EXPLORING THE PRINCIPLES OF GREEN ARCHITECTURE FOR THE DESIGN OF KADA INTERNATIONAL HOTEL, KADUNA

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BY

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SEPTEMBER, 2015

DECLARATION

I declare that the work in the thesis entitled Exploring the Principles of Green Architecture for the Design of Kada International Hotel, Kaduna has been by me in the Department of Architecture. The information derived from the literature has been duly acknowledged in the text and a list of reference provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

Bello Rahama Mohammed	(Signature)	(Date)

CERTIFICATION

This dissertation entitled EXPLORING THE PRINCIPLES OF GREEN ARCHITECTURE FOR THE DESIGN OF KADA INTERNATIONAL HOTEL, KADUNA by Rahama Mohammed BELLO meets the regulations governing the award of the degree of Master of Science in Architecture of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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I am very appreciative to my supervisors Arc M H Mukhtar, Arc M L Sagada and the entire staff of the department of architecture ABU Zaria for their endless effort and encouragement.

I'm very thankful to my classmates and course mates, working together as a team really inspired me. To my friends who are too numerous to mention, thank you very much for all the support and encouragement.

DEDICATION

I dedicate this thesis to my late father, Justice Mohammed Bello. We love you, miss you and you will always be in our hearts. May your Gentle soul rest in peace and Aljanna Firdausi be your final resting abode. Amin.

ABSTRACT

Buildings have a lot to answer for in terms of the amount of natural resources consumed, the amount of pollution created, the amount of energy wasted and the amount of wastes generated. Construction activity is known to have a major impact on the environment and is a major consumer of a wide range of naturally occurring and synthesized resources. Despite the recognition that environmental issues are important to the survival of the construction industry, the industry continues to degrade the environment, exploiting resources and generating waste, and is slow to change its conventional practices to incorporate environmental matters as part of its decision making process.

With increased awareness and knowledge of these impacts, efforts are being made to avoid these adverse effects and to work towards impact improvement. Among these is Green Architecture.

This thesis aimed to highlight and describe approaches to green architecture and how they were adopted to a hotel design, with special regard to the climatic conditions.

Case studies were carried out both locally and internationally to have a good understanding of the topic. The buildings examined include the Bank of America Tower and the G Tower Malaysia. These buildings were analyzed with respect to the benefits derived from the use of principles of architecture such as passive solar design, day lighting, greywater and rainwater systems, construction materials and pattern of site development. Burj al Arab Hotel Dubai and Transcorp Hilton Hotel Abuja were also studied for hotel design, spatial organization and space requirements, as well as the Songjiang Hotel china, a green hotel.

The findings of the case studies were applied to design the hotel with energy and water efficiency being the main focus of the study. For energy efficiency, the hotel is designed with the environment: passive cooling techniques such as natural ventilation, evapourative cooling, shading, landscaping and day lighting are employed. Photovoltaic is used on the building facade. Evacuated solar tubes on the roof deck heat rainwater captured as well as greywater system is used to make the hotel water efficient.

The five star Kada International Hotel which is located by the River Kaduna bank has 122 rooms and suites, conference and exhibition hall, restaurants, leisure facilities, shops and rentable office spaces.

The study concluded with the proposition that the application of green architecture will result to a more environmental friendly hotel, decreased running costs, and increased property values, while ensuring that resources and planetary systems are protected for future generations to come.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Since the time when humans lived in caves and enjoyed the benefits of stable temperatures and natural ventilation with zero mortgage and environmental impact, we have been refining our use of resources to provide improved shelter. Until very recently in human history, this refinement occurred within sustainable principles because it was dependent on available resources and technologies. These limitations mean that solutions had to be effective yet work with the environment and available materials rather than transforming and dominating them. With green architecture the two objectives meet with as little compromise between protecting the earth and meeting human needs.

Man has been affected by climate and its influence over the earth. Today, with the help of new climate technology, architects and builders are making use of climate-responsive architecture and its benefits in helping to keep humans comfortable. Climate responsive architecture takes advantage of free energy in the form of heat and light. Each region of the world employs its own techniques and designs in its buildings that are best suited to that particular region. (Turner, 2003)

A hotel is a commercial establishment that provides paid lodging, food and other services to the public, usually on a short term basis. Thus, it provides the basic accommodation for visitors.

The hotel and tourism industry should design hotels and accommodation that will make important environmental improvements to its structure in order to minimize its impact on

the environment. Buildings that need fewer resources and materials to build, occupy and maintain, and are more comfortable and healthy to live and work in with minimum adverse impact to the environment.

1.2 Problem Statement

In the tropical Nigeria, the main climatic issue is that of high temperatures and humidity. Buildings have to be designed in a way to make the temperatures optimal for human comfort or mechanical aided cooling devices have to be used. This increases to the energy consumption of the building which already account to about 50% of the world's total energy consumption. And the insufficiency of power nationwide has reported an estimated 40 million litres of petrol/diesel per day for the private generation of electricity. (The Vanguard Newspaper Jan 28, 2008)

The amount of water available for use on the planet is finite, so as population grows, the available supply of water per person drops. Demand in every area of water use—urban, industrial, and agricultural—has increased. According to Public Technology Inc (1998), Per capita water supplies worldwide have decreased by one-third since 1970, as the world's population has grown by 1.8 billion.

Hotels in Nigeria are very expensive and are not environmental friendly because they burn a lot of fuels to generate power to keep them going. This thesis will address these environmental problems by applying the principles of green architecture focusing on energy and water efficiency.

1.3 Motivation and Justification

Kaduna is one of the key centers for political, economical and agricultural activities in the country. Recently the town has been expanding because of increased businesses and economical activities. The creation of the millennium city and the revival of the factories will however invite business tycoons, industrialists and investors from all over the world.

Energy efficiency is necessary in hotels to reduce pollution from burning fuels of generators. A very good design will help reduce the burning of the fuels which cause CO2 emission and global warming, and when it is not sufficient, power from renewable energy should be utilized.

A large quantity of water is consumed in hotels: from showers, baths, toilets, laundry, swimming pools and irrigation of gardens. With increase in water demand and limited supply it is essential to preserve water by using it wisely and to recycle it where possible.

1.4 Aim and Objectives

The aim of this research is to explore the principles of green architecture in the tropical climate and applying it to a hotel design to create an eco friendly environment, and to reduce environmental impacts of buildings.

The aim will be achieved through the following objectives:

(a) To study and understand the concept of green architecture and its principles.

(b) To study the climatic elements and how they affect buildings and occupants.

(c) Identifying which of the principles of green architecture are applicable to the tropical climate.

(d) How these principles can be applied to a hotel.

1.5 Scope of Study

This research will be based on the general findings which will be used to design an environmental friendly five star hotel located in the millennium city, Kaduna. This hotel will comprise the following:

(a) Accommodation, from single rooms to luxurious suites.

(b) Meeting and business facilities

(c) Restaurants and bars

(d) Fun and leisure facilities

1.6 Target Users

(a) Visitors seeking for accommodation

(b) Patrons of meeting and banquet facilities

(c) Patrons of leisure facilities like gym, swimming pool etc

1.7 Definition of Some Key Terms

(a) Green Architecture: is a general term that describes environmentally-conscious design techniques in the field of architecture. A green approach to built environment considers all the resources that go into the building.

(b) Sustainable architecture: is a general term that describes environmentally conscious design techniques in the field of architecture. Sustainable architecture is framed by the larger discussion of sustainability and the pressing economic and political issues of our world. In the broad context, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space.

(c) Eco-architecture: this sees buildings as part of the ecology of the planet and the building as part of a living habitat as opposed to many architects who see a building as a work of art, or exhibition.

(d) Hotel: this is a commercial establishment that provides paid lodging, food, and other services to the public, usually on a short-term basis.

(e) Leadership in Energy & Environmental Design (LEED): this is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies intended to improve performance in metrics such as energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

CHAPTER TWO

GREEN ARCHITECTURE

2.1 What is Green Architecture?

Roaf, Fuentes and Thomas (2001) defines green architecture as "the creation or restructuring of buildings so that they have a minimal impact on the environment. Green Architecture is not a style, trend or a vernacular and neither is it new. It is a climatically, geographically and culturally appropriate way of architecture and building, combining the best of both old and new technology."

According to U S Environmental Protection Agency (2011) green building is "a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort."

McLaren (2009) reports that buildings account for 72 percent of electricity consumption, 39 percent of energy use, 38 percent of all carbon-dioxide emissions, 40 percent of raw materials used, 30 percent of waste output and 14 percent of potable water consumption worldwide. Green building or architecture is intended to minimize consumption and waste while maximizing your comfort and quality of life.

Typical building construction, use, and demolition, as well as the manufacturing of building materials, contribute significantly to environmental problems. Green building also has tangible economic and public health benefits. These include lower operating costs via reduced energy and water utility bills, and reduced maintenance and replacement costs due

to greater durability of materials. The use of non-toxic materials in construction is especially important in protecting children from respiratory and other diseases. (Tree Media Group, 2004)

The earth's ecological condition is becoming increasingly unsafe. The consumption rate of natural resources is simply unsustainable. Therefore there is a need to build smarter and the only way to do so is to utilize green architecture.

Green architecture is also known as sustainable architecture, Sustainable development, eco-design, eco-architecture, earth-friendly architecture, environmental architecture, natural architecture. The term ecological, green and sustainable are often used to describe environmentally responsive designs. But each term is heavily influenced with social and political implications. The variation of the terms ecological, sustainable and green is negligible. They have the same primary aim and objectives. So, whatever a building is called from the three words is the same.

2.2 History of Green Architecture

BStone (2011) wrote the following:

The history of green building dates back much further than the 1970's, it was in the midst of the industrial revolution that Henri Becquerel first witnessed the transformation of solar energy into electrical energy, known as photovoltaic power. However, in the late 1800's to early 1900's, a number of solar power plants were built to utilize the sun's energy for steam power. Then, in the 1950's, solar energy was used on an extremely small-scale, making way for the solar panel solution twenty years later.

During the energy crisis of the 1970's, green building moved from research and development to reality. Builders and designers were looking for a way to reduce the reliance of buildings and homes on fossil fuels. Solar panels were used to make more environmentally friendly homes, although only in small numbers due to high initial costs.

In the 1980s came the next big shock – climate change. It was then that the rates of depletion in the ozone layer and the increase in greenhouse gases and global warming became apparent. (Roaf, Fuentes and Thomas, 2001)

During this transition period, designers and consumers started wondering, if solar panels can make buildings more efficient, lower energy bills, and reduce the negative impact on the environment, what other steps can be taken to build even greener homes? Aside from harnessing the earth's richest energy source — sunlight — green builders and designers examine a number of issues to make a building eco-friendly. Now, eco construction involves so much more than simply using solar panels. (BStone, 2011)

2.3 Principles of Green Architecture

In view of present global crises - population expansion, natural resource depletion and ecological disasters, there was an urgent need to align development and architecture with the concept of sustainability, thus, Green Architecture. Over the years green architects come-up with different principles of Green Architecture. The five basic principles issued by the LEED are:

(a) Energy efficiency

(b) Water efficiency

(c) Materials and resources

(d) Sustainable site

(e) Indoor environmental quality

2.3.1 Energy efficiency

According to Roaf, Fuentes and Thomas (2001), approximately 50 percent of the energy use in buildings is devoted to producing an artificial indoor climate through heating, cooling, ventilation, and lighting. Green buildings often include measures to reduce energy use. Passive solar building design, day lighting, shading, and the use of onsite generation of renewable energy are some of the ways in which energy efficiency can be obtained in the building envelope.

Energy efficient can be achieved through Passive solar design and renewable energy.

Passive Solar Design

Passive solar design is a broad term used to encompass a wide range of strategies and options resulting in energy-efficient building design and increased occupant comfort. The concept emphasizes architectural design approaches that minimize building energy consumption by integrating conventional energy-efficient devices, such as mechanical and electrical pumps, fans, lighting fixtures, and other equipment, with passive design elements, such as building siting, an efficient envelope, appropriate amounts of fenestration, increased daylighting design, and thermal mass. (Public Technology Inc, 1996)

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun.

In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. The key to designing a passive solar building is to best take advantage of the local climate (Texas Solar Energy Society, 2011).

The first step in creating comfort and thermal delight in buildings is to understand the relationship between the climate and our need for shelter. For this thesis, the tropic is the area of study therefore passive cooling will be discussed.

(i) Passive Cooling Passive cooling is a system whereby a building's structure (or an element of it) is designed to permit increased ventilation and retention of coolness within the building components. The intention is to minimize or eliminate the need for mechanical means of cooling (NKBA, 2009). Before refrigeration technology first appeared, people kept cool using natural and fountains as well as large amounts of stone and earth absorbing daytime heat. These ideas were developed over thousands of years as integral parts of building design. Today they are called "passive cooling." (Ecotect Community Wiki, 2011)

Hyde (2008) stated the following: The building envelope comprises elements of the building from the building’s line of enclosure, marking the inside from the outside. The building envelope can be thought of as primarily comprising opaque and semi-opaque elements, such as walls, floors, roofs and shading devices, as well as transparent elements, such as windows and skylights. The primary function of the building envelope is to filter the external environment in such a way as to facilitate passive and, possibly, active systems of cooling (and, in some cases, also heating). The design challenge is complex, involving a balance of often contradicting

requirements. Invariably, however, a poor-quality building envelope results in less comfort for the occupants. The lack of comfort means a reliance on active systems such air conditioning, which uses more energy, as well as creating the need for larger plant and equipment. There are different passive cooling techniques which include:

Natural ventilation: depends solely on air movement to cool occupants. Window and openings on opposite sides of the building enhance cross ventilation driven by breezes (Oikos, 2007) as shown in Figure 2.1

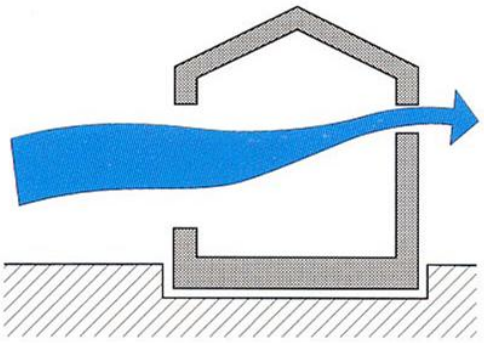


Figure 2.1 Opening to enhance ventilation

Source: Keeffe (n.d)

Since natural breezes can't be scheduled, designers often choose to enhance natural ventilation using tall spaces within buildings called stacks. With openings near the top of the stack, warm air can escape, while cooler air enters the building from openings near the ground. Ventilation requires the building to be open during the day to allow air flow. (Oikos, 2007) as shown in Figure 2.2 and Figure 2.3

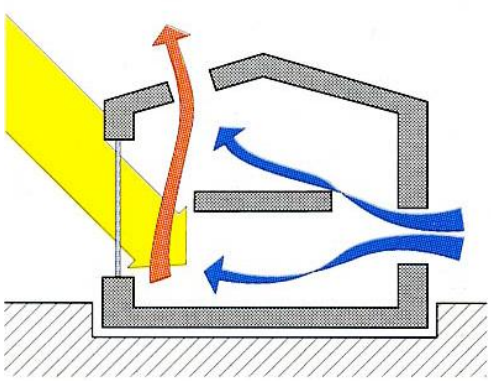


Figure 2.2 Stack effect used to create ventilation

Source: Keeffe (n.d)

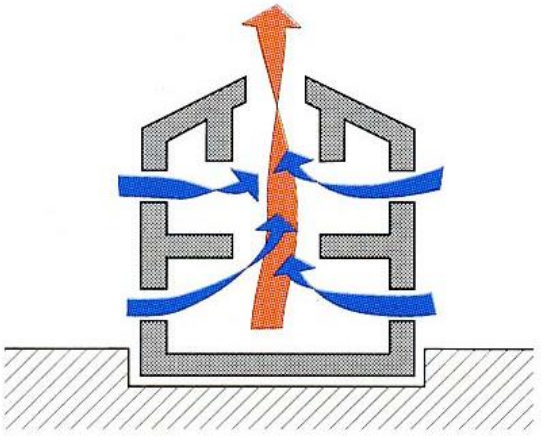


Figure 2.3 Chimeny effect to create natural ventilation

Source: keeffe (n.d)

Thermal mass: depends on the ability of materials in the building to absorb heat during the day, as shown in Figure 2.4. Each night the mass releases heat, as shown in Figure 2.5, making it ready to absorb heat again the next day. High thermal mass with night ventilation relies on the daily heat storage of thermal mass combined with night ventilation that cools the mass. The building must be closed during the day and opened at night to flush the heat away. (Oikos, 2007)

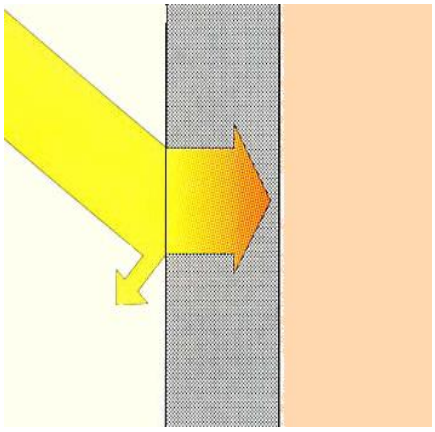


Figure 2.4 Building absorbing heat during the day.

Source: Keeffe (n.d)

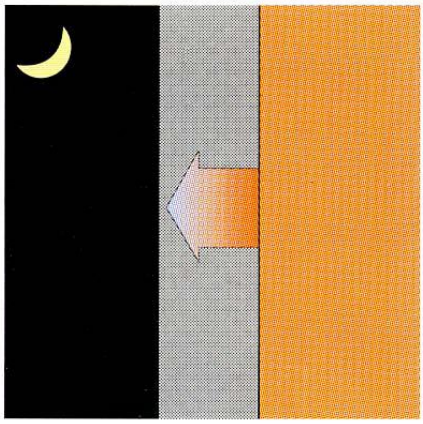


Figure 2.5 Mass releases heat at night

Source: Keeffe (n.d)

Evaporative cooling: lowers the indoor air temperature by evaporating water. Large amounts of heat are consumed by water as it evaporates, as shown in Figure 2.6. This is called the latent heat of evaporation. This heat is partially drawn from surrounding air, causing cooling. Evaporation is an effective passive cooling method. It works best when relative humidity is lower (70 per cent or less during hottest periods) and the air has a greater capacity to take up water vapor. In dry climates, this is commonly done directly in the space. But indirect methods, such as

roof ponds, allow evaporative cooling to be used in more temperate climates too. (Oikos, 2007)

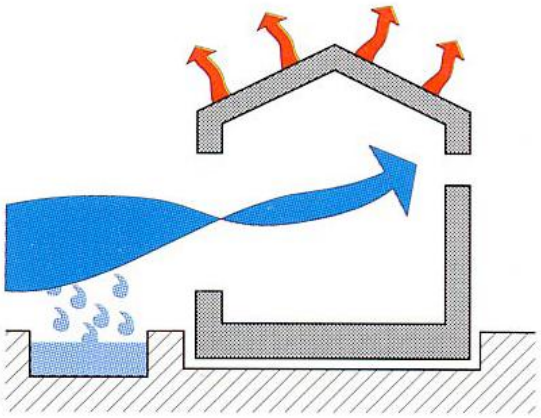


Figure 2.6 Evapourative cooling.

Source: Keeffe (n.d)

Shading: Shading of the building and outdoor spaces reduces temperatures, improves comfort and saves energy. Direct sun can generate the same heat as a single bar radiator over each square metre of a surface. Shading can block up to 90 percent of this heat. Shading can block the sun when it is not wanted. Overhangs above north facing windows are the most effective. Moveable shades are good for east and west facing windows. Deciduous trees can be effective but even without leaves can block some sun in winter as shown in Figure 2.7 and Figure 2.8. Fixed shading options include eaves, fixed louvers, covered balconies, trees etc. Adjustable or moveable shading options include curtains, adjustable louvers, shutters etc.

