CHAPTER 6

ENERGY EFFICIENCY AND CLIMATE RESPONSIVE FEATURES OF VERNACULAR DWELLINGS

6.1 INTRODUCTION

The climate of a region has a direct influence on the settlement and on its built form. Any good building should relate and respond to the climate it is situated in. A built form is designed to absorb the beneficial aspects of the climate, and to reduce the impact of unfavourable conditions (Dhote, KK et al, 2012). The layout, orientation and scale of buildings and settlements should therefore be controlled, in relation to the climatic zones. The sustainability of built forms depends directly on its climate conscious and energy efficient design principles, that are specific to the context.

6.2 SITE SELECTION AND SETTLEMENT PLANNING

In Thanjavur region, the settlements originated during the medieval Chola period (in 10th cent. AD) by the rulers and people associated with royal community, and developed during the subsequent Nayaks’ and Marathas’ periods. Hence, their influence is seen in the settlement planning and architectural details.

The settlements were originally developed as a number of small community clusters, with people having specialized skills in certain specific areas. In due course of time, the clusters expanded and merged with each
other, and became a settlement with people of all communities living in distinct clusters within the settlement. These settlements had become highly sustainable, because of the living together in close proximity of people of different communities with specific skills, who could serve each other as required. One of the best examples is Swamimalai, a traditional community settlement located 35kms from Thanjavur. During the Chola period, the trained Stone sculptors and Sthapathis were made to settle near Thanjavur in Swamimalai, to get involved in the construction of the Brahadeeswara Temple at Thanjavur, and in the making of the temple idols. The clusters of the service community people (agricultural labourers and others) were located surrounding Swamimalai, and now it is one of the important traditional settlements in this region, which has maintained its vernacular characteristics till today.

In addition, during the mediaeval ages, the influence of religion on society, due to royal patronage was more (especially Saivism), which resulted in a number of religious structures, starting from small shrines to large temple complexes. They were developed either in an already established settlement or in a new development.

The sites selected for the settlements were located along the river (Cauvery) banks or close to the water sources, to facilitate the agricultural and allied activities. They were surrounded by dense vegetation and agricultural fields. Along with the water bodies nearby, these green cover had a greater impact on the micro climatic conditions of the settlement.

i) Vallam

The settlement is on a slightly elevated plain, as it was originally located within the fortified town, inhabited by the agricultural community, mainly to feed the civilians in the fort. Though the main occupation was
agriculture, part of the population was involved in allied activities such as cattle raising and lathe works (for making agricultural equipments).

The residential and work zone are interwoven in the Vallam settlement planning. The entire settlement is surrounded by agricultural fields on its south and west side whereas the northern part of the village is inhabited by the business community and the eastern side with commercial activities.

The settlement shows a moderately dense and low rise development, with a regular grid iron planning in each street in the east – west orientation. The residential streets running east-west end in agricultural fields on its west side and a large water body on its east side. The grid iron network of streets facilitates people to access their work places easily and directly which are well connected to their residential zone.

![Figure 6.1 The land use map of Vallam settlement showing the residential and work zones](Source: Google maps 2013)

In the lay out plan, the residences are set within a narrow plot abutting the street edge in its front, forming a strict row housing pattern. But, each house has a small lane on its side, which provides access to the backyard without entering the house. This makes the rigid street slightly porous, which facilitates continuous air movement within the settlement.
Figure 6.2 Street view of Vallam settlement showing houses with side lane

The settlement does not have any community open space, and no religious structure is found to facilitate community gatherings. (A church located at its South-West corner is a later addition). The reason might be, that as it was a service community for the fort town that was actively involved in agricultural activities, it would not have had time for relaxation and recreation. Streets were considered to be the extended outdoor activity area for the residents, where the elders and males socialised with neighbours, and children played during evenings and nights. Hence, the residential streets are wide enough to accommodate these community activities.

