Guidelines for Cooling Centers

National Disaster Management Authority (NDMA)

Government of India

GUIDELINES FOR COOLING CENTERS

MAY 2025

NATIONAL DISASTER MANAGEMENT AUTHORITY

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Government of India

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With contribution from

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***Image Source**: Business Standard-India*

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Executive Summary

Climate change has resulted in more and more regions of the world grappling with exposure to higher temperatures. This has increased the frequency and intensity of heatwaves, resulting in several regions facing high heat risk including India. Over the past few years, the number of heatwave days have increased significantly in India. The seasonal forecast of India Meteorological Department for April-June 2025 predicts an increase of 5-7 heatwave days across most heatwave prone states in India. Indian cities face higher risks due to the impacts of heatwaves considering the large population that resides in the Indian cities.

Globally, heatwaves are the deadliest natural hazard but their impact on human health and mortality usually goes unnoticed or unaccounted for. The extreme heat in India in 2024 is suspected to have resulted in over 44,000 heatstroke cases. Increasing temperatures and humidity in many parts of India severely impacts the outdoor livelihoods and poses several challenges to health and well-being of people. The combination of daytime heat and increased nighttime temperatures also decreases people's ability to recover from daytime heat stress, making the vulnerable population more prone to heat-related illnesses. Prolonged exposure to high temperatures may also lead to increasing the severity of heat related illnesses. To reduce the impacts of heatwaves on human health, the outdoor exposure of vulnerable population needs to be curtailed. Additionally, thermal comfort needs to be ensured for the outdoor working population to reduce the prolonged exposure to the extreme heat. In response, Heat Action Plans (HAPs) have been developed and are continuing to be prepared at the city, district, and state levels across India.

Cooling Centers offer a potential solution to ensure thermal comfort, serving as community-scale interventions where people can take refuge from extreme heat. These are typically air-conditioned or otherwise cooled buildings, that has been designated as a site to provide respite and safety during extreme heat. They may also be set-up outdoors in or near parks, near water bodies or premises of schools, public buildings etc. These centers are designed to provide a safe and cool environment, helping individuals escape the scorching temperatures and reduce the risks associated with heat stress. This is particularly targeted to those who are most exposed to heat, have the least resources to access cooling and need urgent thermal comfort to avoid heat-related health events. Cooling centers have proven to be an effective response to heat waves, with nearly all HAPs identifying them as vital short-term adaptation measures.

This document is intended to be used by municipal bodies, city authorities and vendors involved in constructing, operating and maintaining these cooling centers across different towns and cities in India. It provides guidelines for good design, construction and operation of cooling centers in the Indian context.

This guideline addresses two types of cooling centers:

- Existing buildings designated as cooling centers
- Temporary structures set up as cooling centers

These guidelines address the following aspects of cooling centers:

- Location
- Capacity
- Passive design principles and recommendations to minimise electricity consumption
- Appropriate and low-energy cooling technologies

In addition, this document also enlists guidelines for the amenities and resources that must be provided in cooling centers, along with operation and maintenance of the centers.

1. Introduction

Over the past few years, the number of heatwave days have increased significantly in India. The seasonal forecast of India Meteorological Department for April-June 2025 predicts an increase of 5-7 heatwave days across most heatwave prone states in India. Indian cities face higher risks due to the impacts of heatwaves considering the large population that resides in the Indian cities. By 2030, nearly 40 per cent of the Indian population is expected to be residing in the cities[1]. The urban centers get critically hot due to the formation of urban heat islands. The increasing temperatures and humidity in many parts of India severely impacts the outdoor livelihoods and poses several challenges to health and well-being of people. The combination of daytime heat and increased nighttime temperatures also decreases people's ability to recover from daytime heat stress, making the vulnerable population more prone to heat-related illnesses. Prolonged exposure to high temperatures may also lead to increasing the severity of heat related illnesses. In 2024, India reported more than 44,000 suspected heat stroke cases[2]. To reduce the impacts of heatwaves on human health, the outdoor exposure of vulnerable population needs to be curtailed. Additionally, thermal comfort needs to be ensured for the outdoor working population to reduce the prolonged exposure to the extreme heat. In response, Heat Action Plans (HAPs) have been developed and are continuing to be prepared at the city, district, and state levels across India.

Cooling centers offer a potential solution to ensure thermal comfort, serving as community-scale interventions where people can take refuge from extreme heat. These centers are designed to provide a safe and cool environment, helping individuals escape the scorching temperatures and reduce the risks associated with heat stress. This is particularly targeted to those who are most exposed to heat, have the least resources to access cooling and need urgent thermal comfort to avoid heat-related health events. Some of these groups include but are not limited to construction workers, vendors, rickshaw pullers, migrant labourers etc. Cooling centers have proven to be an effective response to heat waves, with nearly all HAPs identifying them as vital short-term adaptation measures. To enhance their impact, local authorities should establish innovative, community-driven cooling centers at identified heat hotspots, based on heat vulnerability assessments conducted through HAPs in towns and cities.

Impact of cool environments

The risk of heat stress mortality is significantly reduced by spending more time in cool environments during heat wave periods. Globally, cooling centers are proved to be a useful intervention in interest of public health against heat waves, especially for vulnerable groups like elder people, pregnant women and children, people with pre-existing medical conditions, as well as workers or dwellers exposed for prolonged periods to extreme temperatures.

[1] Economic Survey 2023-24, Ministry of Finance, Gov. Of India (Available at: https://www.indiabudget.gov.in/budget2023-24/economicsurvey/index.php)

[2] Report on Heat-Health Preparedness & Response Activities, National Programme on Climate Change & Human Health, National Programme on Climate Change and Human Health, Minstry of Health and Family Welfare, Gov. Of India. (Available at: https://ncdc.mohfw.gov.in/wp-content/uploads/2024/12/Report-of-Heat-Related-Activities-2024_NPCCHH.pdf)

What are cooling centers?

A cooling center is a location, typically an air-conditioned or otherwise cooled building, that has been designated as a site to provide respite and safety during extreme heat[3]. This may be a government-owned building such as a school, community center, religious center, recreation center, or a private business such as a shopping mall, sports complex, or movie theatre etc. Given ownership concerns, it will be more feasible to designate government and community-owned buildings as cooling centers instead of private business buildings. Cooling centers may also be set-up outdoors in or near parks, near water bodies or premises of schools, malls etc. Temporary cooling centers may also be created, especially during planned events with large gatherings of people.

It is important to note that, although cooling centers improve heat resilience, they are a short-term response against extreme heat. Strengthening the heat resilience of basic infrastructure and buildings like homes, hospitals, schools etc. must be prioritized for long-term impact. Kindly refer to HAP of various cities for long-term resilience and relief measures.

It has also been seen that some cooling centers in India have followed good design and construction practices, while several others have not, indicating that there is a need to disseminate this information more widely. There is also an imperative to scale-up the cooling center infrastructure quickly and affordably. Therefore, these guidelines have been prepared keeping in mind the varied Indian context, need to operate frugally and achieve thermal comfort with low-energy, low-cost interventions. In practice, the document can serve as a ready checklist for municipal bodies, city authorities and vendors involved in constructing, operating and maintaining these cooling centers across different towns and cities in India. Going forward, the goal should be to make cooling centers net-zero, i.e., centers that provide thermal comfort through passive design and renewable energy with minimal grid dependency.

This guideline addresses the following types of cooling centers:

- Existing buildings designated as cooling centers
- Temporary structures set up as cooling centers

Both these types are operated as cooling centers during periods of extreme heat, providing cooled spaces for the public to temporarily escape the heat and prevent heat-related illnesses.

This guideline uses the terms “cooling center” and “cooling room”. The term **cooling room** is used to denote the cooled spaces in a cooling center. A **cooling center** may consist of one or more cooling rooms. In addition to cooling rooms, a cooling center must also have facilities like toilets, storage space etc.

[3] Modified from Widerynski et al. The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation. Retrieved from https://ghhin.org/wp-content/uploads/cdc_47657_DS1-compressed-1.pdf

2. Existing buildings as Cooling Centers

- ***Description:*** Existing government or community-owned buildings are most easily converted into cooling centers.
- ***Land ownership*** is a critical factor. Government and community owned buildings are preferred due to simpler permissions and existing public ownership.
- ***Examples:*** Public schools, primary health centers, transport hubs like bus terminals, railway stations, metro stations etc., community centers, anganwadi, temples, existing disaster shelters etc.
- ***Primary operation:***
    - These centers are required to be identified and prepared for service before on-set of the heat wave period (April – June).
    - These centers will be used for daytime relief from the high heat as needed.
    - When a high alert / heatwave is declared by Indian Meteorological Department (IMD), these structures can be used as daytime as well as night-time shelters.
    - Cooling centers should be freely accessible to all members of the communities.
- ***Potential beneficiaries:*** To be used by the general population, and more specifically vulnerable populations from informal settlements and the informal economy sector.

Location

Any existing structure to be used as cooling center are permanent buildings / structures and must be accessible and visible to the intended users. Although the identification of the location is highly contextual, below are a few considerations to start with:

- Should be accessible by public transport or within 15-minute walking distance from the intended users
- Should be within 0.5 km radius from vulnerable hotspot areas, i.e., vulnerable areas, identified through Urban Heat Island (UHI) mapping and assessments. Cities with existing HAPs may already have identified hot spots.
- Should be near primary healthcare center or other healthcare facility.
- Should be accessible to vehicles like ambulance and small goods carriers
- Should have entrance ramps, etc. to be made accessible to people with disabilities.
- Should be away from any kind of risks like flood prone area, fire prone area, chemical hazards, etc.

Capacity

A cooling center may have a single cooling room or multiple (e.g. in schools). The capacity of a cooling center should be preferably 4 – 6 m^2 per person, and in any case, should not be less than 2m^2 per person. For e.g. the maximum number of people in a cooling space of 20 m^2 is recommended to be capped at 10. This will avoid increased internal heat gains from occupants and allow ventilation space between the occupants.

Building characteristics

Buildings to be used as cooling centers should ideally have the following characteristics to ensure optimum comfort as well as low-energy cooling:

- All windows and other external glass areas must be shaded.

