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CLIMATE ADAPTING AND CLIMATE REJECTING OFFICE BUILDING TYPES: A COMPARATIVE ANALYSIS

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ABSTRACT
*A building must be sympathetic to the climatic zone it is situated in. Basic building forms in various climatic zones have been a direct response to the extremities of the micro-climate. Building interior space plays a major role influencing the demand for environmental control system. This paper attempts to compare office type **A** which is climate adapting and office type **B** which is climate rejecting. The influence technology has exerted on the deveopment of existing models is also considered. From the study, the annual energy cost of climate adapting buildings is far less than that for climate rejecting buildings with higher energy load. The analysis shows that climate adapting office buildings have more surface area which exposed them to day lighting and other external climatic elements. This reduces the overall building's lighting load. Climate rejecting office buildings exclude the direct influence of exterior climate on the interior environment and provide most of its services internally from control sources. This paper suggest that in a developing country like Nigeria where power supply is erratic, office types that do not rely exclusively on mechanical systems are preferable.*

Keywords: ***Office buildings, Building envelope, Climate adapting, Climate rejecting, Environment***

INTRODUCTION

A relationship is observed in building types and the climatic region they were located. The demands climatic extremes exerted is reflected in the building forms of the people. The vernacular architecture typical in the hot dry regions of the north in Nigeria is characterized by massive earth wall construction with relatively flat roofs. The proportion of wall openings to the surface area was also minimal. The purpose of this massive construction was to delay heat impact into the interior of the building. In contrast, the vernacular building type evident in the hot and humid zones Nigeria had structures of low insulation value, with the sloping thatched roof being the major building element.

A larger proportion of openings to surface area were essential to enhance effective air movement. It is instructive that traditional builders adapted buildings to the regional climate and had results that proved suitable to them in terms of the indoor climate being thermally stable and comfortable.

The assessment of whether a building is climate adapting or rejecting can be done subjectively. Buildings that do not maximize natural day lighting are likely to be unpopular with office occupiers. The high values attributed to the use of windows rather than air conditioning reflects the inherent need for natural light and good views out of the building

(Croome, 1997). A building's indoor environmental conditions affect comfort, health, safety and the general well-being of the occupants. Room volume, floor area, ceiling height and other parameters of internal space are seldom treated as factors of environment in a building with high mechanical and electrical controls. Therefore, altering the conditions of temperature, lighting and noise in different parts of the building could alter the resulting mental models of the building on which its occupants base their behavior patterns. A climatic building system either adapts and integrates the building form to modify the climate or ignores the climatic variables and proffers a mechanically controlled option. This paper identifies two types of climate responsive based building types with particular reference to office buildings, these are; climate adapting building type A and climate rejecting building type B.

INTERACTIONS BETWEEN EXTERNAL ENVIRONMENT AND INTERNAL ENVIRONMENT

Buildings are designed to suit the environment in which they are located and the functions they performed. Since the beginning of time, man has been affected by climate and its influence over the earth. However, the first documentation of architectural design with climate interests in mind dated back to fourth century B.C. in Greece (Turner, 2003). To create energy-responsive buildings, architects must be sensitive to the diversity of influences that shape a building's development, especially the approach used in designing their buildings. "Using the appropriate design approach is important because it will directly influence energy responsive design solution that is found" (Ternoey, 1985). A comfortable environment offers freedom from annoyance and distraction, so that working or pleasure tasks can be carried out without physical or mental hindrances. A sustainable office environment is an environment that is climatically sensitive, flexible and adaptable. According to Croome (1997), people are not passive recipients of the environment but take adaptive measures to secure thermal comfort. They can modify their clothing or activity; they can modify the environment such as the internal heat gains or modify the ventilation rate through opening doors and windows. These can only be achieved and effective through the interaction between external and internal environmental that is adaptive to the climate.

The building envelope acts as the interface between the external and the internal environmental conditions. The extent to which an office building is climate adapting or climate rejecting is dependent on the architectural intervention in the building envelope. Givoni (1997), correctly argues that the actual relationship between the indoor and the outdoor climates depends to a great extent on the architectural and structural design of the buildings and so the indoor climate can be controlled by building design that accommodate human comfort needs. Hawkes and Owers (1982), represents this interaction between the building envelope (its form and fabric) and its external and internal environment as shown in figure 1. This approach considers the effect of the activity occurring within the building envelope and when necessary the input of a mechanical plant.