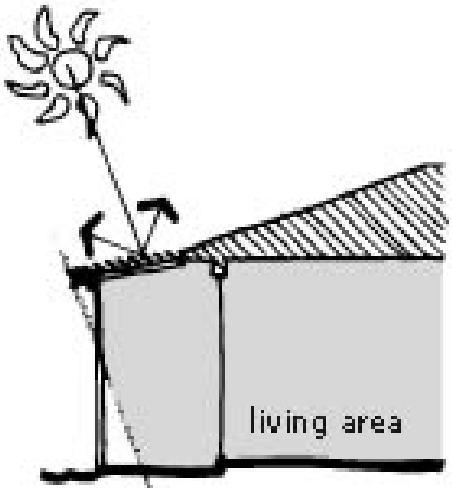


Figure 2.7 Eaves and covered balconies provide shading

Source: Olgyay and Olgyay

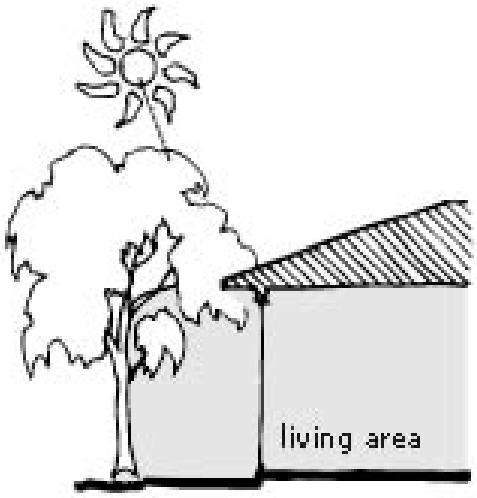


Figure 2.8 Trees provide shading.

Source: Olgyay and Olgyay

Landscaping and Greenery: can be used to enhance a passive cooling system. The use of vegetation to shade a house is a cooling technique that can be very effective. A well-placed plant can deliver effective, cool shade, as well as add to the aesthetic value of a building. As well as shade, plants are also effective for cooling because

they absorb the heat as shown in Plate 1. Since leaves are generally dark and coarse they reflect very little light, they make ideal solar radiation controllers. Photosynthesis is the way plants convert light into nourishment. During photosynthesis, a process known as evapo-transpiration occurs, in which large amounts of water vapour escape through the leaves. That water vapour cools the air passing by it, thus providing a source of cool air for the building. (Givoni, 2001)



Plate I Folliage used as solar filter on Elephant and Castle Eco-Tower
Source: Keeffen (n.d)

Designed by Ken Yeang, the tower forms the centrepiece of the Elephant & Castle redevelopment in London, set for completion in 2010. The building is a mixed-use comprising apartments, bars, restaurant, shops, sports facilities, and playgrounds. The 35 storey tower introduces environmental concepts for tall buildings developed in Asia to the European context. The tower is split in two volumes that incorporate

a centrally natural ventilated sky court between them. Public facilities and sky-gardens are distributed all over the tower. The porosity of the tower encourages natural ventilation to cool apartment units, and the operable windows in the double-glazed façade allows occupants to regulate the fresh air according to the buildings mechanical mode, which ranges from passive to mixed, to full and productive. (Crosbie, 2011)



Plate II: Swirling Green Roof tops Nanyang Art School Singapore

Source: http://inhabitat.com/amazing-green-roof-art-school-in-singapore

The roofs of Nanyang Art School Singapore as shown in Plate II serve as informal gathering spaces challenging linear ideas and stirring perception. The roofs create open space, insulate the building, cool the surrounding air and harvest rainwater for landscaping irrigation. (Crosbie, 2008)

Orientation: Orientation of the building generally used to refer to solar orientation which is the siting of building with respect to solar access. The placement of windows is critical to a house's ability to collect heat from the sun – north facing windows are best, east and west facing windows can lead to glare and overheating,

while south facing windows receive very little direct sun. (Texas Solar Energy Society, 2011)

Hyde (2008) suggested a typology set for a subtropical climate is as follows:

• A rectangular shape for detached houses, stretched along an east-west axis, with the main orientation towards the north/south;

• For higher density multistorey developments (up to three storeys), a narrow plan with associated external communal spaces is recommended (it is important that these buildings are located to allow ventilation through to other buildings, preventing wind shadows);

• A narrow plan, oriented along the long axis towards the north-north-east to capture prevailing breezes;

• Sun shading and insulation to elements on the western and eastern side of the building.

Form**:** Forms with large surface areas are preferred to compact buildings. This favours ventilation and heat emission at nighttime. The main goal is the reduction of direct heat gain by radiation through openings and of the internal surface temperature. The greater the amount of building skin in relation to the volume of space enclosed, the more the building is influenced by heat exchanges at the skin. The building should therefore be designed not only with protected openings, but also with protected walls. This task will be much easier if the building is kept low.

In addition, the roof should extend far beyond the line of walls, with broad overhanging eaves and other means of shading. (Oikos, 2007)

(ii) Daylighting

Public Technology (1996) stated the following:

Daylighting is the practice of bringing light into a building interior and distributing it in a way that provides more desirable and better-quality illumination than artificial light sources. This reduces the need for electrical light sources, thus cutting down on electricity use and its associated costs and pollution.

Daylighting requires the correct placement of openings, or apertures, in the building envelope to allow light penetration while providing adequate distribution and diffusion of the light. A well-designed system avoids excessive thermal gains and excessive brightness resulting from direct sunlight, which can impair vision and cause discomfort. To control excessive brightness or contrast, windows are often equipped with additional elements such as shades, blinds, and light shelves.

Establish the location, shape, and orientation of the building on the site based on daylighting performance objectives as part of an integrated passive solar heating and cooling strategy. Specify glazing materials based on climate, fenestration position, and solar orientation, maintaining the highest possible luminous efficacy.

Traditional Daylighting Strategies

Windows and Sidelighting: Windows are the most common way to admit daylight into a space. Their vertical orientation means that they selectively admit sunlight and diffuse daylight at different times of the day and year. Therefore windows on

multiple orientations must usually be combined to produce the right mix of light for the building, depending on the climate and latitude. (Public Technology Inc, 1996)

Clerestory windows: Another important element in creating daylighting is the use of clerestory windows. These are high, vertically-placed windows. They can be used to increase direct solar gain when oriented towards the equator. (Public Technology Inc, 1996) As shown in Figure 2.9

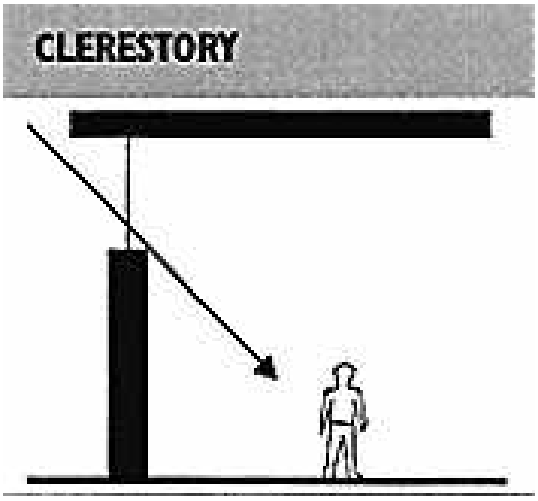


Figure 2.9 Clerestory

Source: Public technology Inc, 1999

Toplighting

Skylight**:** Skylight is any horizontal window, Roof lantern or Oculus, placed at the roof of the building, often used for daylighting. White translucent acrylic is a 'Lambertian Diffuser' meaning transmitted light is perfectly diffused and distributed evenly over affected areas. (Everest555, 2011)

Sawtooth Roof: Another roof-angled glass alternative is a "sawtooth roof" (found on older factories). Sawtooth roofs have vertical roof glass facing away from the

equator side of the building to capture diffused light (not harsh direct equator-side solar gain). (Public Technology Inc, 2008) as shown in Figure 2.10

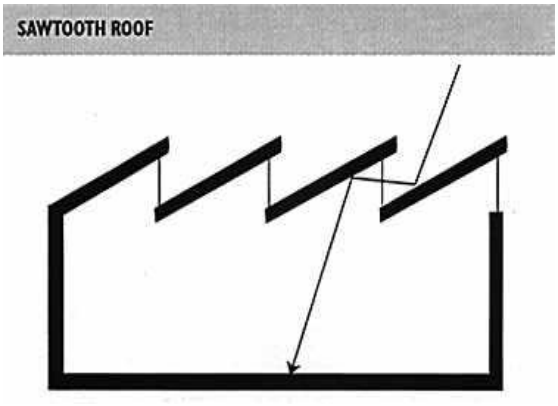


Figure 2.10 Sawtooth Roof

Source: Public technology Inc, 1996

Monitors**:** Monitors are a type of clerestory that usually involves a stepped roof, allowing light to enter from two or more directions at once, as shown in Figure 2.11.

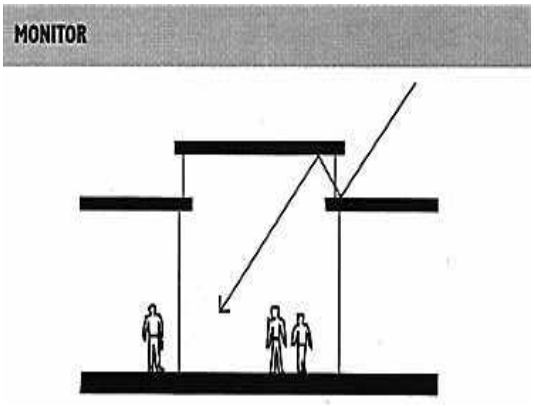


Figure 2.11 Monitor Roof

Source: Public technology Inc, 1996

Light shelves: Light shelves are an effective way to enhance the lighting from windows on the equator-facing side of a structure, this effect being obtained by placing a white or reflective metal light shelf outside the window as shown in Figure 2.12. Usually the window will be protected from direct summer season sun by a projecting eave. (Everest555, 2011)

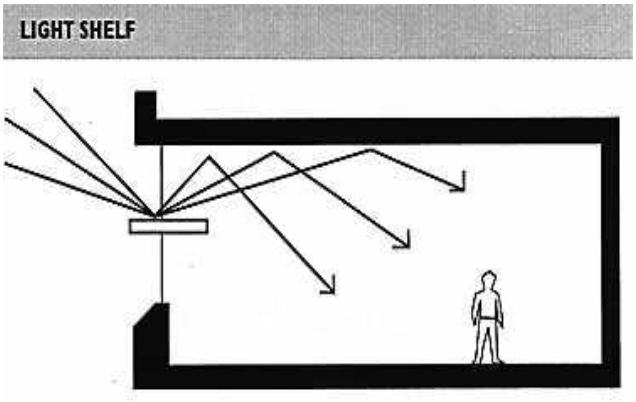


Figure 2.12 Light Shelves

Source: Public technology Inc, 1996

Renewable Energy

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). (Fatona, 2011)

(i) Photovoltaic (Solar Energy)

Photovoltaic (PV) technology is the direct conversion of sunlight to electricity using semiconductor devices called solar cells. (Sunpower, 2011). Photovoltaic are almost maintenance-free and seem to have a long life span. The photoelectric conversion process produces no pollution and can make use of free solar energy. Overall, the longevity, simplicity, and minimal resources used

to produce electricity via PV systems make this a highly sustainable technology. (Public Technology Inc, 1996)

Photovoltaic (PV) systems are modular and so their electrical power output can be engineered for virtually any application, from low-powered wristwatches, calculators, remote telecommunications systems and small battery-chargers to huge centralized power stations generating energy only from the sun. (Stone, 2011)

Public Technology Inc (2006) states that the most common technology in use today is single-crystal PVs, which use wafers of silicon wired together and attached to a module substrate. Thin-film PV, such as amorphous silicon technology, is based on depositing silicon and other chemicals directly on a substrate such as glass or flexible stainless steel as shown in Plate III. Thin-film PV materials can look almost like tinted glass. They can be designed to generate electricity from a portion of the incoming light while still allowing some light to pass through for daylighting and view.

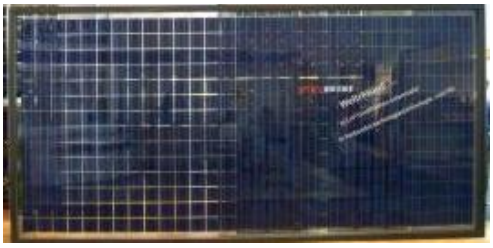


Plate III: Large transparent module glass/ glass laminate
Source: http://www.ertex-solar.at

According to Roaf, Fuentes and Thomas, (2001) PV cells are typically grouped together in a module for ease of use. A PV system consists of one or more PV

modules, which convert sunlight directly into electricity, and a range of other system components that may include an AC/DC inverter, back-up source of energy, battery to store the electricity until it is needed, battery charger, control centre, mounting structures and miscellaneous wires and fuses.

Photovoltaic elements have a double benefit. On one hand, they can produce electricity and on the other they replace construction materials, such as building components thus performing an additional function as part of the weatherproofing of the walls or roof. Replacing conventional elements of the building envelope (roof tiles, metal roofs, façade elements, windows, shading devices, etc.) as shown in Plate IV, Plate V and Plate VI, with PV modules reduces the total cost of the building as compared to when the PV modules are not integrated into the building.



Plate IV: PV Panels on the roof top

Source: http://www.pvresources.com



Plate V: PV Panels on the wall.

Source: http://www.solartechnologies.co.uk.png



Plate VI: PV panels used as a shading device

Source: http://www.pvresources.com

PV panels produce direct current, not the alternating current used to power most building equipment. Direct current is easily stored in batteries; a device called an inverter is required to transform the direct current to alternating current. With an inverter creating alternating current, it is possible to transfer excess electricity generated by a photovoltaic system back into the utility grid rather than into batteries for off-grid systems. (Roaf, Fuentes and Thomas, 2001)

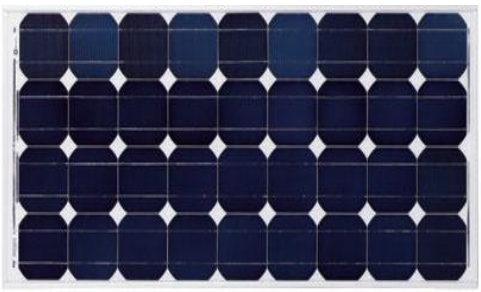


Figure 2.13A typical photovoltaic module.

Source: http://en.wikipedia.org/wiki/Renewable_energy.

Roaf, Fuentes and Thomas (2001) states the there are many different types of PV systems available with different features, capabilities and costs.

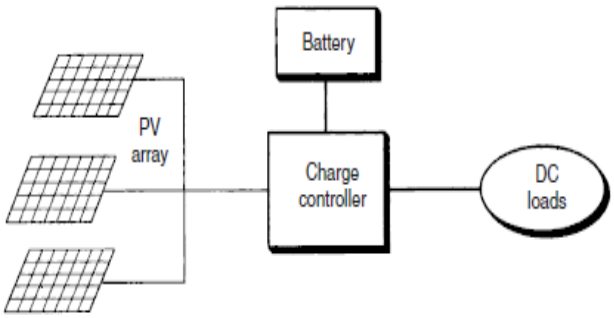


Figure 2.14 Stand-alone DC system

Source: Roaf, Fuentes, Thomas 2001

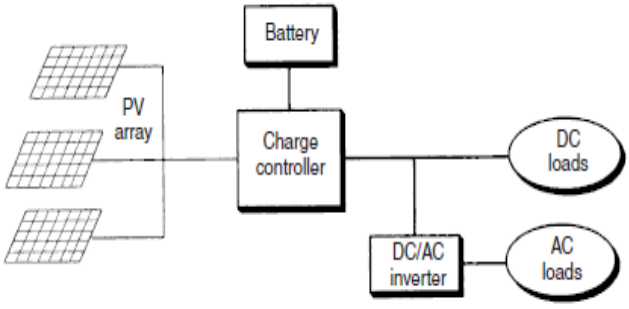


Figure 2.15 Stand-alone DC/AC system

Source: Roaf, Fuentes, Thomas 2001

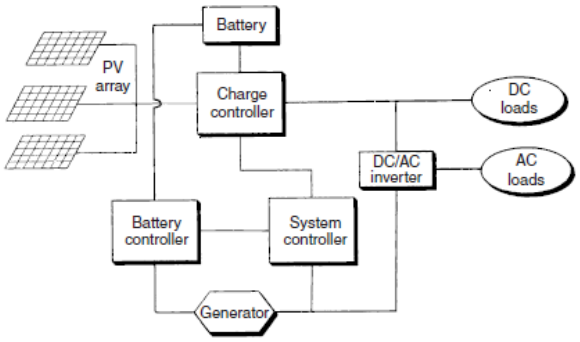


Figure 2.16 Hybrid system

Source: Roaf, Fuentes, Thomas 2001

Public technology Inc (1996) states the following:

Optimizing the panel's tilt to the sun improves performance. Most existing commercial buildings have large, flat roofs exposed to lots of sun, making them good candidates for PV arrays. The PV panels can be designed as the primary "weather skin" for sloped roofs or walls and can be integrated into shading devices. The panels would allow diffuse light through a window while also producing electricity from energy that would otherwise be rejected from the building.

Photovoltaic are environmental friendly. They are beneficial for the direct conversion of solar energy into electricity and are considered environmentally efficient as the energy payback time in most applications is calculated to be about four years. They generate energy virtually free of greenhouse emissions (CO2, NOx and SOx), they are silent and they recover the energy used in production of the cells several times over. On the other hand, the main source for the construction of PV cells and modules is the silicon, an element which is inexhaustible and freely disposed. (Roaf, Fuentes and Thomas, 1996)

Solar hot water systems

Solar hot water systems collect energy from the sun radiation and turn it into heat and distribute in the form of water to the storage as shown in Figure 2.17. It consists of solar collectors, hot water storage tanks, and pump. The collector is made up of absorber (black metal bit that turns the sun‟ s radiation into heat; a translucent glass cover; and insulation to prevent heat loss. Collectors are either flat plate or evacuated tube. The hot water storage will either be inside the house, or integrated into the absorber. If the solar array is mounted on at low level, the system can be thermo-siphon system; if at high level, it should be pumped system. (Home Innovation Research Lab, 2011)

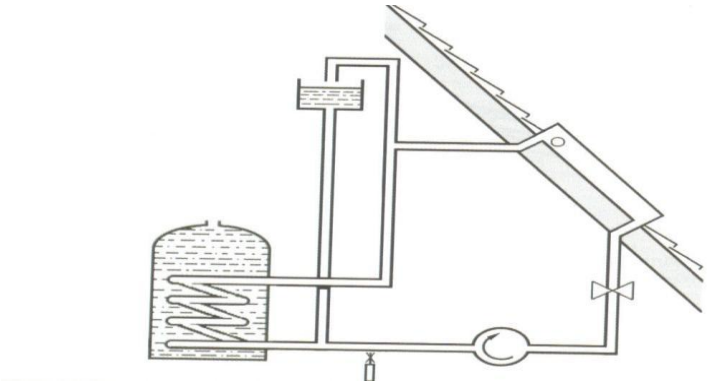


Figure 2.17 A solar hot water pumped system

Source: Roaf, Fuentes, Thomas 2001

(ii) Wind power

Airflows can be used to run wind turbines. The power output of a turbine is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as

offshore and high altitude sites are preferred locations for wind farms. (Roaf, Fuentes and Thomas, 1996)

(iii) Hydropower

Energy in water can be harnessed and used. Since water is about 800 times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. Hydroelectric energy is a term usually reserved for large-scale hydroelectric dams.(Roaf, Fuentes and Thomas, 1996)

2.3.2 Water efficiency

According to Roaf, Fuentes, Thomas (2001) four things are conspiring to make fresh water one of the most valuable commodities in the twenty-first century:

- increasing world populations;
- climate change;
- man's ever increasing interference with the natural flow of water;
- Pollution.

This increasing demand for water can be met either by increasing the capacity of supply (e.g. by building new reservoirs), by reducing the consumption of water or by re-using water where we can. Water conservation and efficiency programs have begun to lead to substantial decreases in the use of water within buildings.