The settlement has both semi-pucca and pucca constructions with three different types of houses; i.e., the basic tripartite division without a courtyard, the house with a central court (typology 1) and house with courtyard on one side (typology 2). Typology 3 (house with double height central space -Eduthukkatt or Kalyanakoodam) is not found in this settlement. One of the important characteristic features of this settlement is the usage of red laterite stone for all types of structures, which is available in abundance in Vallam area.

ii) Melattur:

It is a properly planned settlement within defined boundaries. Five temples meant for different community groups are located within the settlement. The settlement follows a strict grid iron pattern with the main
access roads running East – West and North – South, thus dividing the entire settlement into four unequal quarters, and all the residential streets running East – West. The main occupation is agriculture, and the inhabitants of the settlement engaged in agricultural activities either directly, or by appointing labourers residing in the peripheral streets of this settlement.

Figure 6.3  The land use map of Melattur settlement showing the residential and work zones
(Source: Google maps 2013)

As a consciously created settlement, Melattur has a strong caste division which is seen in its settlement planning. The people associated with the temples / engaged in temple related activities reside in close proximity to the temples. The landlords occupy the core area or the main streets of the settlement and the agricultural labourers have their dwellings along the periphery, very nearer to the agricultural fields, which surround the entire settlement on all the sides. The main street running north south connects the two main water bodies meant for irrigation, located on the north and south end of the of the settlement and the residential streets running east west, leads to the agricultural fields in the periphery.

The entire settlement has mostly single storey tiled structures, or G+1 structures with Madras Terrace roofing. Each Agraharam street is
10m wide to accommodate the temple processions and other related activities. No particular hierarchy was followed in the planning of the residential streets, and the parallel streets are interconnected through narrow lanes at regular intervals.

![Wide Streets of Melattur settlement to accommodate religious processions](image)

**Figure 6.4** Wide Streets of Melattur settlement to accommodate religious processions

All the structures found in this settlement are pucca, and there are three different typologies of houses, such as the house with a central courtyard, the one with the courtyard on one side, and the one with a double height central space (*Eduthukkatti* or *Kalyanakoodam*).

The residential plots are of three types, based on the dimensions. *Othamanakkattu* (Single plot) is 6.5m to 7m x 33m, *Rettamanakkattu* (Double plot) is 10.2m to 10.5m x 33m, and *moonumanakkattu* (Triple plot) is 13.2m to 13.5m x 33m. The plots were allotted to the inhabitants, based mainly on the family size rather than the affordability. The typology 1 houses are seen both in *rettamanakkattu* and *moonumanakkattu*, typology 2 houses are seen in *othamanakkattu*, and typology 3 houses are seen in *rettamanakkattu* plots.

The settlement has proper drainage facility in the form of canal type ducts, situated at the backyard of each house between two streets, and connected to a pond located on its eastern part.
iii) **Someshwarapuram**

It is an organically grown settlement, based on the Someshwara temple developed along the banks of river cauvery. It is a community based settlement whose main occupation is agriculture. The entire settlement is surrounded by agricultural fields, where paddy and sugarcane are the main crops.

The settlement has four major residential streets, forming a rectilinear core area, which is divided into two parts by a connecting street. All the residential streets end in agricultural fields which facilitate the agricultural community to easily access their work place very often and as and when required.

![The land use map of Someshwarapuram settlement showing the residential and work zones](image)

*Figure 6.5  The land use map of Someshwarapuram settlement showing the residential and work zones*

(Source: Google maps 2013)

The core area is inhabited by the upper caste people who are land lords, and the settlement plan shows dense and compact row housing in the core area, which has mostly double storeyed structures.

Basically, there are three different typologies of houses seen here, such as kachcha and semi permanent houses without courtyards, courtyard
type dwellings (either at the centre or on one side), and houses with a double
highness central space (*Eduthukkatti* or *Kalyanakoodam*).

![Figure 6.6 Street view of Someshwarapuram settlement](image)

The peripheral area is occupied by the other communities who are
agricultural labourers, and it has loosely arranged single storey tile roofed
structures. There are some temporary structures also, seen in the peripheral
areas which belong to the service communities.

The predominant materials used in construction are brick, and mud
mortar for single storey tile roofed structures, and lime mortar for the double
storeyed structures, wood and country tiles.

