Ministry of Housing and Urban Affairs
Government of India

Passive-design Response in Increasing Thermal Comfort with Viable Solutions (PRiTHVi)

PRiTHVi for better LiFE in Affordable Housing

Single Family Affordable Housing

Volume - 1

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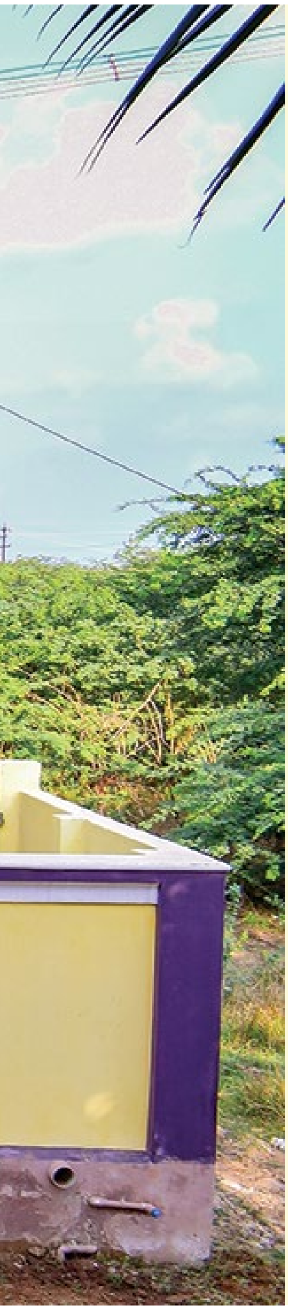
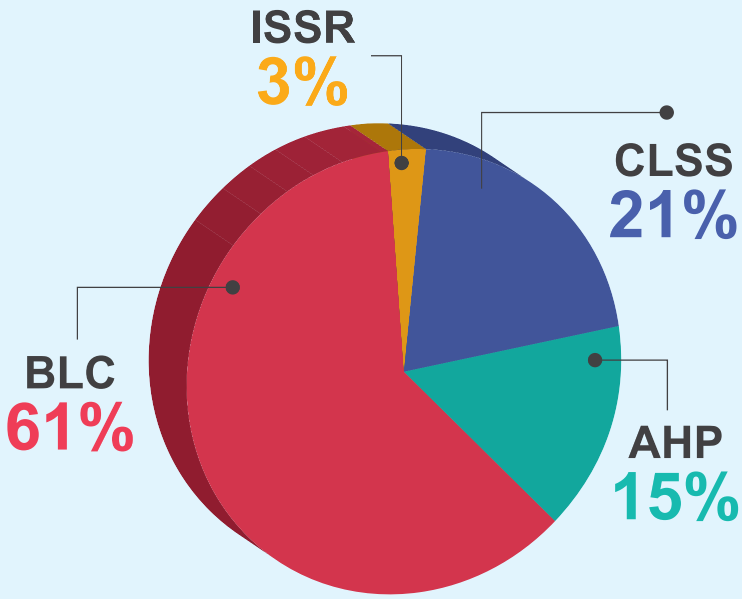


WHY PRiTHVi FOR AFFORDABLE HOMES?

The Ministry of Housing and Urban Affairs launched the Pradhan Mantri Awas Yojana-Urban in 2015 with a vision to meet affordable housing demand in urban areas. This vision is a step towards providing a better quality of life to the citizens. Therefore, it becomes necessary that the housing we build is also equipped to provide optimal thermal comfort to its occupants while ensuring that affordable homes remain affordable.

Actual photographs of houses constructed under Beneficiary Led Construction (BLC) category across the country under PMAY Scheme.

HOUSES IN VERTICALS



Under PMAY-U majority of the homes are being constructed by individual homeowners or small contractors in self-build formats under the 'Beneficiary Led Construction (BLC)' vertical.

This housing stock being added today will not only add to the current demand on energy and resources but also impact the demand for the next 50–60 years. For the sake of our mother earth ("PRITHVI"), it is essential that the homes we construct today be future-ready, are affordable, and comfortable to occupy and maintain over its lifespan. To achieve this, we must follow a defined set of guiding principles and adopt simple solutions with nil or minimal cost implication to provide the habitants with increasingly important requirement of "Thermal Comfort."

Actual photographs of houses constructed under Beneficiary Led Construction (BLC) category across the country under PMAY Scheme.

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खण्ड
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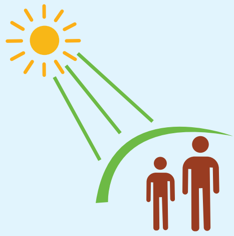
INTRODUCTION

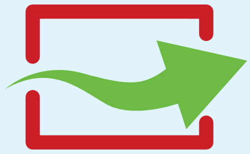
PRiTHVi for Affordable Housing

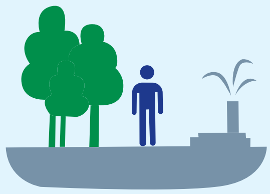
Passive-design Response in Increasing Thermal Comfort with Viable Solutions (PRiTHVi) is a guiding standard on how to build for achieving thermal comfort using passive design. Passive building design is a set of design principles or strategies that allow for attaining an eco-friendly building that caters to the occupant's thermal comfort with minimal or no additional cost. These design principles can be applied to all buildings, including single-family homes, multi-family apartment buildings, schools, skyscrapers and more.

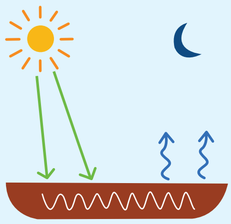
This document provides such viable solutions to achieve desired thermal comfort through passive-design interventions which need to be adopted from the conception of a project and integrated at various stages of design and construction.

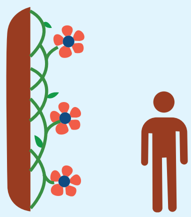
Passive design responds and benefits from the local climate to provide thermal comfort to its occupant eliminating or reducing the need for mechanical air-conditioning, thus reducing impact on environment and cost of operations.



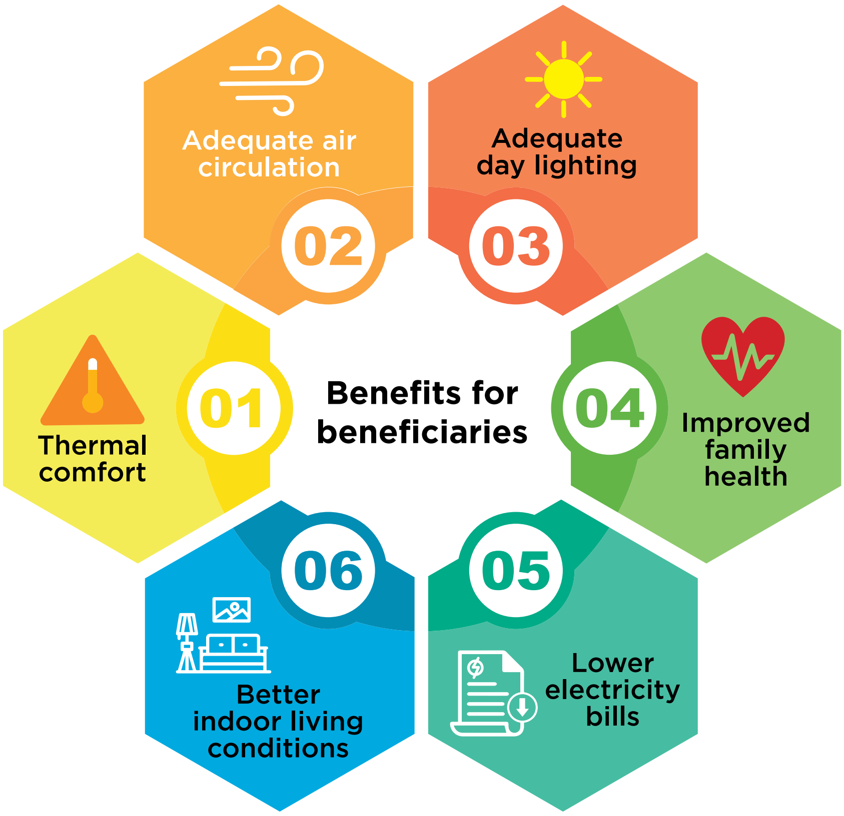








Passive design is sensitive to the seasonal and day-to-day variations in temperature, wind direction and speed, sun movement, rainfall, etc., and utilizes it to maintain a comfortable living environment inside the building. Passive design relies on the understanding and behaviour of its occupant to operate the building to its full potential.



Through climate-responsive passive design, the end user can gain the direct benefits of increased comfortable hours, minimal energy requirements and low operational costs.

Thermal Comfort Performance Levels for Single Family Homes

Two (2) levels of thermal comfort performance are defined in PRiTHVi for Single Family Homes

Level 1 PRiTHVi Compliant Home

(Minimum Thermal Comfort Performance Level)

This level of compliance will help home dwellers achieve the **acceptable level of thermally comfortable hours** inside the building and reduce the need of active cooling or heating **considerably.**

Level 2 Swarna PRiTHVi Compliant Home

(Advanced Thermal Comfort Performance Level)

This level of compliance will help home dwellers achieve the **maximized thermally comfortable hours** inside the building and reduce the use of active cooling or heating **significantly.**

For details on compliance, please refer to खण्ड 3: Prescriptive Self-Declaration Form of this booklet.

PRiTHVi for **Thermal Comfort**

> **That condition of mind that expresses satisfaction with the thermal environment.**
> *(ASHRAE 55)*

Thermal comfort is one of the key components that add to improved lifestyle additional to the promise of a safe, secure and permanent shelter. This document brings forward simple and low-cost ways of achieving thermal comfort in single family affordable homes.

PRiTHVi for **Improved Ventilation**

Provision of fresh air by improved ventilation

It is necessary to have a defined set of guiding principles with simple and low-cost solutions that can be implemented to provide benefits from improved air circulation and take advantage of natural ventilation in maintaining comfort in low-cost homes.

PRiTHVi for **Adequate Day Lighting**

Excellent levels of day light and visual comfort

Home owners and builders have a critical role to play in the process of making sustainable choices by adopting simple measures such as

- Favourable orientation with respect to the sun
- Basic shading according to sun and optimized for minimum heat gain and maximum day light

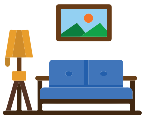
PRiTHVi for **Lower Energy Bills**

Very low energy demands, thus low energy costs

There is an urgent need to regulate building practices, to ensure:

- Being affordable for the occupants to maintain and operate in the long term
- Being sustainable and energy efficient, by reducing energy demands in near future, dependent upon air conditioners and having reduced energy bills

PRiTHVi for **Better Indoor Living Conditions**

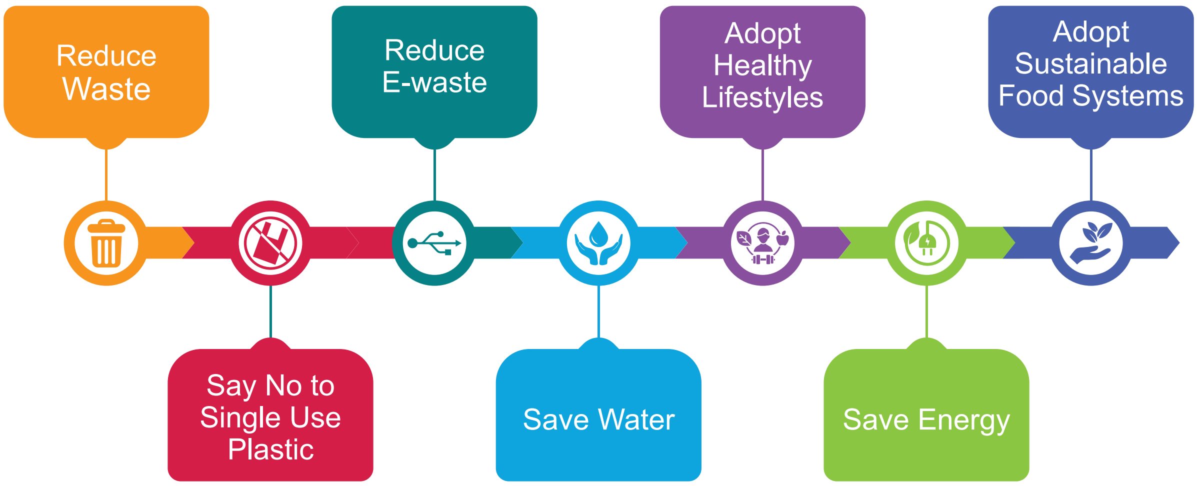


Better indoor living conditions through passive design measures

Passive design strategies promote principles like compactness, optimized window sizes and shading and ventilation which helps improve the living condition in built environment.

PRiTHVi for **Improved LiFE** (Lifestyle for Environment)

LiFE Themes



PRiTHVi is based on the historic guiding principles of building design and construction which emphasizes on the use of nature and environment to make buildings adapt to their environment and provide thermal comfort to the occupants. Since this urges users to rely on natural ventilation, optimize solar radiations, enhance day lighting inside building via natural means, it facilitates and strengthens many verticals under the LiFE Mission of India.

LiFE – Lifestyle for Environment as a key to combating climate change.

Scope for PRiTHVi

Big Dreams, Better Homes, PRiTHVi contributes to make LiFE better.

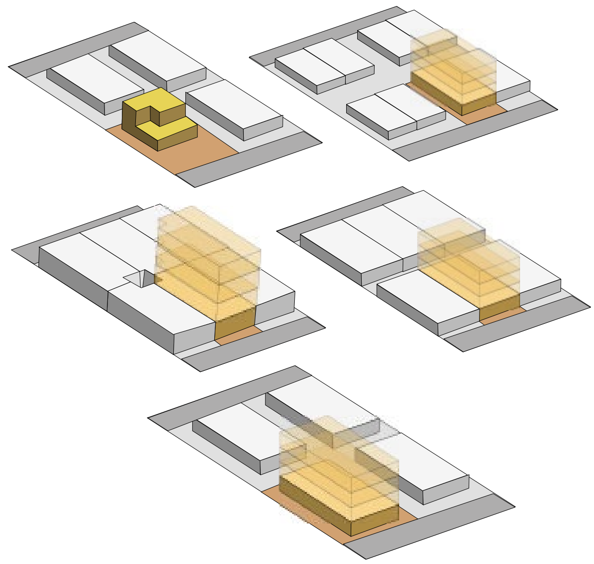
This document provides opportunity to passively design homes that may provide improved thermal comfort to the building occupant.

It identifies opportunities to provide thermal comfort based on no cost solutions widely available via nature or intelligent planning or minimal cost which shall retain the affordability of an affordable housing.

It sets the guiding principles which apply to all single family affordable homes and small plot sizes.

It aims to meet the need to reach the ground level in owner driven construction in cities and small towns.

It is structured as simple Do's and Don'ts to make a dream house 'Thermally Comfortable'.



Tips to read and understand the document

This document is written as a simple and easy to follow guideline. Throughout the document visual cues help identify the do's and don'ts to follow for different climatic conditions across India:

1

- Cold Climate zone
- Warm-Humid Climate zone
- Composite Climate zone
- Temperate Climate zone
- Hot-Dry Climate zone

2

- Pros
- Cons

3

- Dos
- Don'ts

खण्ड २

PRiTHVi PANCHAMRIT FOR SINGLE FAMILY HOMES

This document lists 5 key areas of intervention at design and planning stage which deal with the site level, internal layout and building level and then go into details of building elements like doors, windows, walls and roof.

At each stage, simple measures to be taken are illustrated, and Dos and Don'ts are listed to assist the occupant, builder, or owner in making informed decisions and understanding their impact on the thermal comfort of the home they will occupy for decades.