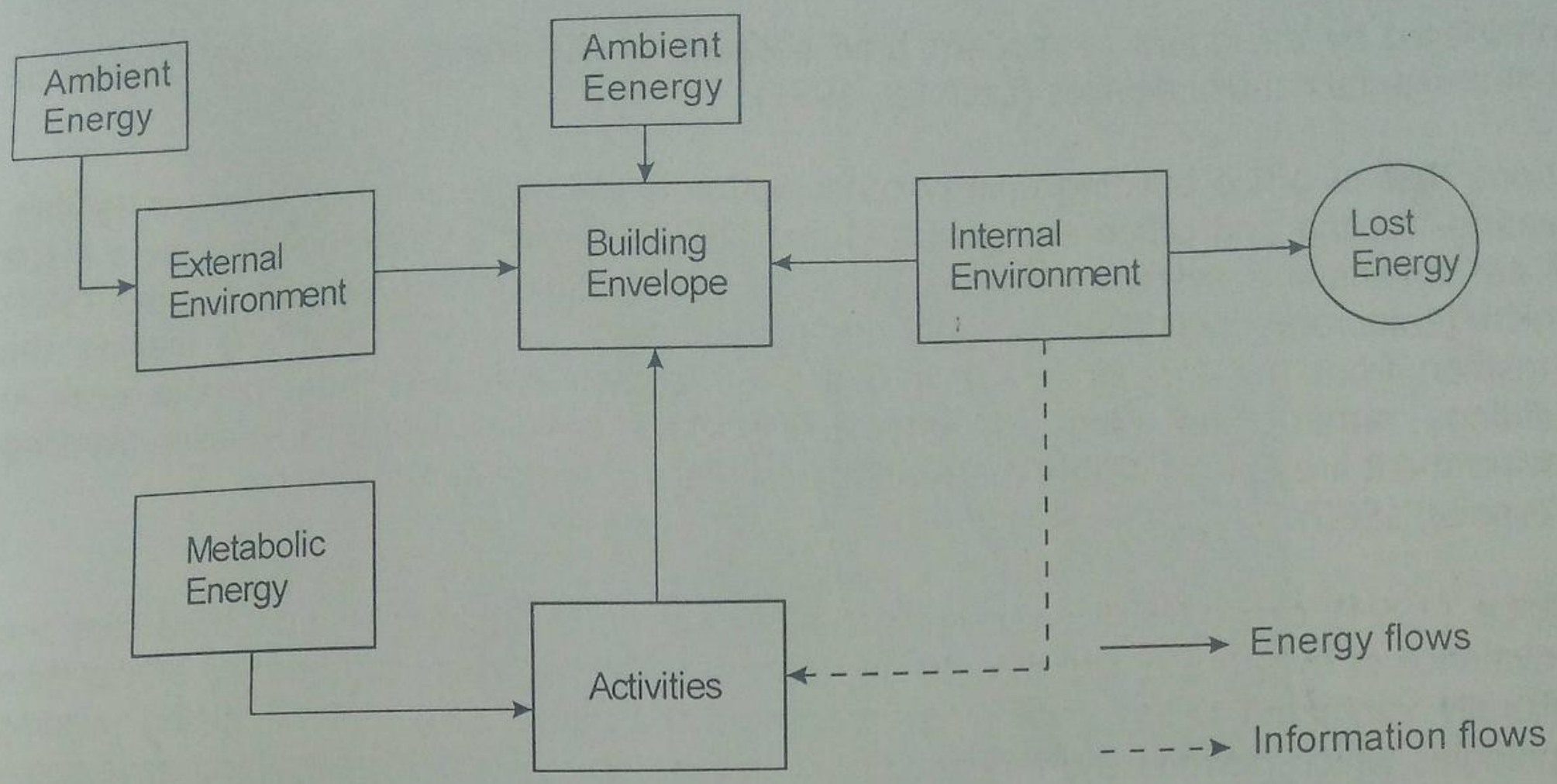

Figure 1. The Environmental Control System

INFLUENCE OF TECHNOLOGY ON CLIMATE – BUILDING ENVELOPE INTERACTIONS

Before the industrial revolution of the nineteenth century, architects could not afford to ignore the existing conditions of the site and by necessity depended on the building envelope to admit light and control other environmental conditions (Moore, 1985. Buildings are supposed to relate with climatic impacts but modern architecture and technology have broken with this understanding of the significance of climate (Martin, 1974). The environment of buildings has become worse in recent years mainly due to poor understanding of solar effects. The attempts to correct these short comings by engineering techniques have led to excessive energy demands by air-conditioning. Many modern office buildings' shapes are designed to exclude all exterior climatic resources, even though there are potentials to take advantage of positive exterior climatic resources such as day lighting and natural ventilation (Lechner, 1991). The development of structural frames permitted larger openings and glazing. These posed great advantages but also great limitations in terms of increased glare and heat gains. According to the English Heritage (2007), we are familiar with the effects of temperature and humidity, especially during warm, 'muggy' summers. Humidity that is too low can also be a problem, making the air feel too dry. The development in artificial lighting and mechanical air-conditioning also exerted great influence on earlier limitations in building forms and depth.

Technological innovations such as mechanical air-conditioning, fluorescent lighting, temperature and humidity control devices allowed for a climate rejecting control approach to office buildings to become standard design solution during the past few decades (Ruck, 1989). Modern designers of buildings have always seen air-conditioning as one principal element to achieve a controlled environment without considering it effects and compatibility with energy conservation. The issue of form in thermal planning is often not

considered by designers in modern time because of the advent of modern mechanical environmental control devices (Lechner, 1991).