### 6.3 BUILDING FORM AND ORIENTATION

The building forms of the vernacular houses of Thanjavur region
are linear rectangles, or an elongated plan. The front and rear door openings
are aligned on a central axis (Typology 1) or shifted axis (Typology 2&3),
which facilitates continuous air movement through the building. The houses
normally orient in the north-south direction and are either north or south
facing. The streets are oriented E-W to take advantage of the prevailing wind.
Among the eight samples selected, six dwellings belonging to Typology 1 and Typology 2 are south facing structures. The planning and orientation of these structures makes the best use of the sun’s heat and light, which is the central principle in vernacular buildings. They have a smaller opening (normally a window or a door) placed in the south west part which acts as an inlet for fresh south west breeze, a courtyard either at the centre or at east / west and a larger opening (rear door) on its north west side to let out the warm air and thus naturally ventilate the internal spaces of the dwellings.

Figure 6.7 Building orientation and openings ease the prevailing wind

Most of the buildings are single storey tiled roof structures, and very few are double storeyed with a Madras Terrace Roof structure. The Hot Humid climate, normally receives heavy rainfall during the rainy season. To overcome this climatic constraint, the houses have a sloping roof facing two or four directions. The sloping roof is projected beyond the building edge at the front and back to protect the wall surfaces from the splashing of rain water and direct solar radiation.

In Vallam, irrespective of the typology, each house has a narrow lane on its side to provide direct access to the backyard from the street which
makes the dense mass porous. This also prevents the exposure of the longer side walls as they are mutually shaded by the adjacent buildings.

In Melattur, it is row housing, with wall to wall construction, and thus, the exposure of the longer side walls to direct solar radiation is totally avoided. The deep recessed *thinnai* protects the front facade from the harsh sun during summer, and heavy rains during the monsoon period.

As all these settlements are inhabited predominantly by an agrarian community, the streets are mainly used for drying of agricultural produce during the sunny day time, and social activities take place only during evening times. The east-west orientation of the streets facilitates them to receive direct heat throughout the day, and provides a shaded outdoor area during evenings.

6.4 BUILDING COMPONENTS

6.4.1 Walls

The external walls of the houses are completely shaded on all the four sides, which is an essential prerequisite, in hot humid climatic conditions. In a strict row housing pattern, the wall surface exposed to the atmosphere is reduced to the maximum extent, and protects the structure from radiation and avoids heat gain considerably.

The walls are heavy and solid with varying thickness and construction techniques, which ensure high thermal insulation for buildings. There is a minimum number of openings in the walls, which are comparatively smaller in size and look plain and austere. In Melattur and Someshwarapuram, the flat brick walls are plastered and smoothly finished with lime mortar, that reflects a considerable amount of incident heat.
6.4.2 Roof

A sloping roof with tile covering, is the skyline of almost all the vernacular settlements in this region. In all the three identified settlements, two types of roof forms are seen. Both typology 1 and typology 2 dwellings have roofs with slopes in all the four directions and typology 3 dwellings have a combination of sloping roofs and flat Madras terrace roofs.

For typology 1 and typology 2, the sloping roof is made of country wood or bamboo rafters and battens, covered with two to three layers of pantiles. The sloping roof is one of the major climate responsive elements in the vernacular setting. It plays a significant role in reducing the incident heat on the surface, due to its angle of slope (30°, 35°), and in reflecting the maximum amount of heat back. The roof height near the ridges is 5m, which acts as a major insulation space and facilitates a good air flow inside. The eaves project 0.7m beyond the wall surface, so that it protects the wall from direct sunlight. As the roof height near the courtyard is very low, it allows filtered light and dissipated heat into the spaces around.

