

# PASSIVE DESIGN PRINCIPLES FOR CONSTRUCTION IN MADHYA PRADESH

DESIGN FOR LCCR CONSTRUCTION



# Low Carbon Climate Resilient Strategies

## Low Carbon Climate Resilient Construction

### Minimised embodied energy

Rationalizing the use of high energy materials like cement, steel, brick, aluminium.

### Minimised operational energy

Maintaining comfortable indoor environmental conditions by adopting passive design strategies

### Disaster Resilience

Providing adequate protection from extremities of local climate and calamities

# Climate Responsive Design

Each climate has specific seasonal characteristics that need corresponding passive design strategies to create a comfortable indoor environment without over-dependence on mechanical heating, cooling and ventilation and by using freely available renewable sources of energy such as sun, wind and natural vegetation.

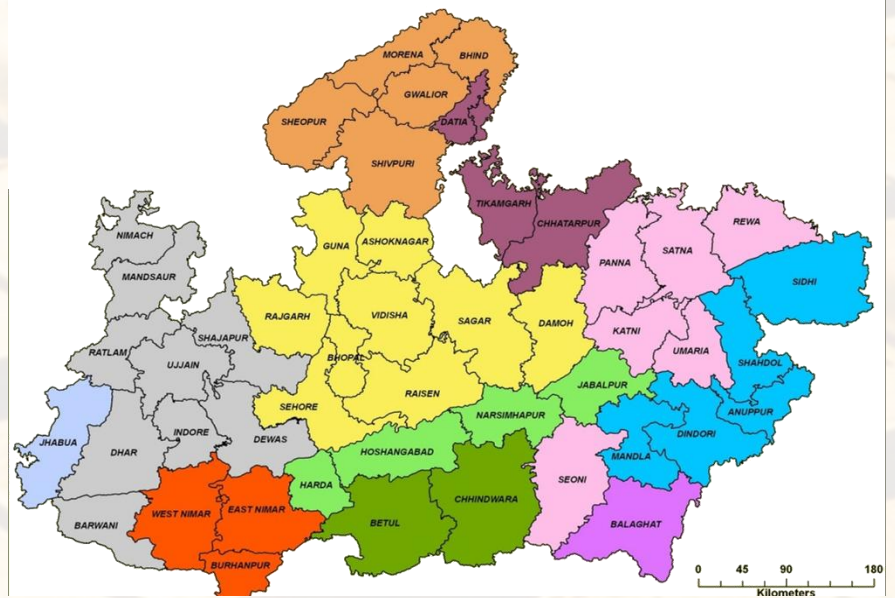
## MICROCLIMATIC FACTORS IN MADHYA PRADESH:

**Solar exposure** - Direction of available solar radiation

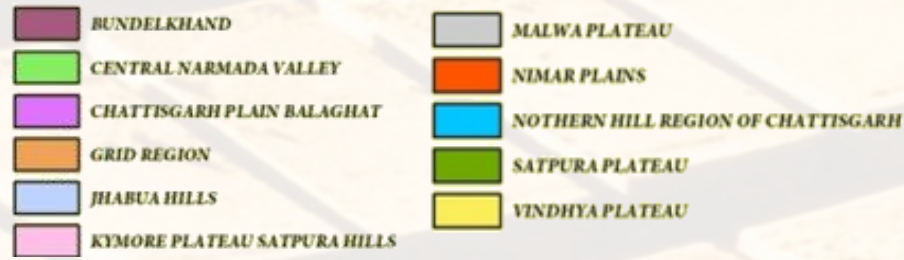
**Rain** – Intensity of precipitation

**Wind** - Velocity and direction of the wind

Parts of MP lie in the semi-arid climatic zone.



### AGROCLIMATIC ZONES



# Seasonal Passive Strategies

## SEASONS:

### Summer:

- Daytime temperatures 32° – 45°C.
- Night time temperatures 27° to 32°C.
- Diurnal range of temperature > 10°C.
- Low humidity levels (20 – 25%).
- High solar gains.
- Hot dusty winds.