- Roofs must be protected or treated to reduce heat gains through the roof assembly. This can be done by shading the roof, having a cool roof and using roof insulation.
- External walls should also be protected from solar radiation. Shade from trees is a good way to protect walls. In their absence, verandahs, additional installed shading can serve the same purpose.
- The building and the spaces / rooms in it must have openable windows and other provisions for ventilation. Fully openable windows (i.e. casement windows) are preferred over sliding windows. Other ventilation features could be provision of exhaust fans or turbo ventilators to induce ventilation inside, presence of solar chimneys in the building etc.
- Buildings with large, glazed surfaces, unshaded windows and MIVAN construction (all RCC walls) must be avoided. Such buildings allow in more solar heat gain and will require a significant amount of cooling energy.

In case where all the above characteristics are not present in a building, the following may be considered:

Identify potential cooling rooms in the building

- Rooms with a northern orientation (i.e. external walls / windows facing north) will be most suitable to be designated as cooling rooms within the center.
- Avoid spaces that have complete glass facades, unless high performance glass is used. Please note that electricity demands to cool such spaces and use them as cooling rooms will be high.
- Top floor space / rooms directly under exposed roofs are not suitable for use as cooling centers. Exceptions can be made for rooms under cool roof, insulated roof and green roofs.

Add external shading on windows that are not shaded

- All external glass areas and glass windows must have external shading, especially those facing west, south and east. South facing windows can be well shaded with an overhang or “chhajja”, east and west facing windows must have movable shading (e.g. bamboo chiks) in front of them. Please refer to Annexure A for shading options for windows facing different orientations,
- In the absence of external shade on windows, and if it is not possible to add external shade, the glass facade / windows may be covered from inside. However, it will not be as effective as external shade and will consume more electricity to cool.

Protect the roof

- Convert conventional RCC roof into cool roof with the help of paints with high SRI (Solar Reflective Index) (Figure 1) or roof tiles. For qualifying as a cool roof, roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.70 and an initial emittance no less than 0.75[4].

[4] Bureau of Energy Efficiency. 2024. ECSBC 2024 Energy Conservation and Sustainable Building Code (for Commercial and Office Buildings)

- Cool-plus-insulated roof (Figure 2) will be even better. Insulation is applied on the external surface of the roof, and the roof is finished with a high SRI paint or roof tile.

Figure 1: Application of high SRI paint

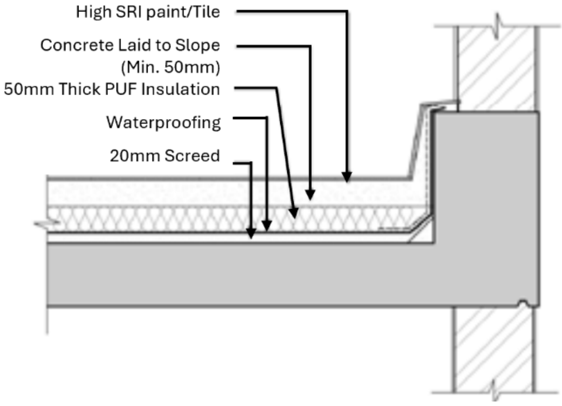


Figure 2: Roof section example for cool-plus-insulated roof

Shade external walls

- If the external walls, facing south, east & west, are not shaded with trees or existing elements like verandahs etc., they may be shaded with fabric awnings etc.
- This would also create a buffer area between the cooling rooms and the extreme heat outside. This can provide a transition which can reduce thermal shocks to the human body. In hot, dry climates, this buffer area could also have evaporative coolers for effectiveness.

Building cooling

An existing building identified as cooling center may or may not already have cooling systems (evaporative coolers, air-conditioners etc.) installed. In case the identified building does not have a cooling system installed, it will need to be arranged by the authorities before it is used as a cooling center.

Indoor air temperature must be maintained between 27–33°C, with relative humidity 50%-60% and air velocity of 0.9–1.4 m/s. Within this given range, the higher the indoor temperature and relative humidity, the higher the air velocity should be to maintain comfortable conditions. Minimum air change rate of 4 air change per hour should be maintained, irrespective of the cooling system installed. The CO_2 concentration should be below 1000 ppm.

It must be noted that measures mentioned under "Building Characteristics" are the first line of defense, and they also help improve the efficiency of the installed cooling system.

Install efficient ceiling fans

- Installation of an adequate number of efficient ceiling fans in the cooling center is mandatory. Minimum BEE 4 star rated (2024) ceiling fans must be installed. The service value for 4 star and 5 star rated ceiling fans is as follows:

	Sweep size of ceiling fan		
	≥ 600mm & ≤750mm	≥ 750mm & ≤1050mm	≥ 1050mm & ≤1550mm
Service value of 4 star rated ceiling fan	≥ 3.0 to < 3.5	≥ 4.6 to < 5.1	≥ 5.5 to < 6.0
Service value of 5 star rated ceiling fan	≥ 3.5	≥ 5.1	≥ 6.0

Alternatively, if space permits, High-Volume Low-Speed (HVLS) fans may also be used.

Evaporative cooling

Evaporative cooling used may be direct evaporative cooling and two-stage “indirect-direct” evaporative cooling. In both types, cooled air is supplied to the cooling room and exhausted out. Evaporative cooling will not work in space with no openings, windows or exhaust system. The effectiveness of evaporative cooling can be augmented with fans.

- If an existing building designated as cooling center does not already have a cooling system installed, portable evaporative coolers i.e., desert coolers can be installed. This is recommended in cities and towns in hot-dry climate zones or when the relative humidity is low (<50%) in composite climate zone. These coolers, when used, must be window-based (i.e. placed outside a window / inlet opening) and not room-based. The air cooled by these coolers is thrown inside the cooling room through the inlet openings / windows and then exhausted out through outlet openings / windows.
- Two-stage “Indirect-Direct” Evaporative Cooling (IDEC) can be used in hot-dry, composite and warm-humid climates. It decreases the temperature without increasing humidity of the air as much as direct evaporative cooling. However, these are not available in portable sizes and have to be designed as ductable systems. Hence, these are not feasible if the building is cooled only when used as a cooling center during heatwaves. These become viable if the existing building has plans for long-term cooling and resilience retrofit.
- Evaporative cooling systems, whether portable or ductable, are sized based on the amount of air they deliver, i.e. in cubic feet per minute (CFM) or cubic meters per hour (CMH). The air delivered should typically achieve 20 – 40 air changes per hour (ACH).
- It is important to ensure that the water used in desert coolers is regularly replaced, and stagnant water is avoided, as it can become a breeding ground for mosquitoes and lead to the spread of waterborne and vector-borne diseases. Proper maintenance and hygiene practices must be followed to ensure safe and effective operation.

Air-conditioning

- In extreme heat and high humidity conditions air-conditioning may be required. If individual air-conditioners are used for cooling, availability of openable windows must be checked in the cooling rooms of the center. Circulating stale air within the room can cause the spread of air-borne diseases and increased CO_2 levels. Windows may need to be opened periodically for short durations to allow enough fresh air inside the center. Depending on the possibility of cross ventilation or single sided ventilation, and, considering an openable window area of 10% of the floor area of the cooling room, windows may be opened for between 5-15 minutes in an hour.
- The setpoint temperature must be kept between 26 - 28°C. The air-conditioning capacity (in ton of refrigeration or TR) will not only depend on the size of the room but also on the envelope of the existing building. If the selected building has all the recommended building characteristics, and the recommended setpoint temperature is adhered to, air-conditioning

capacity is likely to be at 250 – 350 sq.ft./TR or 23 – 33 sq.m./TR. This can indicate the number of individual air-conditioners that will be required.

- If the cooling center is already equipped with centralized HVAC, then the system must have a working fresh air system too.

3. Temporary structures set up as Cooling Centers

- ***Description:*** These are structures which can be quickly assembled on an open ground/ shaded area and may be dismantled when not required. These are not meant for long-term stay. They are generally intended to provide respite from harsh outdoor conditions for people working outside. Such cooling centers may be required:
    - in the absence of feasible existing buildings that could function as cooling center in hot spots
    - for planned events with a high volume of attendees
    - certain outdoor work sites. For e.g. in construction sites for the site workers
- ***Examples:*** Modular temporary structures, made of appropriate materials (heat insulating or reflecting), open unpaved areas, open playgrounds, sports complexes, parks, etc.
- ***Primary operation:***
    - According to the heat vulnerability in any city, the structures can be erected in pre-summer season (February – March) by the city authorities.
    - Mandatorily required in construction sites and other identified work sites
    - Cooling centers should be freely accessible to all members of the communities.
    - Operation for daytime use during summer season for various vulnerable groups. Due to safety concerns, these facilities are not recommended for night-time use.
- ***Potential beneficiaries:*** Primarily construction workers, day-time labor, delivery personnel vulnerable population nearby etc.

Location

The site / location for this type of cooling center will differ according to the context and targeted users. Some considerations:

- Should be accessible by public transport or within 15-minute walking distance from the intended users
- Should be within 0.5 km radius from vulnerable hotspot areas, i.e., vulnerable areas, identified through Urban Heat Island (UHI) mapping and assessments. Cities with existing HAPs may already have identifies hot spots.
- Such cooling centers must be erected on an open / semi-paved area. Concrete and paved areas are to be avoided as a base for temporary structures.
- Location within a park, shaded areas or near water body can be preferred.
- The center must be made accessible to people with disabilities.
- Ensure the area selected for the structure is away from any kind of risks like flood prone area, fire prone area, chemical hazards, etc.
- The location to be near a drinking water source and electricity connection. Avoid an area where diesel generators will be continuously required for operating the shelter.
- Should be near primary healthcare center or other healthcare facility.
- Should be accessible to vehicles like ambulance and small goods carriers

Capacity

The capacity of each cooling room in a cooling center should be preferably 4 – 6 m^2 per person. A suggested size range for temporary structures set up as cooling centers is 250 m^2 to 350 m^2 accommodating 60 to 80 people. In any case, the capacity of a cooling center must not be less than 2m^2 per person. This will avoid increased internal heat gains from occupants and allow ventilation space between the occupants.

Building characteristics

- Design and orient the temporary structure so longer façade faces north-south.
- Materials used to construct the temporary structure must be light, easy to assemble and dismantle.
- The construction assemblies (roof, wall and windows) must be designed to reduce heat gain and remove heat accumulated inside.
  - Roof: Avoiding heat ingress from the roof is critical. Some roof assembly options include:

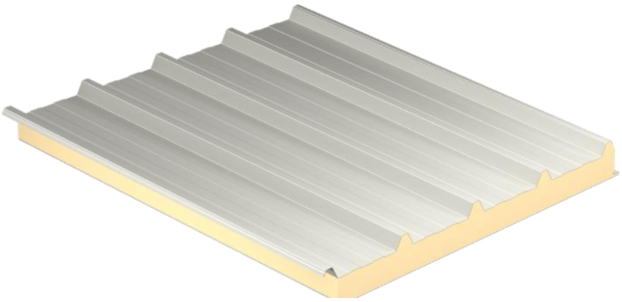


Figure 3: Insulated roof panel

    - Insulated roof panels (Figure 3) with high SRI coating on the outer surface. Roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.70 and an initial emittance no less than 0.75[5].
    - Metal roof assembly with only GI sheet must be avoided.