SITE PLANNING

The site planning defines the building foot printing and its neighbouring surroundings which is the first step in establishing how much of the building interacts with the outside environment.

भाग 1: Plot Layout and Site Planning | भाग 2: Landscaping to Reduce Heat Island Effect | भाग 3: Rainwater Harvesting: Water Conservation

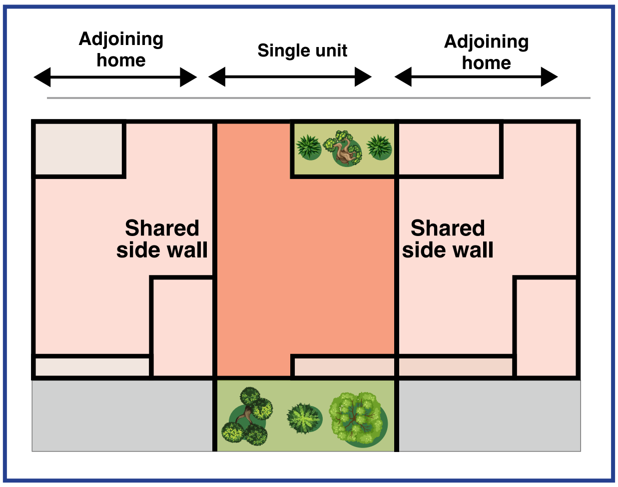
भाग १ Plot Layout and Site Planning

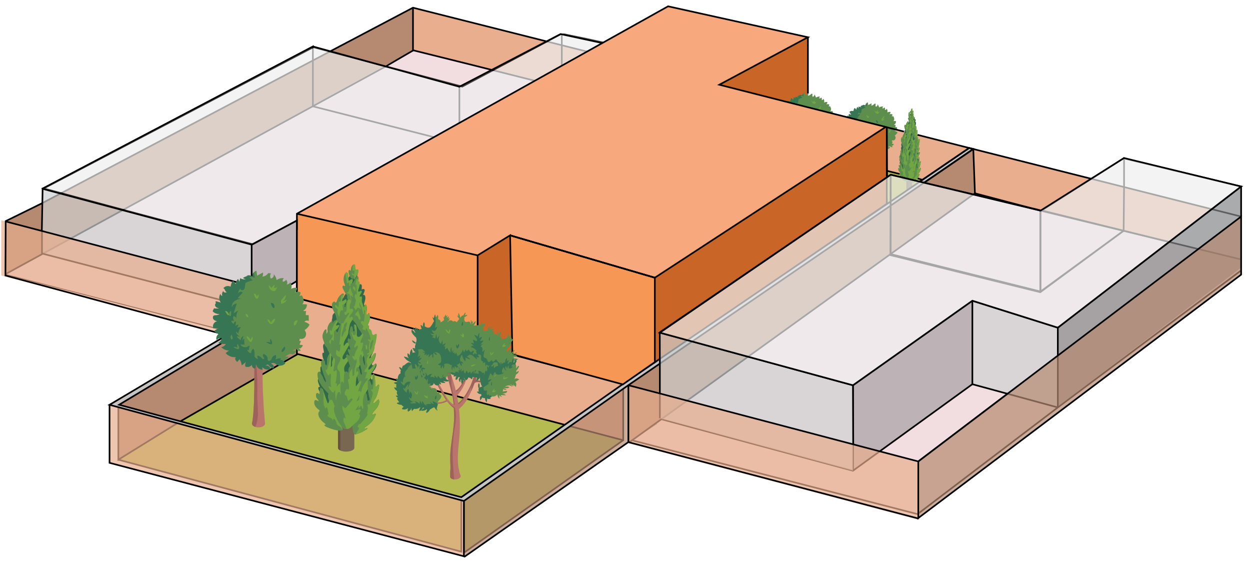
The three typologies for plotted layouts that are most prevalent are:

1. Row house – 2 side open
2. Semi-detached house – 3 side open
3. Detached house – 4 side open

1. ROW HOUSE – 2 SIDE OPEN – in which adjacent homes along the street or path are built touching each other. The ho mes have open space on two sides – toward the street front and at the back – from which they receive light and air.

- Ideal for small plots
- Allows maximum ground coverage



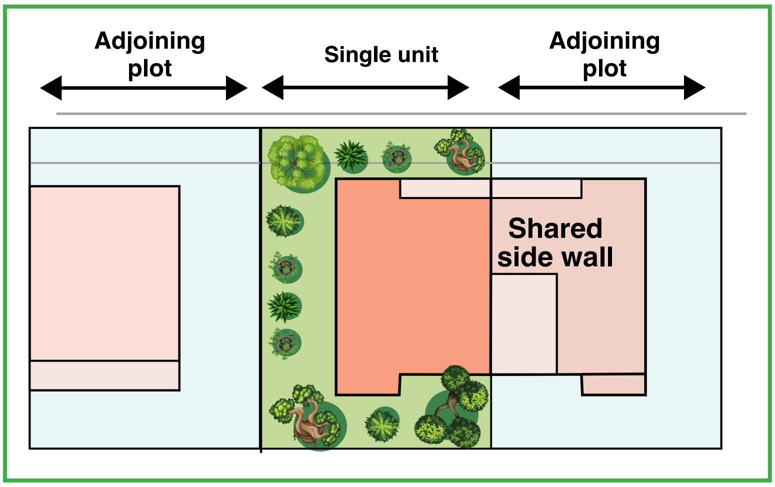


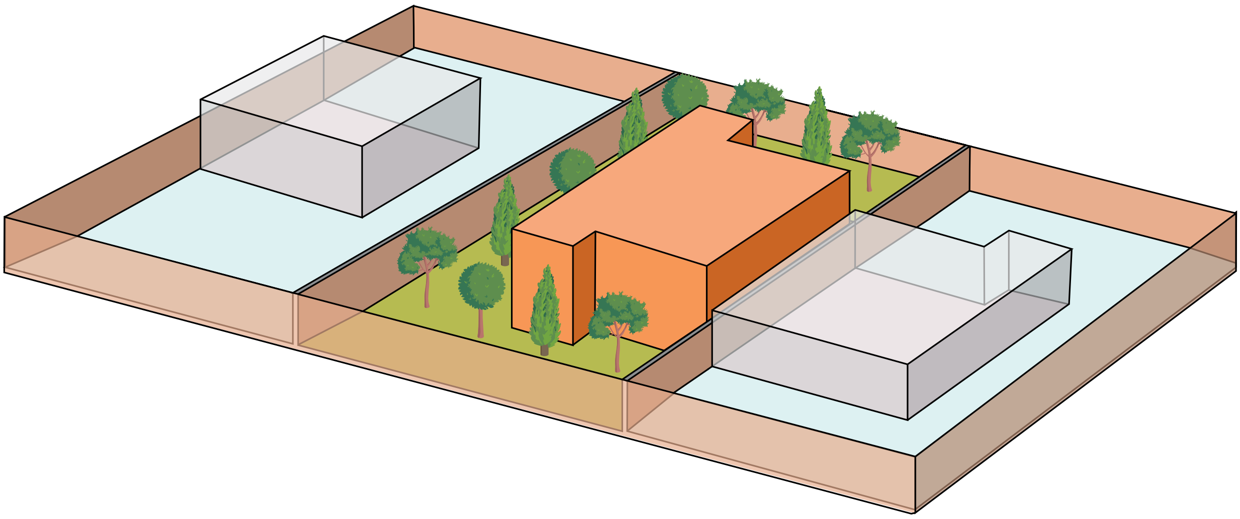
Key recommendations to adopt for 2 side open houses:

- Maximize the green area by planting local trees and plants
- Maximize windows in front and back to optimize cross-ventilation and day lighting
- Adopt roof-top rain water harvesting system

- Reduce paved areas and hardscape
- Reduce direct solar radiations inside the building with proper shading
- Avoid habitat disturbance by adopting local architecture

2. SEMI DETACHED HOUSE – 3 SIDE OPEN – in which two adjacent homes are paired, touching each other, and leaving open space between each such pair. Each house in this arrangement now has open space on three sides – from which it receives light and air.



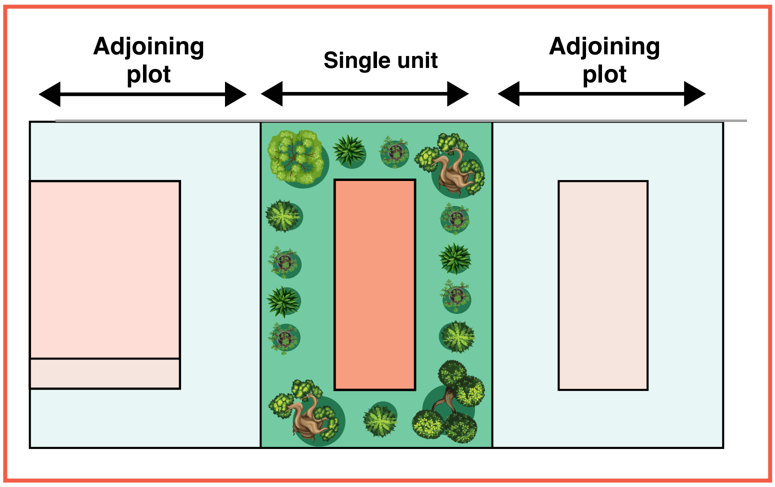


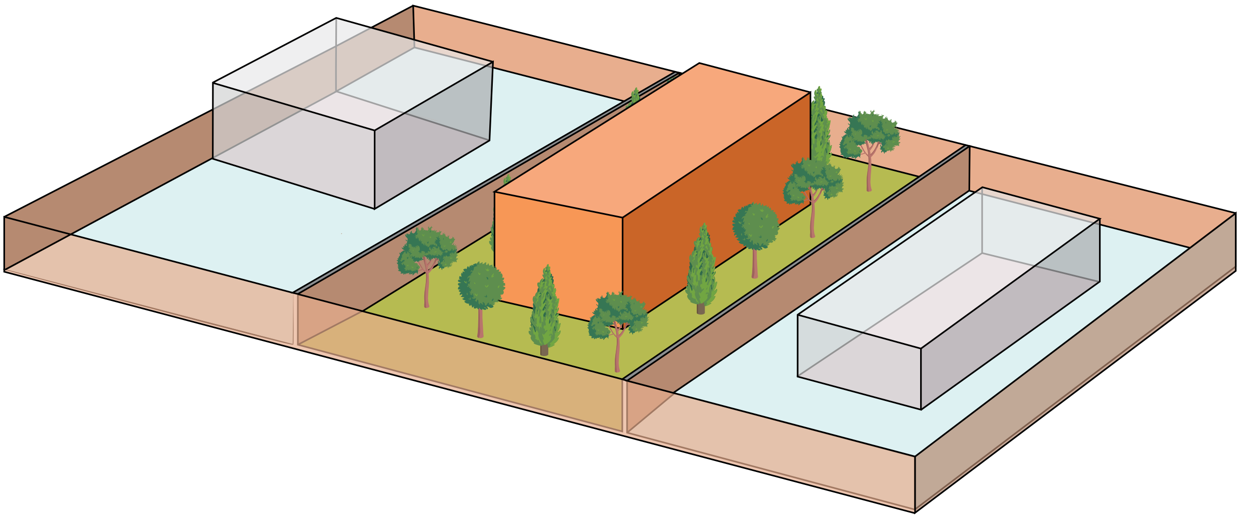
Key recommendations to adopt for semi detached – 3 side open houses

- Plan windows evenly in all direction with maximum windows on façade facing north and south
- Save natural and existing plants on site
- For all hot and warm climate, incorporate enhanced wind circulation techniques like courtyards, balconies, porches and decks
- Plan internal space layout relative to sun, wind and views
- Reduce, control, and treat surface runoff through effective storm water practices that treat both the quantity and quality of runoff.

- Reduce paved areas and hardscape
- Reduce direct solar radiations inside the building with proper shading in all directions
- Avoid habitat disturbance by adopting local architecture

3. DETACHED HOUSE – 4 SIDE OPEN – in which the unit sits in the middle of the plot and has open spaces on all 4 sides – from which is receives light and air.





Key Recommendations to Adopt for Semi Detached – 4 side open Houses

- Orient building with longer façade facing north and south direction to be able to integrate passive and active solar strategies (Refer 'खंड ग').
- Plan maximum windows on façade facing north and south direction.
- Save natural and existing plants on site. Plan vegetated areas and diverse landscape.
- For all hot and warm climate, incorporate enhanced wind circulation techniques like courtyards, balconies, porches, and decks.
- Plan internal space layout relative to sun, wind and views.
- Reduce, control, and treat surface runoff through effective storm water practices that treat both the quantity and quality of runoff.

- Reduce paved areas and hardscape
- Reduce direct solar radiations inside the building with proper shading in all directions
- Avoid habitat disturbance by adopting local architecture and construction techniques

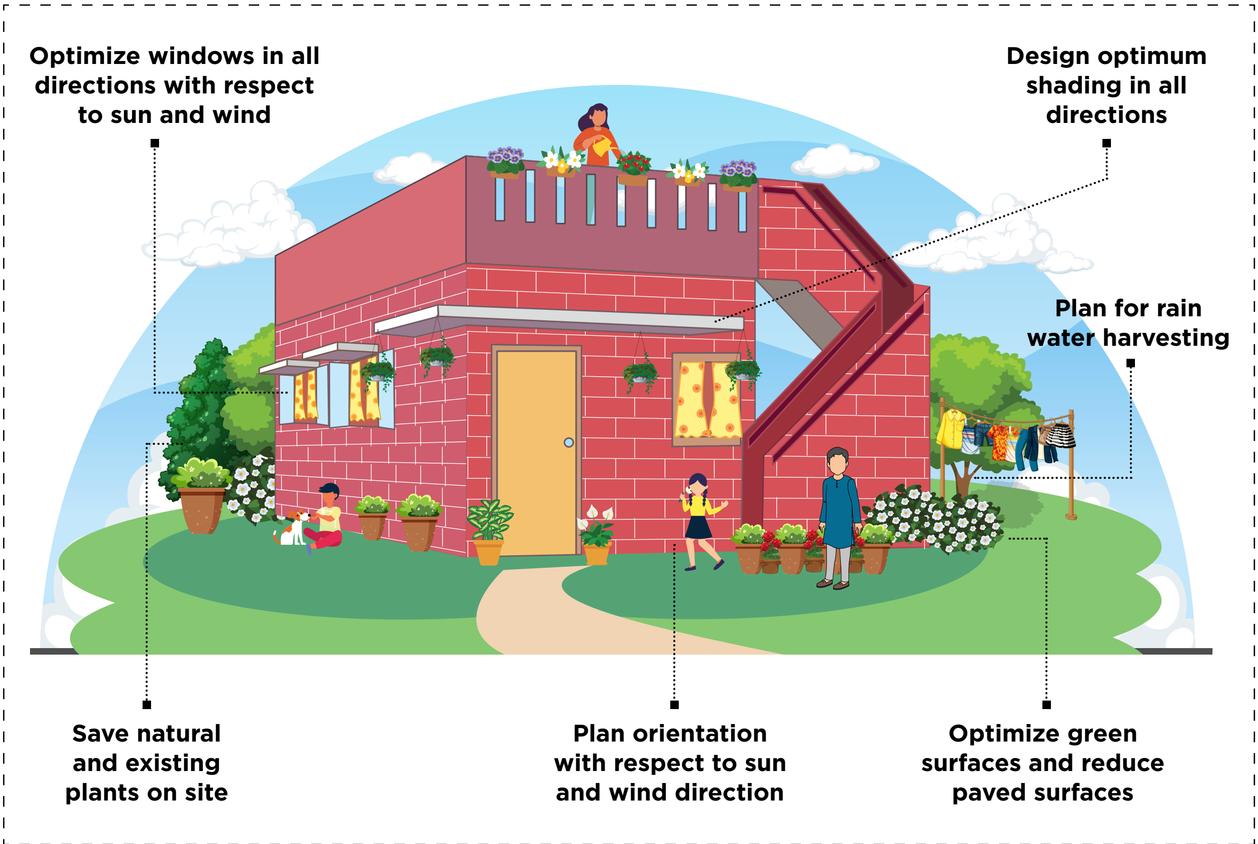
PLANNING PRINCIPLES

- Minimize disturbance of existing site typographic, existing flora, and amount of natural land converted to impervious surfaces.
- Prevent erosion and restore the health of sites by improving habitat for indigenous species by planting native and climate-adapted vegetations, and rebuilding depleted soil through sustainable organic methods.
- Incorporate bicycle racks and EV charging provisions at the parking area of the site.
- Respect existing aesthetic view sheds from existing buildings, landscape features, and elements.

