11.1 Climatic zones for architectural design
11.2 General design guidelines
11.3 Design in the coastal zone
11.4 Design in the forest zone
11.5 Design in the transitional zone
11.6 Design in the highland zone
11.7 Design in the savannah zone
11.8 Design in the semi-desert zone

INTRODUCTION

Climatic zones for architectural design are defined by boundaries where a change in the thermal comfort requirements should be reflected in changed building elements. Six such zones have been defined for Nigeria: the Coastal Zone, the Forest Zone, the Transitional Zone, the Savannah Zone, the Highland Zone and the Semi-desert Zone. There are some general design guidelines common to all these zones. However, site planning, design of openings, recommended structure and materials as well as need for provision of outdoor spaces require varying specifications.

11.1 CLIMATIC ZONES FOR ARCHITECTURAL DESIGN

The form of dwellings, the insulation value of roofs and walls, the orientation, size of windows and several other design variables are determined by the requirements for thermal comfort. Requirements for thermal comfort are related directly to the climate. There is therefore a strong link between the climate and building design, but this link should not be seen as a direct one. The same condition of thermal distress or comfort may be created by various combinations of climatic variables. Climatic variables vary over distance and time in a continuous manner resulting in variations in thermal comfort conditions that are also continuous. It is however possible to determine the appropriate boundaries where a change in the climate and a change in the thermal comfort requirements should be reflected in changed building elements. These boundaries will effectively define the climatic zones for architectural design.

There are several definitions of climatic zones for architectural design in Nigeria. Recent research by the author has identified six zones in Nigeria (Ref. 18). The following architectural design zones are recognised for the purposes of our discussion. See table 11.1.

THE COASTAL ZONE

This includes such cities as Ikeja, Lagos, Ondo, Benin, Warri, Port-Harcourt and Calabar. The climate is characterised by high humidity and hot discomfort for eleven or more months in the year. This makes provision of permanent ventilation essential. The monthly rainfall exceeds 200mm for three or more months making adequate drainage necessary. There is no need for thermal storage as a high diurnal temperature range of more than 10 degrees coupled with low humidity is not experienced for more than one month in the year.

The maximum monthly temperature never falls below the comfort limit, thus no special precautions need be taken against cold discomfort.
FOREST ZONE
This covers Ibadan and Oshogbo. There is need for permanent provision for ventilation for ten months of the year as a result of the combination of high humidity and hot discomfort in the day. The monthly rainfall never exceeds 200mm. Despite the hot and humid nature of the climate thermal storage is still needed for two months of the year as a result of the combination of low humidity and high diurnal range of more than 10 degrees Celsius. There is no need to provide outdoor living space and protection against cold is not required.

TRANSITIONAL ZONE
This covers Ilorin, Lokoja, Enugu and Makurdi. There is need for cross ventilation for three to nine months in the year. Buildings should be protected from heavy rainfall as a result of downpours exceeding 200mm in some months. There is need for thermal storage for three to five months. High humidity and low diurnal temperature ranges make external sleeping spaces unworkable. Severe cold does not constitute a problem.

SAVANNAH ZONE
This zone covers a large portion of the country and it includes towns like Yelwa, Sokoto, Gusau, Kano, Potiskum, Maiduguri, Yola, Ibi and other slightly wetter towns like Zaria, Kaduna, Minna, Bida and Abuja. There is need for cross ventilation for three to nine months in the year due to hot day discomfort. There is need to protect buildings against rain as a result of the intensity of downpours when they finally arrive. Cold nights and hot days alternate for six to ten months of the year. This is accentuated during the harmattan and thermal storage is needed for cooling interiors in the day and for providing warmth at night. Outdoor sleeping space should be provided since it is impossible to achieve night comfort during the very hot period.

