Passive Design Approach to Sustainable Buildings

Jit Kumar Gupta

Former Chairman, Chandigarh Chapter, IGBC, Chandigarh

jit.kumar1944@gmail.com

Buildings- Context, Role and Importance

- Buildings-- integral part of human history, growth, development
- Buildings --continue to define future journey of human growth
- Buildings-- manmade environment
- Buildings-- vital for human growth
- Buildings – are living organism
- Buildings – are structures catering to all human activities
- Buildings – valuable – 80% human life

Buildings- Built Environment

- Operational domain of Architects /Engineers revolves around:
- -- Siting,
- -- designing,
- --construction,
- --operation,
- -- maintenance
- --Demolition and
- -Reconstruction
- -creating state of art built environment.
- Professionals-- have critical role and responsibility to;
- --make value addition to resources ,environment ,ecology
- -- by creating sustainable built environment.

Considering implications of Buildings-- resources, environment and ecology

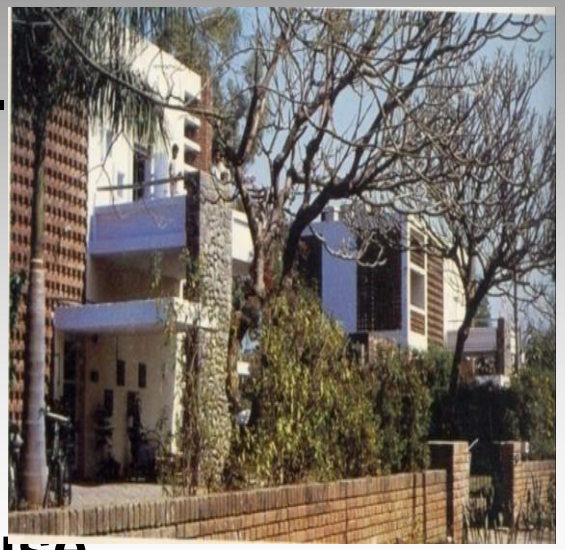
-- Going green

-- a necessity - to ensure sustainable tomorrow

-Each building unique--requires different options to make it green

BUILDINGS --AS CONSUMERS OF RESOURCES

- **Built environment– significantly impact environment /consumption of resources/generators of waste/climate change/rising temperature:**



  - **16% of world's fresh water withdrawal.**
  - **25% of wood harvested.**
  - **30% of consumption of raw material.**
  - **50% of global energy consumption.**
  - **35% of world's CO2 emission**
  - **40% of Municipal solid waste.**
  - **50% of Ozone depleting CFC's still in use.**
  - **30% of residents having sick building syndrome**

- --70% of global warming outcome of ;
- --built environment & transportation

-- Majority of existing buildings

--- low concern for energy conservation.

Implications of Built Environment

Aspects of Built Environment	Consumption	Environmental Effects	Ultimate Effects
• Siting • Design • Construction • Operation • Maintenance • Renovation • Deconstruction	• Energy • **Water** • Materials • Natural Resources	• Waste • Air pollution • Water pollution • Indoor pollution • Heat islands • **Stormwater runoff** • Noise	• Harm to Human Health • Environment Degradation • Loss of Resources

Need for Sustainable Buildings

- Annual addition of 700-900 msqm- built space ;
- ---global energy/ environment implications critical.
- Buildings--must be designed with utmost care/ considerations for—
- -- energy/ sustainability/ resources/pollution.

- Large reduction of-- energy consumption/ water/ resources/ green house gas emission possible by;
  - *Adopting integrated approach to creating built environment.*
  - *Evolving climatic responsive building designs*
  - *Using Energy efficient equipment/technologies.*
  - *Retro fitting existing buildings*
- -- To make buildings sustainable –
- -- a new field -- "green building" -- gaining momentum
- --SDG calls for
- --Promoting Energy efficient buildings,
- ----Net Zero energy buildings and
- -- Green Rated Buildings

SDG 11- Make cities / human settlements- inclusive ,safe, resilient and sustainable


WORLD GREEN BUILDING COUNCIL
SUSTAINABLE DEVELOPMENT GOALS
Green buildings can improve people's health & wellbeing
Green buildings can use renewable energy, becoming cheaper to run
Building green infrastructure creates jobs & boosts the economy
Green building design can spur innovation & contribute to climate resilient infrastructure
Green buildings are the fabric of sustainable communities & cities
Green buildings use 'circular' principles, where resources aren't wasted
Green buildings produce fewer emissions, helping to combat climate change
Green buildings can improve biodiversity, save water resources & help to protect forests
Through building green we create strong, global partnerships
3 GOOD HEALTH AND WELL-BEING
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
15 LIFE ON LAND
17 PARTNERSHIPS FOR THE GOALS

Defining- Green Buildings

DEFINITION:

- "A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

Tangible Benefits

- Reduce operating costs
- Optimize life cycle economic performance
  - Sustained savings

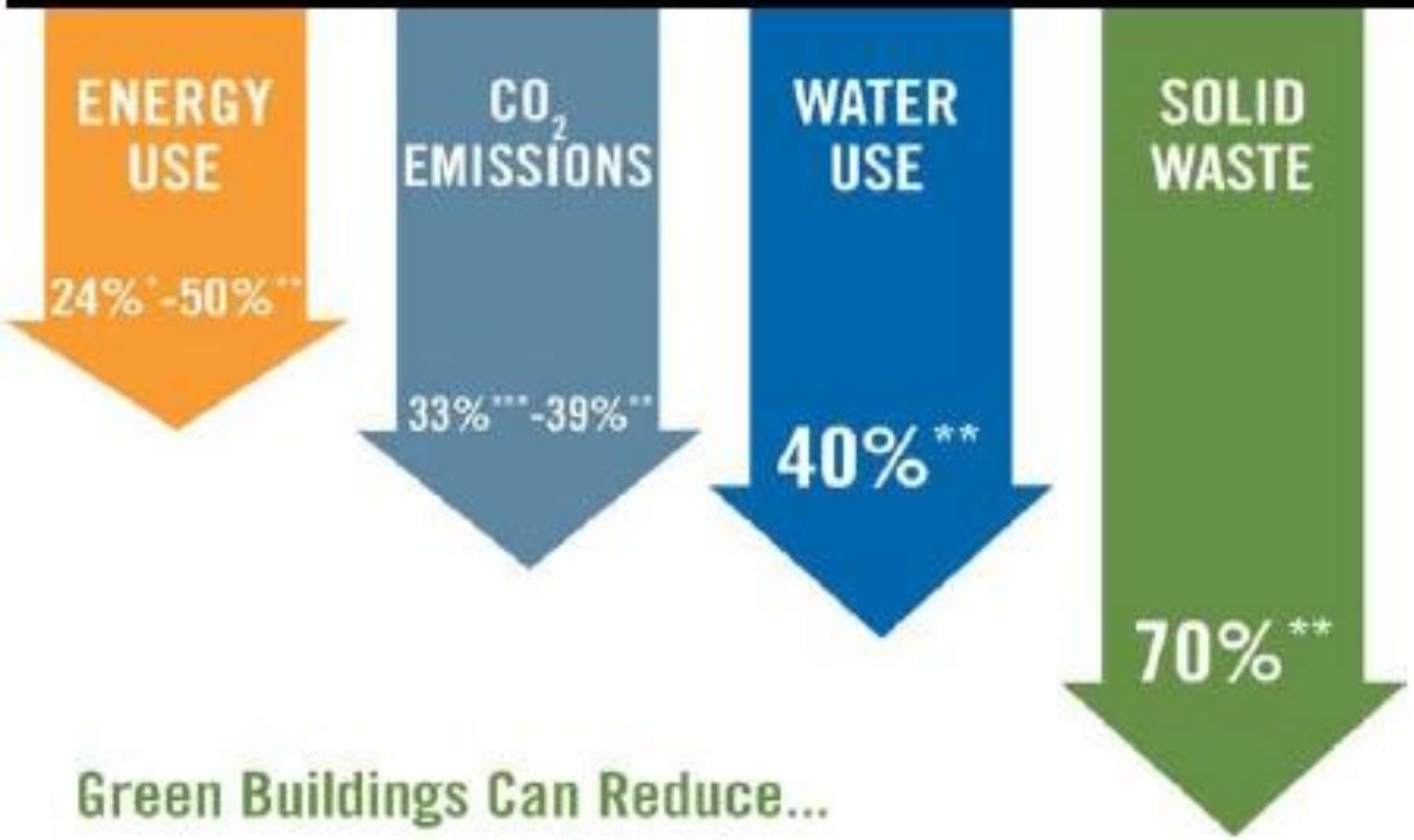
HPCL-Admin Building, Vizag

- **Energy savings: up to 50 %**
- **Water savings: up to 40 %**

In-tangible Benefits of Green Design

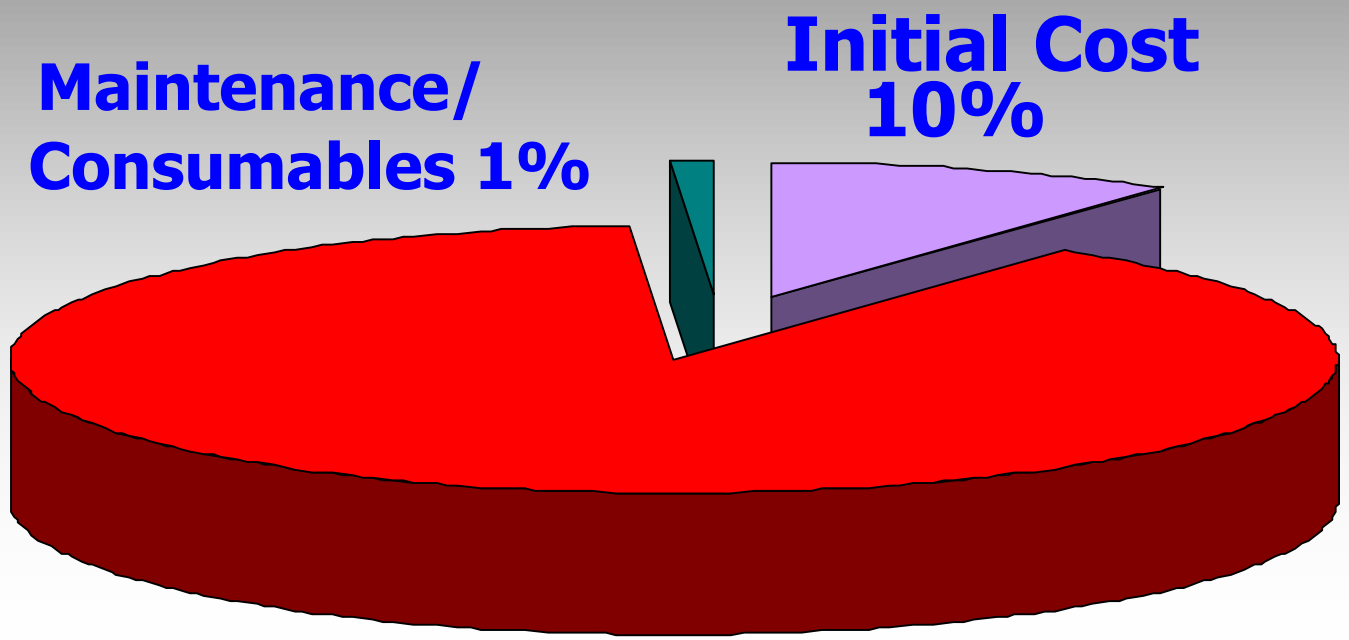
- **Environmental benefits**
  - Reduce impact on environment
- **Health and Safety benefits**
  - Enhance occupant comfort
- **Improve Productivity of occupants**

Advantages of Green Buildings



* Turner, C. & Frankel, M. (2008). Energy performance of LEED for New Construction buildings. Final report.
** Kats, G. (2003). The Costs and Financial Benefits of Green Building: A Report to California's Sustainable Building Task Force.
*** GSA Public Buildings Service (2008). Assessing green building performance: A post occupancy evaluation of 12 GSA buildings.

Green Buildings- life cycle costs



Cost of Green Buildings-Indian Experience

Building	Year awarded	Built-in Area (sq.ft)	Rating Achieved	% Increase in cost	Payback (Yrs)
CII-Godrej GBC, Hyderabad	2003	20,000	Platinum	18 %	7 years
ITC Green Centre, Gurgaon	2004	1,70,000	Platinum	15 %	6 years
Wipro, Gurgaon	2005	1,75,000	Platinum	8 %	5 years
Technopolis, Kolkata	2006	72,000	Gold	6%	3 years
Spectral Services Consultants Office, Noida	2007	15,000	Platinum	8%	4 years
Kalpataru Square	2008	3,00,000	Platinum	2%	2 years
Suzlon One Earth, Pune	2010	8,00,000	Platinum	2%	2 years

- **Cost showing a decreasing trend over the years**
- **Incremental Cost lower-- if base design has already factored normal Green features**

- ***DESIGNING GREEN***
- ***BUILDINGS***

Designing Green Buildings

i ***Decision to Build Green - taken initially in design process for*:**

- ***--Maximizing green potential***
- ***--Minimizing re-design***
- ***--Assured overall success and***
- ***--Achieving economic viability of Green Building Project***
- Ii. ***Setting Green Goals/ Objectives for:***
- ***-Energy Efficiency***
- ***--Water consumption***
- ***--On site treatment of rain/storm water***
- ***--Material/ Resource management***
- ***--Construction waste Management***

iii. ***Building a Green Team-***

- **--Hiring a design team of-- Architect, Engineering Consultants with expertise, knowledge, experience, understanding of Green Concept**

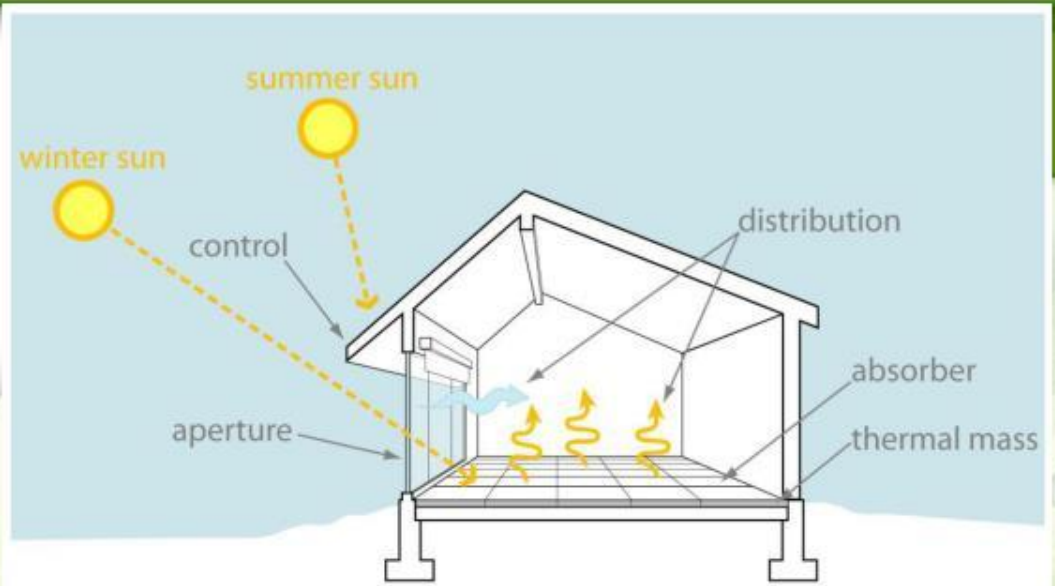
Iv *Adopting an Integrated Approach to Design-*

v Key Principles /Strategies-

- **i Sustainable built environment,**
- **Ii Water/waste management ,**
- **Iii Energy Management,**
- **Iv Material/ Resource Management and**
- **V Indoor air Quality**

Differentiating Passive vs. Active Design

Passive design results when a building is created and simply works "on its own".



Active design uses equipment to modify the state of the building, create energy and comfort; ie. Fans, pumps, etc.

Passive Design/ Green Building

- ***Passive Design/Green building design involves*** :
- **i.** ***Designing building in harmony with nature– using natural resources***
  ii. Optimizing use of site potential
- ***iii Specify 'green' building materials sourced locally***
- ***Iv Reducing structural loads---***
- ***V Optimize systems--- HVAC***
- ***Vi Generating on-site renewable energy.***
  vii Finding balance between building and environment
  viii Promoting energy reduction
- ***ix Preparing plans with energy as focus,***
- ***x Making best use of sun and wind energy***
  xi Involving cooperation of design team at all stages– Architects, Engineers, Promoters
- ***xii Minimizing water consumption***
- ***xiii Using non-toxic, sustainable materials***
- ***xiv Preserving/promoting environment in design, construction and operation***
- ***xv Promoting quality of life-- of occupants in design, construction and operation***
  xvi Promoting re-use and recycling
  xvii Ensuring Good indoor environmental air quality

Green Building practice expands/ complements

- economy,
-utility,
-durability,
-comfort.

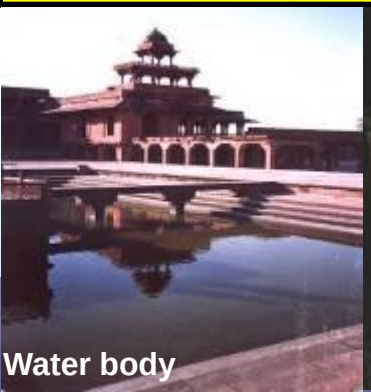
Passive Design/Designing Green Buildings

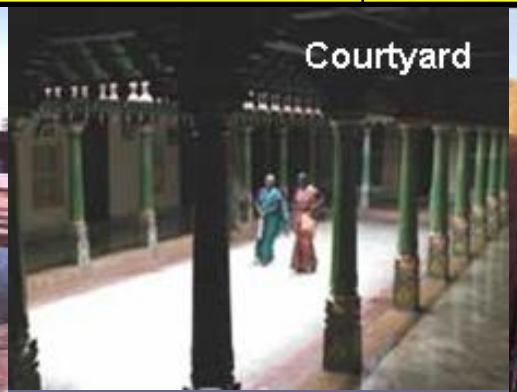
- *1. Adopting integrated approach to building design*
- *2. Design based on Climate*
- *Macro Climate – Regional climate; Meso Climate– local climate*
- *Micro Climate--Site climate -- based on site characteristics,*
- *3. Orientation -- to optimize light , heat gain/ heat loss*
- *4. Sun movement-- to maximizes use of free solar energy for heating /lighting*
- *5.Wind direction---using air movement for ventilation/ cooling*
- *6. Planning of Building-- optimize site, size, shape, planning spaces, allocating uses, placing rooms, circulation, promoting building efficiency, promoting natural sunlight, air / ventilation*
- *7.Designing Building Envelop---– Mass – space relationships/ solids/voids, positioning –openings/projections, shading devices, height, shape of building, natural lighting and ventilations etc*
- *8. Materials- low embodied energy; locally ; natural form, lightweight*
- *9.-Technology- cost effective/material efficient/speedier/energy efficient*
- *10.ndoor Air Quality-Creating optimum living conditions for occupants*

Indian Way of approaching design

- Rediscovery of Indian ethos
  - We worship 5 elements of Nature (Panchabhutas)

Prithvi (Earth)	Sustainable Sites
Jal (Water)	Water Efficiency
Agni (Energy)	Energy Efficiency
Vayu (Air)	Indoor Environmental Quality
Akash (Sky)	Daylight


Water body




Local materials


Views


Daylighting

Focus Areas: Green Buildings

- **Climatic Zones in India**

CLIMATIC ZONES AND THEIR CHARACTERISTICS

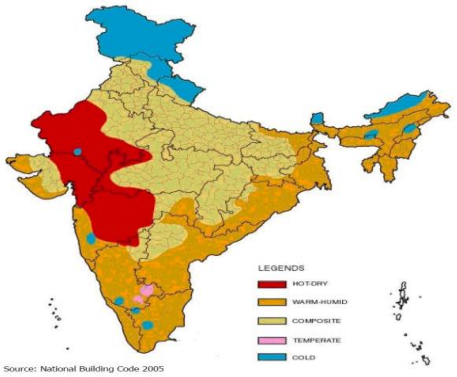
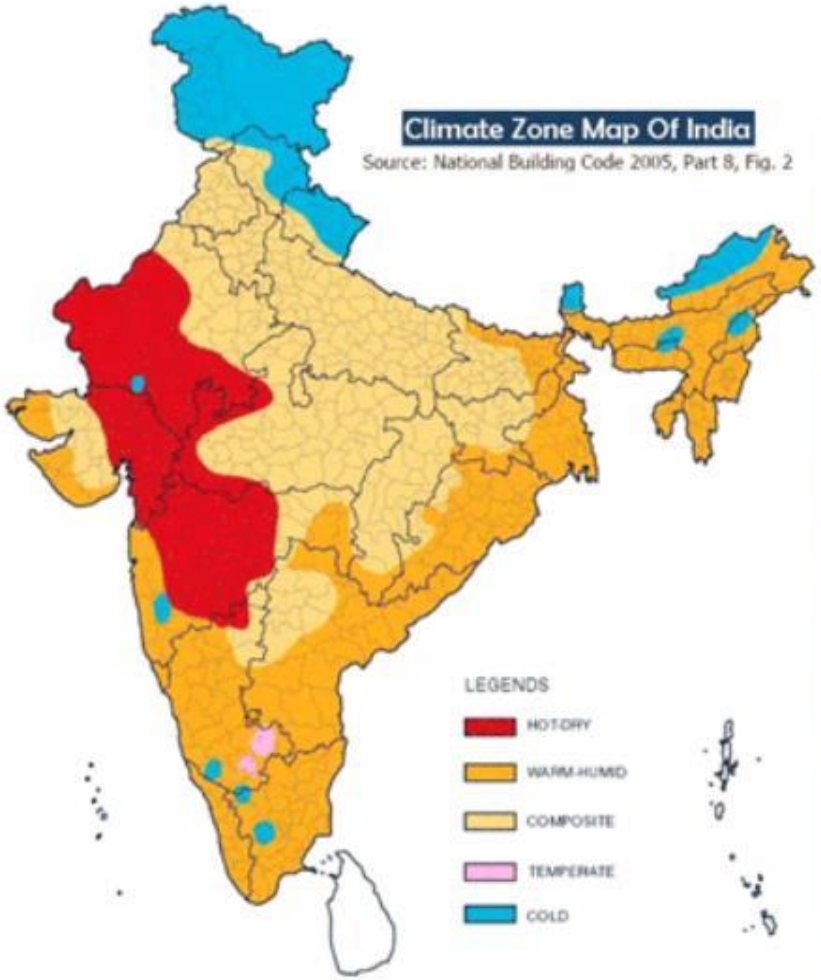