01 It is important to **maximize green space** with local plants and minimize paved hard surface.

02 In cold climate have **enough space between buildings to allow for maximum sunlight** to take advantage of solar heating.

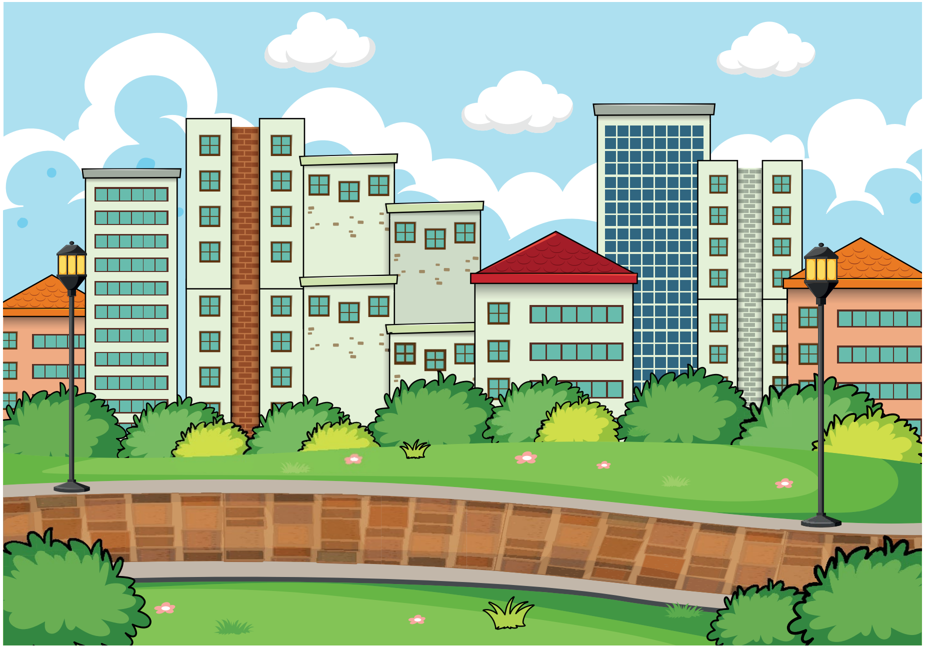
03 In warm climate **narrow streets provide shaded space around the buildings** keeping the walls shaded and the surroundings cool.



भाग २ Landscaping to Reduce Heat Island Effect

Surface finishes play a major role in reflecting or absorbing the sun's heat during the day.

Maximize green area: Trees, vegetation, green, soft paved surfaces help in keeping the surroundings cooler. Such spaces also allow water percolation reducing the risk of flooding and maximizing ground water recharge.



Minimize hard paved surfaces: Roads and paved surfaces heat up quickly and radiate more heat to the surrounding leading to higher temperatures in dense areas.

Enhancing Sustainability: A Strategic Guide to Plantation for Affordable Housing in India

The strategic plantation around affordable housing in India serves as a vital aspect in the quest for optimizing natural elements like wind and sunlight. Thoughtful placement of trees emerges as a pivotal factor in not only enhancing the overall comfort within housing structures but also improving energy efficiency and contributing to long-term sustainability.

The following strategies can be considered for better performance:

Objective

Provide effective shading, thereby reducing heat gain during the afternoon

Strategy

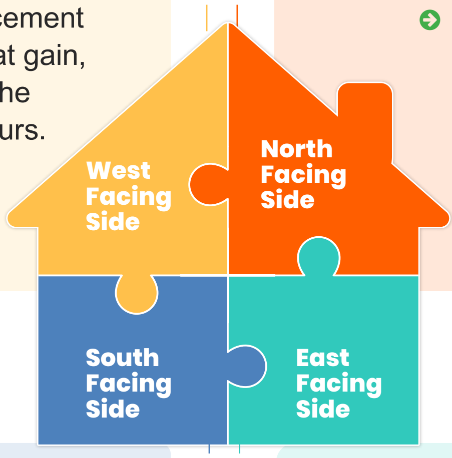
- Planting evergreen trees and closely spaced shrubs/ plants on the western side is recommended.
- This deliberate placement minimizes solar heat gain, particularly during the hotter afternoon hours.

Objective

Facilitate ample daylight penetration into the building

Strategy

- Plant low level plants or trees at a significant distance from the north-facing side.
- This strategic positioning ensures unobstructed access to sunlight throughout the day, creating a naturally well-lit and comfortable interior.



Objective

Allow solar access during winter while preventing excessive heat gain in summer

Strategy

- The south-facing side benefits from the strategic planting of deciduous trees that shed leaves during winter.
- Additionally, incorporating deep verandahs on the south side creates shaded outdoor spaces, protecting against direct sunlight.

Objective

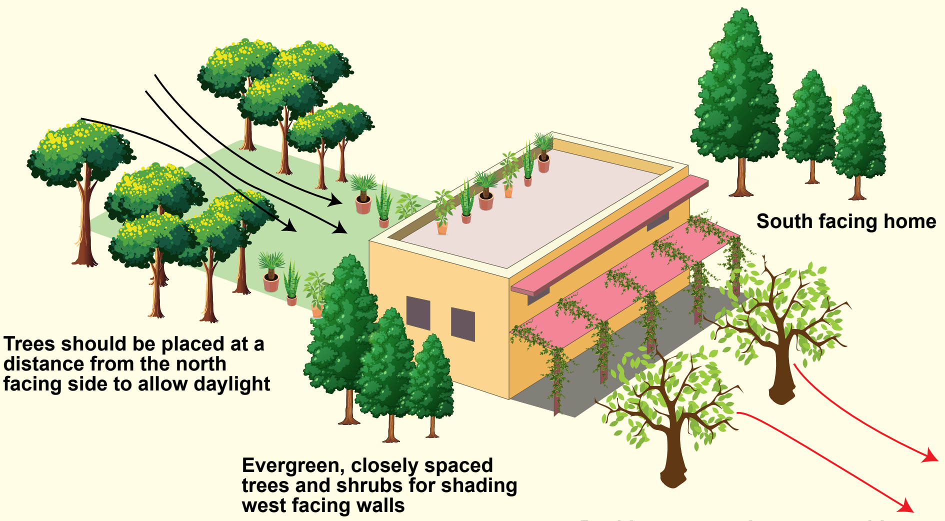
Optimize morning sunlight penetration to allow morning sunshine but reduce heat gain

Strategy

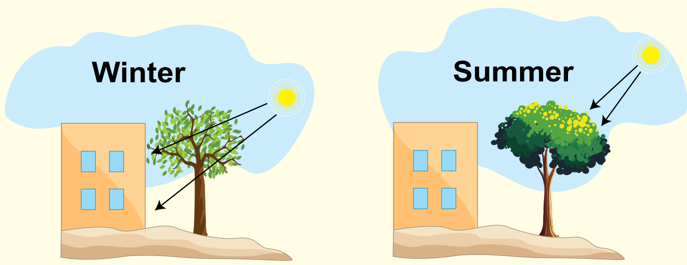
- Planting evergreen trees at a distance from the east-facing wall is the strategic approach to provide shading without completely obstructing the morning sunlight.
- This strategic move aids in moderating temperature fluctuations and maintaining a comfortable indoor environment.

Site Level: Leveraging Plantations

Appropriate plantation of trees and plants to promote shading and ventilation in respective direction.



The image alongside given here shows deciduous trees that allow sun penetration in winter and block sun access during summer.



Deciduous trees allow sun penetration in winter and block sun access during summer

General Considerations

Local Adaptation

Choose tree species that are well-adapted to the local climate, soil conditions, and water availability. This ensures better survivability and growth of the planted vegetation, promoting a sustainable and resilient landscape.

Examples of deciduous trees or plants
Neem, Curry, Sal, etc., or any other specie which sheds leaves in winters.

Examples of evergreen trees or plants
Krishnachura, Indian rosewood, Tulsi, gulmohar, bamboo, banana, etc.

भाग ३ Rainwater Harvesting: Water Conservation

Rainwater harvesting is a simple strategy for collecting and storing rainwater for future use and replenishing groundwater levels. Rainwater is collected and stored using artificially designed systems that run off naturally or by using man-made catchment areas such as rooftops, compounds, rocky surfaces, hill slopes, and so on.

With depleting groundwater levels and fluctuating climate conditions, this measure has the potential to significantly reduce the negative effects of rising water scarcity. Rainwater conservation can help recharge local aquifers, reduce urban flooding, and, most importantly, ensure water availability in drought-prone areas.

There are two major techniques of rainwater harvesting:

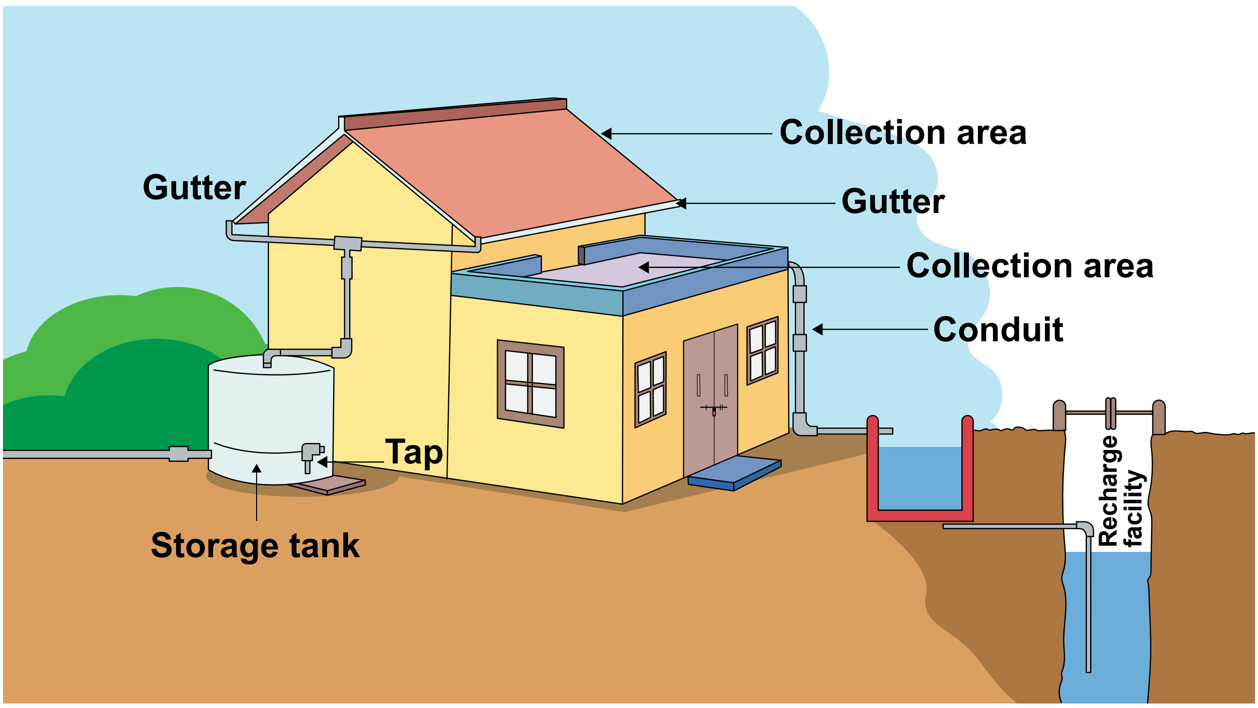
The strategic plantation around affordable housing in India serves as a vital aspect in the quest for optimizing natural elements like wind and sunlight. Thoughtful placement of trees emerges as a pivotal factor in not only enhancing the overall comfort within housing structures but also improving energy efficiency and contributing to long-term sustainability.

a. Rooftop Rainwater Harvesting

Rooftop rainwater harvesting systems collect rainwater from the roofs of homes and buildings, primarily for domestic use. Typically, this system is set up by using and installing gutters, pipes, and downspouts to channel rainwater from the roof into storage tanks or underground reservoirs. Once this water is collected, the rainwater can be used for various purposes like irrigation, vehicle washing, toilet facilities, and even drinking, but only if the water is properly treated.

This method is particularly useful for urban plots with limited surface-level water storage space or in areas with few groundwater sources. It makes use of existing infrastructure, is cost-effective, and reduces demand for municipal water supply, thereby mitigating water scarcity issues.

Rain Water Harvesting

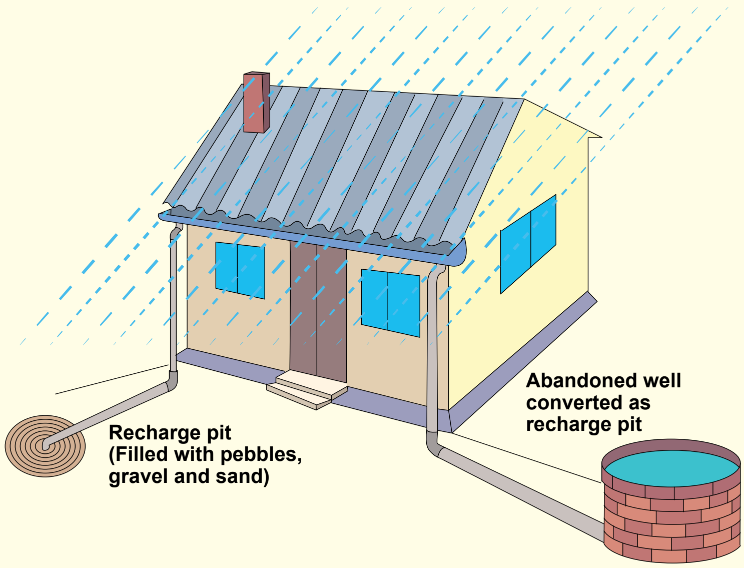


b. Surface Runoff Harvesting

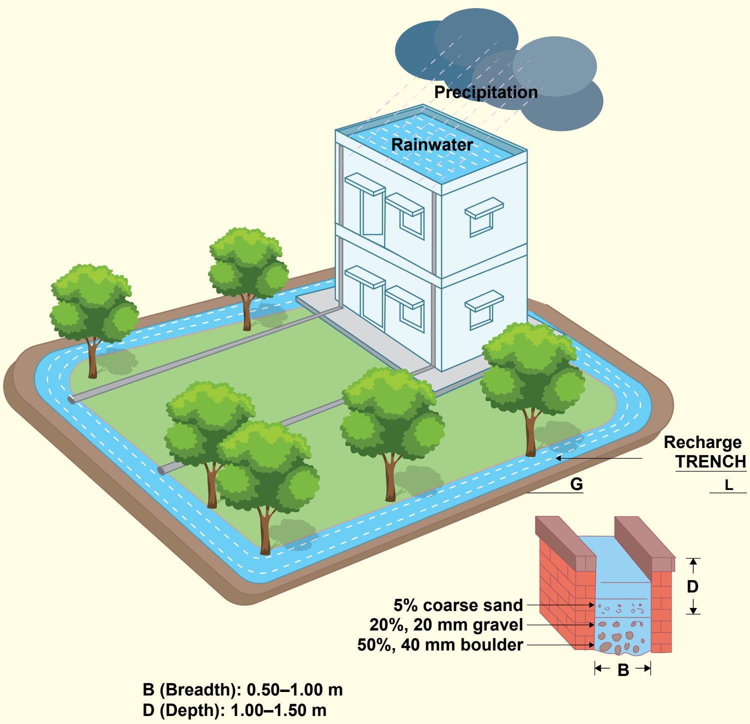
Surface runoff rainwater harvesting is the process of collecting rainwater from ground surfaces such as roads, pavements, parking lots, and open areas and storing it for later use. This method redirects surface runoff into storage structures or infiltration basins in order to recharge groundwater. Rainwater runoff is collected and recharged aquifers using techniques such as recharge pits, trenches, wells, and green space construction.

