Lecture-3

Brief Introduction to Architecture (Orientation of the Building)

by

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Learning objectives

- How to decide the orientation of a building
- What are the different factors affecting the Orientation of building

Orientation of the Building

Orientation is the positioning of a building in relation to seasonal variations in the sun's path as well as prevailing wind patterns

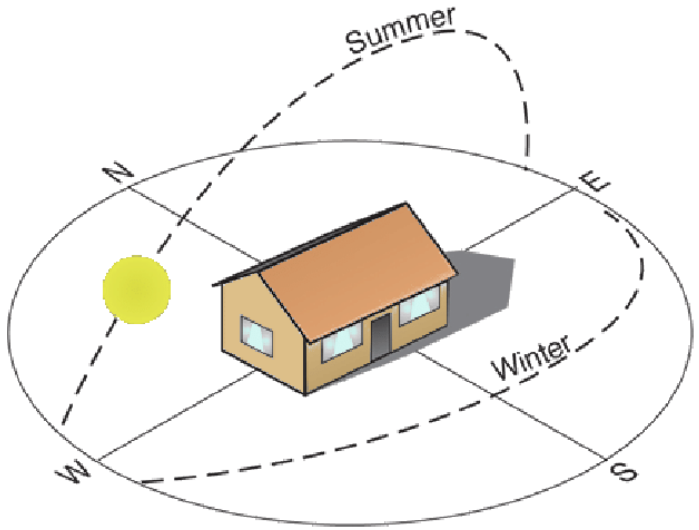
- Good orientation can increase the energy efficiency and making it more comfortable to live in and cheaper to run.
- It also improves the thermal comfort for occupants of a building.
- It affects the amount of sun falling on surfaces, daylighting and direction of winds.
- Good orientation can help to reduce or even eliminate the need for auxiliary heating and cooling, resulting in lower energy bills, reduced greenhouse gas emissions and improved comfort.
- Building designs vary according to context of its location and climate.

Principle of building design: Maximising amount of solar radiation in winter and minimizing the amount in summers, which directly depends on the orientation of the building.

Orientation

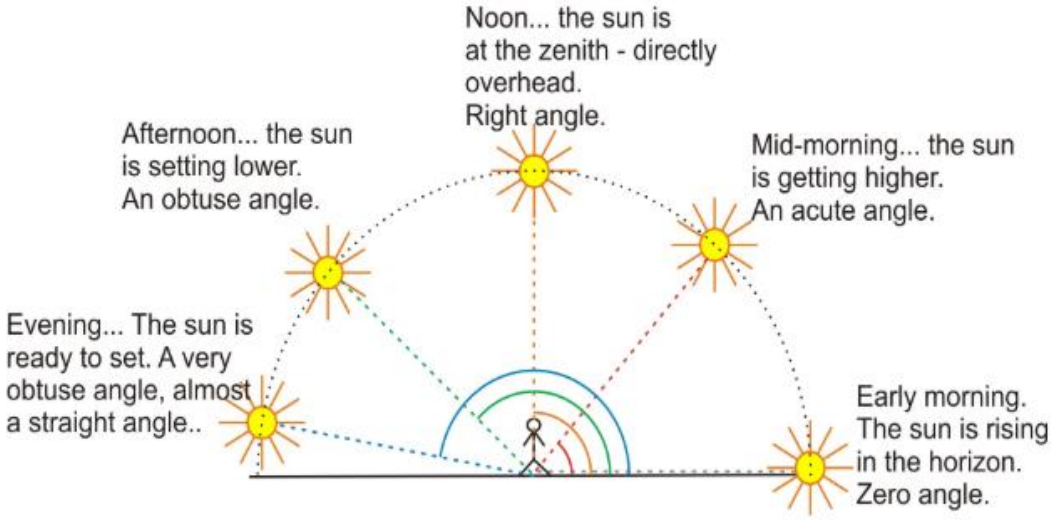
Good orientation can increase the energy efficiency of your home, making it more comfortable to live in and cheaper to run.

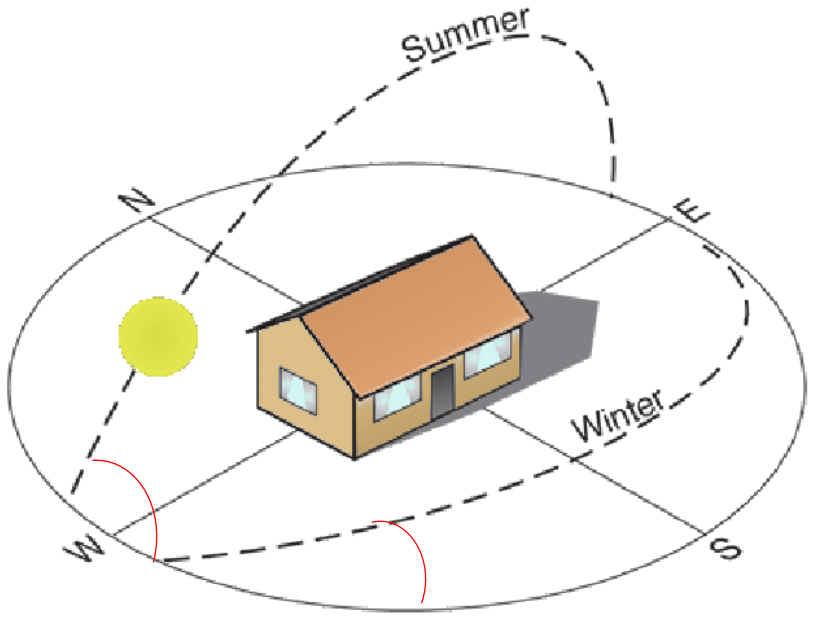
Good orientation can help reduce or even eliminate the need for auxiliary heating and cooling, resulting in lower energy bills, reduced greenhouse gas emissions and improved comfort.



Orientation of the building depends upon Sun Path Diagram

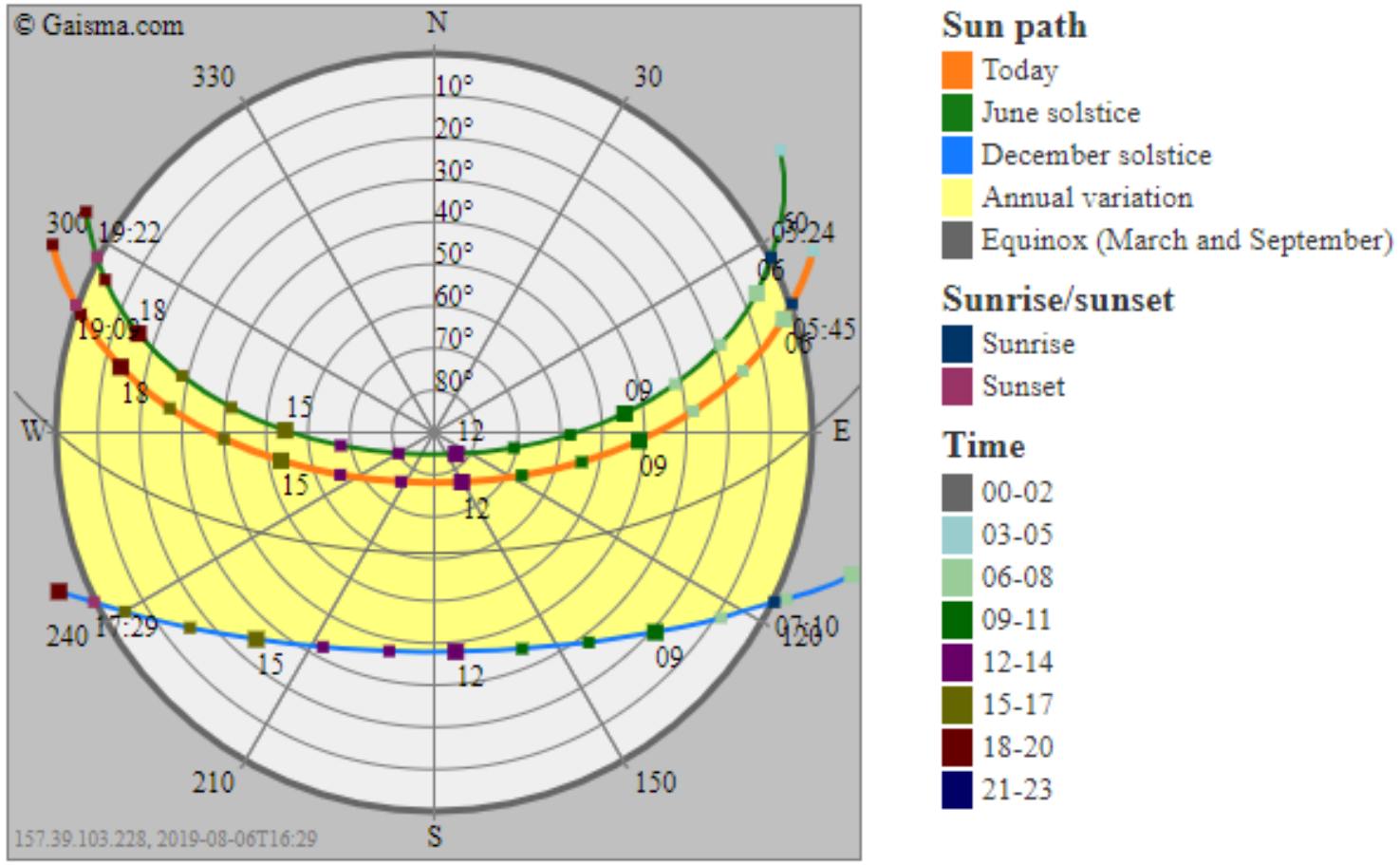
- *The sun is at a low angle during the winters and to the south of east-west axis.*
- *During summer, its path is at a high angle and slightly north to the east west axis.*
- *The alteration in path affects solar radiation penetration patterns during different seasons and consequently, heat gain and loss in a building.*





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.