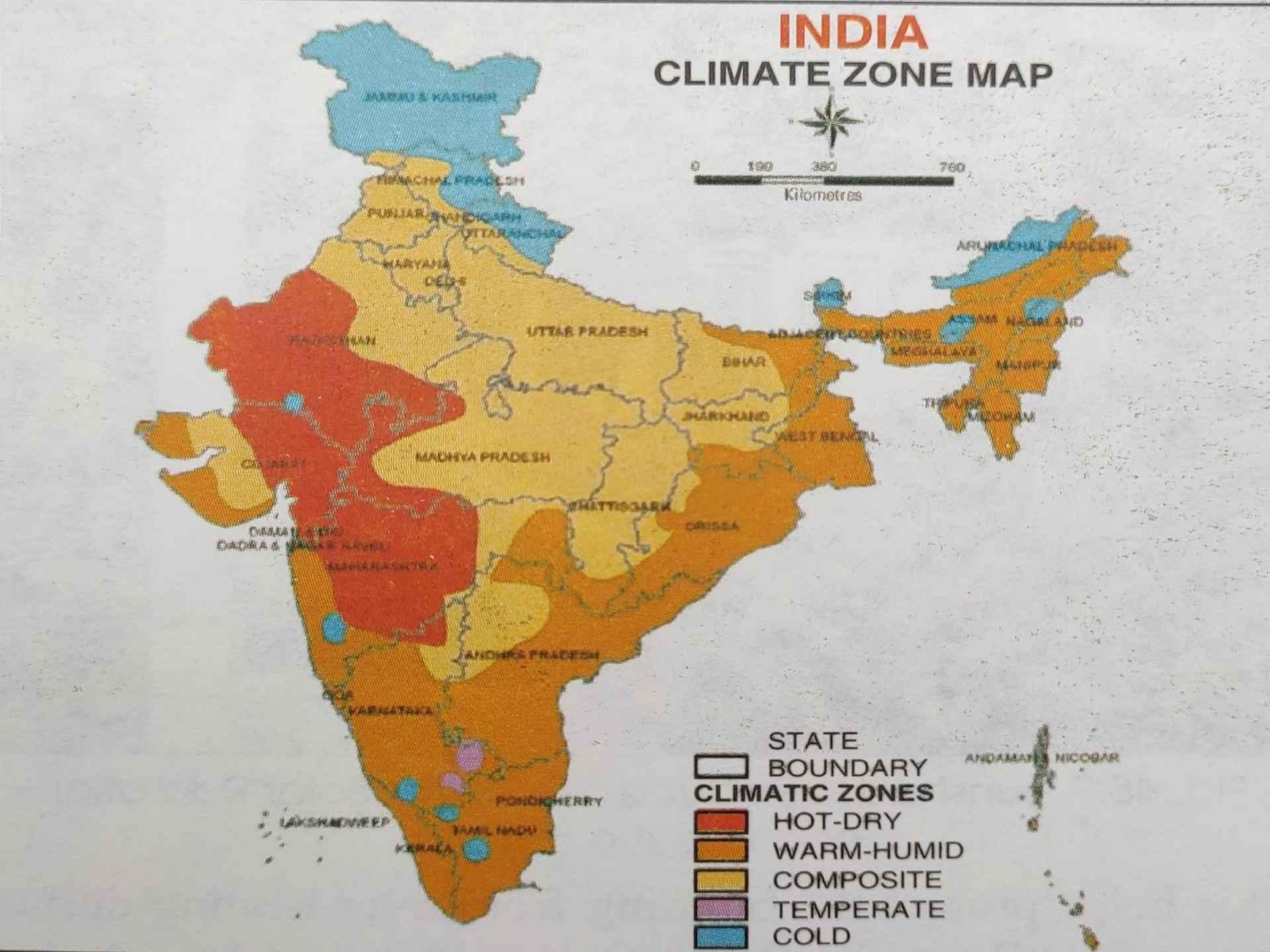
Table 2.1 Classification of Climates

Criteria of Bansal et al. [1]			Criteria of SP 7: 2005 [9]		
Climate	**Mean monthly temperature (°C)**	**Relative humidity (%)**	**Climate**	**Mean monthly maximum temperature(°C)**	**Relative humidity (%)**
Hot and dry	>30	<55	Hot and dry	>30	<55
Warm and humid	>30	>55	Warm and humid	>30 >25	>55 >75
Moderate	25-30	<75	Temperate	25-30	<75
Cold and cloudy	<25	>55	Cold	<25	All values
Cold and sunny	<25	<55			
Composite	This applies, when six months or more do not fall within any of the above categories		Composite	This applies, when six months or more do not fall within any of the above categories	

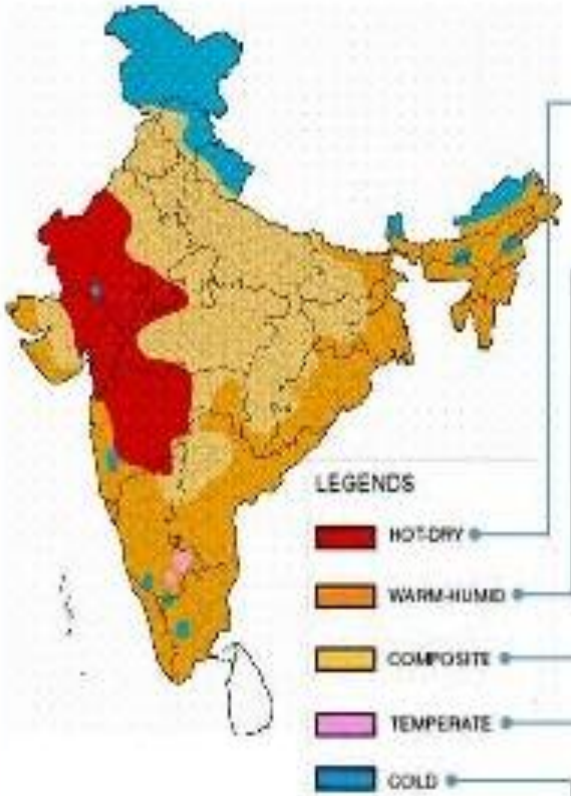
Climatic zones of India



- Hot & Dry
- Warm & Humid
- Composite
- Temperate
- Cold


INDIA
CLIMATE ZONE MAP
0 190 380 760
Kilometres
UTTAR PRADESH
BIHAR
MADHYA PRADESH
ORISSA
ANDHRA PRADESH
KARNATAKA
PONDICHERRY
TAMIL NADU
KERALA
STATE
BOUNDARY
CLIMATIC ZONES
HOT-DRY
WARM-HUMID
COMPOSITE
TEMPERATE
COLD

Climate Zones in India



High temperature • Low humidity and rainfall • Intense solar radiation and a generally clear sky • Hot winds during the day and cool winds at night

Temperature is moderately high during day and night • Very high humidity and rainfall • Diffused solar radiation if cloud cover is high and intense if sky is clear • Calm to very high winds from prevailing wind directions

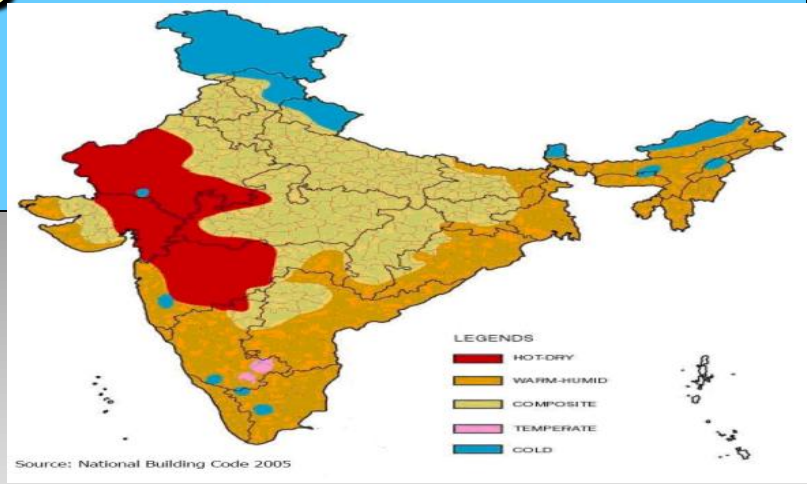
This applies when 6 months or more do not fall within any of the other categories • High temperature in summer and cold in winter • Low humidity in summer and high in monsoons • High direct solar radiation in all seasons except monsoons high diffused radiation • Occasional hazy sky Hot winds in summer, cold winds in winter and strong wind in monsoons

Moderate temperature • Moderate humidity and rainfall • Solar radiation same throughout the year and sky is generally clear • High winds during summer depending on topography

Moderate summer temperatures and very low in winter • Low humidity in cold/sunny and high humidity in cold/cloudy • Low precipitation in cold/sunny and high in cold/cloudy • High solar radiation in cold/sunny and low in cold/cloudy • Cold winds in winter

SOURCE: Bureau of Indian Standards, National Building Code of India 2005, Part 8 Building Services, Section 3 Air Conditioning, Heating and Mechanical Ventilation; Bansal, N. K. & G. Minke (1994), Climatic Zones and Rural Housing in India; Krishan, A., N. V. Baker & S. V. Szokolay (2001), Climate Responsive Architecture - A Design Handbook for Energy Efficient Buildings, Tata McGraw Hill

Integrated Design Process



- **Five Climatic Zones In India-**
- ***Hot and Dry***
- ***Warm and Humid***
- ***Moderate / Temperate***
- ***Cold (Cloudy/Sunny)***
- ***Composite***
- All green buildings need not-- to be same

All zones have specific requirements regarding:

--light,
--heat,
--ventilation and
--thermal comfort

Different zones require different design strategies regarding -- building envelop,

- ***--HVAC,***
- ***-- Lighting ,***
- ***-- Fenestration,***
- ***-- Performance standards***

- ***Site***
- ***Analysis***

Site Analysis- Factors considered

i) Understanding Site
ii) Location
iii) Orientation- *rising sun- position of a building in relation to an east-west axis.*
iv) Wind direction
v) Soil conditions
vi) Topography
vii) Vegetation and Natural Features
viii) Hydrology and Precipitation
ix) Infrastructures
x) Surrounding Land uses & Buildings
xi) Vision / Visual Linkages

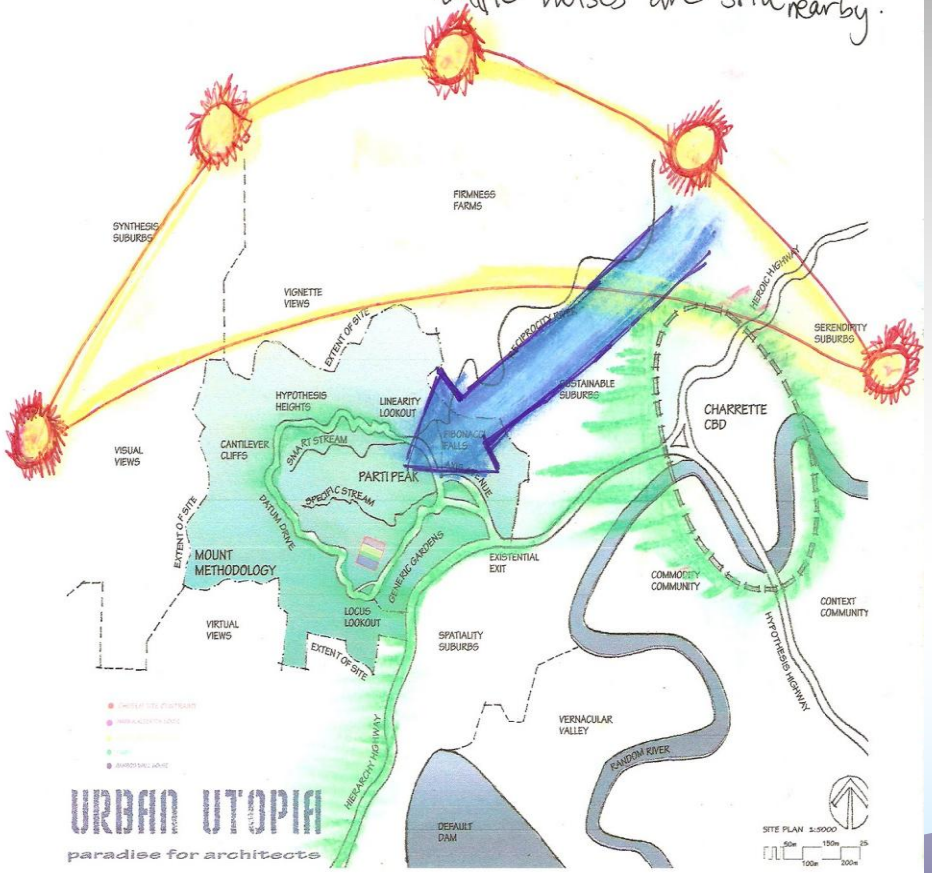
Site Analysis

Sun path

Wind Direction

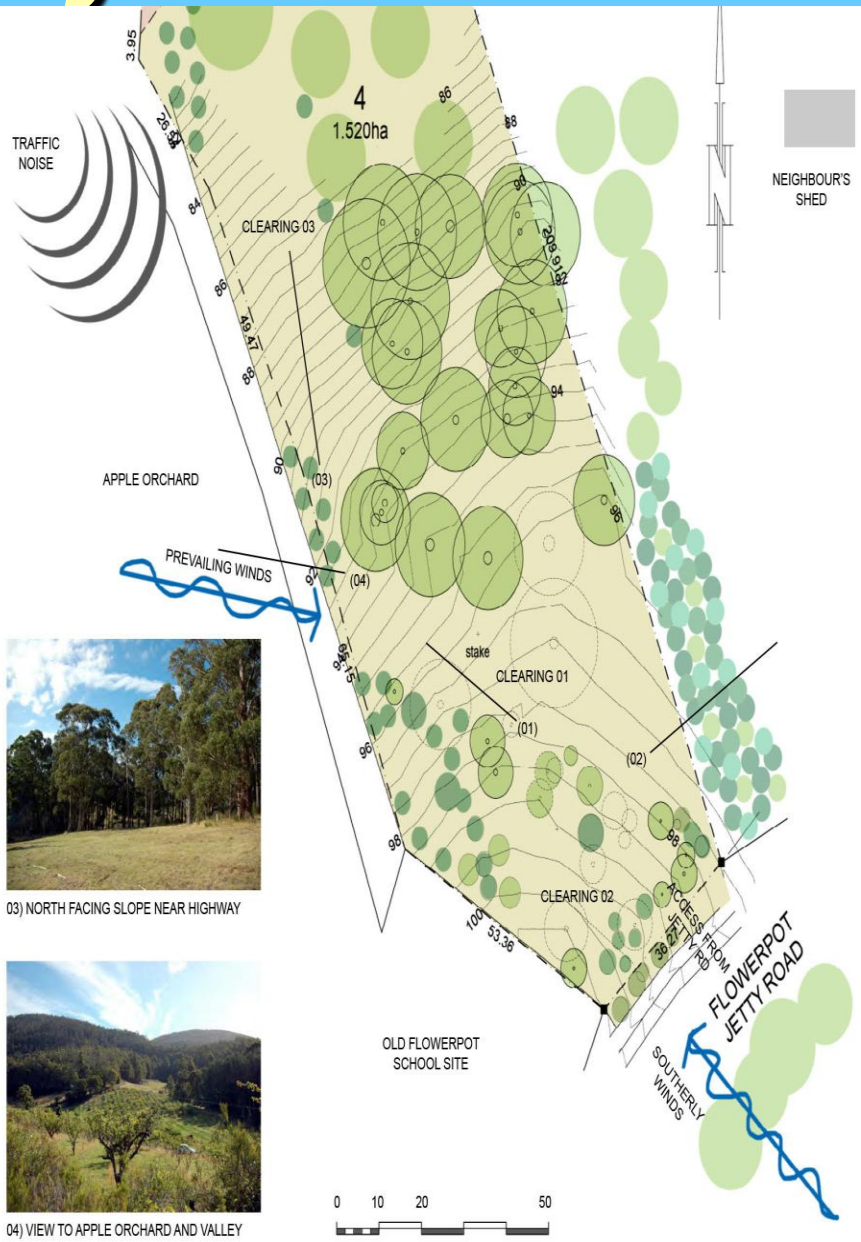
Noise flow

The site is located on an elevated surface which increases breezes and reduces noise from the city. The distance from the city reduces the noise however the site is located near roads thus local traffic noises are still nearby.



URBAN UTOPIA
paradise for architects

SITE ANALYSIS
CABIN + EXEMPLARS



03) NORTH FACING SLOPE NEAR HIGHWAY

04) VIEW TO APPLE ORCHARD AND VALLEY

SITE ANALYSIS

SWOT

STRENGTH

- The site is near to the business and agriculture land of the place.
- It has good condition of accessibility through road.
- The area has enough water supply,power lines, telephones and communication lines are available.
-

WEAKNESSES

- There is a possible to deal with noise pollution.
- There are problems in heavy traffic during weekdays.

OPPORTUNITIES

- It can also provide job opportunities to the locals.
- The rich and the poor have the opportunity to socialize with one another.
- Can also provide opportunities for families with no sufficient income for the facilities to be built.
- All families have the opportunity to choose their residence to the best of their income.
- This project can also add to the development increase of the city.

THREATS

INTRODUCTION

Tanauan,Batangas has a tropical climate.The is a great deal of rainfall in Tanauan, even in the driest month.The Koppen-Geiger climate classification is Af.The avverage annual temperature is 27.0° C in Tanauan.The average annual rainfall is 2459 mm.

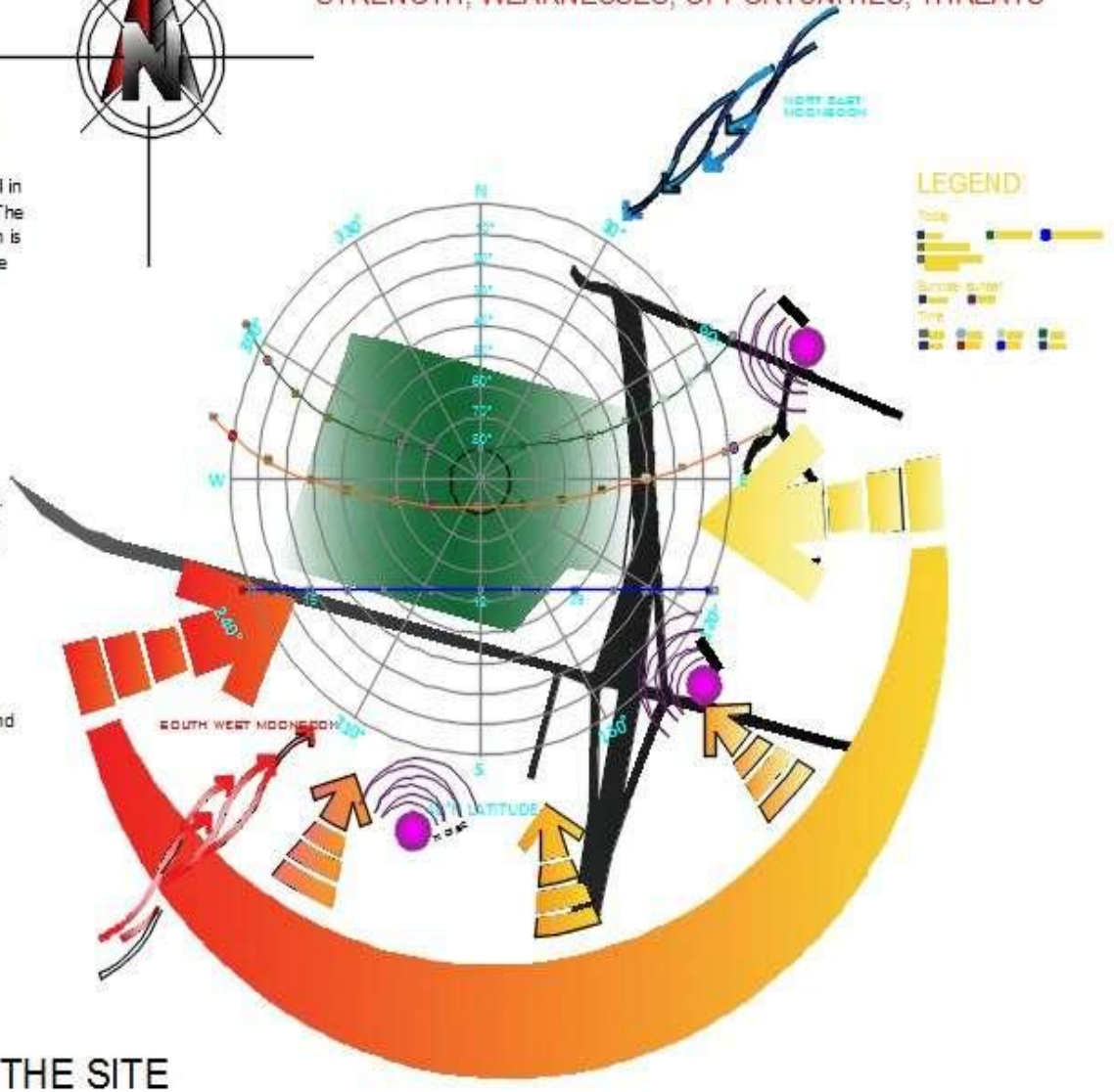
CLIMATOLOGY

The temperatures are highest on average in August, at around 27.8°C. The lowest average temperatures in the year occur in January, when it is around 25.9°C.

