MaS-SHIP

Mainstreaming Sustainable Social Housing in India Project

Guidelines for integrating sustainability in social housing developments in India

October 2018

Temperate climate zone

The purpose of this document is to compliment the guidance provided by the Government and Green Building certification bodies in India.

These guidelines are based on learning derived from the MaS-SHIP project as well as secondary literature.

Insights are also shared from resident surveys conducted in five social housing developments in India.

Incorporating these guidelines in the design and construction of social housing developments will contribute to enhance the sustainability and quality of life of the residents.

Key principles

- Provide convenient accessibility to basic day to day amenities and proper connectivity to places of work.
- The building envelope should restrict heat gain by reducing the direct solar exposure of the surface area by thoughtful orientation
- Optimally sized openable windows are best suitable to help natural ventilation. These must be protected by extended overhangs and movable shading, particularly in southern and western facades, which are subject to harsh sun during the course of the day.
- Maintain quality of construction to developing of cracks, breakage in walls and material joints. Adequate water proofing and good quality plumbing design and installation is imperative to avoid discomfort and damage caused due to occurrence of dampness.
- Planting deciduous vegetation to facilitate mutual shading is favourable as it would protect the facades from direct solar heat gain in summer and enhance the microclimate of the surroundings.

Laggare Housing Society, Bangalore

Prominent Indian cities within the composite climatic zone (1)

Bangalore

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Climatic characteristics

- Moderately high temperatures in summer and comfortably low temperatures in winters.
- Humidity remains low throughout the year, except for monsoon season.
- Moderate direct solar radiation due to overcast sky conditions throughout the year.
- Breezy weather throughout the year.
- Moderately cloudy during summer (Feb to Apr) with total sky cover ranging from 0-40%. Overcast skies in monsoons (Jul to Sep) with total sky cover varying from 55-95%
- Wind direction varies topographically for a location, but remains west to east predominantly.

Climate data (1)		
Mean temperature	Summer midday	27to 33 deg. C
	Summer night	20 to 23 deg. C
	Winter midday	25 to 27 deg. C
	Winter night	16 to 20 deg. C
	Diurnal variations	7 to 10 deg. C
Relative humidity	Min. 45% to 75%;	Max. upto 85%
Rainfall	Variable - 500 to 900 mm/year	

Monthly temperature and relative humidity in prominent cities (2)