As typology 3 has a flat roof, a Madras Terrace construction is adopted. The thickness (40cm to 50cm) and the layering of different materials of the typical Madras Terrace roof, provide excellent thermal insulation. As there is no central open-to-sky space, the house depends mainly on the door and window openings provided at the front and rear walls, for letting in the air and clerestory openings at the double height central space, to let out the hot air. In this typology, the roof height is maintained as 4m to 5m in the central living space.
Courtyards have a greater impact on the thermal performance of the dwellings. It is an excellent thermal regulator in many ways. Courtyards play a significant role in the moderation of the climate in the hot summer seasons, and provide comfortable living conditions for the families. The central courtyard acts as a light well, as well as an air shaft, bringing both daylight and air circulation into the rooms around it (Dili, AS et al, 2010). Due to the incident solar radiation in the courtyard, the air in the courtyard becomes warmer and rises up. To replace it, cool air from the ground level flows through the louvered openings of the room, thus producing the air flow. During the night, the process is reversed. As the warm roof surface gets cooled by convection and radiation, a stage is reached when its surface temperature equals the dry bulb temperature of the ambient air. If the roof surfaces are sloped towards an internal courtyard, the cooled air sinks into the court, and enters the living space through the low level openings, and leaves through the higher level openings (Meir, I. A et al 1995, Anupama Sharma et al, 2003).
Figure 6.9 Air flow facilitated through the aligned openings and court

Though the size of the courtyard is very small in some houses, it helps in providing natural diffused day light to the entire house which reduces the energy consumption to a greater extent. The passage around the courtyard with proper light, temperature and air flow, acts as the space for household activities. It acts as a buffer space to filter the light to the living area.

The courtyard is also used for ablution and washing purposes. Most of the time as it remains wet, it also keeps the surrounding spaces cool. The habitable spaces are arranged around the courtyard in such a way as to permit adequate air movement in all seasons.
Openings:

A simple way to reduce the heat-gain of the building is for the windows to catch the prevailing breezes. There are two factors used in determining the openings in a tropical building; solar shade and size (Mohammad Arif Kamal 2012). Cross ventilation is of prime importance in humid tropical climates, as well as the solar protection of the roof.

Doors, windows and clerestory windows (in typology 3) are the openings in these vernacular dwellings, and they are minimal in number. They are completely wooden structures and opened depending on the occupant’s requirements. The proportions of windows are nearly 1/2. As the streets have row housing, the side walls of the structures are not provided with windows. The sizes of these openings are small which regulate the air flow, and control the amount of light entering the buildings. All the windows have
the same size in a building. The front and back door alignment with the courtyard, eases the wind flow from the exterior to the interior. The less number of openings are mainly to maintain the privacy, temperature and required lighting level.

**Table 6.1 Area and Proportion of inlet and outlet openings**

<table>
<thead>
<tr>
<th>Typology / Sample / Location</th>
<th>Position</th>
<th>Number</th>
<th>Opening</th>
<th>Size</th>
<th>Area</th>
<th>Ratio (between inlet and outlet)</th>
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<tbody>
<tr>
<td>Typology 1 T₁-SD₁-V Vallam</td>
<td>Front wall (South facing)</td>
<td>1</td>
<td>Door</td>
<td>0.9 m x 1.65m</td>
<td>1.49 m²</td>
<td>3.65 m²</td>
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<tr>
<td></td>
<td></td>
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<td>-</td>
<td></td>
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<tr>
<td>Typology 1 T₁-SD₁-M Melattur</td>
<td>Front wall (South facing)</td>
<td>1</td>
<td>Door</td>
<td>0.9 m x 1.8m</td>
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<td>Window</td>
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<td></td>
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<th>Area</th>
<th>Ratio (between inlet and outlet)</th>
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</table>

In typology 3 (Eduththukatti houses), the clerestory openings provided at the upper level, play a major role in letting out the heat and smoke, produced during Homams and other religious rituals.

Figure 6.11 Clerestorey openings in typology 3 dwellings
6.4.5 Columns / Pillars

The vertical elements (columns / pillars) located along the edge of the thinnai and the edge of the courtyards reduce the heat gain by the spaces, by dissipating the heat back to the atmosphere. In addition, in some larger houses, they create buffer spaces in between the habitable spaces and the exterior. These buffer spaces provide filtered light to the spaces around the court throughout the day, which facilitates the inmates of different age groups to use the spaces continuously for different activities at different time periods.

Figure 6.12 Columns as space defining elements around the courtyard.

