BUILDING AND ENVIRONMENTAL SCIENCE

Lectures Notes

Government Polytechnic, Bhubaneswar
Diploma in Architecture Assistantship | IV Semester

Ipsita Dash
Lect. In AA

1. Climatic condition

Climatology in Architecture:-

Contents :-

- ✓ Introduction
- ✓ Architectural climatology
- ✓ Sight planning
- ✓ Topography
- ✓ Passive solar design
- ✓ Day lighting
- ✓ Ventilation
- ✓ Moisture
- ✓ Noise control system

Introduction:-

Climate means a region with a certain condition of temperature, dryness, wind, light, etc.It is rather integration in time of physical states of atmospheric environment, characteristics of geographical location.

Weather is the momentary state of atmospheric environment at a certain location. Climate can be called the integration of time of weather condition.

Climate has four major elements:-

Earth-Soil

Water-humidity

Fire- sun and temperature

Air- wind

Climatology is all about the study of these elements.

Architectural climatology

Architecture is all about Art and Technology

In include public services, water supply and drainage, air conditioning, ventilation, lighting etc.

It is basic science a designer is concerned about.

It involves majority on :-Climatic elements how they are behaving on us to be benefitted by these climatic elements how to protect ourselves from the adverse effect of climatic elements.

The major steps in architectural climatology are:-

Climatology –study fo climatic elements

Biology:- Study of human comfort level with respect to climatology

Technology- creating of built environment architecture

The combination of the above and the final product is **Architectural climatology.**

Site planning :-in landscape architecture and architecture refers to the organizational stage of the design process.

It involves the organization of land use zoning, access, circulation, privacy, security, shelter, land drainage, and other factors.

This is done by arranging the compositional elements of land form, planting, water, buildings and paving.

Site planning generally begins by assessing a potential site for development through site analysis.

Information about slope, soils, hydrology, vegetation, parcel ownership, orientation etc are assessed and mapped.

By determining areas that are poor/ better for development, the architect can asses optimal location and design a structure that works there.

So the major concern of planning are:=

Topography

Air temperature

Humidity

Precipitation

Air movement

Vegetation and local factors.

Topography

Topography is concerned with local details in general including not only relief but also vegetative and human made features and even local history and culture.

Topographic mapping:-

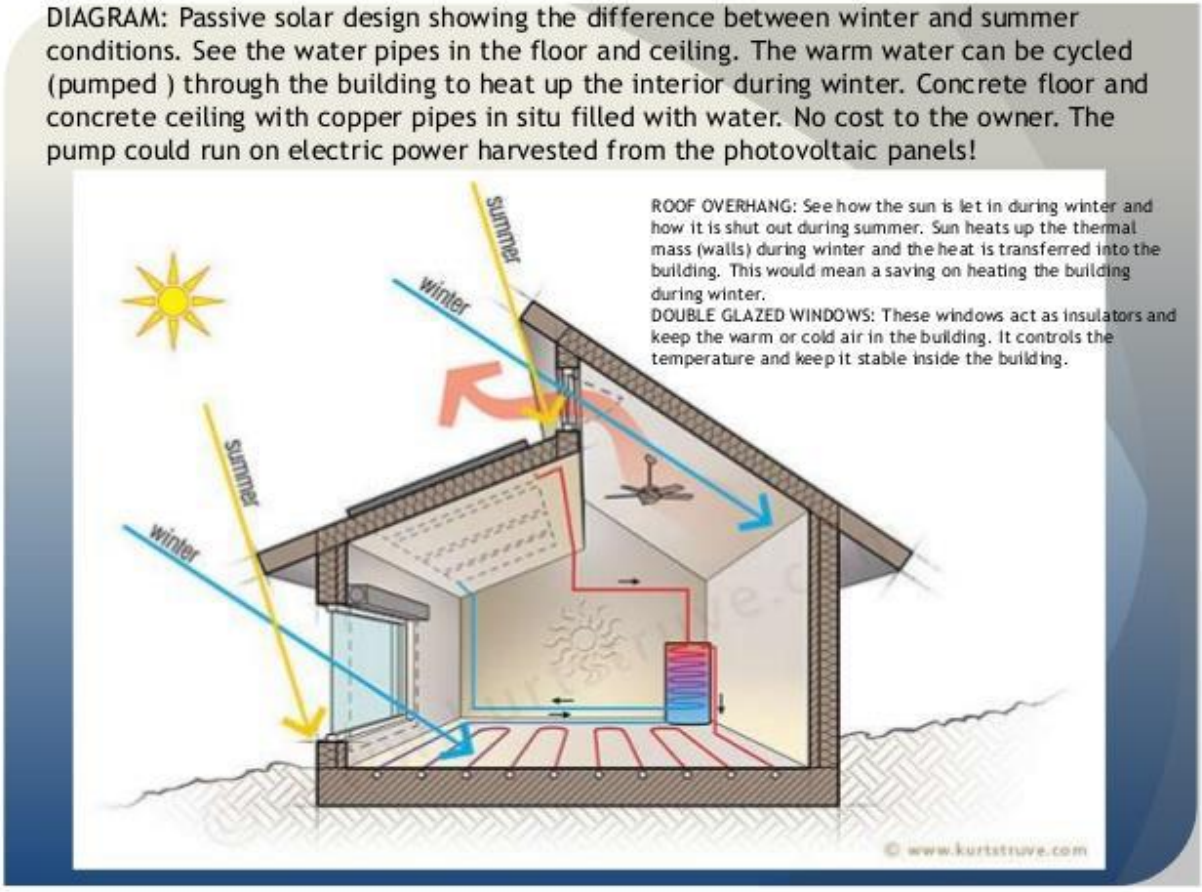
In its contemporary definition topographic mapping shows relief. In the united stated USGS topographic map show relief using contour lines. In India it is found on Geographical survey of India Maps.

These maps show not only the contours but also any significant stream or other water bodies , forest cover, built up areas or individual buildings and other features and points of interest.

1.0 Climatic condition.
1.1 Introduction to Climatology and its effect on human comfort.
1.2 Brief study of world climatic zones, tropical climate in particular.
1.3 Elements of climate:
Solar Radiation, Temperature, Humidity, Wind and Precipitation data and measurement
1.4 Influence of topography and vegetation on climatic design

INTRODUCTION
Climatology is simply the scientific study of the climates. Building Climatology is therefore the scientific study of climates with regards to the built environment. Buildings do not exist in isolation; they exist within a particular geographical context. Architecture as a scientific discipline seeks to ensure that the building and the contextual geographical environment are in a symphonic unity. If this is not achieved, the building will not yield maximum user comfort and will thus not fulfill its purpose.
Weather is a sum total of atmospheric conditions of a relatively small geographical area in a short period of time. Climate on the other hand, is the sum total of atmospheric conditions observed in large geographical area over a long period of time. The period of this observation could be 25 – 30 years. Hence, climate can be said to be an average of weather conditions taken over a long time.

ELEMENTS OF CLIMATE
There are five major climatic elements affecting the built environment. They are :-
1) Solar radiation
2Temperature
3) Humidity
4)Wind
5) Precipitation
1)Solar radiation:-
Solar Energy, radiation produced by nuclear fusion reactions deep in the Sun’s core. The Sun provides almost all the heat and light Earth receives and therefore sustains every living being.



The solar energy that falls naturally on a building can be used to heat the building without special devices to capture or collect sunlight. Passive solar heating makes use of large sun-facing windows and building materials such as brick and tile that absorb and slowly release solar heat.

A designer plans the building so that the longest walls run from east to west, providing lengthy southern exposures that allow solar heat to enter the home in the winter. A well-insulated building with such construction features can trap the Sun's energy and reduce heating bills as much as 50 percent. Passive solar designs also include natural ventilation for cooling. Shading and window overhangs also reduce summer heat while permitting winter Sun.

2)Temperature- Temperature is the degree of hotness or coldness of the atmosphere. Of all the other climatic elements, temperature is the most important because it influences the other elements. Temperature goes a long way to influence thermal comfort of the building. Thermal comfort is the condition of the mind which expresses satisfaction with the thermal environment. The human thermal environment is not straight forward and cannot be expressed in degrees. Nor can it be satisfactorily defined by acceptable temperature ranges. It is a personal experience dependent on a great number of criteria and can be different from one person to another within the same space. For example, a person walking up stairs in a cold environment whilst wearing a coat might feel too hot, whilst someone sat still in a shirt in the same environment might feel too cold.

The factors affecting thermal comfort in buildings could be Environmental or Personal. Environmental in the sense that such factor surrounds you and may be beyond your control, or personal in the sense that you can directly influence the factors and control them.
Environmental factors affecting thermal comfort.

- • The temperature of the air
- • The velocity of the air
- • Radiant temperature
- • Relative humidity (RH)

Personal factors affecting thermal comfort

• Clothing. Clothes insulate a person from exchanging heat with the surrounding air and surfaces as well as affecting the loss of heat through the evaporation of sweat. Clothing can be directly controlled by a person (ie they can take off or put on a jacket) whereas environmental factors may be beyond their control
• Metabolic heat. The heat we produce through physical activity. A stationary person will tend to feel cooler than a person that is exercising.
• Well being generally and sickness, such as the common cold or flu which affect our ability to maintain body temperature, 37C at the core.
Effects of temperature on buildings
• Thermal expansivity. Building components such as metals expand when hot and contract when cold. The higher the temperature rise in a building, the more the expansion of building components in that building. We may not readily see the effects of this due to the small of fraction of change that occurs, but over the years, the wear and tear will be evident.
• Economic effect. The cost of mechanical Heating, Ventilation and Air Conditioning (HVAC) will normally rise with adverse effect of temperature rise or decline. During the hot season, mechanical ventilators and air conditioners are over worked which leads to the probable damage of these systems. The operational cost too and cost of repairs and servicing will be on the increase. Conversely, during the cold season, there may be attendant need to look alternative means of heating up indoor spaces; this too is will lead to further expenses.
The instrument for measuring temperature is the thermometer which is a narrow glass tube filled with mercury or alcohol. It works on the principle that mercury expands when heated and contracts when cooled.
On thermometers, temperatures are marked in one of two ways. In °F. (Fahrenheit) the freezing-point is 32°F. and the boiling-point is 212°F. For most scientific purposes the Centigrade °C. scale is preferred. Its freezing-point is 0°C. and its boiling-point is 100°C.
3) Humidity
Humidity is the amount of water vapour in the atmosphere. It becomes Relative Humidity when a ratio is taken between the actual amount of water vapour in the air and the maximum amount of water vapour that the air can hold at that given air temperature.
It is usually given as a percentage. The effects of humidity can be seen as it effects thermal comfort. In a very humid environment, people will tend to sweat a lot, and clothes will not get dry easily after laundry.

The instrument for measuring relative humidity is the hygrometer, which comprises wet-and dry-bulb thermometers placed side by side in the Stevenson Screen

4)Wind

Wind is air in motion. It is caused by horizontal variations in air pressure. The greater the difference in air pressure between any two places at the same altitude, the stronger the wind will be. The wind direction is the direction from which the wind is blowing. A north wind blows from the north and a south wind blows from the south. The prevailing wind is the wind direction most often observed during a given time period. Wind speed is the rate at which the air moves past a stationary object. Wind is the major component of ventilation in buildings. The pressure between the building envelope and the external environment differ, and that is why ventilation is possible.

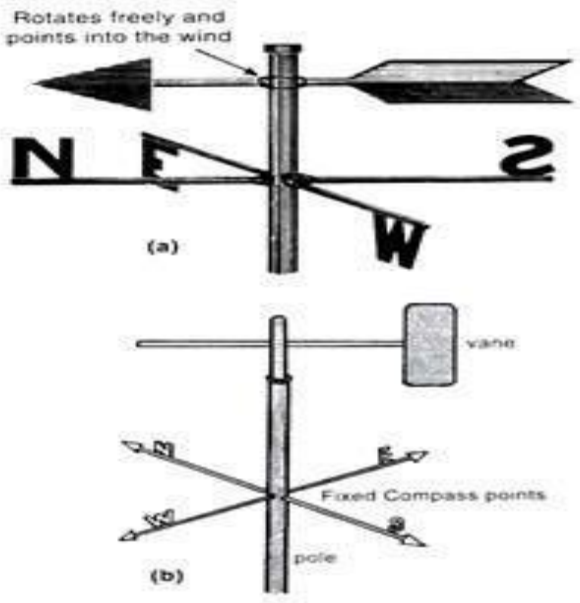


Fig 105 Wind Vanes

Adequate fenestration is required to harness this. Spread of communicable diseases is faster in poorly ventilated places..

The instrument widely used for measuring wind direction is a wind vane or weather cock. As wind direction is always blocked by trees and tall buildings, weather cocks and wind vanes need to be erected in an exposed position, to get a true directions

5) Precipitation

Precipitation is the product of a rapid condensation process (if this process is slow, it only causes cloudy skies). It may include snow, hail, sleet, drizzle and rain.

Precipitation occurs when a portion of the atmosphere becomes saturated with water vapor (reaching 100% relative humidity), so that the water condenses and "precipitates".

The standard way of measuring rainfall or snowfall is the standard rain gauge, which can be found in 100 mm (4 in) plastic and 200 mm (8 in) metal varieties.

Influence of topography and vegetation on climatic design

Topography:-The effects of topography on the climate of any given region are powerful.

• Topography Affects Rain and Snowfall

Mountains play an important role in precipitation patterns. Topographic barriers such as mountains and hills force prevailing winds up and over their slopes. As air rises, it also cools.