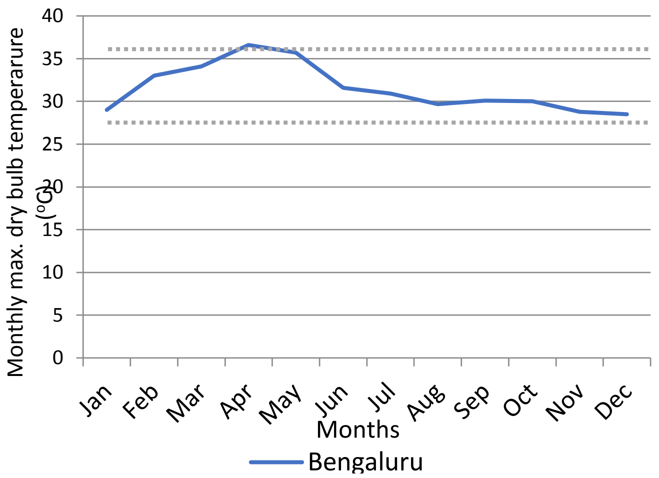

Figure 1: Monthly maximum dry bulb temperature

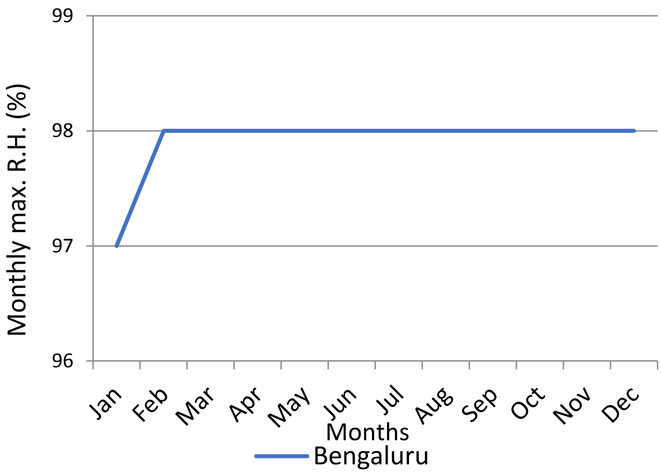

Figure 3: Monthly maximum relative humidity

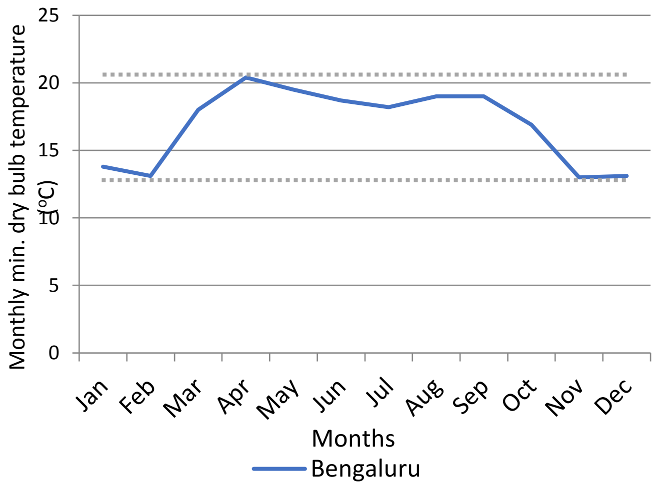

Figure 2: Monthly minimum dry bulb temperature

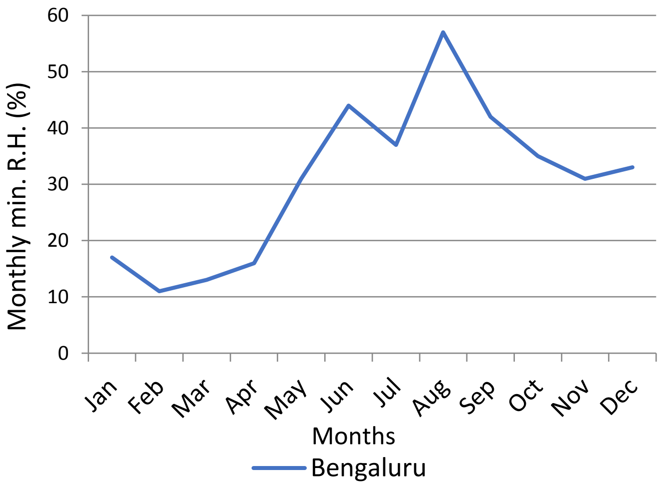

Figure 4: Monthly minimum relative humidity

Site Location

Convenient access to basic day to day amenities around the development has been identified as an important aspect of approach towards sustainability of a housing development. (3, 4).

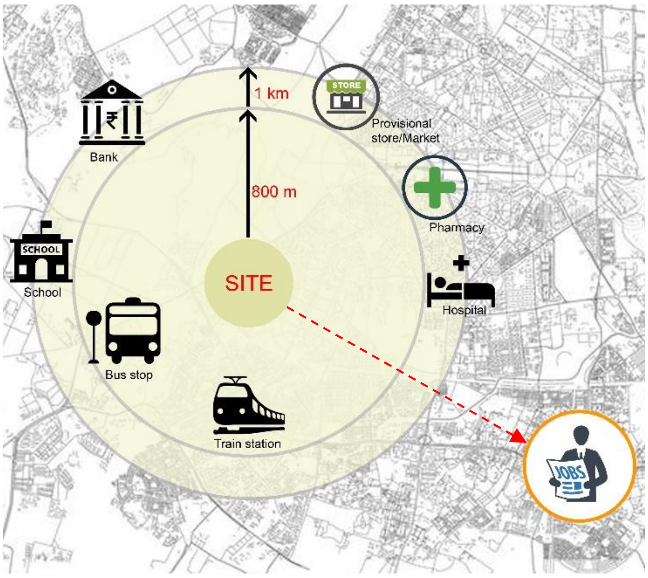

Figure 5: Site location

- Public transport facilities (intra-city station/bus stop/ metro) to be at a maximum distance of 800 meters from the development.
- Basic amenities like hospital/clinic, pharmacy, schools, market/provisional store, ATM/bank to be within a walking distance of 1 km from the development.
- The site location should be such that it either provides the residents easy access to job opportunities or is well connected with the city's main commercial/employment centric areas where the residents work/could find work.