### Monsoon:

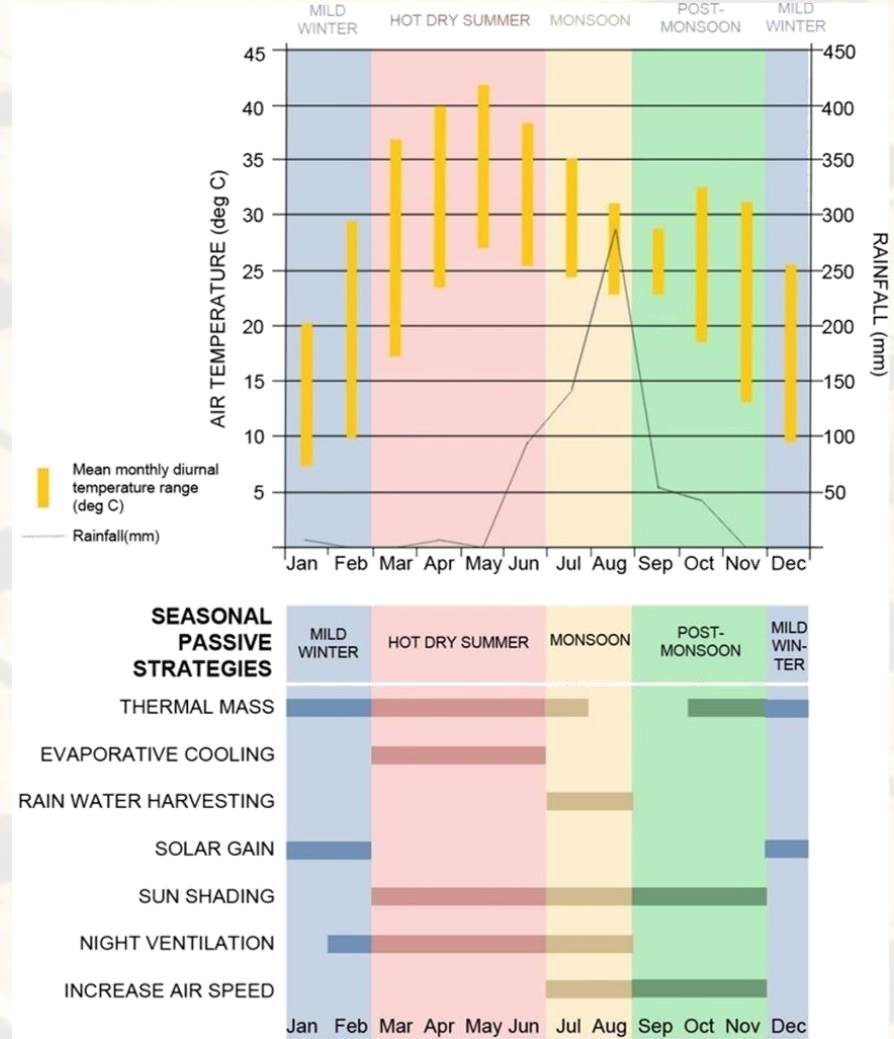
- Rainfall resulting in high RH (55%-95%).
- Temperatures < 35°C
- The diurnal range of temperature < 10°C.

### Post-monsoon:

- Pleasant weather with diurnal range of temperature ≈ 10°C.
- Moderate temperature and humidity.