Delhi, India - Sun path diagram



https://www.gaisma.com/en/location/delhi.html

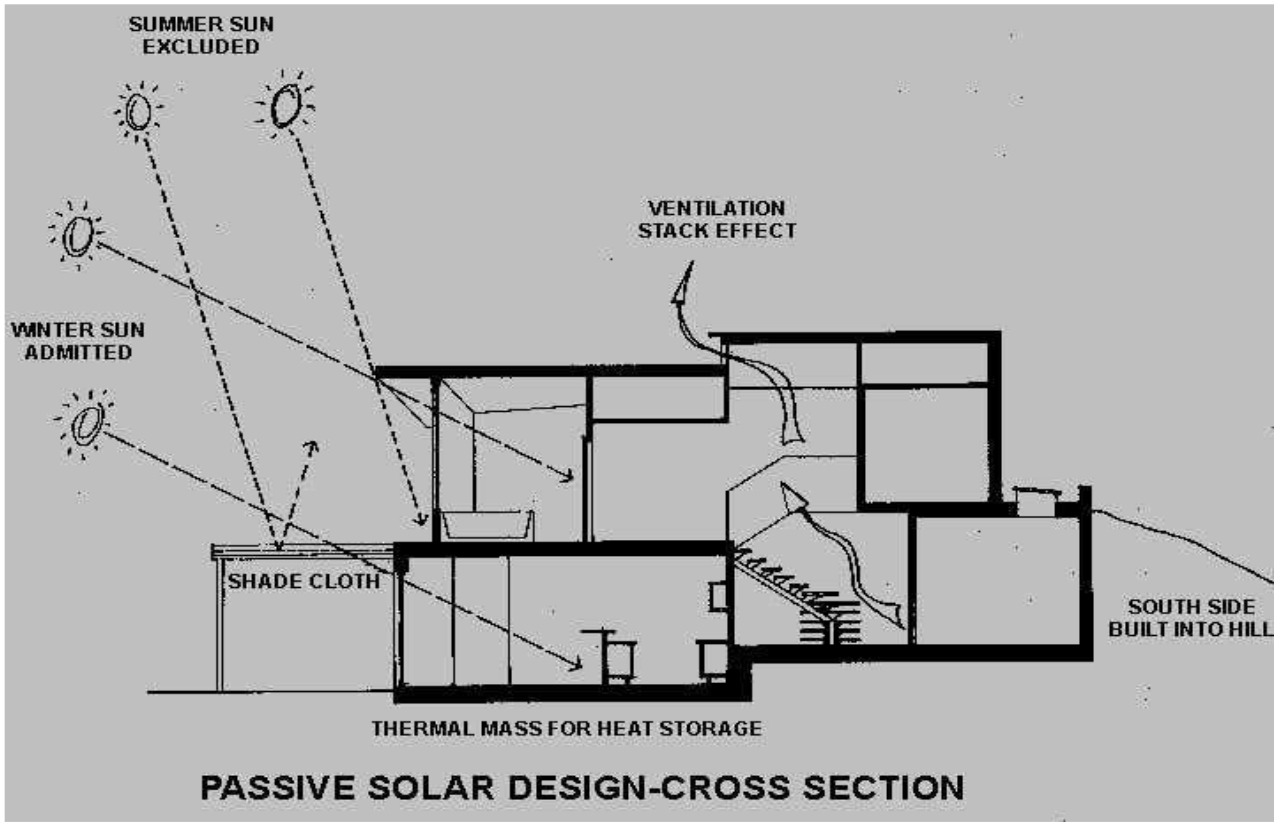
Orientation

Orientation of the building also depends on passive solar building design.

Passive solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles whilst reducing the requirement for active heating and cooling systems.

In **passive solar building design**, windows, walls, and floors are made to collect, store, reflect, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design because, unlike active solar heating systems, it does not involve the use of mechanical and electrical devices.

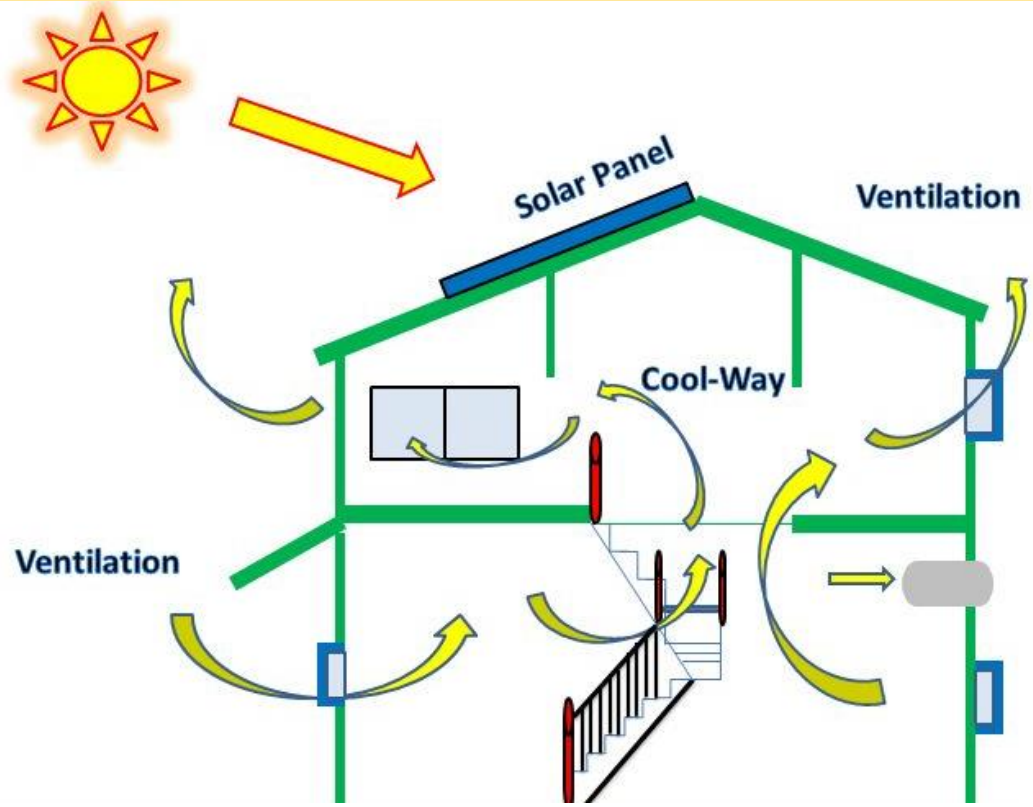
It affects the amount of sun rays falling on surfaces, daylighting and direction of winds.



Passive solar building design

Passive solar technologies use sunlight without active mechanical systems (as contrasted to active solar). Such technologies convert sunlight into usable heat (in water, air, and thermal mass), cause air-movement for ventilating, or future use, with little use of other energy sources.