HIGHLAND ZONE
This is a cool climate to be found at high altitudes. This climate is associated with Jos on the Jos Plateau but it can also be found on the Mambilla plateau and other mountainous regions along the Cameroonian border. There is need for cross ventilation only during one month of the year though good ventilation is desirable during other months. Monthly rainfall exceeding 200 mm for three or more months in the year dictates the need for protection against heavy downpours. Thermal storage is needed for six to ten months in the year to dampen fluctuations in indoor temperatures. Outdoor sleeping spaces are not required and special provision for winter are unnecessary.

SEMI-DESERT ZONE
This covers Katsina and Nguru. Ventilation is essential for one or two months in the year. It is characterised by low rainfall with monthly readings of more than 200 mm occurring only during one or two months in the year. Hot and humid conditions are experienced during one or two months and thermal storage is needed for more than six months in the year. There should be provision of outdoor sleeping space. Extreme winter conditions are however non-existent.

11.2 GENERAL DESIGN GUIDELINES
There are some design recommendations that are applicable all over the country. Mosquitoes and flies are a common problem and protective screens should always be used. Curtains provide privacy and help regulate ventilation. Whenever good ventilation is needed it is advisable to design some internal openings without doors, subject however to user's consent. Security bars and screens are installed for security reasons. Screens reduce the ventilation and daylighting and must be compensated for in window design. The type of windows used depend on requirements for permanent ventilation. Louvres always permit infiltration and help direct the flow of air, while casement windows eliminate rain penetration and draughts. Rain protection is needed in all parts of the country, even in the supposedly dry areas in the Savannah and Semi-desert Zones. This is because it is not only the annual rainfall but also the intensity of rainfall that matters. Flats roofs should never be used since they will certainly leak unless adequate waterproofing is properly done. The roof slope should not be less than 10 degrees, preferably more in very wet zones. There is a common belief that high ceilings considerably improve comfort conditions. Research has shown that the improvement is minimal and not commensurate with the additional costs. A ceiling height of 2.5-3 m has been recommended.
11.3 Design in the Coastal Zone

**Site Planning:** The layout of buildings should be north-south with the longer axis facing east-west. There should be large spaces between buildings to allow breeze penetration. Buildings should be single banked to enable cross ventilation. The house form should reduce exposure to solar radiation. See table 11.2.

**Openings** should be large and situated preferably in north and south walls. Permanent ventilation should be provided. Their position should encourage body cooling. Sun-shading devices must exclude the sun throughout the year. Rain penetration through windows is a problem that needs to be solved.

**Structure and materials:** Walls and floors should ideally be light and of low thermal capacity. This requirement is difficult to satisfy for floors but walls can be made of louvred shutters and lightweight materials of minimal thermal storage capacities. Roofs should be light, with a reflective surface and cavity for ventilation. The reflective surface of roofs reduces solar heat gain by the roof. The finishing of walls and roofs should be light to reflect solar heat. These finishes should protect against driving rain.

**Outdoor spaces:** Overhangs and verandas should be used for sun-protection. Balconies should be provided in high rise buildings, so that occupants can enjoy the evening breeze. Courtyards help in achieving cross ventilation in bigger buildings.

11.4 Design in the Forest Zone

**Site planning:** The layout of buildings should expose as little of the building surface to the western sun as possible. The spacing of buildings should allow breeze penetration and single banking should be used. There is however need to use trees and shrubs for protection against hot and cold winds. Trees should provide adequate shading.

**Openings:** Medium size openings of approximately 25 to 40% of the wall area should be situated in north and south walls. Permanent ventilation should be provided. These openings should provide adequate body cooling and they must be shaded throughout the year from the sun and driving rain.

**Structure and materials:** Walls and floors should be of lightweight materials of low thermal capacity and short time lag. Roofs should be light, with a reflective surface and cavity. Wall and roof finishes should be light in colour. Walls should be protected against driving rain.

**Outdoor spaces:** Overhangs, verandas and balconies should be provided. Courtyard design should be used to improve cross ventilation.

