CHAPTER 4

QUALITATIVE ANALYSIS OF TRADITIONAL AND MODERN BUILDINGS IN THANJAVUR REGION

INTRODUCTION
Natural and passive cooling methods for buildings can improve indoor environment quality; provide thermal comfort and reducing energy consumption in buildings. As a result, the study of natural and passive methods for controlling indoor environment has gained more and more attention in recent years. The qualitative analysis of traditional and modern buildings in Thanjavur region is aimed to investigate the characteristic features of energy efficient solar passive architecture to check the appropriateness and applicability of these principles in the present conditions to create pertinent buildings to the context.

Traditional houses in Thanjavur region can be classified under two types:

Type – 1  
(a) Houses with central courtyard  
(b) Houses with courtyard on one side

Type – 2  
(a) Houses without courtyard having tripartite divisions  
(b) Houses with raised ceiling (double height) central space – Eduthukkattu or atrium

Traditional buildings from the settlements of Vishnampettai, Ariacheri and Pazhamarneri of Thanjavur district are taken for qualitative analysis and to extract solar passive architecture features incorporated in it. The distance of these traditional settlements located within the district from Thanjavur to Vishnampettai is 29 km; Ariacheri is 42 km; and Pazhamarneri is 20 km. Identified houses are more than 100 years old. Traditional buildings in this region are mostly of single storey with tiled roof structures except a few.

Four traditional houses selected for the qualitative analysis are

- A house with central courtyard at Pazhamarneri village (Type -1a)
- A house with courtyard on one side at Ariacheri village (Type -1b)
- A house with raised ceiling (double height) central space (Eduthukkattu or Atrium) at Vishnampettai village (Type -2a) and
4.1 BUILDING COMPONENTS IN TRADITIONAL HOUSES IN THANJAVUR

4.1.1 Orientation and Planning

The built forms of the traditional houses found in Thanjavur region are linear rectangular plans. To facilitate continuous air movement inside the building, the main front door and the rear openings of the traditional buildings in this region are aligned with courtyard or atrium on central axis or shifted axis. The traditional houses in this region are usually oriented along North – South direction and the streets are oriented along East – West direction. The longer side walls of the building are mutually shaded by adjacent buildings or wall to wall construction. All the three settlements, Vishnampetttai, Ariacheri and Pazhamarneri are inhabited predominantly by Agrarian community. The East - West oriented streets are mainly used for drying agricultural produce during daytime and social activities take place in shaded outdoor area during evening times.

4.1.2 Courtyards and Atrium spaces

Another important space in the traditional buildings is the courtyard. It is called Haveli in North India, Rajbari in West Bengal, Wada in Maharashtra, Deori in Hyderabad, Naalukettu in Kerala and Muttram in Tamilnadu. Air movement is helpful in achieving thermal comfort. The air movement, in combination with air temperature, will affect the rate at which warm air or vapor is taken away from the body thus cooling the body temperature. This philosophy is found to have been applied in the traditional interiors in the form of courtyards and atrium spaces, in an effective manner. Courtyards of varying sizes and double height space with clerestory openings (atrium) have a greater impact on the thermal performance of the traditional houses of this region. During hot summer courtyard plays a vital role in providing comfortable indoor for the inhabitants. These central or side aligned courtyards and high ceiling atrium spaces act as a light well, bringing adequate daylight and air into the rooms around it as shown in Figure 4.1 and Figure 4.2. When the warm air rises up through these openings, fresh cool air flows through door and window openings for replacement. During nights, the cool air sinks into the court and enters living space and leaves through the higher level openings.
Though the size of the courtyard is very small as in certain (Ariacheri) houses, it helps in providing natural diffused day light and adequate air flow in all seasons. Narrow courtyards are prominently seen in these houses. It acts as a good thermal regulator in many ways.

![Figure 4.1 Courtyards in various traditional houses at Ariacheri and Vishnampettai](image)

The control of convective heat flow is an important aspect of traditional architecture of Thanjavur region. The internal verandah around the courtyard protects the court from receiving direct sunlight there by reducing the heat gain through the solar radiation. This helps to maintain the internal court with lowest temperature. The effect of air movement on human thermal comfort becomes critical depending on the air temperature and relative humidity.

