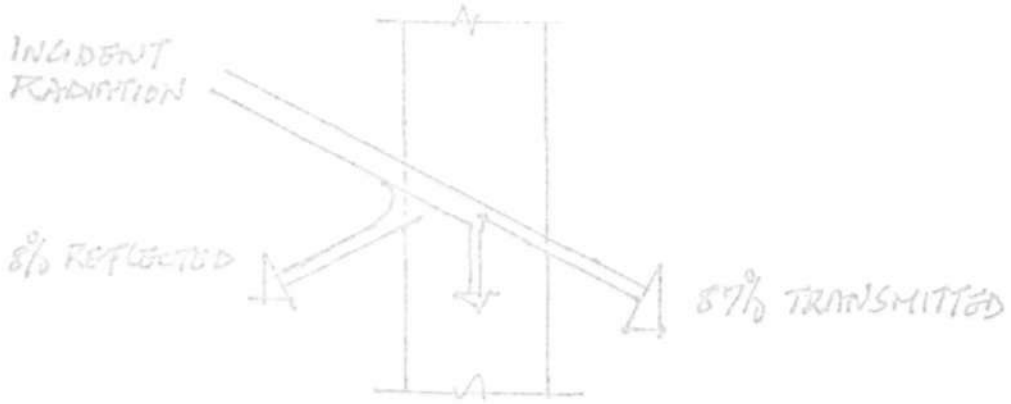
b. The direct solar radiation is first absorbed by the shading device before reaching the external wall of the building, it has been calculated, the shading device has an area of 264m² while the external wall has exposed area of 524m² hence the shading device absorbs approximately 50% of the solar insolation.

c. The white paint harsh used, this was delibrate because while paint has the highest reflectance of 75% when it is new, and 50% when old or dirty.

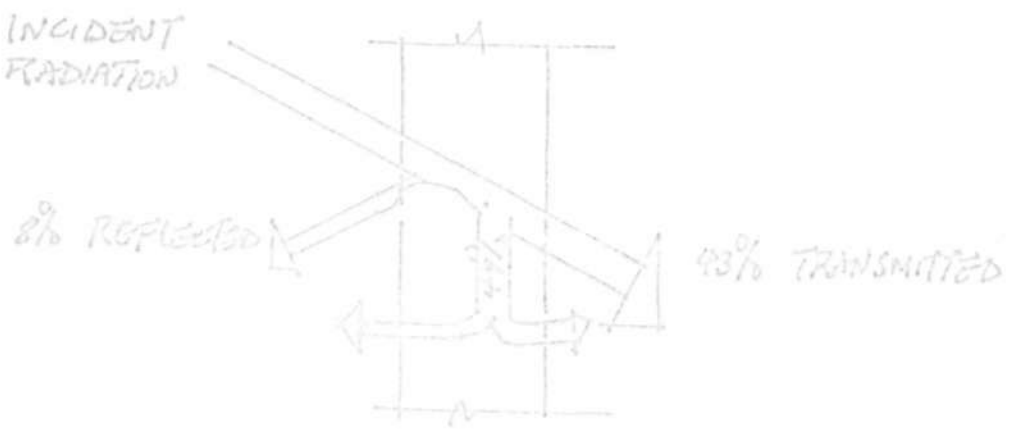
d. In the orientation, the building is on the North-south axis for the longest side and the shortest side facing east-west sides this will ensure reduced direct solar radiation since windows are placed along the longer axis.

e. The use of construction materials was also part of solar energy control measures adopted because materials that passes minimum time lag of either hours, and solar treat factor of at least four hours, these include; roofs e.g corrigated Aluminium sheets which was specified, and the use of heavy wall like hollow block, cavily for both external and

GLAZING AS SOLAR ENERGY CONTROL ELEMENT



(A) CLEAR GLASS



(B) HEAT ABSORBING GLASS

(C) REFLECTIVE GLASS (RECOMMENDED)

SOURCE: NORBERT-L (1996)

internal wall, this ensure the delay of transmission of heat.

f. The use of glass as a solar absorbant, the glass recommended is reflective glazing which reflects at least 50% of the solar radiation.