### Winter:

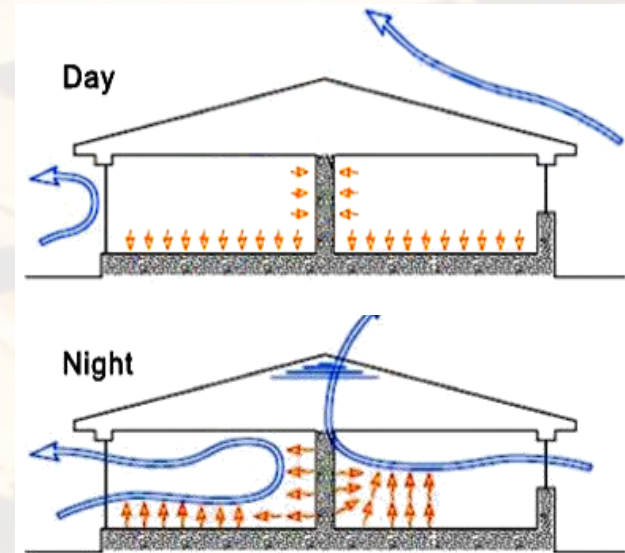
- Lower temperatures and low humidity.
- Daytime temperatures 10°-25°C.
- Night time temperatures 3°-10°C.
- Diurnal range of temperature > 10°C.



# Summer and Monsoon Strategies

## PREVENTING OVERHEATING

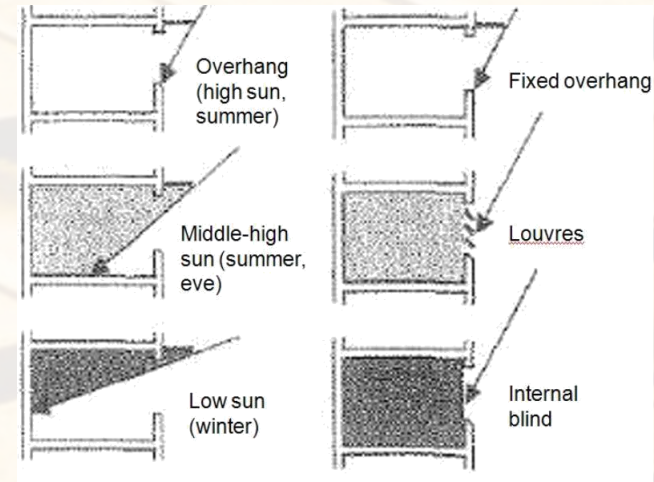
- The fenestration should be partly operable to flush out heat, whenever needed.
- Night time ventilation can be used for removal of accumulated heat loads of the day using night time winds and can be very effective for keeping interiors cool during warm summers. It is usually coupled with thermal mass use during the warmer seasons in places of high diurnal range of temperature and good prevailing winds.
- Operable shading features to cut down the solar gain.
- Deciduous trees to provide seasonal shading



# Summer and Monsoon Strategies

## Shading:

- Should be based on the degree and angle of incident solar radiation.
- Combine optimum orientation of the building and sizing of windows,
- Shading devices: horizontal overhangs (sunshades), vertical fins, louvers, operable blinds, screens, etc.
- Should be provided for unfavourable orientation such as the west, where it is difficult to block sun till late in the afternoon in summer season.



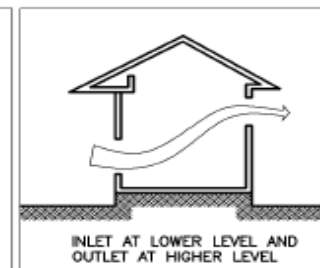
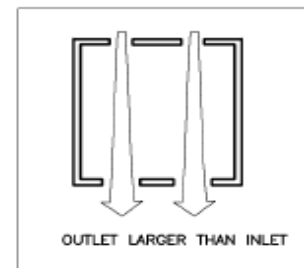
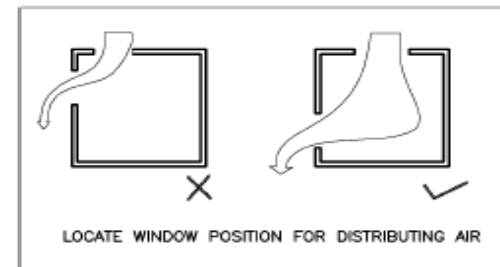
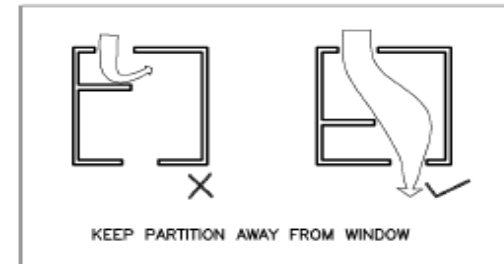
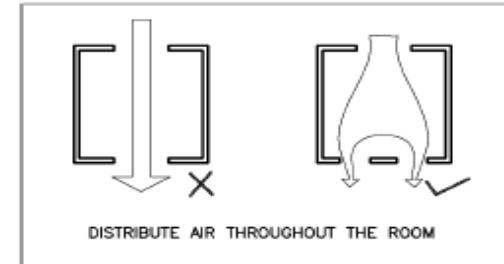
**Climate Resilience And Climate Change Mitigation to this as the most cost effective and simple strategy for cutting down solar radiation during the day time.**