Water-efficient appliances and fixtures, behavioral changes, and changes in irrigation methods can reduce consumption by up to 50 percent. As demand on water increases with urban growth, the economic impact of water conservation and efficiency will increase

proportionately. Water efficiency not only can lead to substantial water savings, it also can reduce the requirement for expansion of water treatment facilities. (Lindstorm, 2000)

To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site. This is done through the following:

Wastewaster System

Wastewater is used water. Wastewater may contain substances such as human waste, food scraps, oils, soaps and chemicals as shown in Figure 2.18. In houses, wastewater can include the water from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Water diverted from the waste stream is either graywater or blackwater, which require different on-site handling. (Lindstorm, 2000)

Tilley (2011) defines blackwater and greywater as follows:

Blackwater is wastewater which is loaded with biological material such as feces or grease. Many people colloquially refer to black water as sewage. Because black water contains dangerous materials, it must be treated before being released or reused; otherwise it could be a source of disease.

Greywater is wastewater generated from domestic activities such as laundry, dishwashing, and bathing, which can be recycled on-site for uses such as landscape irrigation and constructed wetlands. Grey water differs from water from the toilets which is designated sewage or black water to indicate it contains human waste. To utilize graywater, a dual plumbing system must be installed to separate it from blackwater, which is wastewater generated from toilet-flushing.

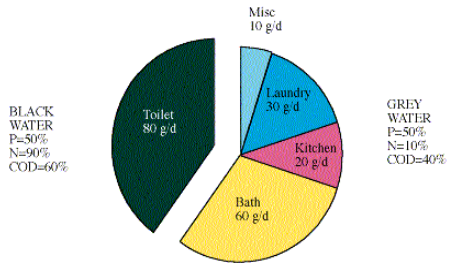


Figure 2.18 Breakdown of typical household water uses

Source: Roaf, Fuentes, Thomas 2001

Greywater Systems

Public technology Inc (1996) states that greywater systems reuse water that has already been used once in the home, such as shower, bath and washing machine water, for secondary, non-potable purposes such as flushing WCs and watering the garden as shown in Figure 2.19. Grey water gets its name from its cloudy appearance and from its status as being between fresh potable water (known as whitewater) and sewage water (blackwater).

Many public and commercial facilities generate relatively small amounts of graywater; other types of commercial and industrial facilities may generate large quantities, such as hotels. (Lindstorm, 2000)

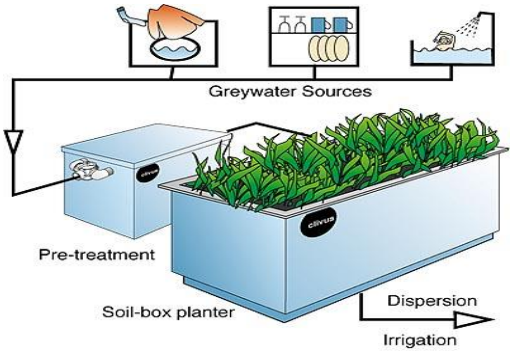


Figure 2.19 Greywater systems

Source: http://www.greywater.com/synopsis.htm

Recycle graywater via a dual distribution system, for such non potable water uses as toilet-flushing, thereby avoiding unnecessary use of high-quality potable water. Another major use of graywater is for irrigation of areas such as golf courses, ornamental landscapes, and turf areas. A separate tank, filter, and special emitters are necessary in graywater irrigation systems. Types of irrigation systems that can utilize graywater include:

(1) Drip irrigation with pressure dosing, which uses a pump system to "dose" the irrigation water at regulated intervals;

(2) More traditional evapotranspiration systems; and

(3) Shallow trench systems, which utilize distribution pipes placed close enough to the surface to allow for irrigation of plant roots. (Public Technology Inc, 1996)

Rain Water Harvest System

Public Technology Inc (1996) gathers that:

Collecting and using precipitation from a roof or other catchment area is an excellent way to take advantage of natural site resources, to reduce site runoff and the need for runoff-control devices, and to minimize the need for utility-provided water. Rainwater collection has long been utilized in arid parts of the world. Particularly in areas where populations are dispersed, rainwater collection offers a low-cost alternative to centralized piped water supply.

The capacity of rainwater harvesting to meet water needs depends on the amount of rainfall in an area, the size of the collection area, the size of the storage area, and water needs. One inch of rainfall translates to 0.6 gallon of rainwater collected per square foot of roof area. Basic components of a rainwater-collection system include the catchment area (usually the

roof), conveyance system (guttering, downspouts, piping), filtration system, storage system (cistern), and distribution system as shown in Figure 2.20. The highest cost in most rainwater-collection systems is for water storage.

Use appropriate roofing materials. The best roof materials for catchment are metal, clay, and concrete-based (such as tile or fiber cement). Asbestos roof materials are not suitable for potable collection because grit can enter the system. Install gutters and downspouts sized for the roof size and rainfall intensity. Install screening so that leaves and debris do not enter the cistern, as well as a "roof-washer" device to divert the first flush of water after a rainfall, preventing it from entering the cistern. Construct cistern storage. Cisterns may be constructed from a wide variety of materials.

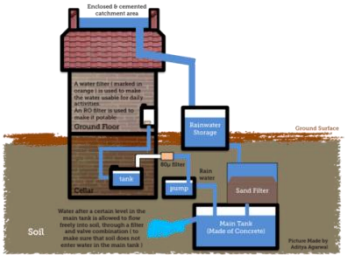


Figure 2.20 Rain water harvesting systems

Source: http://en.m.wikipedia.org/wiki/rainwater_harvest_system

Prefabricated cisterns in steel or fiberglass are available, but tend to be quite expensive. Cisterns also may be constructed on site from concrete, ferro-cement, stone, or compressed earth. Cistern interior surfaces must, of course, be watertight. Health codes require them to be covered to prevent mosquito breeding and contamination. To prevent algae growth, this occurs with exposure to sunlight, use opaque materials only.

Simple filtration with graded screens and paper filters can filter harvested rainwater for use in irrigation. With additional treatment, rainwater can also be potable. (Public Technology Inc, 1996)

Indoor Water Conservation

Reducing overall water use reduces wastewater. Water-efficient fixtures and appliances are readily available, including toilets that are virtually waterless. Faucet bubblers, low flow showerheads, and flow restrictors further reduce water consumption.

2.3.3 Materials and resources

Roaf, Fuentes and Thomas ,2001 states that:

The choice of building materials affects the environmental impact of a building. All building materials are processed in some way before they can be incorporated into a building. The processing may be minimal, as in the case of a traditional cottage constructed from materials found locally, or it may be extensive, as in the case of prefabricated construction. This processing of materials inevitably requires the use of energy and results in waste generation.

When choosing materials several factors have to be considered, and it is unlikely that absolute rules can be given for all situations. Factors determined by a material's qualities are, for example:

- energy required to produce the material;
- CO2 emissions resulting from the material's manufacture;

- Impact on the local environment resulting from the extraction of the material (e.g. quarry pit, wood taken from a forest, oil spills from an oil well, etc.);
- toxicity of the material;
- transportation of the material during its manufacture and delivery to site;
- Degree of pollution resulting from the material at the end of its useful life.

Concrete

Making Portland cement for concrete requires substantial energy, causing a significant amount of carbon dioxide emissions. Because concrete is such a high-mass material and is used in buildings in large quantities, considering alternatives is important. If the selection is based on life-cycle assessment principles, other materials may be preferable. (Public Technology Inc, 1996)

Fly-ash concrete is available in many regions, as an alternative to conventional mixes (Public technology Inc, 1996). Fly ash is a waste material from coal-burning power plants. It can be used to replace up to about 30 percent of the Portland cement in conventional mixes. It is also mixed with ground blast-furnace slag, a waste from metal smelting. Fly ash produces a superior concrete with excellent finishing characteristics; however, only some types of ash are appropriate for certain applications and the proportions are restricted. (Public Technology Inc, 1996)

Metals

It is stated in Public technology Inc (1996) that "steel is the most common metal used in building products. It is highly recyclable, and its scrap has value. Aluminum, the second most common metal, is probably the most recyclable material in buildings. Stainless steel

and brass products are alloyed metals that are recyclable if carefully separated by type. Copper is also a highly valued recyclable."

Metal plating is common in building products, especially in architectural metals, door hardware, and office systems and furniture. Chromium, cadmium, brass, and nickel plating is often carried out by electroplating plants, sometimes resulting in high levels of pollution. Emissions such as hexavalent chromium and cadmium and acid wastes are environmentally toxic. (Public Technology Inc, 1996)

Many sustainable advocates will point out that both concrete and steel have high embodied energy in their manufacturing process. This includes the direct and indirect energy used for their production but also for their extraction, transportation and installation. All that burning of fossil fuels tends to result in pollution. Therefore for some, these materials are not seen as being environmentally friendly, however until new technologies for building high rise buildings come about, concrete and steel will still remain the structural framework for these buildings. In addition much of the steel used in construction tends to be recycled steel. If construction methods were approached from a sustainable viewpoint, with long term planning taken into consideration, it would make sense that using light weight panels or materials would lessen the loads on the structure of these buildings. A lighter load in turn requires less structure to support it. Less structure in turn means less materials, resources, labor and pollution for its construction. (Gerard Lee Architects, 2009)

Timber and Wood

Timber is a material that is generally considered to have excellent environmental credentials. As a renewable resource, its main attributes are that it reduces the amount of CO2 in the atmosphere until it decays or is burnt and it is easily worked. There are,

however, possible disadvantages associated with timber, the principal one resulting from imported timber. This may have been transported over long distances. Another potential problem has to do with the way the timber is grown and if trees are replanted when mature ones are cut. Some of the timber comes from trees that will be replanted but there is a very high possibility that some will not be replaced. (Public Technology Inc, 1996)

Plastic

Most plastics are made from "nonrenewable" petroleum or natural gas feedstock. Their production may involve use of toxic and potentially hazardous substances. They are, on the other hand, waste products from the production of petroleum. So, it can be argued that by using plastics we reduce the accumulation of waste material. (Public Technology Inc, 1996)

2.3.4 Sustainable site

The foundation of any construction project is rooted in the concept and design stages. The concept stage, in fact, is one of the major steps in a project life cycle, as it has the largest impact on cost and performance. In designing environmentally optimal buildings, the objective is to minimize the total environmental impact associated with all life-cycle stages of the building project. However, building as a process is not as streamlined as an industrial process, and varies from one building to the other, never repeating itself identically.

Sustainable site planning and design do not impose building design on the site. Rather, they identify the ecological characteristics of the site, determine whether it is appropriate for its proposed use, and design ways to integrate the building with the site. The intent is to lessen the environmental impact of human activity, while using natural characteristics of the site

to enhance human comfort and health, and potentially provide a significant portion of the building's energy requirement. Preservation of site resources and conservation of energy and materials in construction and building operations are important results of good site design. (Public Technology Inc, 1996)

Selecting a building site begins the process of calculating the degree of resource use and the degree of disturbance of existing natural systems that will be required to support a building's development. The most environmentally sound development is one that disturbs as little of the existing site as possible.

2.3.5 Indoor environmental quality

Designing and installing environmentally sound and energy-efficient systems have a long-term impact on the cost-effective operations of a building and on the productivity of building occupants.

Public Technology Inc (1996) states the following:

The amount of energy used annually by heating, ventilating, and air-conditioning (HVAC) systems typically ranges from 40 to 60 percent of the overall energy consumption in a building, depending on the building's design, the use of renewable energy strategies, climate, the building's function, and its condition. HVAC systems also affect the health and comfort of building occupants. These systems serve an essential function and are identified as problem areas more often than other occupancy issues.

The goal of environmentally sound HVAC system design is to meet occupant needs through the most efficient and environmentally positive means at the lowest initial and life-cycle costs. Solutions that have evolved provide environmental comfort while accounting

for climatic conditions, use of space, and building technology. These green system designs take into consideration factors such as solar orientation, footplate depth, thermal mass, insulation, selection of architectural materials, placement and type of doors and windows, and natural ventilation.

2.4 Benefits of Green Architecture

There are many benefits of green architecture that can generally be broken down into three categories: environmental, economic, and health benefits.

(a) Environmental Benefits

The environmental benefits of green architecture are significant. Green buildings promote and protect ecosystems and biodiversity, improve the quality of air and water, reduce solid waste and conserve natural resources. The built environment has a significant impact on the natural environment, and green architecture and green building helps reduce consumption of natural resources--especially water. Eco-friendly buildings often incorporate water-saving strategies to optimize use of rainwater for outdoor purposes, reducing the need to tap into underground sources.

(b) Economic Benefits

Plenty of economic benefits stem from sustainable building, including reduced operating costs, increased asset value and profits, higher employee satisfaction and productivity. (Roaf, Fuentes and Thomas, 2001).

(c) Health & Community Benefits

The health and community benefits of eco-friendly buildings include improved indoor air quality, temperature regulation and acoustics; optimal occupant comfort

and health; a reduced burden on local infrastructure; and a higher overall quality of life. (Roaf, Fuentes and Thomas, 2001)

If we continue to produce greenhouse gasses at the current rates of increase, predictions by the UK Meteorological Office indicates impacts will be substantial and by 2080 will include:

- A rise of 3 degrees centigrade in global average temperature by 2080;
- Substantial decrease in rainfall amounts in most part of the world;
- Dieback of tropical forests and grasslands;
- Increase in the risk of food shortage in some regions due to decrease in cereal yields;
- Rise of 40 cm in the sea levels with an increase number of flooding by 2080;
- Health impacts will be widespread and diverse (Roaf, Fuentes and Thomas, 2001)

CHAPTER THREE

HOTELS AND HOTEL DESIGN

3.1 Definition

A hotel is defined as a public establishment offering travelers and temporary visitors, against payment, tow basic services, accommodation and meals. (Lawson, 1995)

A hotel is usually a large house or building where travelers, holiday makers etc receive lodging, food etc in return for payment. (The Free Dictionary, 2011)

A hotel is an establishment that provides paid lodging on a short-term basis. (Graham, 2011)

A hotel is a commercial establishment that provides lodging, food, and other services to the public. (Encarta encyclopaedia, 2010)

The word hotel derives from the French hotel, which referred to a French version of a townhouse, not a place offering accommodation. According to the Guinness Book of World Records, the oldest hotel still in operation is the Hoshi Ryokan, in Awazu, Japan, opened in 717 CE, and features hot springs. And the construction of large scale hotels in pretensions began in America in the 19th century. (Fleming, Honour and Pevsner, 1999)

3.2 Services and Facilities in a Hotel

The provision of basic accommodation, in times past, consisting only of a room with a bed, a cupboard, a small table and a washstand has largely been replaced by rooms with modern facilities including en-suite bathrooms and air conditioning or climate control.

Additional common features found in hotel rooms are a telephone, an alarm clock, a television, a safe, a mini-bar with snack foods and drinks, and facilities for making tea and coffee. Luxury features include bathrobes and slippers, a pillow menu, twin-sink vanities, and Jacuzzi bathtubs.

Larger hotels may provide additional guest facilities such as a restaurant, bars, swimming pool, fitness center, beauty salon, spa, business center, childcare, playground, shopping, conference facilities, and social function services and so on. (Graham, 2011)

3.3 Types of Hotel

Graham (2011) gathers that:

Hotel operations vary in size, function, and cost. Most hotels and major hospitality companies that operate hotels have set widely accepted industry standards to classify hotel types. General categories include the following;

3.3.1 Upscale luxury:

Luxury comes in many guises and defining an upscale luxury hotel is challenging; luxury is constantly evolving and means different things to different people. For some it may be a hotel offering simplicity, privacy and spiritual wellbeing whereas for others it may be 24 hour butler service or a personal shopper. Needs may differ according to the nature and purpose of the trip, the origin of the guest and the location of the hotel.

However, luxury is generally regarded as a combination of facilities and style and something you don't normally experience at home. But no precise definition of what constitutes a luxury hotel exists, reflecting the fact that many operators have developed

their own self-styled luxury product adding luxurious type items and services on the lower end.

3.3.2 Full service:

Full-service hotels are generally mid-price, upscale or luxury hotels with a restaurant, lounge facilities and meeting space as well as minimum service levels often including bell service and room service. These hotels report food and beverage revenue.

3.3.3 Select service:

This category of hotel provides upscale amenities, but does not include many of the features of a full-service hotel, such as an onsite restaurant.

3.3.4 Limited service:

Limited-service hotels have rooms-only operations, (i.e. without food and beverage service) or offer a bedroom and bathroom for the night, but very few other services and amenities.

3.3.5 Extended stay:

This is a serviced apartment complex that uses a hotel style booking system. It is similar to renting an apartment, but with no fixed contracts and occupants can 'check-out' whenever they wish.

3.3.6 Timeshare:

A timeshare is a form of ownership or right to the use of a property, or the term used to describe such properties. These properties are typically resort condominium units, in which multiple parties hold rights to use the property, and each s/harer is allotted a period of time

(typically one week, and almost always the same time every year) in which they may use the property.

3.3.7 Destination club:

In exchange for a one-time, upfront, mostly refundable membership fee, and annual membership dues, a member gets access to a roster of luxury vacation homes around the world, which can be booked based on some factors.

3.4 Classification of Hotels

Early hotels and inns were little more than available bed and something palatable to eat. The emergence of tourism in the latter half of the 19th century brought with an improvement of the standards of the early inns. some pressure was placed on these facilities to offer some minimum standards where customers were able to identify property with specific amenities. (Caribbean Tourism Organization, 2002)

Classification is based on many criteria; the hotel industry is so vast that many hotels do not fit into single well defined category. These criteria include location, official hotel and resort rating (OHRG), star rating (AA star rating), size of property, and service type and theme and so on.

3.4.1 Classification based on location

Caribbean Tourism Organization (2002) classified and defined hotels based on their location. City centre, airport etc are such categories under this classification. They include:

(i) City center: Generally located in the heart of city within a short distance from business center, shopping arcade.

(ii) Motels: They are located primarily on highways as shown in Plate VII, they provide lodging to highway travelers and also provide ample parking space. The length of stay is usually overnight.



Plate VII The Glamcy Motel, Colorado

Source: http://www.john-daly.com

(iii) Suburban hotels: They are located in suburban areas, it generally have high traffic on weekend. It is ideal for budget travelers. In this type of hotel rates are moderately low as shown in Plate VIII.



Plate VIII Marsh Farm Hotel UK

Source: hotel-world.com

(iv) Airport hotels: These hotels are set up near by the airport as shown in Plate IX. They have transit guest who stay over between flights.



Plate IX Sheraton CDG Airport, Paris

Source: http://www.hotels-world.com/charles_de_gaule

(v) Resort hotels: They are also termed as health resort or beach hill resort and so depending on their position and location. They cater a person who wants to relax, enjoy themselves at such destinations as shown in Plate X.



Plate X Furama Resort, Vietnam

Source: http://www.vietnamtrain.net?resort

(vi) Floating hotels: As name implies these hotels are established on luxury liners or ship as shown in Plate XI. It is located on river, sea or big lakes. In cruise ships, rooms are generally small and all furniture is fixed down. It has long stay guest. (Abhijeet, 2011)



Plate XI Ice Maidan Tyneside

Source: http://www. offshore247.com/maiden-ice?1=234

3.4.2 Classification based on official hotel and resort guide (ohrg)

Caribbean Tourism Organization, 2002 gathers that:

These ratings combine 2 elements,

1. Quality of quest accommodation: room size, quality of furnishings.
2. Extent of hotel facilities: number and size of public rooms and meeting facilities.

The categories include: deluxe, first class and tourist. These are further sub divided as follows:

(i) Deluxe

Superior Deluxe: An exclusive and expensive luxury hotel, often palatial, offering the highest standards of service, accommodations and facilities, and possessing elegant and luxurious public rooms. It usually would have a prestigious address and would rank among the world's top hotels.

Deluxe: An outstanding property offering many of the same features as superior deluxe, except in some cases (mainly in Europe), a small number of minimum rated accommodations may be of inferior grade. It may be less grand and offer more

reasonable rates than the Superior Deluxe properties, yet in many instances may be just as satisfactory.

Moderate Deluxe**:** This is basically a Deluxe Hotel but with qualifications. In some cases the hotel may be a well established famous name, depending heavily on past reputation. If modern, the hotel may be heavily marketed to building clients, with fine accommodations and public rooms offering Deluxe standards in comfort, but lacking in atmosphere or personal service.