Cooler air is capable of holding less water vapor than warmer air. As air cools, this water vapor is forced to condense, depositing rain or snow on windward slopes.

• Topography Creates Distinctive Regional Winds

Mountain barriers also create and funnel regional winds, an important element of climate. As wind descends the leeward slopes, the air compresses, becoming more dense and warm.

• Higher Elevations and Cooler Temperatures

Land at higher elevations, such as mountains or plateaus, are naturally cooler due to a phenomenon known as the environmental lapse rate.

• Orientation of Topography and Microclimates

The orientation of slopes in relation to the sun has a profound effect on climate. In the northern hemisphere, south-facing slopes are sunnier and support entirely different ecological communities than north-facing slopes. The south side of a mountain may experience spring conditions weeks or even months ahead of its north side. Where year-round snow or glaciers exist, they are nurtured by the shade provided by north- and west-facing slopes.

Vegetation:-

Vegetation covers a considerable portion of the earth and has an effect on weather and climate. Vegetation influences both albedo of the earth and the amount of water vapor and carbon dioxide in the air.

Vegetation includes all plants from evergreen forests to grassy meadows and cropland. All types of plants play a role in both the water cycle and the earth's energy balance. They affect weather and climate mostly through evapotranspiration and albedo.

Plants process and release water vapor (necessary for cloud formation) and absorb and emit energy used to drive weather. Plants also produce their own micro-weather by controlling the humidity and temperature immediately surrounding their leaves through transpiration.

Since climate is basically an average of the weather over a long period of time, vegetation is important to climate. In fact, the process of photosynthesis is responsible for building up atmospheric oxygen to the level we enjoy today (21% concentration). Plants also help keep our climate stable over time by offsetting temperature and moisture fluctuations through transpiration. Plants also use carbon dioxide during photosynthesis, which slightly offsets the amount of greenhouse gas being released in the atmosphere through the burning of fossil fuels. Vegetation is necessary for normal weather and climate.

BRIEF STUDY OF WORLD CLIMATIC ZONES

The world has several climatic zones but geographer defined the climatic region is based on maximum and minimum temperatures and the temperature range as well as the total and seasonal distribution of precipitation for better understanding.

The major climatic regions of the world are discussed below:

1. Equatorial Climatic Region (100 N to 100 S)

It is found between 5° and 10° north and south of the equator. This region gets heavy precipitation which is between 150 cm/year. Due to the great heat, the mornings are bright and sunny and evening receive convectional rainfall. Amazon basin (South America), Zaire Basin (Africa) especially in western part, and South East Asia (mainly islands) are three well defined regions of this category.

2. The Savana or Sudan Climate (100 to 200 N and S)

It is a transitional type of climate found between the equatorial forests and the trade wind hot deserts. This climate is characterised by an alternate hot, rainy season and cool, dry season. The prevailing winds of the region are the Trade Winds, which bring rain to the coastal districts. Savanna is grasslands of tropical zone. They are known as natural Zoo of the World. Llanos and Campos in South America; Kano and Salisbury region in Africa; Northern and Central part of Australia are the important region of this category.

3. The Hot Desert and Mid-Latitude Desert Climate (200 to 300 N and S)

The aridity of hot desert is mainly due to the effects of off-shore trade winds; hence they are also called trade wind deserts. Sahara (Africa) is the biggest desert and the next biggest is Great Australian desert. It is found between 200 to 300 N and S. Hot deserts: **Sahara, Australia, Arabian, Iranian, Thar, Kalahari, Namib, Nubian, Mohave (USA), Atacama** etc. Cold Desert: **Patagonia, Turkestan, Gobi** etc.

4. The Warm Temperate Western Margin or Mediterranean Climate (300 to 400 N and S)

It is a climate that has dry summers that are hot or warm as well as winters that are cool or mild with moderate or high rainfall. It is found in many places that are roughly between latitudes 30° to 40° north and south of the equator.

Important Regions are: **Coastal region of Mediterranean Sea; Southern Tips of South-west Africa near Cape Town; Southern Australian (in southern Victoria and around Adelaide, bordering the St. Vincent and Spencer Gulfs); South West Australia (Swanland); California around San Francisco; Central Chile in South America**.

This region is famous for orchard farming e.g. **Citrus and fibrous fruits**.

5. Temperate Grasslands or Steppe Climate (400 to 550 N and S)

It is dry lands due to their position in land masses away from oceanic influences

Steppes (Eurasia); **Pustaz** (Hungary); **Prairies** (USA); **Pampas** (South America- Argentina and Uruguay); Velds (South Africa); **Downs** (Australia-Murray-Darling basin of southern Australia); **Canterbury** (New Zealand).

6. Cool Temperate Continental or Taiga or Siberian Climate (550 to 700 N and S)

It is characterised by a bitterly cold winter of long duration and a cool brief summer. This type of climate is experienced in northern hemisphere only because there is no land mass in southern hemisphere.ImportantImportant regions: **Alaska across Canada into Labrador and high Rocky Mountains; Moscow and adjoining belt in Siberia; Central Europe**.

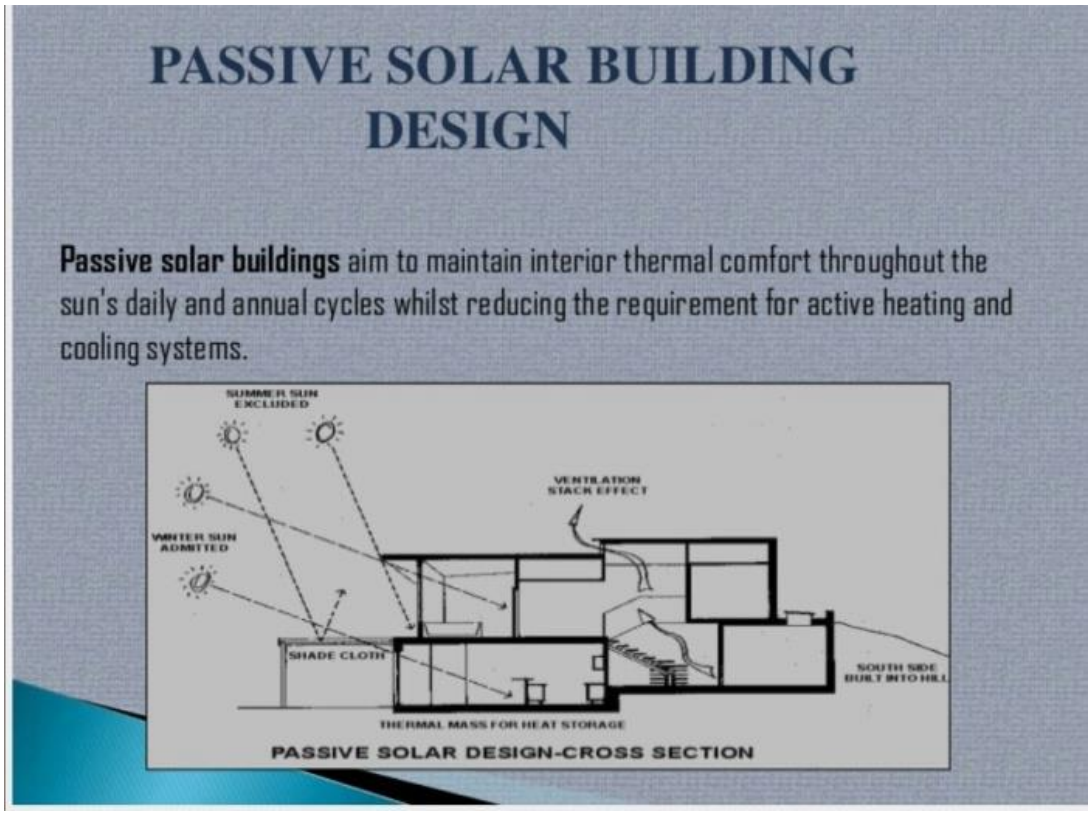
7. The Arctic or Polar or Tundra Climate (700 to 900 N and S)

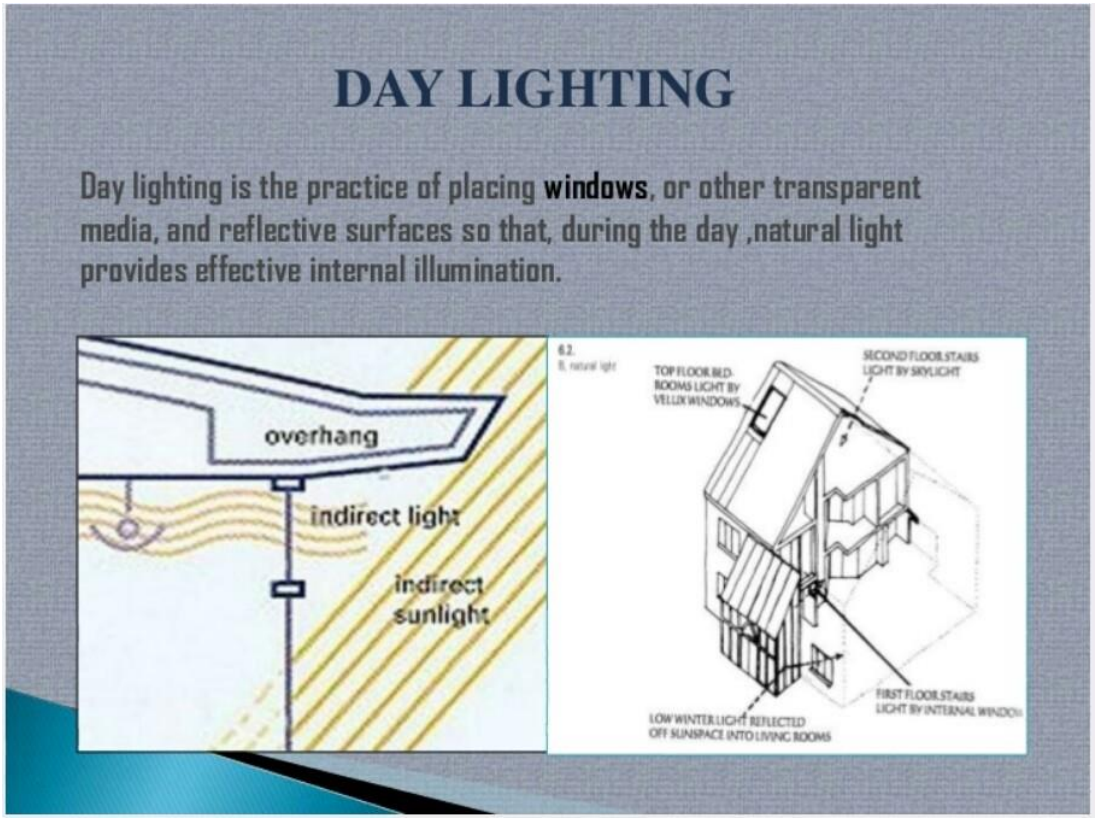
It is among Earth's coldest, harshest biomes. The ecosystems of this climatic region are treeless regions found in the Arctic and on the tops of mountains, where the climate is cold and windy and rainfall is scant. The lands of this region are snow-covered for much of the year, until summer brings a burst of wildflowers.

8. The Tropical Monsoon and Tropical marine Climate

It is also known as a tropical wet climate or trade-wind littoral climate. It is a tropical climate that is primarily influenced by the ocean. It is usually experienced by islands and coastal areas 10° to 20° north and south of the equator. There are two main seasons in a tropical marine climate: the wet season and the dry season. The annual rainfall is 1000 to over 1500 mm (39 to 59 inches). The temperature ranges from 20 °C to 35 °C (68 ° to 95 °F). The trade winds blow

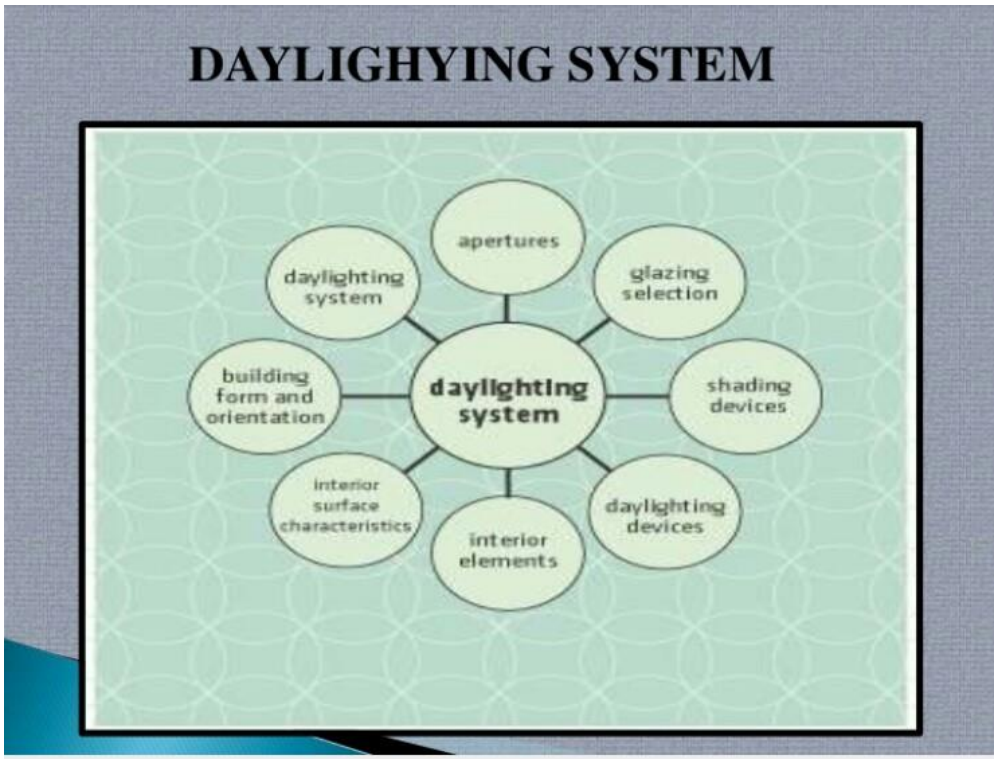
all year round and are moist, as they pass over warm seas. These climatic conditions are found, for example, across the Caribbean; the eastern coasts of Brazil, Madagascar and Queensland; and many islands in tropical waters.