This method is advantageous because it utilizes unused space and can be used in parks, open areas, and along roadways. It aids in flood control by capturing and storing excess rainwater, lowering urban flooding. It also improves groundwater recharge and helps to replenish groundwater resources.

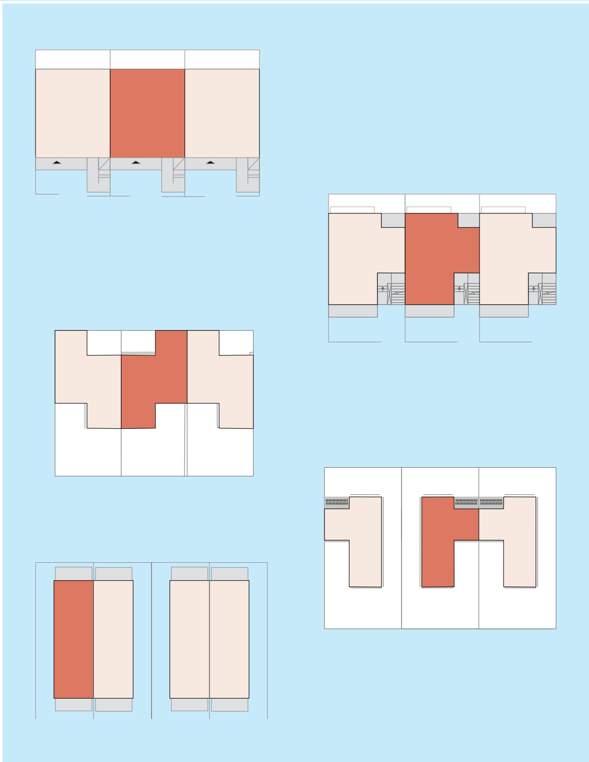
Recharge wells and pits



A recharge trench dug shallow



BUILT FORM AND LOCAL ARCHITECTURE

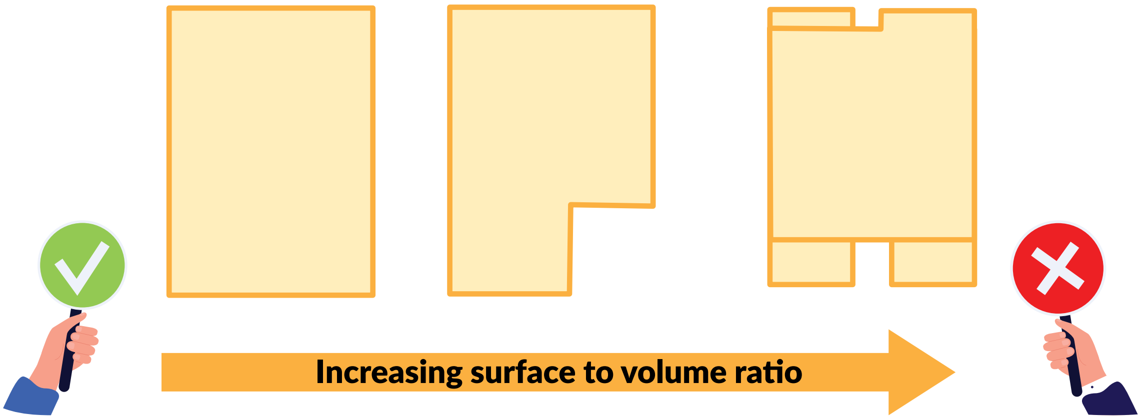


The shape of the building is chosen for more than just aesthetic value or visual preference. It defines the level of comfort inside the building and can be used to modulate air movement and heat gain caused by the built form.

भाग १: Compactness | भाग २: Building Shape |
भाग ३: Local Architecture

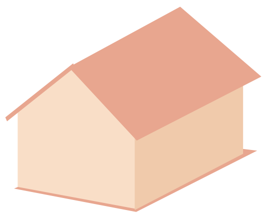
भाग १ Compactness

Simple building form needs to be adopted where the external wall area is minimum. This reduces the loss of heat in cold climate and gain of heat through the walls in warm climate.

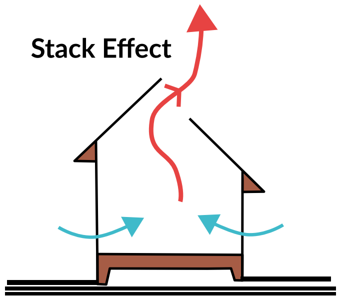


भाग २ Building Shape

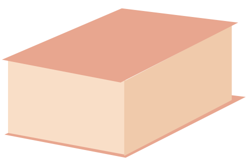
The inner volume of the building and the shape of the roof also impact the comfort inside the house.

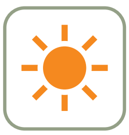


Sloping roof for rain and snow

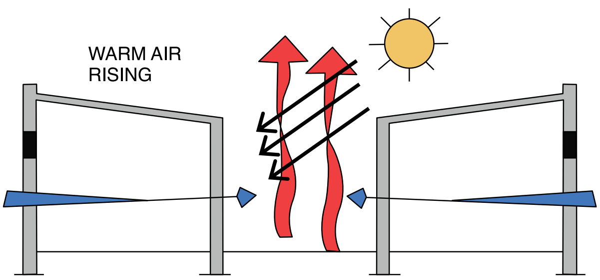


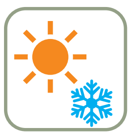
More height for ventilation in hot and humid climate





Flat roof for hot climate





Inner courtyards for stack effect in composite climate

भाग ३ Local Architecture

THE SUSTAINABLE ASPECTS OF VERNACULAR CONSTRUCTION PRACTICES ACROSS INDIA

India's diverse landscape, varied climate, and rich cultural heritage have given rise to numerous local architectural practices. These practices showcase thermal comfort within buildings, are rooted in local communities, and are well adapted to the specific climate conditions of each region. This chapter explores the local architecture and construction methods used across the country that contribute to achieving optimal thermal comfort inside buildings.

A Local Architecture for Cold Climate (The Himalayan Region) – like Kathkuni Architecture which uses Stone and Wood

In the Himalayan region, local architecture makes use of stone and wood resources to ensure optimal thermal comfort. One of the most prevalent architectural styles found in cold regions like Himachal Pradesh, Uttarakhand, and parts of Jammu and Kashmir is Kathkuni architecture. The term '*Kathkuni*' is a combination of '*Kath*' meaning wood and '*Kuni*' meaning stone.

Thermal Comfort in Practice

In cold climates, locally sourced stone and wood are used for optimized thermal comfort and sustainability.

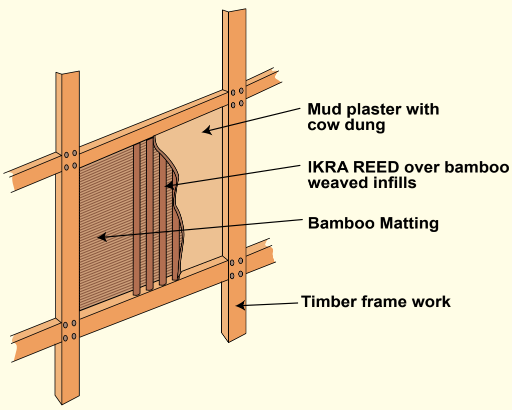
A two-storey darbargadh in Sainj

Benefits

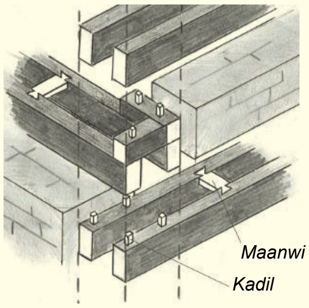
1. It has low embodied energy, requiring minimal extraction and processing.
2. These materials are good for insulation and have a low environmental impact.
3. Deodar or cedar wood - known for durability and resistance to pests, ensures longevity and minimal maintenance.
4. It has desired thermal resistance and mass, keeping interiors warm in winter and cool in summer.

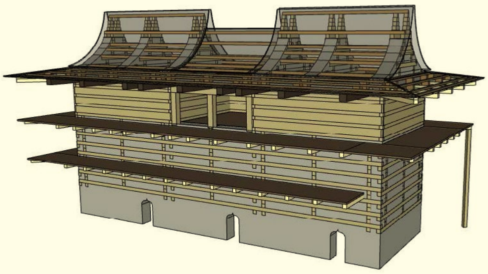
Structural Stability and Techniques

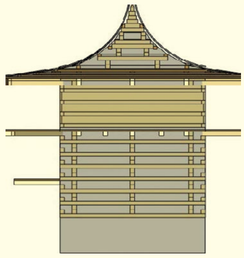
- Stone construction in the seismic-prone Himalayan region ensures structural stability.
- Wood, a primary material in Himalayan vernacular architecture, offers versatility and rustic elegance.
- Timber is used for structural elements, roofs, and intricate detailing.
- Locally sourced stones for foundations and lower levels to ensure stability.



- Warm tones of wood and earthy hues of stone ensure Kathkuni houses seamlessly blend with the natural environment.







Illustrations derived from Marloes Lisa van der Zanden's master's thesis titled 'Assessment of the seismic performance and sustainability of the Kath-Kuni building style in the Indian Himalaya'.

B Local Architecture for Hot and Dry Climate (The Kutch Region) – uses mud and locally available Wood

In the Thar Desert, where resources are limited and the climate is harsh, vernacular architecture uses mud and locally available wood to build sustainable and climate-responsive structures.

Habitats of Kutch – Bhunga

Thermal Comfort in Practice

In a hot and dry climate, mud, which is readily available, serves as a key building material. It demonstrates resilience in withstanding the harsh environment while ensuring thermal comfort.

Benefits

1. Mud bricks provide exceptional thermal mass, regulating temperatures effectively as they absorb heat during the day and release it at night. Use 'Adobe', a mixture of mud, sand, and other organic materials such as animal dung, to make bricks.
2. It is a sustainable and eco-friendly material with minimal environmental impact, reducing energy-intensive processes.
3. They provide effective insulation against daytime heat.

Structural Stability and Techniques

- Khejri and Rohida trees support building structures in the Thar Desert.
- Bhungas, traditional houses in Kutch, have a unique circular structure and thatched roofs. These are constructed using locally available materials such as mud, clay, bamboo, and timber. Moreover it exhibits earthquake resistance.
- Substantial wooden posts support the roof, with wooden-framed windows for cross-ventilation.
- The thatched roof, crafted from bamboo sticks and forming a cone, is tied with dried grass ropes and coated with a mixture of cow dung and mud for protection, showcasing traditional building techniques.

C Local Architecture for Warm and Humid Climate Near Seas and Oceans (Southern Region) – like Toda Huts and use local pines and daub construction

The architectural styles in the southern region are known for using local pine and daub construction. Another form of local architecture is that of the Nilgiris, called the 'Toda Hut' for the tribal buffalo herdsmen.

Thermal Comfort in Practice

Wattle and Daub involve a woven lattice of wooden strips coated with clay or mud provide thermal comfort in colder regions and promote ventilation in warmer areas.

Toda hut.

Benefits

1. Materials used in wattle and daub have low embodied energy and carbon footprint. They are a suitable choice for promoting ventilation in warmer areas.
2. Components used in construction, primarily wood or bamboo, are renewable and biodegradable, ensuring minimal environmental impact.
3. The composition of the daub serves as a natural insulator, contributing significantly to the thermal comfort of the structure.
4. Use of locally available materials not only reduces environmental impact but also fosters local economies.

Structural Stability and Techniques

Wattle Construction Method

- Thin branches, bamboo, or other flexible wooden strips are locally sourced, creating a harmonious connection between the built environment and natural resources.
- The weaving of wattle into a lattice structure forms the backbone of this construction method, enhancing structural robustness and allowing for a flexible framework.

Daub Coating

- The daub mixture applied to the wattle lattice includes locally sourced materials in the Indian context, often involving clay, mud, straw, or other natural fibers.
- Applying daub to the wattle lattice involves filling gaps and creating a cohesive, solid structure, enhancing both structural integrity and thermal properties for a comfortable living environment.

Varied typologies of traditional vernacular dwellings in Kerala

D Local Architecture for Warm and Humid Climate (North East Region) – use of Bamboo Construction

In the landscapes of North Eastern India, bamboo construction reflects sustainable building practices ingrained in the region's culture and environment. This ancient tradition, utilizing bamboo's versatility, not only demonstrates architectural creativity but also upholds sustainability principles, emphasising low energy use and resilience to earthquakes.

Thermal Comfort in Practice

The most common building material used in construction is bamboo, which has a low long-term environmental impact due to its biodegradable nature.

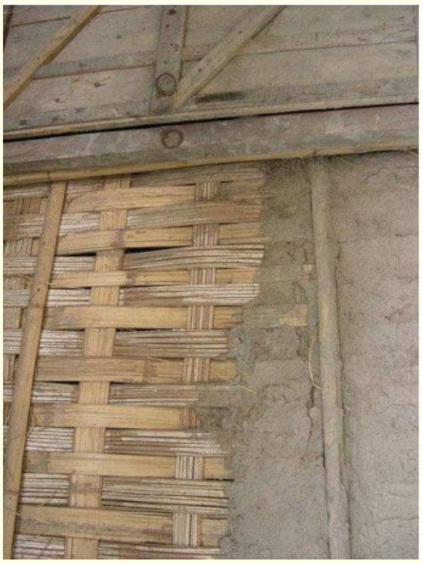
Detail of Ikra application in timber framework for typical Assam type houses

Benefits

1. Bamboo's versatility allows for diverse architectural applications, and it is a locally available material which aligns with sustainable construction practices.
2. The integration of bamboo and wood elements ensures thermal comfort and low carbon footprint.
3. Utilises Ikra shoots, mud plaster, and cow dung for wall construction, providing insulation and resistance to insect attacks.

Structural Stability and Techniques

- Bamboo exhibits high performance in seismic-prone regions. Use of flexible joints and interlocking bamboo elements are part of a vernacular knowledge system that enhances the seismic performance of bamboo structures.
- Flexibility and elasticity allow structures to sway and absorb shock during earthquakes.
- Lightweight nature mitigates lateral forces, enhancing overall safety.
- The roof is structured with a tall gable, covering approximately one-third to one-fifth of the roof width, in order to manage the heavy rainfall characteristic of the region.



Typical wall with weaved bamboo infill and mud plaster over

E Local Architecture for Composite Climate (Central Region)

In the Central part of India, lies the diverse threads of tribal heritage. Among this heritage, the tribal architecture of Chhattisgarh, Odisha, Jharkhand, and Madhya Pradesh stands out, and these regions are shaped by indigenous communities like the Gond, Bhil, Oraon, and Santhals. This architectural style reflects their deep connection with the natural environment and showcases a sustainable way of life.