About 70% of office building energy consumption is electricity which is used for lighting, heating, cooling and office equipment (Juerg, 2007). Environmental pollution as a result of air-conditioning system in office buildings can cause sick building syndrome (SBS) which temporarily fail to cope with the environment. As our society is making the transition from the industrial age into the information age and more people work in buildings rather than factories, energy-responsive buildings and a quality working environment are critical issues confronting designers of today and tomorrow (Ternoey, 1985).

Hedge (1994) carried out an investigation in six office buildings and found that the prevalence of eye, noise and throat symptoms were higher in air-conditioned offices than naturally ventilated ones. Technology presented the model of climate rejecting building typologies which permits the influence of climate to be ignored. The building envelope – external environment interactions in this model type is extremely limited and highly energy intensive.

CASE STUDY OF CLIMATE ADAPTING BUILDING TYPE A

A healthy building has vital features such as unadulterated fresh air, day lighting, individual control and planned maintenance. Climate adapting office buildings provide for passive air flow system and appropriate indoor environment during most of the year. These buildings generate moderate climate through courtyard and open plans. This reduces heating and cooling loads in the office building. Climate adopting office buildings have open form configuration to maximize cross ventilation and day lighting. For an open plan office space layout, the amount of energy used in maintaining internal thermal comfort is reduced to minimum. The design of this building is in sympathy with the climate having fabrics with good thermal performance which help to stabilize temperature and reduce overheating. This type of office building uses its envelope to provide suitable environment rather than relying on heating or cooling plants.

Examples of this type of buildings are the Plateau State Secretariat office complexes, Jos and Federal Secretariat complex, Jos.

The main characteristics features of this office building types are:

- They have open plan form configuration to maximize natural cross ventilation, day lighting and beneficial solar heat gain.
- Attenuate excess perimeter daylight with free-standing courtyards
- Have good views through window openings with very high level of solar shading.
- The design used the building structure, form and internal environmental needs to inform its architectural expression.
- Building envelope acts as a filter not a barrier.
- Orientation and shape is formed to make the best use of ambient energy.
- Corridors, stairs and lifts are located on the sides to enhance natural light and ventilation.