Orientation of building design:-

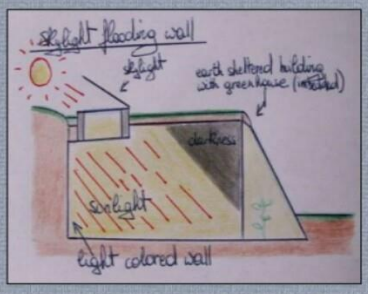
The orientation of the larger face of the building towards north south direction is considered to be the best as it avoids the deeply penetrating rays of east and west. It avoids heating up of the larger side at evening time maintaining temperature balance.

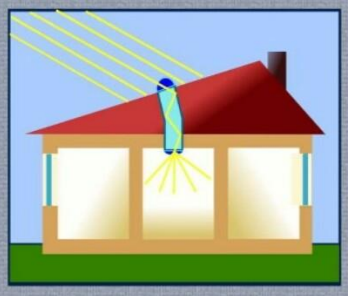


Windows :- windows ar the most common way to admit daylight into a space. Their vertical orientation means that they selectively admit sunlight and diffuse daylight at different times of the day and year.

- ✓ Place window close to a light coloured wall.
- ✓ Slant the sides of window opening so that inner opening is larger than the outer opening.
- ✓ Use a large light coloured window sill to project light into the room.

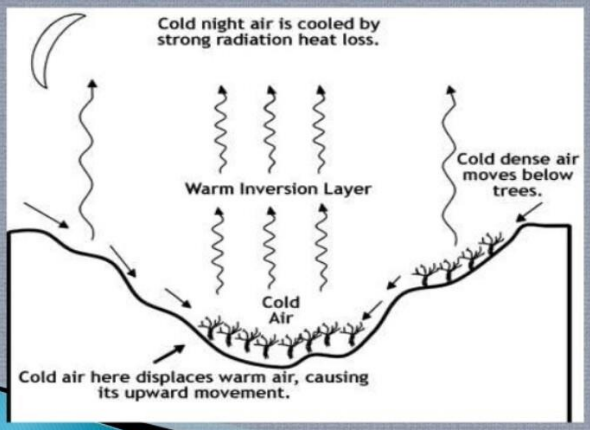
Skylights are often used for daylighting. They are horizontal windows placed at the roof of buildings. FIG.1





Light tubes also called solar tubes, placed into a roof and admitting light to a focused area of the interior. These somewhat resemble recessed light fixtures in the ceiling. FIG.2

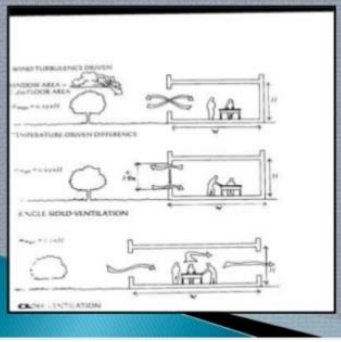
WIND AND BUILDING DESIGN

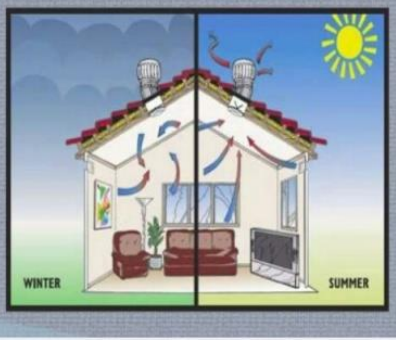


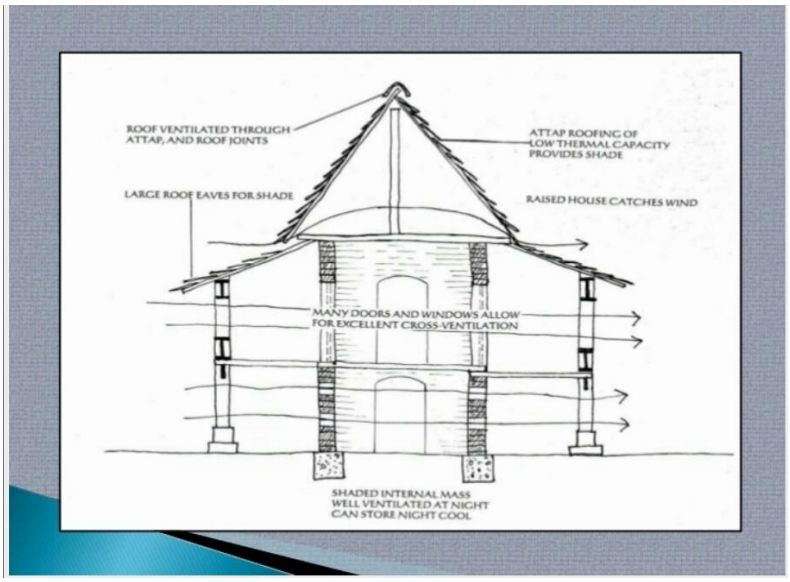
VENTILATION

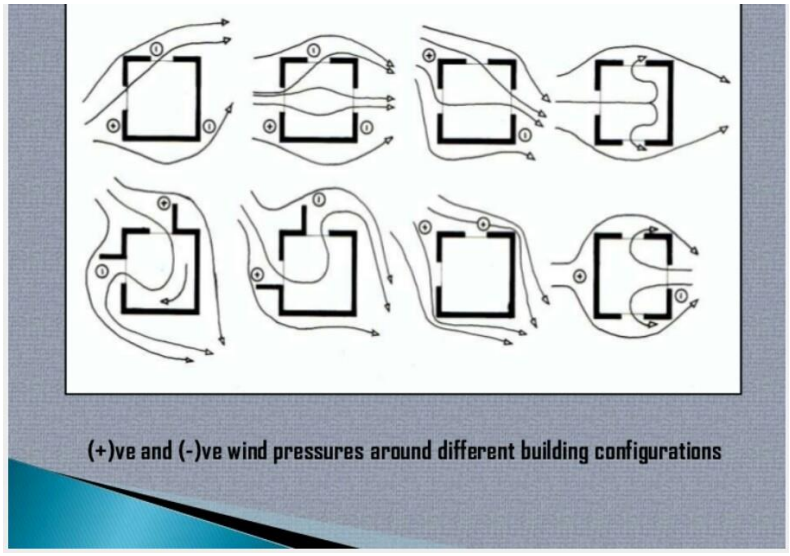
Ventilation is the movement of air within a building and between the building and the outdoors.

Control of ventilation is most subtle yet important concerns in building design.

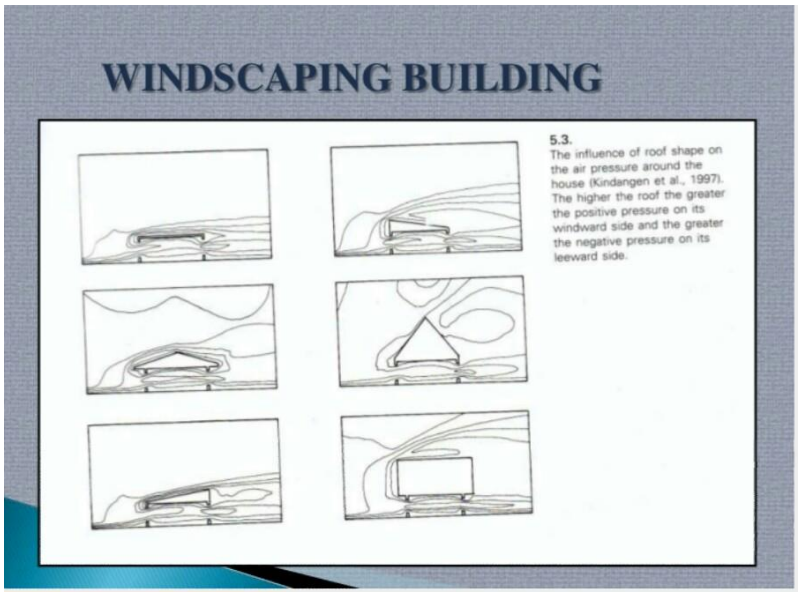








(+)ve and (-)ve wind pressures around different building configurations



Humidity and building design:-

Moisture can be a liability if it comes in the form of humidity, causing such stickiness that one cannot evaporative cool(cooling by perspiring) in summer.

Strategies to reduce the discomfort of high humidity:-

- ✓ **Maximizing ventilation.**
- ✓ **Inducing air flow around facilities.**
- ✓ **Venting or moving moisture-producing functions such as kitchens and shower rooms to outside areas.**
- ✓ **Nature can be an asset by evaporating in hot, dry climates to cool and humidify the air (a natural air conditions)**
- ✓ **Techniques for evaporative cooling include placing facilities where breezes will pass over water features before reaching the facility and providing fountains ,pools and plants.**

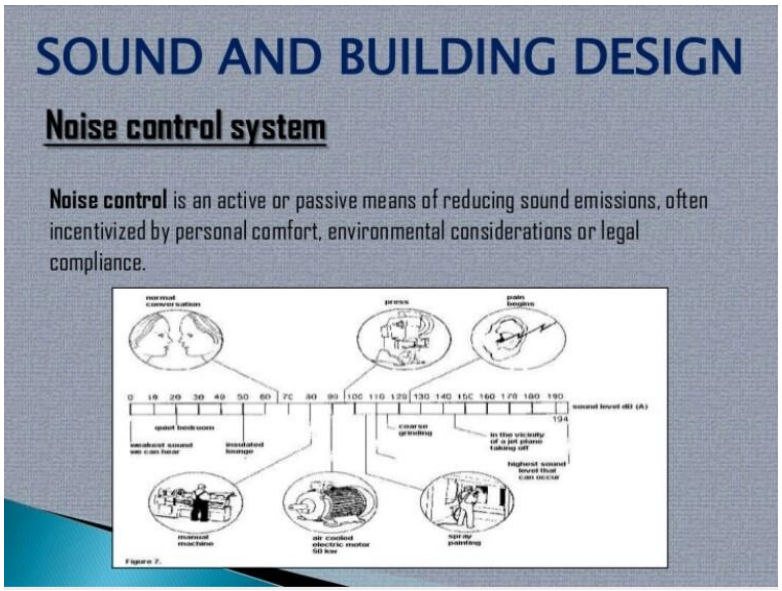
Other climatic considerations:-

Rainfall can be a liability if any concentrated runoff from developed surfaces is not managed to avoid erosion.

Rainfall can be an asset if it is collected off roofs for use as drinking water.

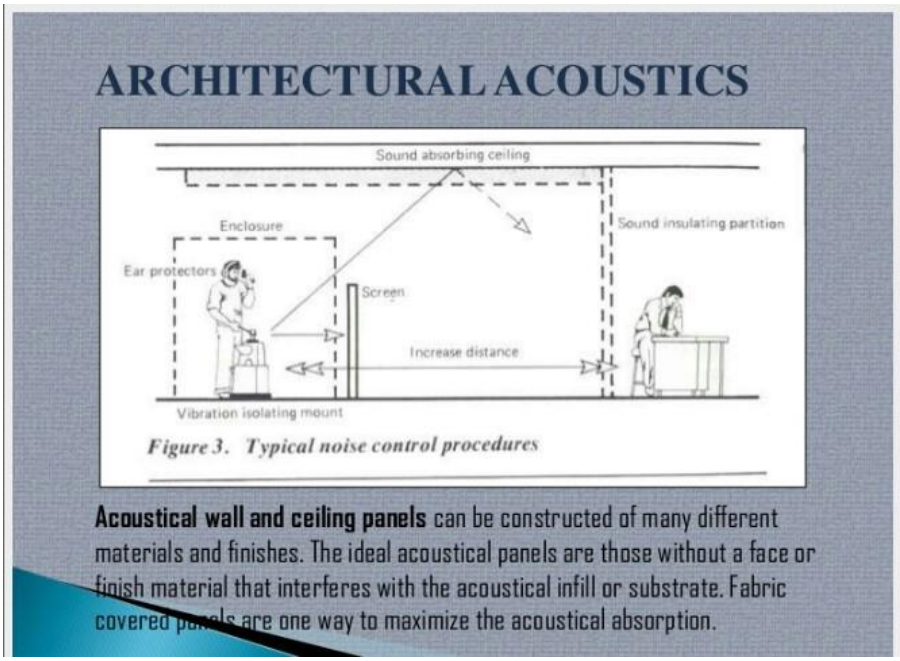
For storms/hurricanes/monsoons/typhoons:-

1. Provide or make arrangements for emergency storm shelters.
2. Avoid devilment in flood plain and storm surge areas.
3. Consider wind effects on walls and roofs
4. Provide storm shutters for openings.
5. Use appropriate wind bracing and tie-downs.
6. Design facilities to be light enough and of readily available and renewable materials to be safely sacrificial to large storms, or of sufficient mass and details to prevent loss of life and material.