(i) First class

First class: This is an averagely comfortable hotel with standardised rooms, amenities and public areas. It is dependable but usually nothing special may have superior executive level or wing.

Limited-Service First Class: A hotel offering full first class quality accommodations, but limited public areas, food service and facilities. Usually moderate in size, the hotel often utilizes a residential scale and architecture. Many offer complimentary breakfast and evening cocktails in the lobby or in a small, informal restaurant, meant for the individual business/ pleasure traveller.

Moderate First Class: Basically a first class establishment, slightly below average. Generally have comfortable, simple accommodations and public areas, though not always kept up to standards. May be lacking in some features e.g. restaurant. Some of the rooms or public areas may tend to be small and functional. (Caribbean Tourism Organization, 2002)

(ii) Tourist

Superior Tourist Class: Primarily a budget property with mostly well kept, functional accommodations, some up to the first class standards. Public rooms may be limited or non-existent. It is often just a place to sleep, but may have some charming or intimate features.

Tourist class: Strictly a budget hotel with some facilities or features of Superior Tourist Class, but usually no first class accommodations.

Moderate Tourist Class: Low-budget hotel which is often quite old and may not be well-kept. (Caribbean Tourism Organization, 2002)

3.4.3 Classification based on AA star rating

According to Caribbean Tourism Organization (2002) the AA rating System (British system) rates hotels using stars and focuses on a consumer's perspective on accommodation properties. The objective was to introduce a classification system easily understood by the consumer. This system is part of the description of properties seen in travel books. The American version is the AAA system which uses diamonds instead of stars. The criteria are divided into five categories, i.e. 1, 2, 3, 4 or 5 stars.

(i) One Star Hotels: Hotels in this classification are likely to be small and independently owned, with a family atmosphere. Services may be provided by the owner and family on an informal basis. There may be a limited range of facilities and meals may be fairly simple. Lunch, for example, may not be served. Some bedrooms may not have en suite bath/shower rooms. Maintenance, cleanliness and comfort should, however, always be of an acceptable standard.

(ii) Two Star Hotels**:** In this classification hotels will typically be small to medium sized and offer more extensive facilities than at the one star level. Some business hotels come into the two star classification and guests can expect comfortable, well equipped, overnight accommodation, usually with an en-suite bath/shower room. Rece\ption and other staff will aim for a more professional presentation than at the one star level, and offer a wider range of straightforward services, including food and drink.

(iii) Three Star Hotels: At this level, hotels are usually of a size to support higher staffing levels, and a significantly greater quality and range of facilities than at the lower star classifications. Reception and the other public rooms will be more spacious and the restaurant will normally also cater for non-residents. All bedrooms will have fully en suite bath and shower rooms and offer a good standard of comfort and equipment, such as a hair dryer, direct dial telephone, toiletries in the bathroom. Some room service can be expected, and some provision for business travellers.

(iv) Four Star Hotels**:** Expectations at this level include a degree of luxury as well as quality in the furnishings, decor and equipment, in every area of the hotel. Bedrooms will also usually offer more space than at the lower star levels, and well designed, coordinated furnishings and decor. The en-suite bathrooms will have both bath and fixed shower. There will be a high enough ratio of staff to guests to provide services like porterage, 24-hour room service, laundry and dry-cleaning. The restaurant will demonstrate a serious approach to its cuisine.

(v) Five Star Hotels: These hotels are characterised by spacious and luxurious accommodation throughout the hotel, matching the best international standards.

Interior design should impress with its quality and attention to detail, comfort and elegance. Furnishings should be immaculate. Services should be formal, well supervised and flawless in attention to guests' needs, without being intrusive. The restaurant will demonstrate a high level of technical skill, producing dishes to the highest international standards. Staff will be knowledgeable, helpful, well versed in all aspects of customer care, combining efficiency with courtesy. (Caribbean Tourism Organization, 2002)

(vi) **'**Seven Star Hotel'**:** The Burj Al Arab is said to be the only seven star hotel in the world. However, this rating is done by the hotel management itself but the international community does not recognise the hotel as a seven star. Other seven star hotels are under construction, they include the Laucala Island in Fiji, Morgan Plaza Beijing, the Flower of the East Kish, Iran, The Centaurus Complex Islamabad, Pakistan and the Pentominium, the Grand Chola in Chennai (India). Nevertheless, the rating will not be ascertained until the hotels are commissioned.

3.4.4 Classification based on size of property

According to Abjhijeet (2011), the main yardstick for the categorization of hotel is by size the number of rooms available in the hotel.

(i) Small hotel**:** hotel with 100 rooms and less may be termed as small hotels.

(ii) Medium sized hotel: hotel which has 100-300 rooms is known as medium sized hotel.

(iii) Large hotels: hotel which have more than 300 rooms are termed as large hotels.

(iv) Mega hotels: are those hotels with more than 1000 rooms.

(v) Chain hotels: these are the groups that have hotels in many numbers of locations around the world.

3.4.5 Classification based on service type

Ahbijeet (2011) states that hotels may be classified into "economy and luxury" hotels on the basis of the level of service they offer.

(i) Economy/ Budget hotels: These hotels meet the basic need of the guest by providing comfortable and clean room for a comfortable stay.

(ii) Mid market hotels: It is suite hotel that offers small living room with appropriate furniture and small bed room with king sized bed.

(iii) Luxury hotels: These offer world class service providing restaurant and lounges, concierge service, meeting rooms, dining facilities. Bath linen is provided to the guest and is replaced accordingly. These guest rooms contains furnishing, artwork etc. prime market for these hotels are celebrities, business executives and high ranking political figures.

3.4.6 Classification based on theme

Depending on theme hotel may be classified into Heritage hotels, Ecotels, Boutique hotels and Spas.

(i) Heritage hotel: In this hotel a guest is graciously welcomed, offered room that have their own history, serve traditional cuisine and are entertained by folk artist. These hotels put their best efforts to give the glimpse of their region as shown in Plate XII.



Plate XII Jai Mahal Palace, Jaipur

Source: http://www.travelmadeeasy.in

(ii) Ecotels: these are environment friendly hotels these hotel use eco friendly items in the room as shown in Plate XIII.

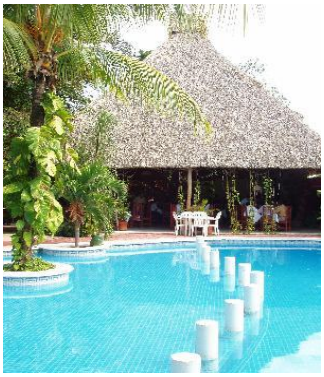


Plate XIII Ecotel Quinta Regia in Valladoid, Yucatan

Source: http://www. cancunsteve.com/ecotel

(iii) Boutique hotels: This hotel provides exceptional accommodation, furniture in a themed and stylish manner and caters to corporate travelers as shown in Plate XIV.



Plate XIV Madison Hotel Downtown Memphis

Source: http://en.wikipedia.org/wiki/Madison_hotel

(iv) Spas: is a resort which provide therapeutic bath and massage along with other features of luxury hotels.

3.5 Hotel Design

According to Graham (2011), hotel design is the discipline concerned with the creation of an environment in which guests can be welcomed and provided with facilities for rest, relaxation and respite from their travels or workaday cares in return for payment to their host. As such the designer is providing the hotelier with the tools to do his job.

Schneider (2007) states that

The discipline of Hotel Design is rooted in traditions of hospitality to travelers dating back to the first movements of early man. From the formalised travels of the court entourage and their expectations of the highest levels of hospitality to the humble journeying of ordinary trades' people the development of specialist buildings to meet their need has been seen in many cultures. Often the development of such refuges was driven by their location – on river crossings, at major trading posts or in locations lending themselves to defense or domination of the local population, such as forts or castles.

Hotel Design today is a sophisticated discipline involving specialist architects, environmental and structural engineers, interior designers and skilled contractors and suppliers. The interior of a hotel may be the refurbishment of an existing building already used for the purpose, the conversion of a building previously used for another purpose or the construction of specialist buildings as a hotel but all need careful design to function effectively, as well as a good location.

Hotel design is essentially a marriage between the client brief and the designer vision. Hotel buildings have a clear specialist range of functions from restaurants to bedrooms, the operations of which must not interfere with each other through factors such as noise or the movement of people. Hotels are usually designed from the inside out to ensure the practical working and relationship of the parts in the most economical manner.

3.6 Trends in Hotel Design

Today's ever-expanding global economy has made travel the number one industry, boasting a customer base that is wealthier and more technologically savvy than ever.

It is not just about designing a place anymore. It is about designing an experience that flows from check-in to sleeping, to bathing to dining. Psychographic profiles are driving design decisions. It is not enough for a hotel to label itself as business or leisure. People are doing business while they play and they are playing while they travel for business. There has to be a degree of escapism even in business hotels. People want to go beyond their routine and try something new. (Hotel Management Asia Staff, 2010)

(a) Lobbies are going multipurpose.

Comfortable, casual, and usable lobbies—marketed as great rooms or gathering rooms—are replacing formal, underutilized lobbies. There is no longer a separate bar, separate sitting area, separate check-in space, separate anything. Instead, hotels are turning the large lobby into a series of small, open living rooms to draw guests out of their rooms and encourage them to hang out. (Schneider, 2007)

(b) Guest rooms are changing shape.

Hotel interiors are changing as well, becoming more open and spacious. Guest rooms are getting wider, squarer, and more functional, with expansive glazing and higher ceilings. When guests work on their laptops, they do not want to look at a wall. They want to see a view, but they also want to watch TV. They want enough space to do yoga or Pilates in their rooms. Guestrooms are getting bigger because they have to be multi-functional. Operators used to think that small rooms encouraged guests to go out and spend more in the restaurants and bars. Now, hoteliers definitely are seeing that guests are willing to pay more for the lifestyle experience afforded by larger guestrooms. (Schneider, 2007)

A little furniture rearranging, and the use of minimalist furniture can create more space in the room.

People are taking better care of themselves. They go to spas. As a result, guest bathrooms have to be more spa-like. More and more, they have natural light. In space-conscious, high-end city hotels, you will see large pampering shower experiences—rather than a tub and shower.

Guestrooms are being designed so that the bathrooms are becoming one with the room so that visual space is borrowed between the bedroom and the bathroom. Tubs are often being replaced by rain showers and toilets are being concealed in innovative ways. (Schneider, 2007)

(c) Experiences Design

One of the big trends in hotel design right now is creating experiences. Designers have to understand what people want in order to develop an experience around them. One of the biggest experiences guests look for is access to a casual, comfortable, clean-line elegant lifestyle. And also a system that makes the experience so good that guest would want to repeat. (Schneider, 2007)

(d) Sustainable Design

The global pollution and rising cost of energy has made hotel designers to design energy and water efficient building from recyclable and renewable building material to create more eco friendly designs. It not only helps the environment and the community; it makes your business more profitable. This is because hotel guests are becoming far more eco-minded about what they consume, how they travel and how their choices can impact upon the environment. (Schneider, 2007)

CHAPTER FOUR

METHOD OF STUDY

4.1 Introduction

The effect of research method on the possible outcome of any research endeavour can never be overstated. When undertaking research it is important to choose the correct methodology, to ensure that the research objectives can be met and that the findings can be validated.

The nature of a research topic, its aims and objectives and the resources available largely determine its design. These criteria largely clued-up the research method developed for carrying out this research. The research phase was achieved through deductive reasoning combined with extensive and critical reviews of a large body of literature, web pages, internet discussion forums and expert focus group approach. These helped to build up a theoretical background to the subject area, providing a foundation for achieving the research aim and insight into many of the major issues concerning the concept of green architecture.

This chapter discusses the research methodology adopted, in this case a quantitative methodology. Miles and Huberman (1994) describe qualitative analysis as a continuous, iterative process that consists of the following concurrent flows of activity:

- data reduction, which refers to the process of selecting, focusing, simplifying, abstracting and transforming the data;
- data display, which is an organised, compressed assembly of information that permits conclusions to be drawn and action; and

- Conclusion-drawing and verification, which refers to the decision about what things mean and how the meanings that emerge from the data have to be tested for their validity.

Figure 4.1 shows the components of qualitative analysis and their flow pattern.

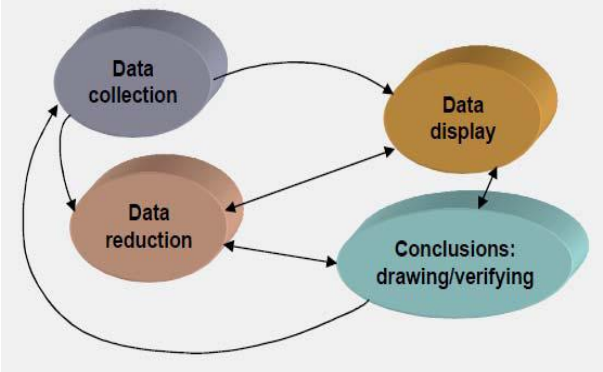


Figure 4.1 Components of Qualitative Analysis

Source: Miles and Huberman, (1994)

4.2 Case Studies

The adopted case studies carried out in this research were based on the purposive sampling of selected buildings both locally and internationally, where the principles of green architecture were applied and also hotel building to examine the spatial organisation and space requirements.

4.3 Instrument of Data Collection

The collection of data was done through various ways which include:

(a) Photographs

Photographs were taken of relevant case studies to ascertain the features of green architecture they possess as well as the extent, to which they were applied, that is to say, if their extent of application was strong, weak or non-existent.

(b) Sketches

Sketches were made of some parts of the selected case studies. These sketches showed the spatial organization of some of the case studies.

(c) Notes

These notes where in form of field forms outlining the variables of green architecture as it relates to hotels and some other public building types.

(d) Data Analysis and Presentation

The data collected from the case studies was analyzed and represented in the following ways:

- Pictures
- Tables
- Figures
- Descriptive analysis.

CHAPTER FIVE

CASE STUDY

5.1 Case Study

As a methodology of this thesis, case studies of five different buildings around the world were conducted. These buildings were carefully selected to give a clearer picture of the green building design and hotel design. The bank of America tower, New York is considered to be the first green high rise building in the world. Even though it is an office building, principles of green architecture are employed in the building.

The G tower Malaysia is a green building designed in the tropical climate. It is also an office building which the micro and macro climatic elements of the site was used to make it energy efficient.

Burj al Arab Dubai is said to be the only seven star hotel and the tall hotel standing alone in the world. This hotel is chosen as one of the case studies because it is an epitome of all the other hotels.

The transcorp Hilton hotel Abuja is a local case study. It is the first five star hotel in Nigeria and one of the best.

The Songjiang hotel is the first hotel of its kind in the world, even though it is still a proposal. When completed, it is going to incorporate all the principles of green architecture.

5.2 Case Study 1: Bank of America Tower (New York City)

5.2.1 Introduction

The Bank of America Tower at One Bryant Park is a 1,200 ft (366 m) skyscraper in the Midtown district of Manhattan in New York City, in the United States as shown in Plate XV. The US$1 billion project (office) has been designed by Cook+Fox Architects to be one of the most efficient and ecologically friendly buildings in the world. It is the second tallest building in New York City, after the Empire State Building, and the fourth tallest building in the United States. Construction began in 2004 and was completed in 2009. (Crosbie, 2010)



Plate XV The Bank of America Tower

Source: http://en.wikipedia.org/wiki/Bank_of_America_Tower

The tower's architectural spire is 255.5 ft tall. The building is 54 stories high and has 2,100,000 square feet of office space. Its final height was reach upon the placement of its spire in December 2007. The building has three escalators and a total of 53 elevators – 52 to serve the offices and one leading to the transit mezzanine below ground.

Several buildings were demolished to make way for the tower. (Crosbie, 2010)

5.2.2 Assessment of the application of principles of green architecture

(a) Energy Efficiency

The design of the building makes it environmentally friendly, using technologies such as floor-to-ceiling insulating glass as shown in Figure 5.1 and Plate XVI to contain heat and maximize natural light, and an automatic daylight dimming system. (Pollak, 2011)

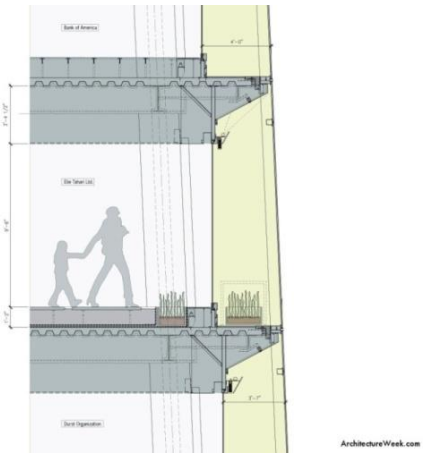


Figure 5.1Curtain-wall section detail drawing

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.



Plate XVI Floor to ceiling insulation glass

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

A 4.6-megawatt cogeneration plant — comparable to what one would need to run a decent-sized college campus — provides half of the building's electrical energy, and the heat generated by the plant is recovered to run other building systems. Efficient generation of the building's own electricity through the natural-gas-fueled cogeneration plant is cheaper than buying that electricity from the local utility, and of course reduces the need to purchase energy from it. (Crosbie, 2010)

Energy conservation is achieved through some highly inventive techniques that help balance the building's heating and cooling so that it runs with optimal efficiency. (Crosbie, 2010) The cooling system produces and stores ice during off-peak hours, and allows the ice to melt to help cool the building during peak load, Forty-four tanks, each with a capacity of 625 cubic feet (17.7 cubic meters) of glycol, are frozen at night and then melted the next day to shave the building's electrical energy demand for air-conditioning by about five percent.

The staggered sizes allow the building to monitor its AC demands and adjust which chillers are on or off to get the most efficient use out of each one. This means that chillers do not run unless they have to, and they run at peak performance, which has a huge impact on lowering the building's energy consumption for AC. (Crosbie, 2010)

(b) Water Efficiency

Conserving water was a major consideration the tower's design. All gray water is treated and reused. "Only toilet water leaves the building," says Appel of Cook + Fox. The rest is recycled as shown in Figure 5.2

Green roofs were kept to a minimum so that more rainwater could be captured; no runoff reaches the city's storm water-drainage system. Cooling-coil condensate is also collected, along with groundwater (not necessarily a more sustainable water source, but reducing the use of potable water and its resource-intensive treatment) — a combined total of about 5,000 gallons (19,000 liters) per day. (Pollak, 2011)

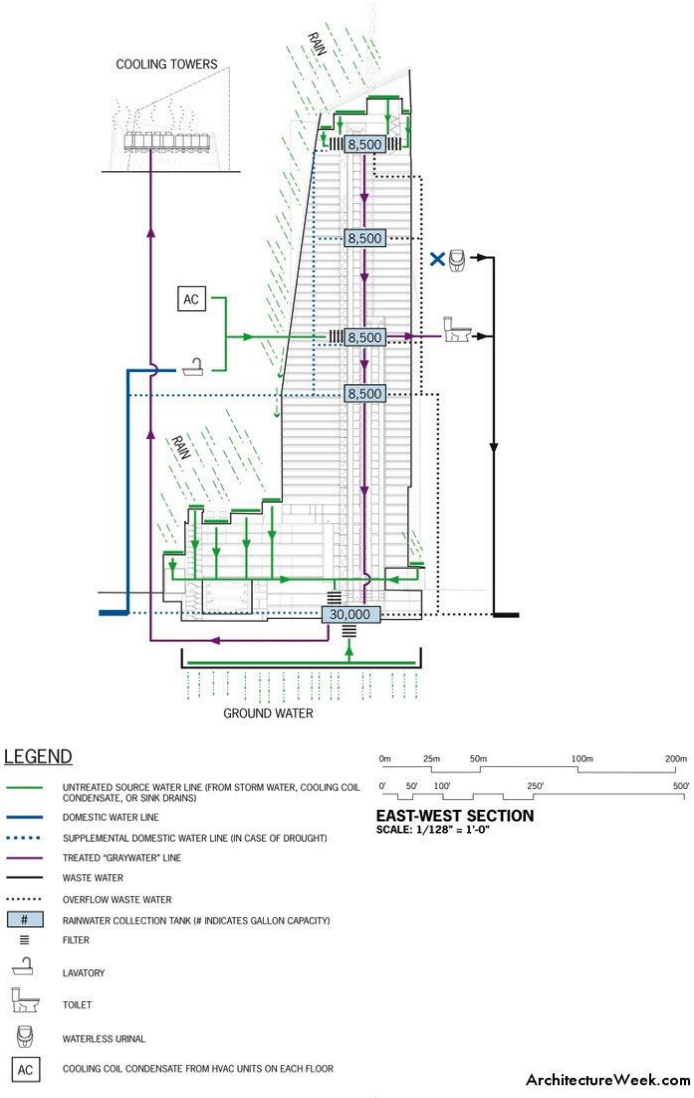


Figure 5.2 Diagram of building water supply and management systems

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

Large holding tanks — totaling about 60,000 gallons (230,000 liters) — are located at four different floor heights to feed toilets and for other gray water uses, such as the cooling towers on the roof.