# Monsoon Strategies

## CROSS VENTILATION

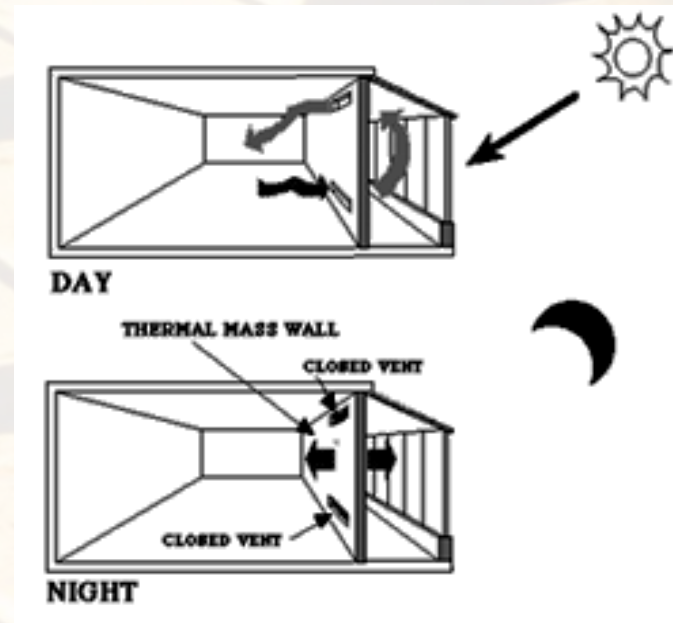
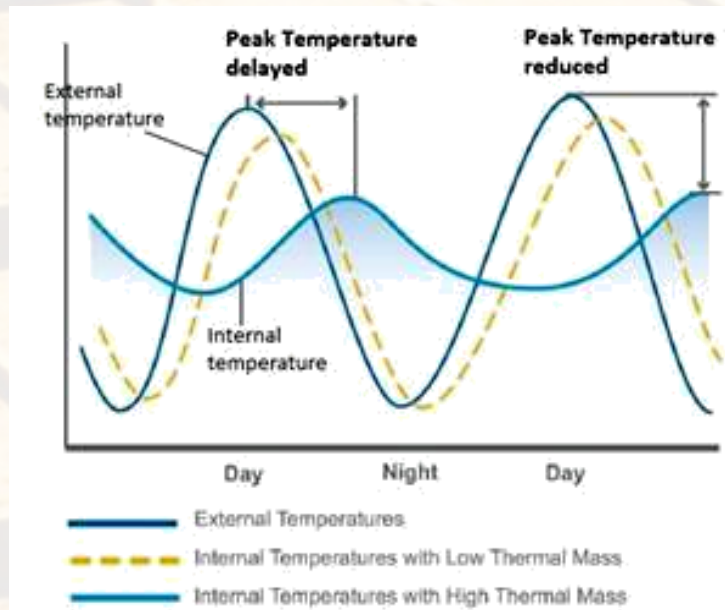
- Keeping all doors and windows for convective cooling.
- Providing shutters, blinds or louvers to shelter the rooms from the sun and rain, as well as for the control of air movement.
- Openings of a comparatively smaller size can be placed on the windward side, while the corresponding openings on the leeward side may be bigger for facilitating a plume effect for natural ventilation.
- Outlets at higher levels serve to vent hot air.