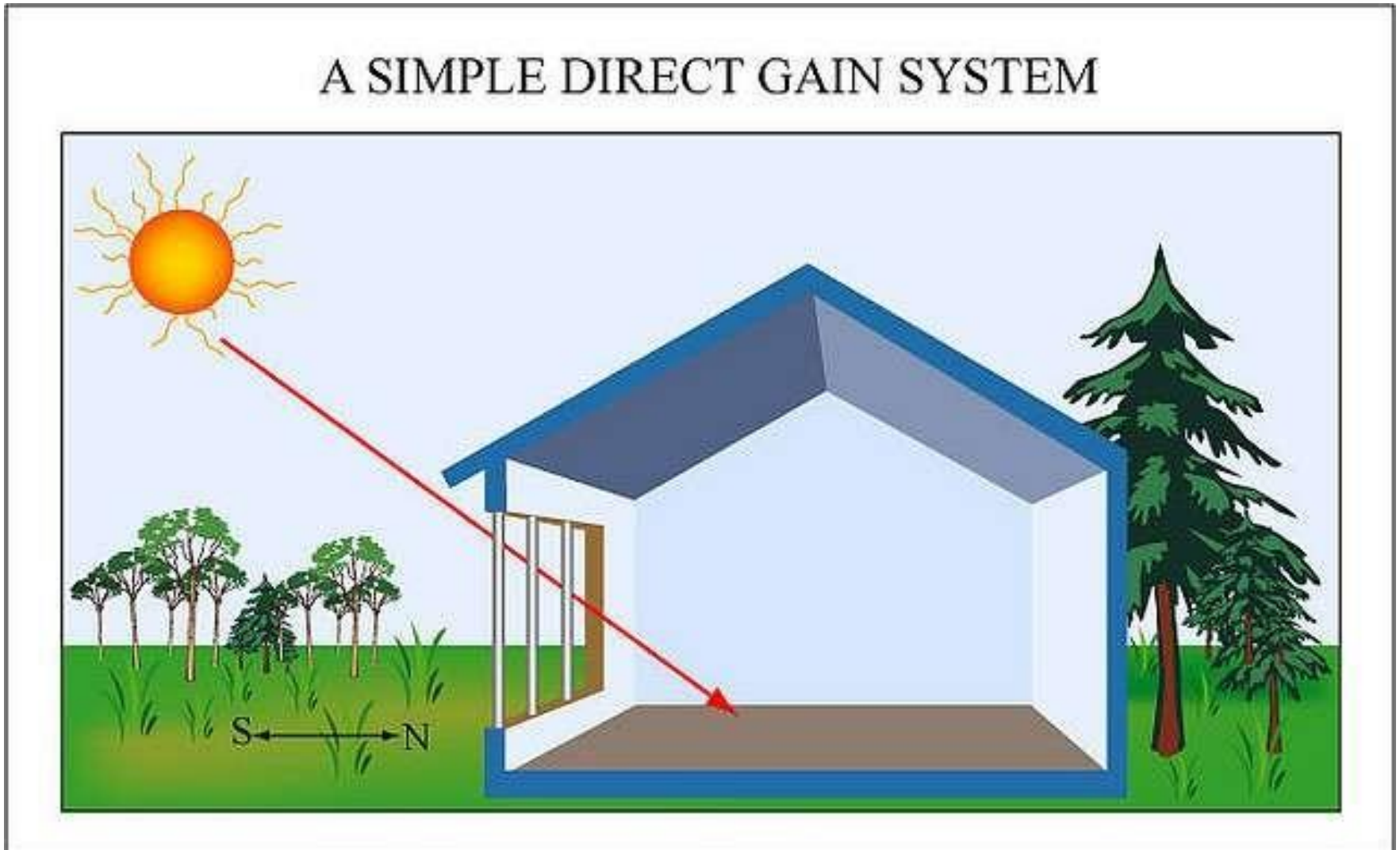
Elements to be considered include window placement and size, and glazing type, thermal insulation, thermal mass, and shading. Passive solar design techniques can be applied most easily to new buildings, but existing buildings can be adapted or "retrofitted".



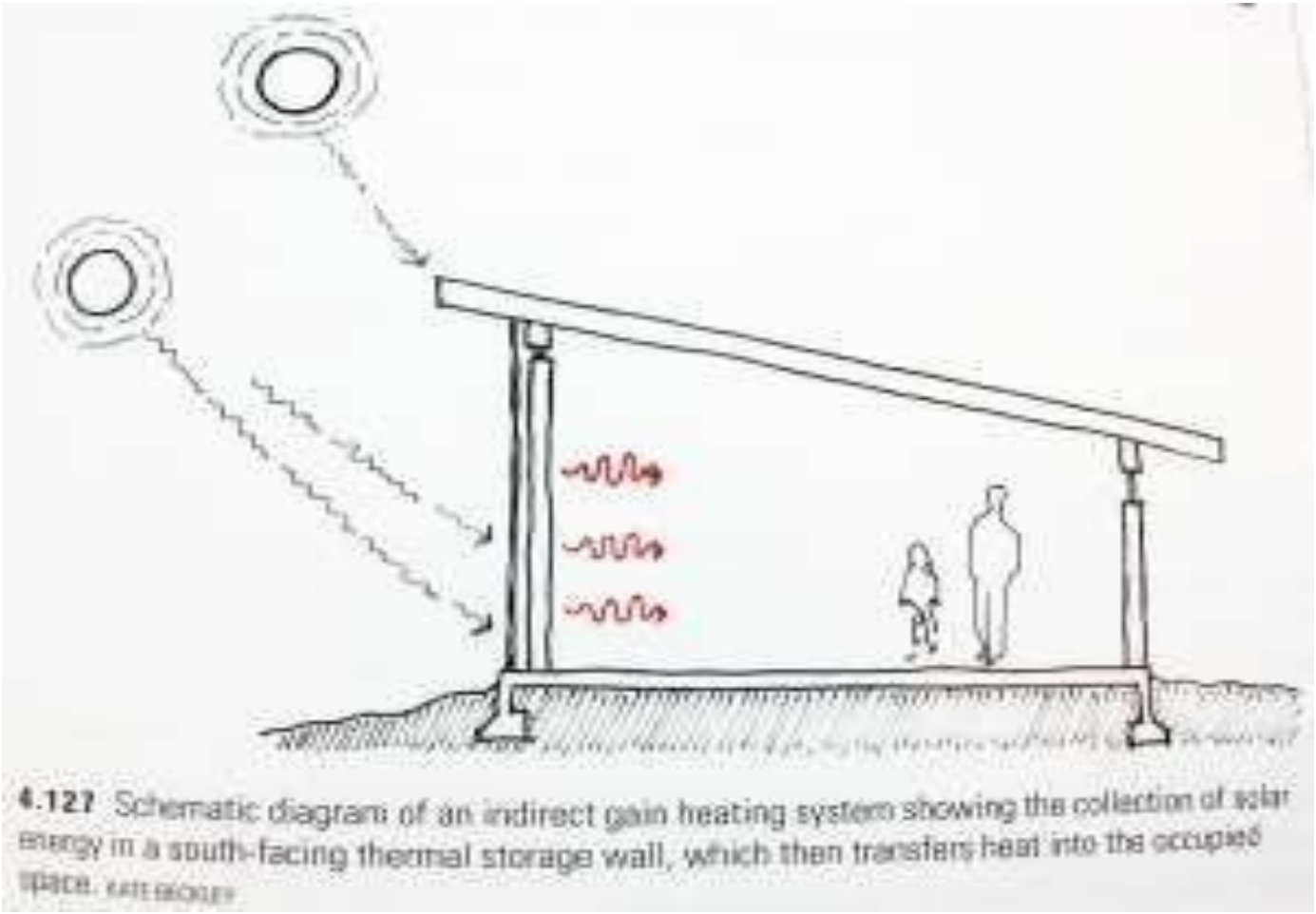
Orientation of the building based Sun Light system