These strategies, coupled with water-conserving plumbing fixtures, result in a 45 percent reduction in the use of city water compared to a conventional building of this size, and a greatly reduced impact on the city's sewage system — about 95 percent less. (Crosbie, 2010)

Waterless urinals are installed, which are estimated to save 8 million gallons of water per year and reduce CO_2 emissions by 144,000 pounds per year. (Ravenscroft, 2010)

(c) Materials and Resources

The Bank of America tower is constructed using a concrete manufactured with slag, a byproduct of blast furnaces. The mixture used in the tower concrete is 55% cement and 45% slag. The use of slag cement reduces damage to the environment by decreasing the amount of cement needed for the building, which in turn lowers the amount of carbon dioxide greenhouse gas produced through normal cement manufacturing. One ton of cement produced emits about one ton of carbon dioxide into the atmosphere. (Pollak, 2011)

(d) Indoor Environmental Quality

The building is effectively a giant air filter. The air entering the building is purified and the air exhausted is even cleaner. The air inside the building is pulled in through intakes at least 100 feet (30 meters) above the street, cleaned through a

filter that captures about 95 percent of particulates, and then cleaned again before it is distributed throughout the building. (Ravenscroft, 2010)

For air distribution, the entire building — bank and other tenant spaces alike — uses floor plenums. This allows heated and cooled air to arrive just where it should, near the occupants, instead of being blown on them from registers in the ceiling. This under floor air system provides users with the ability to control their own space temperature as well as improving the ventilation effectiveness. When building churn occurs, workstation moves can be performed easier with lower cost and less product waste. (Ravenscroft, 2010)

A deep overhang, clad in wood, shades the glazed curtain wall of the lobby at the Bank of America Tower as shown in Plate XVII.

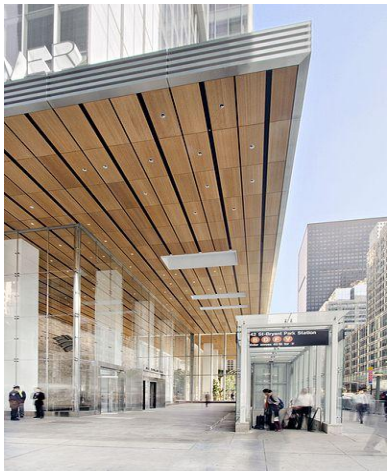


Plate XVII Roof overhang

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

A winter garden is positioned at the building's northwest corner, adjacent to the main lobby as shown in Plate XVIII.



Plate XVIII Indoor garden in the building

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

(e) Sustainable Site

The skyscraper is located in the heart of Manhattan, across from the expansive Bryant Park at 42nd Street and Avenue of the Americas.

The facade of Henry Miller's Theatre (1918) was preserved as part of the Bank of America Tower project. Most of the theater building was demolished and a new LEED-CI Gold-rated theater space, renamed the Stephen Sondheim Theatre, was integrated into the tower. (Ravenscroft, 2010)

Several buildings were demolished to make way for the tower. This therefore makes the building not site efficient as shown in Figure 5.3.



Figure 5.3 Site Plan of the Bank of America

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

5.2.3 Architectural drawings of the bank of america tower

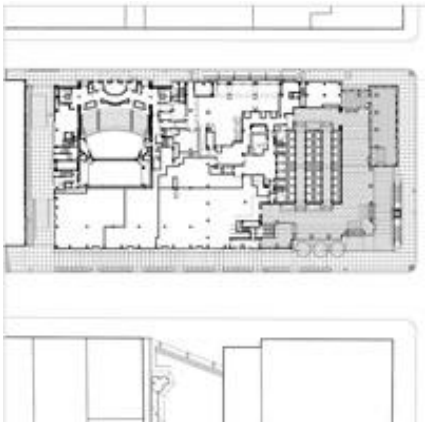


Figure 5.4 Ground Floor Plan

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

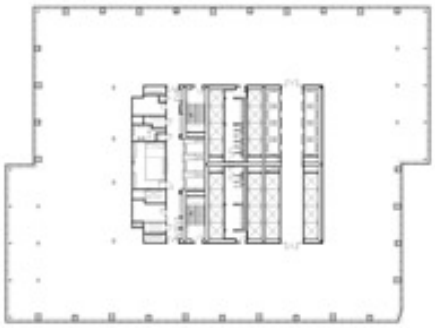


Figure 5.5 20th Floor plan drawing

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.



Figure 5.6 50th Floor plan drawing

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

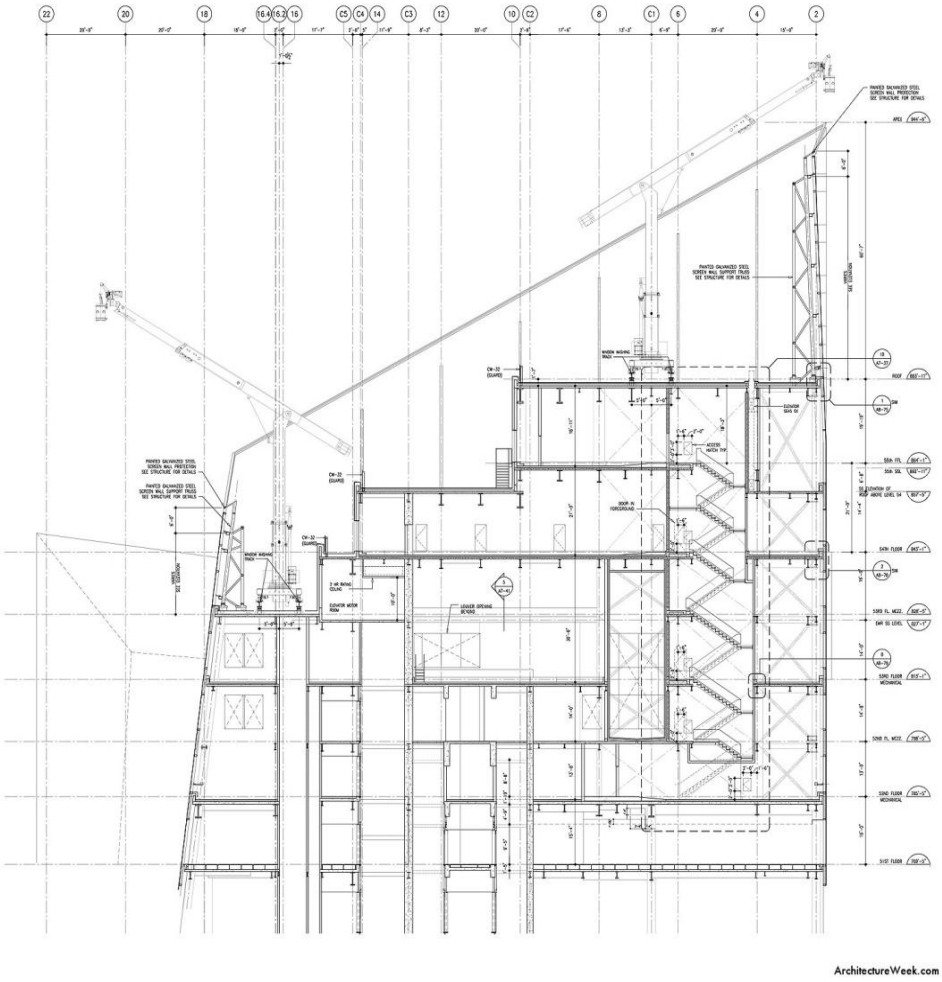


Figure 5.7 Partial section through upper floors and roof

Source: http://www.architectureweek.com/topics/One_Bryant_Park.html.

5.3 Case Study 2: G Tower Malaysia

5.3.1 Introduction

G Tower (formally known as Goldis Tower) is a new building in Kuala Lumpur, Malaysia, that has won the Green Mark Gold Award by the Building and Construction Authority (BCA) of Singapore. The30-story twin G Tower is located at the crossroads of two major thoroughfares in downtown Kuala Lumpur, and is a mixed development comprising retail, hotel service apartments and offices as shown in Plate XIX. Constructed by Goldis Bhd, the RM470mil building has been designed to be energy and water efficient, and is the first "carbon positive" structure in the country. (Gtower Sbd Bhd, 2010)



Plate XIX A night view of the G Tower

Source: http://www.worldinteriordesignnetwork.com/g-tower

The building houses offices, a hotel and club. It will comprise 120,000sq ft of office space, a 180-room five-star boutique hotel, 112 CEO duplex office suites ranging in size from 2,500sq ft to 7,200sq ft, stylish club facilities, as well as food and beverage, and recreational facilities. (Gtower Sbd Bhd, 2010)

The tower incorporated green elements right from the design stage such as proper orientation to the sun, water features, overlay green walls, koi pond and green walls system to help cool the building. (World Interior Design Network, 2010)

G tower uses 25% less energy compared to other buildings of similar size and location due to its efficient air conditioning and lighting systems. The extensive landscaping with sky gardens and green walls, help improve air quality. The building uses double glazed glass panel allowing for maximum entry of natural light while minimizing the amount of heat transmission. (World Interior Design Network, 2010)

5.3.2 Assessment of the application principles of green architecture

(a) Energy Efficiency

Provision for extensive landscaping, green roof and vertical greening has been made for the G tower to reduce heat gained from solar radiation and to improve air quality. The use of greenery such as landscaping, rooftop/ sky garden and green roof can alleviate urban heat through shading and evaporative cooling as shown in Plate XX, Plate XXI, Figure 5.8 and Figure 5.9 . These in-built green walls play an essential role as natural air purifiers, absorbing Co2 and releasing oxygen in return to help maintain air quality. (Gtower Sbd Bhd, 2010)



Plate XX Vertical greenery

Source: http://www.techcentral.com/my



Plate XXI Vertical greenery

Source: http://www.techcentral.com/my



Figure 5.8 Roof plan showing green roof and sky garden

Source: http://www.scribd.com/doc/19771047



Figure 5.9 Lower Ground floor

Source: http://www.scribd.com/doc/19771047

The main entrance, defined by the site and main road access is oriented with an elevation surface towards east of northeast. In the tropical climate cyclonic activities and of convection rain, most sun radiation is received from 10am to 1pm. Due to high directional temperatures from the west sun, services and lift core are placed nearer to this surface. (Amrutkar, 2011)

The direction in forming the mass was the necessity in making a greater surface for indirect sun lighting, shaded from east-west radiation from the center, the mass truncated towards the east. The east façade which receives the most direct sunlight has a reduced surface area as shown in Plate XXII, while the carve-out zone provides for the penetration of indirect sunlight. (Amrutkar, 2011)



Plate XXII Carved out zones for penetration of light

Source: http://www.gtower.com.my

Use of heat recovered from condensation units has been designed for the building to generate hot water for hotel rooms, thus reducing energy consumption. A state-of-the-art chilled water centralised air-condition chillers circulates cool air through the rooms but at lower energy consumption than traditional air-conditioning systems.

In addition to energy efficient lighting system, motion sensors and photo sensors are used for lighting control. Efficient lift and escalator system is also used. (Amrutkar, 2011)

(b) Water Efficiency

Another green initiative of the G tower is the provision of rainwater harvesting system, created key water catchments areas to harvest rainwater for irrigating the large landscaping and vertical greening area found throughout the entire building. In this way, the use of portable water can be greatly reduced. Condensation water

for air conditioning is collected and makes up for water in tank top. (Gtower Sbd Bhd, 2010)

Energy efficient fittings are installed throughout the entire building such as toilets, shower rooms and pantries, reducing the usage of water without affecting comfort levels.

(c) Materials and Resource

Some parts of the building have incorporated old recycled timber strips for its walls and flooring which lend a rustic feel to the building. The interior decor features some old furniture that has been refurbished and reused. (World Interior Design Network, 2010)

The infinity pool at the G tower, with the Kuala Lumpur skyline as a backdrop is a showcase eco friendly pool as shown in Plate XXIII. To reduce the use of chemicals, salt is used to condition the water. The pool is heated from waste energy from the air conditioning units.



Plate XXIII The Infinity pool

Source: http://www.gtower.com.my

5.3.3 Architectural drawings of the g tower

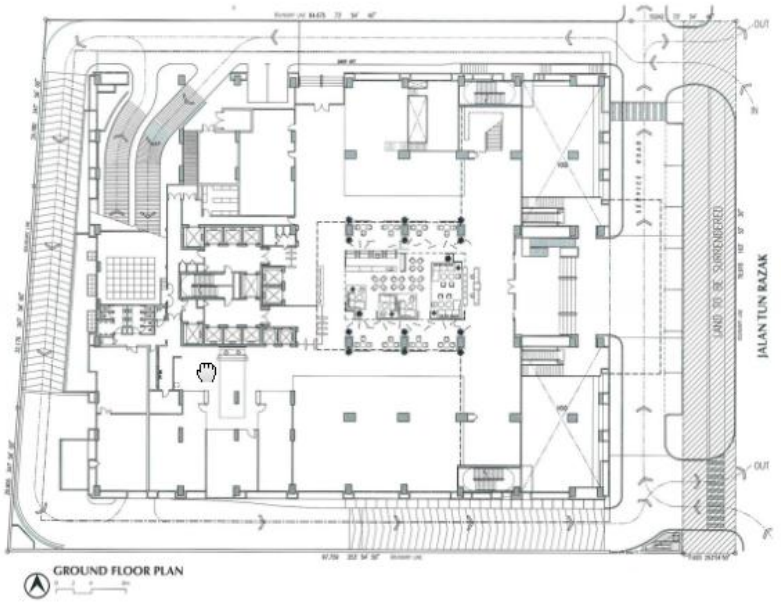


Figure 5.10 Ground Floor plan

Source: http://www.scribd.com/doc/19771047

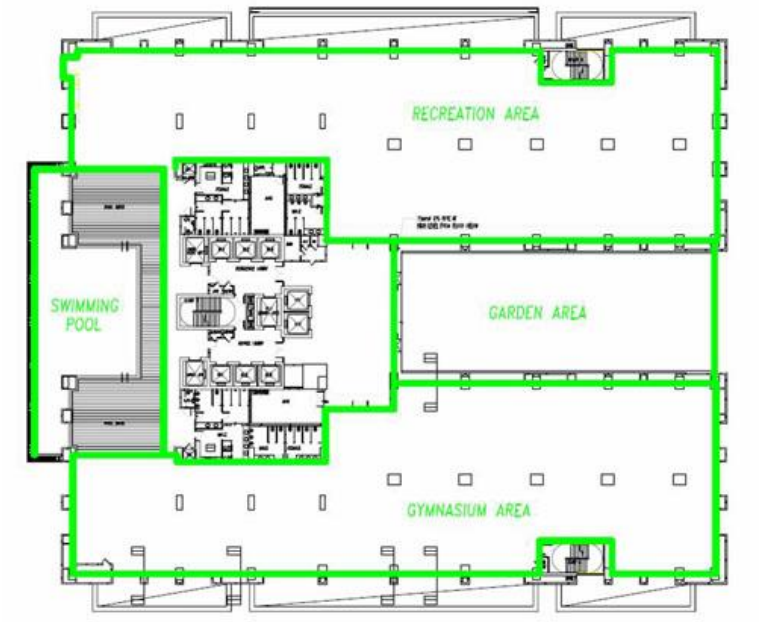


Figure 5.1111th Floor plan

Source: http://www.scribd.com/doc/19771047

5.4 Case Study 3: Burj Al Arab

5.4.1 Introduction

The Burj Al Arab, Plate XXIV, is a luxury hotel in Dubai, United Arab Emirates managed by the Jumeirah Group and built by Said Khalil. It was designed by Tom Wright of WS Atkins PLC. The Burj al Arab (or Arabian Tower) hotel is built in the shape of a modern yacht sail to reflect Dubai′s seafaring heritage combined with a modern aspect moving forwards into the future. It is 321 metres high and is the tallest stand-alone hotel structure in the world, accommodating 202 one, two and three bedroom suites. Construction started in 1994 and was completed in 1999. (Damluyi, 2011)



Plate XXIV View of Burj Al Arab at night

Source: http://www.dubai-architecture.info/DUB-003.htm

The Burj is built 290 metres off the Dubai coast on a triangular, manmade, landscaped island with sides of 150 m in length built off the sea bed in 7.5 metres of open sea as shown

in Plate XXV. The gross area of the Burj al Arab is 1.2 million square feet with 28 double height space floors; each floor is 7m high. (Dexter, 2011)



Plate XXV View of the Burj on the main island road

Source: http://www.dubai-architecture.info/DUB-003.htm



Plate XXVI Bridge connecting the island to the mainland

Source: http://www.dubai-architecture.info/DUB-003.htm

A gently curving road bridge links the island (which is some 450m offshore) to the Dubai mainland shown in Plate XXVI. The island is protected by special hollow concrete armour units. These present a perforated sloping surface to the sea that absorbs the waves without throwing water onto the island. (Damluyi, 2011)

The building design features a steel exoskeleton wrapped around a reinforced concrete tower. Notably the building is shaped like the sail of a dhow, with two "wings" spread in a V to form a vast "mast". The space between the wings is enclosed by a Teflon-coated fibre glass sail, curving across the front of the building and creating an atrium inside. The sail is made of a material called Dyneon. During the day, the white fabric allows a soft, milky light inside the hotel, whereas a clear glass front would produce blinding amounts of glare and a constantly increasing temperature. At night, both inside and outside, the fabric is lit by color-changing lights. (Damluyi, 2011)

Near the top of the building is a suspended helipad supported by a cantilever. The helipad has featured some of the hotel's notable publicity events as shown in Plate XXVII.



Plate XXVII Suspended helipad

Source: http://www.dubai-architecture.info/DUB-003.htm

The hotel is officially rated Five-Star Deluxe. However, it is frequently described as "the world's only Seven-Star hotel", although the hotel management claims to never have done that themselves. (Damluyi, 2011)

5.4.2 Facilities in the hotel

(a) Accommodation:

The accommodation wings enclose two sides of a huge triangular atrium that runs up the full height of the accommodation floors. The third side, facing the shore, is enclosed by a double skinned, Teflon coated woven glass fibre screen. (Dexter, 2011)

The atrium, Plate XXVIII, is the tallest in the world at 182 metres high. Dicroyic lights illuminate the exterior of the hotel in varying colours throughout the night. (Dexter, 2011)



Plate XXVIII Atrium with glass fibre screen

Source: http://www.dubai-architecture.info/DUB-003.htm

The Burj Al Arab holds only 28 double-story floors which accommodate 202 bedroom suites which feature design details that juxtapose east and west. The 202 duplex suites, ranges from 170 to 780 sq metres, across 27 floors each with its own Guest Services exclusive for in-suites check-in and butler services, with a dining, living and office area. The suites range from one and two bedroom deluxe suites,

panoramic suites, Club suites, Diplomatic suite, Presidential suite and Royal suite as shown in Plate XXIX,Plate XXX and Plate XXXI. (Jumeirah International LLC, 2011)



Plate XXIX Interior of the one bedroom deplex

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab



Plate XXX One bedroom duplex

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab



Plate XXXI Interior of the Royal suite

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

White Tuscan columns and a spiral staircase covered in marble with a wrought-iron gold leaf railing show influence from classicism and art nouveau as shown in Plate XXXII.