The warm air from outside that is pulled into the interiors becomes cooler during its gentle flow towards the interior spaces as it interacts with the cooler internal surfaces and the cold air deposition in the courtyard. The total air volume in the interiors is reduced by providing low room height. The cold air deposited in the courtyard during night will be
sufficient for conditioning the total air in the interior throughout the day since the indoor air is maintained at a lower temperature, a gentle (controlled) air flow is sufficient to provide thermal comfort to the occupants.

Figure 4.2 Houses with high ceiling central space at Vishnampettai

4.1.3 Fenestrations

Different types of openings found in traditional buildings of this region are doors, windows, ventilators, openings at higher level like the clerestory windows and double height ceiling as shown in Figure 4.3.

These fenestrations serve as passive cooling elements by providing adequate cross ventilation. All the openings in the traditional buildings are the key factor for solar passive design techniques towards achieving climate responsive buildings for thermal comfort. The building system with proper / required window openings induces a controlled and continuous air flow inside the building. Air flow is important for thermal comfort and to prevent dead spaces inside the building. The position of window sill is kept at low level (45 cm from floor level) to induce better air circulation inside the
building. Thus the natural ventilation is promoted in traditional dwellings providing thermal comfort as noted in several researches.

Figure 4.3 Different types of openings incorporated in traditional houses at Vishnampettai

4.1.4 Buffer spaces (Attic space, Verandah space around courtyard, Thinnai)

The sloping roof or lean to roof is projected beyond the building edge to protect the wall surfaces from rain water and protects the buildings from direct solar radiation. Hence, the wall surface is protected from radiation and avoids heat gain considerably. 

*Thinnai* (Patio) are needed in east or west facing houses in order to shield the interior from direct solar radiations. All these traditional houses have recessed *Thinnai* protecting the front facade from harsh summer solar radiations and are shown in Figure 4.4.
Figure 4.4 Traditional Houses at Pazhamarneri and Vishnampettai with roof overhang in front at Thinnai space

In addition to these roofs which are mentioned above, there is an attic space (a loft) of height about 3’ to 4’ also called ‘Paranai’ (a structurally stable false ceiling). False ceiling arrangements are present in most of these houses to minimize the heat gain during daytime. These are normally constructed below the sloped roofing or below the lean to roofs or in the areas of passages and rooms. These are supported by the wooden beams which connect the rafters as a tie member. This reduces the heat transfer significantly and acts as an air trap and this construction technique can very well be considered as a good passive cooling construction technique. The Paranai is normally used to store old or used or unwanted household items.

4.1.5 Building envelope

The traditional structures have thermal mass in the building envelope that makes a significant difference in comfort performance. This thermal mass absorbs heat, retains it and then releases heat slowly over time, which helps to moderate the temperature.
fluctuations within the building. Roof and walls form the building envelope which protects the inhabitants from the harsh exterior climatic conditions.

4.1.5.1 Roof
The roof system with a combination of air cavities within the clay tiles and well ventilated attic space insulate the building from conductive and convective heat flow through the roof.
Sloping roof plays a vital role by its form, exposure and angle of the slope in reducing the incident solar radiations and in reflecting the maximum heat by proper insulation. Pazhamarneri and Ariacheri houses have roofs with slopes on all directions. Certain houses at Vishnampettai have a combination of sloping roof and flat Madras terrace roofs.
The roof height is very low near the courtyard and at the ridges, it is high which offers good insulation space; it allows filtered light and air movement into the spaces around.
Flat Madras terrace roof construction with 40 - 50cm thickness and layers of different materials offers excellent thermal insulation
The roof height is 10’ (3.2 m). The sloping roof is made out of country wood, bamboo rafters, battens and purlins with three layers of country pan tiles covering it as shown in Figure 4.5. Wooden roof truss with segmental arches are used in these houses. The slope roof is made of handmade terracotta roof pan tiles which are laid in three courses. This three layer terracotta tile is thermally designed and constructed in such a way that they are laid one above the other with minute air gaps in between so as to allow hot air to escape.

Figure 4.5 Traditional houses at Vishnampettai having sloping roof made of country wood and rafters
4.1.5.2 Walls

The traditional building system is highly insulated against conduction. The walls are thick, heavy and solid with varying thickness and construction techniques, which provide high thermal insulation as building envelope.