- Direct Gain
- Indirect Gain
- Day lighting

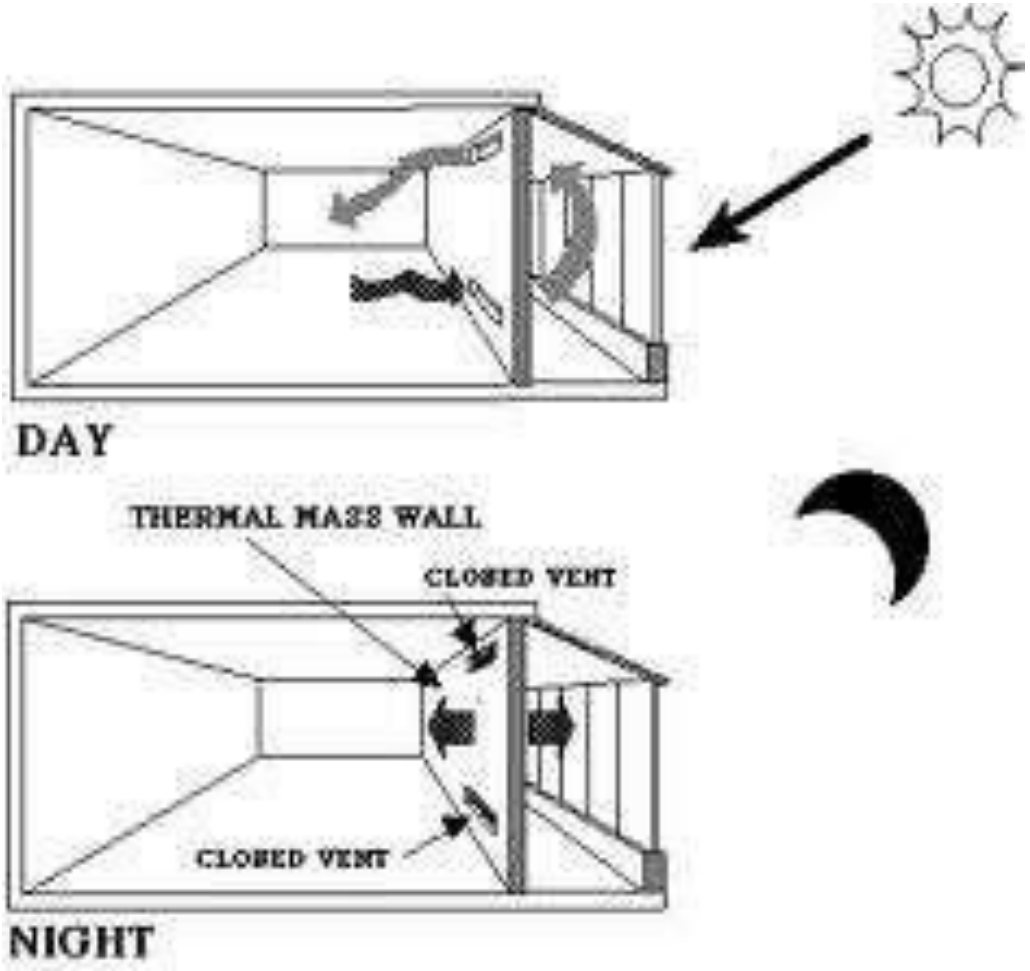
Direct Gain



Indirect gain

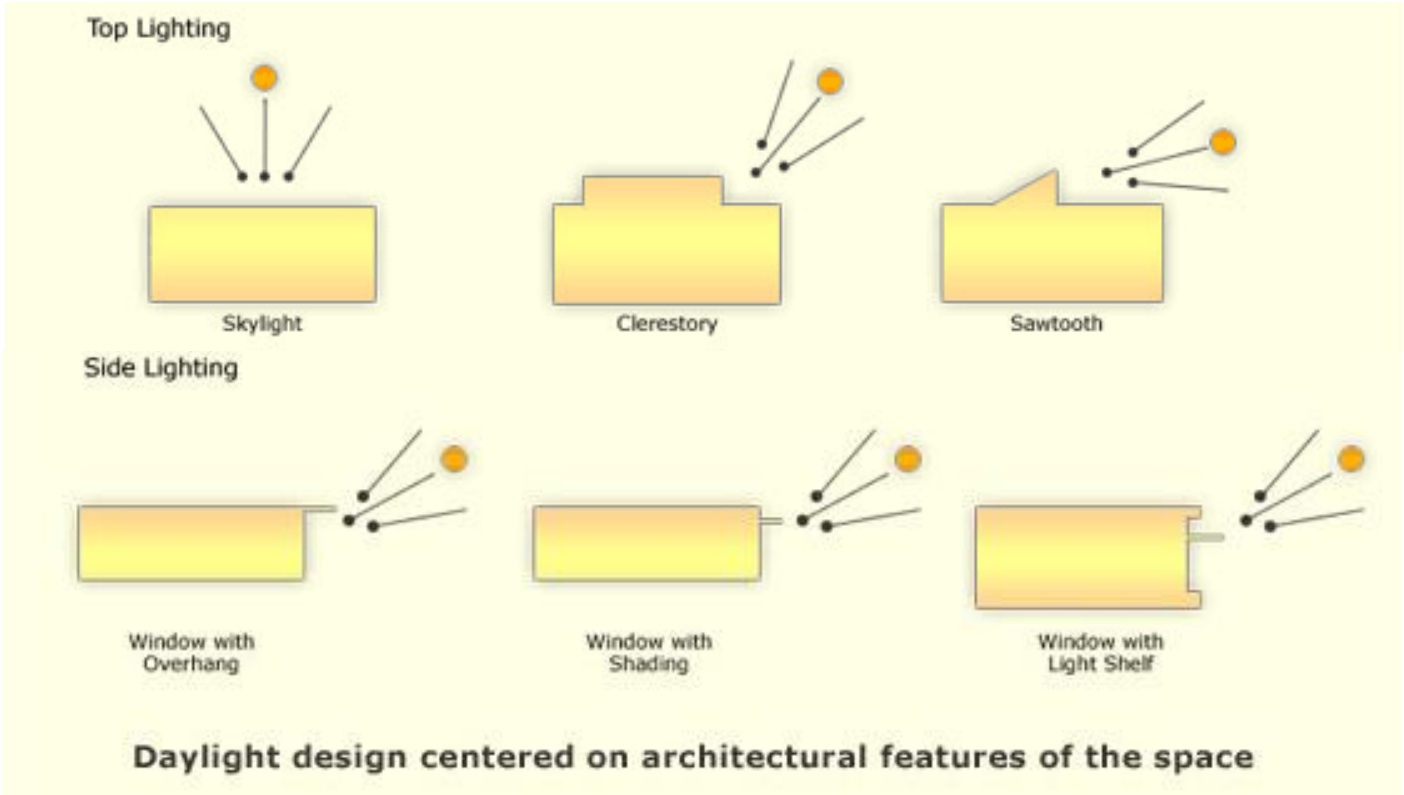


4.127 Schematic diagram of an indirect gain heating system showing the collection of solar energy in a south-facing thermal storage wall, which then transfers heat into the occupied space.

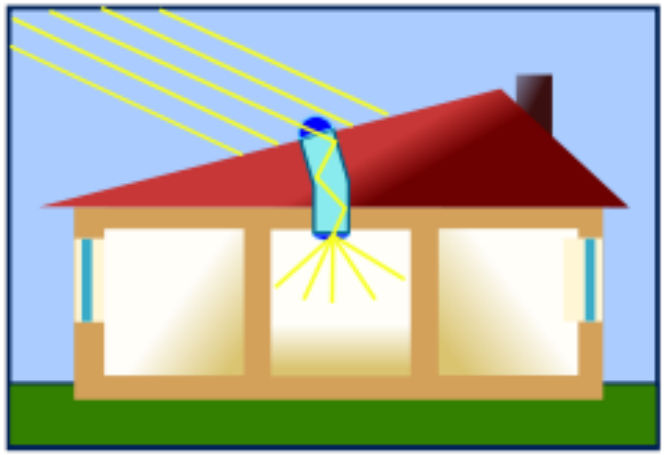


Day lighting

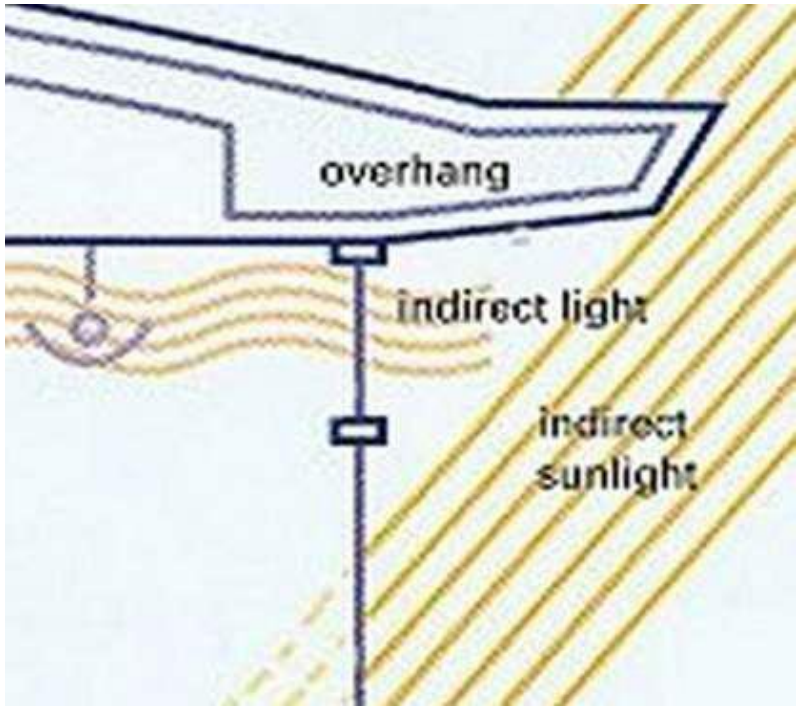
Day lighting is the practice of placing windows, or other transparent media, and reflective surfaces so that, during the day, natural light provides effective internal illumination.