Figure 6: View of market near Jakkampudi colony in Vijayawada (Despite being 11km from the city centre, the residents of Jakkampudi colony had easy access basic amenities)

Massing and space planning

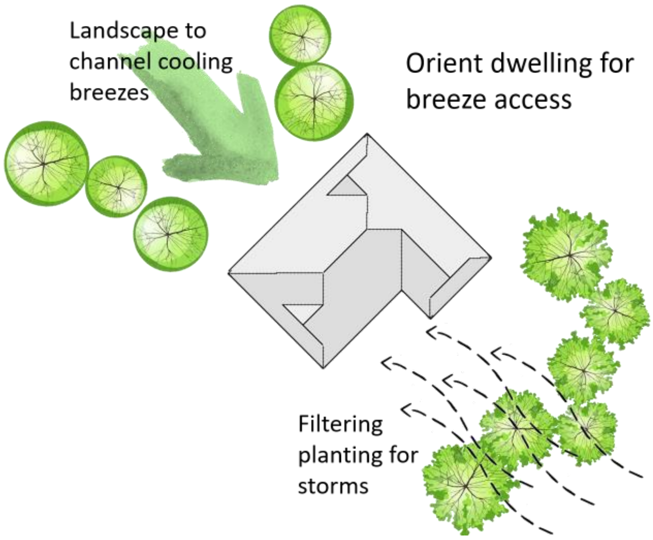

Figure 7: Orienting dwelling for optimum breeze access

- Orient the building with the long axes in the east-west direction so that the longest walls face north & south and only the short walls face east-west, to minimise solar exposure of external walls.
- Attempts must be made to design effective external shading. The longer southern walls must be protected by use of shading devices, mutual shading from neighbouring buildings, or vegetative features.
- Local wind patterns should be studied and considered while finalising the building orientation in order to facilitate optimal positioning of windows and aide natural ventilation whenever outside temperatures are favourable.
- Internal planning of the habitable spaces must be done in compact manner, with ancillary spaces like storeroom, staircase and toilets placed in eastern and western zones, and living spaces placed in north and centre of the building. This would avoid the occupants to experience discomfort in areas subject to more heat gains.

Building envelope

Thermal performance

Placement of living spaces defines its share to direct heat gain and opportunity to avail adequate daylight and ventilation. Therefore, optimal selection of the envelope assembly and treatment of the exposed façade would contribute immensely to the occupant comfort.

Given the low diurnal temperature variations in the temperate climatic zones, building materials with medium thermal mass prove effective in regulating heat gain and loss inside the buildings.

The design and material specifications of building envelope should be aimed to achieve:

1. Comfortable indoor temperatures (with minimum possible active measures) during both summer and winter.
2. Healthy indoor air quality, by allowing for adequate natural ventilation.
3. Adequate provision of natural lighting in the regularly occupied areas of the dwellings (5).

- The baseline thermal conductivity (U-value) value for different building components as defined in IGBC Green Affordable housing for temperate climate are provided below (4).

Building component	U-value (W/m2K)
Wall	≤1.1
Roof	≤1.2
Glazing	≤5.7
Glazing (SHGC)	
WWR <20%	0.6
WWR >20	0.48

- Having light coloured external walls (absorptivity<0.4) can reduce heat gain through building envelopes.

- Heat gain from roof surface can be reduced by using roofing materials with high Solar Reflective Index (SRI), like white broken china mosaic, high SRI paints etc. on the roof surfaces.

- Cost effectiveness is a prime concern, especially when it comes to social housing. Under the given situation, thermally insulating the building envelope may not be economically conducive. Thus, it makes it important to ensure the construction processes lead to good quality structures. This would minimise the chances of cracks and faults, therefore air leakages, thus improving overall living experience.

Window openings and shading

- The window to wall ratio (WWR) on each façade should be determined based on the duration of sun exposure on the particular facade

- Adequate shading on the south side windows must be ensured to cut direct solar radiation during the summer months but permit winter sun.