  - Walls: Exterior grade wall panels with or without insulation may be used. Some examples include:
    - Cement bonded particle board (e.g. bison board) panels;
    - Sandwich panels with aerated concrete core surrounded by two layers of non-asbestos fiber cement boards (Figure 4)
    - Insulated metal wall panels (Figure 5)

    The walls must be shaded with deep overhangs or by extending the roof to form a shaded verandah around the cooling center.

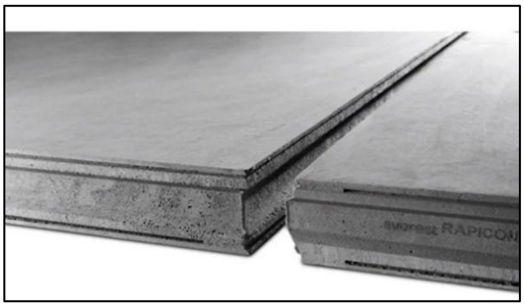


Figure 4: Sandwich panel with aerated concrete core

Figure 5: Insulated metal wall panel

  - Windows / openings: Cross ventilation is important to be provided in these cooling centers and the openings must be designed to perform this function well.
    - Openings must ideally be fully openable windows (i.e. casement windows) instead of sliding windows and must be uniformly distributed on the walls. Openings on opposite walls may also be placed at different heights- one side at human height level and the opposite side at a higher level (Figure 6). This can help take

[5] Bureau of Energy Efficiency. 2024. ECSBC 2024 Energy Conservation and Sustainable Building Code (for Commercial and Office Buildings)

advantage of the stack ventilation effect and allow the installation of exhaust fans to induce greater air flow inside the cooling center when necessary.

- All openings and glass windows must be shaded, either with deep overhangs or external movable shading. Please refer to Annexure A for shading options for windows facing different orientations.

- Floor: If the temporary structure is to be erected on a concrete paved surface or asphalt, its floor must be raised by at least 450mm. This will avoid heat from the ground and make it less vulnerable to any unforeseen flooding.

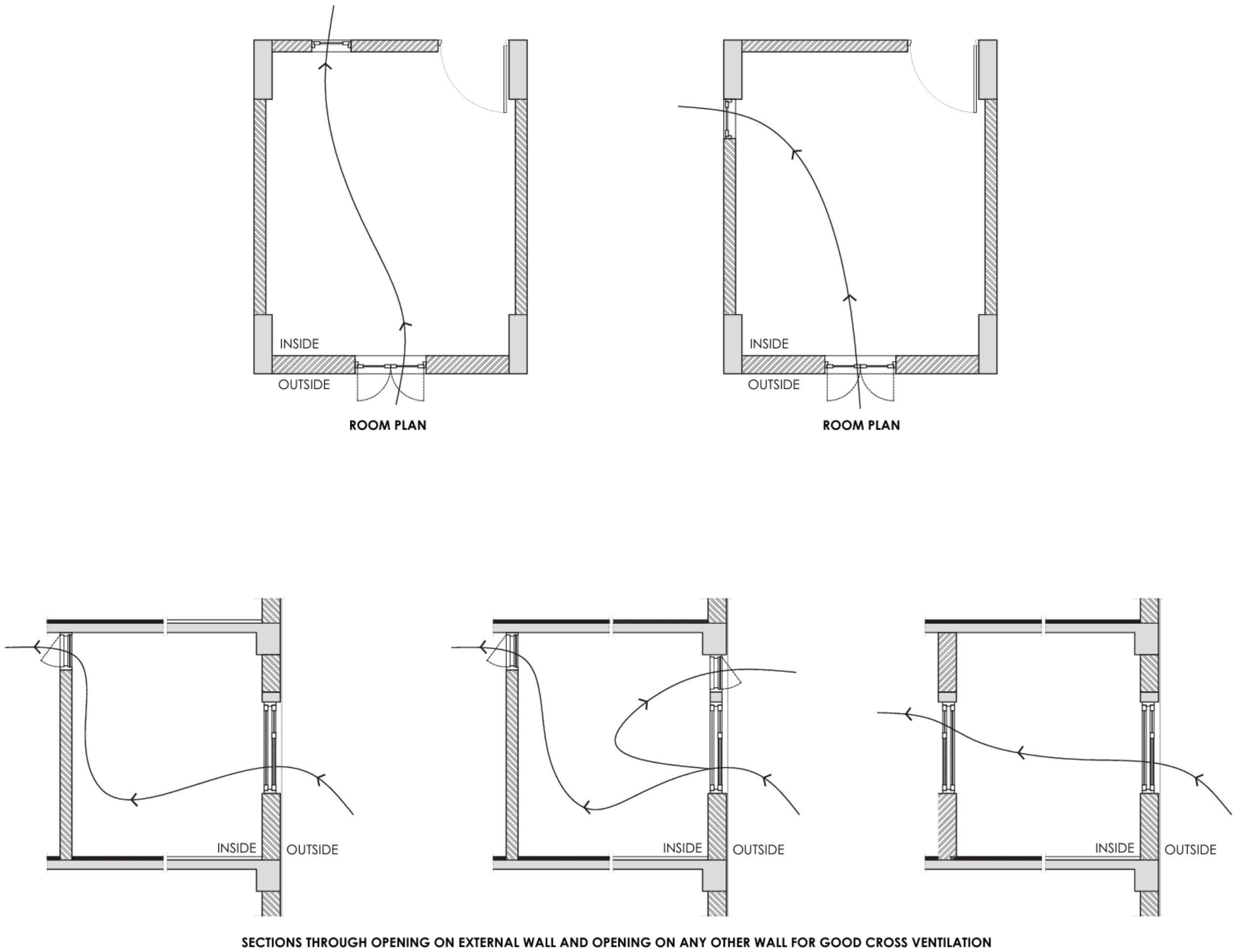


Figure 6: Suggested placement of windows for cross ventilation (Source: Bureau of Energy Efficiency. 2024. Eco-Niwas Samhita 2024; Energy Conservation and Sustainable Building Code: Residential)

Building Cooling

These cooling centers are intended to provide respite from harsh outdoor conditions for people working outside during the daytime. As such, cooling through air-conditioning is not an anticipated requirement here. Evaporative cooling and fans are adequate cooling measures here.

Indoor air temperature must be maintained between 27–33°C, with relative humidity 50%-60% and air velocity of 0.9–1.4 m/s. Within this given range, the higher the indoor temperature and relative humidity, the higher the air velocity should be to maintain comfortable conditions.

Minimum air change rate of 4 air change per hour should be maintained, irrespective of the cooling system installed. The CO_2 concentration should be below 1000 ppm.

It must be noted that measures mentioned under "Building Characteristics" are the first line of defense, and they also help improve the efficiency of the installed cooling system.

Install efficient ceiling fans

- Adequate ceiling fans in the cooling rooms are mandatory. Minimum BEE 4 star rated (2024) ceiling fans must be installed. The service value for 4 star and 5 star rated ceiling fans is as follows:

	Sweep size of ceiling fan		
	≥ 600mm & ≤750mm	≥ 750mm & ≤1050mm	≥ 1050mm & ≤1550mm
Service value of 4 star rated ceiling fan	≥ 3.0 to < 3.5	≥ 4.6 to < 5.1	≥ 5.5 to < 6.0
Service value of 5 star rated ceiling fan	≥ 3.5	≥ 5.1	≥ 6.0

Alternatively, High-Volume Low-Speed (HVLS) fans may also be used.

Evaporative cooling

Evaporative cooling used may be direct evaporative cooling and two-stage "indirect-direct" evaporative cooling. In both types, cooled air is supplied to the cooling room and exhausted out. Evaporative cooling will not work in space with no openings, windows or exhaust system. The effectiveness of evaporative cooling can be augmented with fans.

- Direct evaporative cooling is recommended in cities and towns in hot-dry climate zones or when the relative humidity is low (<50%) in composite climate zone. Direct evaporative cooling can be provided through portable as well as ductable coolers.
    - Portable evaporative coolers (e.g. desert coolers), when used, must be window-based (i.e. placed outside a window / inlet opening) and not room-based. The air cooled by these coolers is thrown inside the cooling room through the inlet openings / windows and then exhausted out through outlet openings / windows. (Figure 7, Figure 8 and Figure 9)
    - Ductable direct evaporative coolers are also available.
    - Alternatively, cooling pads / "khus" panels can be installed on openings / windows with sprinklers to keep them wet. Exhaust fans on selected openings or on the roof can induce air flow, cooled on the wet cooling pads, into the cooling center and out (See Figure 13).

- Two-stage "Indirect-Direct" Evaporative Cooling (IDEC) can be used in hot-dry, composite and warm-humid climates. It decreases the temperature without increasing humidity of the air as much as direct evaporative cooling. These are not available in portable sizes and have to be designed as ductable systems (Figure 10, Figure 11 and Figure 12).

- Evaporative cooling systems, whether portable or ductable, are sized based on the amount of air they deliver, i.e. in cubic feet per minute (CFM) or cubic meters per hour (CMH). The air delivered should typically achieve 20 – 40 air changes per hour (ACH). For e.g. for a cooling room of area 350 m^2 and height 4 m, accommodating 80 people, an evaporative cooling of 42000 CMH will be required to maintain 30 ACH. This can be designed by using multiple window-based portable evaporative coolers or by ductable systems using direct evaporative coolers or two-stage IDEC. Please see Table 1.

- It is important to ensure that the water used in desert coolers is regularly replaced, and stagnant water is avoided, as it can become a breeding ground for mosquitoes and lead to the spread of waterborne and vector-borne diseases. Proper maintenance and hygiene practices must be followed to ensure safe and effective operation.

Air-conditioning

- In extreme heat and high humidity conditions air conditioning may be required. Air conditioning should only be resorted to if comfortable inside conditions are not achieved through indirect evaporative cooling.
- If individual air-conditioners are used for cooling, windows must be opened periodically to allow fresh air inside. Circulating stale air within the room might cause the spread of air-borne diseases and increase CO_2 levels inside the cooling room. Depending on the possibility of cross ventilation or single sided ventilation, and, considering an openable window area of 10% of the floor area of the cooling zone, windows may be opened between 5-15 minutes in an hour.