Four basic principles of noise control:-

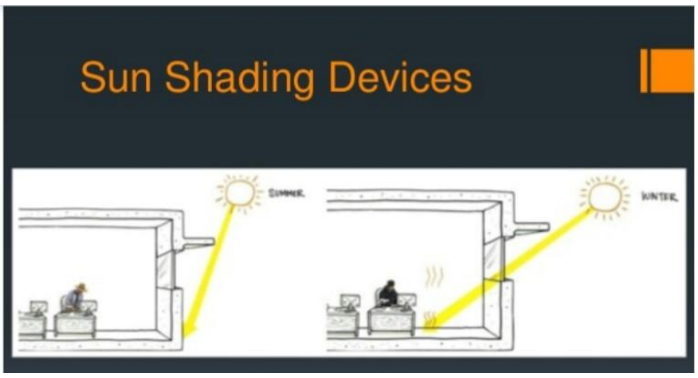
- **Sound insulation**: prevent the transmission of noise by the introduction of mass barriers. Common material has high-density properties such a brick concrete, metal etc.
- **Sound absorption**: a porous material which acts as a noise sponge by converting the sound energy into heat within the material. Common sound absorption materials include open cell foams and fibreglass.
- **Vibration isolation**: - prevents transmission of vibration energy from a source to a receiver by introducing a flexible element of a physical break. Common vibration isolators are springs, rubber mounts, cork etc.



2. Climatic control in building

Introduction:-

- Sun shading devices inhibit the solar radiation (Block, allow, etc) incident on a building and are used either internally of externally or in between the internal and the external building space.
- They can be any mechanical equipment (like dynamic facades), projection (challa), cantilevers, louvers, fins, jaalis, or even textiles.
- They can be fixed, manual and automatic moveable
- The primary objective of creating a comfortable internal environment, that is , cool in the summer and warm in the winter.



Importance of sun shading devices:-

- Solar radiation is an important factor of thermal comfort. Sun shading devices improve internal environment I order to provide greater comfort for occupants.
- To reduce the heat gains during summer and promote heat gain during winter, reduce the HVAC loads and therefore minimize energy costs. Use of shading device can improve building energy performance.
- To prevent glare (causing discomfort or disability of vision)
- To increase useful daylight availability.
- To create a sense of security-internal sun shading devices like curtain help to beautify internal space and create a sense of privacy,

Use of shading:-

- Solar controls should be considered for all glazed opening exposed to direct sunlight.
- Solar control is particularly important on south to west facing facades since the solar gains will coincide with the hottest part of the day.
- Solar control is also vital for lightweight buildings with large areas of glazing.

Constraints of shading devices:-

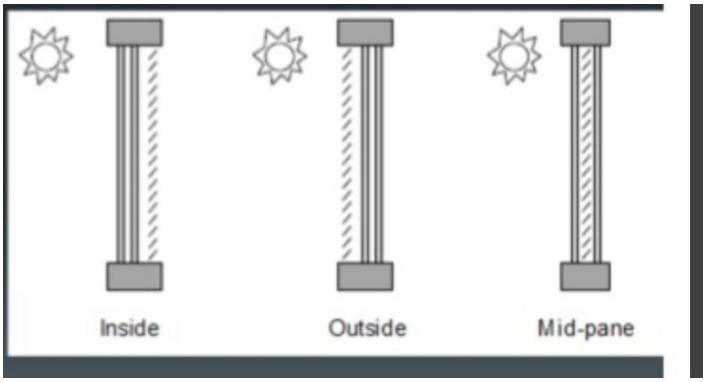
- Sun path and wind direction are usually different. Maintenance of air flow through the non-sir conditioned buildings during the cooler hours of the day.
- There will be a need for admitting controlled levels of diffused day light.
- In most cases there will be a requirement of views out of the window.

Solar shading

- When sunlight hits a pane of glass, is splits in to three components –
  - Reflected:-no effect on heating
  - Absorbed:-glass heats up which would transfer heat by conduction and also emits heat (
  - Transmitted: - Heat up surface behind it.
    The proportion between the three components is determined by the angle of incidence and by the type of glazing.
    For most types of glazing the transmitted components is very small if the angle of incidence is larger than 45'from the normal to the glazing.
    If the angle is more than 60', most of the radiation is reflected.

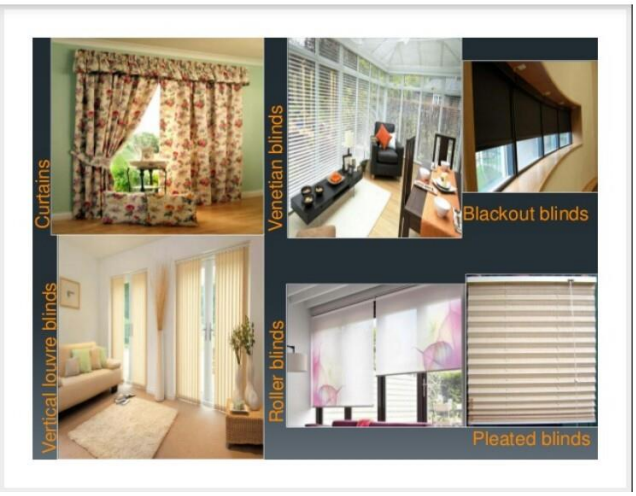
Types of sun shading devices

- On the basis of their position in a building Internal/External/Interpane.



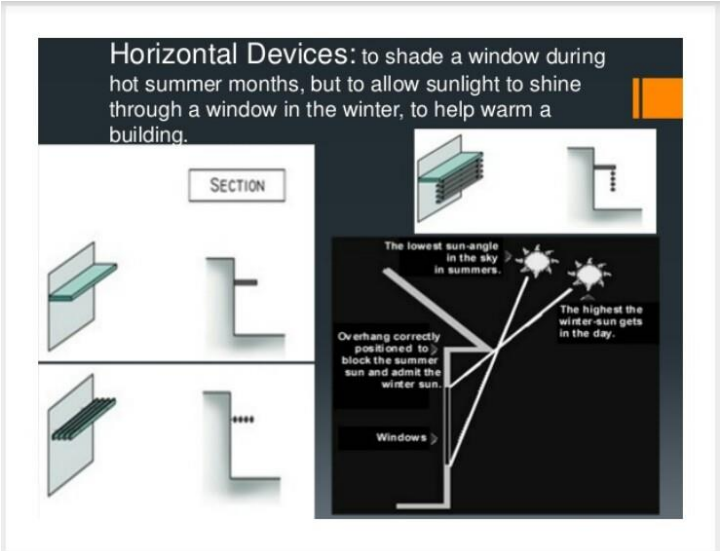
Internal sun shading devices:-

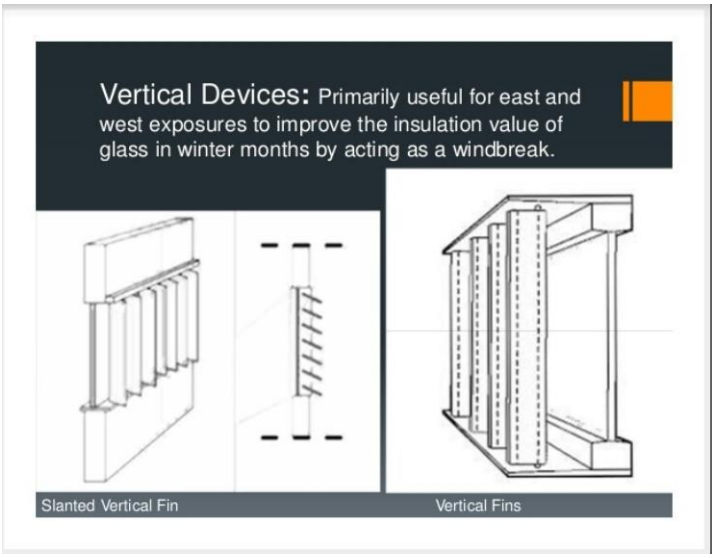
- Limit the glare resulting from solar radiation
- Usually these are adjustable and allow occupants to regulate the amount of direct light entering their space.

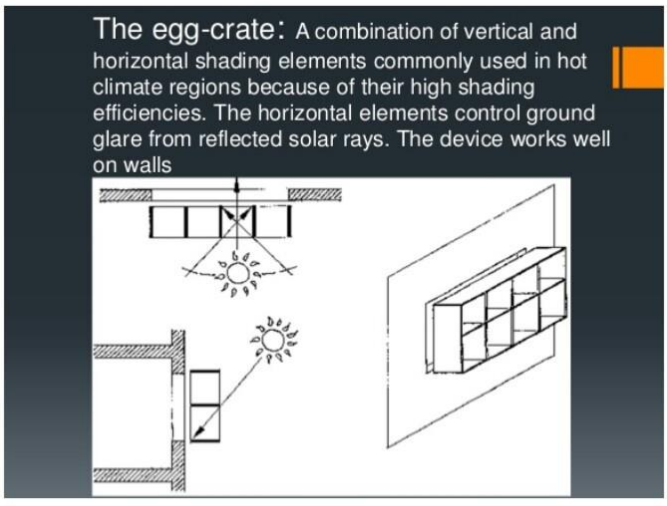


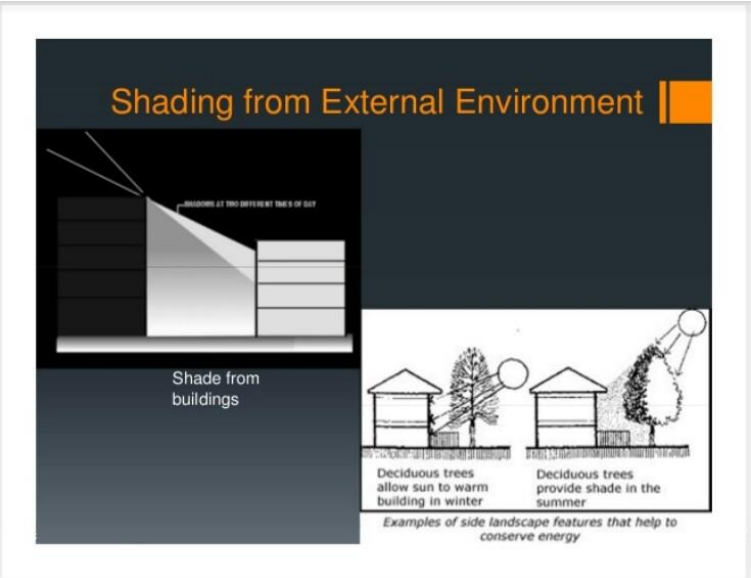
External sun shading devices:-

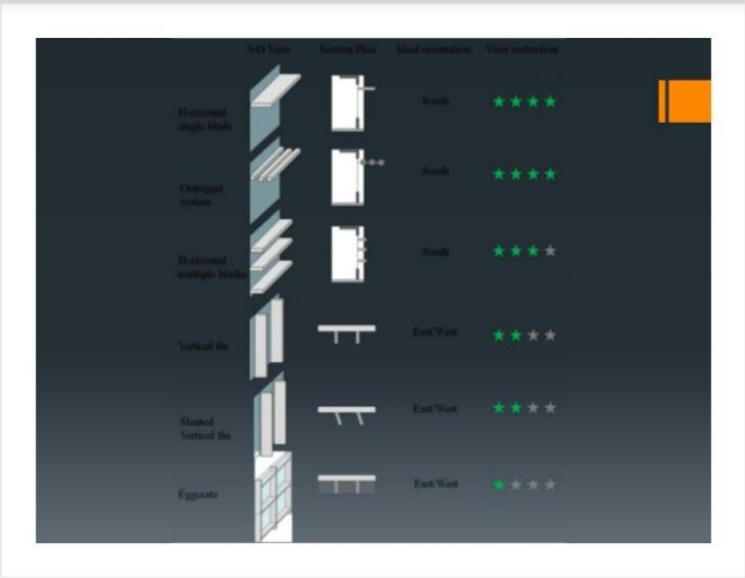
- Most thermally efficient as it controls the amount of radiation entering the building externally.
- Horizontal, vertical or egg crate devices
- Vegetation and other buildings can also act as shading devices.