- Fenestrations on the northern façade should be positioned to harness diffused daylight and reduce use of artificial lighting whenever possible.

- Minimum projection factor for external shading should be 0.5 (3).

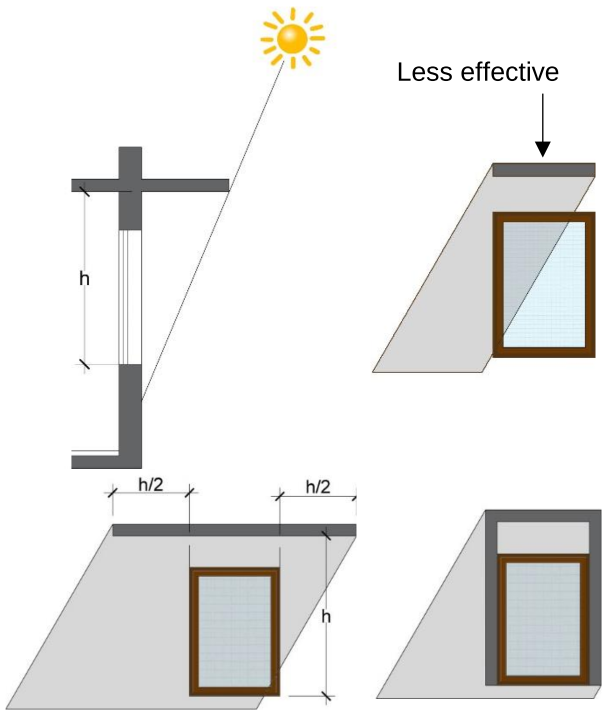

Figure 8: Guideline for designing effective horizontal shading for windows on south façade. Image adapted from: The Carbon Neutral Design Project (8)

Daylighting

A WWR of 10%-15% in bedrooms and 30% in living areas is sufficient to provide optimum daylight for day-to-day purposes.

- Providing windows with higher lintel levels or use of light shelves can increase the daylight penetration into the building. Larger fenestrations could be carefully planned on facades not exposed to direct insolation for longer durations of day. It is feasible to have them on facades which may remain shaded perpetually for longer time of the year.

- As a rule of thumb- daylight penetrates a room approx. 2.5 times the height of the top of the window.

Figure 9: Daylight penetration extent in a space

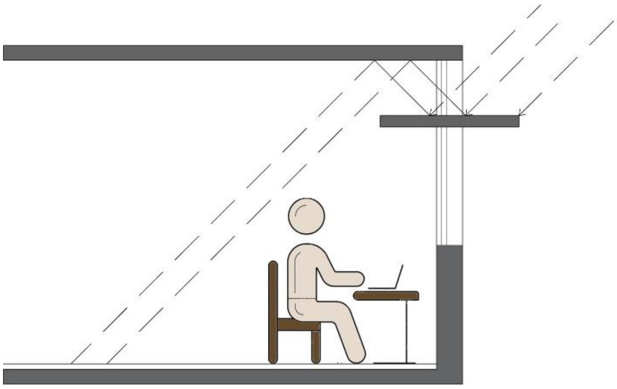

Figure 10: ***Light shelves*** *(Externa/internal light shelves allow diffused light penetration & shade)*

Ventilation and passive cooling

- Given the overall temperature conditions throughout the year, and limited impact of building's thermal mass, cooling by different modes of natural ventilation should be effectively utilised to remove the heat stored inside the building.

Cross ventilation

- One of the effective passive cooling techniques that can be used for buildings in this climatic zone is cross ventilation. Strategic placement of fenestrations can provide adequate cross ventilation by optimizing the air flow through the building, removing heat from the space and enhancing comfort levels of the occupants.
- The placement of windows should not be exactly opposite to each other. It should be positioned in a manner that allows the room's air to mix, distributing the cool fresh air better.
- The effect can be enhanced by placing inlet openings on windward and high pressure zones and outlets at leeward and low pressure zones.
- Operable paned windows are more effective over sliding windows as they have greater openable window area for natural ventilation.