The use of sun-shading device as a design concept (philosophy) was done by Frank Lloyd Wright in his design of the price tower, Bartsville O.K.

"The sun control device has to be on the outside of the building, an element of the facade, an element of Architecture" (Marcel Breyer)

5.7.2 Wind Energy

Wind energy control measures employed includes:

a. Orientation to the wind direction where the building was placed at 45° to the direction of both winds.

b. The use of trees as butters for the wind, this greatly help to reduce the wind speed before it reaches the building, this was possible by creating a turbulence of the wind, and

hence absorb the energy by frictional drag.

c. The sun-shading devices used also allows free circulation of air because of the 'gap' between it and the external wall.

d. The sun-shading devices used also serves as sand still, i.e dust carried by wind are filtered and deposited.

5.7.3 Sound Energy

This was taken care of through the design, i.e by segregating the noisy area and quiet areas - i.e Block 'A' and 'B' where students activities which produced a lot of noise was separated with the executive offices i.e Block 'D'

5.7.4 Electrical Energy

Electrical energy is used in an office building for basically two purposes:

i. lighting

ii. for operating machinery

In this case and in this design, daylighting has been encourage through the provision of adequate window area in both the offices and the corridor.

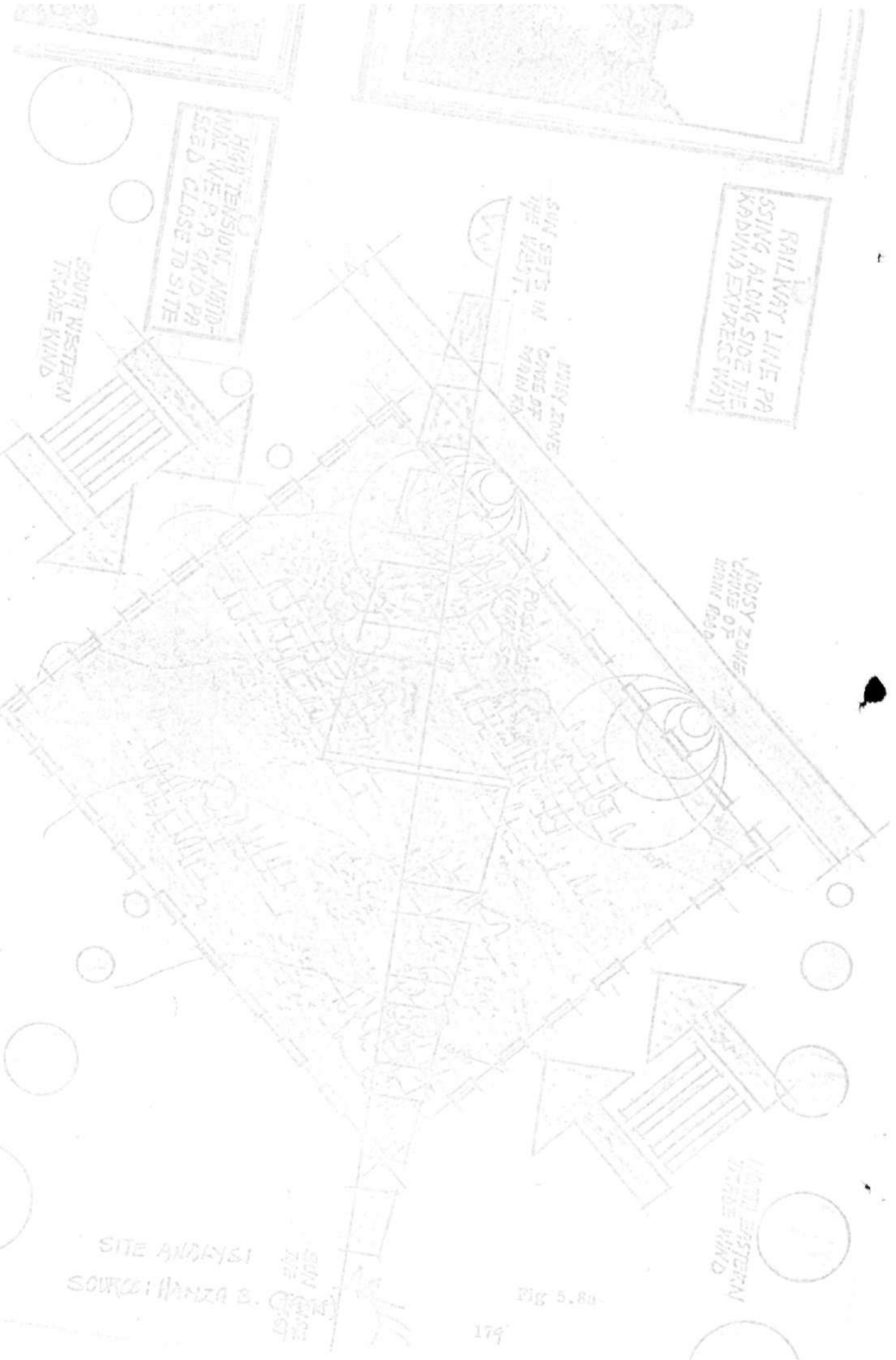
5.7.3 Mechanical Energy

In this building, there is very minimum use of Machineries, except for the computer rooms where there is need for air conditioner to enhance computers efficiency.

Chapter V

REFERENCES

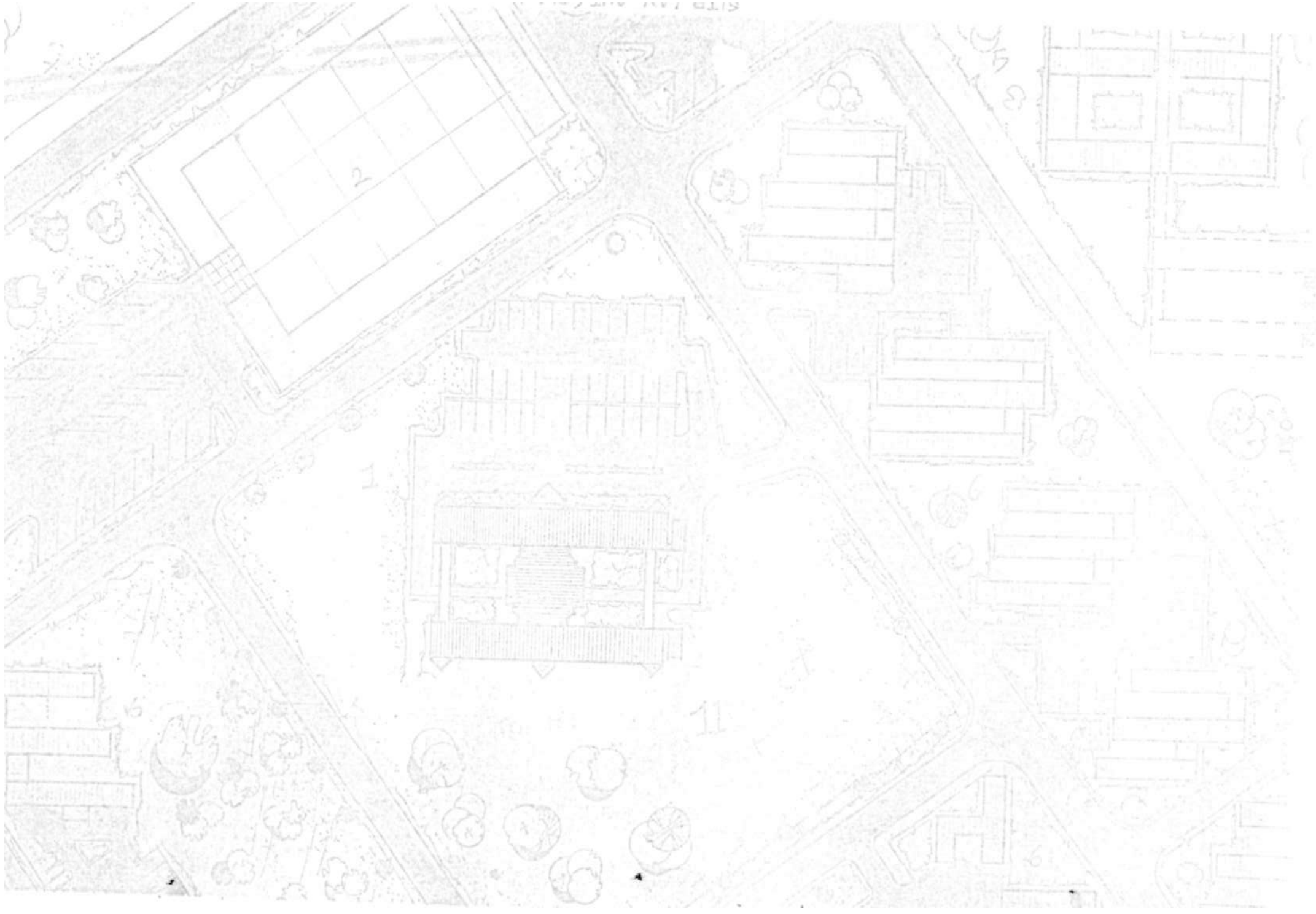
1. Neufert E. (1970) — Architects data Granads Publishing Co. London
2. Joseph C. (1980) — Time Saver Standard
3. Ramsay and Sleaper — Architectural Graphic Standards
4. Boulet. R (1494) — Controlling Air Matement: A Manual for Architects and Builders
5. Frazer R. (19 — Architectural Draftmanship
6. Nigerian Universitis Commission (1979) — Stand and Guide for Universities