TOPOGRAPHY

The city of Tanauan covers a total land area of 10,716 hectares which represents 3.38% of the total land area of the province (316,581 ha).Majority of the areas in Tanauan City belong to 0 to 15 percent slope that are undulating to rolling.

STRENGTH, WEAKNESSES, OPPORTUNITIES, THREATS



VIEWS FROM THE SITE

Orientation & Buildings

Understanding/Valuing Sun

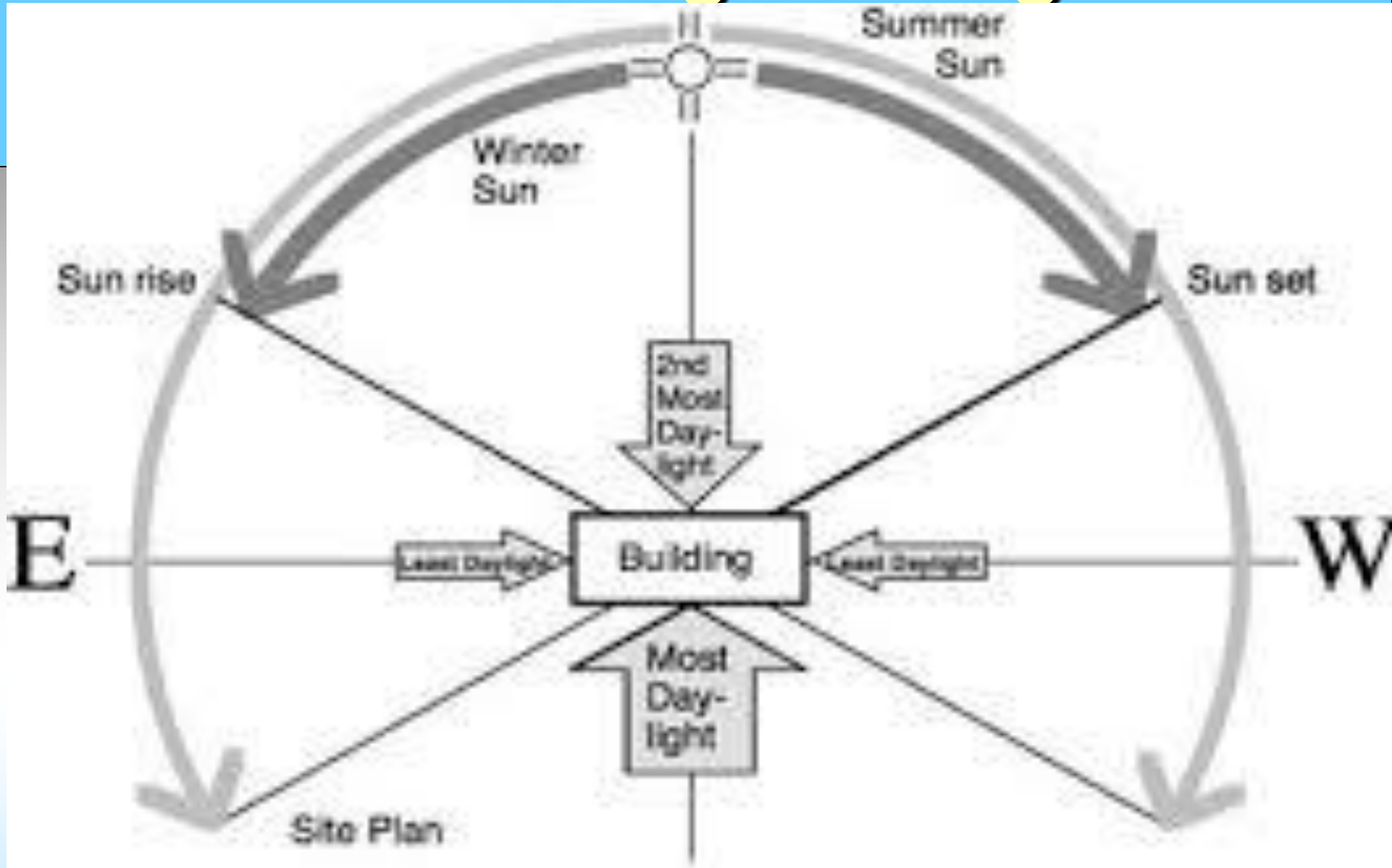
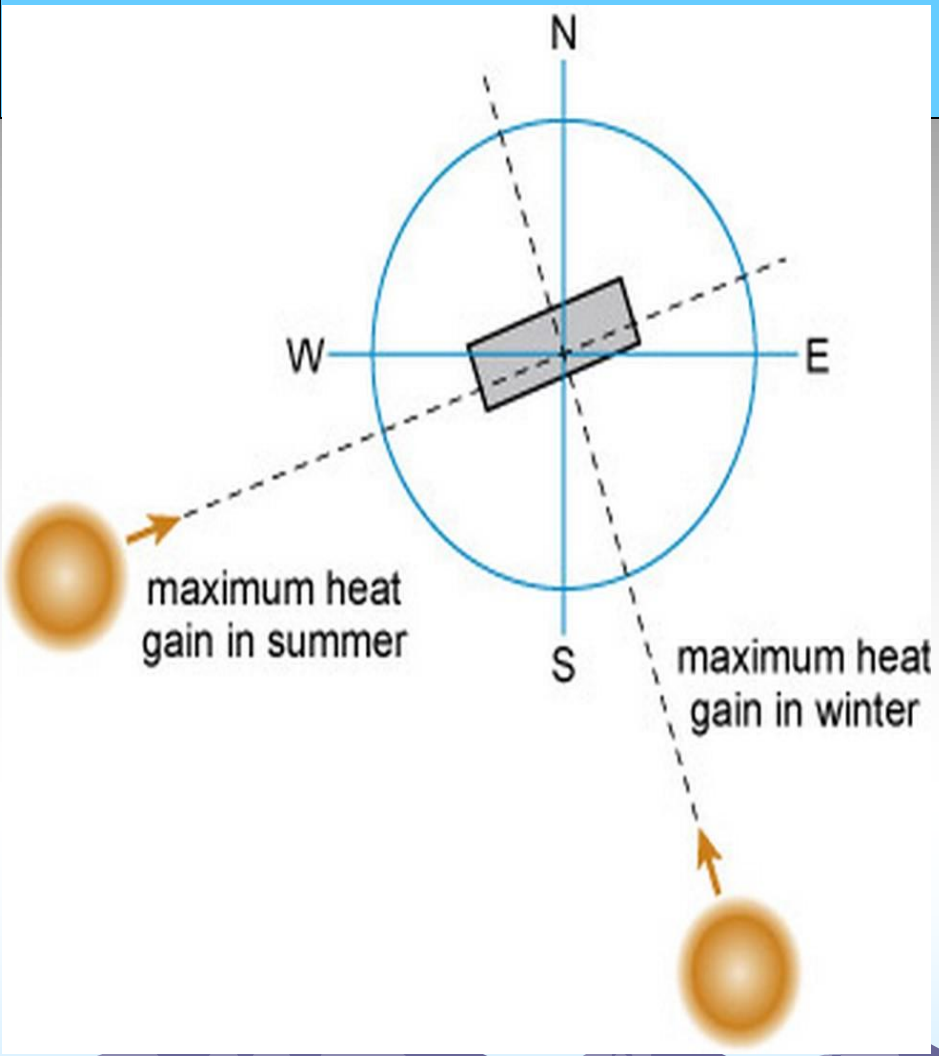


Figure 1

- NORTH; SOUTH; EAST; WEST; SUN & WIND patterns.

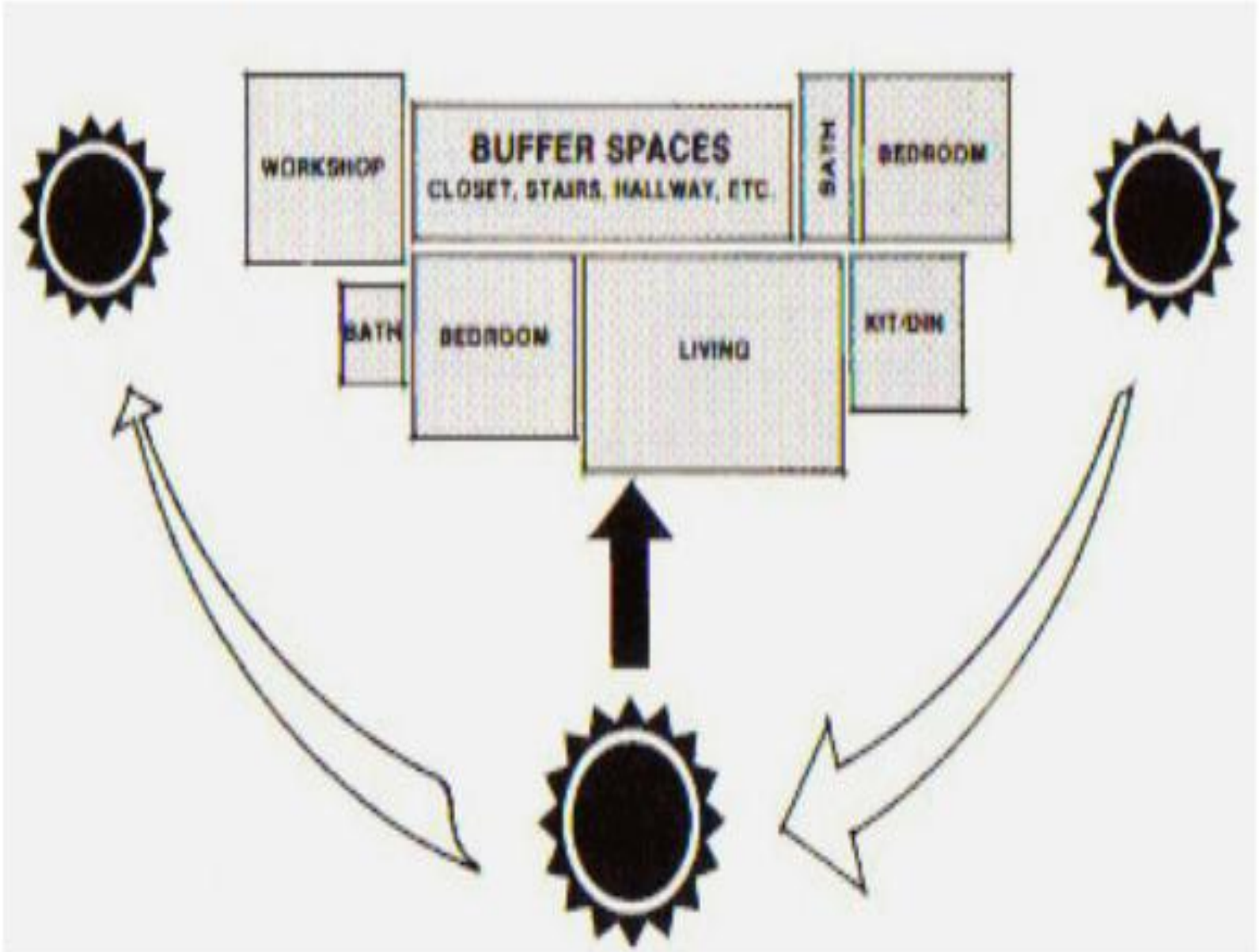


--Orientation – a Technique for improving thermal comfort inside building.

Orientation- critical for planning /Designing Buildings

-Optimizes heating / cooling needs throughout building.

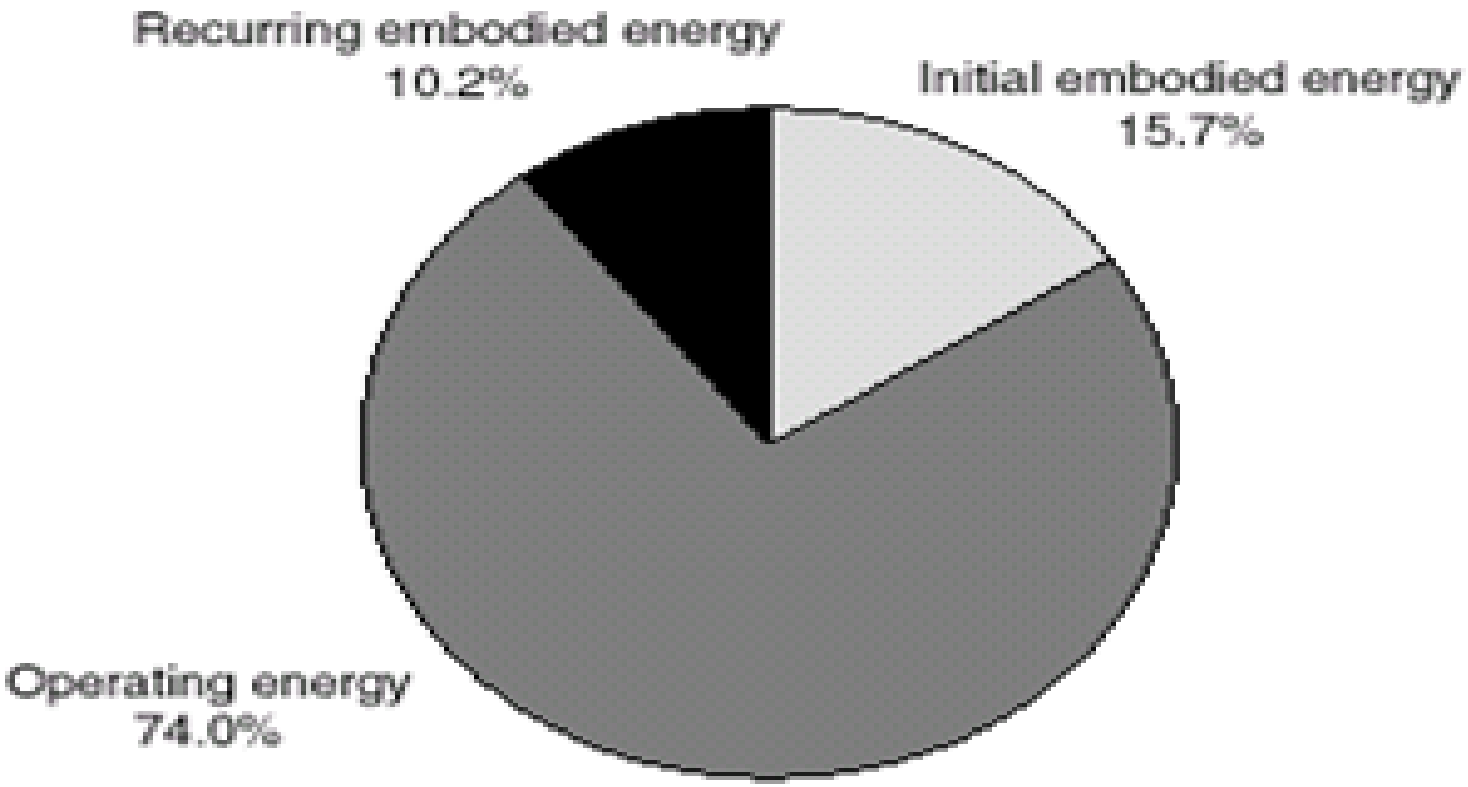
Planning for spaces in buildings



TOWER OF SHADOWS

Energy Implications of buildings

Figure 3: Distribution of Life-cycle Energy Consumption.



Energy Efficiency

- ***Green buildings reduce energy consumption in two ways-***
- **i. *Embodied energy-* extract, process, transport and install building materials and**
- **Ii. *Operating energy--* to provide services to make buildings operational-- such as heating, lighting, air conditioning, ventilation and power for equipment.**
- **High-performance buildings use less operating energy,**
- ***Embodied Energy importance* – upto 15.7 % of total energy consumption.**
- ***For reducing Embodied energy –*Use local materials/ materials in natural form- which consume less energy for manufacturing --buildings made of wood have lower embodied energy than steel/concrete**
- ***For reducing Operating energy –*--reduce air leakage through building envelop**
- **--Specify high-performance windows**
- **--Provide extra insulation in walls, ceilings, and floors.**
- **-- use Passive solar building design**
- **-- Orient windows and walls rationally ,**
- **-- Use trees shade windows /roofs during summer for cutting sun- in hot areas/zones**
- **- while ensuring maximizing solar gain in winter- in cold areas**
- **-- effective window placement (day lighting)-- to provide more natural light /reduce need for electric lighting during day.**
- **-- Solar water heating reduces energy costs.**
- **--Onsite generation of renewable energy through solar power wind power, hydro power or biomass significantly reduce environmental impact Of building**

Energy efficiency- Embodied energy

What is embodied energy?

The quantity of energy required to manufacture, and supply to the point of use including:

- Extraction
- Transportation
- Manufacturing
- Assembly
- Installation
- Some definitions also include: Disassembly & Removal