- 
Horizontal Devices: to shade a window during hot summer months, but to allow sunlight to shine through a window in the winter, to help warm a building.
SECTION
The lowest sun-angle in the sky in summers.
The highest the winter-sun gets in the day.
Overhang correctly positioned to block the summer sun and admit the winter sun.
Windows

- 
Vertical Devices: Primarily useful for east and west exposures to improve the insulation value of glass in winter months by acting as a windbreak.
Slanted Vertical Fin
Vertical Fins

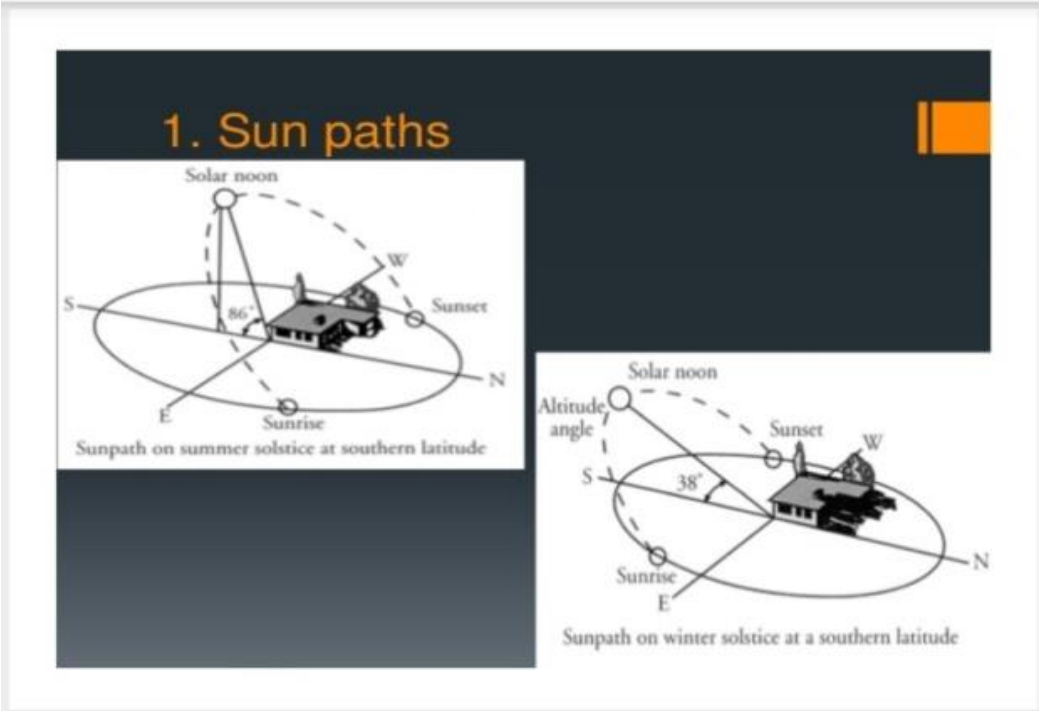
- 
The egg-crate: A combination of vertical and horizontal shading elements commonly used in hot climate regions because of their high shading efficiencies. The horizontal elements control ground glare from reflected solar rays. The device works well on walls

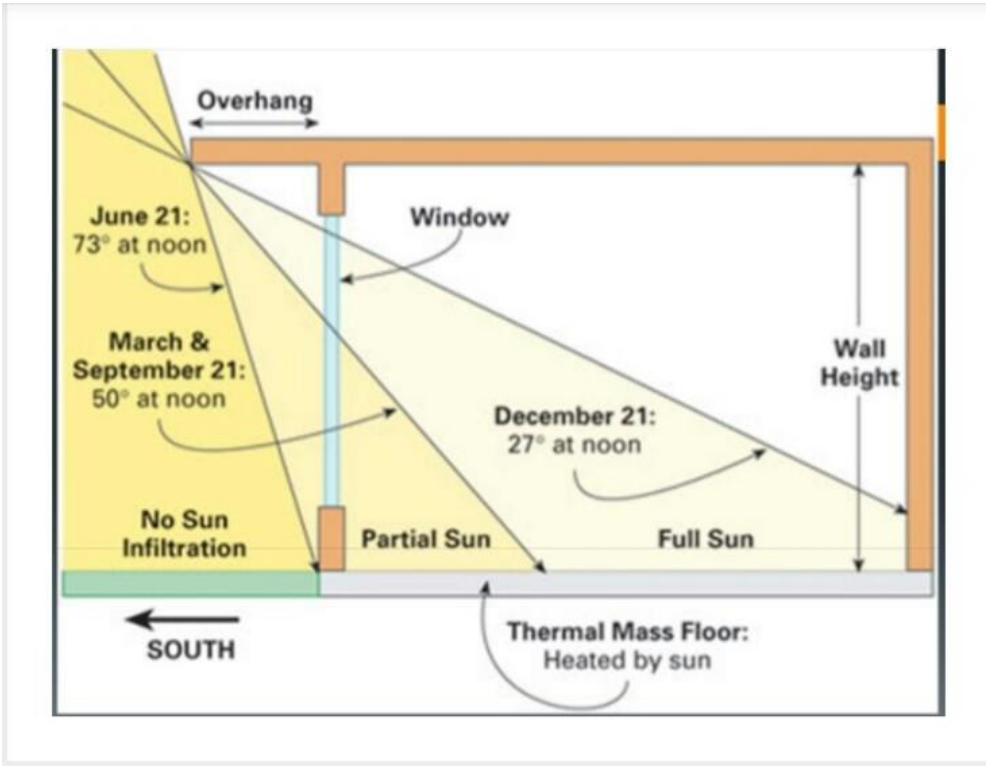




Designing shading device:-

1. Understand the path of the place.
2. Select shading type.
    a. Horizontal
    b. Vertical
    c. Egg crate
3. Identify category
    a. Fixed
    b. Adjustable
4. Calculate design dimensions
    a. Understand horizontal and vertical shadow angles.


1. Sun paths
Solar noon
W
S
86°
Sunset
N
E
Sunrise
Sunpath on summer solstice at southern latitude
Solar noon
Altitude angle
Sunset
W
S
38°
N
Sunrise
E
Sunpath on winter solstice at a southern latitude


Overhang
June 21:
73° at noon
Window
March &
September 21:
50° at noon
Wall
Height
December 21:
27° at noon
No Sun
Infiltration
Partial Sun
Full Sun
SOUTH
Thermal Mass Floor:
Heated by sun

2. & 3. Select Shading Type & Category

Orientation	Suggested Shading Type
North	fixed or adjustable shading placed horizontally above window
East and West	adjustable vertical screens outside window
NE and NW	adjustable shading
SE and SW	planting

Climatic zones	Requirements
Hot and dry	Complete one year round shading
Warm and humid	Complete year round shading , but design should be made such that ventilation is not affected
Temperature	Complete year round shading but only during major sunshine hours
Cold and cloudy	No shading
Cold and sunny	Shading during summer months only
Composite	Shading during summer months only

Shading from External Environment

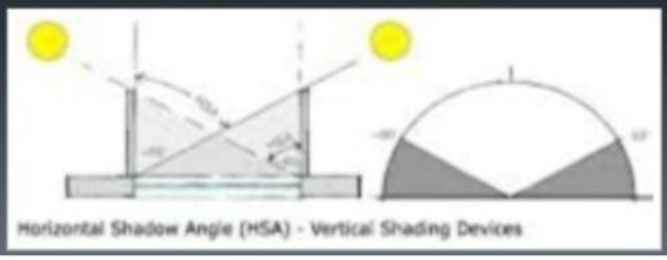
- Shadow angles are formed by sun shading devices or projections on a wall exposed to the sun.
- Different design of sun shading devices form different shadow angles.
- The performance of shading device is specified by two angles :
  - Horizontal shadow angle
  - Vertical shadow angle
- These angles depend on the position of the sun and the orientation where the window is facing.

Horizontal shadow angle

The ***horizontal shadow angle (HSA)*** is required for (or cast by) *vertical shading devices*.

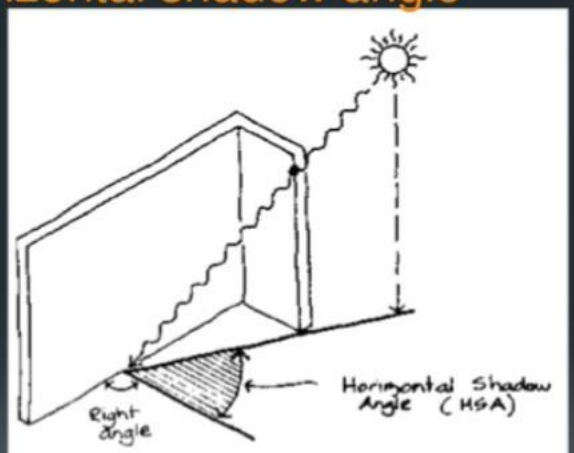
It is the horizontal angle between the normal of the window pane and the azimuth of the sun.

HSA = wall azimuth – solar azimuth

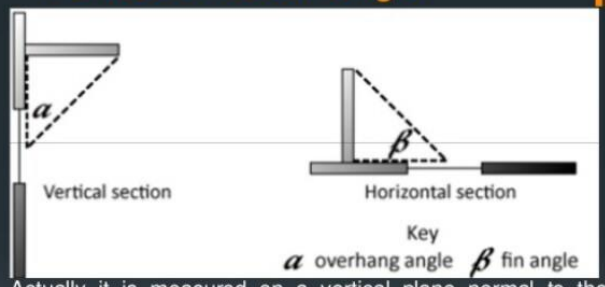


Horizontal Shadow Angle (HSA) - Vertical Shading Devices

Horizontal shadow angle



Vertical shadow angle

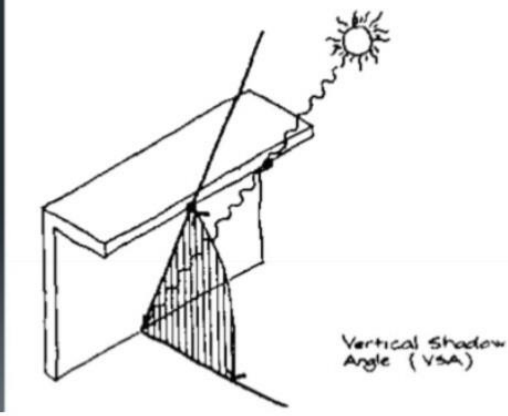


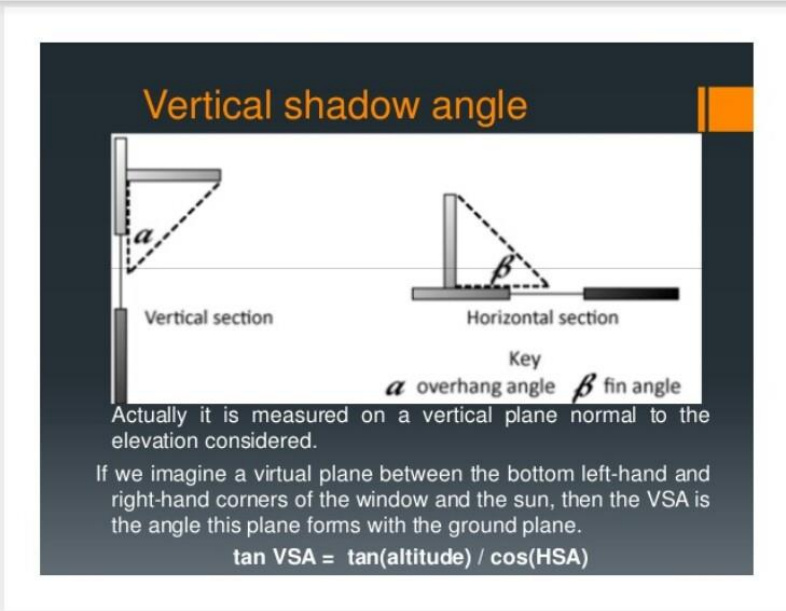
Actually it is measured on a vertical plane normal to the elevation considered.

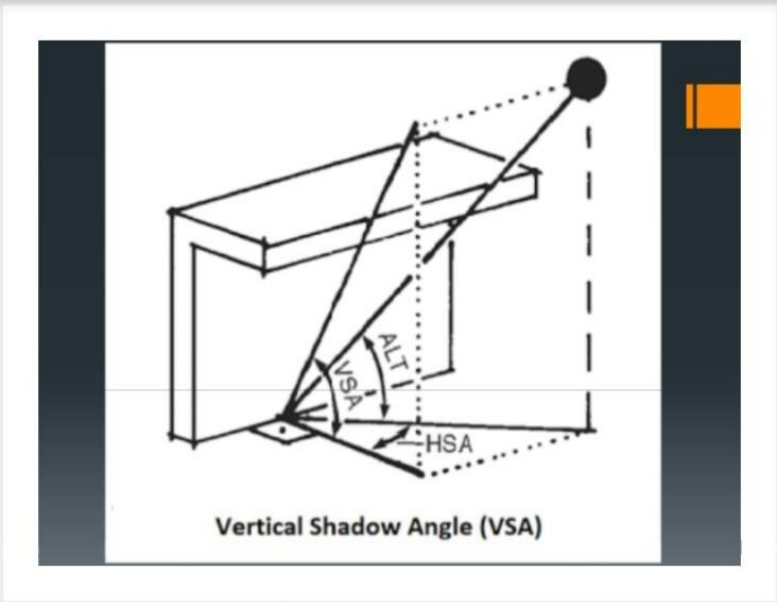
If we imagine a virtual plane between the bottom left-hand and right-hand corners of the window and the sun, then the VSA is the angle this plane forms with the ground plane.

tan VSA = tan(altitude) / cos(HSA)

Vertical shadow angle







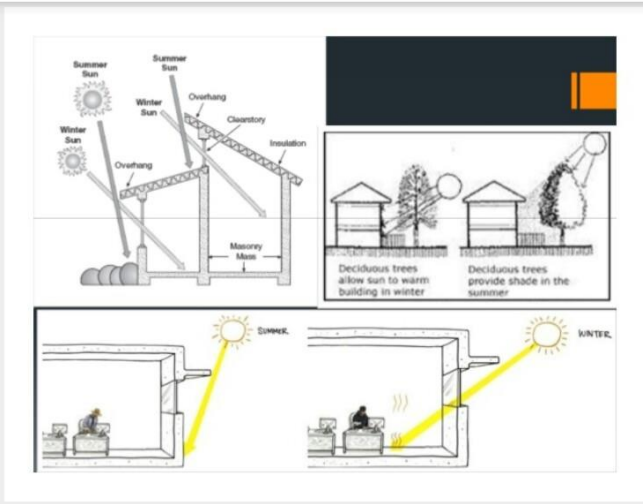
Solar altitude angle & VSA:-

- Solar altitude angle describe sun's position in relation to the horizon, while VSA describes the performance of the shading device.
- Numerically the two coincide when, the sun is exactly opposite the wall considered i.e. when solar azimuth and wall azimuth angle are same and HAS=0.
- For all other cases, when the sun is sideways from the perpendicular, the VSA is always larger than the solar altitude angle.