SITE ANALYSIS

SOURCE: WANZA B. CHAN

Fig 5.8a



GROUND FLOOR PLAN 1:200

THIRD FLOOR PLAN 1:500
ROOF
ROOF

ROOF PLAN 1:250

REAR ELEVATION 1:200

SIDE ELEVATION (EAST) 1:100

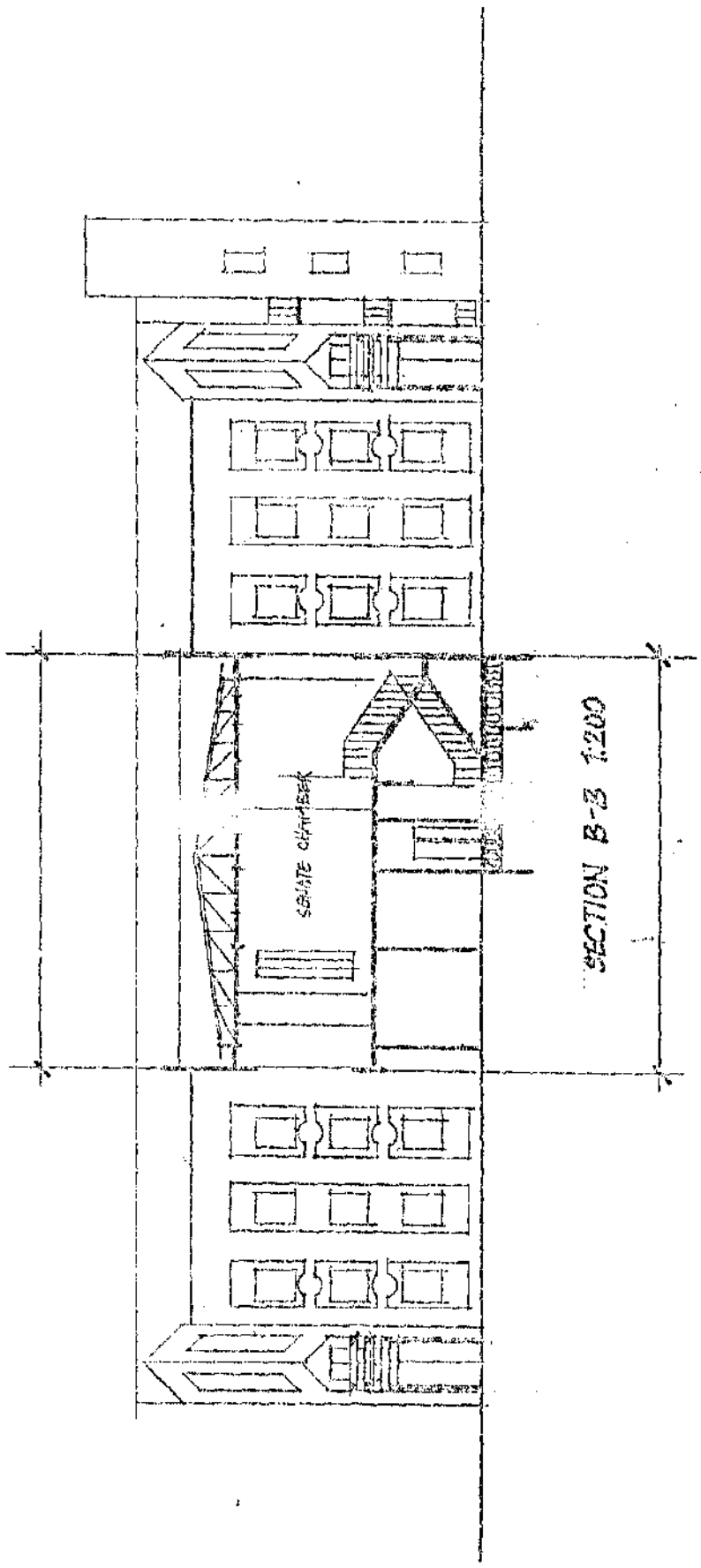


Fig 5.8k

Chapter Six

6.0 CONCLUSION/RECOMMENDATION

During the course of this research, various ways were employed to control the most problematic form of energy in the area as it affect building i.e solar energy.

The energy control measures were 'passive' that is through natural means and through Architectural design, these included the use of plan shapes i.e rectangular in a H-form which is known for its energy efficiency, the orientation of the building where the longest side faces North - South in order to avoid direct solar radiation, the use of heavy building materials for walls and roofs which will delay the heat transmission into the building, the finishing, which was recommended to be white paint because of its high percentage reflectance, the choice of glazing i.e reflective glass that was recommended and most important of all, the sun-shading device used which formed the basis for the main design concept.

The sun-shading device used was designed by the author after [illegible] of existing types of sun-shading devices.

BIBLIOGRAPHY

1. **ABU Master plan:**	ABU Press Zaria (1980)