Building Envelop- Heat Loss/Gain, Cooling Natural Light, Ventilation

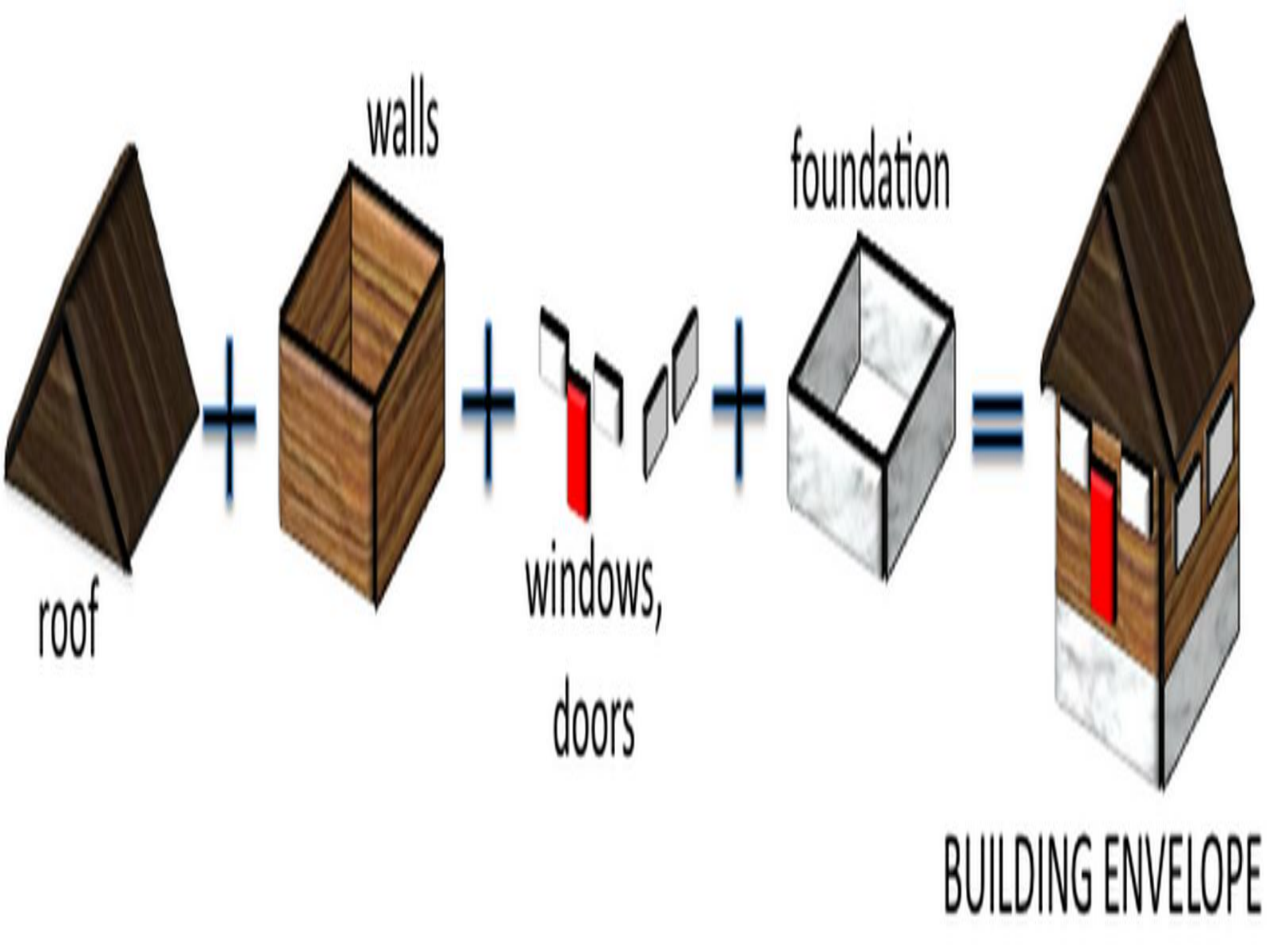
Building Envelope

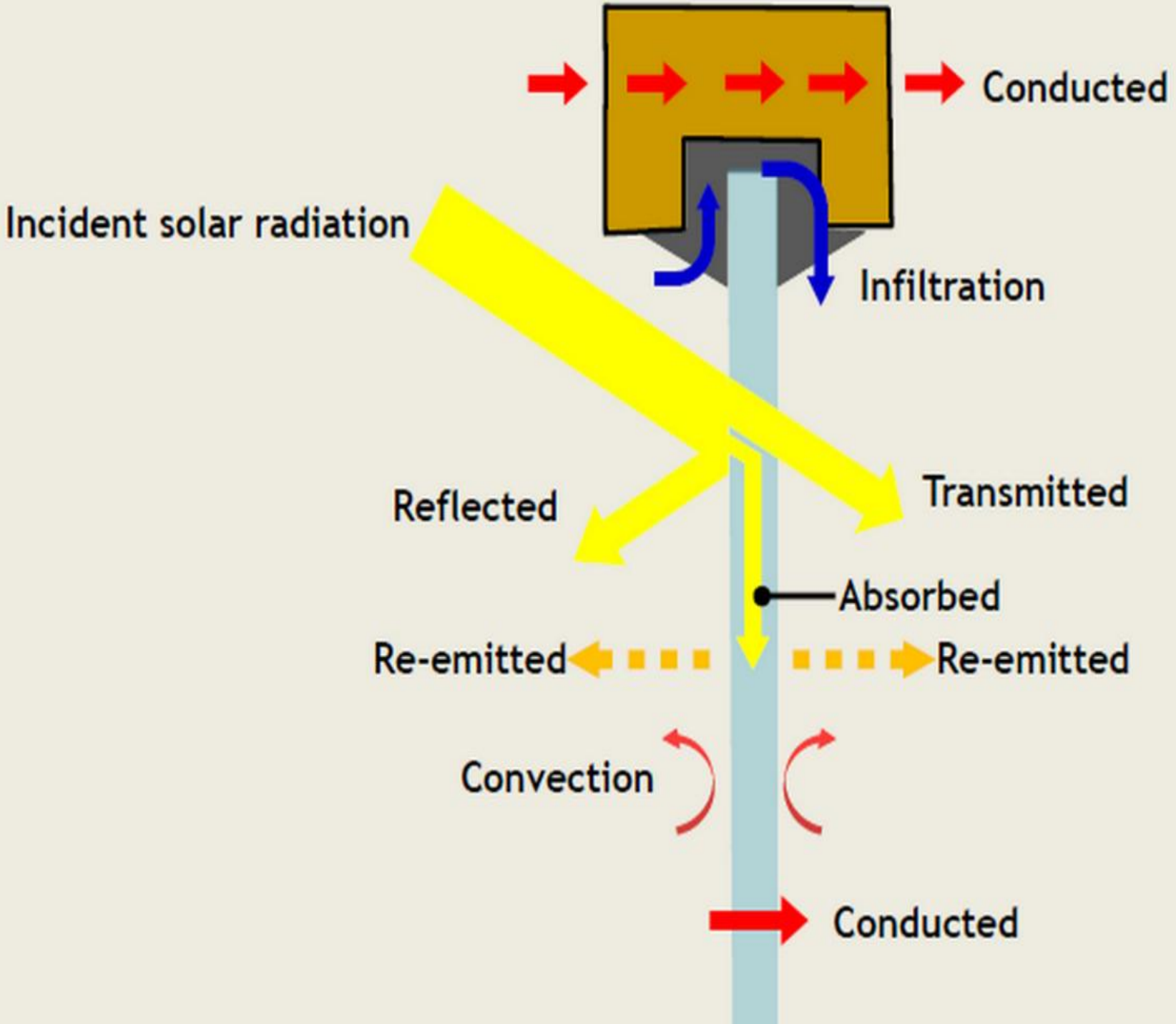
Building Envelope

- *Building envelope;*
- *-Divides – natural / Manmade Environment*

--First line of defense- against natural forces – rain , heat, cold, storm

- *-- Barrier between interior/exterior of a building*
- *- controls exchange of air/water/heating/ cooling in interior.*
- *-Components constituting Envelope; Roof, Walls, Doors, Windows, Foundations, Projections, Recesses, Louvers; shading devices*
- *--Envelop- Involves structural loads , air, heat, moisture loads.*
- *Colour/texture- contributes to heat gain/loss within*


walls
foundation
roof
windows,
doors
BUILDING ENVELOPE


Conducted
Incident solar radiation
Infiltration
Reflected
Transmitted
Absorbed
Re-emitted
Re-emitted
Convection
Conducted

Efficiency of Building Envelope

Fig 2

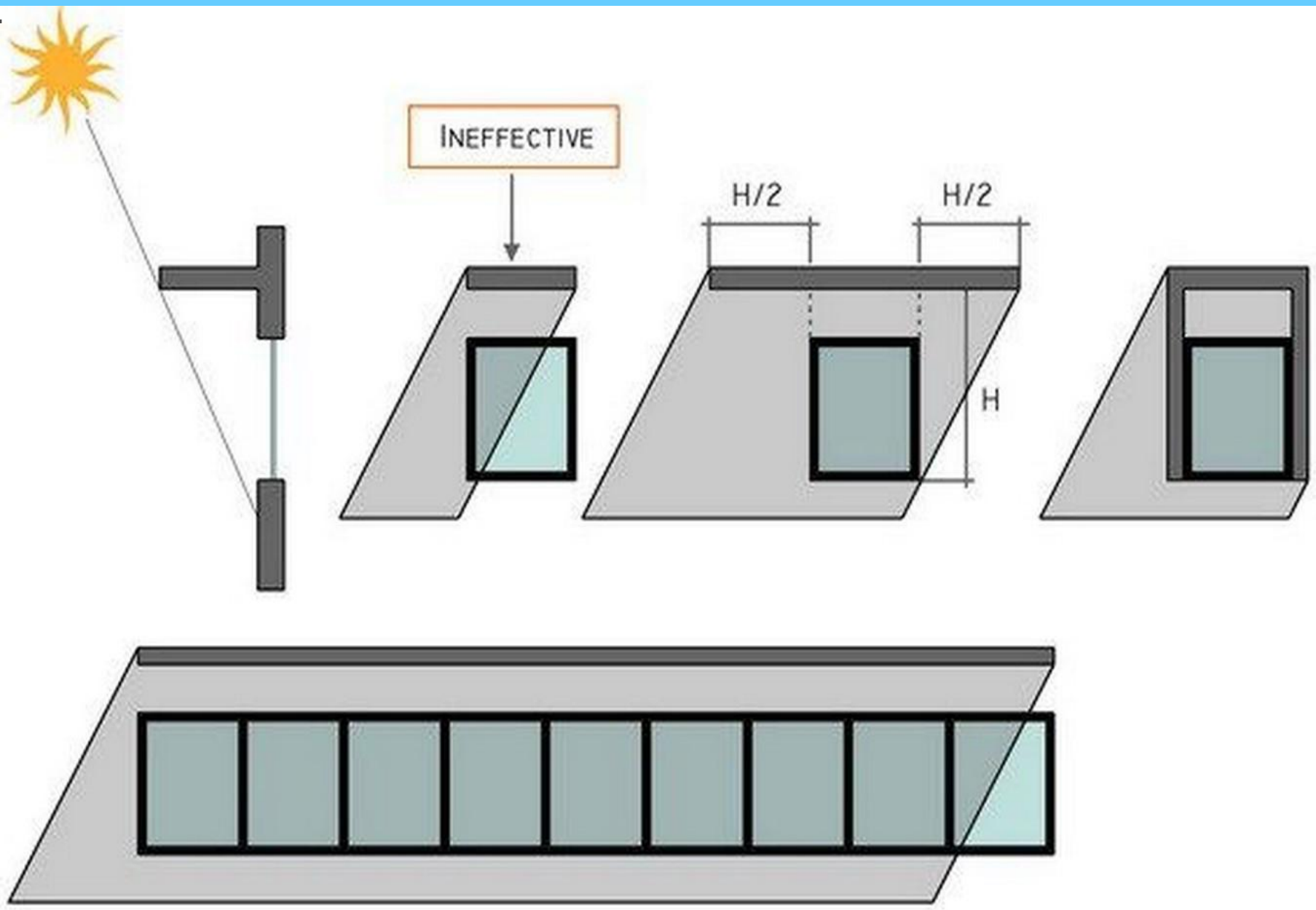
FACADE ARTICULATION

- Max. ventilation
- Orientation of smaller side of structure along east-west
- North-south orientation for max. air movement
- High density of façade that is open and yet shaded.
- Faint/pale colours on outer surfaces
- Building materials with insulating/reflecting properties that resist heat transfer.

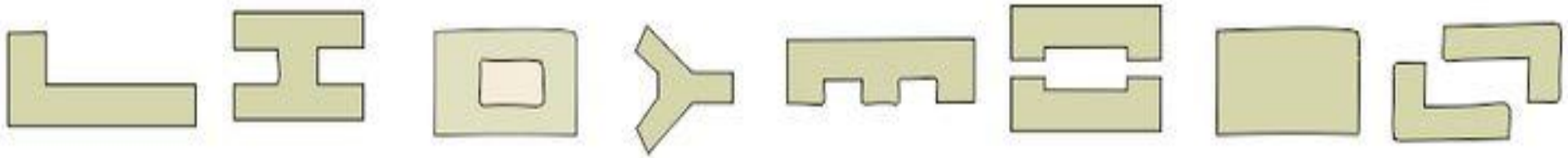
Solar Shading

- *Solar control / shading --directly impact -- energy efficiency*
- *--cooling load minimized to one-fourth of building's load.*
- *-Shading devices – fins/ chajjas (overhangs) designed*
- *--to get a minimum exposure of sun in summer*
- *-- while allowing winter sun inside the space.*
- *-- helps in regulating /reducing electrical load on building.*
- *-- Solar orientation important -- while designing an effective shading device.*
- *-- Some solar shading elements -- trees, hedges, overhangs, vertical fins, low-shading coefficient glass, blinds, and louvers*

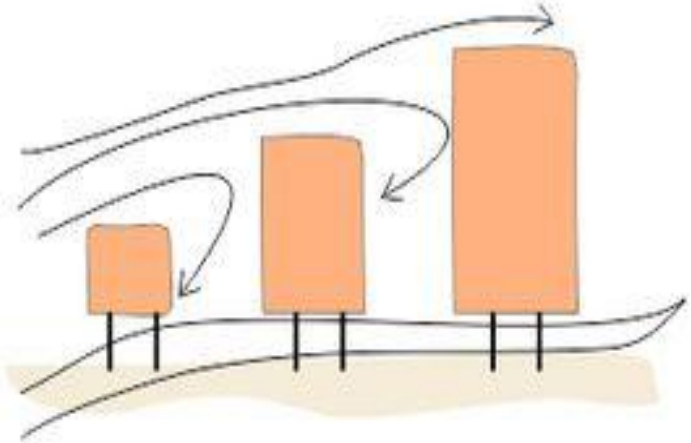
Solar shading



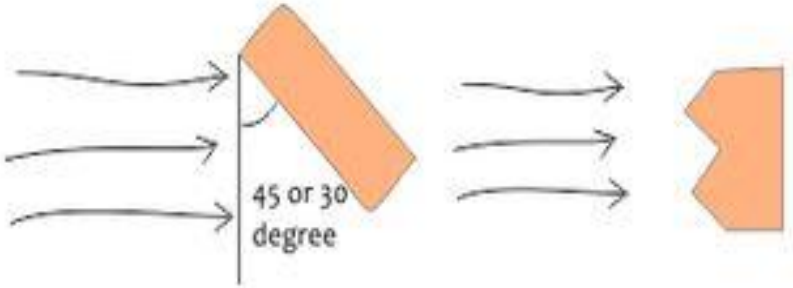
Planning with wind



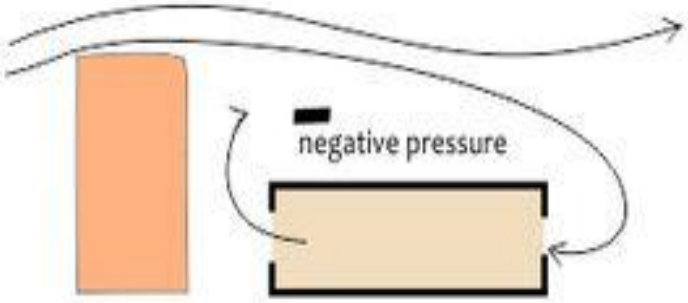
Orient longer facades along the north. This will provide glare free light in summer from north without shading and winter sun penetration from the south.



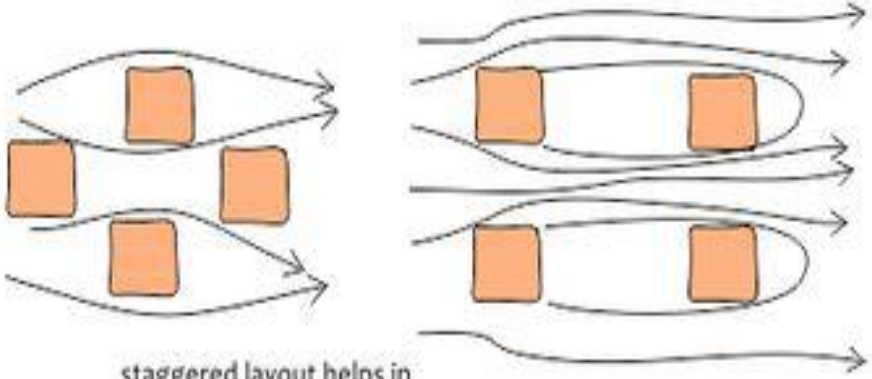
if a site has multiple buildings, they should be arranged in ascending order of their heights and be built on stilts to allow ventilation



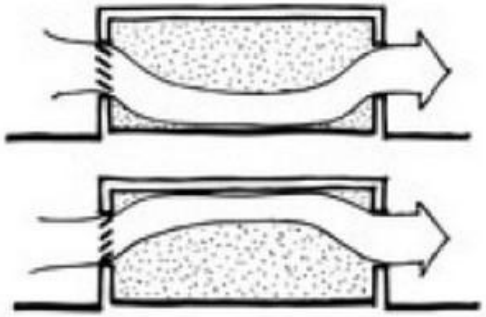
Place buildings at a 30 or 45 degree angle to the direction of wind for enhanced ventilation. Form can be staggered in the wind facing direction also to achieve the same result.



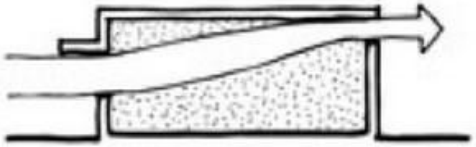
Taller forms in the wind direction of prevailing wind can alter the wind movement pattern for low lying buildings behind them



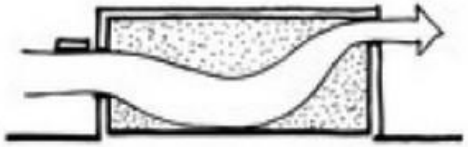
staggered layout helps in accentuating wind movement



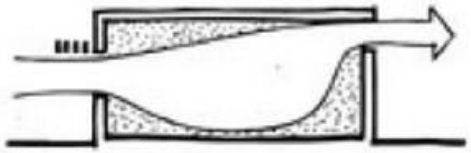
Louvres can direct airflow upward or downward.



A canopy over a window tends to direct air upward.



A gap between canopy and wall ensures a downward pressure.



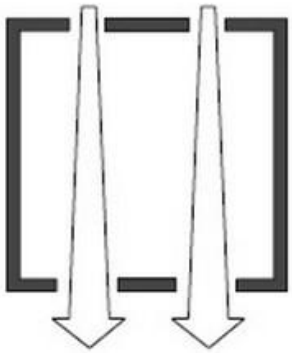
Downward pressure is improved further in the case of a louvered sunshade.

Steve Szokolay

_cross-ventilation

_higher up windows to allow hot air to escape

_smaller inlet windows facing prevailing winds and larger outlet windows on opposite side



Designing with Regional Climate

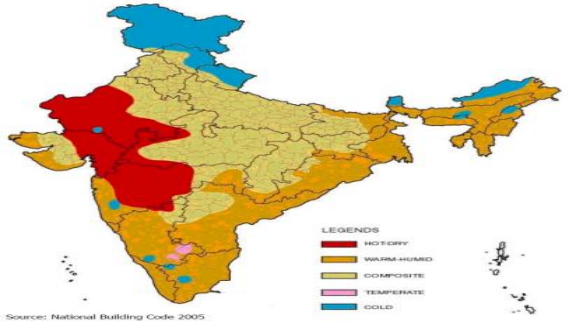
- # Hot & Dry Climate

Hot and dry climate

- This zone lies in western and central part of India, jaisalmer, jodhpur, etc.
- This region is usually flat, sandy, rocky ground with spares vegetation of cacti thorny bushes.
- Water level is very low here.
- The diurnal variation in temperature is quite high more than 10°C.

Hot and Dry Climate Zone-

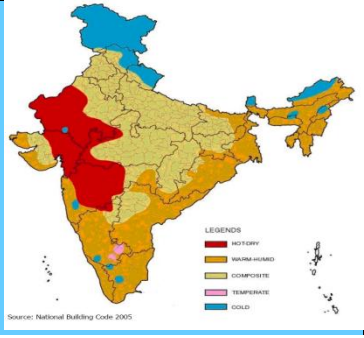
Comfort requirements and Physical manifestations in Buildings



Thermal Requirements	Physical Manifestation
Reduce Heat Gain	
Decrease exposed surface area	Orientation and shape of building
Increase thermal resistance	Insulation of building envelope/roof/walls
Increase thermal capacity (Time lag)	Massive structure
Decrease air exchange rate (ventilation during the day)	Smaller windows openings, night ventilation
Increase buffer spaces	Air locks/lobbies/balconies/verandahs
Increase shading	External surfaces protected-overhangs, fins, trees
Increase surface reflectivity	Pale colour, glazed china mosaic tiles etc.
Reduce solar heat gain	Use glazing with lower Solar Heat Gain Co-efficient-SHGC and provide shading for windows. Minimize glazing in East and West
Promote Heat Loss	
Increase air exchange rate (ventilation during night-time)	Courtyards/wind tower/arrangement of openings

Hot and Dry Climate Zone-

Comfort requirements and Physical manifestations in Buildings



HOT

COOL

LIVING ROOM

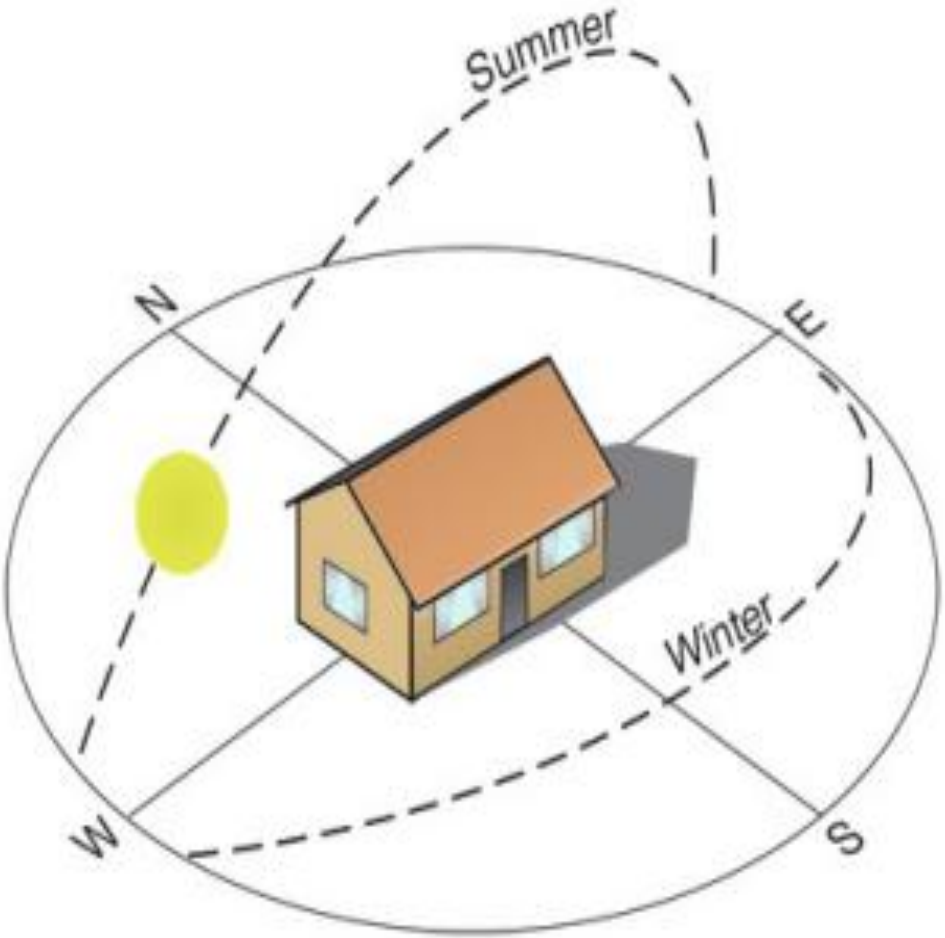
EVAPORATIVE COOLER

Cavity Walls

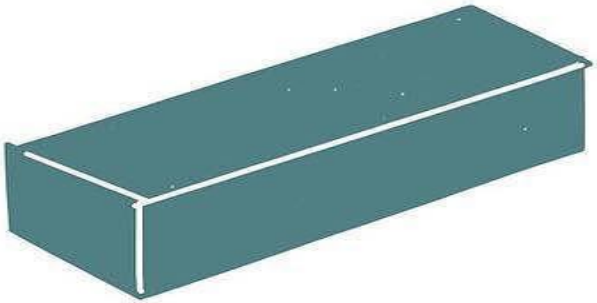
Understanding Orientation

5. Building Orientation and Shading

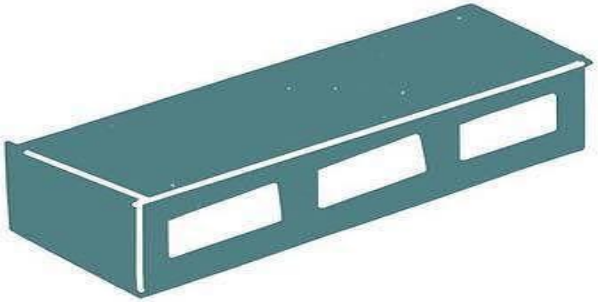
5.1 The building shall be oriented with the long sides facing north and south whenever the site and location permit such orientation.