Plate XXXII Spiral staircase in Club suite

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

Spa-like bathrooms are accented by mosaic tile patterns on the floors and walls, with Arabian-influenced geometries, which are also found everywhere in the building as shown in Plate XXXIII and Plate XXXIV. (Damluyi, 2011)

The interior was designed by Khuan Chew, Design Principal of KCA International.



Plate XXXIII Bathroom of the Royal suite

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab



Plate XXXIV Bathroom of the Presidential suite

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

(b) Restaurants and Bars

There are 10 luxurious restaurants and bars in the hotel. One of its restaurants, Al Muntaha (Arabic meaning "Highest" or "Ultimate"), is located 200 meters above the Persian Gulf, offering a view of Dubai accessed by a panoramic elevator as shown in Plate XXXV.

Another restaurant, the Al Mahara (Arabic "The Oyster"), which is accessed via a simulated submarine voyage, features a large seawater aquarium, holding roughly 35,000 cubic feet (over one million liters) of water. The tank, made of acrylic glass in order to reduce the magnification effect, is about 18 cm (7.5 inches) thick as shown in Plate XXXVI. (Jumeirah Internationa LLC, 2011)

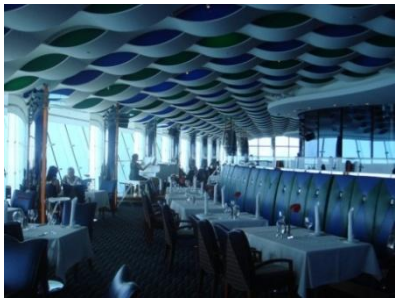


Plate XXXV Al Muntaha Restaurant

Source: http://www.dubai-architecture.info/DUB-003.htm

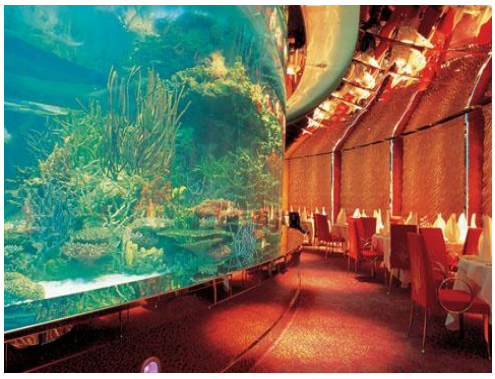


Plate XXXVI Al Mahara Restaurant

Source: http://www.dubai-architecture.info/DUB-003.htm

(c) Private Banqueting & Meeting Facilities

Several banqueting and meeting facilities are available at the hotel. Al Falak Ballroom is a palatial, two-tiered, domed ballroom crowned with a unique crystal chandelier, located at the top of Burj Al Arab as shown in Plate XXXVII. Boardrooms and Majlis also located on the 27th floor offering stunning views, the very latest technology and services to match as shown in Plate XXXVIII. Assawan Amphitheatre and Marina Garden are perfect locations for cocktail receptions. (Jumeirah International LLC, 2011)



Plate XXXVII Al Falak Ballroom

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab



Plate XXXVIII Suha and Athuraya Boardroom

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

(d) Reception Areas and Lounges

There is no main reception desk the Burj Al Arab, guests are escorted directly to their suite for check-in but there is a private reception desk on every floor. On the ground floor are the concierge desk and escalator that takes guests up to the Burj main lobby, past a cascading water feature and large aquariums as shown in Plate XXXIX and Plate XL. (Jumeirah International LLC, 2011)



Plate XXXIX Entrance lobby with concierge desk

Source: http://www.dubai-architecture.info/DUB-003.htm



Plate XLThe Burj main lobby

Source: http://www.dubai-architecture.info/DUB-003.htm

(e) Leisure Activities

Perched by white sandy beaches and bordered by the blue waters of the Arabian Gulf, Burj Al Arab is a prime leisure spot for water sports and activities. Relax in the superb outdoor pool or soak up the rays on the private beach as shown in Plate XLI.



Plate XLI Lawn by the sandy beach

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

The Assawan Spa & Health Club situated on the 18th floor with magnificent views over the Gulf. Treatment rooms, hydrotherapy baths, oriental massage, sauna, steam rooms and jacuzzi, two infinity pools, squash court, two fully equipped fitness studios and an aerobics floor as shown in Plate XLII.

The Sinbad's Kid's Club is located on the 18th floor of Burj Al Arab, adjacent to the Diwania Library and is staffed at all times by professional care. The service is offered exclusive to in-house guests and Spa Members on a complimentary basis and caters for children aged between 1–12 years of age.

One of the world's most impressive water parks, Wild Wadi is a playground that is guaranteed to delight both the young and the young at heart. It is the perfect location for leisure, as well as special events. Burj Al Arab guests can enjoy unlimited access to Wild Wadi water park, Plate XLIII, which is accessible via a complimentary buggy drive or short walk. (Jumeirah international LLC, 2011)



Plate XLII The Asswan Spa and Health Club

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab



Plate XLIII Wild Wadi Water Park

Source: http://www.jumeirah.com/en/hotels-resort/dubai/burj-al-arab

5.5 Case Study 4: Transcorp Hilton, Abuja

5.5.1 Introduction

Transcorp Hilton hotel Abuja, formally known as Nicon Noga Hilton hotel is an imposing 'Y' shaped five star hotel situated in the high brow maitama central business district of Nigeria's capital city Abuja as shown in Plate XLIV. It is the foremost hotel in town and the first five star hotel to be built in Nigeria. It is the preferred host for many public and private functions in Abuja. (Bureau of Public Enterprises, 2011)



Plate XLIV Transcorp Hilton Hotel Abuja

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

Preparatory work for the hotel began in 1981, at that time there were hardly any infrastructure in the city. To finance the job, National insurance company of Nigeria (NICON) took a loan of $118,875,000 from a consortium of foreign banks. The hotel was fully commissioned in 1987. (Bureau of Public Enterprises, 2011)

The hotel has a 'y' shaped plan with 670 rooms and is 10 storey high. The rooms are furnished in art deco style, original artwork on the walls and marble in the bathrooms. The rooms are double banked opening into a poorly lit corridor. The building is designed as

framed structures, constructed from concrete, glass and steel materials. (Bureau of Public Enterprises, 2011)

5.5.2 Facilities in the hotel

(a) Accommodation

The 10 storey hotel has a total of 670 rooms and suites. Enjoy your stay in a 26m²/280sq.ft Art Deco-style room with a city view. The bright and airy room, with original artwork, has large opening windows. Catch up on work at the desk, check your emails with high-speed internet, recline on the mini chaise longue or re-energize in the marble bathroom. Guest rooms range from king deluxe room, king guest room, king guest room plus, king royal suite and twin guestroom. As shown in Plate XLV, Plate XLVI and Plate XLVII



Plate XLV King Deluuxe Room

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate XLVI King Guest Room Plus

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

Executive rooms are more spacious than guestrooms.. This vibrant room is 41m²/441sq. ft and benefits from double aspect windows and large marble bathroom. They range from king executive, king executive plus and twin executive. (Hilton Worldwide Inc, 2011)



Plate XLVII King Executive Room

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate XLVIII Marble Bathroom

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

Most suites have 2nd bedroom, bathroom, lounge area and city views, and range from executive royal rooms, king ambassador suites, king business suite, king executive presidential suite, king pent house executive suite, king pent house suite, royal room and royal studio. (Hilton Worldwide Inc, 2011)



Plate XLIX King Executive Presidential Suite

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate L Ambassador Suite

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

(b) Restaurants and Bars

There are a total of 7 restaurants and bars in the hotel that serve different type of food form oriental to local Nigerian dishes. The oriental restaurant serves continental dishes, furnished with oriental chandeliers, mosaics and maroon sofas as shown in Plate LI. Zuma Restaurant has ambient low lighting that forms the backdrop to romantic dining overlooking the water fountain. It serves Mediterranean favorites and light tasty dishes. Bukka Restaurant serves traditional Nigerian cuisine. African-style dark woods blend with light walls as natural light streams in to the restaurant as shown in Plate LII. (Hilton Worldwide Inc, 2011)



Plate LI The Oriental Restaurant

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate LII The Bukka Restaurant

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

The Fulani pool bar and the capital bar are also located in the hotel. The Fulani pool bar has traditional thatched roofing, mats and statues that reflect the culture of Nigeria's Fulani people as shown in Plate LIII. There is also a pastry shop. (Hilton Worldwide Inc, 2011)



Plate LIII The Fulani Pool Bar

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate LIV The Capital Bar

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

(c) Private Banqueting & Meeting Facilities

The hotel provides venues form small meetings to very big venues for social gatherings like weddings and fund raisers as shown in Plate LV. The hotel hosts a lot of private and public functions in Abuja because of its central location and proximity to diplomatic area and government offices. (Hilton Hotels, 2011)



Plate LV Hilton Congress Hall

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

(d) Reception Areas and Lounges

The main hotel lobby, Plate LVI, is located on the ground floor. Door men, reception staff, concierge and porters are available at the main hotel lobby 24 hour a day. The executive lounge is exclusive to guests in the executive rooms and suites as shown in Plate LVII.



Plate LVI Main Lobby Area

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate LVII Executive Lounge

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

(e) Leisure Activities

There are several leisure activities in the hotel local. You can revive yourself in the Precor fitness center as shown in Plate LVIII or take a dip in the outdoor pool as

shown in Plate LIX. You can also play badminton in the Sports Hall or try your luck in the Domo casino. There is an onsite shopping arcade and a crafts village. (Hilton Hotels, 2011)



Plate LVIII Precor Fitness Center

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate LIX Outdoor Swimming Pool

Source: http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html



Plate LX Crafts Village

Source:http://m.hilton/mt/ww3.hilton.com/en/hotels/nigeria/transcorp-hilton-abuja-ABUHITW/index.html

5.6 Case Study 5: Songjiang Hotel, China

5.6.1 Introduction

Designed by the Atkins group, the hotel design is a five-star resort hotel set within a beautiful water-filled quarry in the Songjiang district close to Shanghai in China. It has a stunning concept designs inspired by the natural water and landscape features as shown in Plate LXI. The hotel is an integral part of the design of a new city on the outskirts of Shanghai for 500,000 people called Songjiang Garden City. This involved the development of a conceptual master plan using garden city philosophy and sustainable design principles. The site was an abandoned quarry until the proposal by Atkins Architects made proper reuse proposal for it. (Boett, 2006)



Plate LXI The Songiang Hotel

Source: http://www.greenroofs.com/projects/pview.php?id=529

The innovative design of the 400-bed resort hotel stands two levels higher than the rock face of the 100 metre deep quarry and includes underwater public areas and guestrooms. It will incorporate conference facilities for up to 1,000 people, a banqueting centre, restaurants, cafés and sports facilities. (E-Architects, 2006)

5.6.2 Assessment of the application of principles of green architecture

(a) Energy Efficiency

Sustainability is integral to the design ranging from using green roofing for the structures above the ground level to geothermal energy extraction. The entire hotel is to be covered in a green roof, while the building will use geothermal energy for its electrical supply and heating as shown in Plate LXII. The quarry will also provide a good source of heat control and shelter from the environment. (Chapa, 2007)



Plate LXII Songiang Hotel showing green roof

Source: http://www.greenroofs.com/projects/pview.php?id=529

An aquatic theme runs through the design both visually and functionally. Curved wings of the main body of the guestrooms enclose a naturally lit internal atrium, which uses the existing rock face with its waterfalls and green vegetation. This will be overlooked by guestroom balconies and contain restaurants and cafés at the base. (E-Architects, 2006)

In the centre, a transparent glass 'waterfall' is created from a central vertical circulation atrium connecting the quarry base with the ground level as shown in

Plate LXIII. This replicates the natural waterfalls on the existing quarry face. (World Architecture News.com, 2006)

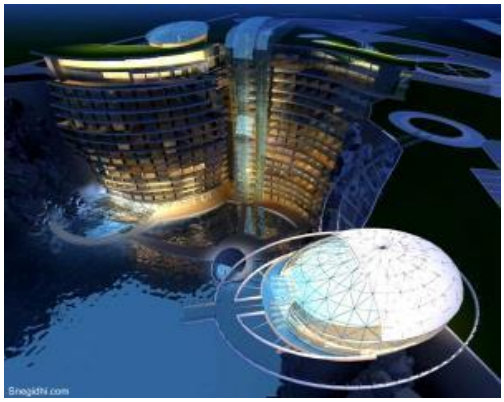


Plate LXIII Water fall pouring from atrium to ground level

Source: http://www.greenroofs.com/projects/pview.php?id=529

(b) Sustainable Site

The reuse of an already existing site means that the environmental impact will hopefully be smaller. Before the proposed hotel, the quarry was just an abandoned site as shown in Plate LXIV. The hotel is a low-rise, sustainable garden city concept, where only the central business district buildings exceed four storeys in height. There is a rich mixture of formal and informal layouts within the district and local centres form the heart of a series of identifiable communities. The existing landscape is laced with waterways and is generally flat rice farming country. The layout builds on these natural qualities to create a unique identity, using linear parks and a major central park as delineating forms in the master plan as shown in Plate LXV. (E-Architects, 2006)



Plate LXIV Quarry before hotel proposal

Source: http://www.parisworkingforart.wordpress.com/songjiang



Plate LXV Proposed Songjiang

Source: http://www.parisworkingforart.wordpress.com/songjiang

(c) Materials and Resources

The architect says that most likely a custom design on In situ concrete substructure will occur - however, they will investigate suitable single source systems. (Velazquez, 2010)

5.6.3 Facilities in the hotel

The 400 bed hotel resort will have variety of facilities apart from accommodation. Conference facilities for up to 1,000 people, a banqueting centre, restaurants, cafés and sports facilities will be incorporated. The accommodation will be located on the curved wings of the hotel. Two underwater levels will house a restaurant and guestrooms facing a ten-metre deep aquarium. The lowest level of the hotel will contain a leisure complex with a swimming pool and water-based sports. An extreme sports centre for activities such as rock climbing and bungee jumping will be cantilevered over the quarry and accessed by special lifts from the water level of the hotel. (E-Architects, 2006)

CHAPTER SIX

THE STUDY AREA (SITE)

6.1 Site Background

Kaduna is the state capital of Kaduna state located in the north central region of Nigeria as shown Figure 6.1. The global location of the city is 10°31′23″N 7°26′25″E. It was founded by the British in 1913 and was made the capital of northern Nigeria in 1917 until 1967. The symbol of Kaduna is the crocodile, called kada in the native Hausa language. (Kaduna State Government, 2010) It is also described the city of crocodiles. It is located on the river Kaduna, with a population of 760,084 (census 2006) and a total land area of 1,189.2 sq mi (3,080 km^2). The main ethnics groups include Hausa, Fulani, Bajju, Kataf, Kagoro, Moro'a, Jaba, Gbaggyi, Kanninkon, Ninzam, Chawai, Atyap, Ham Kurama etc but the most spoken languages are English and Hausa. (Travelgrove Inc, 2010)



Figure 6.1 Map of Nigeria showing Kaduna

Source: http://en.wikipedia.org/wiki/Kaduna

Kaduna State is the fourth most populous state in the Federation and represents a major focus and centre of political and economic activities in the nation. It occupies a very strategic position in terms of its historical role, contemporary political development and economic activities, developments in Kaduna State invariably have national implications.

Thus, Kaduna is a trade center and a major transport hub for the surrounding agricultural area. It is also an industrial center of Northern Nigeria, manufacturing products like textiles, machinery, steel, aluminum, petroleum products and bearings. (Kaduna State Government, 2010)

The new Kaduna city, known as the millennium city was created due to increase population and unavailability of land in the old city, hence there was need for expansion. It is located on the eastern part of Kaduna metropolis, across river Kaduna as shown in Plate LXVI. The new city cover about 900 hectares of land, having residential buildings, high rise office buildings, new shopping malls, new hotels, new markets, new hospitals, new schools, golf course, marina for boat sport-tares of land, etc as shown in Figure 6.2. (Jegede, 2009)



Plate LXVI Picture showing the old Kaduna and new Kaduna cities with the river in between

Source: http://nigerianarchitecture.blogspot.co.ok/2009/08/new-kaduna-city.html?m=1

The site for this thesis (Kada International Hotel Kaduna) is located in the new Kaduna city, Kaduna millennium city.

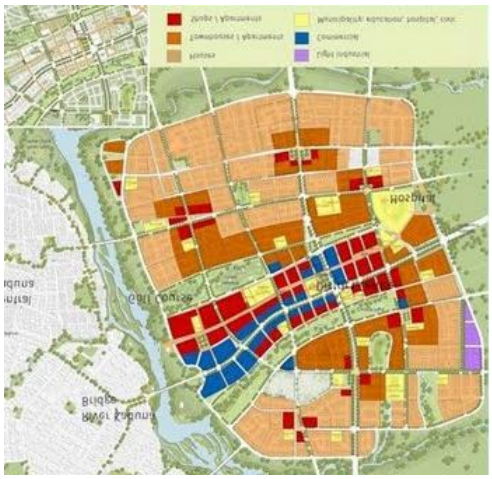


Figure 6.2 Kaduna Millenium City land use Map

Source: http://nigerianarchitecture.blogspot.co.ok/2009/08/new-kaduna-city.html?m=1

The Ministry of lands, survey and country planning, 2008 states that:

Kaduna millennium city will sit within the rolling slopes of the eastern bank of the River Kaduna. The natural streams and valleys found in the lush landscape serve as the idyllic backdrop for the city's future residents and visitors, helping to create a garden site retreat with luxury and recreational facilities and a quality lifestyle. The city will accommodate a million people and will feature:

- Up to 110,000 residents in 18,000 homes
- New golf courses with views from across the river
- 900+ hectares of prime development land for the growing city of Kaduna
- 35,000 new jobs
- Easy access to the Kaduna city centre via the river Kaduna bridge
- Easy access to both Abuja and Kano by the proposed Kaduna eastern bypass



Plate LXVII New Kaduna City Master Plan

Source: from http://nigerianarchitecture.blogspot.co.ok/2009/08/new-kaduna-city.html?m=1



Plate LXVIII Day Vuew of the new Kaduna City

Source: from http://nigerianarchitecture.blogspot.co.ok/2009/08/new-kaduna-city.html?m=1

6.2 Site Location

The site is located on the river Kaduna bridge road, on the left hand side of the road just after the bridge as shown in Plate LXIX. To the north of the site is a proposed green area, a park for recreation. To the south is the main road and across is a designated commercial site. East is site for other commercial buildings and to the west is the Kaduna River.

The site covers an area of about 38,400 sq meters and has quite some interesting features on it. Other sites were chosen but this particular site was best for the project.