Daylight design centered on architectural features of the space



Day lighting



6.2.
B, natural light

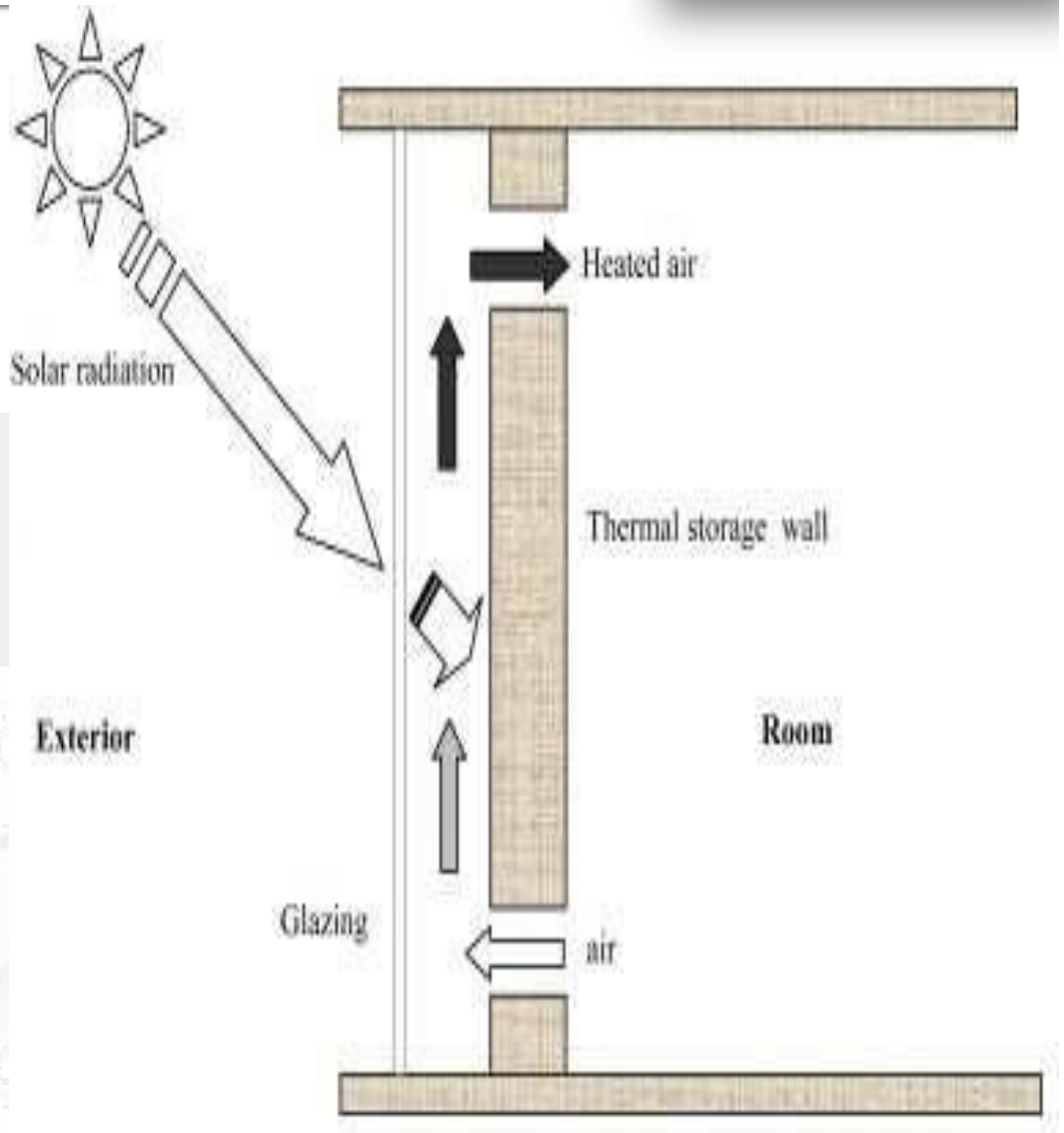
Radiant Panels:

➢Radiant panels are simple passive solar systems that are inexpensive and well suited as retrofits to metal buildings.

Photo credit: Xedos4

Thermal storage walls

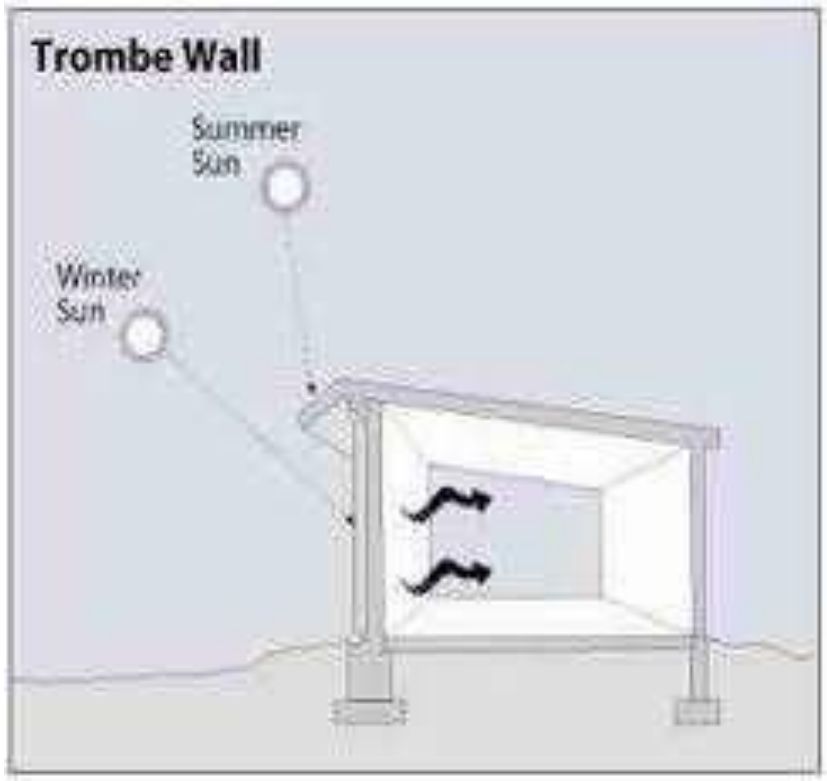
- A thermal storage wall is a passive solar heating system in which the primary thermal storage medium is placed directly behind the glazing of the solar aperture.
- Heat transfer to the living space is sometimes augmented by the addition of circulation vents placed at the top and bottom of the mass wall.



Trombe Walls

In summer

The density of the materials in the Trombe wall acts as a method of slow heat absorption and transfer.

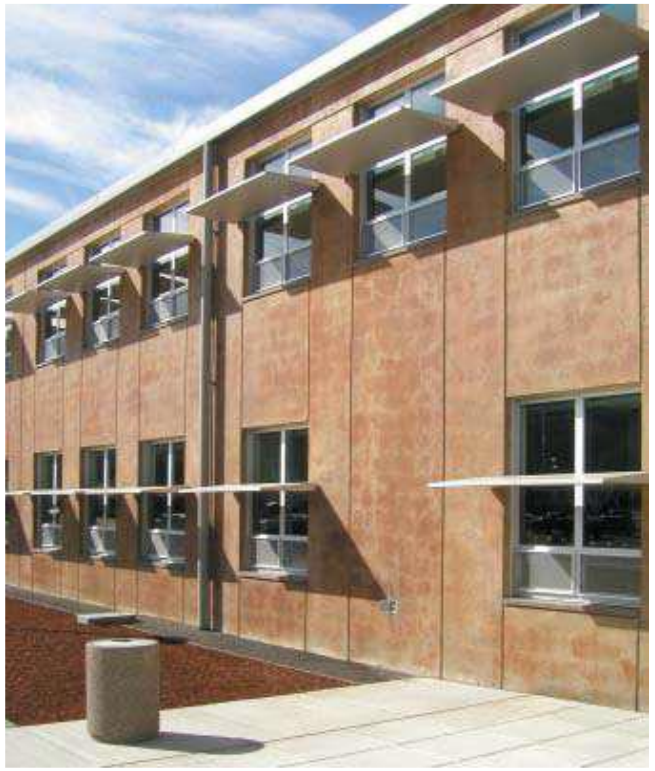


ORIENTATION BASED ON CLIMATIC ZONE

Orientation of the Solids (Built) and Openings (Fenestration):

The building should respond well with the surroundings and in order to achieve this it is planned and oriented on site so that it resists various climatic changes around. The main four climatic zones of India are:

1.Hot and Dry
2.Warm and Humid
3.Moderate
4.Cold

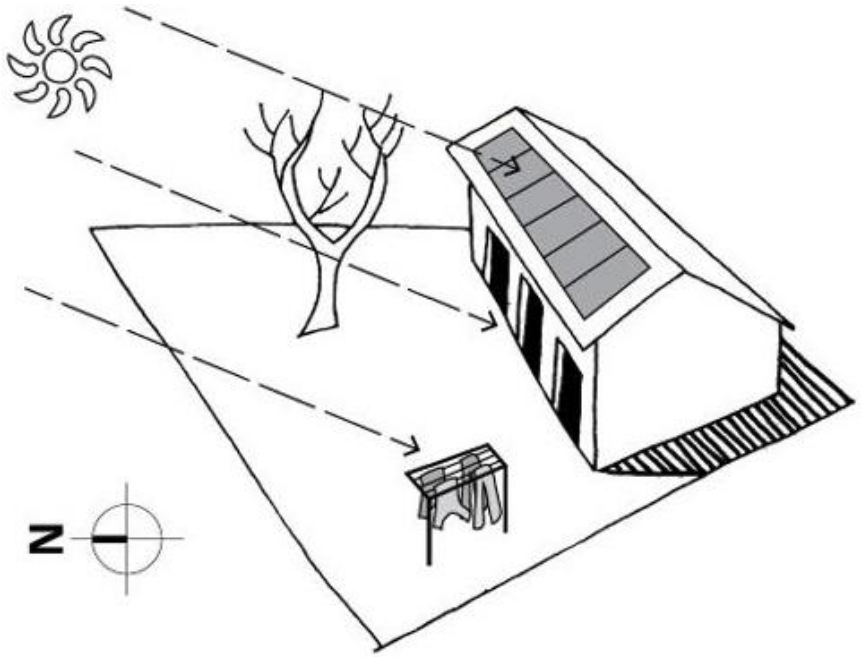


Hot And Dry Regions

Exterior:

The main criteria here is to minimize the exposure of the built form with the direct sun in summers.