Thermal Comfort in Practice

Locally available materials such as mud, bamboo, wood, and thatch, are widely used by tribal communities in Chhattisgarh, Odisha, Jharkhand and Madhya Pradesh.

Benefits

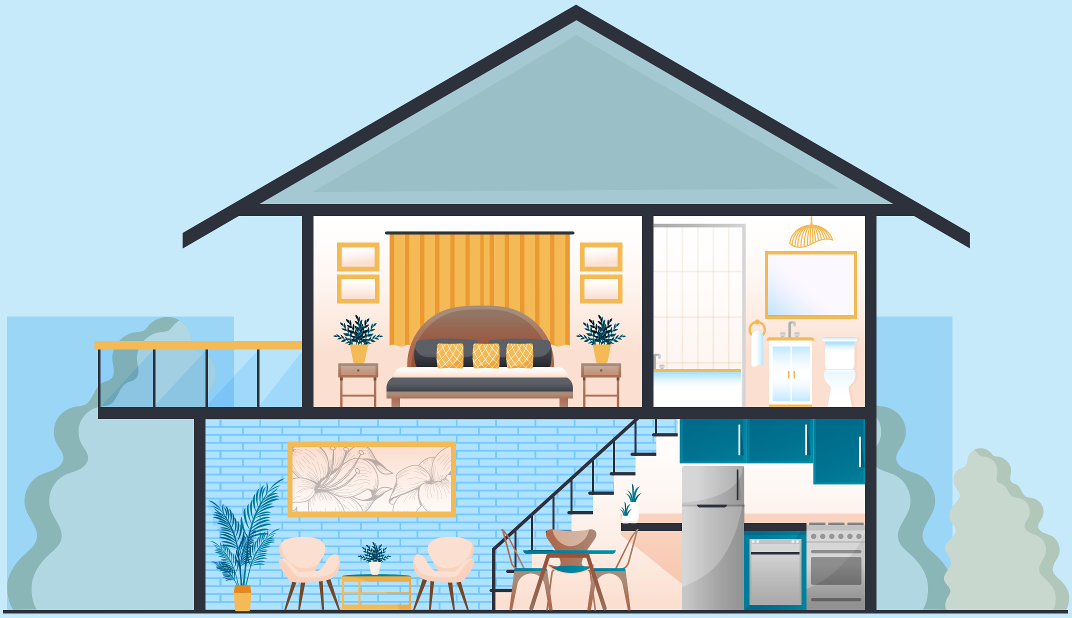
1. In these regions, mud is used in construction for excellent insulation and also keeps interiors cool during hot weather.
2. Thatched roofs, woven from locally sourced materials resist heat and also showcase tribes' craftsmanship.

Structural Stability and Techniques

- Gond Tribe (primarily found in Chhattisgarh and Madhya Pradesh), uses locally available materials like mud, bamboo and thatch for construction. This architectural style features raised platforms and low-sloping roofs that enhance ventilation.

Gond Tribal Houses in Kanha

ग SPACE PLANNING



Plots in India usually have a rectangular configuration with the shorter side facing the street and the depth being longer.

As the city becomes more crowded and land gets more expensive, the plots tend to become long and narrow as street frontage and access becomes more prime.

This section gives inputs on how to plan internal spaces efficiently for small plotted homes.

भाग १: Orientation: Space Planning as per Solar Design |
भाग २: Internal Space Planning

भाग १ Orientation: Space Planning as per Solar Design

Orientation refers to the placement of the building block on site in relation to the movement of the sun. Building orientation has a significant impact on heat gain or loss for achieving comfort through passive measures.

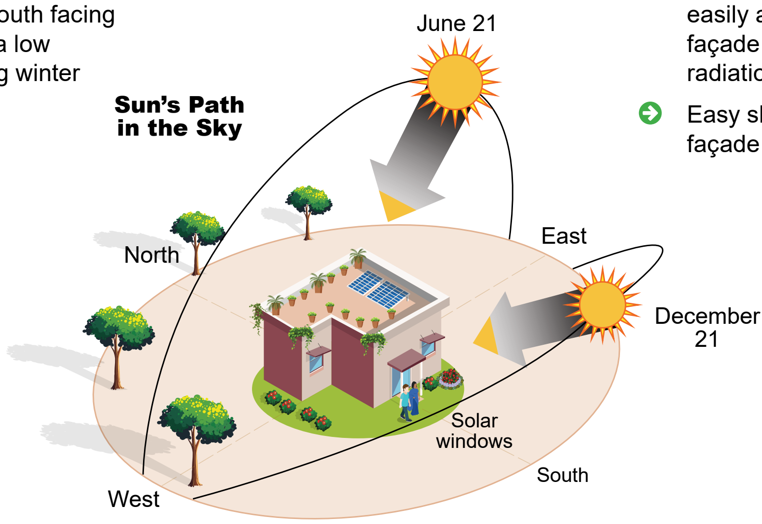
Understanding the Movement of the Sun

Winter Sun

- Sun path is at a lower angle in winter season
- Solar radiation will penetrate south facing façades at a low angle during winter

Summer Sun

- Sun path is at a higher angle in summer season
- Glare free daylight is most easily available on north façade as minimal solar radiation will fall at high angle
- Easy shading of south façade from high angle sun

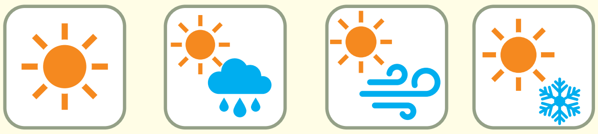


East and west façade receive uniform and strong sun radiations at low angle throughout the year.

In plotted housing (row housing and semidetached housing) the choice of orienting the building ideally is limited due to small plot sizes and fixed proportions. Here it is essential to limit exposure of walls to sun through shared walls and to design and place windows and shading in response to the given orientation of the building block.

For **DETACHED HOUSES (4 SIDE OPEN)** - Orient buildings to be able to integrate passive and active solar strategies. This can be achieved with longer façade of homes to face north and south direction and minimize wall exposed to east and west direction.

RECOMMENDATIONS FOR HOMES LOCATED IN SUMMER DOMINATED CLIMATE



Hot-Dry Warm-Humid Temperate Composite

South

Response: Low angle of the sun in winter: ideal to allow sunlight,

High angle of the sun in summer: can be shaded

Strategy: Ideal to locate windows and master bedrooms of the house.

North

Response: Very little direct sun received, best for receiving uniform daylight.

Strategy: Ideal for cool spaces requiring uniform light such as a study and living room.

East

Response: Receives morning sun at low angle.

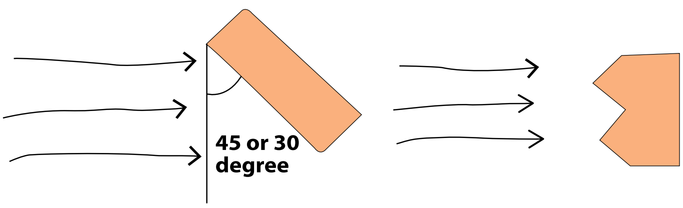
Strategy: Ideal for children bedrooms, puja room and kitchen to catch morning sun. Windows can be shaded with side fins or louvers.

West

Response: Maximum effect of the harsh evening sun specially in summers.

Strategy: Avoid windows, openings, ideal to locate staircase or utility areas. Have least wall area facing west, shade wall with vegetation.

In warm and humid climates apart from orientation in relation to the sun, the direction of wind is also important. The openings and vegetation should be located in response to the local wind direction.



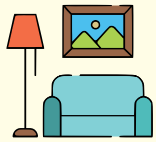
Source: https://nzebnew.pivotaldesign.biz/knowledge-centre/passive-design/form-orientation/#

RECOMMENDATIONS FOR HOME LOCATED IN WINTER DOMINATED CLIMATE

South

Response: Receives maximum sunlight and warmth during the day.

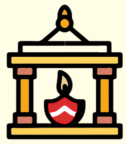
Strategy: Ideal to locate sun balconies to capture warmth during the day and living spaces of the house.



East

Response: Receives morning sun at low angle.

Strategy: Ideal for catching morning sun and keep areas warm during the day such as kitchen and puja room.



West

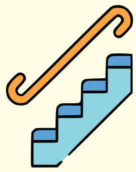
Response: Receives evening sun.

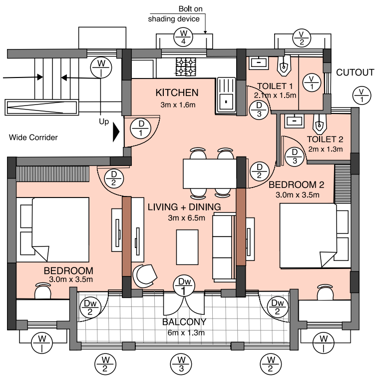
Strategy: Ideal for catching evening sun and keeping areas warm during the night (can plan bedrooms here).

North

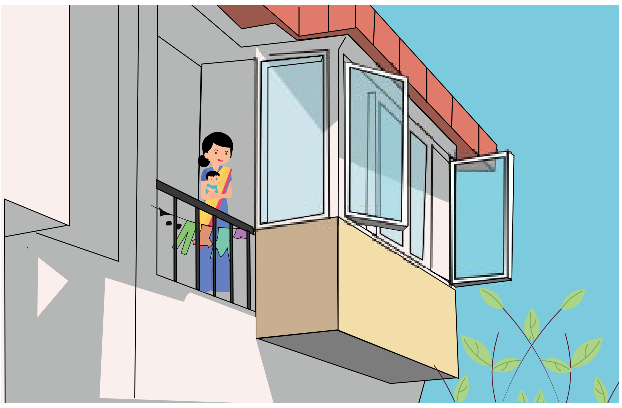
Response: Very little direct sun received, best for receiving uniform daylight.

Strategy: Ideal for cool spaces requiring uniform light such as utility areas and staircases.





Living areas are located facing South, East and West, Utility areas are located facing North.



Sun balcony on south façade to trap maximum heat inside.

भाग २ Internal Space Planning

LAYOUT

After site planning, the second step to passive design is to have an efficient internal layout that makes the best possible use of the orientation, built form, access to light and ventilation through functional spaces.

Plot setbacks

Minimum setback range of 2-3 m in front and 1-2 m in rear to ensure optimum light and ventilation. (These may be superseded by local byelaws in each location.)

01

Unit size and design

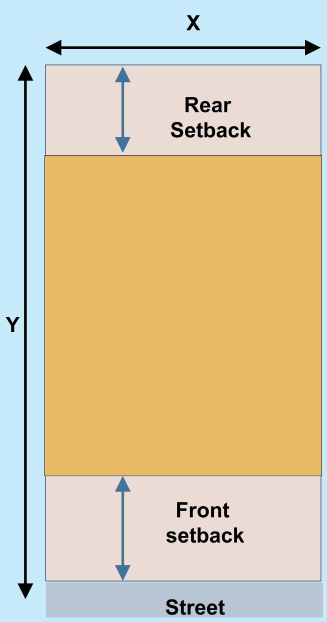
Unit with its typical 3.5 m wide structural bay for living rooms and 2.5 m wide bay for services gives optimum space and circulation.

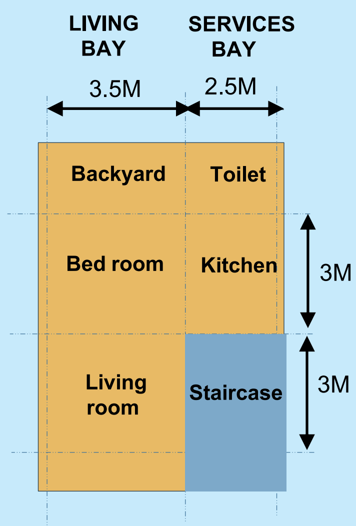
02

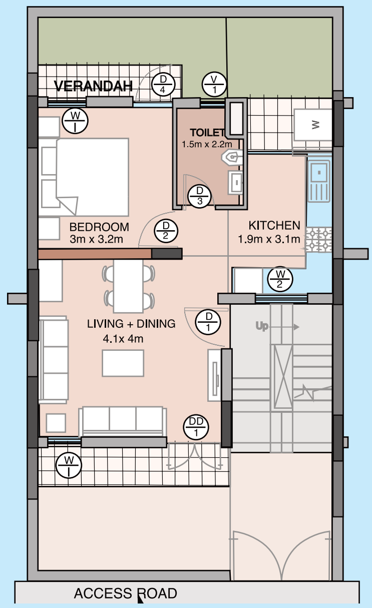
Unit plan

An efficient internal layout makes the best possible use of the orientation, built form, access to light and ventilation through functional spaces.

03



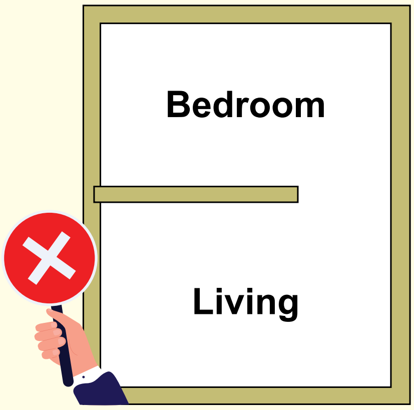


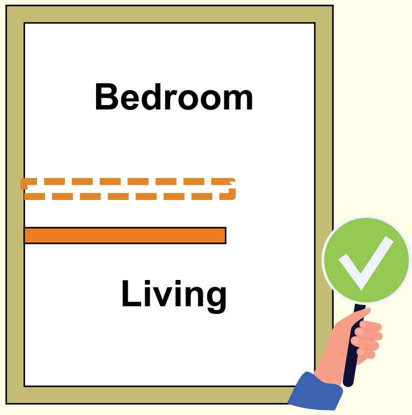


२.१ INTERNAL FLEXIBILITY

While the external walls provide protection to the occupant from the harsh conditions and extreme weather outside, the internal walls help organize the internal space for various functions and carrying out various activities inside the house. Few points to keep in mind for internal planning are:

1 Structural Walls vs Partitions





Fixed Structural Wall

Flexible Partition Wall

Keep internal walls flexible wherever possible to allow flexibility in space usage. If not structural these can be movable partitions with openings/ventilators on top for air flow between rooms.

2 Wall shelves and recessed windows – elements for thermal comfort and multi-purpose storage

Cluttered floor space in small homes

Multi-function use of space and walls for storage

In small homes storage needs to be maximized. Wall shelves and recesses help clear floor space. Cupboards can function as partitions. Recessed windows provide shade as well as storage above and below.

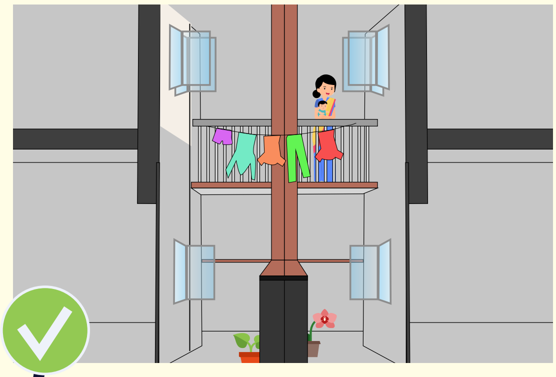
3 Front and back open spaces for ventilation

Front and back setbacks for light, ventilation and activity

Congested housing without setbacks

Open spaces in the front and back of the house are important for ventilation, shading and thermal comfort but also for washing, drying, parking, socializing, etc. Minimize the amount of natural land converted for impervious surfaces and maximize green spaces.