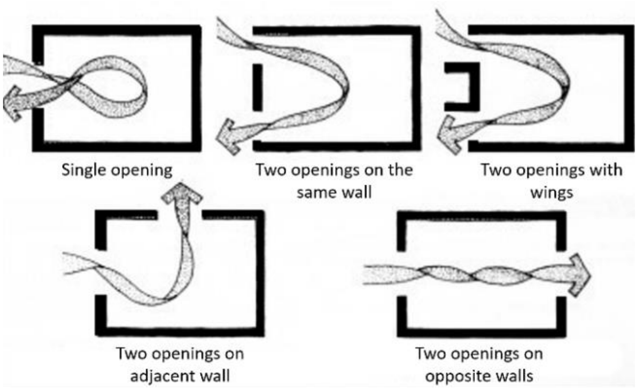

Figure 11: Cross Ventilation

Drainage & Waste management

- The site plan should be developed so as to minimize the disturbance caused to the existing natural habitat at the site. Detailed guidelines for providing and developing green areas at site are available in NBC vol 2, 2016.

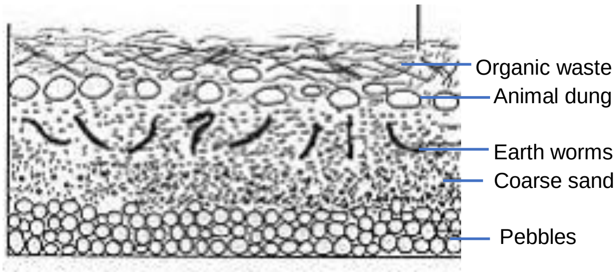

Figure 12: Diagram of vermicomposting pit

- Segregation and disposal of organic waste through natural process like dump-pits, vermi-composting etc. should be incorporated in the design and planning of the project to encourage cleanliness at site. A regulatory body can be formed from among the residents to oversee the regular disposal of garbage. This will help provide them with a sense of responsibility and also assist in job creating.

Water conservation

Rainwater Harvesting

- Capturing and preserving rain water is an efficient way to reduce portable water consumption and address water crisis.
- Rainwater harvesting can be done either for-

  I. Storage (underground or over-ground tanks) and direct use of rain water, or

  II. Charge into the ground – Ground water recharge.

- Rainwater harvesting system for a minimum of 20% of run-off volume from impervious surfaces (both site & roof) should be provided.

Or

- If the ground water table is less than 4m, rainwater harvesting storage tanks for a minimum of 7.5% system for a minimum of 20% of run-off volume from impervious surfaces (both site & roof) should be provided (4).

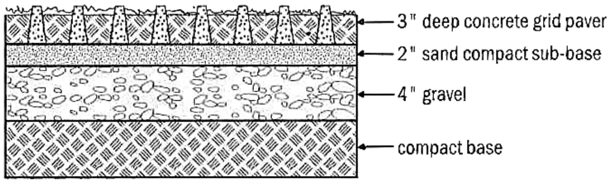

Figure 13: Performed lattice unit grids for storm run-off control, pedestrian pathways and soil conservation. Image adapted from: Sustainable Building Design Manual, Vol.2(8)

- Providing pervious &/or semi-pervious surfaces on site, in the form of grass pavers, pebble beds etc. can also lead to less run-off and allow for ground water recharge through a larger area.

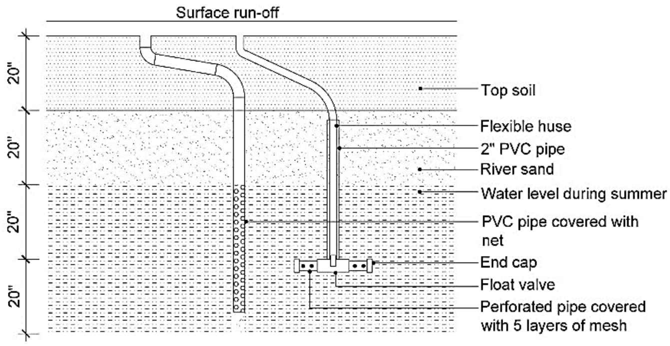

Figure 14: Rainwater harvesting combined with a pavement design at an interval dependent on the run-off. Image adapted from: Sustainable Building Design Manual, Vol.2 (9)

- The type & amount of rainwater harvesting suitable for a development varies and depends on the climatic zone, rainfall intensity, soil conditions, run-off volume and site design. NBC and Local Building Byelaws must be referred for planning and detailing RWH system in a development.