The form of the structure needs to be compact enough to minimize the surface area it shares with the exterior climate. The shading should be adequate enough in case of summers and in winters the shade should be transformable enough to let the sun in.



The ideal house orientation is one that runs along an East-West axis so that wall areas receiving hot morning and afternoon sun are minimised.

The larger building face should face NORTH – SOUTH. **Orientation along the west is never preferred in case of hot and dry climatic regions.**

Hot And Dry Regions

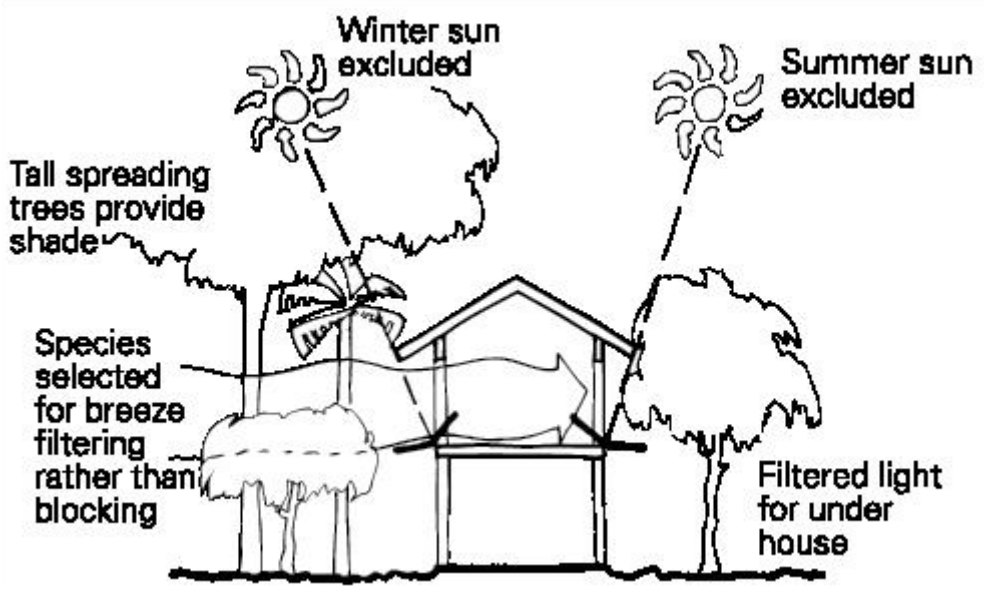
Interior:

1. In case of residential buildings or bungalows the **bedrooms should be located on the east side** whereas the **living room should be located on the north or south side.**
2. The **materials** used should be bad at absorbing heat like sun – **dried earth bricks** and the walls should be made thick enough to resist heat.
3. Walls of daytime living areas should be made of heat-storing materials. **East and west walls** should preferably be shaded. Double walls with **insulation in between are a suitable solution**. Use of cavity walls is recommended for bungalows and load bearing structures.
4. **A larger number of windows should be provided in the north façade of the building** as compared to the east, west and south as it receives lesser radiation from the sun throughout the year. **Openings** are necessary for natural lighting and ventilation. **Windows should be shaded.** This can be achieved either by shading devices, roof overhangs or by deciduous trees. The size of the windows on the west and east sides should be minimum in order to reduce heat gains into the house in the early morning and late afternoon.
5. Cooling can be achieved by the evaporation of water, which is by using passive cooling. **The courtyard is designed with proper placement of water and plants, so that it acts as a cooling source.** Internal courtyards provides **cross ventilation** thus enhancing natural cooling. Thus, openings should be provided to internal courtyard rather than external walls if possible.
6. **Colors used should be heat reflective** and flat roofs are recommended to be painted with reflective colors like white and thatched roofs or roofs exposing lesser surface area to the sun should be used to reduce the heat gain from top. Minimum number of openings should be provided on the roofs.

Hot And Dry Regions

Vegetation:

1.In hot and dry climate, heat gain is to be minimized. Trees can be used to cut off hot breezes
2.Planting deciduous trees is very useful in hot and dry
3.On site trees also play a major role in orienting and reducing the heat gain of the structure making it thermally comfortable.

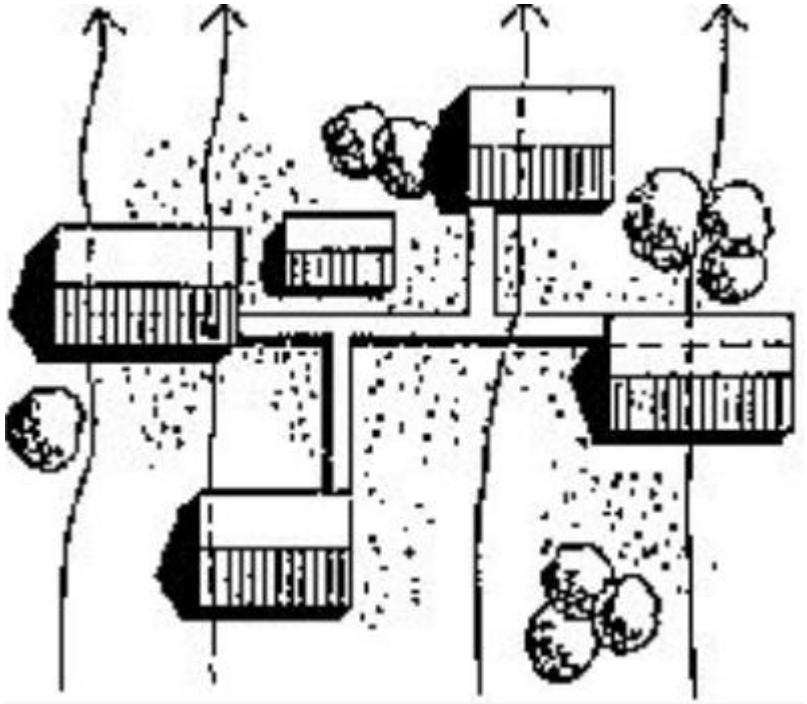


Warm And Humid Regions

Exterior

1.The structures planned in such climatic regions need to be oriented away from each other giving them a clear scope for **cross ventilation without any obstructions**.

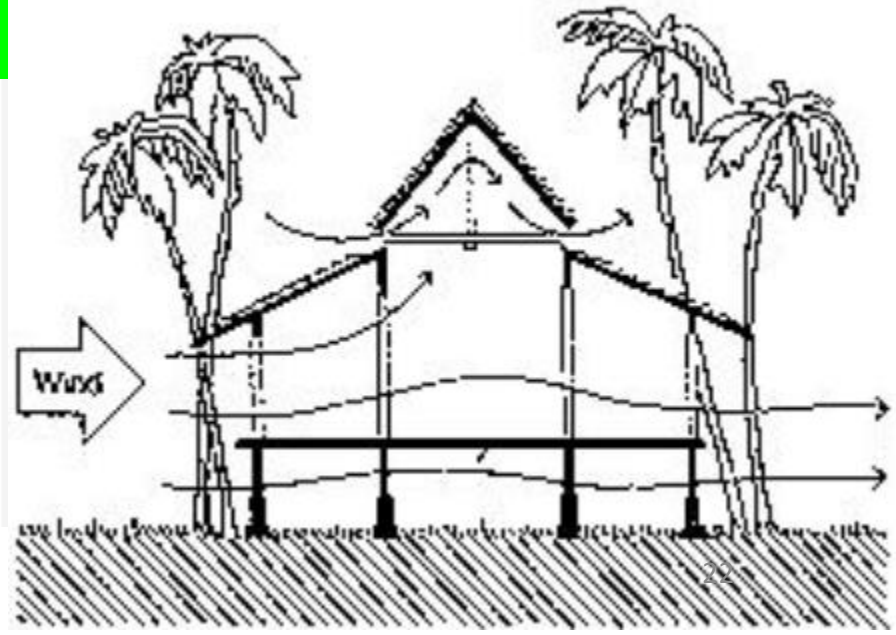
2.The east – west slopes receive more radiation as compared to north – south slopes, thus the planning and orientation need to be in such a way they don't absorb more of warm radiations from east – west slopes and increase the heat gain.