4 Natural light



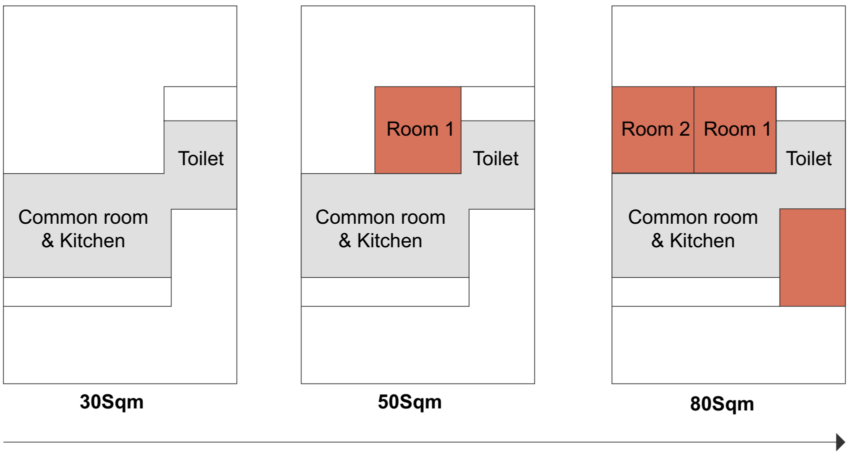
Internal courtyard for daylight and ventilation in middle rooms

Deep plots with no courtyards and high dependence on lights

With long narrow plots, it is important to have light and ventilation through the back or through a courtyard or shaft in the middle to get light and ventilation in the back rooms.

२.२ FUTURE EXPANSION

A dwelling unit that is built today will serve the needs of the household for many years to come. If the plot size permits, as incomes rise and needs expand, this dwelling unit will extend. Upper storeys may also be built as the demand for additional homes arises with time.



The building would also add upper floors as an extension of the home, or for sale or rent, taking advantage of growing demand. Eventually, most buildings in such a colony will grow to four stories.

The design of the individual dwelling unit must, therefore, **anticipate extension and growth incrementally.** The patterns of extension and growth:

Maintain adequate daylight and ventilation – enough distance between buildings should be maintained and cut outs should be provided so that light and ventilation is not blocked as additions happen on ground or above.

Need to be efficient and functional- if new rooms are added they must have proper access, provision should be left on the ground floor to add a staircase for terrace access.

Optimize passive strategies in buildings - in order to maintain optimal thermal comfort.

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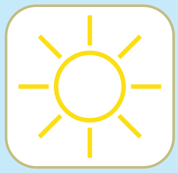
WINDOW DESIGN –
LOCATION, VENTILATION AND SHADING

Views



Day light

Ventilation

Window design is a critical component of the building envelope as this is the only element which can be controlled to modulate interaction between the indoor and outdoor environment at various times of the day and night cycle. The careful design and operation of windows can ensure maximum benefit of cooling and lighting through natural elements thus reducing dependence on electrical or mechanical systems that add to operational cost and CO_2 emissions.

भाग १: Window Design Guidelines | भाग २: Cross-ventilation | भाग ३: Shading

Windows play a crucial role in buildings. They provide views of the outdoors, allow daylight, and help in introducing fresh air inside the buildings.

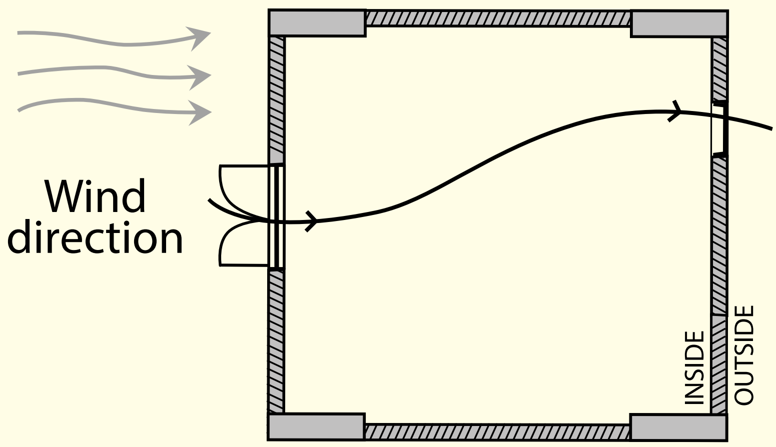
To ensure comfort, windows should be designed such that the building receives adequate daylight while keeping the heat outside and taking advantage of natural ventilation in cooling the homes.

भाग १ Window Design Guidelines

This section provides guidelines for optimal window design in terms of the direction and location, type, size, position etc.

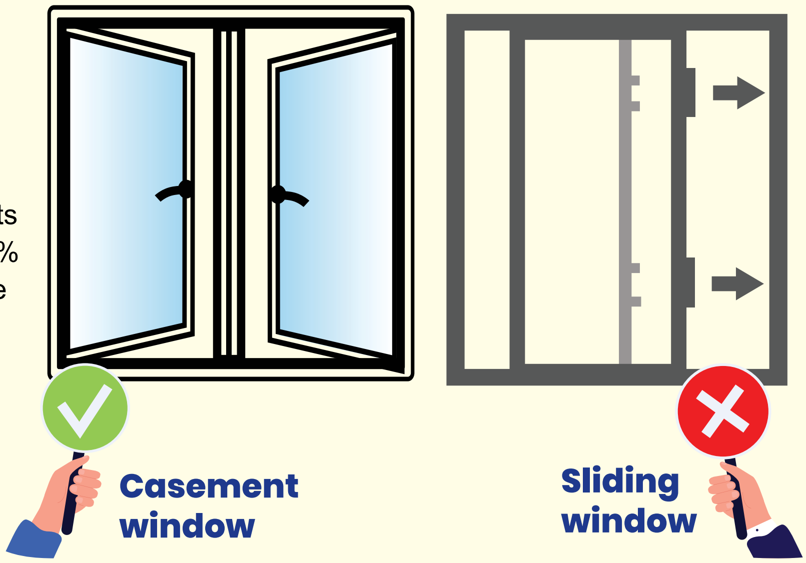
1 ORIENTATION

Windows facing the natural wind direction should be larger and the windows or openings on the opposite side should be smaller to encourage cross-ventilation and increase the velocity of the wind in the room.



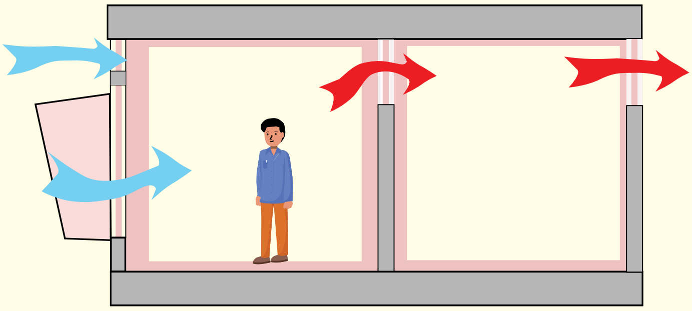
2 WINDOW TYPE

Casement windows allow 90% of the window area to be openable and effective towards ventilation. Avoid sliding windows as it restricts the openable area to 50-60% therefore leaving less scope for ventilation.



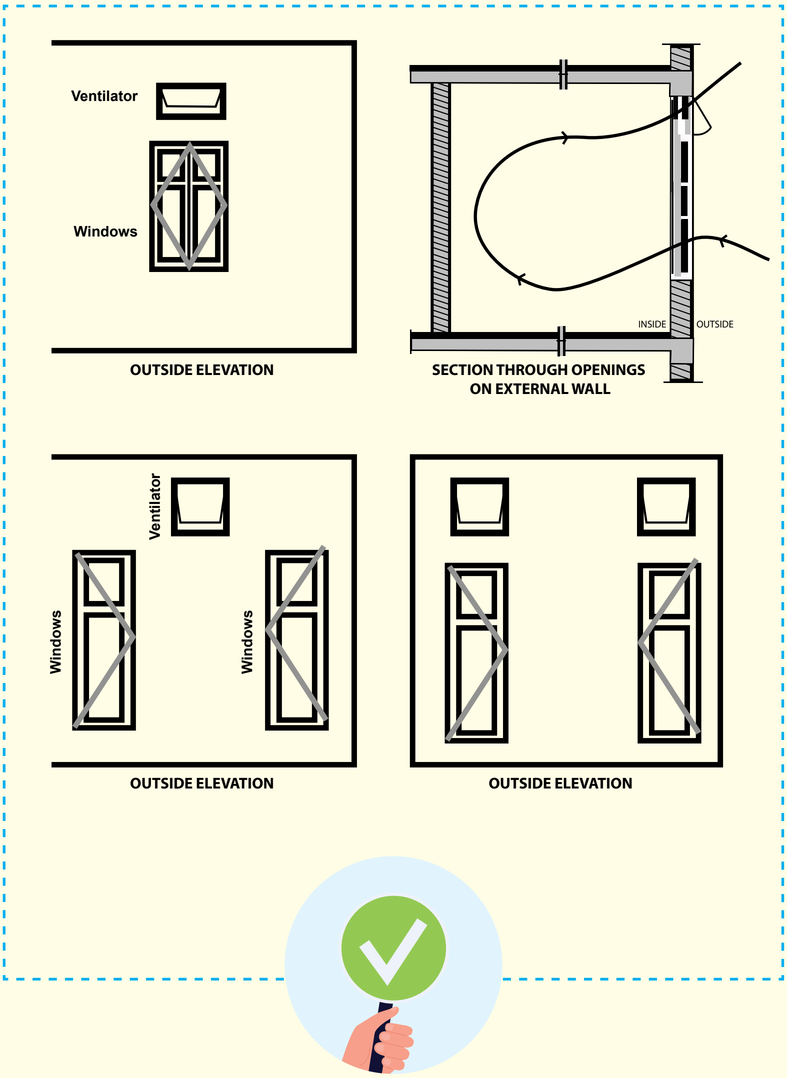
3 Ventilators and Jaali Doors

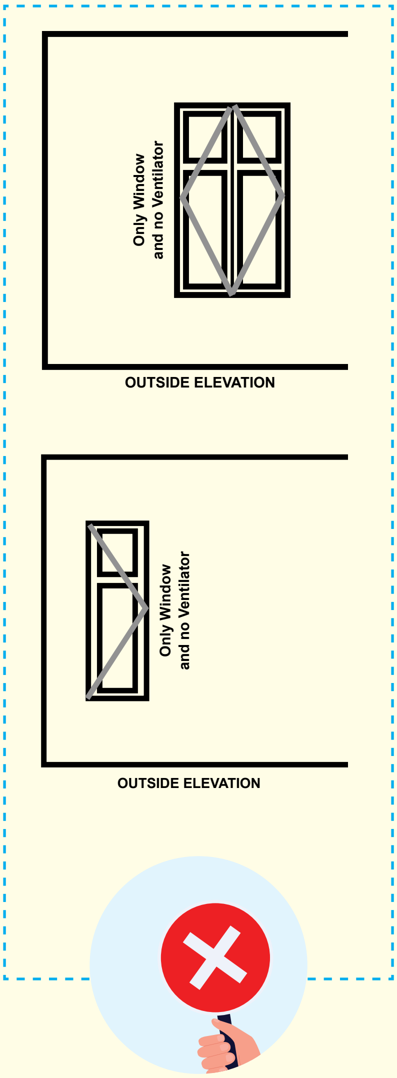
Having ventilators on top helps assist air flow even when the lower windows are closed due to security or privacy. Having ventilators between rooms also helps promote cross-ventilation in small homes.



Adding ventilators above windows improves ventilation especially when only one external wall is available to place windows. The hot air rises and escapes from the ventilator making way for cool air from outside. Here, ventilators are provided in 3 window design options for natural ventilation.

Furthermore, in small houses, having a jaali door in addition to the main door or balcony doors significantly aid in ventilation and air circulation.





भाग २ Cross-ventilation

When the weather is pleasant, windows are opened. When the outside temperature is too hot or cold the windows should remain shut. Effective design for windows and controlled opening and closing can help keep the homes comfortable without additional cost. The size, location and orientation of windows controls the natural ventilation inside the house.

RECOMMENDATION FOR DIFFERENT CLIMATE ZONES

Hot-Dry

In **hot climate**, evenings and nights are cooler than daytime. It is necessary for the windows to be opened for cool air to flow through the rooms. The walls, ceiling and floor can cool down. During the afternoon, when it is hot outside, the windows are closed to keep the coolth inside.

Warm-Humid

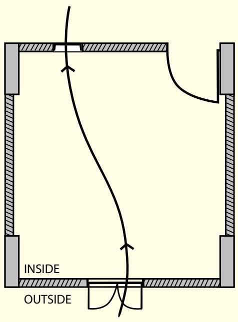
In **warm and humid climate**, more cross-ventilation is needed. Larger window openings, with additional ventilators above, need to be provided.

Cold

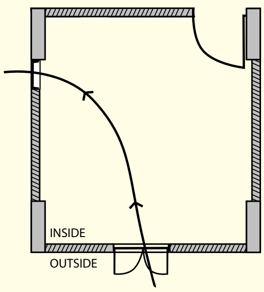
In **cold climate,** having glass windows instead of open balconies or verandahs helps trap the sun's heat during the day and keeps the house warm at night.

CROSS-VENTILATION

Following are a few best practices to enhance the natural ventilation potential in affordable housing dwelling unit.

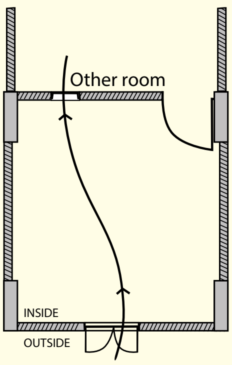


Plan

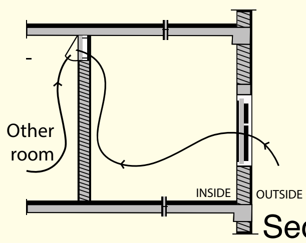


Plan

Openings on adjacent or opposite external walls for cross-ventilation



Plan



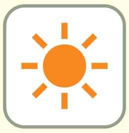
Section

Openings on external wall and internal wall via ventilator for cross-ventilation

भाग ३ Shading

Shading devices help cut direct sun and heat entering the home through windows. Shading devices can be chosen depending on the location and position of sun.

RECOMMENDATION FOR DIFFERENT CLIMATE ZONES



In **warm climate** or during warm and hot seasons, the hot sun's rays should not enter a room directly. Windows should be protected from the sun using horizontal and vertical shading outside the window having minimum depth of 600 mm.

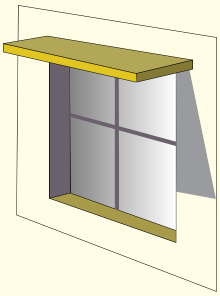
In a **cold climate**, or during a cold winter, the shade or projection above the windows needs to be sized so that it cuts out the Sun when the sun is high during the summer, but lets the sun into the window during the winter when the Sun is lower in the sky.

Having shade in South, East and west directions is very important for hot climates. Its important to design the shade with respect to the direction the opening is facing. As mentioned below:

RECOMMENDATION FOR DIFFERENT DIRECTIONS

South

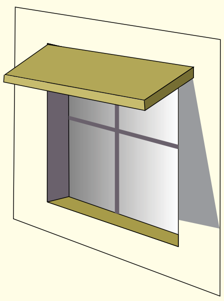
A chajja or overhang of 600 mm depth works best for windows in the south. This allows low winter sun while blocking the high summer sun.