Shade Dimensions:-

- These two angles, HAS and VSA, can then be used to determine the size of the shading device required for a window.
- If the height value refers to the vertical distance between the shade and the window still, then the depth of the shade and its width from each side of the window can be determined using relatively simple trigonometry.

- Shade Depth : The depth is given by
  - Depth=height/tan(VSA)
- Shade width: The width is given by
  - Width=depth x tan(HSA)



Disadvantages of Sun Shading Devices:-

- Difficulties can be experienced in handling the internal shading devices like curtains and blinds.
- In the use of shading devices like light shelves problems with low angle winter sunlight penetration can give rise to glare.
- If the building is highly stylized (eg Neoclassical or glass cube)it may be impossible to reconcile external shading with the original style.
- Shading always blocks a part of the view. As a minimum it blocks the portion of the sky where the sun travels.
- Some shading methods are extremely specific to compass orientation (Azimuth). For example fixed horizontal shading may leak sunlight in to the building during the morning or afternoon.

3. Introduction to landscape design

Defining Public Open Space and Green Space Varying definitions of Public Open Space (POS) are used across all levels of government and academic literature and multiple definitions, spatial units and data sets have been found to influence area-based POS calculations. One of the greatest complexities is the lack of consensus on the separation between POS and green space, or the use of clearly defined constructs in the literature. There is considerable overlap between the two constructs as described in Figure 1. Figure 1: The overlapping constructs of Public Open Space and Green Space. POS describes vegetated and non-vegetated land freely available to the public within the urban landscape. Vegetated areas include parks, many streetscapes, public gardens, playgrounds, sporting grounds, rivers, lakes, wetlands, conservation areas, some civic squares, community and some rooftop gardens in the public realm.

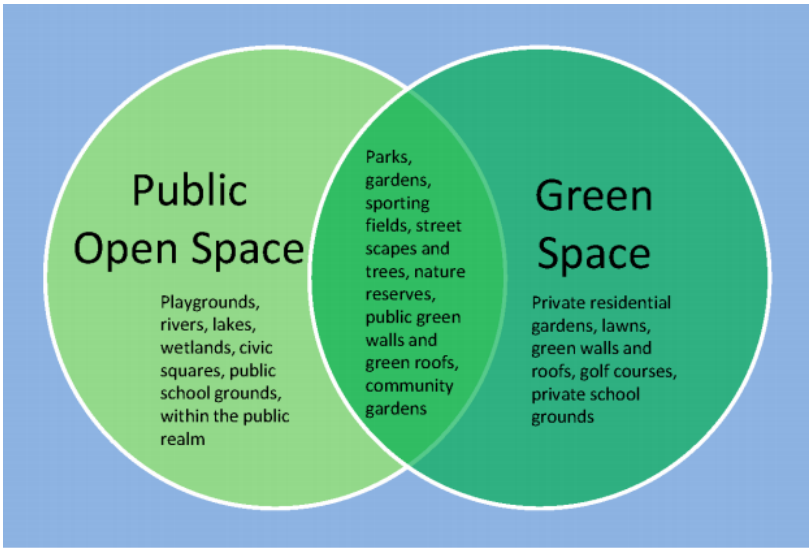


Figure 1: The overlapping constructs of Public Open Space and Green Space.

The variety of spaces included within POS means that it often includes both a mixture of hard (i.e. impervious) and soft (permeable) landscape surfaces. 3 Green space is a broader but overlapping concept to POS because it is not solely dependent on public access or public management and is defined as both public and private spaces with predominantly soft permeable surfaces such as soil, grass, shrubs and trees. Green space includes all public and private urban vegetated areas including parks, sporting grounds, private gardens, treed streetscapes, remnant native vegetation, golf courses, green roofs, and green walls.

A **park** is an area of natural, semi-natural or planted space set aside for human enjoyment and recreation or for the protection of wildlife or natural habitats. Urban parks are green spaces set aside for recreation inside towns and cities. National parks and country parks are green spaces used for recreation in the countryside. State parks and provincial parks are administered by sub-national government states and agencies. Parks may consist of grassy areas, rocks, soil and trees, but may also contain buildings and other artifacts such as

monuments, fountains or playground structures. Many parks have fields for playing sports such as baseball and football, and paved areas for games such as basketball. Many parks have trails for walking, biking and other activities. Some parks are built adjacent to bodies of water or watercourses and may comprise a beach or boat dock area. Urban parks often have benches for sitting and may contain picnic tables and barbecue grills.

The largest parks can be vast natural areas of hundreds of thousands of square kilometers (or square miles), with abundant wildlife and natural features such as mountains and rivers. In many large parks, camping in tents is allowed with a permit. Many natural parks are protected by law, and users may have to follow restrictions (e.g. rules against open fires or bringing in glass bottles). Large national and sub-national parks are typically overseen by a park ranger. Large parks may have areas for canoeing and hiking in the warmer months and, in some northern hemisphere countries, cross-country skiing and snowshoeing in colder months. There are also amusement parks which have live shows, fairground rides, refreshments, and games of chance or skill.

Factors That Affect Landscaping Design

It's hard to know where to start with **landscaping design**. Selecting the right plants, trees, and shrubs will maximize your budget and extend the life of your garden — but how do you know what to choose? If you're located near Lincoln, NE, call the experts at **Landmark Landscapes** for a consultation. Otherwise, consider these five elements that affect your landscape design.

Climate & Soil Type

The **USDA Plant Hardiness Map** is a great tool to discover which plants, trees, and shrubs will thrive in your climate. The drainage, richness, texture, and pH level of the soil in your yard determine what types of plants will thrive there and what kind of watering systems you'll need to put in place.

Budget

Professional landscapers recommend spending about 10% of the value of your home on landscaping to preserve or increase the property's worth. If your budget doesn't allow for this amount, try working with a landscaping consultant to plan the most effective way to use your funds. This can prevent bad decisions that lead to further costs down the road.

Time Of Year

If you live in a rainy or snowy climate, it's a great idea to start planning your landscaping design in the winter months. This will give you ample time to plan and save for the coming spring, when the ground temperatures warm and become receptive to new plants.

1.1 Size Of The Space

Whether you're working with an acre or a 10-foot square patch, there are endless landscaping designs to take **inspiration** from. Rolling green lawns, stone fountains, garden beds, container plants, water features, and fire pits are all beautiful elements to consider.

1.2 Your Needs

Do you enjoy taking care of plants that need seasonal care? Are there pets on the property that might cause damage to delicate species? Will the space be used by children, for hosting parties, or growing herbs and vegetables for the household? Keep all of these factors in mind as you design your landscape.

4. Principles of landscape design

PRINCIPLE OF DESIGN

The principles of design serve as guidelines that govern the organization of the design elements and materials in accordance with the laws of nature.

- The design elements are the tools a designer uses to accomplish the design principles in a project.
- Definitions and understanding differ from one person to another.

IMPORTANCE OF LANDCAPE DESIGN

- Landscape designers use these principles of design to create landscape designs that are both functional and aesthetically pleasing.

Outdoor Rooms

- Creating "Rooms" throughout the Landscape.
- Provides a welcoming atmosphere
- Encourages movement
- Defines special use areas
- Allows for family privacy
- Public area-"front yard"
- Family Iiving area- "back yard"
- Service Area utilitarian space

•Private living Area frequently a quiet spot located off the Master Bedroom

Public Area

Puts home in at tractive setting Identifies the point of entry Provides access to the entry.

Family Living Area

Links homes to yard for social occasions Usually the largest areas where most activities take place Sun and wind orientation for maximum usage

Thoughtful design created for individual families results in:-

- Greater use of entire home space
- A personalized statement of family values

- Improvement and increased home value

PRINCIPLE OF LANDSCAPE DESIGN

- Focalization
- Proportion And Scale
- Balance
- Order And Unity
- Repetition
- Rhythm And Sequence
- Interconnection

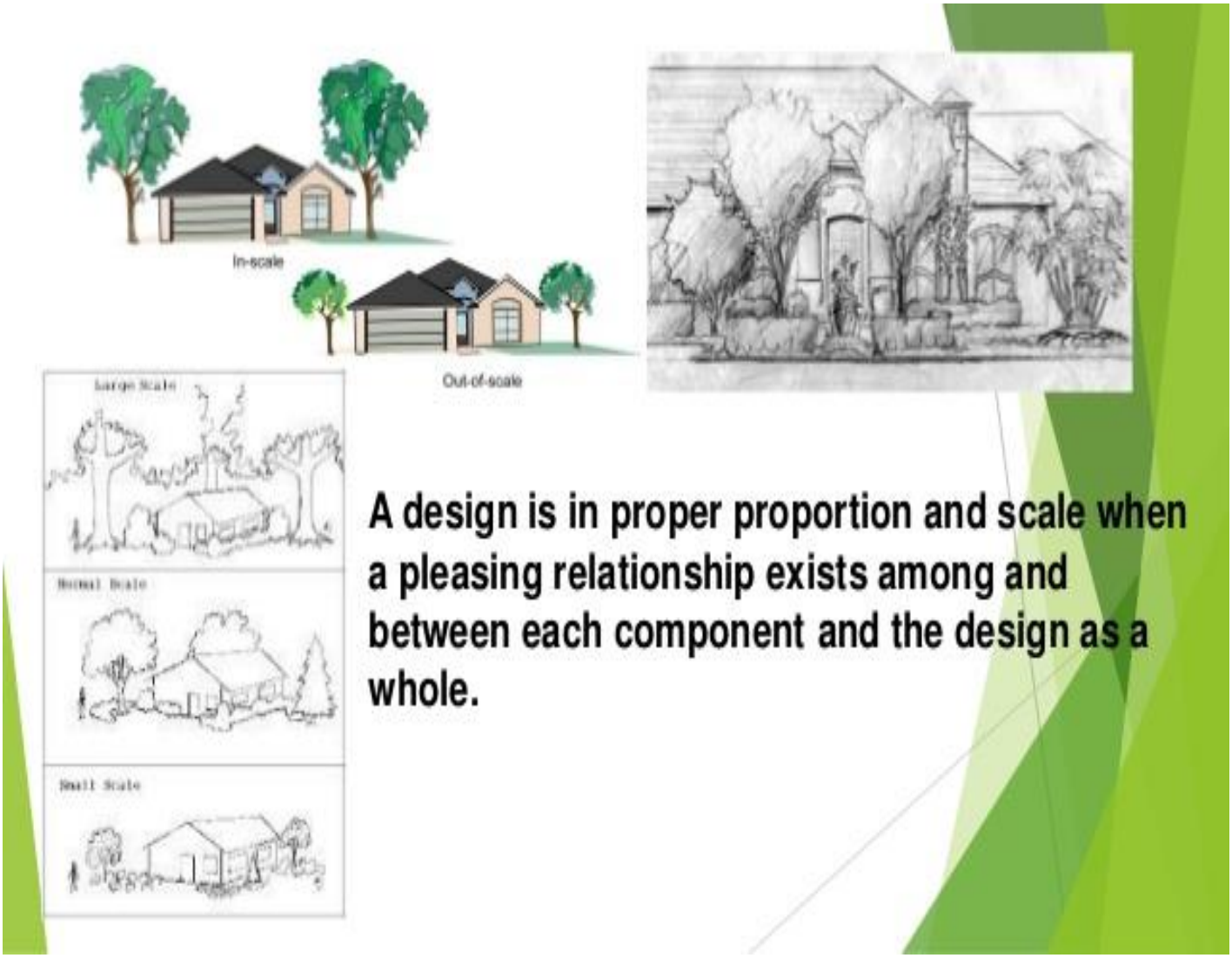
Focalization

Focalization is created as a visual break in the sequence and flow of the landscape. The focal point is the point or area of the landscape that attracts the viewer's eyes. I The visual break captures the attention of the viewer and draws it to the focal point. Without a point or area on which to focus, the viewer 's eyes become lost and confused throughout the landscape.

As a designer, create an accent or focal point that is strong and effective. Do not incorporate too many focal points into the landscape. Otherwise, their effect will be lost. Use the design elements (line, form, texture, and color) to move the viewer’s eyes through the landscape to the place of the focal point.

Proportion And Scale

- Proportion is the relationship that exists among the components of a landscape. It also describes the relationship between the components of the landscape and the landscape as a hole.
- Proportion involves the size relationships between and among the components making up the landscape.
- Proportion describes the mathematical relationships among the dimensions of space and site components making up an area.
- These mathematical relationships are totally separate from human perception dimension sense, proportion is similar to a ratio. For example, comer plantings next to a house that are two -thirds the distance from the ground to the eave are proportional to the house. The height of the comer plantings is proportional to the height of the eave.
- Scale is the human perception of the size of space and form related to the human dimension Scale is relative to the perception of the viewer. For a large two-story house, comer plantings that are proportional to the house may appear out of scale to the viewer.