6.5 INDIGENOUS MATERIALS AND TECHNIQUES

The vernacular dwellings found in this region are about 250 years old. These structures require very minimum repairs and maintenance, that too, due to the drastic change in environmental and climatic conditions. The stability and sustainability of these structures is mainly due to the materials and techniques adopted in the construction (Venkatarama Reddi, BV, 2004). In addition, the structures were created rather than built, and the people involved in the process were skilled artisans and craftsmen, who had gained the skills and knowledge from their ancestors, and practiced for years together (Nasir Uddin 2008).
6.5.1 Foundation and Walls

Flat bricks, mud and lime mortar are the predominant materials used for the construction of the foundation and walls in Thanjavur region. In addition, Laterite blocks are used in Vallam, as they are abundantly available.

The variation in wall thickness makes a significant difference in the comfort performance of houses. The rooms with thicker walls tend to be more comfortable and houses which have thick walls and are on lower floors can be comfortable all the year round, as opposed to the ones that are on the top floors.

Massing of the enclosing envelope is a parameter, that is mostly related to the thickness and type of the construction material used, and its ability to delay heat transfer through the building structure over a period of time. The thermal mass of the vernacular structures makes a significant difference in their comfort performance. The Thermal mass is the ability of high-density materials to absorb heat, retain it and then release it again slowly over time, helping to moderate the temperature fluctuations within a room. Different materials absorb and radiate heat at different rates. The thermal performance of a building envelope is determined by the thermal properties of the materials used in its construction and characterized by its ability to absorb or emit solar heat, in addition to the overall U-value of the corresponding component including insulation (Lin Borong 2004).

The vernacular dwellings in Thanjavur region have a varying wall thicknesses and construction techniques in different parts of this region. In the Vallam settlement, the outer walls of the pucca construction (Both typology 1 and typology 2) are of 60 cm thickness, consisting of composite construction having a core of flat bricks in mud mortar, lined externally with dressed laterite stone. The walls have an exposed Laterite stone surface, which works very well by absorbing the humidity, and helping the building to breathe. The inner walls are 20cm to 30cm thick made of flat bricks and mud/lime mortar.
In semi-pucca and kachcha construction, the external wall is 30cm thick, constructed using laterite stone in mud and lime mortar. In Melattur and Someshwarapuram, the walls are constructed with flat bricks and plastered both internally and externally with lime mortar, in which the thickness of the external walls are 45cm to 60cm and the internal walls are 20cm to 30cm.

Flat Bricks: High density and high strength flat bricks are made of sediment soil, as the settlements are located in the delta region. The dimensions of the brick are 8.5cm x 11cm x 4cm, and they are used in both semi-pukka and Pukka construction. They possess high compressive strength compared to the modern country bricks, and are used mostly in exterior and interior walls, and Madras terrace roof constructions.

Laterite blocks are available in abundance in Vallam and the surrounding areas, and are the major materials of construction. They are used as undressed blocks in semi-pukka construction and dressed blocks in pukka...
construction. The normal dimensions of the dressed blocks are 55cm x 10cm x 30cm (approx.).

The laterite blocks are mainly used as an external layer of the composite walls in Vallam region, within which the flat bricks in mud mortar are used as the core. The material consists of innumerable air gaps which provides high thermal insulation to the walls. For the foundation, lime and brick bat concrete is laid in a thickness of 15 cm as the base layer, and flat brick stepped footing with a depth of 30cm for each layer is done above this, and continued as the wall.

![Figure 6.15 Flat brick and Laterite block with modular brick.](image)

**Mortar:** The sediment soil is mixed with sand, water and herbal juices (jaggery or molasses, nutmeg (*kadukkai*) and amla), and ground manually to a consistency of a nice paste, which is nothing but mud mortar. This was used as the main binding mortar in both semi pukka and pukka constructions. In samples (T2- SD3-S and T2- SD6-S) in Someshwarapuram, broken pan tiles and parts of broken pots are mixed with mud mortar and used for internal plastering. Lime mortar was used in the structures which belonged to people with a higher economic status. Invariably, all the structures were plastered with lime mortar only. At the time of construction, jaggery or
molasses, nutmeg (kadukkai) juice and amla juice are mixed with the fermented lime which increases the binding nature of the mortar.