Example of sizing the cooling system

Table 1: Example of cooling system size for cooling room of 350 m^2

<table>
<tr><th>Cooling room size</th><th>Occupancy</th><th colspan="3">Sizing options for evaporative cooling</th><th>Sizing for air-conditioning</th></tr>
<tr><td rowspan="3">350 m^2 (say 25m x 14m)</td><td rowspan="3">80 (~ 4 m^2 per person)</td><td colspan="3">42000 CMH to achieve 30 ACH</td><td>~12 TR*</td></tr>
<tr><td>Portable direct evaporative cooler</td><td>Ductable direct evaporative cooler</td><td>Ductable two-stage IDEC</td><td rowspan="2">*When the cooling center has the recommended building characteristics and with a setpoint of 28°C</td></tr>
<tr><td>5 nos. portable coolers having air flow rate 8500 CMH</td><td colspan="2">1 cooling unit having air flow rate 42000 CMH</td></tr>
</table>

Illustrative example of window-based direct evaporative cooling

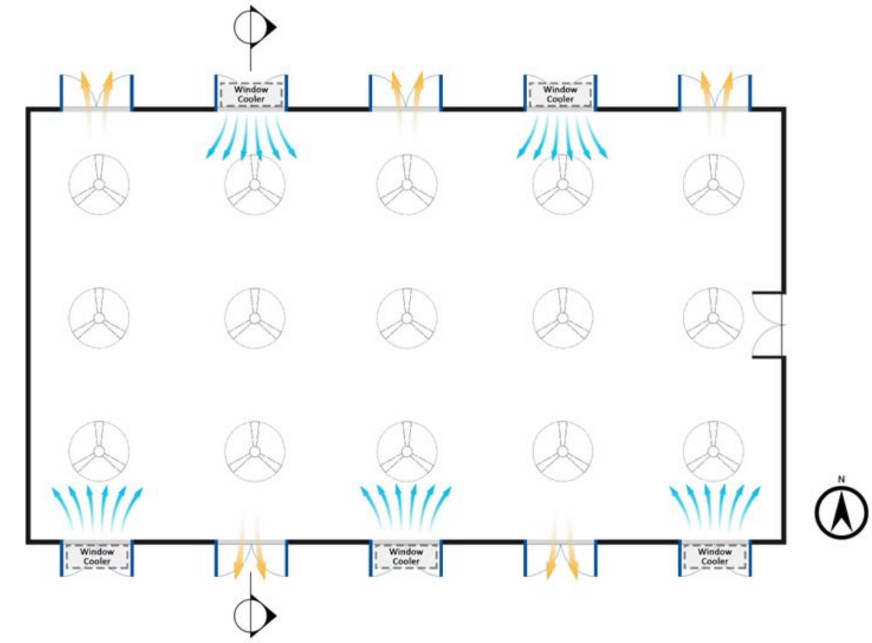


Figure 7: Conceptual plan showing location of portable direct evaporative coolers in a cooling center (temporary structure)

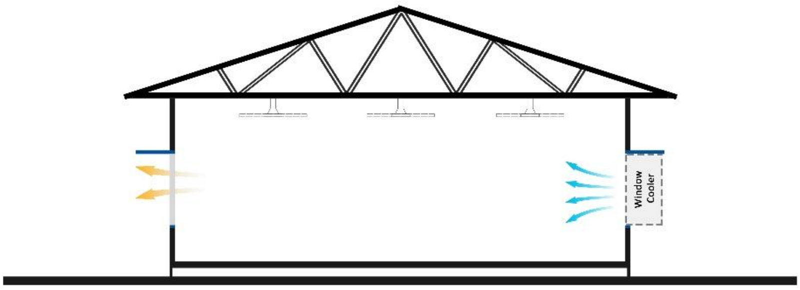


Figure 8: Conceptual section showing location of portable direct evaporative coolers in a cooling center (temporary structure)

Figure 9: Examples of portable direct evaporative coolers that can be installed coolers in a cooling center (temporary structure)

Illustrative example of ductable Two-stage Indirect-Direct evaporative cooling (IDEC)

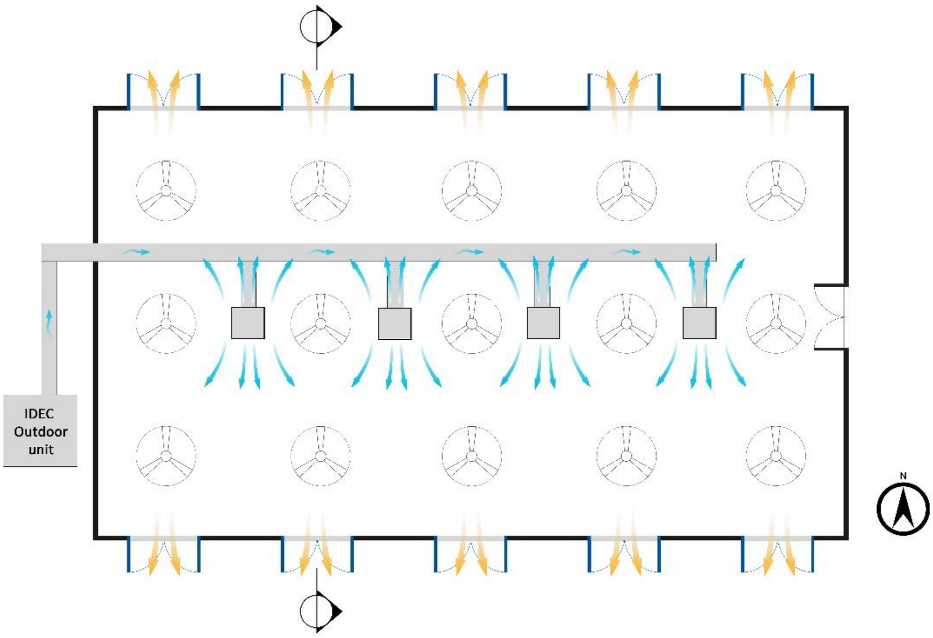


Figure 10: Conceptual plan showing layout of the cooling system for IDEC system in a cooling center (temporary structure)

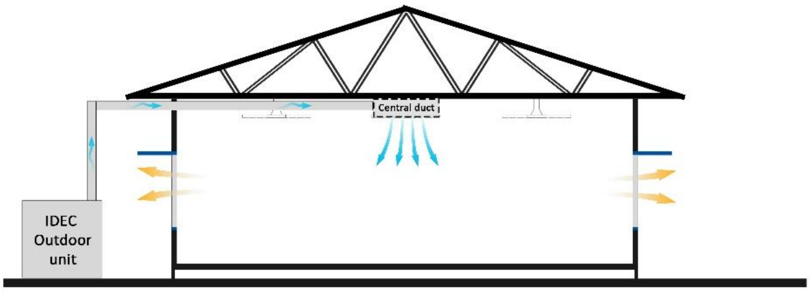


Figure 11: Conceptual section showing layout of the cooling system for IDEC system in a cooling center (temporary structure)

Figure 12: Examples of the cooling unit of IDEC systems

Examples of cooling centers in India and abroad

In April 2024, Mahila Housing Trust (MHT) and Jodhpur Nagar Nigam North (JNNN) introduced a first-of-its-kind Net-Zero Cooling Station (Figure 13 and Figure 14). This cooling station was installed in a heat-vulnerable ward in Jodhpur North identified through the HAP's vulnerability assessment and includes several unique features.

Direct evaporative cooling is implemented by sprinkling water over the "khus panels" and drawing air through the wet panels using the turbo ventilator.

Figure 13: Cooling center in Jodhpur (exterior view)

Figure 14: Cooling center in Jodhpur (interior view)

Figure 15: 'COOLtainers' located on northern Tucson's (USA) commercial corridor. These air-conditioned stations are solar-powered. One of them is equipped with cots for 5 people for napping, while the other has tables and chairs, and also offers snacks, games and hygiene items.

Figure 16: The Multnomah County in the city of Portland, Oregon (USA) along with citizen volunteers, collaborated on preparing two major buildings as cooling centers, issuing communications and arranging transportation to those who needed it during seven-day heat wave

Figure 17: An example of a senior center being used as a cooling center in Panorama City, Los Angeles (USA). Designating locations, where people can retreat when it's hot outside, is a key public health strategy during extreme heat waves in Los Angeles

4. Amenities and Resources

As these are structures normally used for different purposes, it is important to ensure the amenities are also aligned to cater to heat vulnerable population when it is being used as a cooling center. Below are a few mandatory requirements for the shelter:

Safety & Inclusivity

- Depending on the location of the cooling centers, separate cooling rooms may be required for males and females. Where required, separate cooling rooms must be assigned in the cooling center for males and females.
- Similarly, gender-segregated toilets and other gender sensitive features like emergency lighting backup in, toilet doors lockable from inside and separate access to toilets etc., must be provided.
- Provisions for differently abled people like ramps on entrance, and lifts (if required) must be ensured. An accessible toilet is also required.
- Install fire safety measures (e.g., extinguishers, clear exits).
- Install CCTV cameras.
- Strict hygiene standards must be maintained, including designating no smoking or drinking zones, providing sanitation blocks and toilets, and ensuring regular cleaning schedules.

Resources

- The cooling center must ensure continuous electricity and water supply. A building with on-site renewable energy provision (e.g. solar PV installation) is preferred for low-carbon operation and resilience of the building. If an inadequate supply is observed frequently, ensure provisions for backups.
- The water storage tank facility in the building should be sufficient for the highest capacity of the center. The suggested amount of water per person for cooling center is 20 Liters/day with 4 liters for drinking. This is in addition to the water required for evaporative cooling. Water tanks must be located so as to avoid heating the stored water.
- Storage spaces for health care amenities like hydration stations, cool storage (refrigerators), ORS and first aid kits are specially provided.
- Availability of furniture like tables, chairs, a few beds if required, charging extensions, etc. to be arranged for the cooling center beneficiaries.