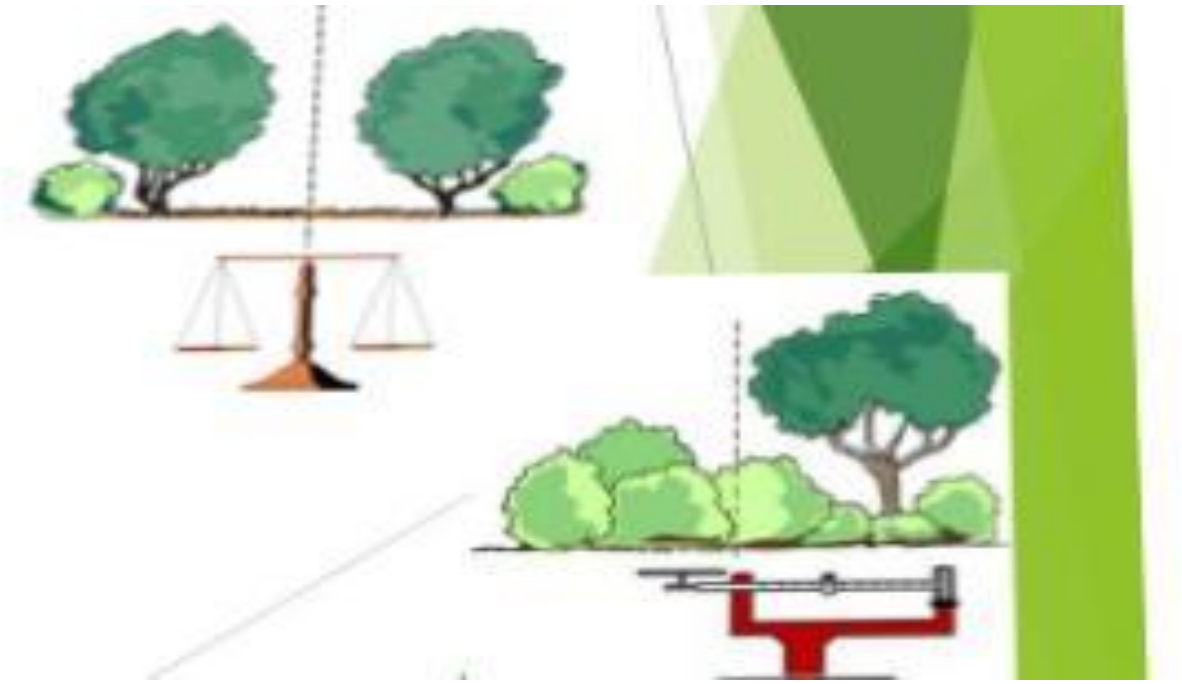
Balance

- Balance is a design principle defined in terms of weight.
- It is the equalization of visual weight from one area of a landscape composition to another.
- Two distinctly different types of balance exist in landscape design:
    - SYMMETRICAL BALANCE
    - ASYMMETRICAL BALANCE

SYMMETRICAL BALANCE

- Symmetrical balance is a symmetry.
- Symmetrical balance is recognizable in that an exact sameness occurs on either side of the composition.
- The same components are repeated on both sides of the composition. If a line (center axis) were drawn through the middle of the form or space, each side would be identical.

- The visual and actual weight is equally distributed on each side.



Balance

Symmetrical

ASYMMETRICAL BALANCE

- Asymmetrically balanced landscape compares to a level balance scale.Both sides of the

scale are level with the exact same weights on each plate.

- Asymmetrical balance is an informal balance. If does not repeat the same plant material in the same quantity or in the same relative position on either side of the center axis.
- An asymmetrically balanced design implies equal weights on either side of the center axis However, it does not have the "sameness" on each side.
- An asymmetrically balanced land scape compares to a level candy scale. Imbalance in a landscape is not desirable.

Order And Unity

- Order and unity are emotional and visual reactions to the overall structure and organization of the design elements.
- The designer blends the design elements and the design detail decisions of materials with the existing site conditions to establish order and unity.
- The concept created by order and unity is carried out throughout the design.
- Order is the overall organization and structure of a design. It is the basic scheme or "skeleton" of the design.
- Order is created and carried out through the composition. Examples of order in a design may be symmetrical versus asymmetrical balance or a formal versus naturalistic arrangement.
- Unity is the harmonious relationship among all elements and characteristics of a design.
- A unified design is homogeneous and congruous. A design lacking unity appears disorderly and haphazard.
- Too many components and materials and the complex use of the elements create competitiveness and a lack of integration within a design.

- To establish unity in a design, stay simple and minimize differences.
- Always remember to simplify diversity and reduce the number of differences between the components in the landscape.

Repetition

- Repetition involves repeating or using an element more than once throughout a design.
- It helps establish and add order and unity to a design.
- Repetition provides a common feature throughout the design that pulls the design together.

Rhythm And Sequence

- Rhythm and sequence describe the dynamic unity or the related, orderly movement that implies continuity.
- They are the apparent flow of lines, textures. and colors that express a feeling of motion rather than confusion.
- Order and repetition help establish rhythm and sequence in a design. Rhythm and sequence characterize continuity and connection from one part of the design to another part.
- They group the components together, drawing the design together. This keeps the viewers eyes busy and allows them follow easier through the design.
- Rhythm and sequence lead the viewer's eyes easily and smoothly along a deliberate, dominant, and visual path.
- The viewer's eyes move back and forth with a feeling of smooth motion between the components of the site and the focal point.
- As a designer, accomplish rhythm and sequence in a design by repeating one or more

of the elements such as line (creating a pattern), form, texture, and color. In addition, build on the other design principles to create rhythm and sequence in a design.

Interconnection

- Interconnection is a design principle for producing unity in the design.
- Various components in the design are physically linked together.

- Repetition helps in establishing interconnection.
- A designer may incorporate inter connection into the entire design or into only a small space within the design.

SUMMARY/ CONCLUSION

- Every design a designer creates is unique. However, the elements and principles of design are probably included in each design. Use the design elements of line, form, texture, and color as guidelines in design development.
- In addition, consider the principles of focalization, proportion and scale, balance, order and unity, repetition, rhythm and sequence, and interconnection.

Different landscape style and historic landscape

Styles of Gardens

- • Formal
- • Informal
- • Free
- • Wild

Features of a formal gardens

- • First plan is made on paper and then land is selected accordingly
- • Land is leveled
- • Symmetrical design

- • Geometrical: Square, rectangular, circular beds and borders
- • Roads and paths cut at right angle
- • Balance is symmetrical as same feature replicated on both sides of central axis
- • Hedges, edges and topiary are trimmed
- • Trees can be selected as individual feature
- • Mughal, Persian, Italian, French and American gardens

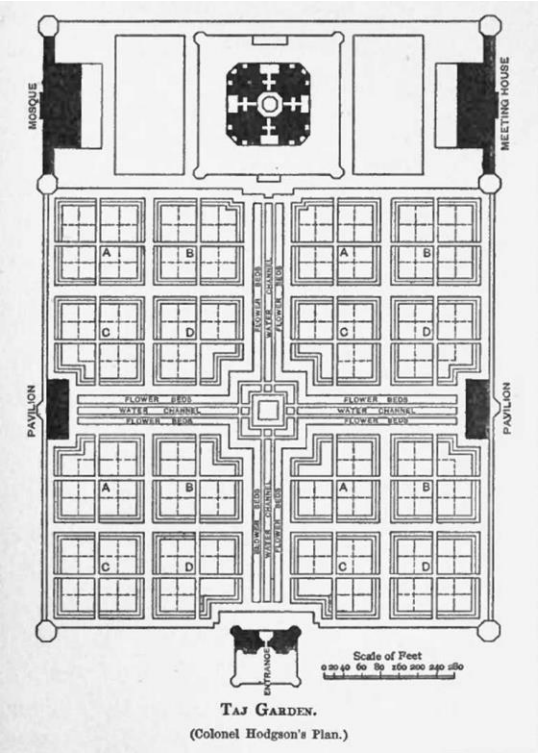
Features of informal gardens

- • Plan is forced to fit the land
- • Main aim is to capture natural scenery
- • Land is not leveled
- • Asymmetrical design
- • Non-geometrical beds and borders
- • Untrimmed hedges, edges and topiary
- • Individual plants are not selected as feature
- • Japanese, Chinese, English gardens

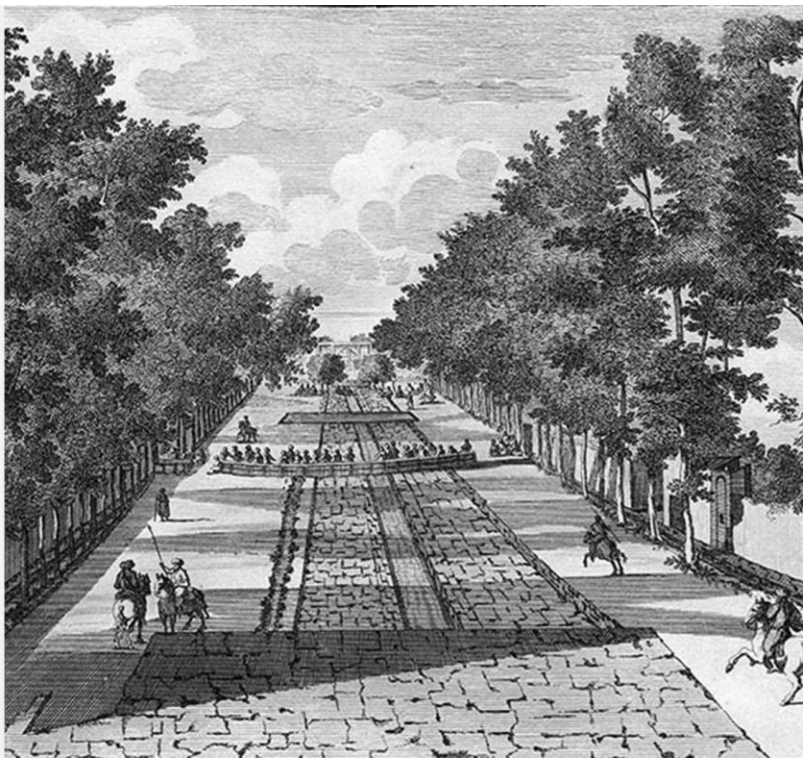
Features of Mughal gardens

- • Site near hill slope with perennial rivulet
- • Gardens enclosed with walls and fitted with tall gates
- • Garden has at least seven, eight or twelve terraces symbolizing 7 planets, 8 paradise or 12 zodiac with entrance at the lowest terrace
- • Running water in canals
- • Terminal building
- • Baradari with twelve doors three in every direction

• Symbolism and plant material



TAJ GARDEN.
(Colonel Hodgson's Plan.)



Pinjore Garden

Nishat garden, Srinagar

Shalimar garden, Srinagar

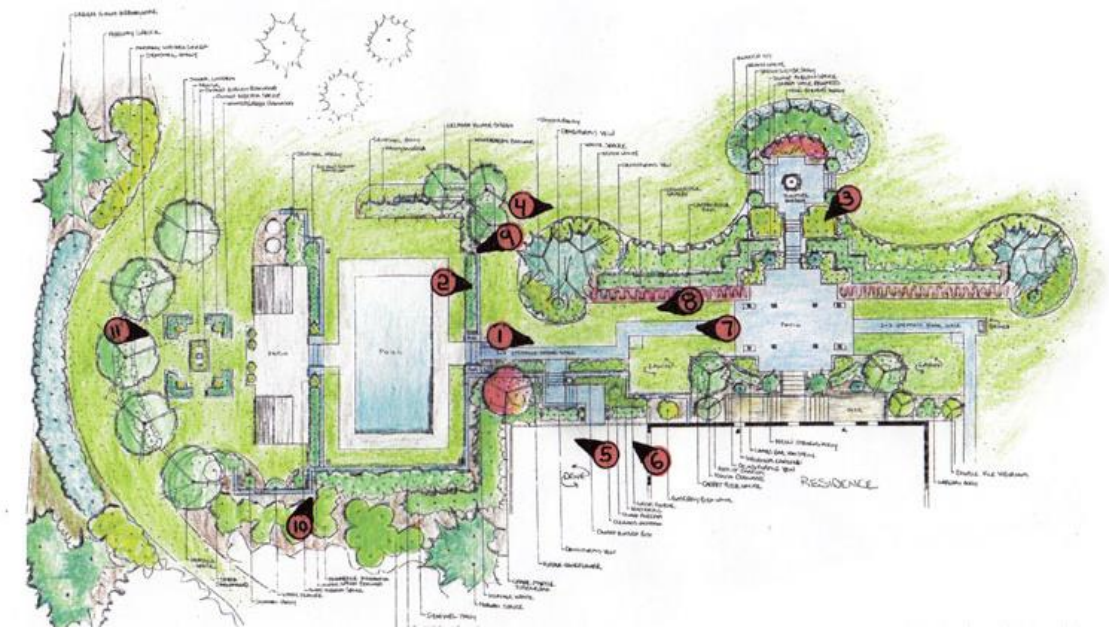
President House Garden, New Delhi

Key factors of English gardening

- • Typical grassland climate in England
- • Gardening is hobby of rich peoples
- • Englishmen were very fond of flowers

Phases of English gardening

- • Search for sustenance (1066-1500 A.D.)
- • Elizabethan period (1500-1700 A.D.)
- • Return to nature (1700 A.D. onwards)



‘Search for Sustenance’

- • Gardens attached with monasteries and
- planted with fruit trees and vegetables for
- food as utilitarian gardens
- • Roses, carnation, violets, lily, hollyhock were
- planted
- • Formal gardens and unnatural