Plate 1. Plateau State Secretariat Complex Jos

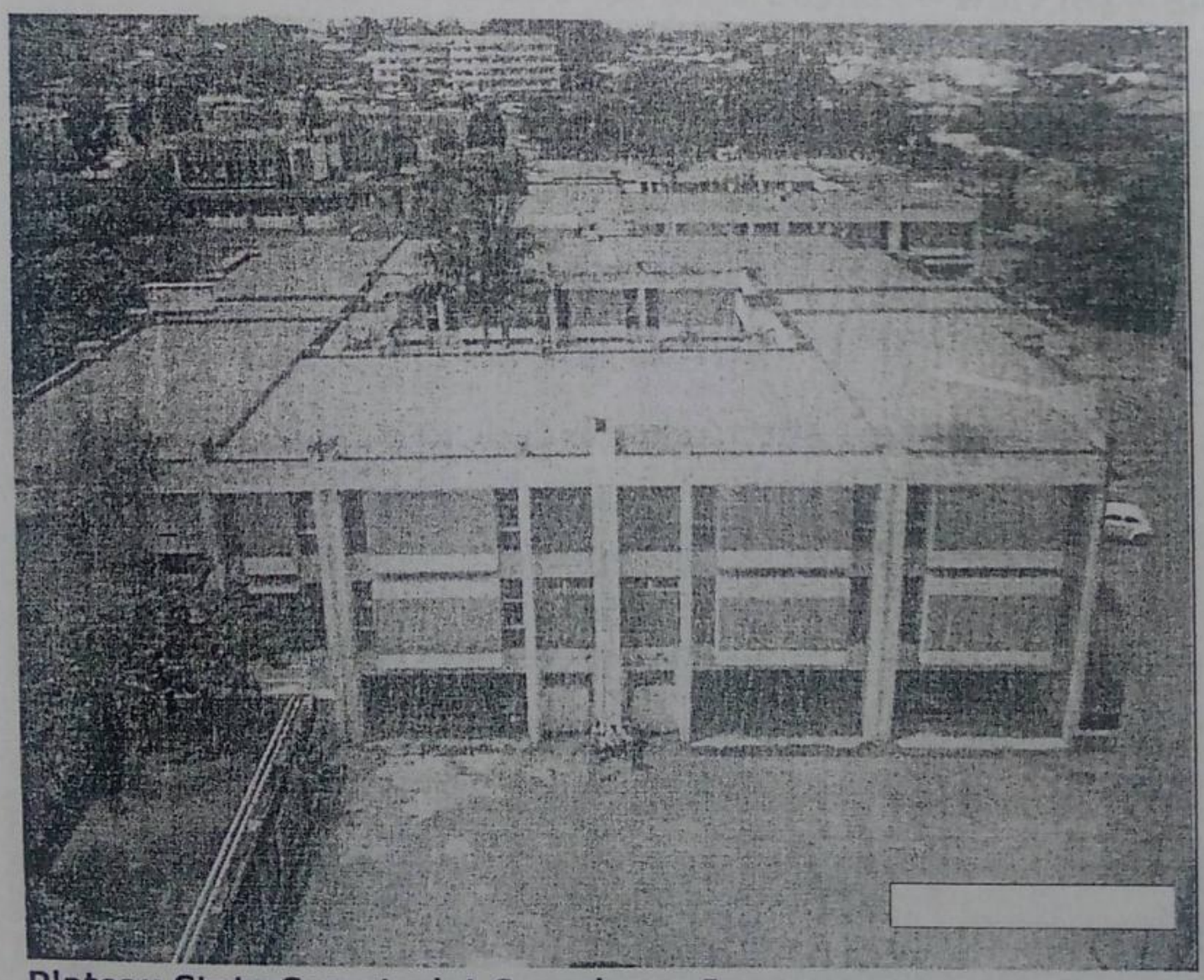

Plate 2. Plateau State Secretariat Complexes Jos

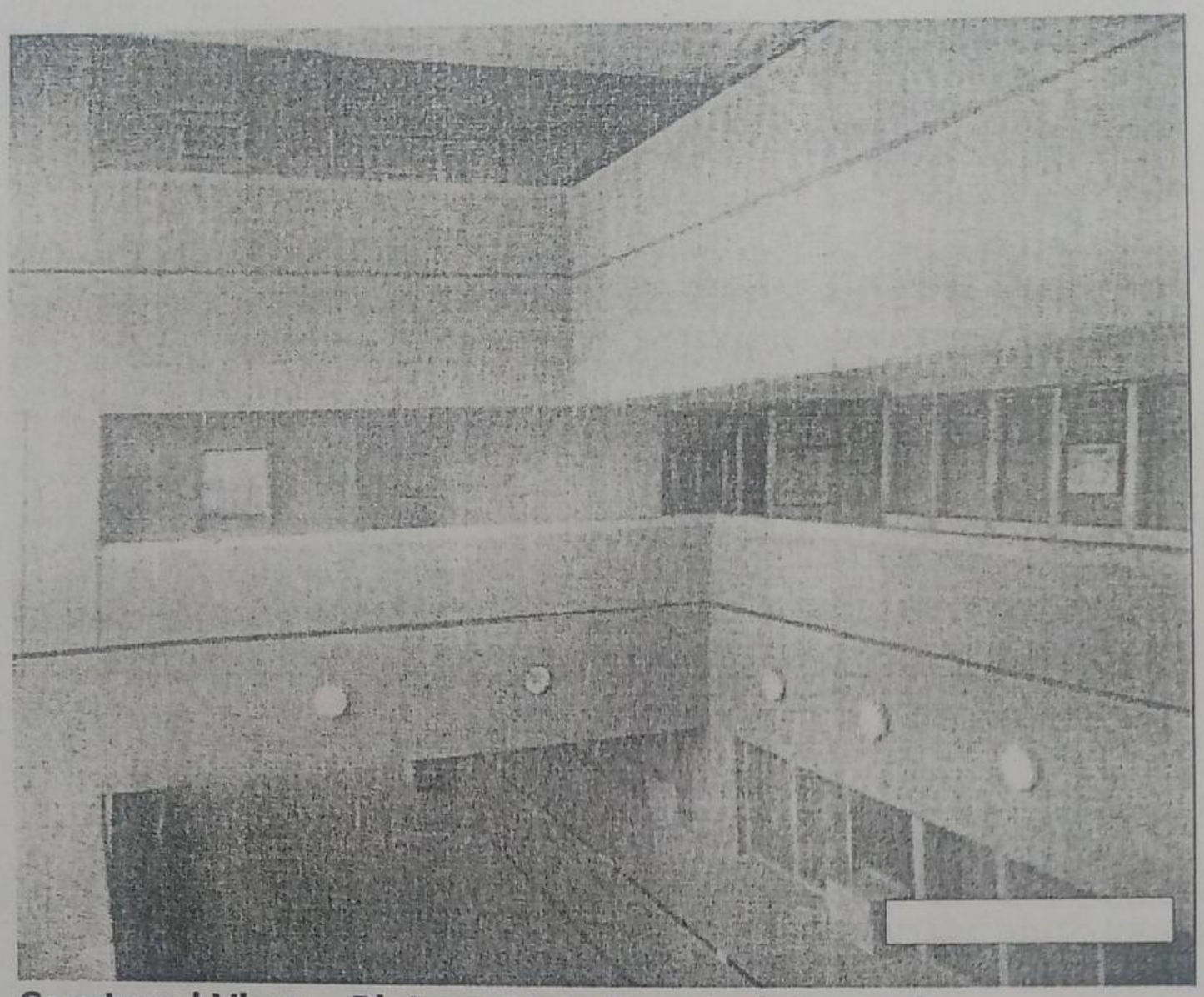

Plate 3. **Courtyard View – Plateau State Secretariat complex**

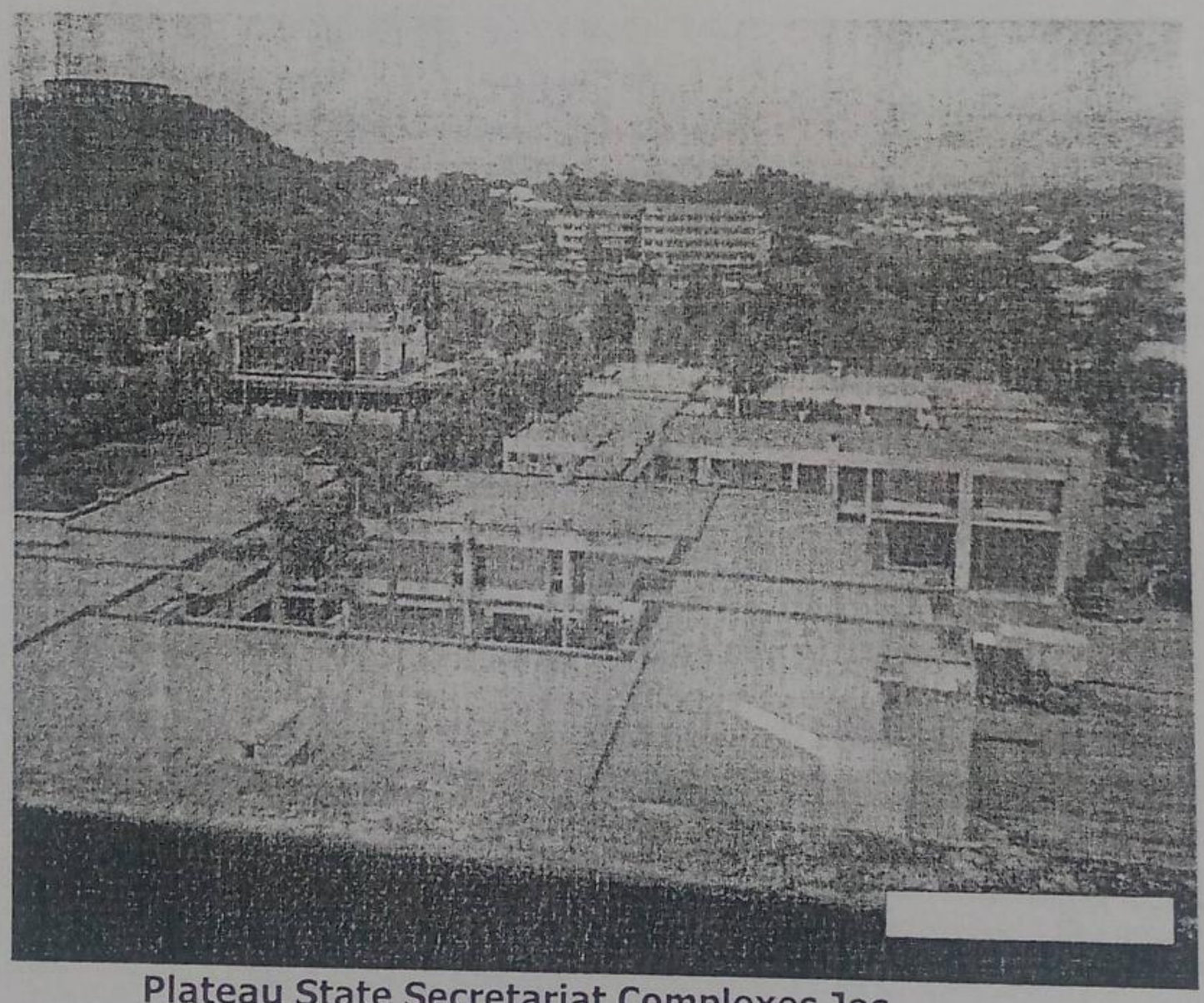

Plate 4. **Plateau State Secretariat Complexes Jos**

Plate 5. Federal Secretariat Complex Jos

Plate 6. Federal Secretariat Complex Jos - Courtyard

CASE STUDY OF CLIMATE REJECTING BUILDING TYPE B

Climate rejecting buildings isolate internal environment from the external using air conditioning and mechanical systems. This achieved temperature control within its space by varying the volume of conditioned air supplied at varying temperature. This type of building lacks freshness of air, no air movement with the air becoming more humid. Climate rejecting office buildings have no connection between the occupied space and the

external environment and therefore generate more heat within the building from lights and people. Examples of climate rejecting building type **B** are the Joseph D. Gomwalk House, Jos and the Murtala Mohammed House, Jos. The basic characteristics of these type of office buildings are:

- The orientation of the buildings is unimportant and the shape compact with the internal environment predominantly controlled artificially and automatically.
- The design utilized high mechanical controls in terms of provision of air temperature, lighting and ventilation.
- High energy demand.
- Requirement for high maintenance and high operating cost.
- Building emphasis closed control rather than looser control offer by passive systems.