![Figure 6.16 Lime mortar and mud mortar for wall plastering](image)

**Lime:** Kankar lime is available in plenty in this region, which is the main source of lime production. Lime is mixed with sand in a 1:2 or 1:3 ratio, and ground manually. These are kept in heaps and covered on top with impermeable sheets for about 6 to 7 days. During this period, fermentation takes place inside the heaps, and the lime starts sweating. In this condition, lime can be kept for months together, and the required amount of the material can be cut and used whenever needed. After one week, the material will be ready for use in construction.

Normally lime plastering is done for exterior wall surfaces and mud plastering for the interior surfaces.

### 6.5.2 Roof

A sloping roof with tile covering is the skyline of almost all the vernacular settlements in this region. It is made of country wood or bamboo rafters and battens, covered with two to three layers of pan tiles. The roof truss is a typical detail in all the dwellings of pukka construction. The wooden beams are bent as segmental arches, and thus minimize the tension.
Country wood: consists of more fibre content, which is suitable for construction. Enn, Poovarasu and Pillai Maruthu are the local varieties of country wood, which are used in the construction of vernacular structures. They are used mainly in places where the tension has to be taken care of.

Bamboo: The semi pukka structures normally have bamboo as their chief building material in rural vernacular construction as rafters and purlins. As treated materials, these bamboo rafters exist without any damage for more than 250 years.
Country tiles (Pan/Pot tiles): Soil is mixed with clay and pressed into tiles and burnt in kilns. This is normally done by the potter community of the villages. Originally, the pot tiles were 15cm x 10cm x 1.5cm in size, with a special locking projection at its top. Later the round country tiles became common, and were used in almost all types of traditional construction. Today, Mangalore tiles are the major roofing materials in rural construction.

For typology 3 dwellings, and for structures where the upper floor is constructed, Madras terrace roofing was provided. Wooden beams would first be placed upon opposite walls across the width of the room, 18 to 24 inches apart. High density and high strength clay tiles, made to a special thin size measuring 2.5cm x 7.5cm x 15cm are used in Madras terracing. Properly mixed and matured lime mortar is used for bonding the flat tiles that are placed at an angle of 45 degrees to the wall, or diagonally across the room width. These terrace tiles, placed on the edge, ensured tensile strength. Thereafter, a 7.5 cm thick layer of broken bricks or brick bats would be laid, where nearly half the volume would be made up of lime mortar, three parts brick, one part gravel and one part sand. This layer provided the compressive strength and load bearing capacity to the roof. The final layer would be courses of flat weather-proof tiles topped by thick mortar to slope.

Figure 6.19 Madras Terrace roof and its construction detail
6.5.3 Openings

Doors, windows and clerestory windows are the openings in these vernacular dwellings. Generally, cut stone lintels were used for openings of pukka construction, and wooden lintels were used for semi pukka and mud wall construction.

Stone: As stone is not locally available anywhere in the Thanjavur region, the usage of this material is restricted to lintels, columns, bed blocks, and steps in pukka construction. The source of stone is Narthamalai, a hillock located 55 kms from Thanjavur in Pudukkottai district. The stone work is very primitive here compared to other parts of the state.

Wherever the wooden beams come into contact with a mud wall, the wooden members were wrapped with lotus leaves and tied with threads and ropes made of fibres from the stem of the lotus flowers. This never allowed the oil content in the wood to be absorbed by the mud walls.

Advantages of the traditional construction techniques:

1. The major elements of traditional construction are compression members.

2. Tension is very minimum in the structures (2-3%), and is taken care of by the wooden members.

3. The usage of herbal juices increases the binding nature of the mortar and strengthens the structures.

4. No structural element is continuous as the load is passed through the centre of gravity, and assembling the components is very easy.
5. To prevent moisture entry through capillary action, stone bed blocks are used, where the wall and roof meet.

6. The use of lime reduces the setting time and thus increases the longevity of the structures.

6.6 SUMMARY

The interaction of solar radiation with the building is the source of maximum heat gain inside the building space. The natural way to cool a building is to minimise the incident solar radiation, by the proper orientation of the buildings, adequate layout with respect to the neighbouring buildings, and by using proper shading devices, to help control the incident solar radiation on a building effectively (Anupama Sharma, et al 2003).