11.5 Design in the Transitional Zone

**Site planning:** Buildings should be protected against solar gain by exposing minimal surfaces to the sun. This is achieved by laying out buildings with their longer axes facing east-west. The space between buildings should enable breeze penetration but trees should be used to protect from hot and cold winds. Buildings should be single banked.

**Openings:** Medium openings occupying 25 to 40% of the wall area should be used and permanent provision made for ventilation. The positioning of openings should help catch breezes which will be directed at the living level to provide body cooling. Sunshading devices should be used and openings protected from driving rain.

**Structure and materials:** Walls and floors should be heavy with high thermal capacity and a time lag of over 8 hours. Roofs should be light and well insulated to prevent heat loss and heat gain. Surfaces should be reflective and water resistant.

**Outdoor spaces:** Courtyards and verandas help improve ventilation.

11.6 Design in the Highland Zone
Site planning: Compact courtyard planning should be used to enclose private and semiprivate outdoor spaces. Air movement is not a prerequisite for comfort so compact planning will economize land usage and help conserve heat. For the same reason double banking should be used with temporary provision for air movement. It is very important to provide shade trees. The orientation of buildings should minimize solar gain but orientation plays a minor role in this climate.

Openings: Composite openings occupying 20 to 35% of the wall area should be used. Internal walls should possess adequate openings for air flow through the building for ventilation purposes. Openings should be protected against sun and rain penetration.

Structure and materials: Walls and floors should be heavy with a time lag of over 8 hours. Roofs should also be heavy with a time lag of over 8 hours. Light and reflective finishes are essential when light or medium weight materials are used.

Outdoor spaces: Courtyards are desirable but the total building surface should be minimized. These courtyards should be shaded and verandas and patios are also desirable.

11.7 DESIGN IN THE SAVANNAH ZONE

Site Planning: The surface of buildings should be protected from solar gains by placing their long axis east-west. Open spacing should be used for ventilation but there must be protection from hot and cold winds. Rooms should be single banked and permanent provision made for air movement.

Openings: Should be composite and occupy 20 to 35% of the wall area. These openings should be able to catch the breeze and improve body cooling, with permanently open ventilation vents. These openings must be protected against sun and rain penetration. See figure 11.1.

Structure and materials: Walls, floors and roofs should be heavy with high thermal capacity and a time lag of over 8 hours.

Outdoor spaces: Shaded and partly enclosed outdoor living spaces should be provided in the form of courtyards and verandas. These spaces can be used for outdoor sleeping when conditions indoors become unbearable.

11.8 DESIGN IN THE SEMI-DESERT ZONE

Site Planning: Compact courtyard planning should be used with double banked rooms and temporary provision for air movement. Trees should be used to provide shade.

Openings: Openings should be small or composite, occupying 15 to 35% of the wall area. These openings should also be provided on internal walls and positioned in a way that will improve body cooling. They should be protected from sun and rain penetration.

Structure and materials: Walls, floors and roofs should be heavy with a time lag of over 8 hours.

Outdoor spaces: Outdoor living space must be provided in the form of courtyards. These must be shaded by trees and boundary walls and designed in a way that enables outdoor sleeping. This means security and privacy must be provided.

TESTS AND EXERCISES

11.1 With the aid of sketches, discuss the choice of building materials, construction methods and the type of architectural planning in:

a. hot dry climates
b. warm humid climates

Explain the 'thermal system' of a small courtyard house in a hot arid tropical climate.

11.2 Discuss how the climate affects architectural planning and design in:
a. Kano - hot and dry climate  
b. Lagos - warm and humid climate.

11.3 Prepare a site analysis and site plan for 20 bungalows forming part of Ahmadu Bello University Intermediate and Junior Staff Quarters (site attached) with special consideration of:

a. orientation  
b. environmental use of planting  
c. type of construction and building materials  
d. ventilation requirements, size and position of openings  
e. landscaping.

REFERENCES