# Winter Strategies

## MAXIMISING HEAT GAIN

- Orientation of building for maximum solar exposure
- Trapping direct solar radiation through sunspaces or skylight windows.
- Trapping heat indirectly through increased thermal mass of buildings or buffer spaces.





# LCCR Design Guidelines

**Location and Cluster design:** The natural topography and vegetation of the land should be used to shield the building from solar radiation and heat waves. The building cluster can have many forms which provide mutual shading and help air movement.

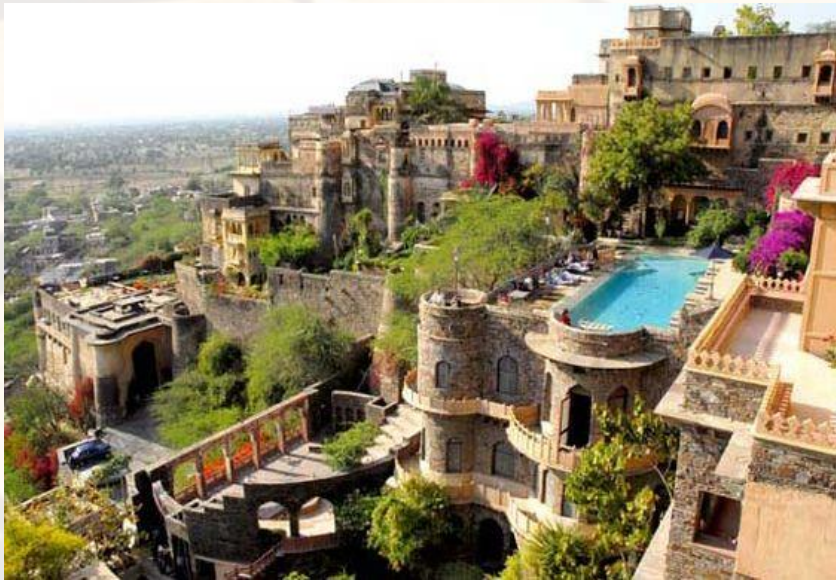


**Building Shape:** Closer and compact built form is more optimum because it reduces volume therefore minimizing heating/cooling needs, reduces amount of building materials needed and is better protected from wind and solar gain. The traditional courtyard morphology in design can be adopted in order to avoid the exposure to sun and store cooler wind, it also assist air exchange during night time.

# LCCR Design Guidelines

## Adaptive Reuse:

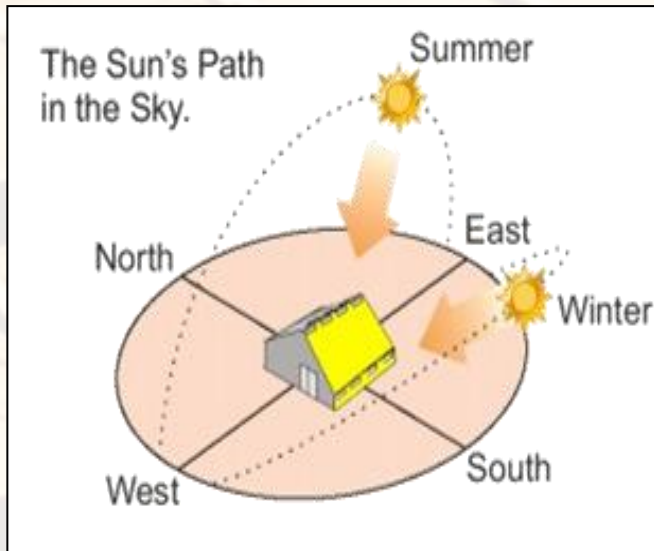
- Many old and deserted buildings can be restored and underused infrastructure can be put to proper use.
- One of the main environmental benefits of reusing buildings is the retention of the original building's “embodied energy”.