Figure 18: Cooling point set up by Lucknow Nagar Nigam. Cool drinking water, shade for sitting, desert coolers and fans for cooling, etc. were provided

5. Operations and maintenance guidelines

Day to day management

- Operating hours should be long and cover the hottest parts of the day (e.g., 8 AM – 8 PM).
- Staffing and training: Use trained volunteers or community members for management and maintenance.
- Incorporate temperature and humidity monitoring of the cooling center inside and outside the facility for performance evaluation. A live digital dashboard recording indoor temperature, humidity, energy consumption, occupancy patterns, user feedback etc., will enable identification of early system failure and as well provide an overall command and control over these centers besides support iterative learning and national benchmarking.
- Link shelter operations with local health departments to ensure real-time referrals and emergency support.
- The maintenance of mechanical systems must be ensured after each season
- The facility should be sustainable and resource efficient.

Security and safety

- Ensuring the security and safety of people, especially women should be a priority, and staff should be sensitized accordingly.
- The staff must ensure that the assets installed are not damaged.
- The staff must keep a regular checklist for the removals and usable in the facility.
- A roster for a regular supply of consumables should be ensured by the management.

Community Awareness & Outreach

- Conduct public awareness campaigns to inform communities about the existence and purpose of cooling centers. Use signage and dissemination materials in local language.
- Consider QR code checklists for real-time updates, self-assessment, and tracking.

Health and Hygiene

- Establish standard operating procedures (SOPs) for regular inspection for ventilation checks, air quality and cleanliness.
- Regular checking and collection of waste. The waste should be segregated into required categories (dry, wet, sanitary, hazardous, medical, etc.).
- Availability and quality of drinking and daily-use water should be frequently checked.
- When using evaporative cooling systems, proper maintenance, hygiene and quality of water used must be ensured to maintain a healthy indoor environment and effectiveness of the systems. Water used in evaporative cooling systems must be regularly replaced. Stagnant water must be avoided, as it can become a breeding ground for mosquitoes and lead to the spread of waterborne and vector-borne diseases.
- Separate washrooms for men and women with regular cleaning should be ensured. The maintenance team should frequently check for the working condition of all the water faucets and drainage in the washrooms.

6. Finance for cooling shelters

The following avenues should be explored to finance development and operation of cooling shelters

Financial resources	Remarks
National Disaster Risk Management Fund (NDRMF) and State Disaster Risk Management Funds (SDRMF)	The 15th Finance Commission has recommended the creation of funds for disaster mitigation along with disaster response, which will now together be called National Disaster Risk Management Fund (NDRMF) and State Disaster Risk Management Funds (SDRMF).
National Disaster Mitigation Fund (NDMF)/State Disaster Mitigation Fund (SDMF)	These funds are exclusively for the purpose of mitigation projects in respect of notified disasters covered under SDRF/ NDRF guidelines and the State specific local disasters notified by the State Governments.
Smart Cities Mission	This Mission promotes sustainable urban development and smart city initiatives. Funds can be used for heatwave mitigation in urban areas, such as creating cooling shelters.
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	This Mission provides basic infrastructure in urban areas, such as water supply, sewage, and green spaces. Funds can be used for heat mitigation measures in urban areas, including the creation of cooling infrastructure.
Other center or state sponsored schemes.	Any relevant center or state sponsored schemes aimed for urban development, or for creating urban or rural infrastructure, can be explored for cooling shelters
Private sector funds	Private sector funds through corporate social responsibility or private donations.

7. Checklist of cooling center must-haves

Location

- Must operate through the hottest parts of the day
- Must be accessible and visible to the intended users.
- Must be away from any kind of risks like flood-prone area, fire-prone area, chemical hazards, etc.

Building

- Must allow capacity preferably 4 – 6 m^2 per person. In any case, the capacity of a cooling center must not be less than $2m^2$ per person.
- Must have all windows well-shaded
- Must have openable windows
- Must have good cross ventilation
- Must have protected roof (using insulation or high SRI-paint)
- Must have protected walls (shaded and made of low heat conducting material)

Cooling

- Must have energy efficient fans
- Must have climate-appropriate, adequately designed, efficient cooling system

Amenities

- Must have adequate water supply (both drinking & other uses) and continuous electricity supply. Avoid areas where diesel generators will be continuously required for operating the shelter.
- Must have storage for health care amenities like hydration stations, cool storage (refrigerators), ORS and first aid kits
- Must have furniture like tables, chairs, a few beds if required, charging extensions, etc. for the cooling center beneficiaries.
- Must have separate cooling rooms for males and females, where required
- Must have toilet facilities (gender-segregated toilets and accessible toilets)
- Must have gender sensitive features like emergency lighting backup in, toilet doors lockable from inside and separate access to toilets etc.
- Must be accessible for differently abled people like ramps on entrance, and lifts (if required)
- Must have safety measures like fire safety measures, CCTV cameras etc.

Operation & maintenance

- Must maintain strict hygiene standards and ensure regular cleaning schedules.
- Must have trained volunteers or community members for management and maintenance.
- Must link cooling center operations with local health departments to ensure real-time referrals and emergency support.
- Must regularly maintain all mechanical systems
- Must regularly check, segregate, collect and safely dispose off waste.
- Must regularly replace water used in evaporative cooling system (if used) to maintain water quality and prevent diseases.

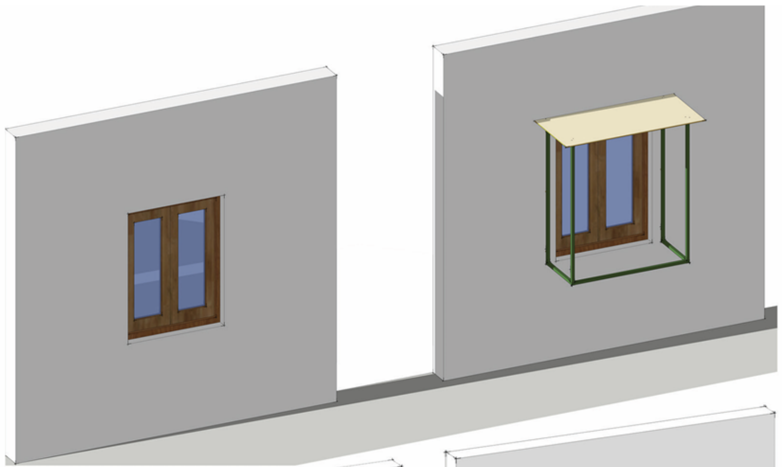
Annexure A

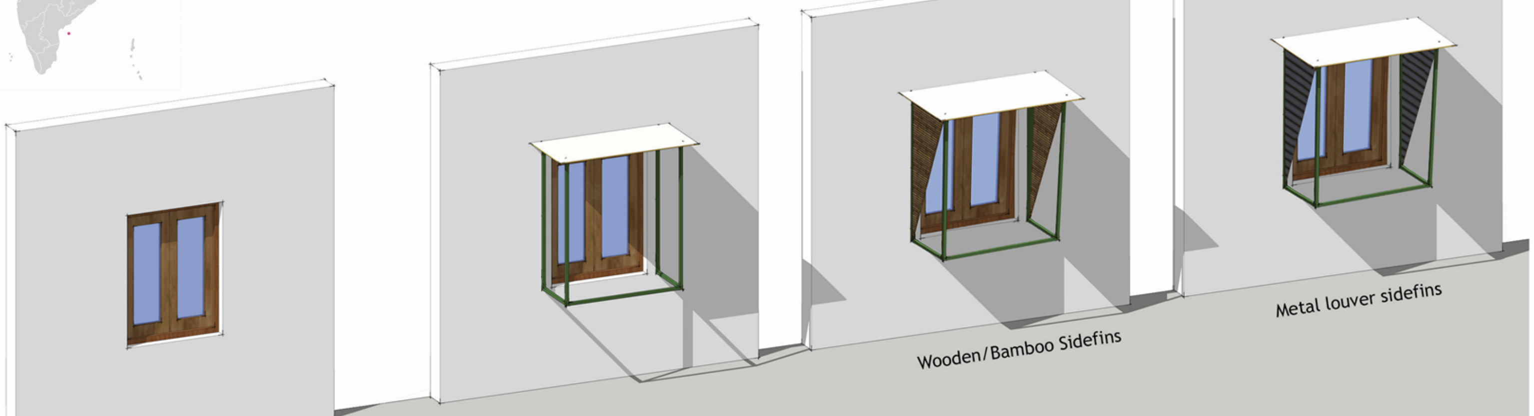
Extracted from Building Envelope Solution Sets (V 1.0) for Eco-Niwas Samhita 2018. Published in 2021. (Pages 30 – 39)

SHADING IN NORTH FACADE

FOR LATITUDES ABOVE THE TROPIC OF CANCER

The northern façade in northern latitudes of India receives direct solar radiation only in the extreme summer months, during early morning hours, and late afternoon hours. Ideally, vertical fins on the eastern and western sides of the window are provided to shade the window during these periods. However, as the angle of incidence of solar radiation on a northern façade is oblique and the impact of this radiation is relatively small, the vertical fins may be sacrificed.

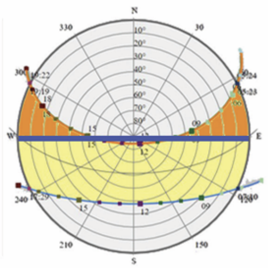




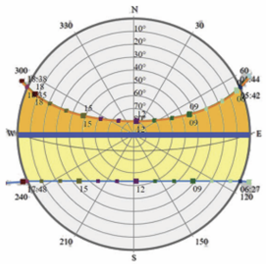
The east facing sidefin help to shade from the early morning sun