Warm And Humid Regions

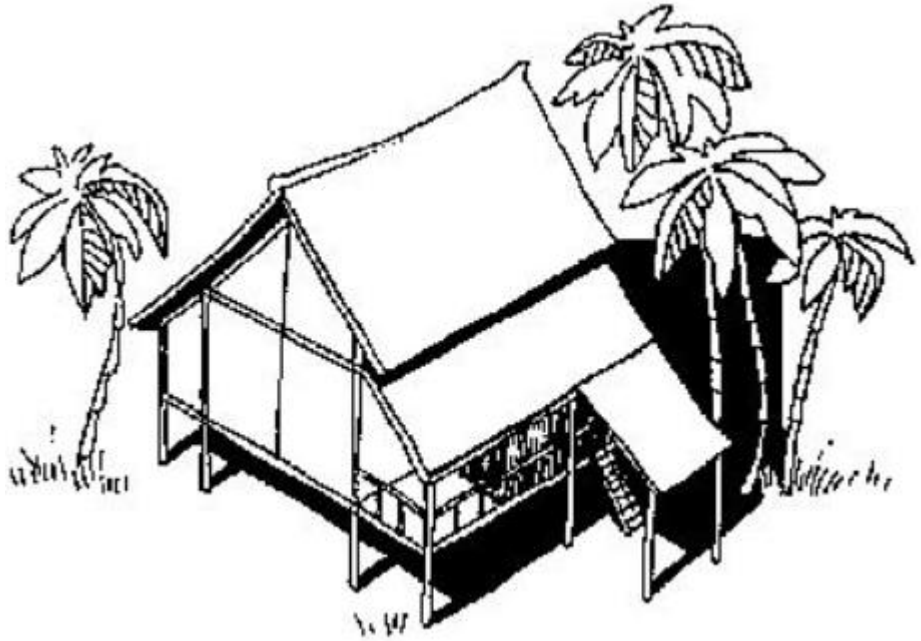
Interior

1.Maximum ventilation by providing large openings and clear air flow without obstructions in the interiors should be provided.
2.Maximum shading should also be provided resisting the direct as well as diffused solar radiations.
3. Roofs used to shelter need to be double layered ventilated.
4.It should be made sure that the cross ventilation throughout the house is maintained so as to maintain the internal thermal comfort of the structure.
5.Heat trapping at corners should be avoided by use of this cross ventilation method as trapped air will have moisture to wear out the interiors.
6.There need to be provision of windows which open maximum and if the structure tends to rise there should be provision of green terraces.



Vegetation

1. In warm and humid climate, vegetation can be employed to maximize air flow by proper planning.
2.Tall trees should be provided such that they provide shade as well as do not hinder the air flow.
3.Green cover should be extended on roofs and walls increasing the cooling effect inside along with reducing the glare and providing filtered air in the interiors.



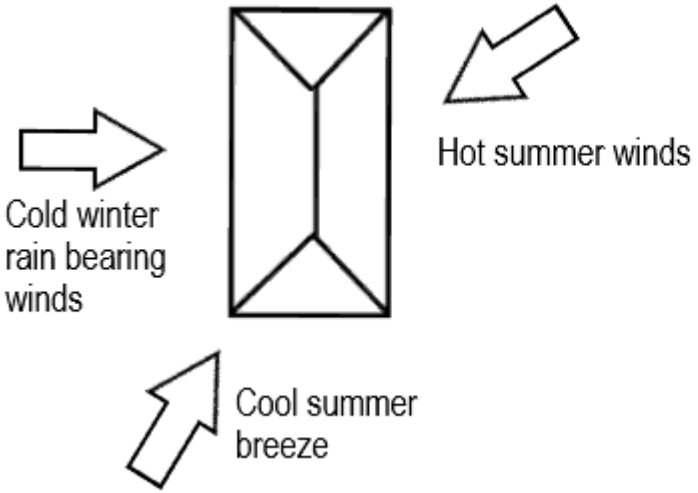
Moderate Regions

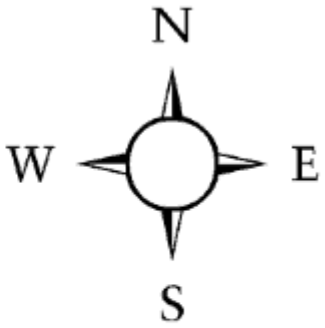
In moderate climate, the temperature difference is not that drastic and climate is average that does not reach peak levels or extreme conditions. Thus, the design can be flexible enough to suite the climatic conditions and well thought on how to reduce het gain and maintain thermal comfort at a major level.

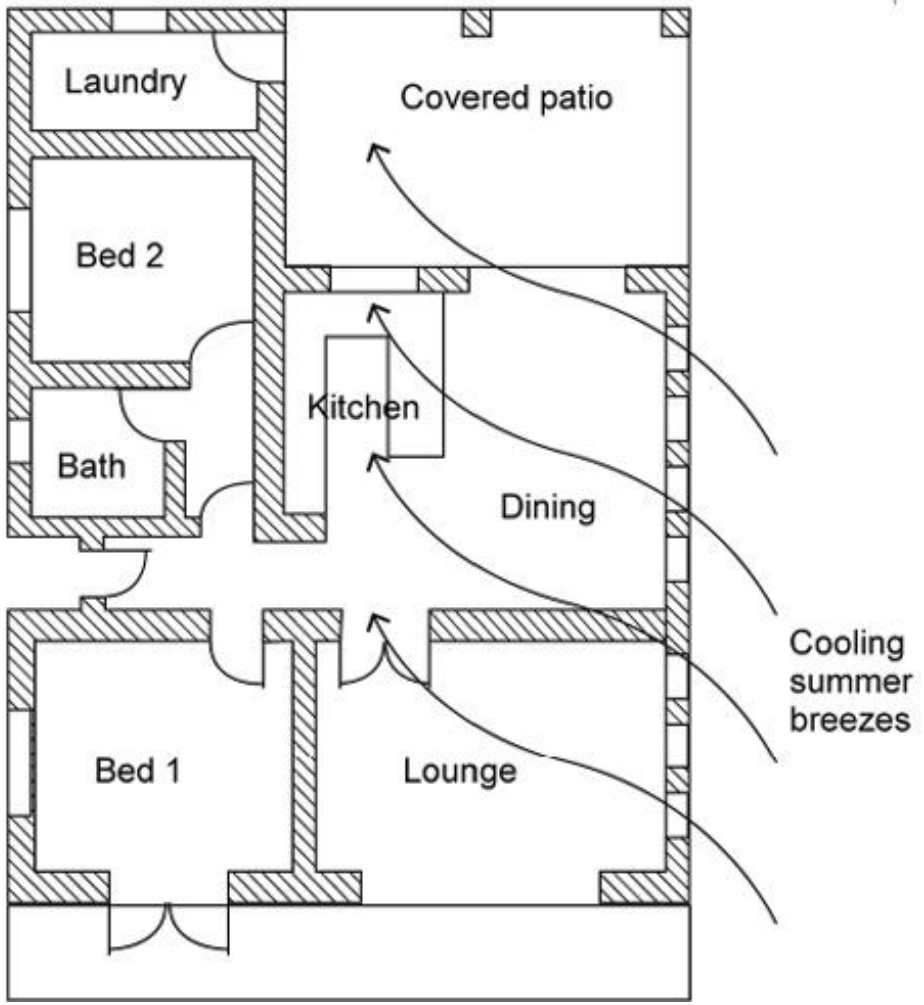
Cold Regions

1.In these regions it is preferred to plan and orient houses on the top of the slope and not at the bottom to avoid the katabatic flow of air.
2.It should be made sure that there is proper cut off ventilation provided to restrict the cold breezes.
3.Vegetation can be provided like evergreen type of foliage (plant leaves collectively) but they will also block the sun radiation which is required in cold regions.

Orientation of the building depends on wind direction







A **patio** is an outdoor space generally used for dining or recreation that adjoins a residence and is typically paved.