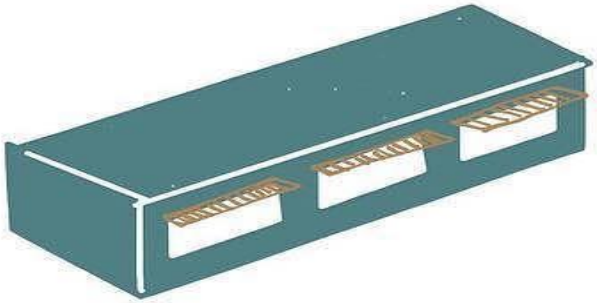
TEMPERATE CLIMATE



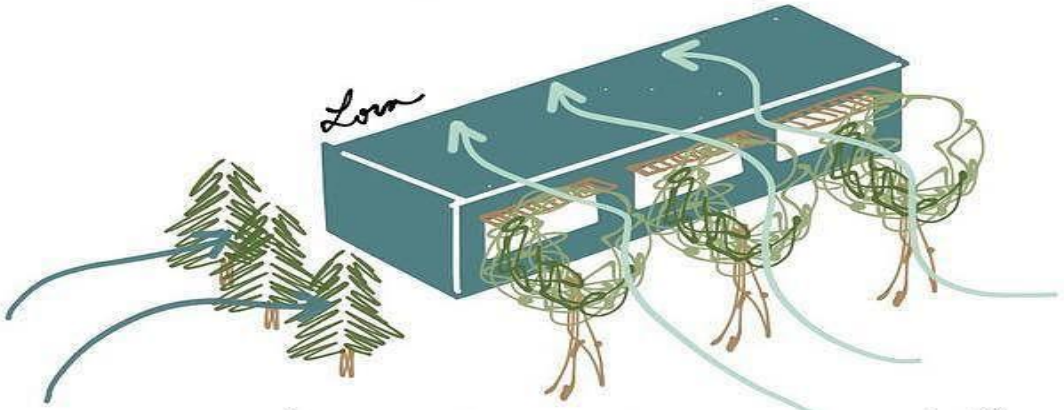
RECTANGULAR BLDG ON E/W AXIS. MEDIUM COLORS.



SOUTH OPENINGS CAPTURE WINTER SUNLIGHT.

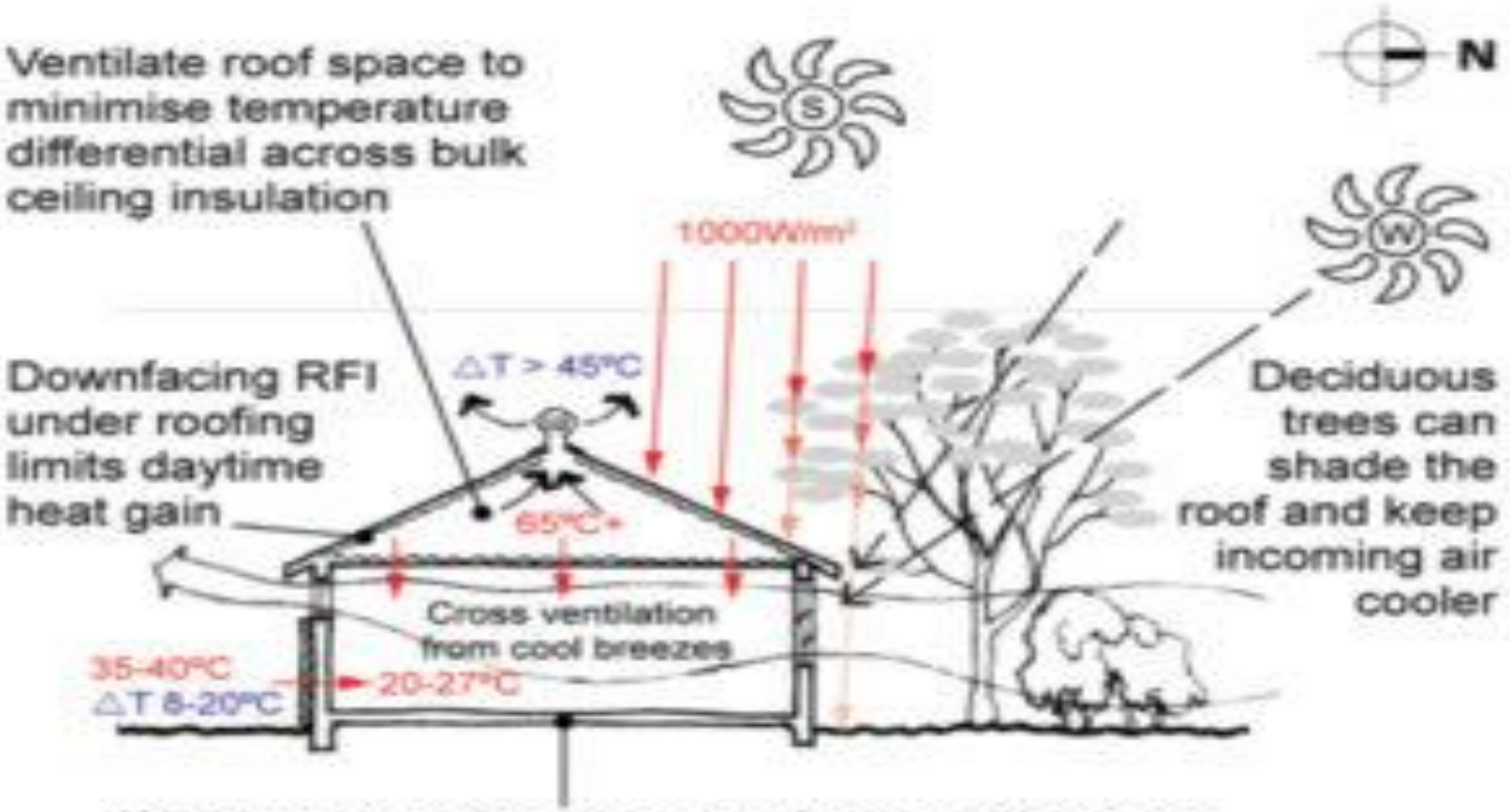


SUMMER SHADE, WINTER SUN.



ALLOW FOR COOLING SUMMER WIND BUT BLOCK COLD WINTER WIND.

Minimise solar gains with passive shading



RFI = reflective foil insulation

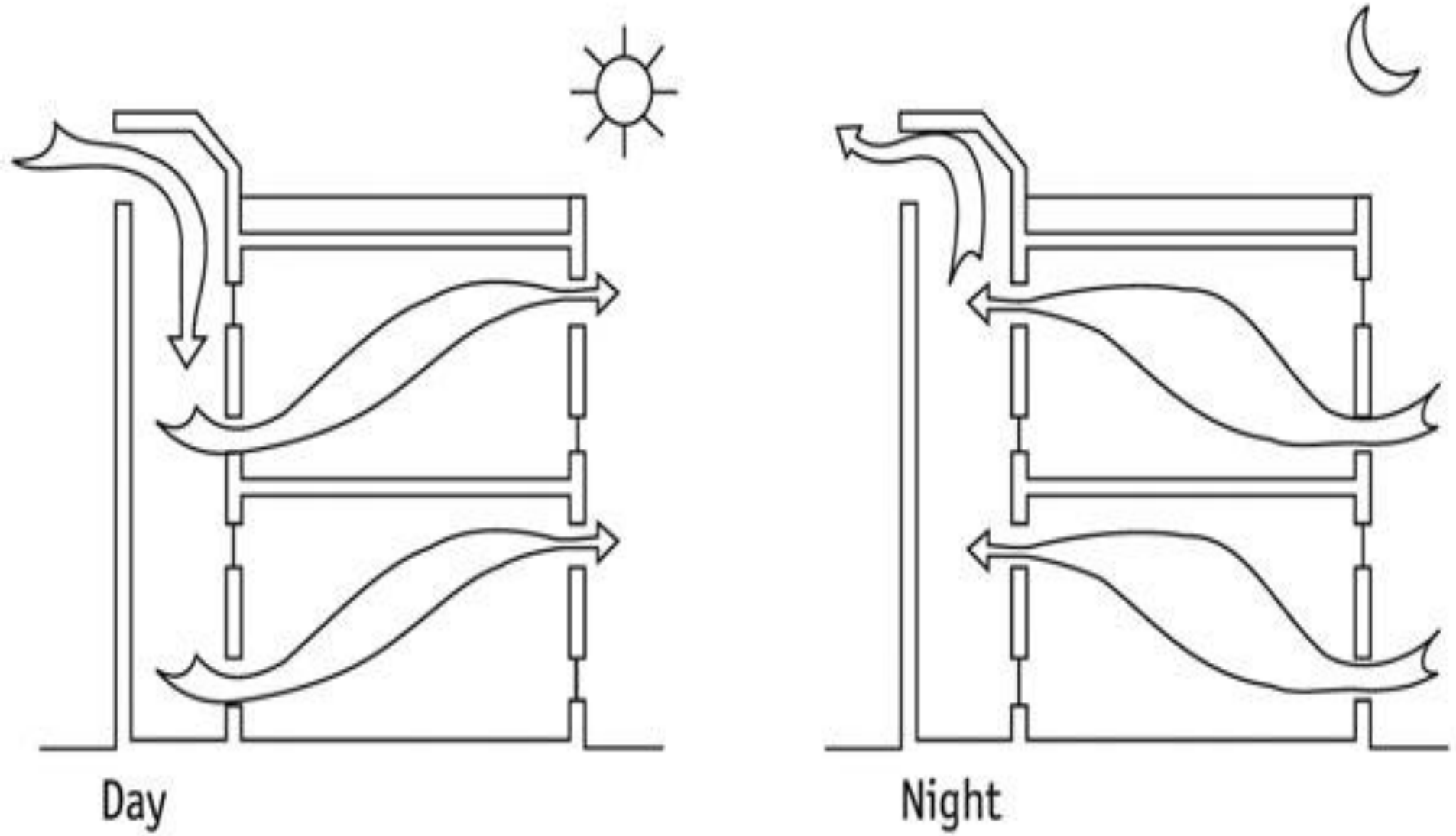
INDIGENOUS HUMAN HABITAT INDIA

A Product of evolution in response to ecological context

Jaiselmer (Hot dry desert India)

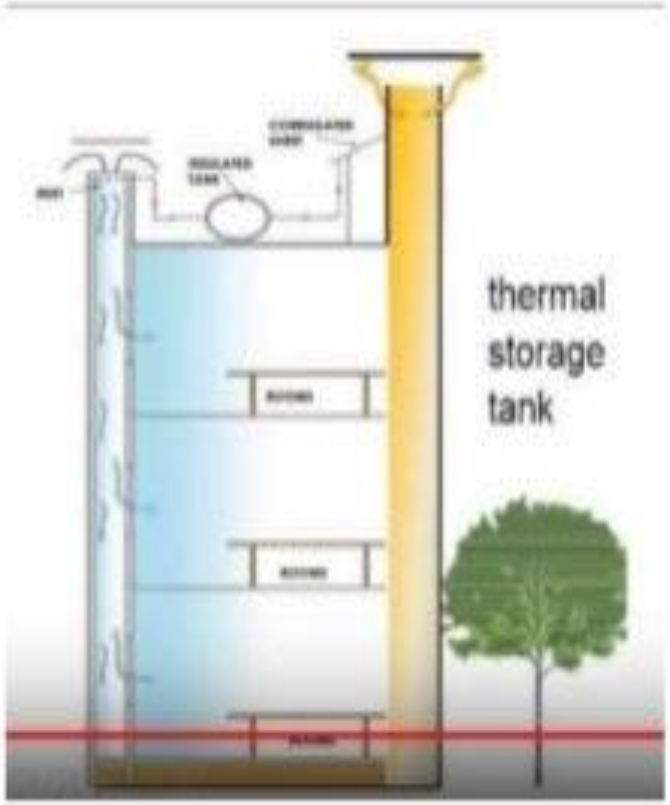
(Max. +52 C)