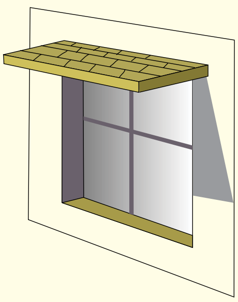
Standard horizontal overhang of 600 mm depth

Other variations

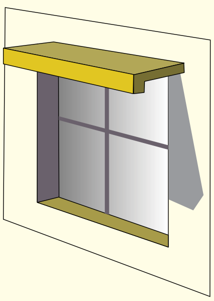
Slope it down for less projection



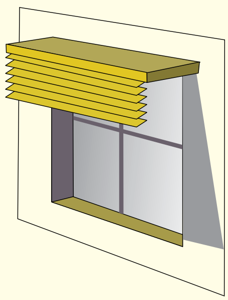
Use louvers in place of solid overhang for more light while still shading



Drop the edge for less projection

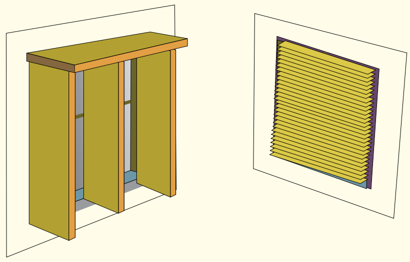


Substitute louvers for the solid dropped edge to let in more light



East and West

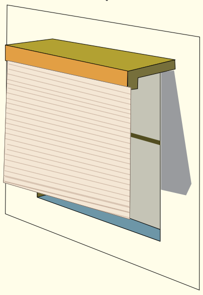
Shading with louvers or vertical fins of minimum depth of 600 mm is crucial if the window is facing towards East or West as the sun is low and harsher from these directions. This can lead to substantial heat gain.



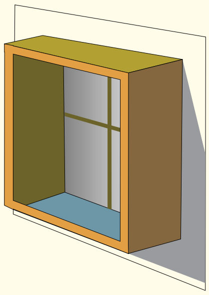
Louvers or fins to cut low Sun in the morning and evening

Other variations

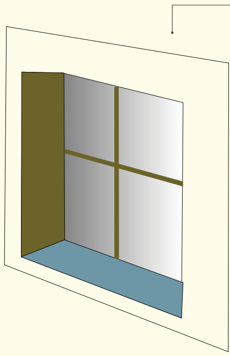
Adjustable shading works well – either roll-up and roll-down bamboo screens or louvres.



Boxed windows with minimum depth of 600 mm projection on all sides.



Recessed window with minimum depth of 600 mm with storage above and below.

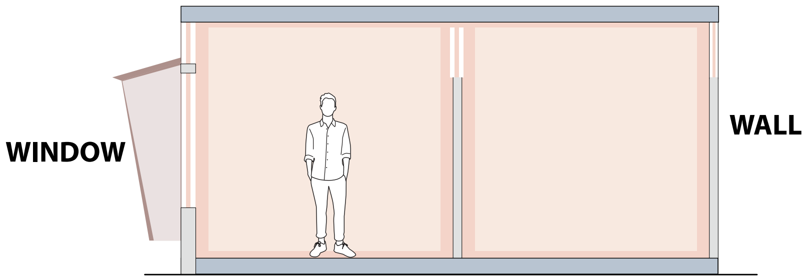


WALL AND ROOF DESIGN

The primary aim of a building is to protect the occupants from the weather elements outside and provide comfort and safety within the building. The key to designing a thermally comfortable building is to design it such that the extreme temperature from the outside has minimal impact on the inside, thus providing thermal comfort to the occupants without the need for mechanical heating or cooling systems. The selection of material and its physical and thermal properties play a major role in regulating the thermal comfort inside the home.

भाग १: Walls | भाग २: Roof

The building envelope: The building envelope is the outer skin of the building which forms a barrier between the inside and the outside environment. This is composed of 3 major elements as shown below:

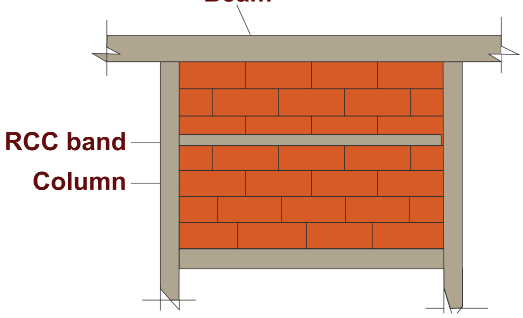


भाग १ Walls

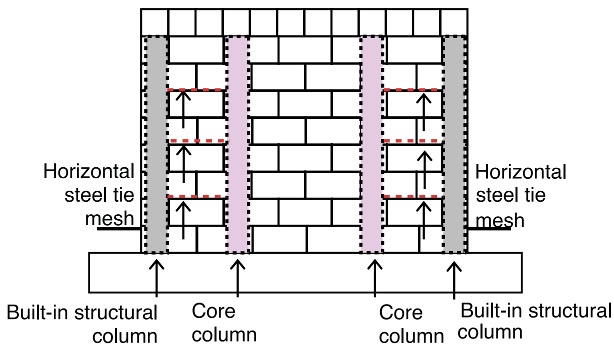
Selection of correct building materials for wall is significant as it affects the thermal comfort of the occupants and energy consumption.

STRUCTURAL SYSTEM

Most beneficiaries of the BLC scheme start by building a single storey dwelling unit of 30 sqm carpet area. As needs and funds grow over time rooms or floors may be added. It is therefore important to ensure that the foundation, and the supporting structure that is built initially allows for the additional floors that may be built later. This requires the structural system, to be either an RCC frame or constrained masonry:



RCC framed structure



Confined masonry structure

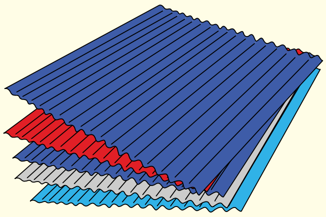
An RCC frame offers choice of walling materials for infill (including walling materials which are not strong enough for load-bearing construction) – such as cement stabilized soil blocks, AAC blocks, low strength burnt clay brick.

The additional cost in the structural provisions for future additional floors would add 8–10% to the RCC frame.

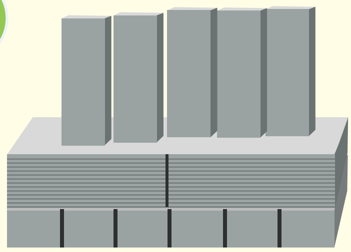
Where good quality masonry blocks, suitable for load-bearing masonry, are available – such as burnt clay brick, hollow clay block, flyash block, concrete block – constrained masonry may be more economical.

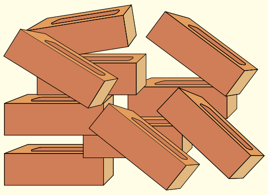
The additional cost in the structural provisions for future additional floors would add a mere 2–3%.

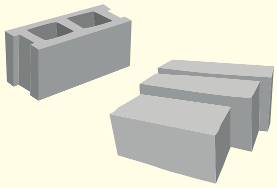
MATERIALS FOR EXTERNAL WALLS

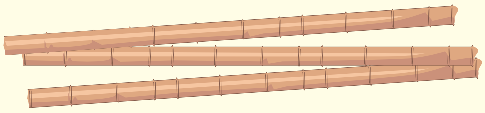


Materials like metal sheets or dark colours should be avoided as they trap more heat.









Materials like local sustainable materials like mud, bamboo, stone, etc. or contemporary materials like AAC blocks, fly ash-based blocks or hollow blocks with light-coloured finish help reduce heat transfer to the inside.

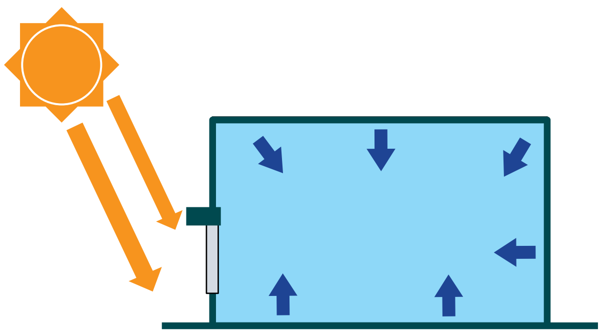
THERMAL PERFORMANCE OF WALLING MATERIALS

How effectively the walls protect the inner space from the extreme hot and cold weather outside, is the measure of their thermal performance. Two properties of a wall affect its thermal performance:

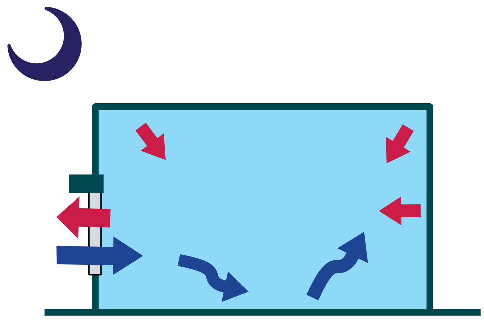
Thermal Capacity – how much heat the wall will absorb for its own temperature to rise by 1°C. Heavy and thick walls made of stone, burnt brick or concrete block take longer to heat up and cool down than light and thin walls. The indoor temperatures will vary less than the outdoor temperatures depending on how much heat the wall lets through.

THERMAL MASS

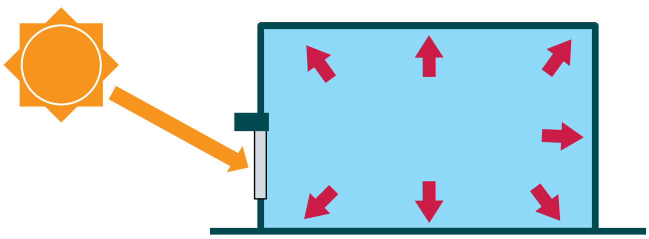
Dense and heavy elements of the building, such as the floors and masonry walls, act as temperature stabilizers. Their temperature varies relatively little through the day and night cycle. They can 'store' heat as well as coolth. This property is referred to as thermal mass.



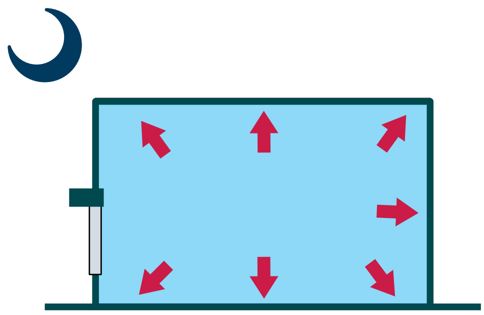
Summer Day: thermal mass will ensure delay in heat transfer to the inside



Summer Night: ventilation at night will help cool the building mass down



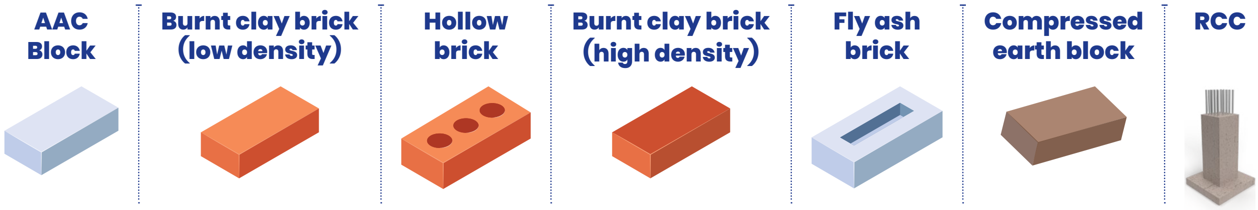
Winter Day: Solar heat gets stored in the build mass

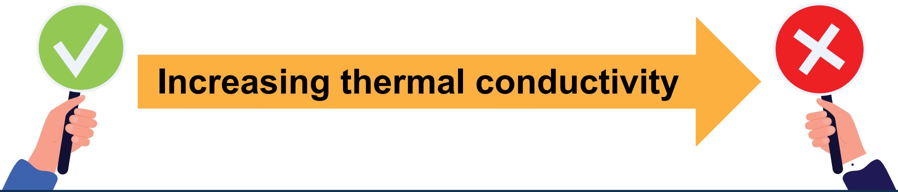


Winter Night: the heat stored during the day is radiated inside

Thermal Conductivity – how quickly heat will travel across the wall from outside to inside for every 1°C difference in temperature between its external face and its internal face. Dense materials like stone and concrete are more conductive than relatively less dense burnt clay bricks or flyash blocks, perforated clay blocks or AAC blocks. These are insulating walling materials.

An insulating wall is effective in keeping the heat outside in hot weather and in retaining the warmth inside in cold weather.





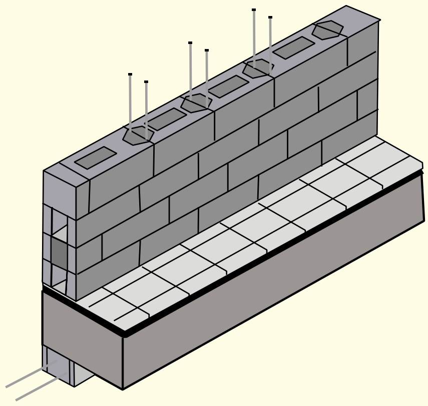
S. no.	Types of materials	Density (kg/m³)	Thermal conductivity (W/m².K)
1.	Solid Burnt Clay brick	1440	0.620
2.	Solid Burnt Clay brick	1600	0.740
3.	Solid Burnt Clay brick	1760	0.850
4.	Solid Burnt Clay brick	1920	0.980
5.	Resource efficient (hollow) brick	1520	0.631
6.	Fly ash brick	1660	0.856
7.	Solid concrete block 25/50	2427	1.396
8.	Solid concrete block 30/60	2349	1.411
9.	Aerated autoclaved concrete (AAC) block	642	0.184
10.	Cement stabilized earth block (CSEB)	1700	0.926
11.	Dense concrete	2410	1.740
12.	Reinforced concrete cement	2288	1.580

ALTERNATIVE CONSTRUCTION TECHNIQUES

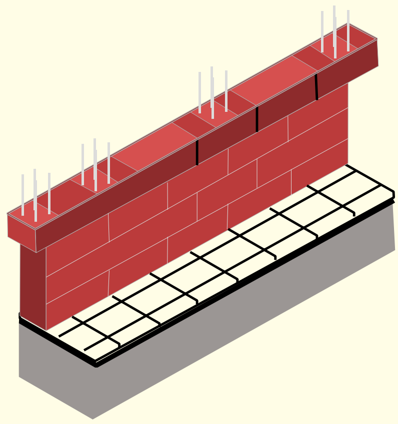
Some alternative construction techniques are discussed in this section for multi-storey low-rise (ground + 3 storey) small-scale construction. They offer three advantages – reasonable thermal capacity, low thermal conductivity, reduced requirement of reinforcement steel.

1 Load-bearing walls with large block size

In this system the vertically aligned hollow of the wall blockwork is reinforced with steel bars and concreted. Formwork is not required and curing of the concrete is avoided. The blockwork becomes an integral part of the structure, carrying some gravity load and providing resistance to lateral earthquake forces. Overall requirement of reinforcement steel is reduced.



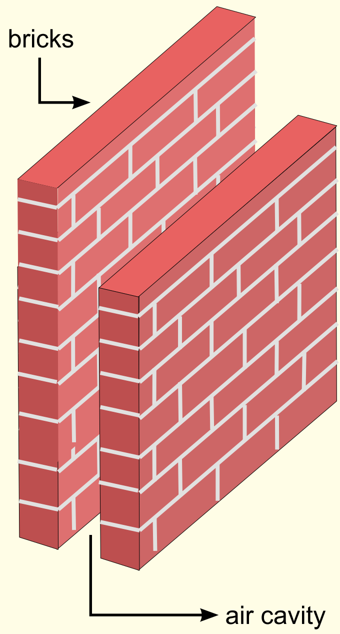
Reinforced hollow concrete block



Reinforced perforated extruded fired clay block.