FOR LATITUDES BELOW THE TROPIC OF CANCER

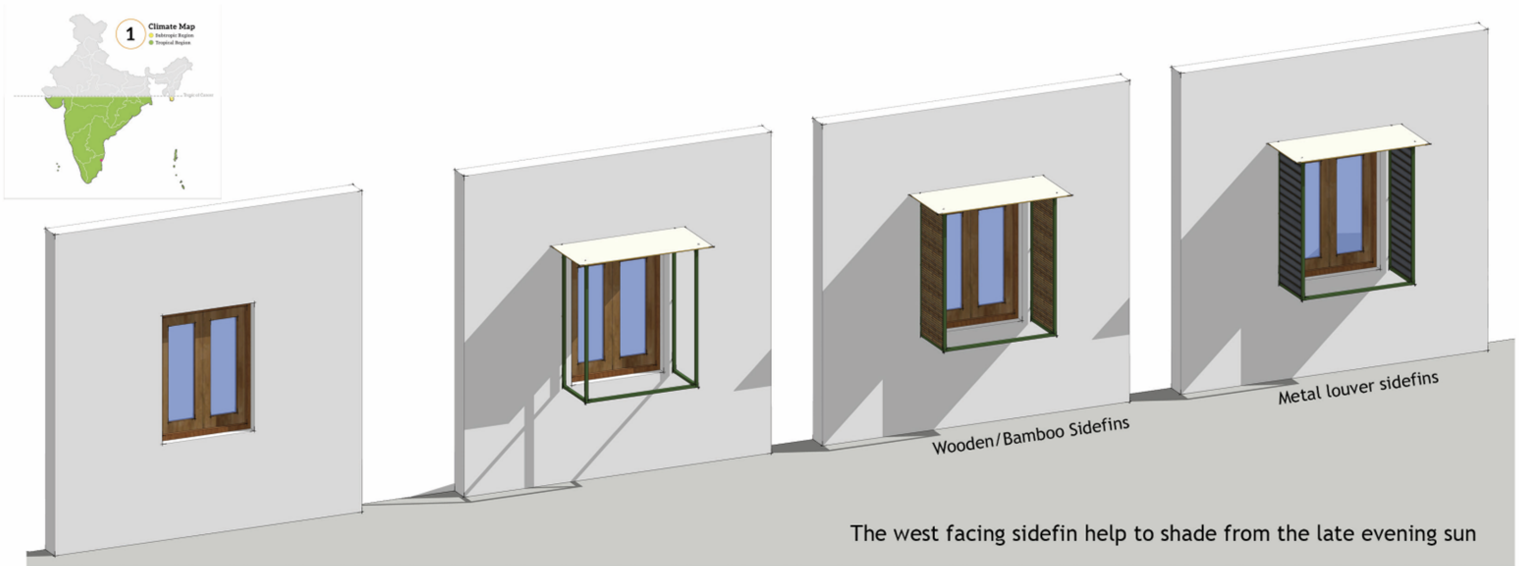
The northern façade in southern latitudes of India, however, is exposed to direct solar radiation during the morning and evening hours for a much longer period of the year, as compared to the exposure in northern latitudes. Also, the angle of incidence of the sun's rays on the façade is less oblique and more impactful. Hence, it is necessary to provide vertical fins on the eastern and western sides of the window in addition to the horizontal overhang above the window.



Delhi sun path
Sun exposure for North facing window



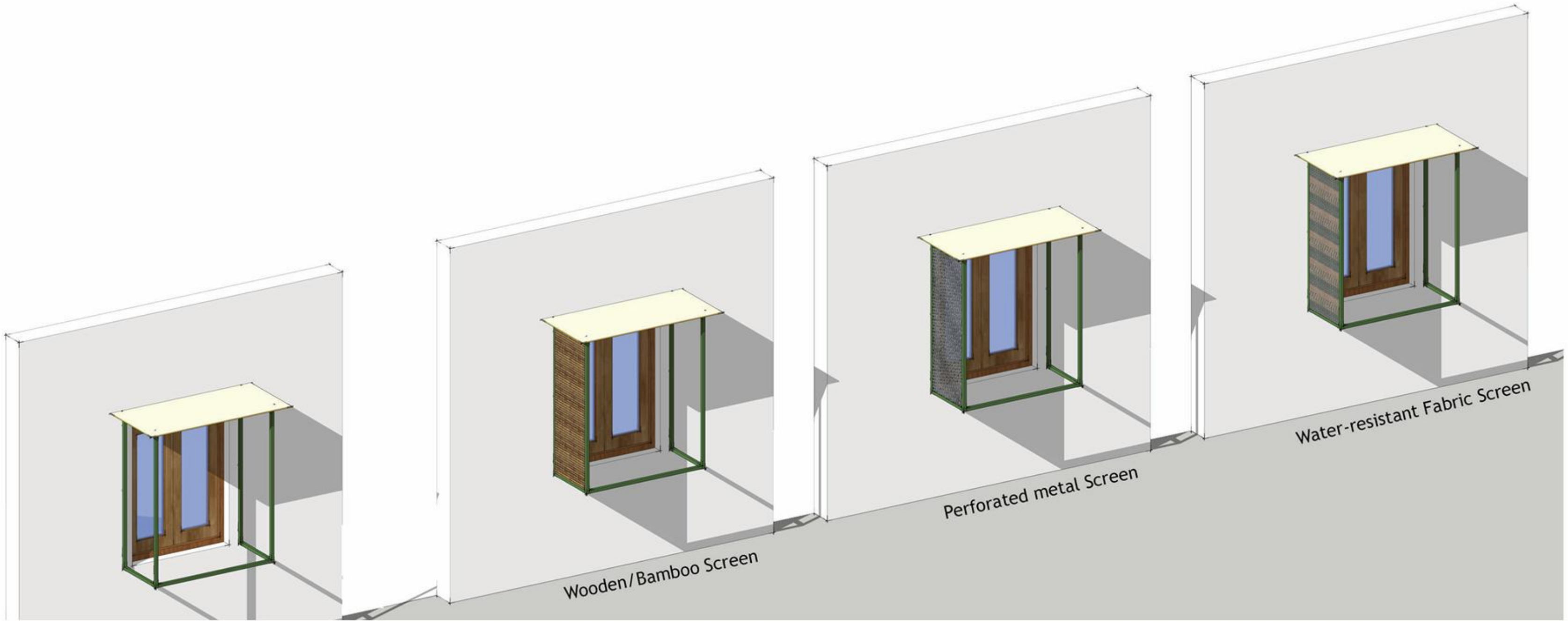
Chennai sun path
Sun exposure for North facing window

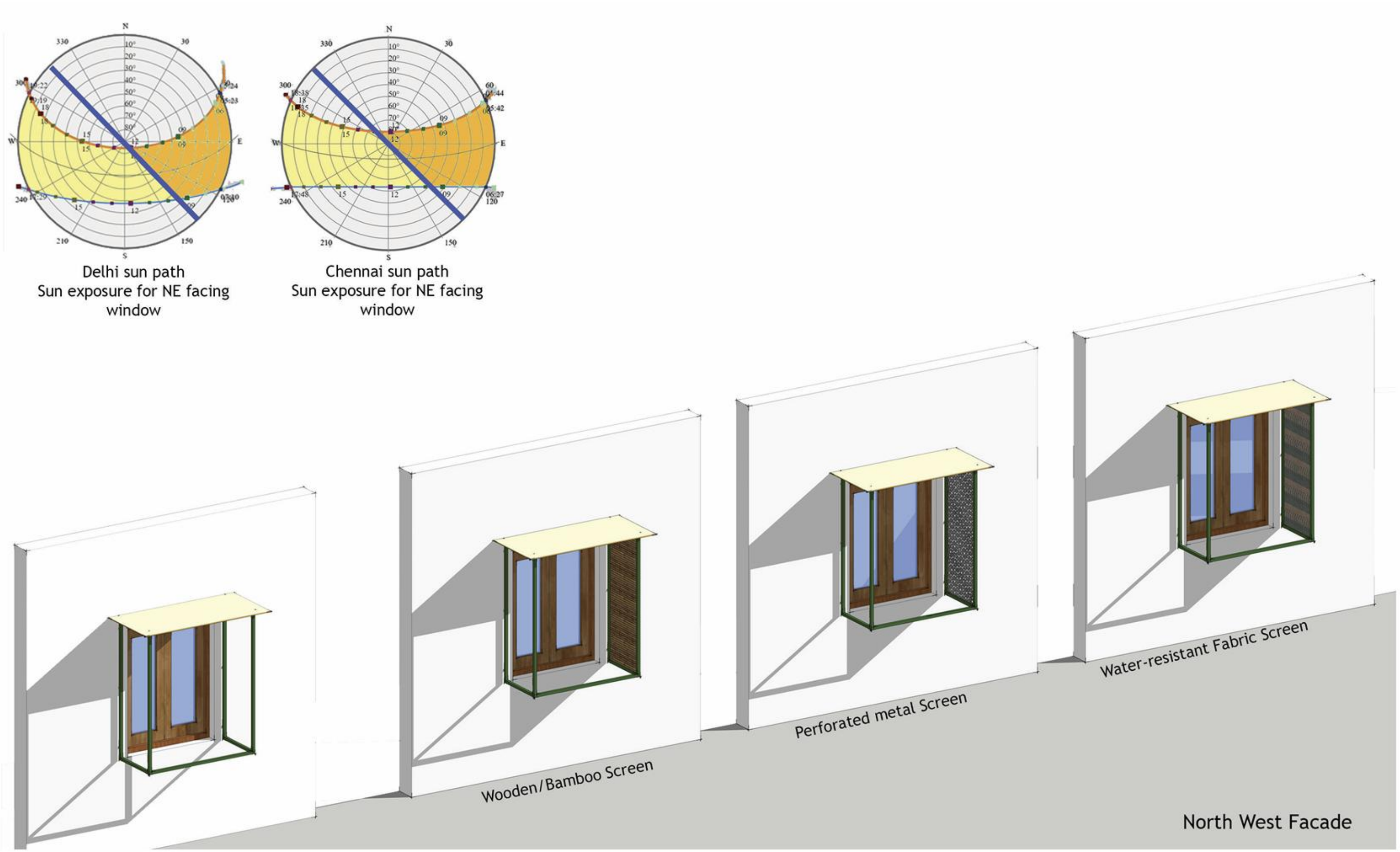


SHADING IN NORTH-EAST/NORTH-WEST FAÇADES

The north-east and north-west façades face the rising and the setting sun, respectively, during the hottest part of the year. The sun angle is low and thus it leads to direct solar radiation into the building. This is most critical for the north-western façade as the ambient temperature is already high in the afternoon.

This can be dealt with by putting fixed screens/shutter across the face of the window as shown in these images. The screen can have slits or perforations on 15%-20% of the surface area. This would allow for better ventilation, while blocking 80% of direct solar radiation. The perforations and slits also help in dissipating the heat that the screen itself would absorb and re-radiate towards the window.




Delhi sun path
Sun exposure for NE facing window
Chennai sun path
Sun exposure for NE facing window
Wooden/Bamboo Screen
Perforated metal Screen
Water-resistant Fabric Screen
North West Facade

SHADING IN SOUTH FAÇADES

The southern façade faces the sun for the longest period. Here, the overhang above the window plays a major role in cutting the solar radiation. The vertical fins on either side of the window cut off the direct solar radiation of the early morning and late afternoon. These fins could be of a triangular shape as shown. They can be made out of wooden or bamboo panels, metal screens, or water-resistant fabrics.