Orientation: Relative Humidity

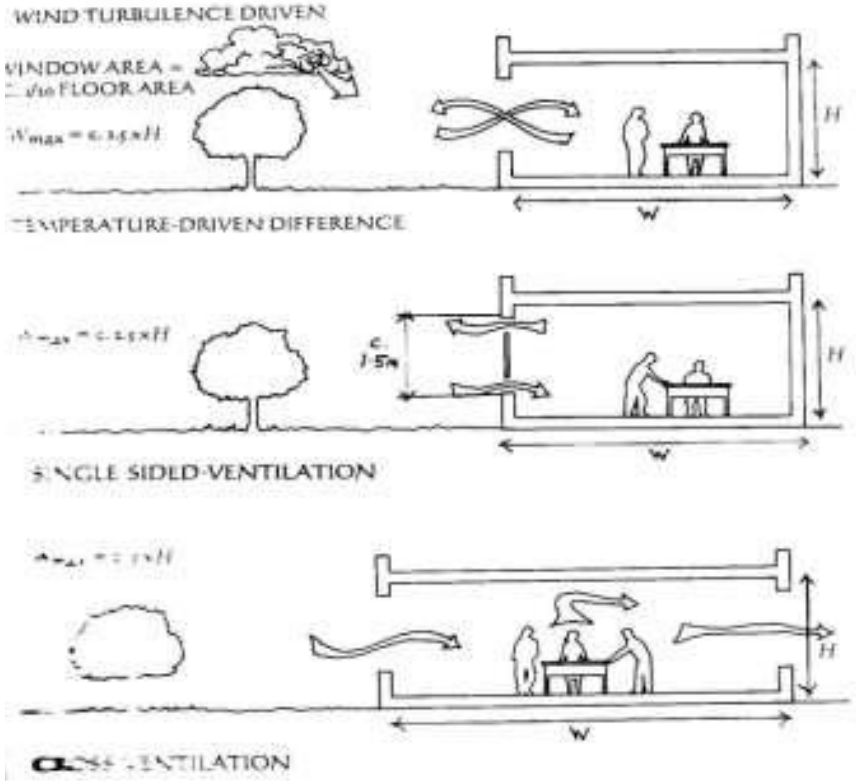
Moisture can be a liability if it comes in the form of humidity, causing such stickiness that one cannot evaporative cool (cooling by perspiring) in summer strategies to reduce the discomfort of high humidity :

- 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 conditioning)

Techniques for evaporative cooling include
placing facilities where breezes will pass over water features before reaching the facility, and providing fountains, pools, and plants

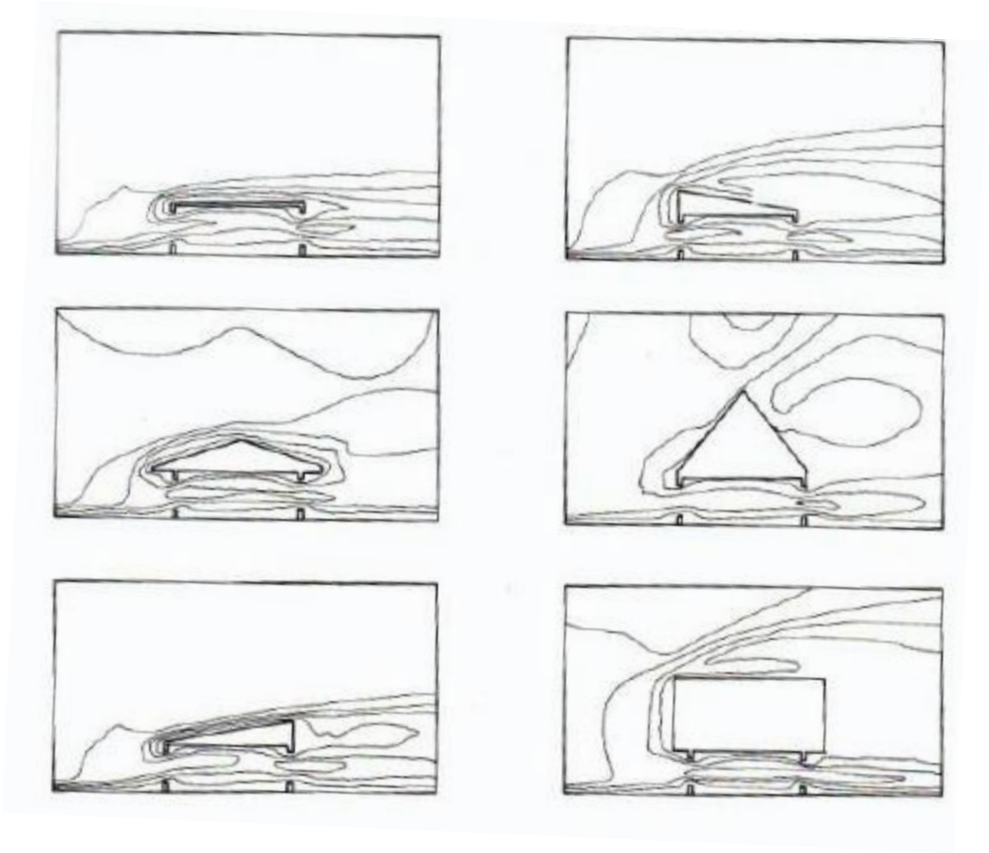
Orientation

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.

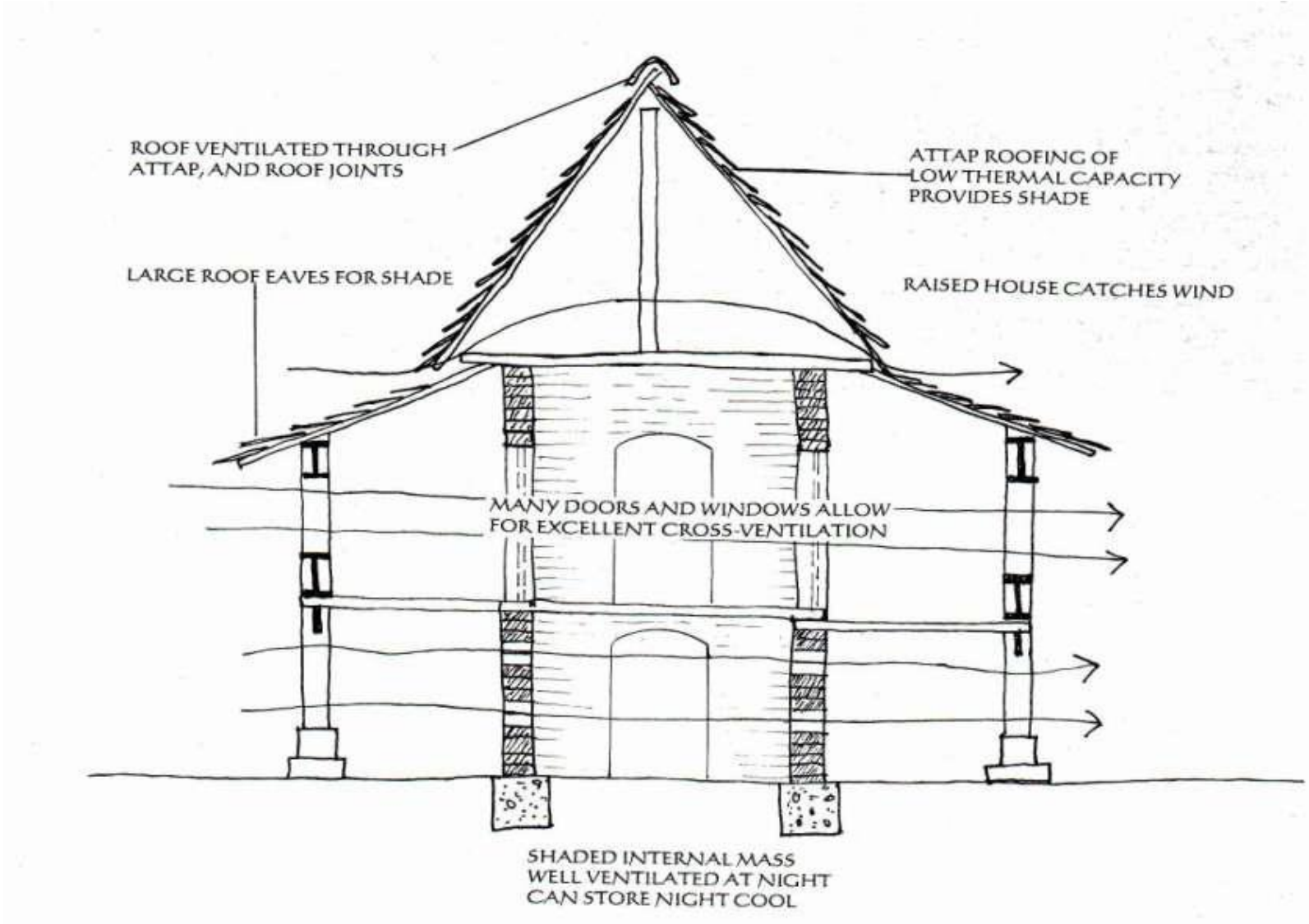


Orientation

WINDSCAPING BUILDING



Influence of roof shape on the air pressure around the house .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LOW THERMAL CAPACITY
PROVIDES SHADE
LARGE ROOF EAVES FOR SHADE
RAISED HOUSE CATCHES WIND
MANY DOORS AND WINDOWS ALLOW
FOR EXCELLENT CROSS-VENTILATION
SHADED INTERNAL MASS
WELL VENTILATED AT NIGHT
CAN STORE NIGHT COOL

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