Plate LXIX A view of the site from Above

Source: Google earth, 2010

6.3 Site Analysis

Climate:

Kaduna experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cool to hot dry and humid to wet. The wet season is usually from April through October, a rainy season of about five (6) months. Two different type of air masses passes through Kaduna, one from the north mostly dry and dusty (continental in origin) blowing from the Sahara desert called the north-east trade winds and the other from the Atlantic in the south, the south-west that brings rainfall, mostly cool and desirable for human comfort. Average annual rainfall is about 1020mm with august having the highest amount recorded. Relative humidity is lowest in December and January about 20%, and highest in August about more than 70%. (Iloeje, 1981)

Temperature**:**

The mean monthly temperatures vary with the movement of the sun, location, rainfall and winds. The temperatures are highest about March to April (40-41°C) when the sun first passes the latitudes of Nigeria on its northward journey to the tropics of cancer, and drops

about July to August as the rains of this season lowers them. They rise to a second but lower peak about October (37-38°C), when the overhead sun returns to Nigeria on its southward journey. The temperature is lowest in December (12°C), under the grip of the cold harmattan wind from the north as shown in Figure 6.3. Average temperature is 27°C and the there is a high temperature range of about 10°C to 15°C (Iloeje, 1981)

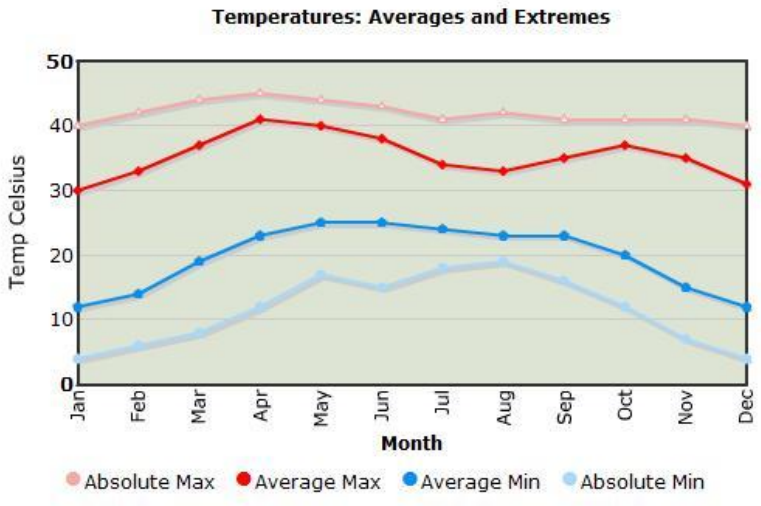


Figure 6.3Average high and low temperatures for each month of the year

Source: http://www.myweather2.com/kaduna/nigeria

Precipitation/ Rainfall:

The rainfall is experienced between April and October but sometimes comes early in March with an annual average of 1020mm. The highest amount of rainfall is experienced in August, about 280mm; this is the peak of the rainfall as shown in Figure 6.4. The type of rain experienced here is the convection rain. (Iloeje, 1981)

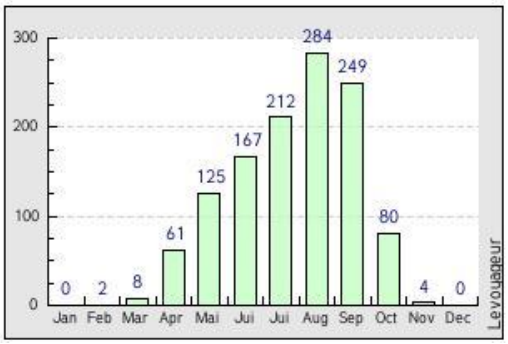


Figure 6.4 Chart showing the average monthly precipitation amount in millimeters

Source: http://www.myweather2.com/kaduna/nigeria

Humidity**:**

In July/August, humidity is high sometimes above 70% and is lowest around January/February, reading as low as 20%. The higher percentages are recorded in the early hours of the morning while the lower percentages in the evening as shown in Figure 6.5.

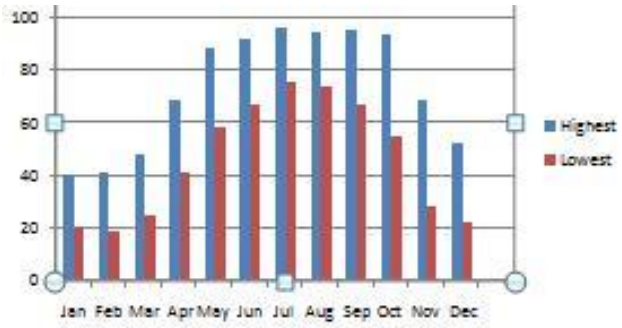


Figure 6.5 Chart showing the average monthly humidity in percentage

Source: http://www.myweather2.com/kaduna/nigeria

Sunshine:

There is an average of 12 hours of sunshine daily all years round. Longer days are experienced in July, Sunrise 06:10am sunset 6.58 pm, shorter days are experienced in December. Sunrise 06:40are sunset 06:05pm as shown in Figure 6.6.

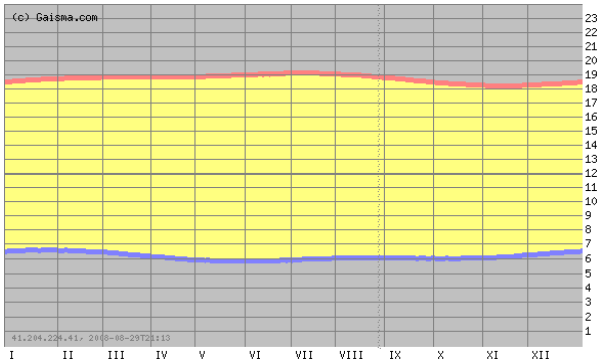


Figure 6.6 Chart showing sunrise, sunset, dusk and dawn times.

Source: http://www.gaisma.com/en/location/kaduna.html

Insolation**:**

The average solar radiation energy received on the site is 5.90kWh/m²/day. (Gaisma, 2011)

The insolation figures are used as an input to worksheets to size solar power systems to be used on the site as shown in Figure 6.7.

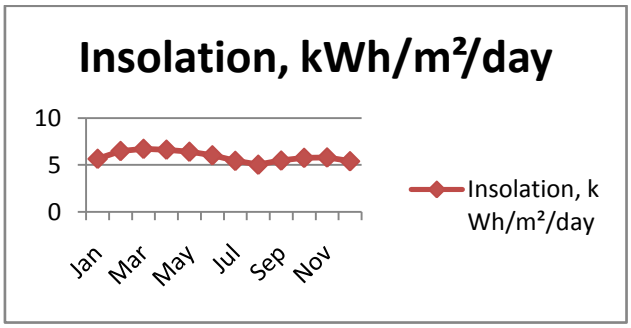


Figure 6.7 Chart showing the average monthly insolation

Source: http://www.gaisma.com/en/location/kaduna.html

Wind speed**:**

Figure 6.8 below plots the average daily wind speed you can expect for any month. It also shows the maximum recorded sustained wind speed for each month.

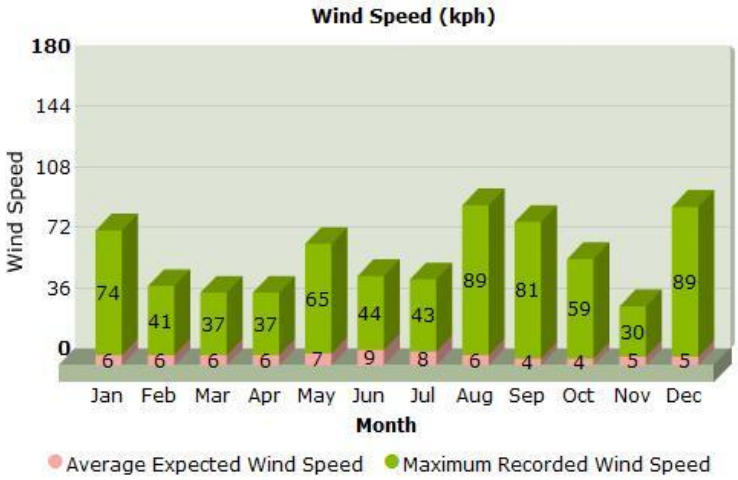


Figure 6.8 Chart showing the average monthly wind speed

Source: http://www.gaisma.com/en/location/kaduna.html

Soil and Vegetation:

The site has good topsoil of medium coarse texture that supports farming as shown in Plate LXX and has a rocky terrain along the river. The vegetation on the site consists of scattered trees of different species and few shrubs. Site is used as a farm land during the raining season.



Plate LXX Topsoil found on the site

Source: Field Survey

Topography:

The site is relatively flat with a gentle slope towards the river valley. The valleys is shallow but wide; grading into flat moist to marshy alleviated bottomlands or floodplains, called "fadama" in Hausa.

Cloud cover:

During the dry season, there is no cloud cover, the skies are very clear. During the wet season there is a bit of cloud cover. The months with the highest amount of rainfall experience higher amount of cloud cover; between July and September.

Access:

The site is located on the River Kaduna bridge road as shown in Plate LXXI and Plate LXXII, right after the bridge. This is a very good location because it is one the major road of the millennium city, in the central commercial and business district. It is very close to the old Kaduna city.



Plate LXXI River Kaduna Bridge Road

Source: Field Survey



Plate LXXII Road to site

Source: Field Survey

Features on site**:**

There are several features found on the site and they include:

Flora: there are few trees scattered around the site with little grass cover as shown in Plate LXXIII. However during the raining season, there are green grasses everywhere as shown in Plate LXXIV. Some of the trees include mango trees and palm trees. There is more vegetation on along the western side of the site, closer to the river.



Plate LXXIII Scattered trees on site

Source: Field Survey



Plate LXXIVGreen grass on site during raining season

Source: Field Survey



Plate LXXV Dry grass during dry season.

Source: Field Survey

Fauna:

There are no animals that permanently live on the site. The animals found they are those that come for grazing and drink water from the river. They include cattle and sheep and their watch dogs. There are some rodents on the site and there is a possibility that there are also snakes because of proximity to the river.

River: To the west of the site is the River Kaduna. During dry season as shown in Plate LXXVII, the water level drops and exposes the rocky terrain and during the raining season, the water level rises and there is a very beautiful view as shown in Plate LXXVI.



Plate LXXVI River Kaduna during raining season

Source: Field Survey



Plate LXXVII River Kaduna during dry season.

Source: Field Survey

Rocks:

Also west to the site is a rocky terrain. They are smooth and beautiful sedimentary rocks with a grayish black colour as shown in Plate LXXVIII. During the raining season when the water level rises, it covers this area.



Plate LXXVIII Rocky terrain near the river

Source: Field Survey

Make shift structures:

There are some make shift structures on the site which are made of planks of wood and zinc and are used for shops and restaurants as shown in Plate LXXIX. In front of the site is like a mini bus station.



Plate LXXIX Make shift structures on site

Source: Field Survey

Services on site:

There are not services on the site yet because the new layout is still under construction. The services that will be on the site are electricity and water.

Possible electricity supplies are:

- Power holding company of Nigeria. Nearness of the site to the old Kaduna site makes it very easy to tap services from nearby existing grids.
- Generator

Possible water supplies include:

- Water board
- Bore hole.

6.4 Site Selection Criteria

Site selection is the first step in the sustainable design process. The site must be compatible with the purpose of the proposed development and be suitable for building.Three (3) alternative sites were chosen for this research, based on purposive sampling. And this particular site was selected.

The criteria used for the selection of the site were:

(a) Location:

The site has a very good location; it is in the new millennium city and not far from the old Kaduna city. It will be used by both settlements. Also, it is in a very conspicuous location and will not be difficult to locate. It is also located at the central commercial and business district.

(b) Access:

The site is on a major high way therefore there is good access to the site.

(c) Geology:

The site is located by the river Kaduna which gives a very beautiful view. It can also be used for water and other leisure activities in the hotel.

(d) Nearness to other existing building:

Even though the site is in a new layout, it is very close to the old Kaduna city. This means that the site is near existing infrastructures like water, electricity etc.

(e) Virgin land:

The site has never been used for any industrial use which might have contaminated the soils or the water.

(f) Target market:

Located in the commercial district, the hotel will attract business men and nearness to the city will make it a very good convention center.

CHAPTER SEVEN

DESIGN REPORT

Hotels are known to be the best buildings of their areas. Because of its economical significance, the complex is loaded throughout the year. It holds conferences, and many public & private functions in-addition to the rentable spaces i.e. rooms. Hence because of its sheer mass and importance it becomes a node and an unmistakable landmark of a region. It is always the most prominent building of its area and has great symbolic value as it is a global tourist port.

In this chapter, the design stage considers the relationships of different parts of the hotel and how the principles of green architecture can be applied.

7.1 Design Brief

This thesis is aimed at designing a five star hotel with the principles of green architecture applied to it to create a more environmental friendly environment. The hotel which its main function is to provide the public with accommodation will also comprise of other functional spaces and facilities. These facilities include: restaurants and bars, lounges, function rooms, meeting facilities, gym and spa, swimming and leisure activities, administrative offices, services and maintenance offices, back house and light shopping.

7.2 Design Concept

(a) Plan concept

The name Kaduna was originated from the word “kada” meaning crocodile in native Hausa language (Kaduna is the plural of kada). Many crocodiles were found along the bank of the river Kaduna. Thus, the plan concept for the hotel is a kada, a

crocodile as shown in Plate LXXX. The building signifies another crocodile by the river bank.



Plate LXXX The Crocodile, Design Concept

Source: http://www.africancrocodiles.com

Figure 7.1A is a sketch of a crocodile, from which figure 7.1B was abstracted from with the head, tail and limbs removed from the main. The head, the body and tail form three blocks with the body being the main block.

Figure 7.1C shows the final structure, the head forms the podium which houses all public and auxiliary services. The main body forms the tower which covers all the accommodation in the hotel. The limbs form the stalls and sit outs attached to the main building.

Figure 7.1 Design Concept Development (Plan)



Figure 7.2 Plan on Site

Source: Researcher’s design

(b) Elevation concept

The approach of the hotel is the head of a crocodile as shown in Plate LXXXI. The domes on either side represent the eyes of the crocodile and the shading devices represent the sharp teeth of the crocodile. The solar panels on the façade and balconies, and the vertical greenery represent the skin and scales of the crocodile as shown in Figure 7.2.



Plate LXXXI Head of a Crocodile, Elevation Concept

Source: http://www.africancrocodiles.com

Figure 7.2A is the front of a crocodile showing head with the eyes nose and the teeth. It is abstracted to form the final structure 7.2B which shows the domes on either sides of the building, and the sharp teeth which are the shading devices.

Figure 7.3 Design Concept Development (elevation)

7.3 Spatial Organization and Design

The hotel has a tower and podium design, with the podium comprising all the public and auxiliary services and the tower covering the accommodation. The hotel is 14 floors high and has a basement; the podium covers 2 floors and the tower 11. There are a total of 122 rooms and suites in the hotel; 80 deluxe rooms, 40 executive suites and 2 presidential suites. Two atria are located in the hotel, one at the podium and the other which runs from the ground floor all the way to the tower.

Site Plan and Landscaping

The site planning is such that the terrain is altered minimally by ensuring that the elements of the design are designed with respect to the nature of the site. Concrete and asphalt is minimally used to allow the ground maintain its natural state. This will reduce heat absorption.

Native species of plants are used to enhance the landscape. Trees and shrubs are used as screens, purifiers wind breakers and noise buffers.

Access is from 2 points. The main access (gate) to the hotel is from the south west of the site. The service gate is on the north western side of the site. Both accesses are off the main road. This will allow for easy traffic and movement.

The hotel building is a single block. However, the leisure facilities form another block independent of the main hotel block. The leisure facilities which include the gym, spa and night club and are semi private areas accessible to both and non residents of the hotel.

The parking lot provides parking for 300 cars.



Figure 7.4 Site Plan

Source: Researcher's design

The Basement

The basement is partially immersed into the ground. This is to allow ventilation and lighting so as to reduce the use of artificial cooling and lighting. It covers an area of 1300 square meters and this is where all the installations of the hotel are located. The basement is accessible from the outside through a ramp. Goods can be dropped off and picked up easily from the stores and the workshops. Spaces in the basement include:

General store, dry store and cold store for the storage of food items, toiletries etc. The stores are located close to the service lifts for easy distribution to different floors.

Electrical and Mechanical services workshop: This is where all the electrical and mechanical installations are located.

Grey water treatment plant and water supplies are also located on the basement.

Refuse collection: this is where all the wastes of the hotel is collected and disposed.

The Podium

The podium houses all the public and auxiliary services. It occupies 2 floors covering a total floor area of 12,200 square meters. The ground covers an area of 8,850 square meters and the second floor covers an area of 3350 square meters:

Ground Floor

The ground floor covers a floor area of 8,850 square meters. The front part of the ground floor is the main hotel entrance and the most public spaces. Behind is the back house which is strictly accessible to hotel staff only. The following are located on the ground floor:

The main hotel entrance which is a very important feature, and the impression created by it is important because it defines the type of hotel. It is obvious and celebrated leading directly to reception. There are three other entrances to the hotel, one from the conference hall and the other two from the restaurant and bar.

Restaurant and Bar are open to nonresidents, so they located for convenient access from outside the hotel in addition to access for resident guests. There is one main restaurant, a bar, a cocktail lounge, traditional African restaurant (located outside the hotel and designed in traditional gazebos) and a sit out with stalls for ice cream, popcorn, “suya”, “shawarma” etc.

The function room is designed to be multi-functional, adaptable for banqueting, dancing, conferences. The exhibition is placed next to the function room.

Shops are placed in a very strategic location on the ground floor so that they can easily be accessible by both residents and non residents of the hotel.

Administrative offices are divided into two groups; the front desk offices and the executive offices. The front desk offices are located near the reception on the ground floor but in a non conspicuous manner. Offices here include reservations office, accounting and so on.

The back house is located on the ground floor. Spaces here include kitchen, laundry, housekeeping department, personnel department, staff changing and lounge, security surveillance and communication room.

The general circulation layout facilitates movement and, as far as possible, provide for the separation of guests and staff. Main lift bank is visible on entering the reception area. There are 4 lift for the hotel guests Service lifts, also 4 in number are provided for services and housekeeping. The main stairs is located beside the lift bank to enable guests to find them easily, with secondary stairs at the end of each corridor. They are designed to serve as fire escape. There is a total of 9 staircases in the hotel, 5 at the tower and 4 at the podium, and 2 of them are service staircases.

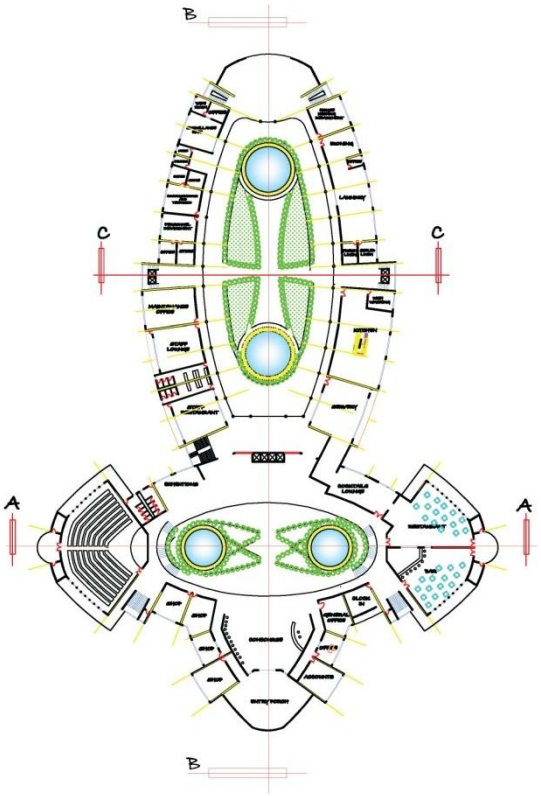


Figure 7.5 Ground Floor Plan

Source: Researcher's design

First Floor

The first floor is also a public area in the hotel but it is not as public and noisy as the ground floor. Spaces here include the following:

The main hotel lounge is located on the first floor just like in Burj Al Arab.

The executive are located on the first floor and they include general manager and assistant hotel manager.

Rentable office spaces are located on the second floor. This is because offices need a little privacy unlike the shops.

Directly above the back house on the first floor is the service floor.

The Tower

The tower covers the accommodation of the hotel. There are 3 types of accommodation, deluxe rooms, executive suites and presidential suites. One side of the tower is sloped so the area of each reduces as it goes up, from the 9th floor. The slope is used for rainwater collection.

The deluxe room consists of a room, bathroom and balcony. The location of the bathroom makes it well lit and ventilated. Light is not required during the day or expellers. It covers an area of 44square meters. The bedroom itself covers 27 square meters, toilet 9.5 square meters and the closet 8.5 square meters.

The executive suites are made up of a bedroom, bathroom and a living room. The bedroom is more spacious than the deluxe room. The executive suites have a view of the River Kaduna. It covers an area of 154 square meters. The bedroom and living room cover 69 square meters and the toilet 15.5 square meters.

The presidential suite consists of a bedroom, bathroom, living room, dining and a kitchenette. The bedrooms are very spacious. The suites which are 2 in number are located on the last floor (14th floor). There is a lot of privacy here.

The accommodation starts from the 2nd floor. Every floor has a security post by the lifts to monitor the movement of people in the hotel. Each floor has housekeeping, room service,

store and a panel room which are directly beside the service floors. Except for the last floor, all other floors have a lounge. From the 2nd to the 8th floor is a repetition of floors. A typical floor consists of 10 deluxe rooms and 4 executive suites. Each floor has housekeeping, room service, store and a panel room.