PLATE 7. Joseph D. Gomwalk House Jos

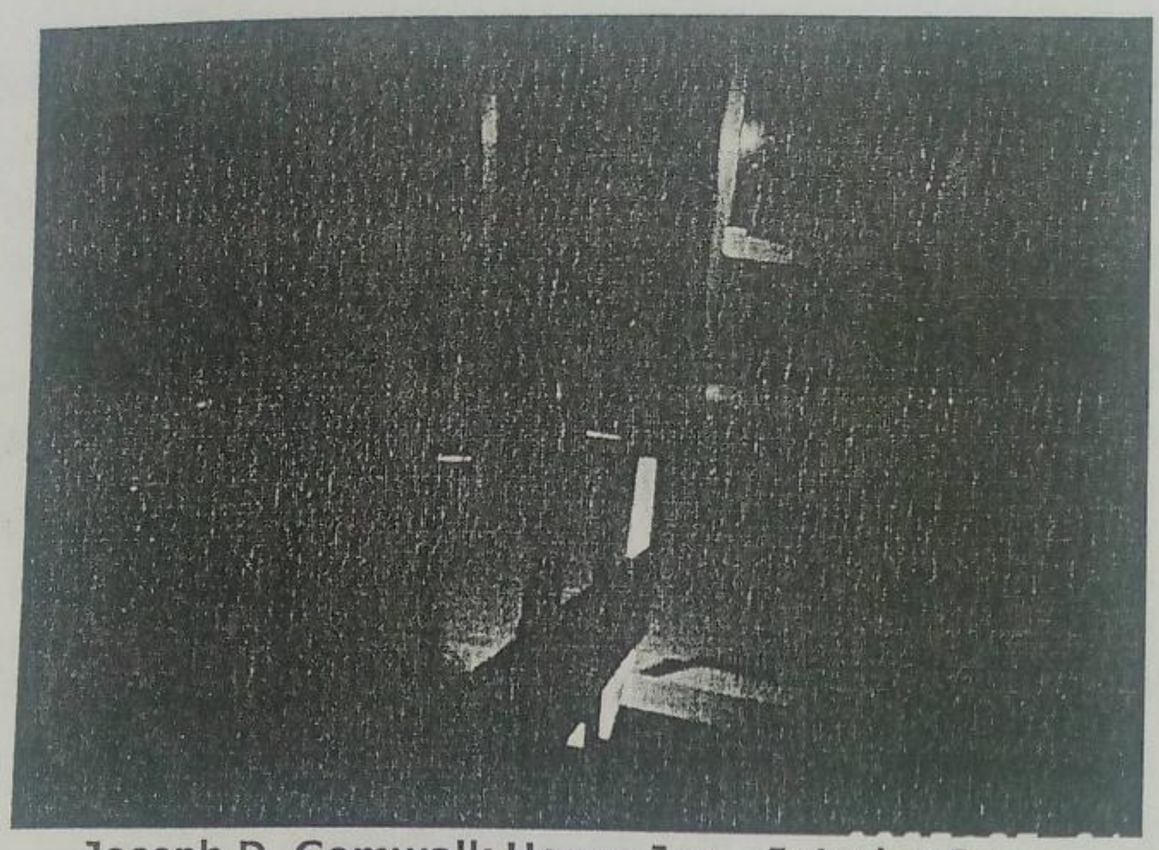

PLATE 8. Joseph D. Gomwalk House Jos – Interior Space

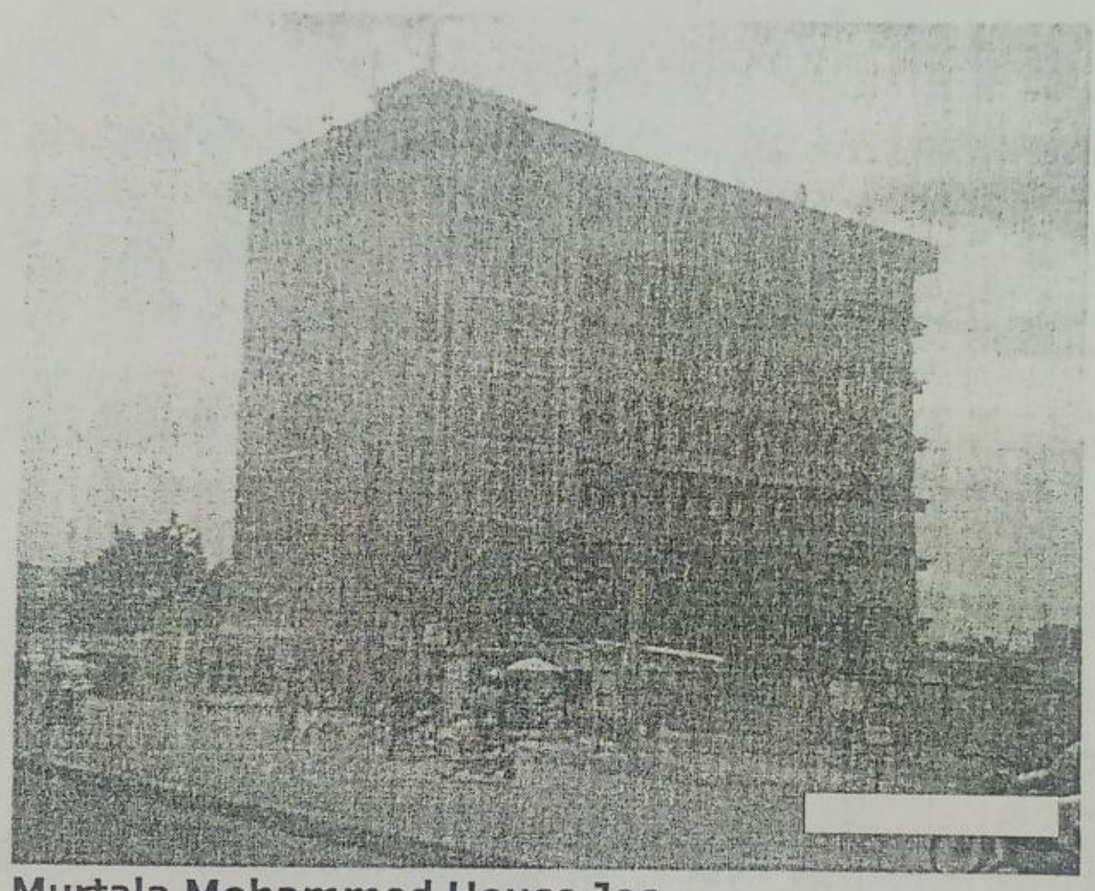

PLATE 9. Murtala Mohammed House Jos

CONCLUSION

To create buildings that respond positively to their climatic zones, architects must be sensitive to the diversity of influences that shape a building's development, especially the approach used in designing it. Architects are expected to use appropriate design approach which offer them greater opportunities to architectural solutions for adaptive buildings. The appropriate design approaches are those that integrate both the external and internal environment into the whole of an architectural design.This study identified six determinants that influence the adaptive nature of an office building. These are; orientation, shape or plan form configuration, exterior and interior space, climatic conditions, building envelope and energy consumption. The response of a building to these determinants resulted into the building being climate adaptive or climate rejecting. Also, the integration of these determinants on a whole building level would result into the responsiveness of the building to the environment.

It can therefore be concluded that climate adapting buildings type **A** are more energy efficient than climate rejecting buildings type **B** that have increase in the heating load of the buildings. The annual energy cost of climate adapting buildings is insignificant as compare to that for climate rejecting buildings with higher energy load. The design of buildings that connect the exterior environment with the interior occupied spaces could be one means of reducing the high demand for electrical and mechanical energy in office complexes. Office buildings must therefore be climatically sensitive, flexible and adaptable to their locations.

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