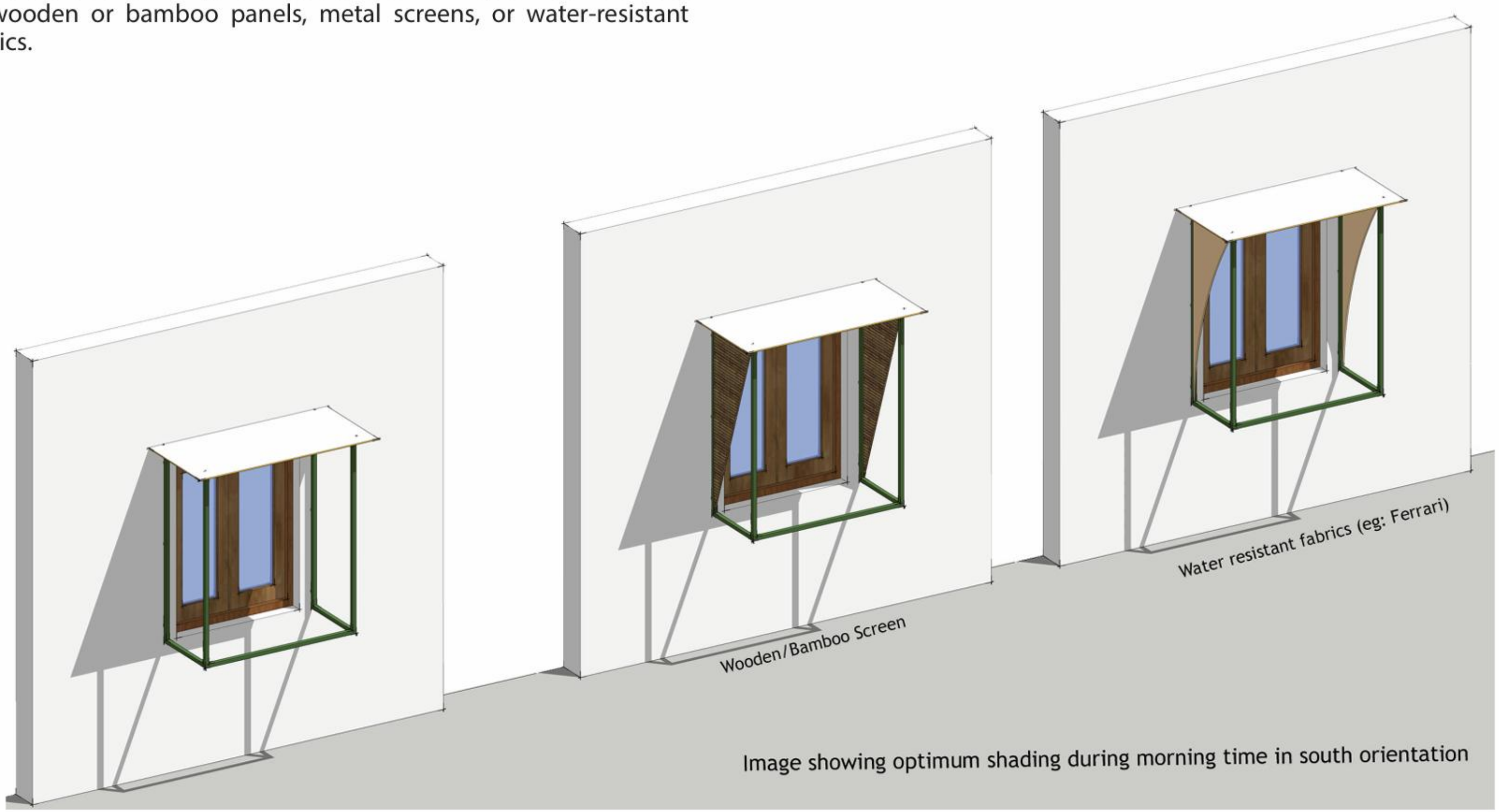
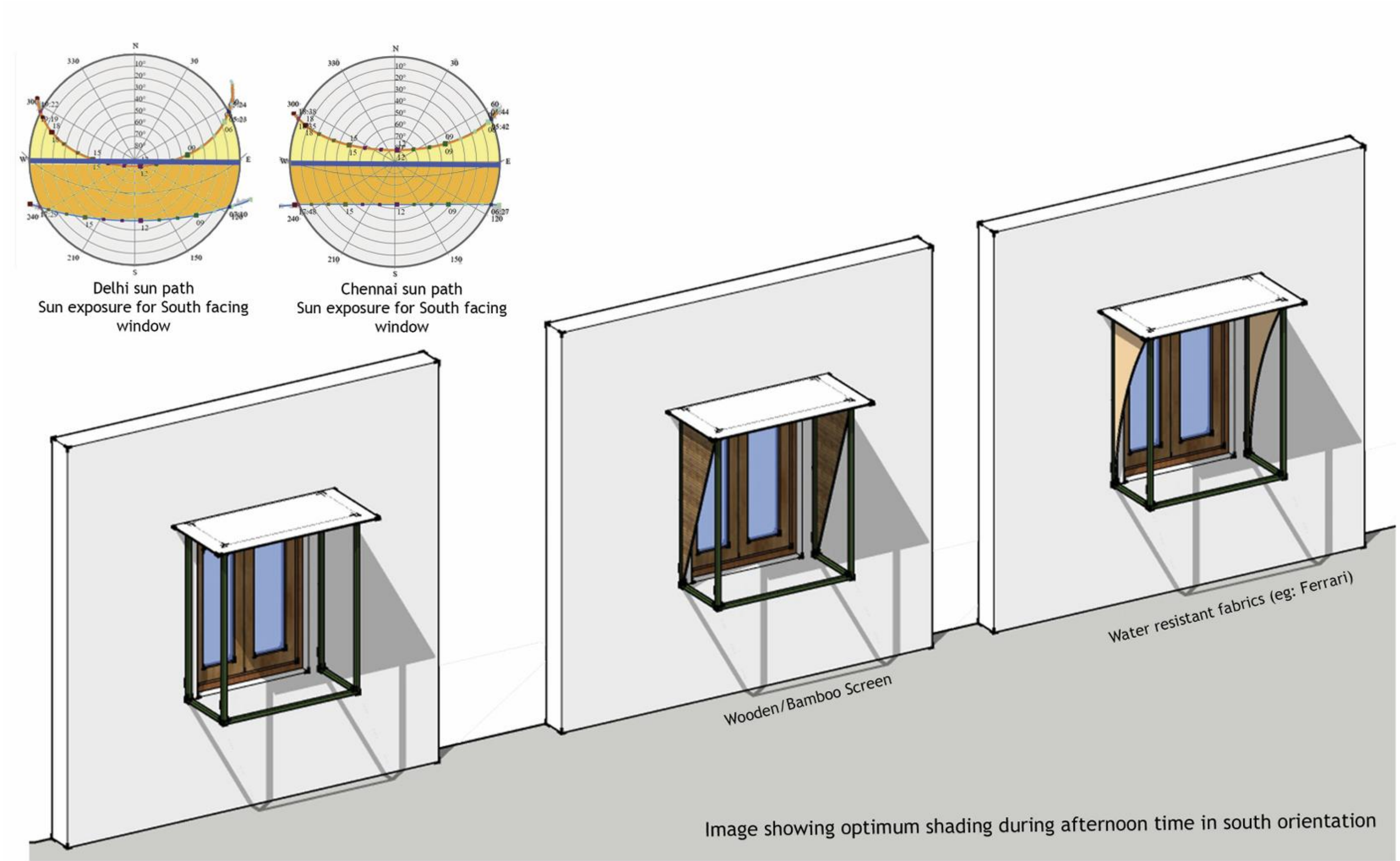
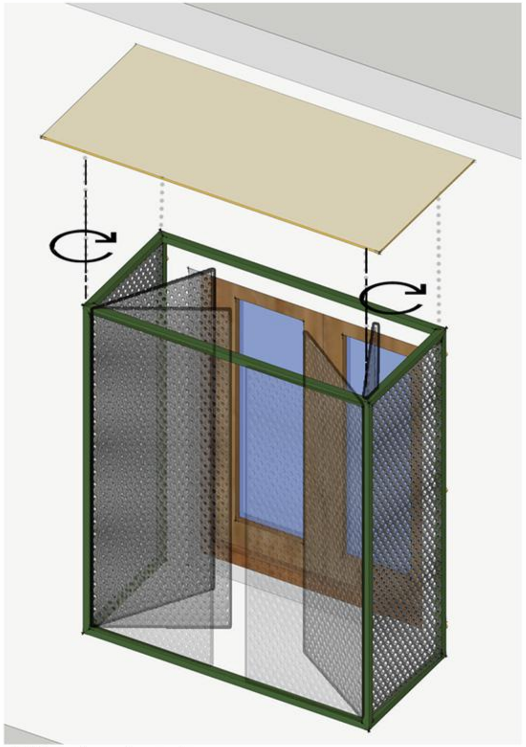


Image showing optimum shading during morning time in south orientation

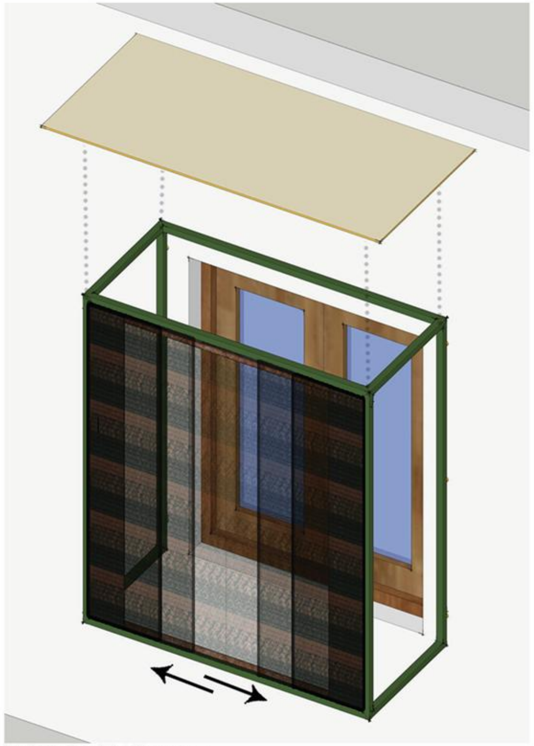

Delhi sun path
Sun exposure for South facing window
Chennai sun path
Sun exposure for South facing window
Wooden/Bamboo Screen
Water resistant fabrics (eg: Ferrari)
Image showing optimum shading during afternoon time in south orientation