Traditional vernacular architecture exhibits a variety of building designs suited to the respective climatic conditions.

The two types of thermal loads are reduced effectively to achieve passive cooling in vernacular buildings by the following methods:

Flexibility in activities contributes to the reduction of internal heat gain. No fixed arrangement is maintained inside, and continuous usage of different spaces for different activities facilitates the reduction of internal heat gain further.

Thick, solid composite walls which are shaded by overhanging and neighbouring buildings, sloping roofs and thick Madras terrace roofing, with layers of different materials, reduce the external heat gain.
## Table 6.2 Solar Passive Techniques used in Vernacular Dwellings

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Architectural aspect</th>
<th>Solar Passive Features</th>
<th>Effect</th>
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</thead>
</table>
| 1.     | Settlement planning  | ● Compact, moderate density and low rise development  
● Grid iron layout with Wide streets in east-west orientation  
● Row housing (with side lane in Vallam settlement)  
● Presence of a water body within the settlement | ● Less exposure to direct solar radiation and thus reduced heat gain during summer and heat loss during winter.  
● Protection of longer sides of the built forms on the east and west side due to row housing. |
| 2.     | Built form and orientation | Linear houses with north-south orientation | ● Reduction of incident heat on the exposed surfaces  
● Enhanced air movement  
● Defined activity spaces with various degrees of filtered lighting level. |
| 3.     | Building components  |                         |        |
| i.     | Walls                | 60 cm thick, solid composite wall using flat brick core with laterite stone lining.  
60 cm thick solid flat brick walls with lime mortar plastering | ● Reduces external heat gain due to the thickness and the materials used.  
● Exposed laterite stone surface work very well by absorbing the humidity and helping the building to breathe.  
● Reflection of incident heat due to the polished surface and reduces external heat gain due to the thickness. |
| ii.    | Roof                 | Sloping on all the four directions with country tile covering | ● Reflects most of the solar radiation back to the atmosphere  
● Dissipates the heat due to surface undulation  
● Provides an excellent insulation with three layers of tile covering with air space below.  
● Increased volume of the space due to the height at the centre increases the thermal comfort conditions |
Table 6.2 (Continued)

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<tr>
<td>i.</td>
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<td>ii.</td>
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<td>iii.</td>
<td>Courtyard</td>
<td>Alignment along the axis with door openings. Sunken floor level to dissipate heat</td>
<td>• Due to the incident solar radiation, the air in the courtyard becomes warmer and rises up and cool air from the exterior flows into house thus producing the air flow. • Allows the cool air to sink into the court as the roof surfaces are sloped towards the courtyard and enters the living space through the low level openings.</td>
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<td>iv.</td>
<td>Openings</td>
<td>Minimum number of small window openings with projecting roofs and eaves. Low level openings due to Raised plinth and projecting eaves. Doors aligned along the axis through courtyard. Clerestory openings in double height central space (Typology 3 houses)</td>
<td>• Direct entry of heat through window openings is minimized and allows required amount of light. • Entry of cool air through the openings from exterior as well as from inner open courtyard. • Axial alignment of openings facilitates easy air movement through the interior. • Let out the hot air and smoke (during rituals) easily.</td>
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<td>v.</td>
<td>Buffer spaces</td>
<td>Filtering the natural light both from exterior and the internal court.</td>
<td>Provides different grades of filtered light to the interior spaces. Makes the user to get adjusted to the indoor environment when he enters the house from bright sunny exterior.</td>
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<td>vi.</td>
<td>Columns / Pillars</td>
<td>Row of wood or stone columns (as both structural as well as functional elements) provided along the building edges both internally (courtyard) and externally (Thinnai).</td>
<td>Dissipates the incident solar radiation and the polished surfaces of the columns reflects the heat back to the environment.</td>
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<td>vii.</td>
<td>Shading Devices</td>
<td>Eaves projection in the front and the rear part of the buildings and into the internal open courtyard.</td>
<td>Protects the exposed surfaces in the front and back from direct solar radiation by shading the walls thus reducing the heat gain considerably.</td>
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