# LCCR Design Guidelines

## Orientation:

- Maximize north and south façade exposure for daylight.
- Reduce east and west facade exposure, as these are difficult to shade.
- Internally, the spaces that need direct solar gain during the winter are oriented towards the south.



# LCCR Design Guidelines

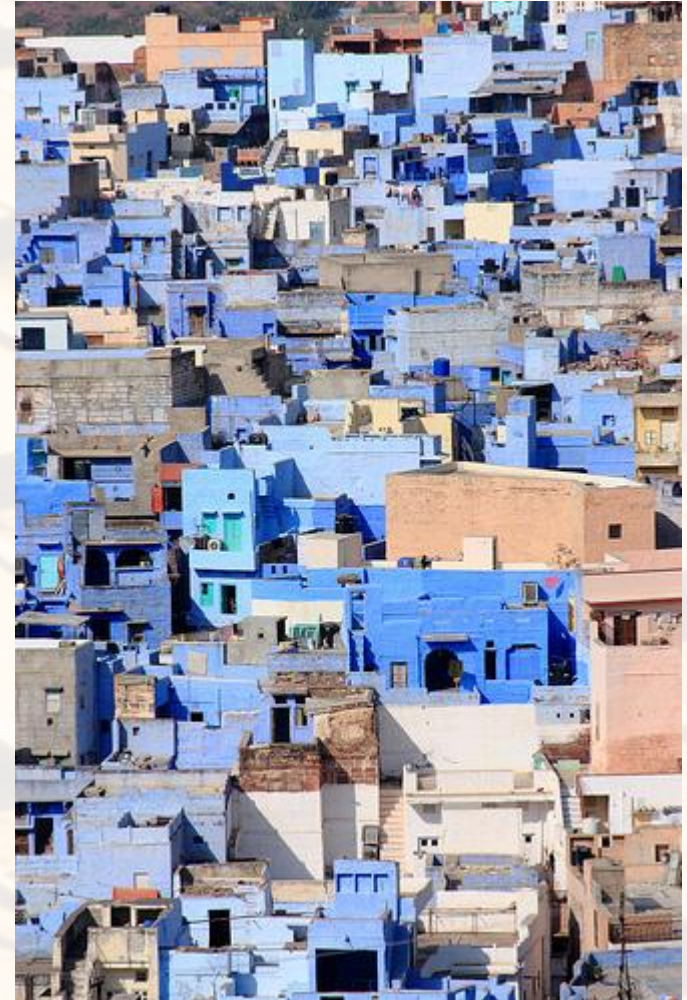
## Roof Design:

- Flat roofs are ideal in this region as heavy rainfall is not a major concern. A reflective and insulated roof accounts for less transmittance of heat



## Wall Design:

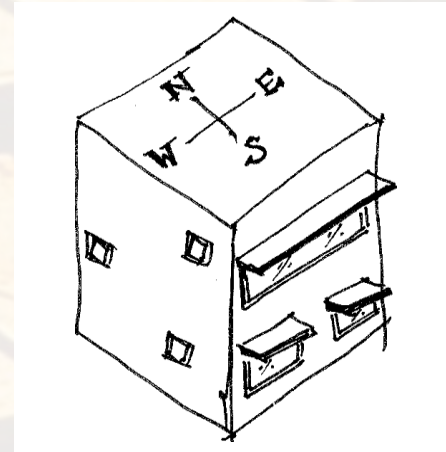
- Hollow or cavity wall construction: reduces transfer of heat from building envelope to indoor areas.
- Thicker and heavy construction materials of high thermal mass also recommended.