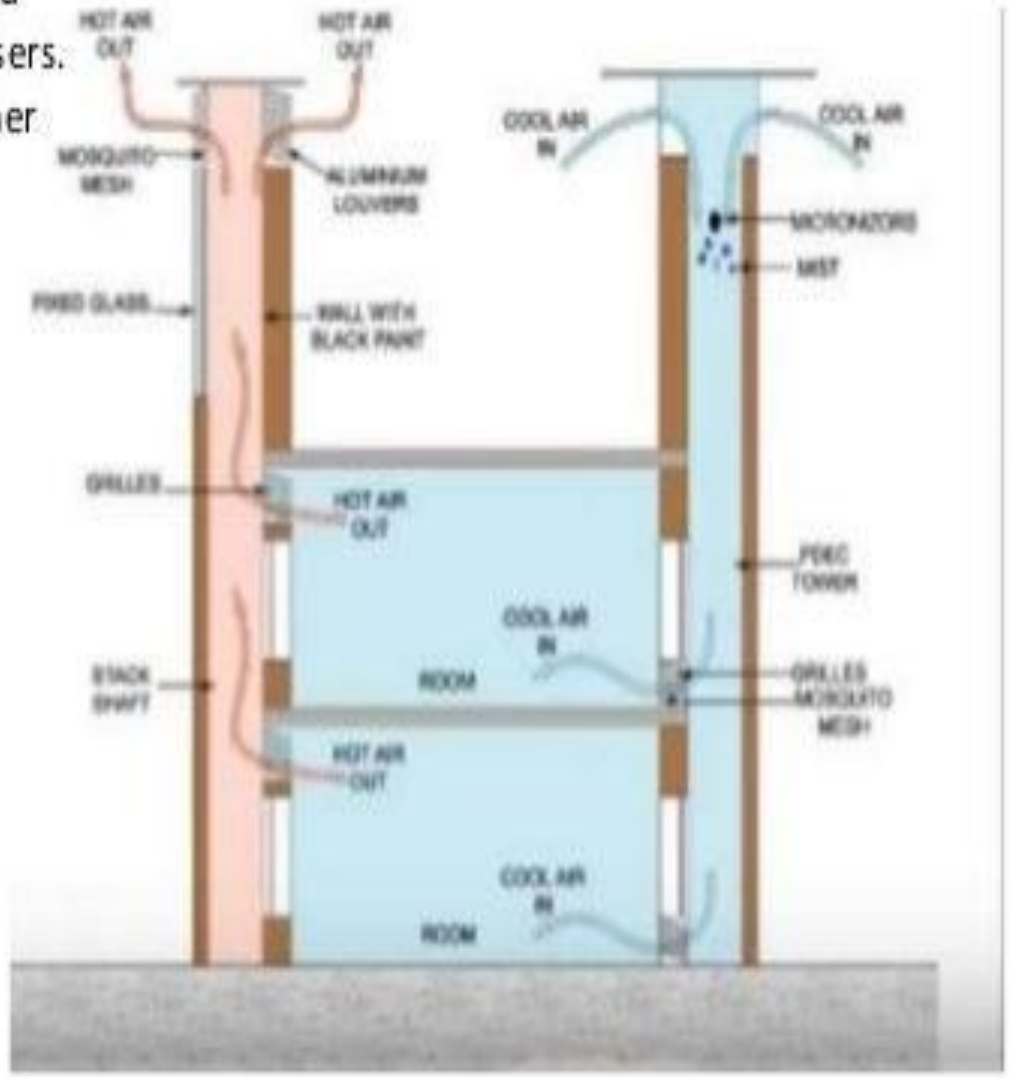
Wind Towers

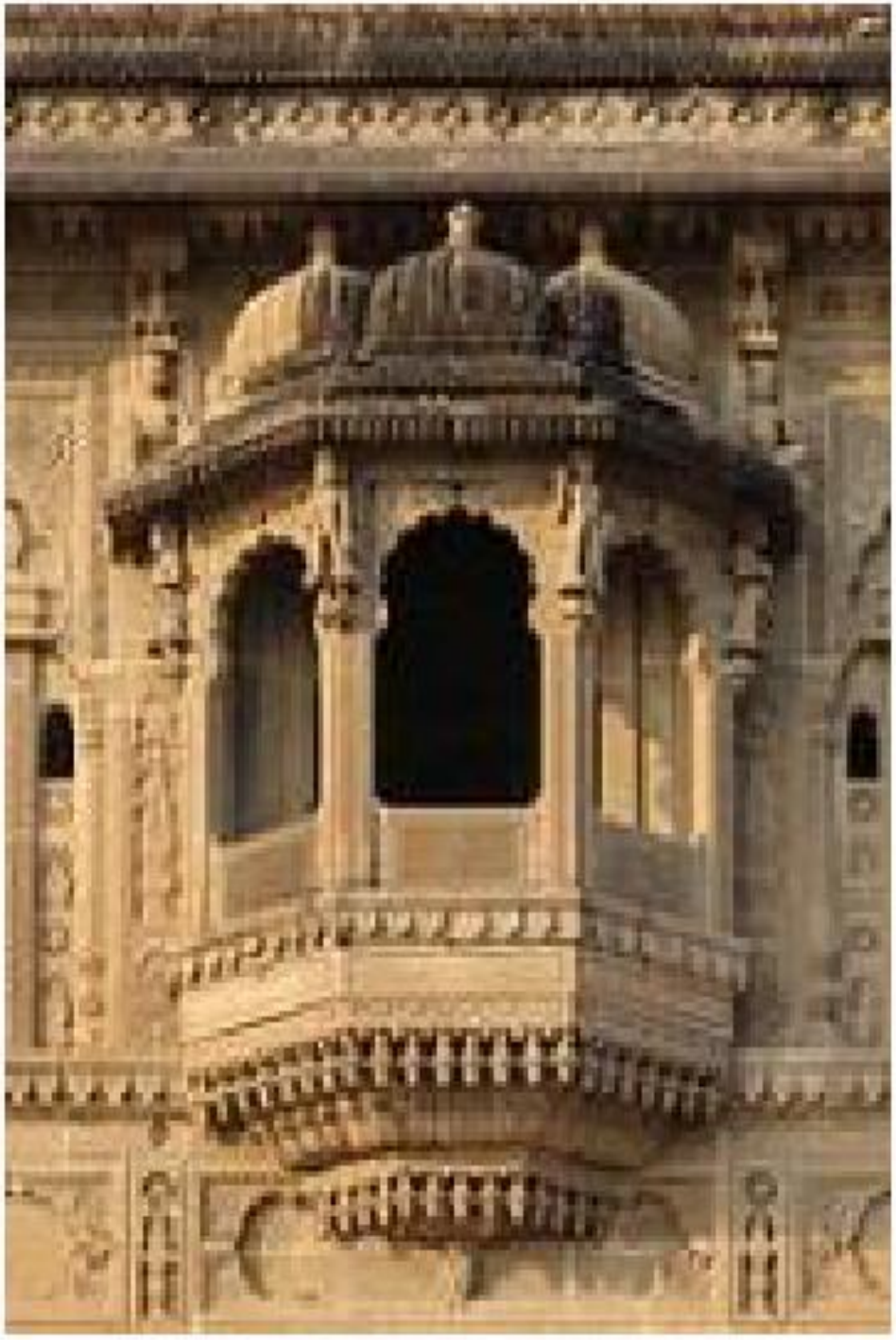


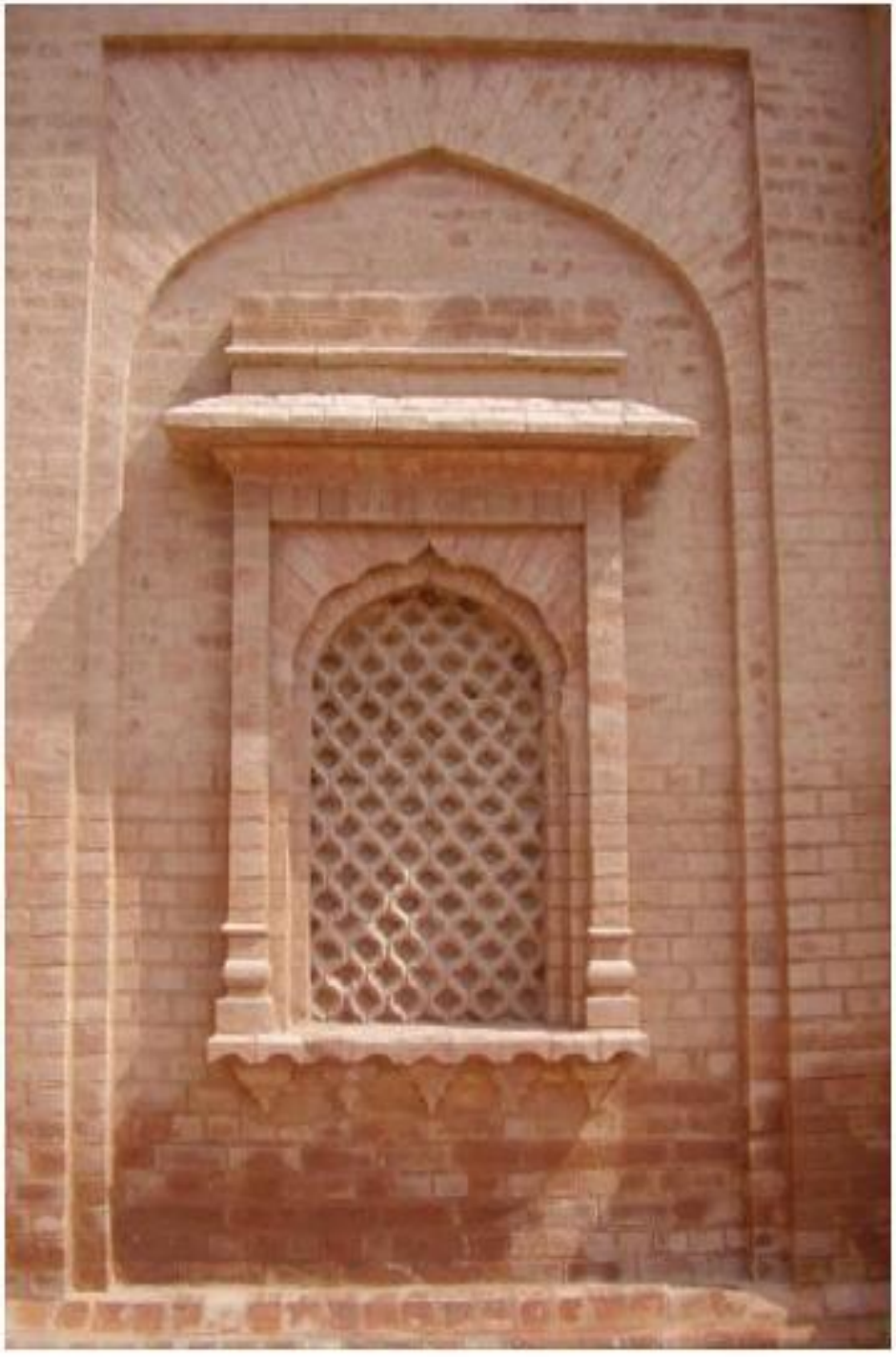
4.Passive downdraft evaporative cooling (PDEC) with night sky cooling

- The system comprises a down draft evaporative cooling tower the fine drops of water is sprayed vertically downwards with the help of mirconisers.
- it is possible to achieve 26 deg.c in peak summer
- It is possible to achieve of 16 deg,c in Hyderabad using this system









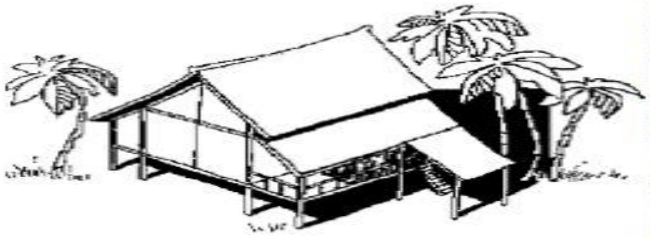
- HOT& HUMID
- ZONE

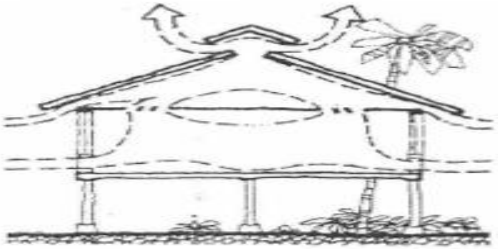
BUILDING DESIGNS FOR HOT & HUMID ZONES

CLIMATIC DESIGNS

Environmental Science 1 (KKSB 1216)
Session 2, 2009/2010

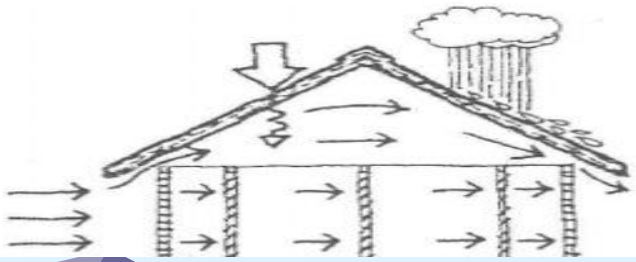
Prepared by: Nik Lukman Nik Ibrahim



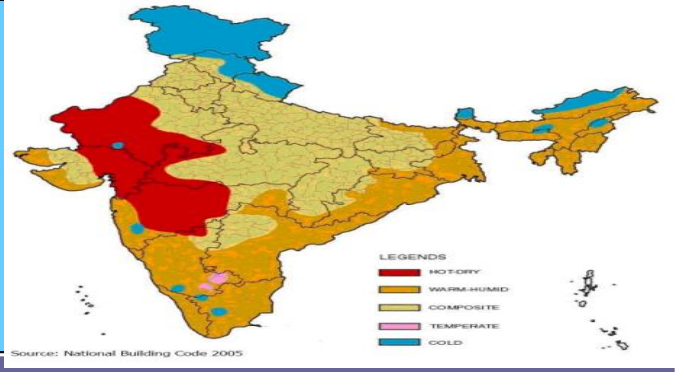


Hot & Humid Regions

Climatic conditions:
-high rainfall and high humidity.
-temperature range around 30 - 35°C and is fairly even during the day and throughout the year.
-due to minimal temperature differences, winds are light or even non-existent for longer periods.
-heavy precipitation and storms occur frequently.



Warm and Humid Climate Zone



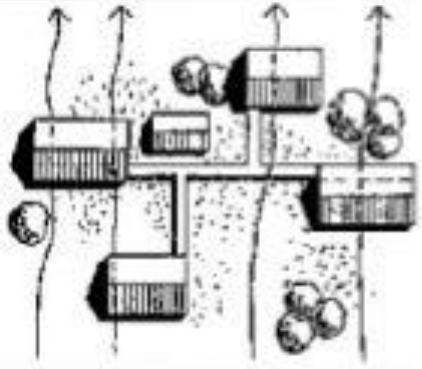
Thermal Requirements	Physical Manifestation
Reduce Heat Gain	
Decrease exposed surface area	Orientation and shape of building
Increase thermal resistance	insulation of Roof and wall
	Reflective surface of roof
Increase buffer spaces	Balconies and verandahs
Increase shading	Walls, glass surfaces protected by overhangs, fins and trees
Increase surface reflectivity	Pale colour, glazed china mosaic tiles etc.
Reduce solar heat gain	Use glazing with lower SHGC and provide shading for windows. Minimize glazing in East and West
Promote Heat Loss	
Increase air exchange rate (ventilation during night-time)	Ventilated roof construction, courtyards/ wind tower and arrangement of openings
Decrease humidity levels	Dehumidifiers/desiccant cooling

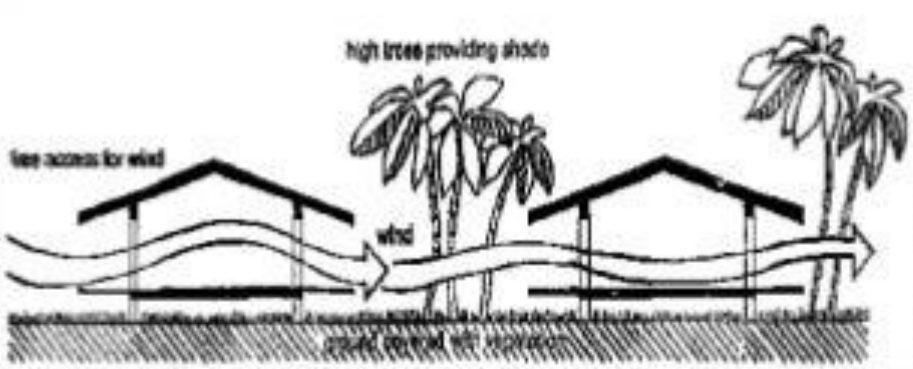
Warm & Humid
(climate in India)

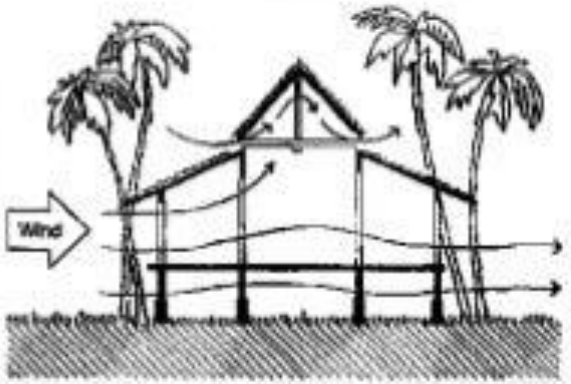
The warm and humid zone covers the coastal parts of the country, such as Kerala, Tamilnadu & Goa. The main design criteria in the warm and humid region are to reduce heat gain by providing shading, and promote heat loss by maximizing cross ventilation.

BUILDING DESIGN IN WARM-HUMID ZONES

Provide maximum ventilation and free air movement by large openings.
Provide maximum shading of direct and diffuse solar radiation.
Avoid heat storage.
Use reflective outer surfaces.
Use ventilated double roofs.
Use vegetation to moderate the solar impact

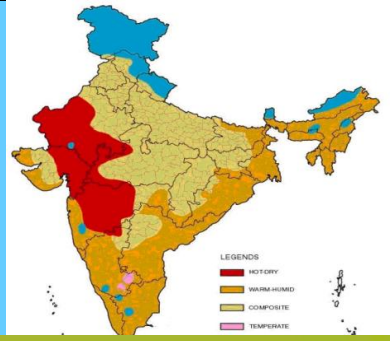






Warm and Humid Climate Zone

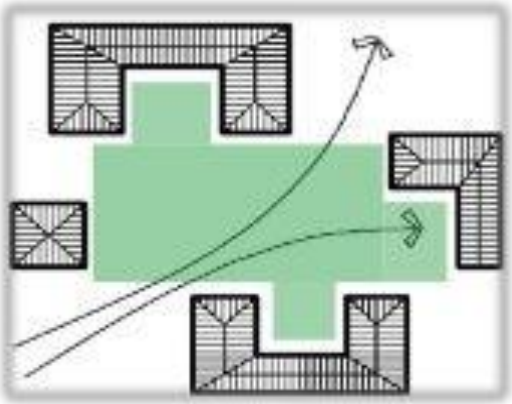
Comfort requirements and Physical manifestations in Buildings

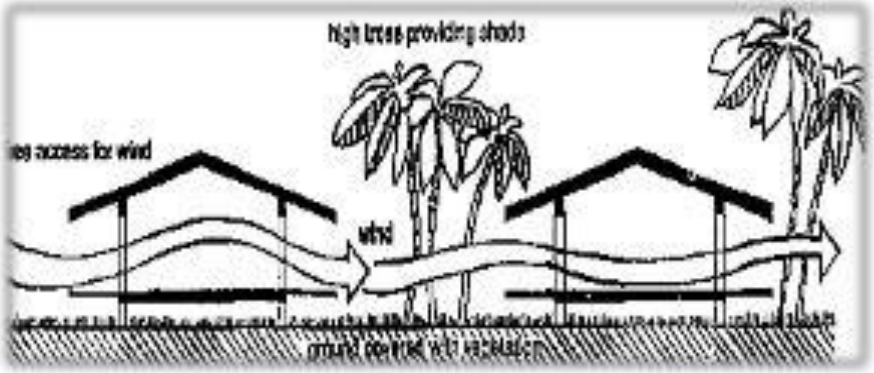


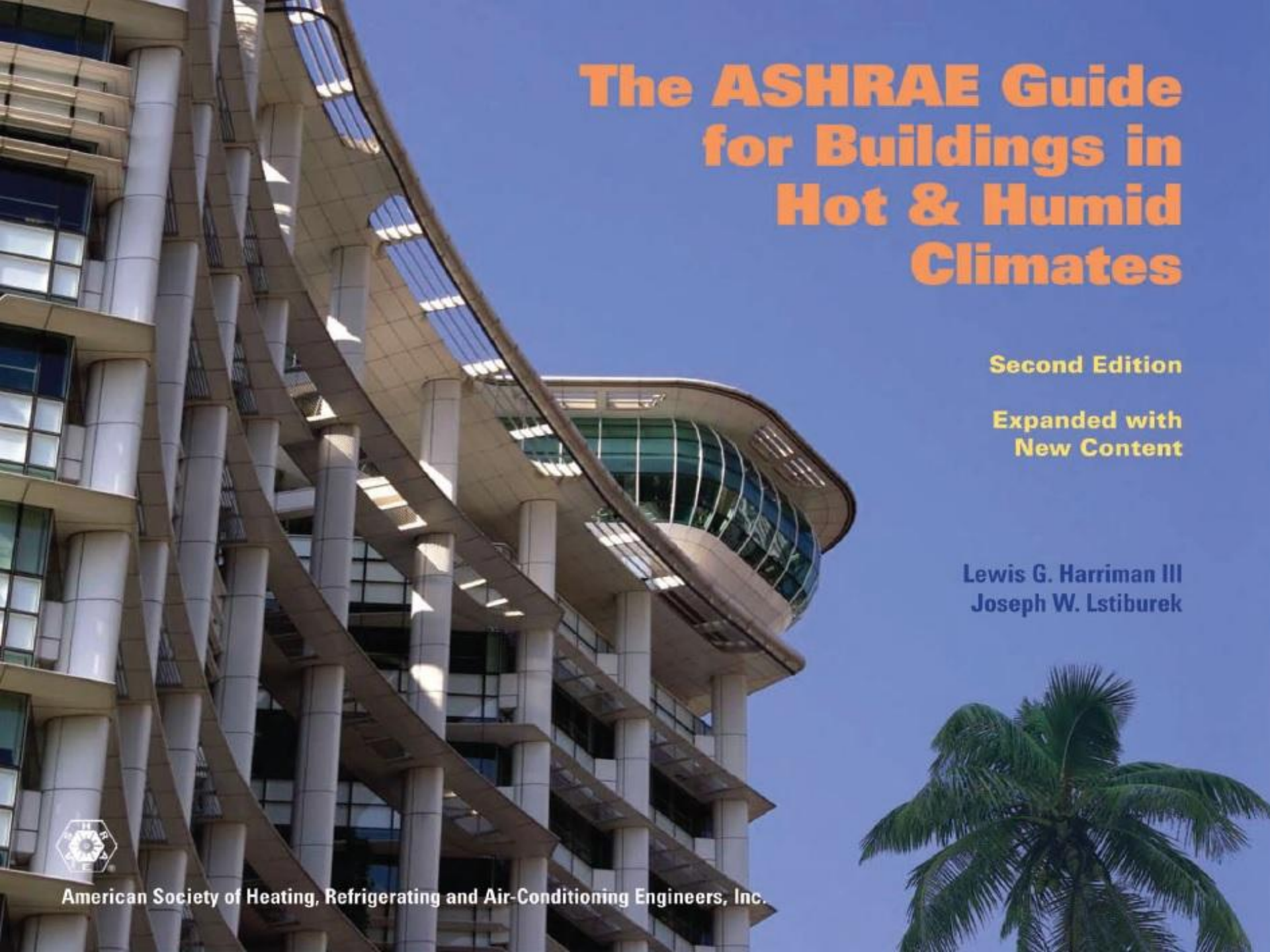
HOT AND HUMID

Orientation and ventilation:

- Semi – open spaces for light and air movement .
- Buildings should be spread out with large open spaces in between for uninterrupted air movement.
- Cross ventilation is very important. large openings to unobstructed air path and to ensure proper ventilation.
- The openings should be shaded by external overhangs. Outlets at higher levels to vent hot air.
- Proper water proofing and quick drainage of water is essential due to heavy Rainfall.







The ASHRAE Guide for Buildings in Hot & Humid Climates

Second Edition

Expanded with New Content

Lewis G. Harriman III
Joseph W. Lstiburek

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

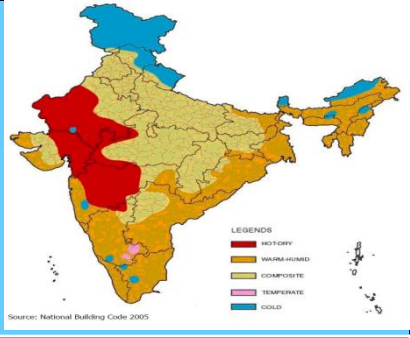
- MODERATE
- CLIMATE

Moderate climate

- The temperate climate has mild to warm summers and cool winters.
- The need for winter home heating is greater than the need for summer cooling.
- It is a relatively comfortable climate, especially near the coast, where summers are cooler and winters warmer than further inland.

Moderate/Temperate Climate Zone

Comfort requirements and Physical manifestations in Buildings



Thermal Requirements	Physical Manifestation
Reduce Heat Gain	
Decrease exposed surface area	Orientation and shape of building
Increase thermal resistance	Roof insulation and East and West wall insulation
Increase shading	East and West Walls, glass surfaces protected by overhangs, fins and trees
Increase surface reflectivity	Pale colour, glazed china mosaic tiles etc.
Promote Heat Loss	
Increase air exchange rate (ventilation)	Courtyards and arrangement of openings

MODERATE

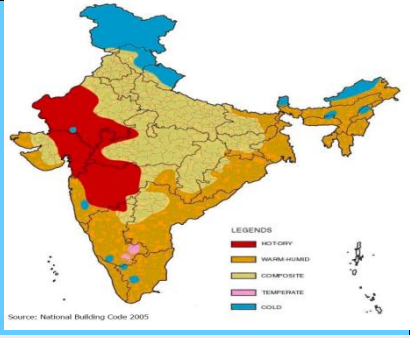
{Local Places (Pune,Bangalore,Etc.)}

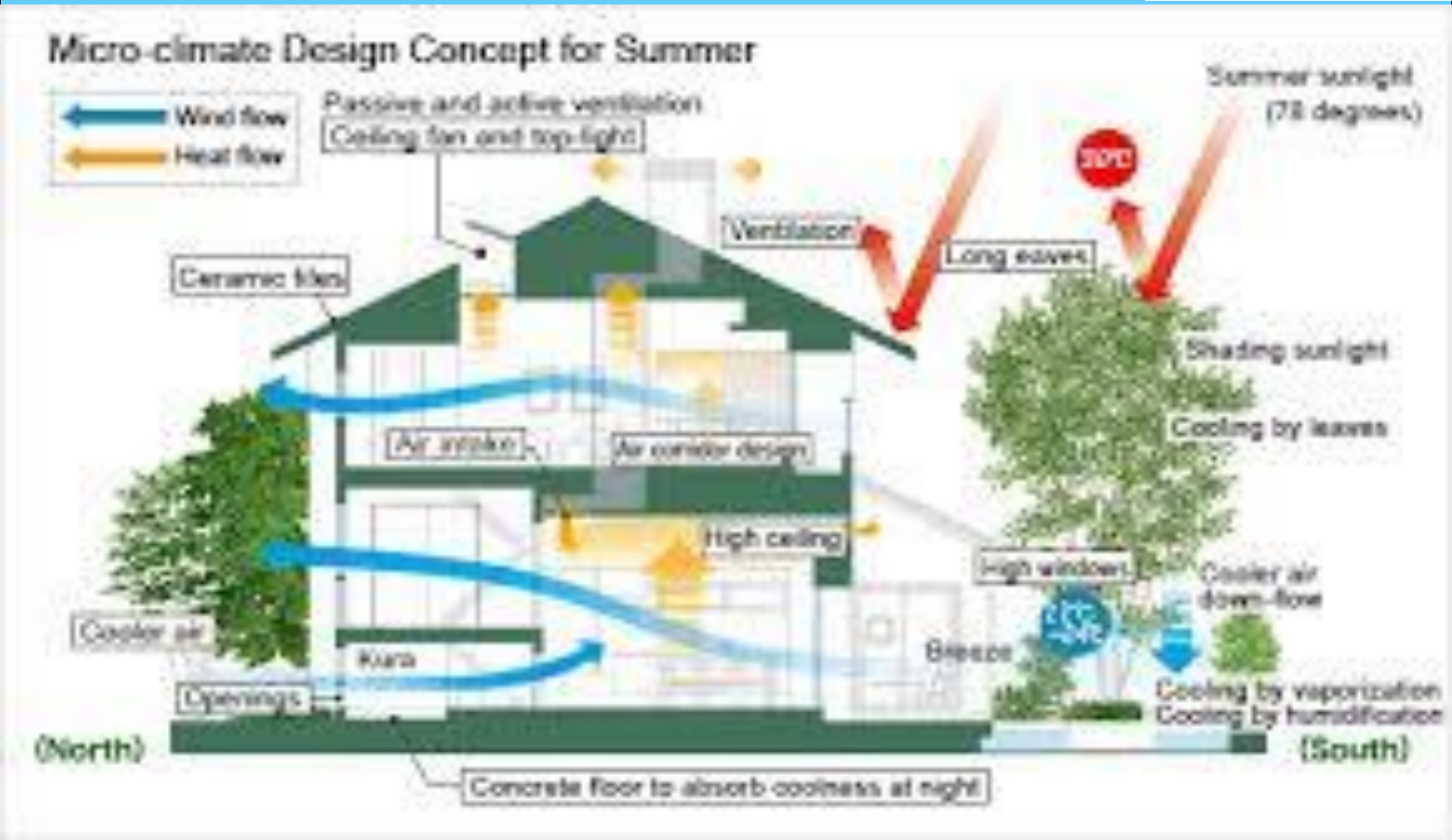
- SOLAR RADIATIONS (Moderate)
- TEMPERATURE RANGE (17-34°C)
- HUMIDITY (30-80%)
- PRECIPITATION (<1000mm)