‘Elizabethan period’

- • Hampton court was built by C. Wolsey
- • Symmetrical plan with walks planted with fruit trees
- • Queen Elizabeth introduced many exotic plants during
- (1558-1603)
- • Utility gardens were converted to liaison gardens
- • Peak of symmetry in gardens with influence of Le Notre
- • Gardens were monotonous and dull looking
- • Claude Lorrain (1600-1682) gave inspiration to many to
- develop informal gardens through landscape paintings

Essential features of English gardens

- • Lawn
- • Herbaceous border, and
- • Rockery

English gardens are in their peak

- • April: Kew, Seville, Wisley
- • May: Bodnant, Ness, Wood bridge
- • June: Chats worth, Harlowcar, York gate
- • September: Stour head, Wilton, Furry,
- Compton acres
- • October: Westonbirt, West bury, Hideote and
- Kift’s gate

Teaching of Japanese gardens

- • ‘Unless a garden has a piece of air, it is not worth place for visiting and garden should be a place where mind finds rest and relaxation

Japanese gardens

• Hill gardens

• Flat gardens

• Tea gardens

• Passage gardens

• Sand gardens

• Fancy gardens

Features of Japanese gardens

• Ornamental water: Ponds, streams, waterfalls, fountains, wells, water basins

• Islands

• Bridges

• Stone lanterns

• Stones

• Pergolas

• Fences and gates

• Plants

Plants in Japanese gardens

• Evergreen: Abies, Cryptomeria, Podocarpus, Juniperus, Magnolia, Michelia

• Deciduos: Acer, Populus, Morus, Salix, Prunus

• Shrubs: Aucuba, Azalea, Gardenia, Nandina, Camellia, Lagerstroemia, Rhododendron, Rosa

• Climbers: Clematis, Lonicera, Trachelospermum, Wisteria

• Annuals: Aster, Chrysanthemum, Carnation


0M
4M
N

5. PROPERTIES AND BEHAVIOUR OF SOUND

Introduction

-sound can be described as disturbance or turbulence which passes through a physical medium and form of longitudinal waves from a source to receiver causing a sensitive hearing.

-This medium could be solid liquid or gas.

-The speed of the sound through this different media differs due to their molecular composition.

Physical properties of sound-

- **wavelength of sound-** This is described this is distance between two peaks of valleys measured in metres(m) and presented in Greek letter(I) Lambda.

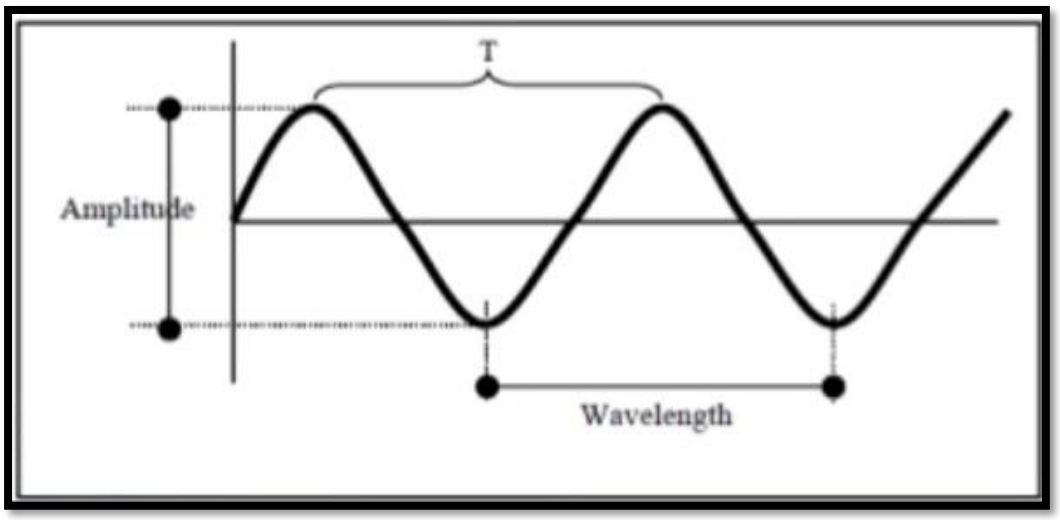
- **Period** -This is the time for incomplete installation this is measured in seconds and represent with letter 'T'.

-**Frequency** -This is the number of oscillation per sound this is represented with F and measured with hertz (Hz).

-**Velocity and sound**- This is the rate at which the sound wave travel from a source through a medium to receive the unit is metre per second.

-**Amplitude**-This is the distance between a crest (highest point)and a valley (lowest point) .

-**Pitch** -It is the Highness or lowness of tone determined of rapid oscillation producing it.



Behaviour of sound in an enclosure

An encloser space is a room or area bounded on every of its sides. The materials for enclosure may be classified into two:

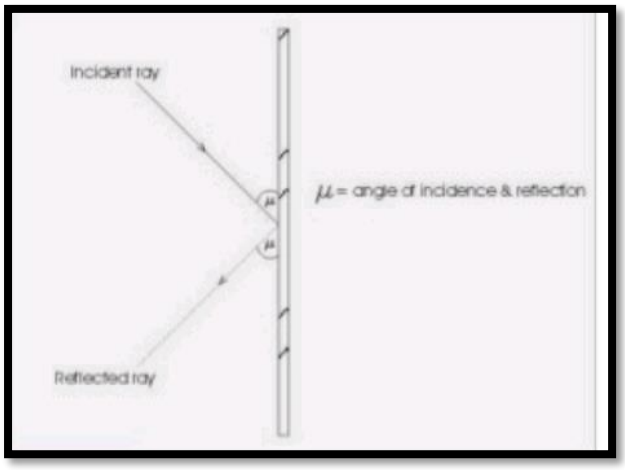
Those that allow sound rays to pass through and those does that allow sound rays to pass through.

On encountering barriers posed by the encloser, sound waves are likely to behave in the following ways:

i. Reflection
ii. Absorption
iii. Refraction
iv. Diffusion
v. Diffraction
vi. Transmission

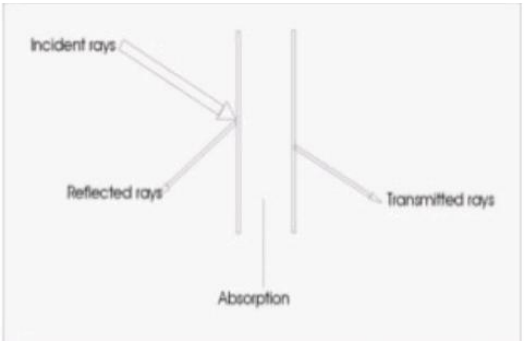
REFLECTION

This occurs when the wavelength of the sound wave is smaller than the surface of the obstacles. In the case of the enclosed space, the sound waves hit every side of the encloser to zero. The amount of waves reflected depends on the smoothness, size and the softness of the materials of the enclosure. The angle of incidence of the sound rays is the equal to that of the reflected is flat. But when it is curved, the angles and different.



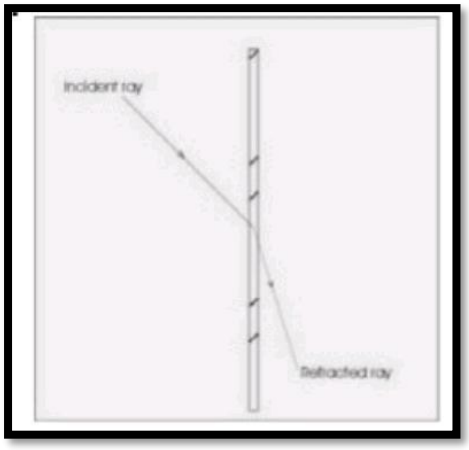
ABSORPTION

Then the sounds waves hits the surface of an obstacles, some of its energy is reflected while some are lost through its transfer to the molecules of the barrier the lost sound energy is said to have been absorbed the barrier the thickness and the nature of the materials as regards its softness and hardness influences the amount of the sound energy absorbed.



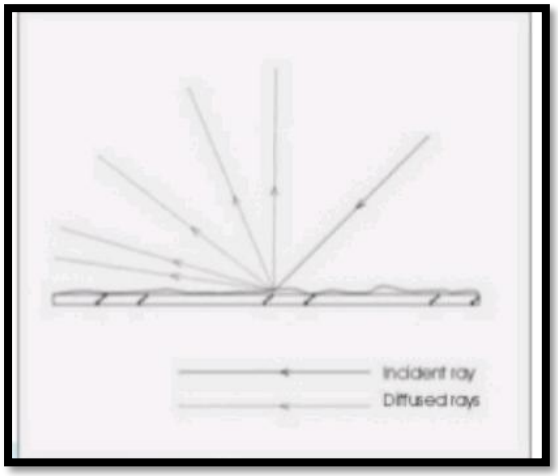
REFRACTION

It is this is the bending of sound when it travels from one medium to another medium the difference is the composition of two different media band was found the angle of incidence was found the angle of incidence angle of incidence in into the angle of refraction as it travel into the new medium.



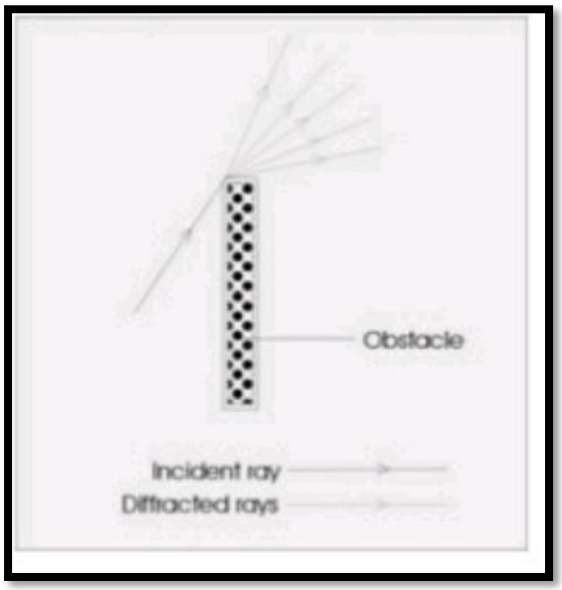
DIFFUSION

This is the setting of waves from surface it software as a result of texture and hardness of the obstacle is comparable to the wavelength of the sound. The direction of the incident ray changes when it strikes the surface of the Abstract satisfaction in his child when sound is her in all the direction at equal level.



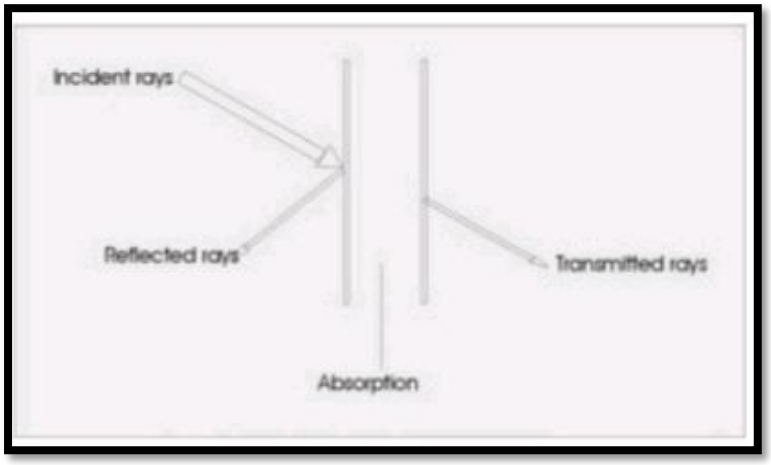
DIFFRACTION

when the wavelength of sound wave is smaller or equal to the size of the obstacle the sound rays tends to bend round the ages of the obstacle that by turning the ages to sound source.



TRANSMISSION

The phenomenon sound wave is carried by molecule of the obstacle through vibration and re-emitted at the other side irrespective of the medium. It can be the structure borne, air borne or impact sound.



FACTORS THAT AFFECT THE BEHAVIOUR OF SOUND IN AN ENCLOSED SPACE

i. Reduction in its intensity of sound -this can result due to the distance between its source and the receiver.
ii. Absorption of direct sound by audience-the listener of the sound observe from of the sound in the process of hearing.
iii. Absorption of direct and reflected Sound By surface-the wall ceiling and roof of enclosed observe and reflect sound waves here by controlling the way of sound behaves.
iv. Reflection of sound from right-angled corners- sound incidence of right angle corner of room will be reflected back towards source if surface are acoustically reflective. This can in turn produce echoes especially in large spaces.
v. dispersion of sides of an enclosure reflection - can be controlled by making one surface depressive not at right angle to eat this would have affected the reflection of sound nearby affecting its behaviour.

FACTORS THAT AFFECT THE BEHAVIOUR OF SOUND IN ENCLOSED SPACE.

- **Edge diffraction of sound**- Edge diffractions result in curvature of path of sound around the age of barrier. This causes the obstacle to scatter the sound waves making it behaves like a source of sound.
- **Sound Shadow**- any barrier integrating a sound wave will create a shadow and two light rays however because of age differentiation some sound will creep into this but such penetration is frequency dependent high frequency are deflected and low frequencies such problems can occur in auditorium with balconies.

- **Primary reflection-** this depend on the angle of incidence which is equal to the angle of reflection. Also, the nature of sound reflector is important.
- **panel resource-** sound waves can propagate through a solid Material by panel vibration the sound does not actually penetrate the material but rather causes this to vibrate and act as a sound source itself. The panel will be vibrated by both direct and reflected sound waves.