# LCCR Design Guidelines

## Fenestration Design:

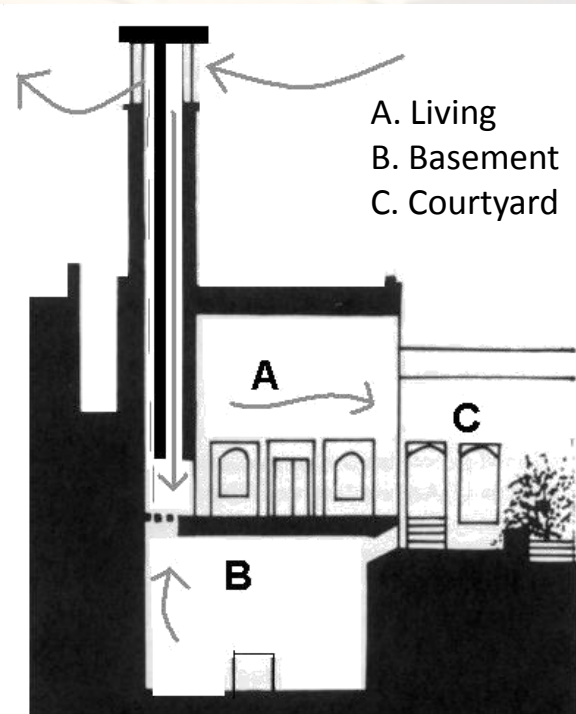
- South façade: Maximum operable openings
- West façade: some openings.
- North façade: minimal openings.
- Opening size based on daylight and ventilation requirements of specific spaces inside.
- Kitchens and living rooms need maximum daylight.
- Kitchens and bathrooms need maximum ventilation.
- Adjustable shading devices: horizontal overhangs (sunshades), vertical fins, louvers, operable blinds, and screens
- Night shutter systems



# LCCR Design Guidelines

## Wind-catchers:

- Usable in a variety of sizes to suit the specific breezes which provide effective convective cooling.



A typical cross section through a wind catcher of a house in Iran.

# LCCR Design Guidelines

## External finishes:

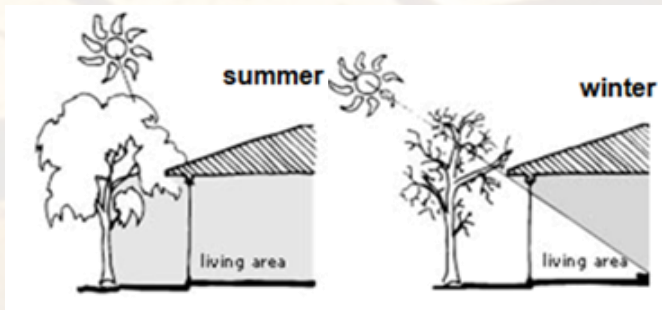
- Use light colored and reflective materials as they reflect surface radiation and therefore reduce heat collection and transfer.

## Semi-outdoor Spaces:

- Courtyards must be used for stack effect.

## Landscaping:

- The existing vegetation and top soil must be conserved to the maximum extent possible.
- Trees on site must be used for protection from strong winds.
- Deciduous can be planted as they provide shade in summer and allow percolation of sunlight during the winter.



# Passive Strategies for Semi-arid Regions

Objective		Physical manifestation
Resist summer heat gain	Decrease exposed surface area	Orientation and shape of the building.
	Increase thermal resistance	Optimum roof insulation, wall insulation.
Resist winter heat loss	Increase shading	Walls, glass surfaces protected by overhangs, fins and trees.
	Increase buffer spaces	Balconies and verandahs.
	Increase surface reflectivity	Light coloured and reflective finishes. Reflective surface on roof.
Promote summer/monsoon heat loss	Increase air exchange rate.	Cross-ventilation through windows/exhausts, courtyards, wind towers, etc. Ventilated roof construction.
	Decrease humidity levels in monsoon	Dehumidifiers/ dessicant coolers.
	Increase humidity levels in summer	Trees/water bodies for evaporative cooling



Thank you

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