2 Cavity wall

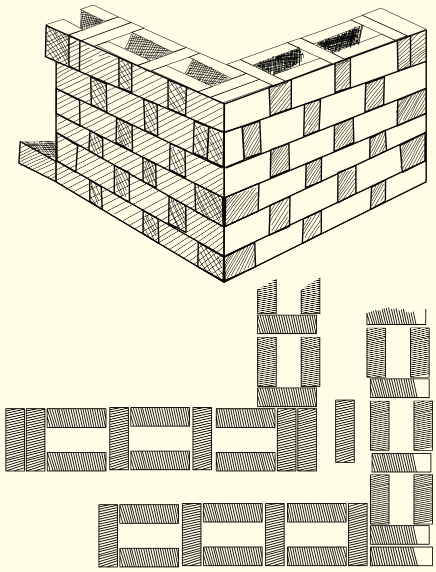
While insulation materials like Expanded Polystyrene (EPS) and Extruded Polystyrene (XPS) may be expensive, building external walls as cavity walls cuts down heat gain substantially. This just uses the air pocket between 2 walls as insulation.



3 Techniques to build with brick

Rat Trap Bond

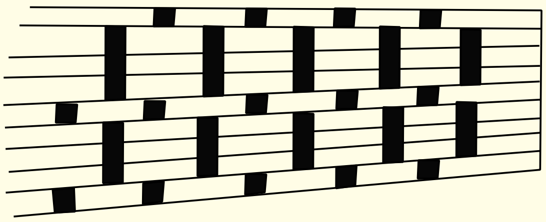
Introduced by renowned architect Laurie Baker, the Rat-Trap bond, is a double-wall technique, that significantly reduces cost of construction, minimizes material and mortar usage, and helps achieve greater thermal efficiency without compromising on the strength of the wall. Nearly 30% of the material (brick and mortar) is conserved, thus shrinking the overall construction cost. Moreover, the presence of the internal cavity yields thermal and sound insulation. This makes Baker's Rat-Trap method both an energy-efficient and an economic alternative to conventional brick masonry.

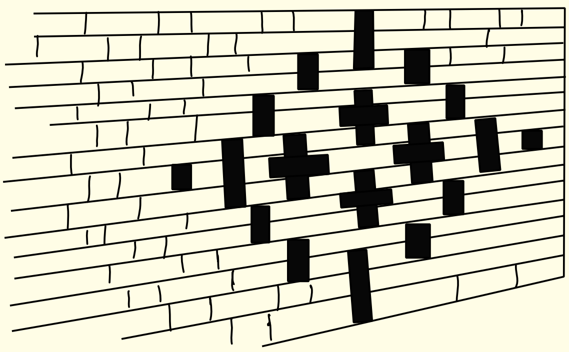


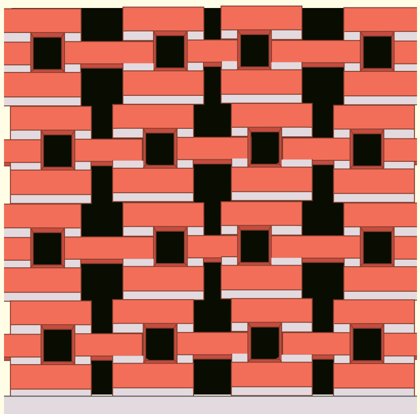
Rat Trap bond masonry

Brick Jali Walls

This technique adopted by Laurie Baker, allows the free flow of natural air into the interiors thus efficiently regulating the temperature. The ventilation holes can take the place of windows thus saving material and labour cost as well as time.







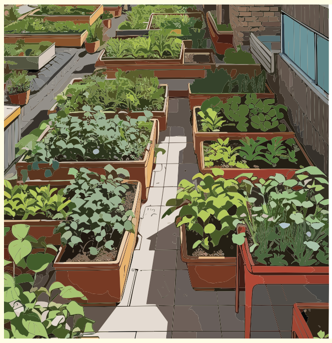
भाग २ Roof

The roof experiences maximum heat gain from the Sun's direct rays. The top floors suffer the most during summers as they get additional heat from the roof. If the roof is of a dark finish it will absorb the heat of the Sun's rays and become extremely hot. The hotter the surface of the roof the more heat will travel to the room below.

Strategies like orientation do not play any role in preventing heat gain through the roof. For preventing heat gains through the roof, the strategies can be threefold:

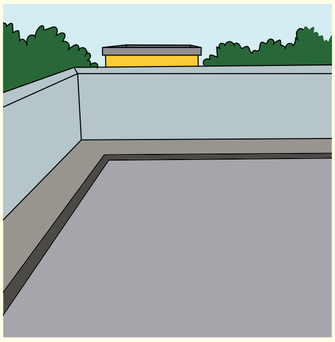
1 SHADE

Shading the roof surface using light weight framed structures. Installing solar PV over the roof also helps shade the roof surface. Vegetation can also be used to cover the roof surface and protect from Sun's rays.

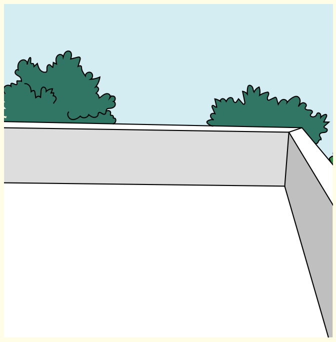


2 REFLECT

Reflect majority of the direct Sun rays falling on the surface. This can be achieved by using a light-coloured roof finish such as china mosaic/ tiles, or limewash, or a heat reflective paint to reflect the sun's rays.



Normal gray or Black roof



Reflective white roof

3 INSULATE

Use layers in the roof assembly that prevent heat transfer to the inside. Using insulation material such as Extruded polystyrene (XPS) or EPS insulation layer or mud phuska or air cavities created using inverted earthen pots are all ways of achieving insulation on the roof.

खण्ड
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PRESCRIPTIVE SELF-DECLARATION FORM

Project Information

Project type: Single Family

Date

Project Address

City

Plot/site area

Applicant Name

Total built up area

Number of floors

Applicant Phone

Project Description

Briefly describe project and construction material used

Prescriptive Self Declaration Checklist

Compliance (Tick Yes if considered and No if not considered)

Panchamrit 1: Site Planning

01 **Have you considered the site planning principles while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

02 **Have you considered the landscaping principles while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

03 **Have you considered the rainwater harvesting methods/systems while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

Panchamrit 2: Built Form and Local Architecture

01 **Have you considered the building shape while designing the house?** YES ☐ NO ☐

Give few examples of incorporated elements

02 **Have you considered any local architecture elements mentioned for your region while designing the house?** YES ☐ NO ☐

Give few examples of incorporated elements

Panchamrit 3: Space Planning

01 **Have you considered orientation and space planning principles as per solar design while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

02 **Have you considered internal space planning criteria while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

Panchamrit 4: Window Design

01 **Have you considered the window design guidelines while designing your house?** YES ☐ NO ☐

Give few examples of incorporated elements

02 **Have you considered any of the cross-ventilation principles in your house design?** YES ☐ NO ☐

Give few examples of incorporated elements

03 Have you considered any of the shading principles in your house design? YES ☐ NO ☐

Give few examples of incorporated elements

Panchamrit 5: Wall and Roof Design

01 Have you considered any of the walling recommendations while designing your house? YES ☐ NO ☐

Give few examples of incorporated elements

02 Have you considered any of the roofing recommendations while designing your house? YES ☐ NO ☐

Give few examples of incorporated elements

Performance Level Achieved

Level 1

PRiTHVi

If number of "Yes" with relevant examples is minimum 9 YES ☐

Level 2

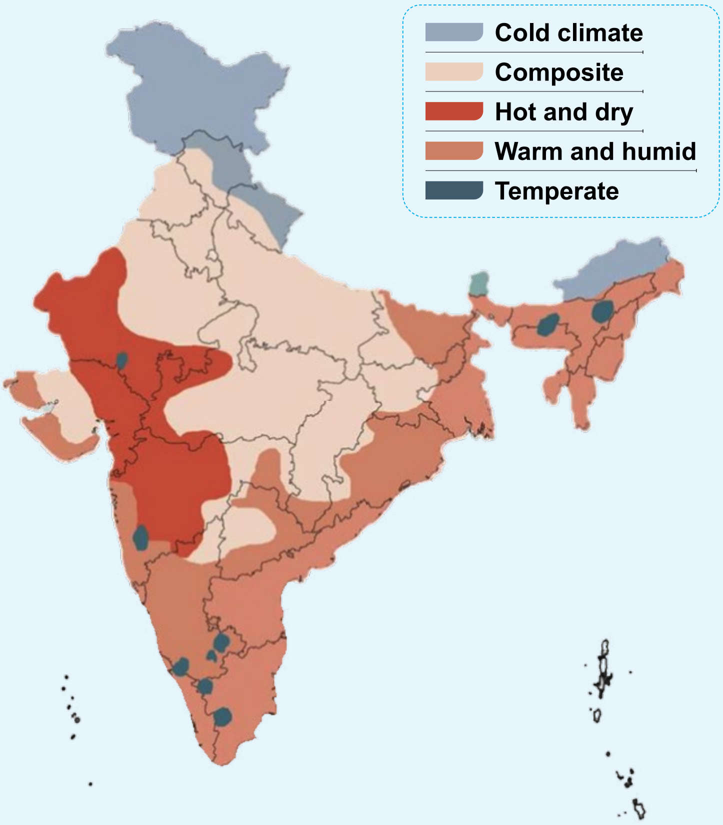
Swarna PRiTHVi

If number of "Yes" with relevant examples is minimum 11 YES ☐

ANNEXURE

Climate Zones of India

The passive design strategies are not a one size that fits all. They must be chosen based on the climate of the region in which the building is located. The variation in climates in India is shown in the "Climatic Zones of India" map as seen in Figure given below.

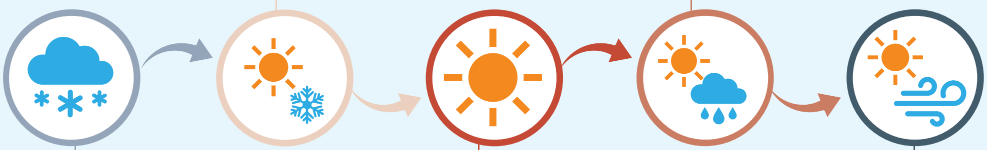


2 Composite climate zone

There is long hot summer and humid monsoon period and a cold winter period.

4 Warm-humid climate zone

It is warm and humid most of the year and pleasant during the brief 'winter' season.



1 Cold climate zone

These are regions at high altitudes and have a cold climate most of the year with a short and relatively pleasant summer season.

3 Hot-dry climate zone

The summer is hot and long and there is a short cool winter period with low humidity.

5 Temperate climate zone

Here it does not become too hot in summer, nor too cold in winter. It is found in few places in India.

However, most of India has predominantly hot climate.

Climate zone for major Indian cities

Find the nearest city to your location of construction from the below list and follow the guidelines recommended for that city.

City	Climate type	City	Climate type
Ahmedabad	Hot-Dry	Kurnool	Warm-Humid
Allahabad	Composite	Leh	Cold
Amritsar	Composite	Lucknow	Composite
Aurangabad	Hot-Dry	Ludhiana	Composite
Bengaluru	Temperate	Chennai	Warm-Humid
Barmer	Hot-Dry	Manali	Cold
Belgaum	Warm-Humid	Mangaluru	Warm-Humid
Bhagalpur	Warm-Humid	Mumbai	Warm-Humid
Bhopal	Composite	Nagpur	Composite
Bhubaneshwar	Warm-Humid	Nellore	Warm-Humid
Bikaner	Hot-Dry	New Delhi	Composite
Chandigarh	Composite	Panjim	Warm-Hunid
Chitradurga	Warm-Humid	Patna	Composite
Dehradun	Composite	Pune	Warm-Hunid
Dibrugarh	Warm-Humid	Raipur	Composite
Guwahati	Warm-Humid	Rajkot	Composite
Gorakhpur	Composite	Ramagundam	Warm-Hunid
Gwalior	Composite	Ranchi	Composite
Hissar	Composite	Ratnagiri	Warm-Hunid
Hyderabad	Composite	Raxaul	Warm-Hunid
Imphal	Warm-Humid	Saharanpur	Composite
Indore	Composite	Shillong	Cold
Jabalpur	Composite	Sholapur	Hot-Dry
Jagdelpur	Warm-Humid	Srinagar	Cold
Jaipur	Composite	Sundernagar	Cold
Jaisalmer	Hot-Dry	Surat	Hot-Dry
Jalandhar	Composite	Tezpur	Warm-Humid
Jamnagar	Warm-Humid	Tiruchirappalli	Warm-Humid
Jodhpur	Hot-Dry	Trivandrum	Warm-Humid
Jorhat	Warm-Humid	Tuticorin	Warm-Humid
Kochi	Warm-Humid	Udhagamandalam	Cold
Kolkata	Warm-Humid	Vadodara	Hot-Dry
Kota	Hot-Dry	Veraval	Warm-Humid
Kullu	Cold	Vishakhapatnam	Warm-Humid

Source: Eco-Niwas Samhita 2018, Energy Conservation Building Code for Residential Buildings, Part-1

List of organizations consulted in the development process of PRiTHVi 1

1. Aliah University
2. Amity University
3. Bhubaneswar Development Authority
4. Bhubaneswar Municipal Corporation
5. Central Public Works Department, Kolkata
6. Chandigarh Administration
7. Chandigarh Housing Board
8. Chitkara University
9. Cuttack Municipal Corporation
10. Department of Housing for All, Haryana
11. District Urban Development Agency, Bhubaneswar
12. Greater Mohali Area Development Authority
13. Housing and Urban Development Corporation Limited
14. Karnataka Rajya Nirmana Kendra
15. Karnataka Slum Development Board, Bangalore
16. Kolkata Metropolitan Development Authority
17. Kolkata Municipal Corporation
18. Mahatma Gandhi State Institute of Public Administration, Government of Punjab
19. Mysore Community Biosphere
20. Nirmithi Kendra
21. Odisha Urban Housing Mission
22. Piloo Mody College of Architecture, BPUT
23. Plaksha University
24. Public Works Department, Bangalore
25. Public Works Department, BBSR
26. Punjab Energy Development Agency
27. Punjab Urban Planning and Development Authority
28. Rajiv Gandhi Housing Corporation Limited
29. State Urban Development Agency
30. West Bengal State Designated Agency

List of Private Stakeholders consulted in the development process of PRiTHVi 1

1. Aditi Architects and Planners
2. Altra Group
3. Archi Morph Design Studio
4. BG Shirke Group
5. Brigade
6. Brookefield
7. DTC Group
8. Ernst & Young
9. Ingenious Atelier
10. Mitsumi
11. Nirman Consultancy
12. Outinord Formworks
13. Plan Arch Studios
14. Salient Design Studio
15. SPD Constructions

Climate Smart Buildings Programme

About the programme

The Ministry of Housing and Urban Affairs, Government of India aims to foster sustainability in built environment by use of sustainable materials for Thermal comfort and in turn improve the environment and climate conditions.

The project extends technical assistance and cooperation making affordable housing under PMAY-U, thermally comfortable. The project aims to enhance climate resilience and thermal comfort in buildings by adopting innovative passive measures, local sustainable and low embodied energy material coupled with best available technologies for affordable housing construction.

These building constructed and operated using innovative technologies and appropriate modern products, materials and designs will lead to sustainability in buildings and mitigation of carbon emissions.