- REDUCE HEAT GAIN BY SHADING DEVICES
- WALLS FACING EAST & WEST PROTECTED BY OVERHANGS.
- COURTYARD PLAN
- WINTER HEATING IS MORE IMPORTANT
- SMALL OPENINGS IN EXTERIOR OF BUILDING
- PROPER CROSS VENTILATION

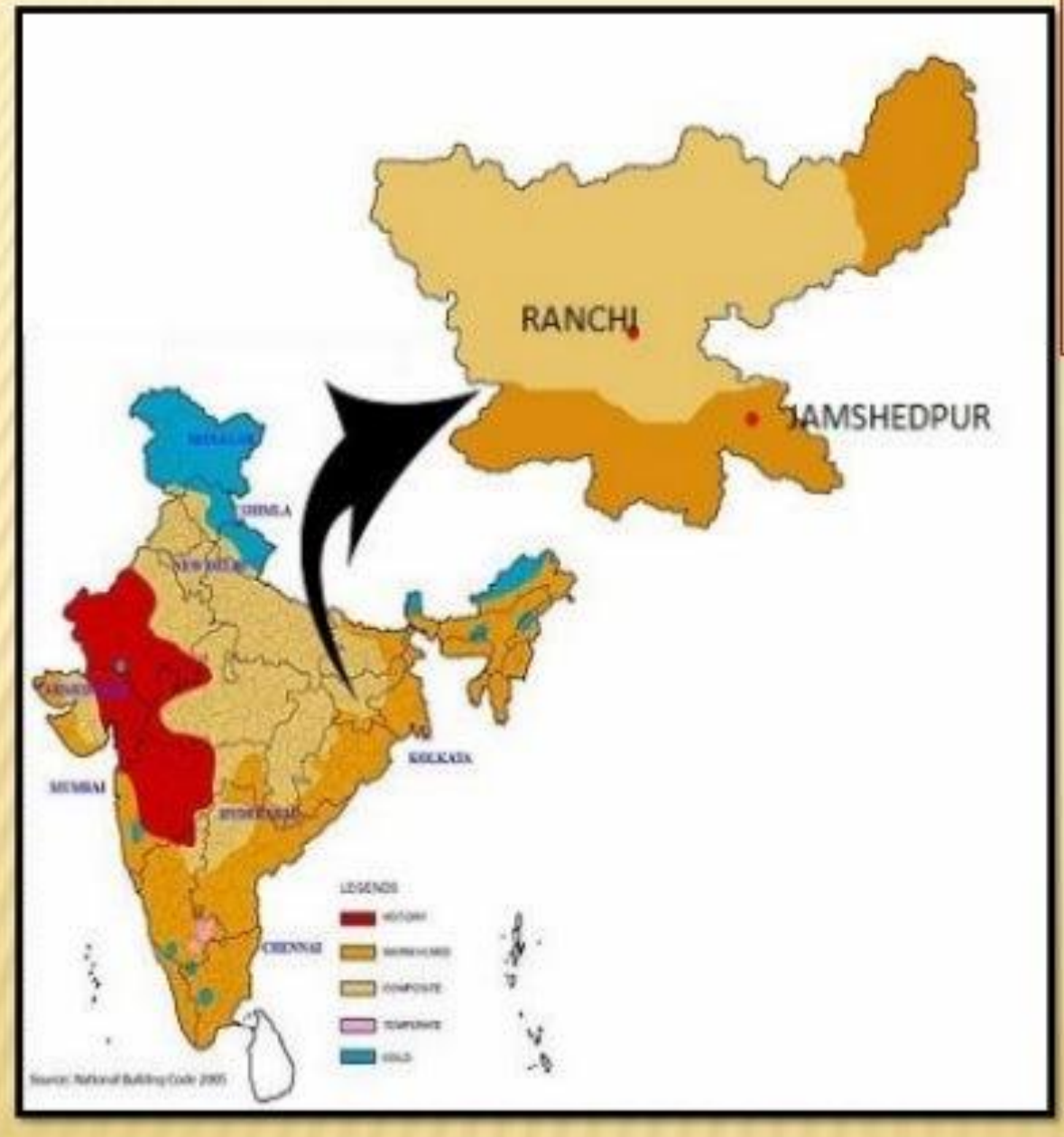
Moderate/Temperate Climate Zone

Comfort requirements and Physical manifestations in Buildings





- COMPOSITE
- CLIMATE



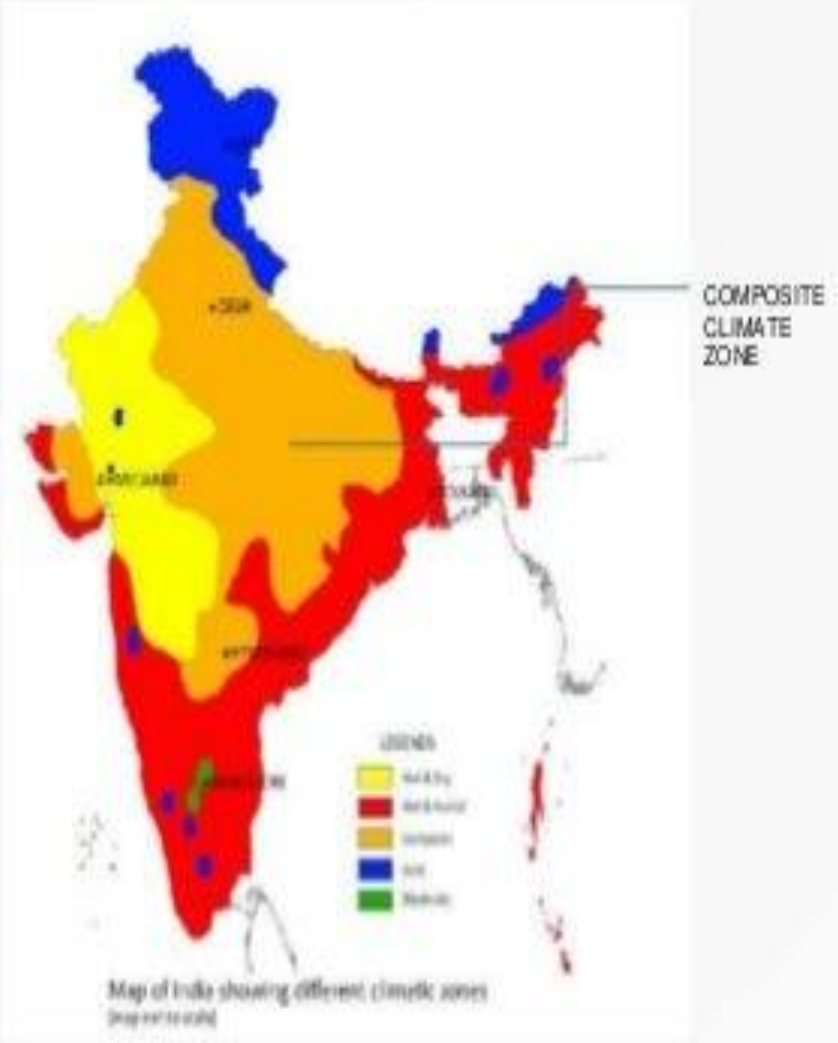
AS PER **NATIONAL BUILDING CODE, 2005** THE CLIMATIC ZONES IN INDIA IS-

1.HOT-DRY
2.WARM-HUMID
3.COMPOSITE
4.TEMPERATE
5.COLD

As can be seen from map the whole of Jharkhand, except a small portion of it to the south, falls within the composite zone of climate. Study-Area Ranchi district falls entirely in composite zone.

Hot and dry summer, followed by a humid season with monsoon rains. With the departure of the monsoon it gradually becomes comfortable in autumn, followed by a relatively short winter (3 months) with the cloudy and wet as well as sunny periods. Before the summer returns there is a comfortable but short spring season.

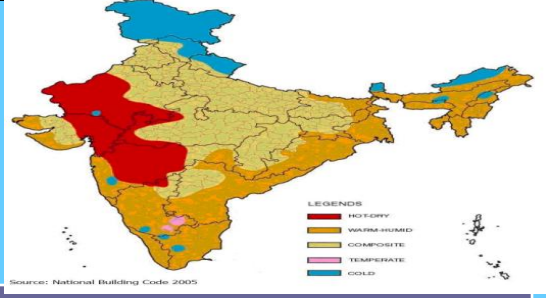
LOCATION AND MAIN CITIES



- The composite zone covers the central part of India. Some cities that experience this type of climate are New Delhi, Kanpur and Allahabad.

Composite Climate Zone-

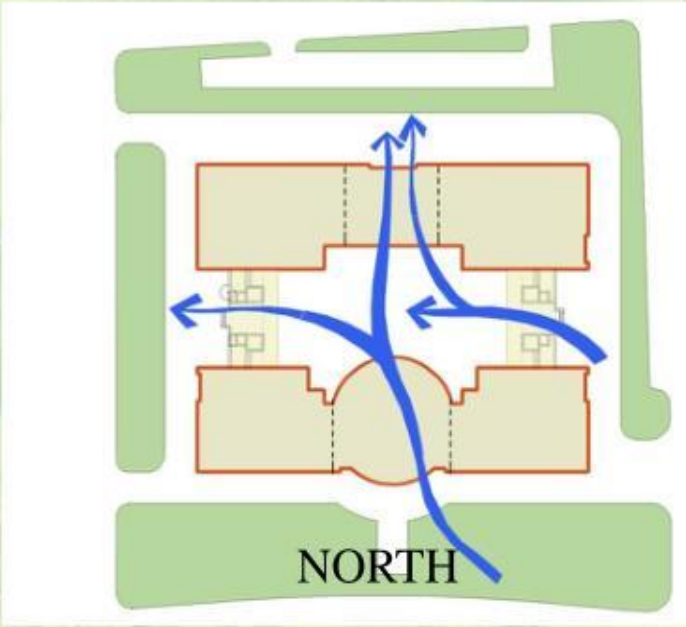
Comfort requirements and Physical manifestations in Buildings



Thermal Requirements	Physical Manifestation
Reduce Heat Gain in Summer and Reduce Heat Loss in Winter	
Decrease exposed surface area	Orientation and shape of building. Use of trees as wind barriers.
Increase thermal resistance	Roof insulation, wall insulation
Increase thermal capacity (Time Lag)	Thicker walls
Increase buffer spaces	Air locks/Balconies
Decrease air exchange rate	Weather stripping (
Increase shading	Walls, glass surfaces protected by overhangs, fins and trees
Increase surface reflectivity	Pale color, glazed chins mosaic tiles, etc.
Reduce solar heat gain	Use glazing with lower SHGC and provide shading for windows. Minimize glazing in East and West
Promote Heat Loss in Summer/Monsoon	
Increase air exchange rate (Ventilation)	Courtyards/wind towers/arrangement of openings
Increase humidity levels in dry summer	Trees and water ponds for evaporative cooling
Decrease humidity in monsoon	Dehumidifiers/desiccant cooling

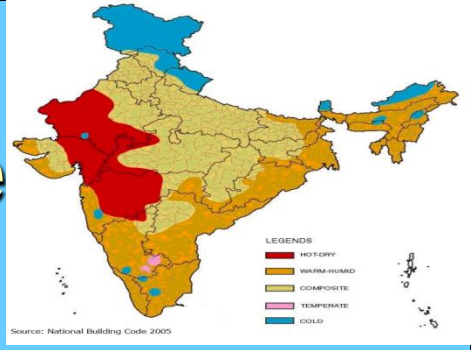
Design Strategies in Composite Climate

- Plan the building around the courtyard.
- Reduce heat gain in the building through building envelope.
- Plan water bodies
- cavity walls, terrace gardens, light shelves.



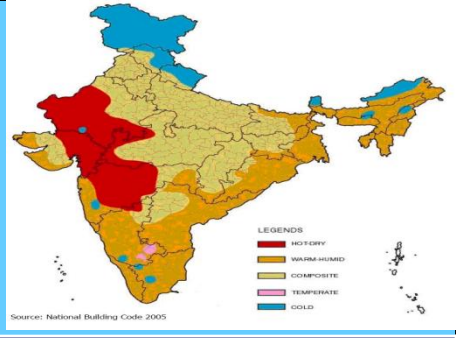
CROSS VENTILATION AT THE MICRO LEVEL THROUGH OPENINGS

Composite Climate Zone



- COLD
- CLIMATE

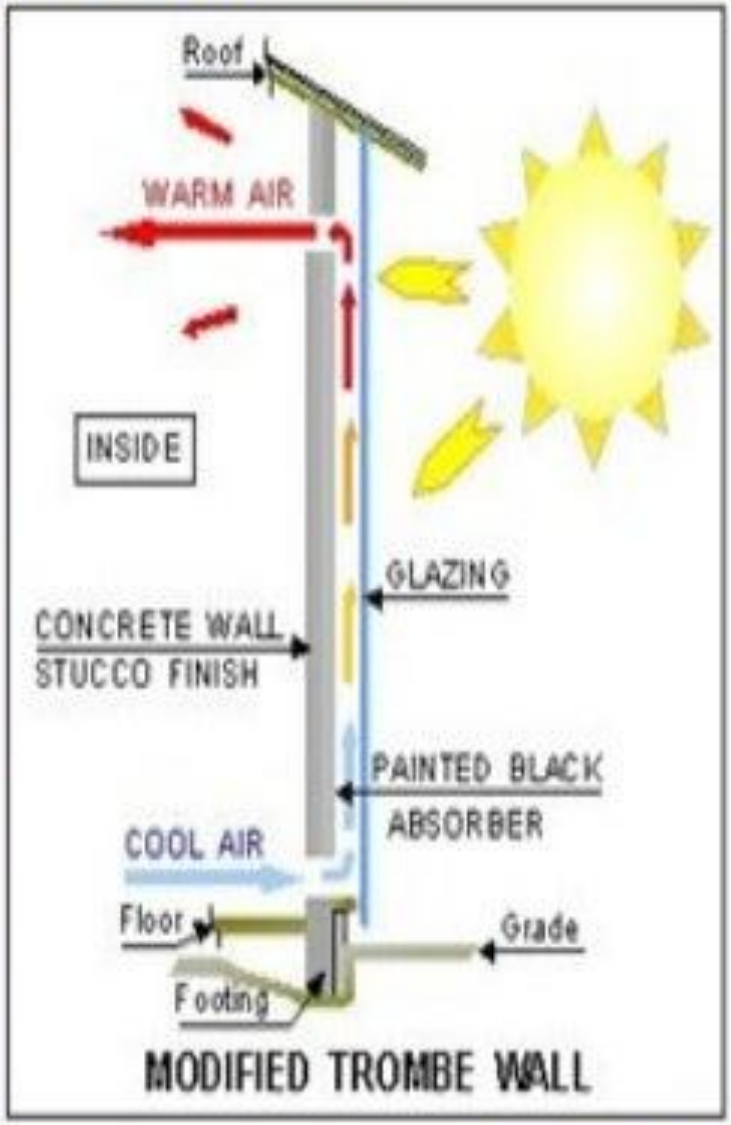
Cold (Cloudy/Sunny) Climate Zone- Comfort requirements and Physical manifestations in Buildings



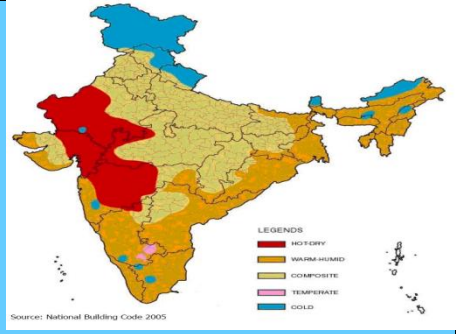
Thermal Requirements	Physical Manifestation
Reduce Heat Loss	
Decrease exposed surface area	Orientation and shape of building. Use of trees as wind barriers.
Increase thermal resistance	Roof insulation, wall insulation and double glazing
Increase thermal capacity (Time Lag)	Thicker walls
Increase buffer spaces	Air locks/Lobbies
Decrease air exchange rate	Weather stripping and reducing air leakage.
Increase surface absorption	Darker colours
Promote Heat Gain	
Reduce shading	Wall and glass surfaces
Trapping heat	Sun spaces/green houses/trombe walls etc.

Design Strategies in Cold Climate

- Glazing windows up to 25% floor area
- Double glazing to avoid heat losses during winter nights.
- Adopt Trombe walls.
- Sunspaces



Cold (Cloudy/Sunny) Climate Zone- Comfort requirements and Physical manifestations in Buildings