SHADING IN EAST/WEST FAÇADES

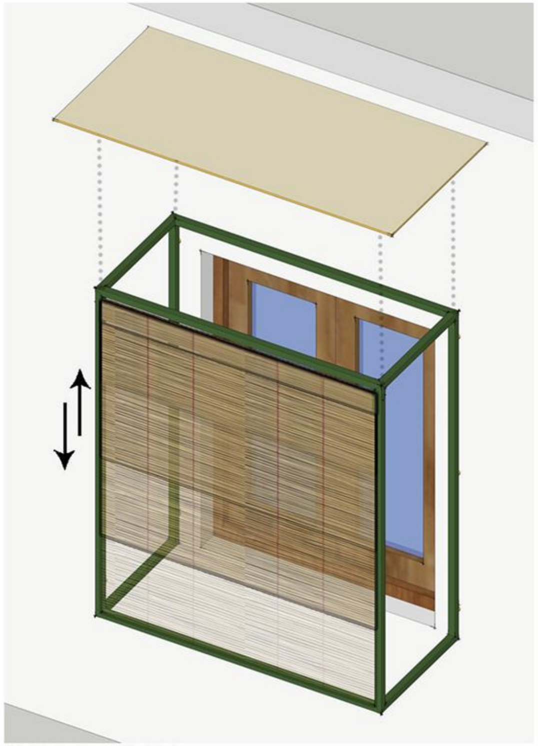
The east and west façades are exposed directly to the strong radiation of the sun for the entire morning on the east face and for the entire afternoon on the west face. Thus, the sun penetrates deeper directly from the front of the window. The east-facing window needs protection from the sun during the morning half of the day. The west-facing window needs to be protected during the afternoon half of the day. Thus, a screen or shutter is necessary across the face of the window to block the direct solar radiation. As this is necessary for only half of the day, a good solution is to have a movable shading system across the face of the window.



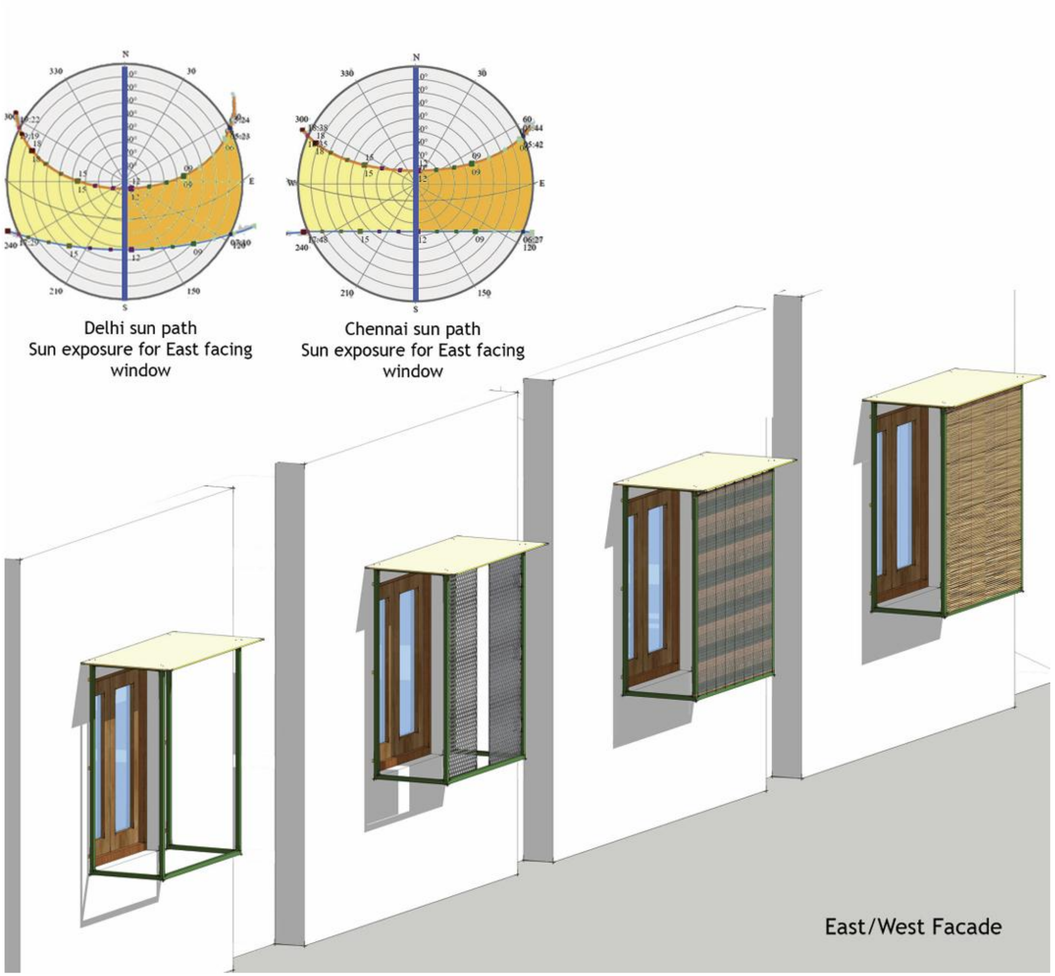
a) Hinged or pivoted type



b) i)Sliding/Folding type



b) ii) Roll-up/Roll-down type



This may be achieved through the following ways:

a) **A hinged** or **pivoted** shutter with optimum size perforations/cut-outs/openings, etc. can be made of various materials such as the following:

1. Punched galvanised steel louver panel
2. Painted louvre wooden panel
3. Perforated metal/plastic screens
4. Water-resistant/WPC boards
5. Treated bamboo chiks

b) **A retractable** system with a breathable and translucent membrane could be further classified in two categories.

i) **Sliding/Folding (horizontal movement)** Here, stretchable, durable, and abrasion-resistant nylon and polyester fabrics/curtains can be slided along two rods fixed on top and bottom of the fabric.

ii) **Roll-up/roll-down (vertical movement)** Here, materials like bamboo chiks, foldable fabrics (ferrari), and cloth could be used.

SHADING IN SOUTH-EAST/SOUTH-WEST FAÇADES

The south-east and south-west façades are exposed to both the lower altitude sun and the overhead sun. Thus, it gets solar radiation from both sides and front. So, it is necessary to have a shading provision on sides and front as well. This could be achieved by having fixed side-fins and a movable front screen. Movable shading screens can operate in the following ways:

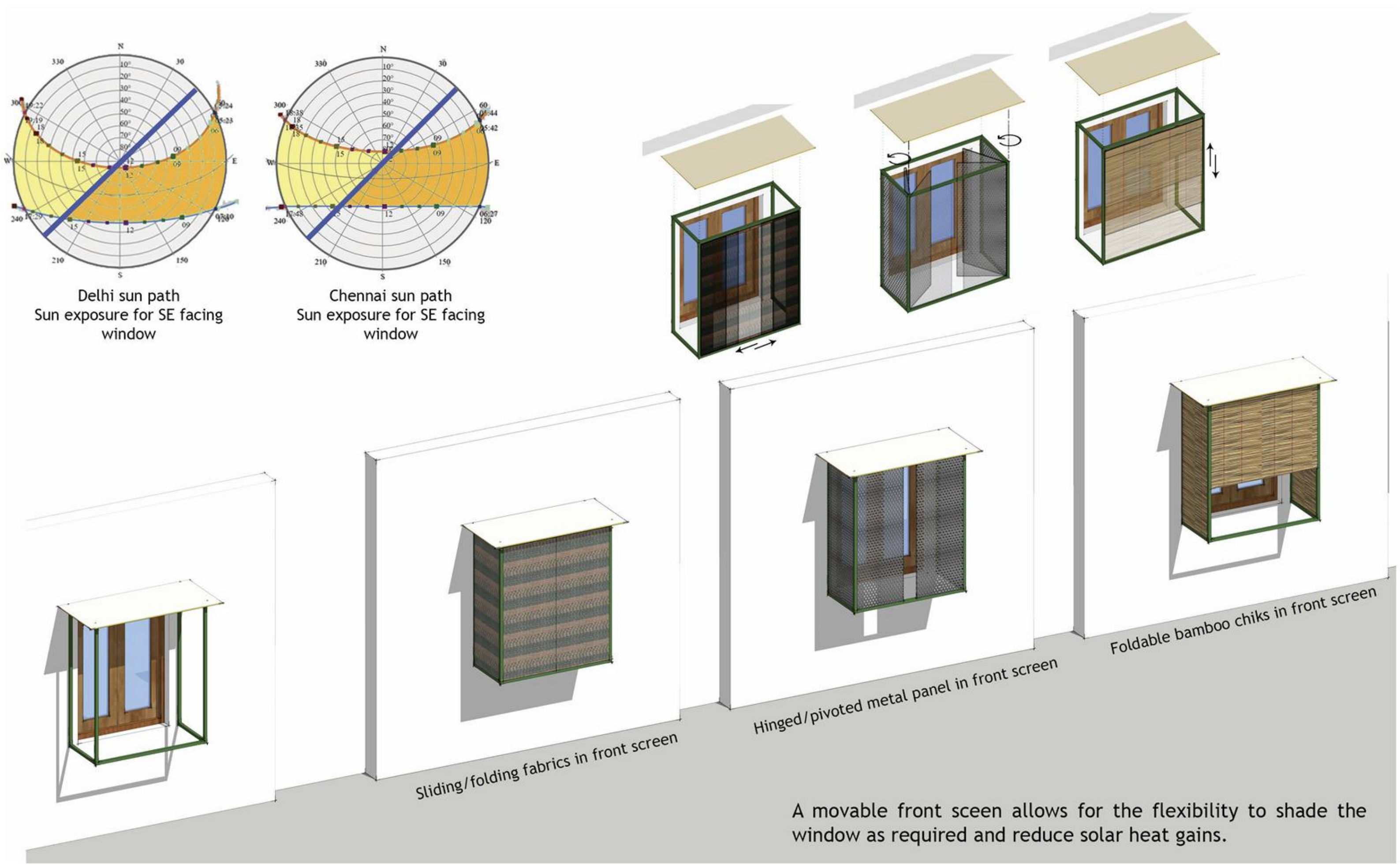
A) A hinged/pivoted system

B) A retractable system

  a. Sliding/folding screen

  b. Roll-up/Roll-down.

Just having fixed sidefins is not enough for the south-east and south-west facades, the solar radiation still penetrates inside from the front side.



A movable front sceen allows for the flexibility to shade the window as required and reduce solar heat gains.