![Figure 4.6 Traditional houses at Vishnampettai with Lime plastering finishes on flat bricks masonry](image)

Flat bricks, mud mortar and lime mortar are the predominant materials used for the construction of foundation and walls in Thanjavur region as shown in Figure 4.6. External wall thickness is 30 cm to 60 cm and the internal walls are 20 cm to 30 cm. The dimensions of the high density and high strength flat bricks are 11cm (L) x 8.5 cm (B) x 4cm (H).

The outer walls of the (Type 2) houses at Vishnampettai have a wall thickness of 60cm, consisting of composite construction having flat bricks masonry with mud mortar, lined externally with dressed laterite stone. Laterite stone consists of innumerable air gaps which provide high thermal insulation to the walls. The exposed laterite stone surface helps the building to breathe by absorbing the humidity as it is porous in nature.

4.1.6 Materials and Construction techniques

For the mud mortar, the sediment soil is mixed with sand, water, jaggery, haritaki (*kadukkai*) and amla, which is ground manually to a nice paste and is used as a binding material. Normally this mud plastering is used for interior surfaces and for masonry walls as shown in the Figure 4.7.
4.2 BUILDING COMPONENTS IN MODERN HOUSES IN THANJAVUR

Two modern buildings in Thanjavur region are taken for qualitative analysis. These modern buildings are less than ten years old. When the modern houses are analysed, it is found that no special techniques or materials are used. Modern houses exhibit a poor stack effect because the average height of the building is only about 10’ (3 m) high and also has no roof level ventilators. This causes hot air to accumulate at the lower portion of the building. The search for climate responsive aspects have been investigated and found that these modern buildings do not possess climate responsive principles and hence lacks thermal comfort. The qualitative analysis of modern buildings in this region shows that:

- Building orientation is not with respect to wind movement or sun movement. Improper spatial arrangement leads to heat transmission from one space to another space.
- Difference between outdoor and indoor temperature is not evidently felt when someone enters the house from outside in hot summer.
- The normal brick masonry wall of 9” (23cm) thickness was used with cement mortar plastering. As the thickness of the brick wall, is only 9”, it is not possible to arrest the radiation and hot air movement inside the house. The thermal time lag is found to be low and as a result building enclosure fails to filter the outside temperature entering inside the house. The design of the building envelope with respect to climate design is not seen in any part of the modern houses.
• As the building envelope allows heat radiations into the modern houses the indoor temperature goes higher. The radiated heat gets trapped inside these spaces without any possibility either to escape outside or to cool down. Poor stack effect results in stagnation of hot air.

• The doors and windows are located at certain places with disproportionate to the size of the rooms resulting in poor ventilation. Also, due to lack of adequate openings as shown in Figure 4.8 and 4.9, the lighting is found inadequate resulting in the use of artificial light during day time itself.

• Loss of heat sink process and absence of cross ventilation is due to improper provisions of openings. Hence, the heat retained inside the building creates a thermal discomfort for the inhabitants, especially during the peak summer season. When the temperature rises, people experience a poor thermal comfort resulting in usage of fan, air conditioners, air coolers and other electromechanical devices.

Figure 4.8 Living room of a modern house at Ariacheri
Figure 4.9 Modern house at Thanjavur showing usage of artificial light during day

4.3 SUMMARY

This investigation on qualitative assessment of climate responsiveness of the traditional buildings in terms of indoor thermal comfort reveals that an effective passive cooling system is embedded in the traditional architecture of Thanjavur region. From the observations; it is also understood that the basic planning principles, construction techniques, designing features, material applications and building orientation are found to be similar in most of the traditional houses selected for the study.

The entire qualitative assessment towards understanding the climate responsive architecture of the modern houses reveals that, these buildings are designed without considering climate design recommendations. Factors such as site characteristics, orientation and architectural design of the building, choice of building materials, etc. are not given enough importance. As a result, modern buildings provide poor thermal comfort. The design factors of modern buildings are more focused on artificial means of creating thermal comfort. It is evident that the natural means of passive cooling techniques are not been considered at all.

From the qualitative analysis, it is evident that the traditional buildings are built with climate responsive techniques and their knowledge in bringing down the external temperature inside the houses is highly appreciable. So, it is understood that the modern buildings need to depend upon the artificial cooling means, unlike the traditional houses that possess thermal comfort naturally on its own without any artificial means.