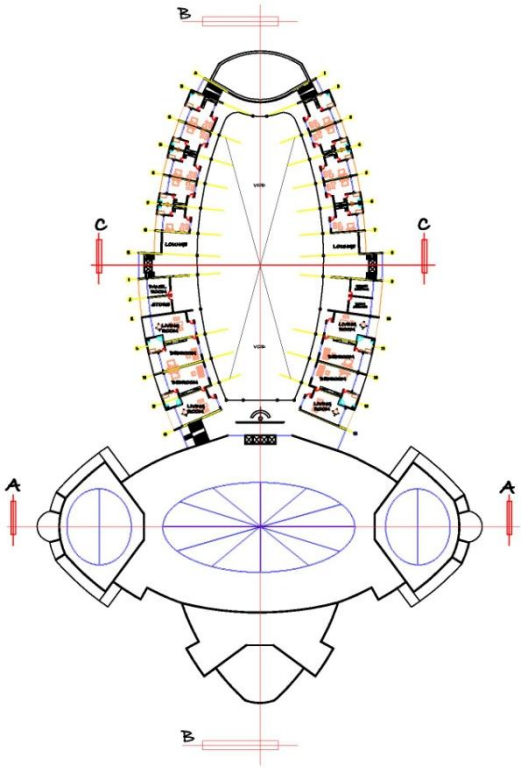


Figure 7.6 Accommodation Floor (2nd to 10th floor)

Source: Researcher's design

7.3.1 Schedule of accommodation

S.NO	SPACE	AREA
1	ACCOMODATION	12,000sqm
	Deluxe rooms (no 80)	45sqm
	Executive suites (no 40)	154sqm
	Presidential suites (no 2)	308sqm
2	ADMINISTRATIVE AREA	410sqm
	Front Desk Offices	
	General front desk office	68sqm
	Accounts and audit office	59sqm
	Reservations office	36sqm
	Front desk manager's office	43sqm
	Executive Offices	
	General manager	59sqm
	Secretary	36sqm
	Assistant general manager	43sqm
	Meeting room	68sqm
3	RESTAURANT	300 sqm
	Main hotel restaurant	225sqm
	Bar	225sqm
	Cocktail lounge	115sqm
	Traditional bukkah restaurant	80sqm (each gazebo 20sqm, no 4)
4	MAIN HOTEL LOUNGE	220sqm

	CONCOURSE AND RECEPTION	273sqm
5	LIESURE FACILITIES Gym Spa Night club	940 sqm 196sqm 93sqm 429sqm
6	SHOPS (no 8) RENTABLE OFFICE SPACE (no 4)	410sqm 172
7	FUNCTION ROOMS Conference Hall Exhibition	520sqm 450sqm 70sqm
8	BACK HOUSE Main Kitchen Laundry Local kitchen	1800 sqm 300sqm 275sqm 60sqm
9	SERVICE FLOOR	1800sqm
10	BASEMENT General store Cold store Dry store Installations Grey water treatment	 215sqm 125sqm 90sqm 420sqM 110sqm
11	PARKING (300 CARS)	

7.4 Principles of Green Architecture Applied in the Design

Energy Efficiency

(i) Passive cooling techniques

Natural ventilation: there is ample natural ventilation in the hotel especially in the guest rooms because there are openings on either side of the room enhancing cross ventilation. Wide openings from the balcony brings in cool air from the outside and the high level opening on the lobby serves as an escape from the rising hot air, releasing it in to the atrium which escapes through chimney effect.

The atrium at the podium is covered with a glass dome. This dome is suspended so that it can allow the movement of air through stack effect and chimney effect, also are the domes in the conference hall and the restaurant/bar.

Evapourative Cooling: there is a water fountain in the atrium which helps drop the temperature within the building envelope, thereby making the building cooler. There are also other water bodies outside the building (swimming pool and fountain) which also provide evapourative cooling as shown in Figure 7.7

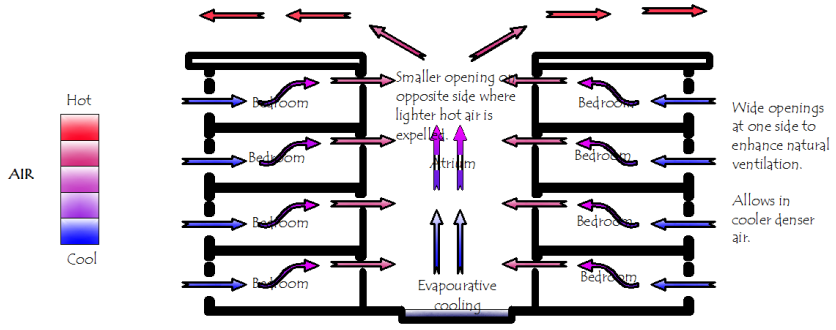


Figure 7.7 Natural Ventilation, Evapourative Cooling and Chimney Effect

Source: Researcher's design

Shading: Balconies in the guestrooms, which are singly banked, overhangs on the north and south facing openings at the podium, and shading devices help block unwanted sun and glare. And at the same time supports daylighting as shown in Figure 7.8

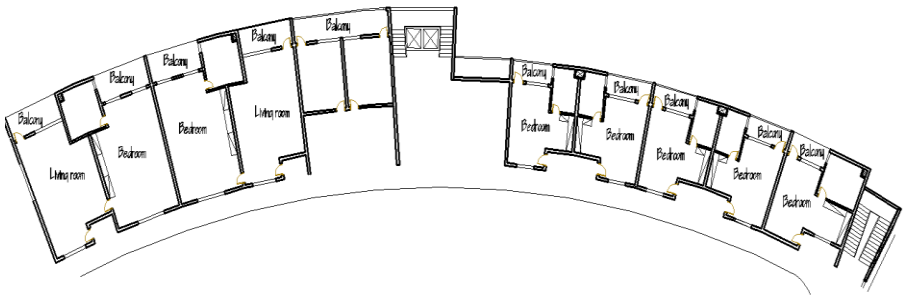


Figure 7.8 Balconies in the guest rooms thet provide shading

Source: Researcher's design

Landscaping: Passive cooling is achieved through the extensive use of greenery. Vertical greenery helps reduce heat absorption from walls and reduce noise and pollution as shown in Figure 7.9. Walk ways and roads are shaded by trees as shown in Figure 7.10.



Figure 7.9 Vertical Greenery and Photovoltaic on the building Facade

Source: Researcher's design

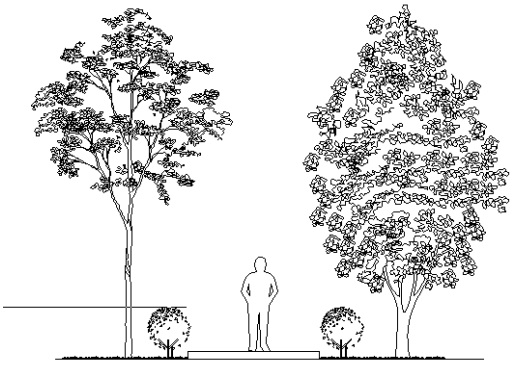


Figure 7.10 Shaded walkways

Source: Author's design

Orientation: the longer side of the building is facing the north-south axis, the shorter side facing the east-west as shown in Figure 7.11. This reduces the total area of the building that receives direct sunlight. The side are also insulated with vertical greenery. Openings are positioned so that they allow wind in to the building. The areas of the building that have direct contact with the sun have shading devices to help reduce the heat radiation and also, services such as lifts and stair cases are positioned on the part of the building with most contact with the sun.

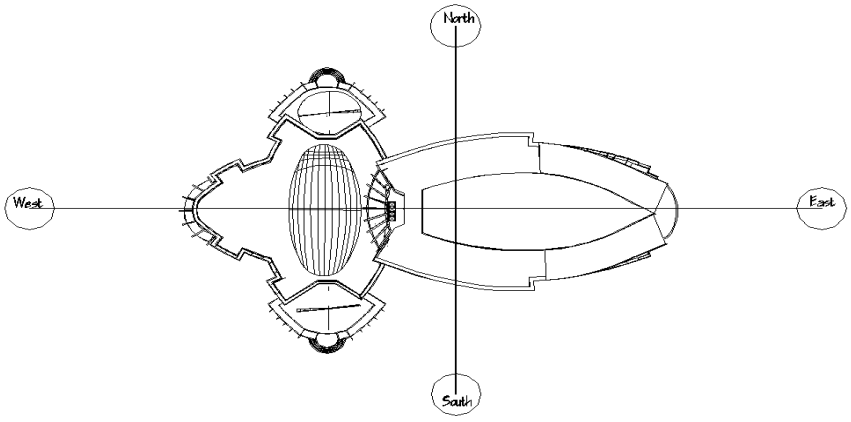


Figure 7.11 Building Orientation

Source: Researcher's design

Form: Forms with large surface areas were used as against compact forms, and the plan is a narrow.

(ii) Daylighting

The traditional daylighting strategy used in the guest rooms is windows and sidelighting. Vertical openings allow light into the building at different time of the day and year. Skylighting is used for the conference hall, restaurant and bar to light up the large area as shown in Figure 7.12.

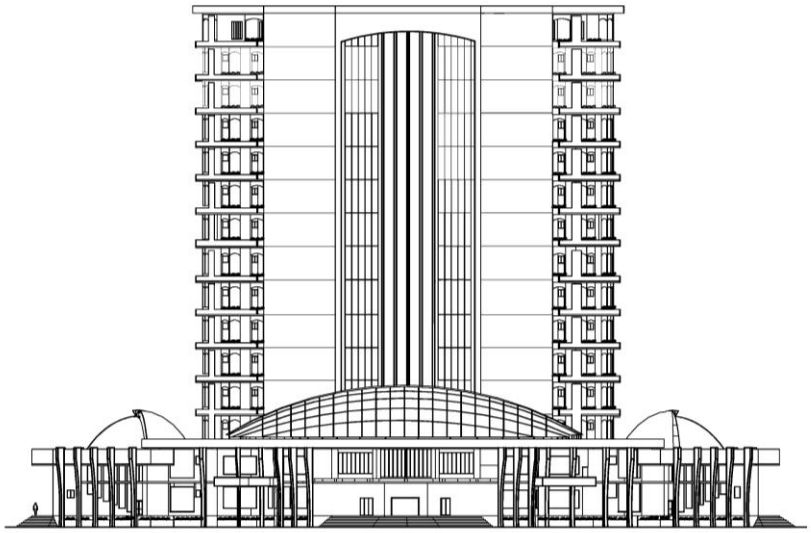


Figure 7.12 Approach Elevation showing Skylighting in Reastaurant, conference Room and concourse.

Source: Researcher's design

Renewable Energy

(i) Photovoltaic

The traditional passive cooling methods alone will not satisfy the thermal comfort in the hotel therefore mechanical methods need to be employed. Photovoltaic used on the building façade use the energy from the sun to produce electricity, reducing the

consumption on the national power grid and generators. The photovoltaic cover about 4000 sq metres.

The photovoltaic panels form a skin on top of the building as well as on the balustrade of the balconies.

An array of solar tubes on the roof heat rainwater captured to reduce demand for electricity for water heating in the hotel as shown in Figure 7.13

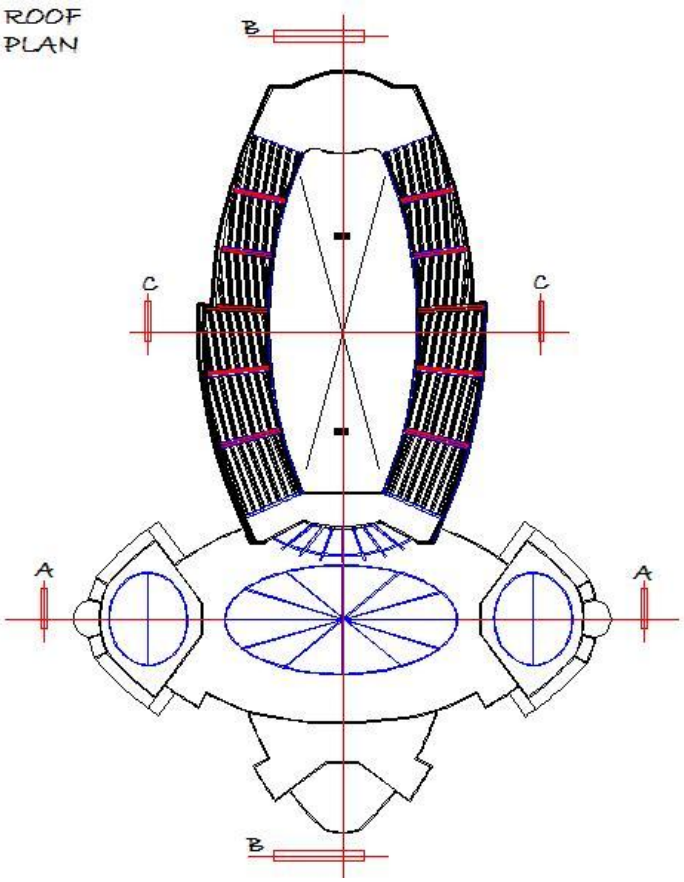


Figure 7.13 Roof plan showing an array of Solar Tubes

Source: Researcher's design

Water Efficiency

The roof is used for rainwater harvesting. From the sloping roofs, as shown in Figure 7.14 the water is collected in tanks through pipes where it is treated and sent for reuse.

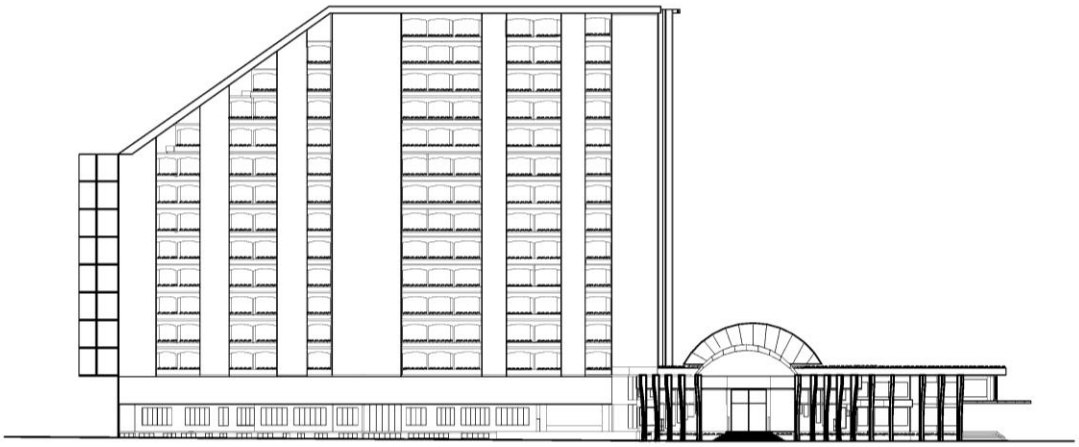


Figure 7.14 Side Elevation showing Sloping Roof for Rainwater Harvest.

Source: Researcher's design

Concrete tiles are used for as the roofing material because it is best for rainwater harvest. The average water use is around 150 liters of water per person a day (department of environment, food and rural studies, UK). The hotel has a total of 122 rooms; therefore a water tank of 200,000 liters is designed to serve the hotel.

Through the cold water inlet, the rainwater is supplied to the evacuated solar tubes on the roof. The evacuated solar tubes are suspended on the roof to allow rainwater capture at the same time. The water is heated as it goes through channels of heating pipes and supplied fitting below through the hot water outlet as shown in Figure 7.15.

Hot water is commonly the second largest single end use for energy accounting for up to 15% of the total energy demand in a hotel. Thus, by using the solar hot water systems, total energy used in the building is cut down by 15%.

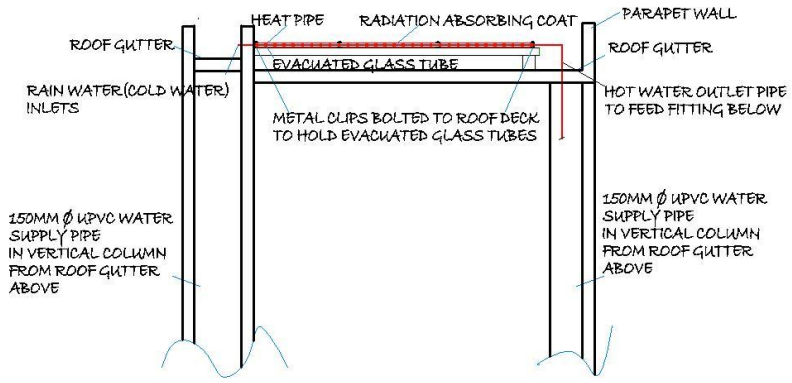


Figure 7.15 Detail of Solar Evacuation Tubes for hot Water

Source: Researcher's design

In order to minimize wastage of water, greywater from sinks, showers and bath, laundry is recycled and use for irrigation and for flushing of toilets.

Siting and Structure Design Efficiency

In choosing a site to build a green design, the first consideration is the understanding of the climate of the region and site. Designing with the environment is therefore necessary. Verticality is encouraged in the design and so the physical footprint of the building is reduced. The natural characteristics if the site is minimally affected. The greenery makes up for the ground lost for the building. This helps to reduce the urban air temperatures.

Porous paving is used to landscape the site, for walk ways and car parks. This allows rainwater to penetrate into the soil rather than run off. The used of asphalt is greatly reduced as it is impermeable and absorbs a lot of heat.



Plate LXXXII Porous Paving allow permeability

Source: www.turfcell2.com



Plate LXXXIII Porous Paving.

Source: www.turfcell2.com

CHAPTER EIGHT

CONCLUSION

8.1 Conclusion

The present state of architecture and development continues to be responsible for the inward twisting of high levels of resource consumption, pollution and wastefulness that have characterized the 21st century. At this present moment in history, humankind has the ability to affect the environment on an unprecedented level. The urgency exists for all to realize that, if we are not part of the solution, then we are part of the problem. In order to do this; development must begin by reflecting on the totality of its effects throughout its various life cycles.

However, it is very important to realize that Green Architecture can demonstrate a vision, and become an inspiration for what a society may entail. In trying to move construction to work with the forces of nature, a far greater equity will be possible within society**.** This will lead to fairer access to resources, better health, improved productivity levels, and decreased running costs, and increased property values, while ensuring that resources and planetary systems are protected for future generations to come.

The objective of the research is to apply the principles of green architecture in a Nigerian five star hotel so as to create a better and healthier environment. And from the case studies carried out, it is evident that internationally, there are very few five star hotels that apply the principles of green architecture, and none in Nigeria.

The research was concluded by proposing a befitting design for the hotel which adopted some principles of green architecture like passive solar design such as building form, orientation, green roofs and shading devices, photovoltaic and rain water catchment.

8.2 Summary of Finding

From the research, some of the following findings were identified. The use of large openings for sufficient ventilation, shading devices, overhangs, green roof reduces heat generation in a build which results to little or no need for artificial cooling and lighting. This makes the building more energy efficient.

Rain water catchment and recycling of grey water makes the hotel water efficient.

Verticality is used against horizontality and the use of porous paving allows rain water to penetrate into the ground.

8.3 Recommendations

The conclusion drawn from these findings are:

1. If hotels are designed with principles of green architecture applied, it will be a more human friendly environment and this will make the occupants more comfortable resulting to better overall output.
2. Cost of running and maintaining the hotel will be cheaper and the building will have a longer life span. This automatically will make the prices of hotels cheaper.
3. The value of the property (hotel) will increase.
4. The world will be less polluted and so reducing the effect of global warming.
5. And most importantly green ratings should be made mandatory as part of the planning process.

8.4 Contribution to Knowledge

In the course of this research, the following original contributions were made to knowledge.

(i) Established that the application of principles of Green Architecture, with main focus on energy efficiency (passive cooling techniques and daylighting) reduce overall energy consumption, running cost and subsequently high cost of hotels in Nigeria.

(ii) Demonstrated that the use of solar tubes to heat water reduce energy consumption of a hotel by 15%.

8.5 Area of Further Research

In Nigeria and most parts of the world, green building materials are quite limited, only very few are readily available. Most of them are imported and their transportation pollutes the environment. Future research in this topic should introduce a number of green materials than are more environmental friendly.

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APPENDIX