Building materials

Selection of material in temperate climate should be done primarily to :

- Reduced heat gain
- Promote quick heat loss
- Be localy availabe to reduce transportation energy.
- Have lower embodied energy (EE).
- Minimise humidity through quick dissipation

- As diurnal variation is low, insulation in the walls and roof does not provide significant improvement in thermal performance (3). RCC filler slab and ferrocement roofing channels help reduce heat gain from the roof and provide considerable savings on cooling loads.

- Heavy constructions such as monolithic concrete construction or stonecrete are not desirable as they heavily affect the cooling load. 230 mm AAC block walls are sufficient in reaching the desired comfort level.

- Exposed materials with high absorption rate perform well when properly sheltered from rain by absorbing humidity from within the living space.

- Glazing of low transmissivity should be used.

- Pale colours are preferable for the exterior surfaces, but dark surfaces may be used in recessed places protected from the sun.

Sustainability Assessment Tool

- The Sustainability Assessment Tool (SAT) is built on a Multi-Criteria Decision support system to provide the targeted beneficiaries with evidence based performance information. This would aid decision making in their choice of building materials and construction technologies, both walling and roofing, for social housing projects in India.

- A total of 17 building materials and technologies have been evaluated on the basis of 18 attributes categorized under 4 main criteria – Resource Efficiency, Operational Performance, User Experience and Economic Impacts

- The link to the SAT is: https://teriindia-my.sharepoint.com/:x:/g/personal/megha_behal_teri_res_in/EYFFmyuT1sdDjvod8oZqlK4BVw-OKPkVGVlnUn-8Rsro4g?e=sZrveE

- The SAT would enable the user to make an informed choice by providing:
    - Order of preference of 17 walling & roofing building materials and technologies across all 18 attributes
    - Order of preference of 17 walling & roofing building materials and technologies across selected attributes
    - Customized results based on the location selected
- The SAT outputs are represented in the form of graphs which provide '**scores**' of the building materials and technologies with respect to the selected attributes. The scores have been calculated on the basis of absolute data gathered for 17 building materials and technologies across 18 weighted attributes.
- Higher score of a building material or technology with respect to others is an indicator of its better performance. Precisely, higher the score, better the building material or technology.

Insights from resident experiences of living in social housing developments in temperate climate

- The use of alternate and cost-effective building materials and technologies such as solid concrete blocks, clay bricks for internal partition walls, clay jail in ventilators and use of Ferro cement may have helped to reduce the construction cost, however the householder survey revealed that indoor comfort was perceived to be (just) *bearable* during both summer and winter.

- Dwellings in social housing developments fail to provide comfort indoor environment especially in summer (in the absence of air–conditioning). 7% residents in temperate climate relied on evaporative cooling by means of desert coolers when the humidity levels remain moderate in summer.

- 35% residents identified and relied on natural ventilation as the primary cooling strategy. Poor design and layout resulted in inadequate air movement in many of these homes.

- The building materials used did not seem to be appropriate for the climatic conditions of the location. The residents living on the upper floors complained of water seepage from the roof and walls during the monsoon season. This could also be indicative of poor workmanship during construction.

- The nail-ability of the walls and difficulty in accessing the plumbing pipe works for repair and maintenance where the primary concerns expressed by the householders.

- The lack of maintenance and up-keep of the common areas and the site was a common sight in all the surveyed developments. In some developments incomplete or poorly planned drainage system lead to water logging around the dwellings, while absence of cleanliness and proper garbage disposal system resulted in unhygienic streets and surroundings.

- All the surveyed households used electricity, but only 41% of them paid for their use. The remaining 59% of the surveyed households did not have electricity meter installed in their homes and hence did not pay any electricity bills. Measuring electricity used by each household is the first step for households to manage their energy use.

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MaS-SHIP

Mainstreaming Sustainable Social Housing Project in India (MaS-SHIP) is a two-year research developed to promote sustainability in terms of environment performance, affordability and social inclusion as an integral part of social housing. Funded by United Nations Environment Programme (UNEP) 10 Year Framework of Programme on Sustainable Consumption and Production (10YFP).

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