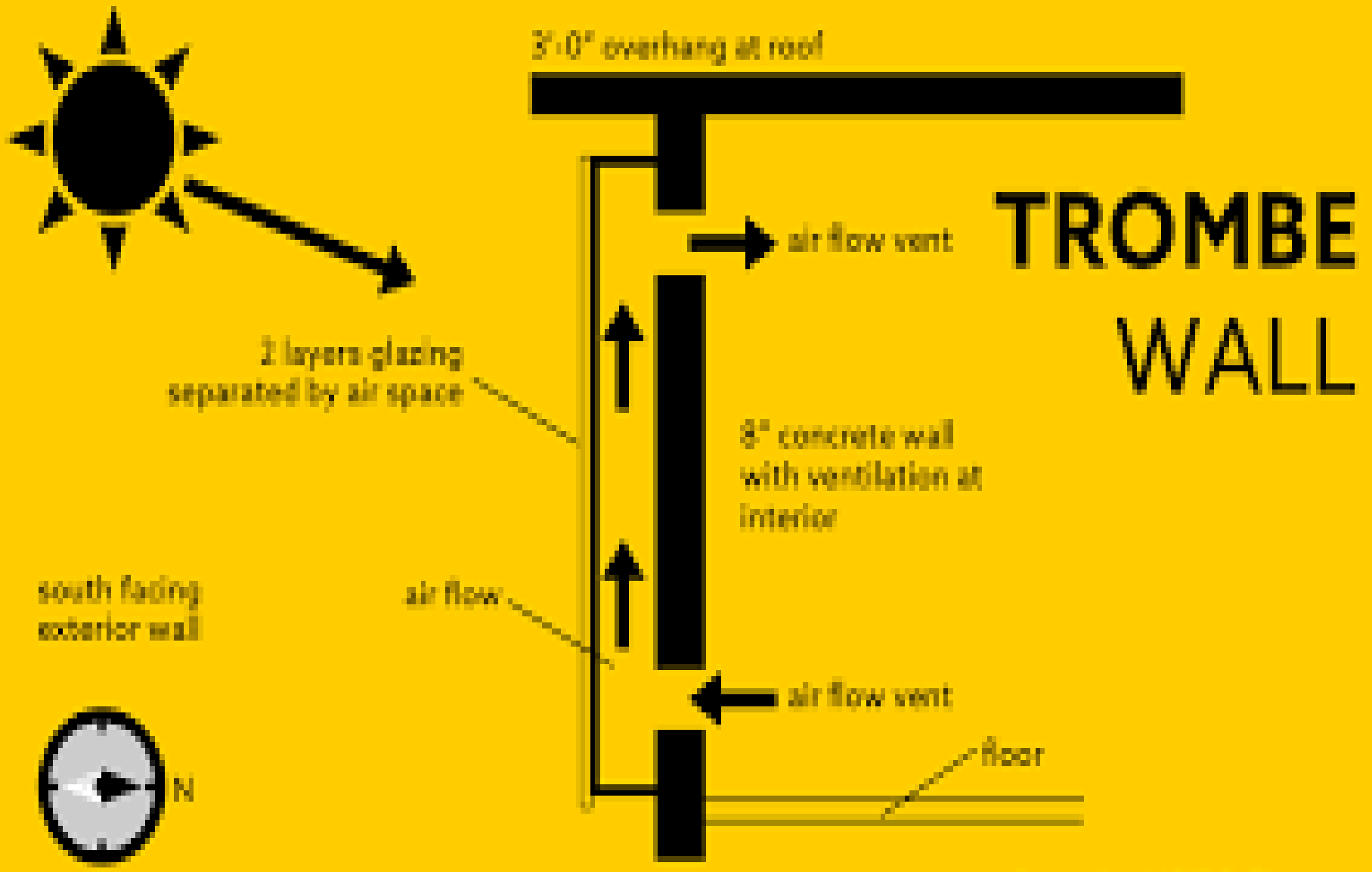


Cold (Cloudy/Sunny) Climate Zone

LADHAKH MONASTRIES

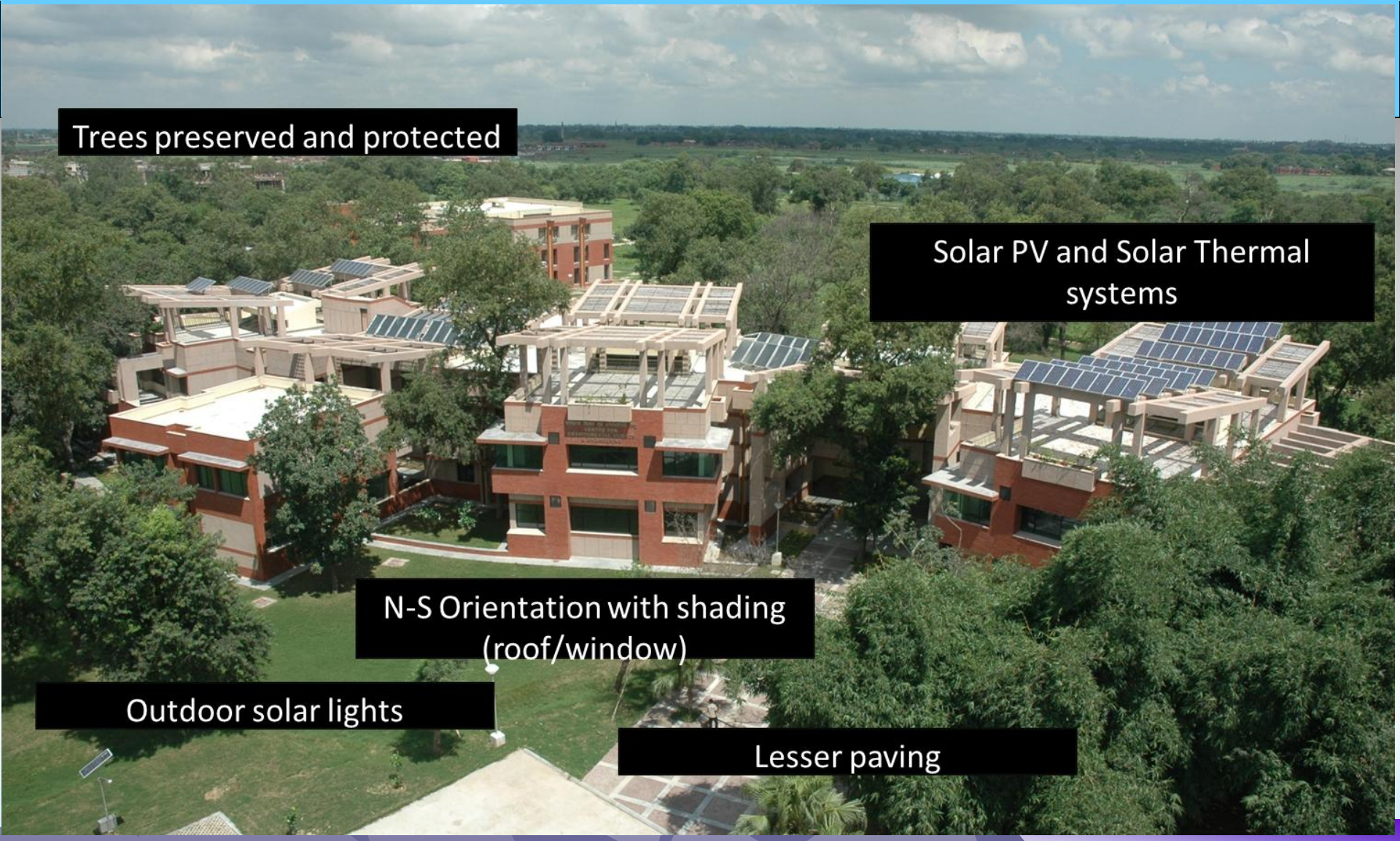
LOCATION OF CITY

TROMBE WALL


3'-0" overhang at roof
air flow vent
TROMBE
WALL
2 layers glazing
separated by air space
8" concrete wall
with ventilation at
interior
south facing
exterior wall
air flow
air flow vent
floor
N
Opractice NCIDQ Glossary

Case Studies

Low Impact Design



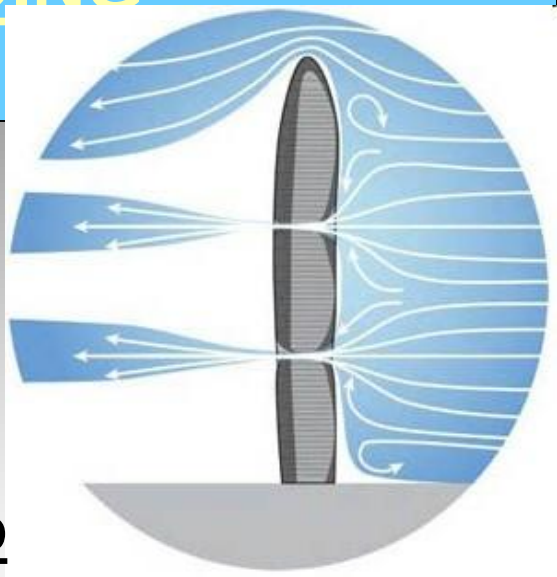

2392

SECRETARIAT

Bahrain World Trade Center - Bahrain

- Generating 15% energy from windmills
- Two 240 meter twin sky scrapers joined by three windmill--, each 3 meters wide, attached to walkways
- :designed/ built by Atkins in city of Manama

PEARL RIVER TOWER- GUANGZHOU, CHINA
NET ZERO ENERGY BUILDING



YEAR OF COMPLETION- 2011
SITE AREA-10635SQ.M.
PROJECT AREA- 214,100SQ.M.
(2.3MILLION SQ.FT.)
NO. OF STORIES- 71
HEIGHT OF BUILDING-309 M

ENERGY EFFICIENCY ACHIEVED THROUGH

- SOLAR PANELS
- PHOTO VOLTAIC CELLS
- WIND TURBINES
- DAY LIGHT HARVESTING

DOUBLE SKIN CURTAIN WALLS
CHILLED CEILING WATER
- UNDER FLOOR VENTILATION

Godrej Sohrab ji Building- Hyderabad- India's first platinum rated building

Indoor Environmental Quality

- Indoor Air Quality is continuously monitored and minimum fresh air is pumped into the conditioned spaces at all times
- Fresh air is also drawn into the building through wind towers
- Use of low Volatile Organic Compound (VOC) Paints & Coatings, Adhesives, Sealants and Carpets
- Maximum daylighting
- Operable windows and lighting controls for better daylighting and views
- Fenestration maximized on the north orientation

Daylight & Views (Glazing)

Cost and Benefits

This was the first green building in the country. Hence, the incremental cost was 18 % higher.

However, green buildings coming up now are being delivered at an incremental cost of 6 - 8%. The initial incremental cost gets paid back in 3 to 4 years.

Benefits achieved so far

- Over 1,20,000 kWh of energy savings per year as compared to ASHRAE 90.1 base case
- Potable water savings of 40% vis-à-vis conventional building
- Excellent indoor air quality
- 100 % daylighting (Artificial lights are switched on just before dusk)
- Higher productivity of occupants

Swales

Project Details

Location
Hyderabad, India

Type
Office Building

Size

- 4.5 acres (Total site area)
- 1,858 sq m (Total built up area)
- 1,115 sq m (Total air conditioned area)

Building details

- Office building
- Seminar hall
- Green Technology Centre displaying the latest and emerging green building materials and technologies in India
- Large number of visitors are escorted on green building tour

Rating
Awarded with LEED Platinum for New Construction (NC) v 2.0 by the US Green Building Council (USGBC) in November 2003

Measurable Results

- **Energy savings**
  120,000 kWh / year
- **Reduction in CO2 emissions**
  100 tons / year (building is functional since January 2004)
- **Water savings**
  40% reduction in potable water consumption
- **Renewable energy generated**
  31,000 kWh / year

Water Body

Parking shaded with trees

Confederation of Indian Industry
CII-Sohrabji Godrej Green Business Centre
S Srinivas
Principal Counsellor
CII-Sohrabji Godrej Green Business Centre,
Survey No 64, Kothaguda Post, Hyderabad - 500 084
Tel: +91 40 44185111, Fax: +91 40 23112837
s.srinivas@cii.in | igbc@cii.in

www.igbc.in

Confederation of Indian Industry

Indian Green Building Council
Greening India since 2001

CII-Sohrabji Godrej Green Business Centre
Hyderabad, India

Towards a green building movement...

Hyderabad, the city of pearls and an IT hub of India can now boast of one of the Greenest Buildings in the world.

CII - Sohrabji Godrej Green Business Centre (CII - Godrej GBC), Hyderabad, is a unique and successful model of public - private partnership between the Government of Andhra Pradesh, Pirojsha Godrej Foundation and the Confederation of Indian Industry (CII), with the technical support of USAID.

CII - Godrej GBC building has been awarded the prestigious 'Platinum rating' under LEED (Leadership in Energy and Environmental Design) program of USGBC (US Green Building Council). The CII - Godrej GBC building is the first LEED Platinum Rated Green Building outside of USA and the third in the world.

The building has transformed a sleepy hamlet studded with undulating terrain and a rocky landscape to a focal point on all aspects related to Green.

Amidst environs surrounded by the HITEC City and an up-market residential area, the 20,000 sq ft building stands out as a symbol of harmony between nature and architecture.

The CII - Godrej GBC is the Centre of Excellence for Green Buildings, Energy Efficiency, Renewable energy, Environment & Recycling, Water Management and Climate Change activities in India.

The inner courtyard of the building

Green Features

The CII - Godrej GBC building heralds the beginning of the Green Building movement in India.

The building has been rated based on the following features:

- Water Efficiency
- Sustainable Site
- Energy Efficiency
- Materials & Resources
- Indoor Environmental Quality

Water Efficiency

Zero water discharge building

- The entire waste water, grey & black water generated in the building is treated by Phytoremediation or Natural Biological System (NBS). The system uses a wide range of natural elements such as plants with proven remediation abilities, sediments with different physical and chemical properties and various Hydrology regimes to treat the waste water. The treated water is reused for landscaping
- Waterless urinals used in men's rest room
- Rain water harvesting system to reuse strom water
- Water efficient fixtures - ultra low & low flow flush fixtures

Phytoremediation

Sustainable Site

Minimum disturbance to the site

- The building design was conceived to have minimum disturbance to the surrounding ecological environment. The disturbance to the site was limited within 40 feet from the building foot print during construction phase
- This has ensured to retain majority of the existing flora & fauna and natural microbiological organisms around the building
- Extensive erosion and sedimentation control measures to prevent top soil erosion have been done at the site during construction
- Large vegetative open spaces

Roof Garden

Double Glazing

Energy Efficiency

- Installed the state-of-the-art Building Management System (BMS) for real time monitoring of energy consumption
- Use of aerated concrete blocks for facades reduces 15 - 20 % load on air-conditioning. U-Value of solid wall: 0.57 Watt / sq m °K
- Double glazed units with argon gas filling between the glass panes, have enhanced the thermal properties. U-Value of double glazing: 1.70 Watt / sq m °K
- Water cooled scroll chiller: 0.8 kW / ton (Water cooled scroll chiller system with CoP: 4.23 at ARI condition)
- Installed two 25 TR chillers
- Secondary chilled water pumps installed with Variable Frequency Drives (VFDs)
- Energy efficient lighting design through Compact Fluorescent Lamps (CFLs)
- Roof garden covering 60% area. U-Value of roof: 0.294 Watt / sq m °K

Other Notable Green Features

- HFC Based refrigerant in chillers
- Swales for storm water collection
- Electric vehicle for staff use
- Car parking shaded with trees
- Energy Efficiency Index (EEI) - 84 kWh / sq m / year

Renewable Energy

- 20 % of the building energy requirements are catered by Solar Photovoltaics
- The Solar PV has an installed capacity of 23.5 kW

Materials and Resources

Furniture made of composite wood

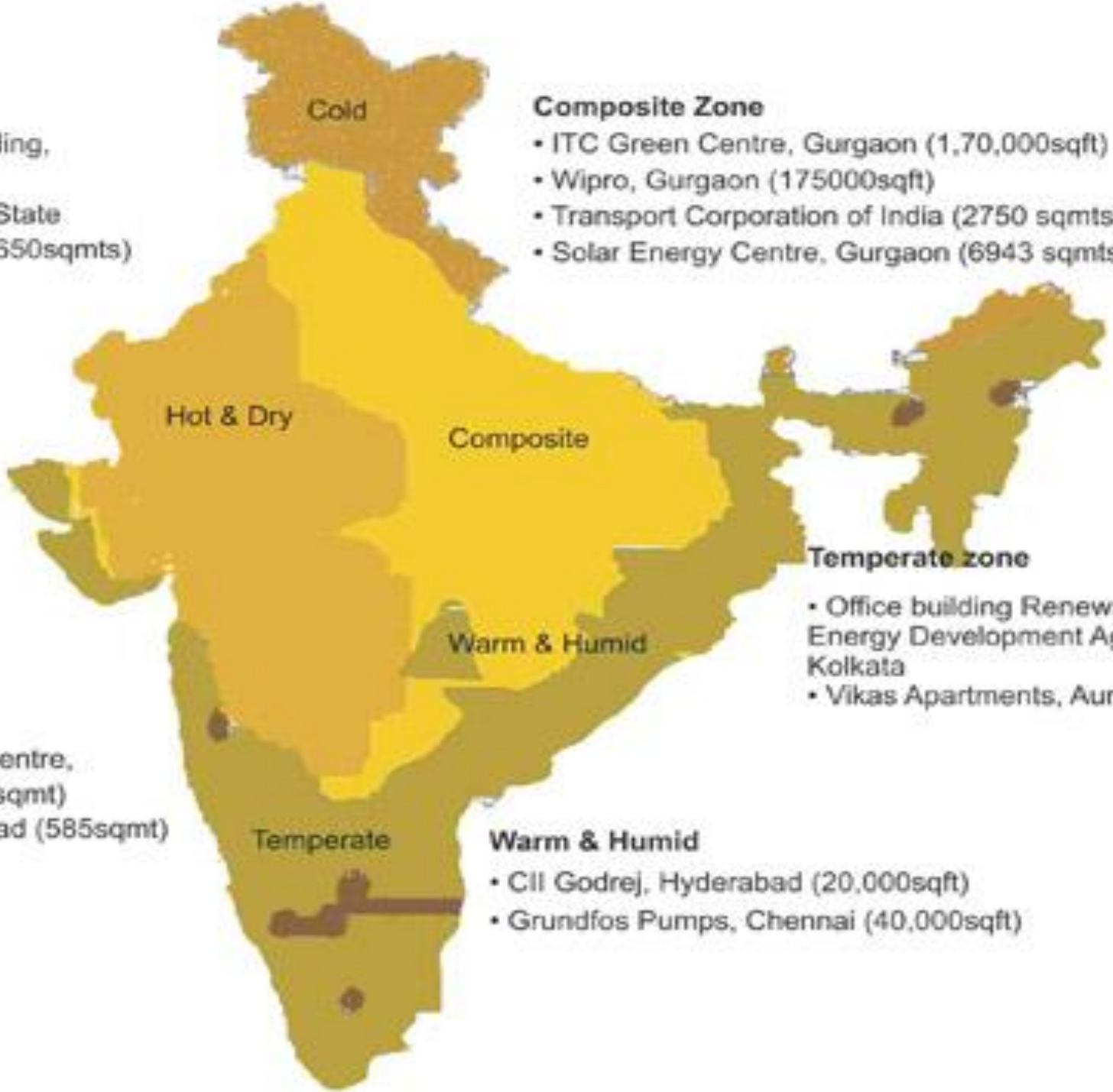
- 80% of the materials used in the building are sourced within 500 miles from the project site. Most of the construction material is also having post consumer & industrial waste as a raw material during manufacturing process
- Fly - ash based bricks, glass, aluminum, and ceramic tiles, which have post consumer and industrial waste are used in constructing the building to encourage usage of recycled content
- Office furniture is made of bagasse based composite wood
- More than 50% of the construction waste is recycled within the building or sent to other sites and diverted from landfill

Salvaged tiles for pillar cladding

Solar Photovoltaics

Cold Zone

- Himurja Office Building, Shimla (635sqmts)
- Himachal Pradesh State Cooperative Bank (1650sqmts)



Composite Zone

- ITC Green Centre, Gurgaon (1,70,000sqft)
- Wipro, Gurgaon (175000sqft)
- Transport Corporation of India (2750 sqmts)
- Solar Energy Centre, Gurgaon (6943 sqmts)

Temperate zone

- Office building Renewable Energy Development Agency, Kolkata
- Vikas Apartments, Auroville

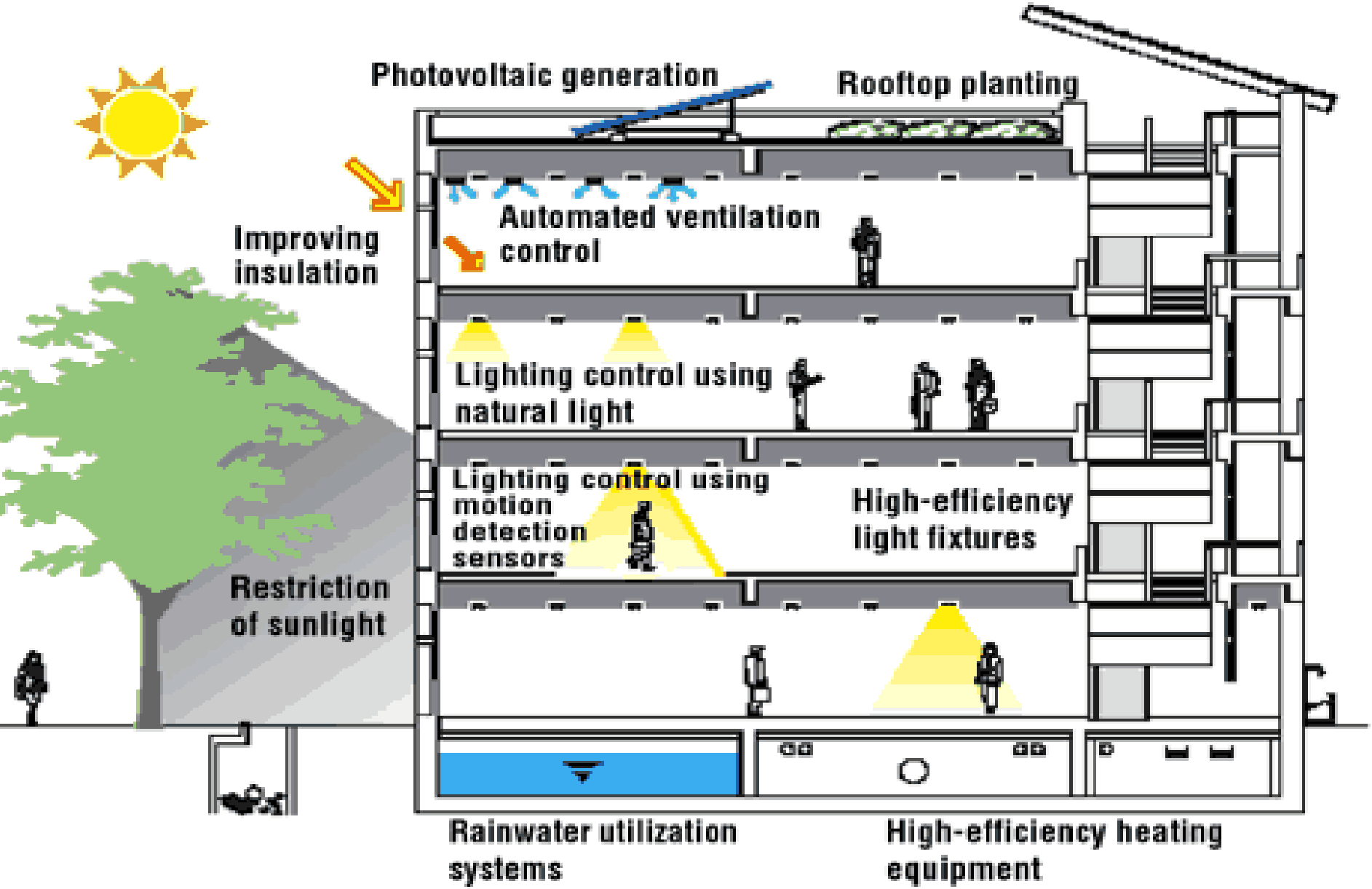
Hot & Dry Zone

- Torrent Research Centre, Ahmedabad (19,700sqmt)
- Sangath, Ahmedabad (585sqmt)

Warm & Humid

- CII Godrej, Hyderabad (20,000sqft)
- Grundfos Pumps, Chennai (40,000sqft)

ELEMENTS OF ENERGY EFFICIENT BUILDING DESIGN - 1



'A Green building makes you

Happy, Healthy and More Productive

-Provides highest quality of indoor environment

-Optimizes Resources, , Reduces Waste,

- Reduces Carbon Footprints

-makes building operations cost effective and energy efficient-

create win-win situation for owner; occupant; user; tenant

– 'Natural Capitalism'

Jit.kumar1944@gmail.com