2. **Anderson (1994):**	Solar Energy; Fundermentals in Building Design.
3. **Brown. M (1993):**	Sun, Wind, and Light, Architectural Design Strategies.
4. **Doi, J.A (1988):**	Islamic Institute of Research and Islamic Studies, Unpublished Msc Thesis, ABU Zaria.
5. **Encyclopedia Brittanica:**	Megraw Hill USA (1992).
6. **Encyclopedia Brittanica:**	Inc Vol 12 London (1978).
7. **Hassan F (1988):**	Natural Energy and Vernacular Architecture.
8. **Idowu I (1994):**	Senate Building LAUTECH Ogbomoso, Unpublished Msc Thesis ABU Zaria.
9. **Joseph C. (1980):**	Time Saver Standards.
10. **Kabir B. (1997):**	Senate Building for A.T.B.U. Bauchi, an Unpublished Msc Thesis ABU Zaria.
11. **Konya (1994):**	Design Primer for Hot Climates
12. **Neufert E. (1970):**	Architects data, Granada Publishin Co. London.
13. **Nigeria Universities Commission - Hand Book (1986):**	Standard Guide for Universities N.U.C. Press.

14.Ogunsote O.O. (1994): Introduction to Building Climatology ABU Press Zaria.

15. Olgay and Olgay (1994) Solar Control and Shading Devices

16. Ove. A (1980): Building Design for Energy Economy, Construction Press London.

17. Seymour. J. (1980): The Architects Guide to Energy Conservation, Kingsport Press London

18. Stein (1994): Architecture and Energy.

19.Sleeper and Ramsey: Architectural Graphics Standards

20.Watson (1994): Designing and Building a Solar House.