International Journal of Engineering & Technology, 7 (3.34) (2018) 624-630

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Functional Adaptability Essence of Hindu Rituals and Architectural Elements of Traditional Domestic Buildings in Kerala: Excerpt from the Vedas

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Abstract

The four knowledge texts of Hindu religion known as Vedas mainly include praises to God, daily rituals and other aspects such as Medicine, Architecture, food habits, personal duties etc. The paper enumerates the various codified principles of food intake during various seasons and daily rituals adopted by a Hindu in ancient Kerala. The author tries to find the importance of thermal balance of the human body that has been maintained through these codified living habits of a Hindu in Kerala which are based on the Vedas. The paper also inevitably looks into the thermal properties of building and architectural elements described in the Vastusastra which are practised in the traditional Hindu domestic buildings in Kerala state in South India. The paper concludes by stating that the food habits, rituals and building construction methods practised according to Hindu customs of Kerala closely link to the original Vedic texts. Most importantly these sustainable practices were found to suit the adaptability of humans with the climate pattern of coastal Kerala towards attaining thermal comfort.

Keywords: *Ayurveda, Food Habits in Kerala, Vastusastra, Traditional Houses of Kerala, Thermal Comfort*

1. Introduction

The state of Kerala is a strip of land in South-Western part of India with an area of 38,863 sq. km. extending across longitude 74^0 52' and $77^0$24' E and latitude 8^0 17' and 12^0 47' N. Its altitude ranges from maximum of 2695 m. to -2.2 m. with respect to sea level. Across the coastal Kerala, climate experienced is warm humid with the temperature ranging from 19.8^0 C to 36.7^0 C and the rainfall ranges from 1520 to 4075 mm.

Numerous existing research show that in Kerala, the Hindu community has followed Vedic texts in various fields such as Medicine, Architecture, daily rituals etc. It is the inherited knowledge passed on through generations which came into practice by Hindu civilization.

A few layouts of traditional domestic buildings of Hindus have been analysed in this paper with respect to the spatial, functional and religious aspects. The human comfort considerations associated with these dwellings are enlisted along with the details of food habits. When the aspects like personal duties, food habits, building materials, construction methods etc. are compared with contents in the Vedas, its relevance in the living pattern of traditional Hindus is clearly observed.

2. Hindu Origin in Kerala State

Kerala in South India is known to have been inhabited originally by Hindu Brahmins in the protohistoric period though Budhists and other religions soon started migrating. Nonetheless the region was under monarchical system ruled by Hindu Perumals [1].

The existence of traditional domestic buildings that are chosen by the author dates back to have built in 18^{th} century AD. Every case study belongs to rich cultural heritage of Hindu community. History of the demography of the region emphasizes the fact that the knowledge of traditional construction methods have been handed over to generations from ancestors of the Vedic era. This fact has been stated by the author after looking into the construction details and planning principles laid down in the Vastusastra and comparing with the methods followed in the traditional construction of Kerala houses by local artisans and carpenters.

As per the census of India 2011, issued by the Office of the Registrar General & Census Commissioner of India, Ministry of Home Affairs, and Government of India; the details on population density and number of houses with tiled roof are enlisted in Table 1. Kerala was found to have a population density of 860 per sq. km. in the year 2011. In the same year 55% of the total population in Kerala were following Hindu religion. It is also noted that out of the total number of houses used by all religions, only 3.5% of houses were having handmade tile roof [2]. This shows the replacement of major amount of traditional buildings with the newly constructed modern concrete houses.

Table I: Census Details Of Kerala In AD 2011

Data on Items	No. of persons or Items/No. of persons in sqkm.
Total Population	33406061
Total Hindu Population	18282492

Population Density	860
Total No. of Houses	9,935,155
Total No. of houses with tiled roof	332,763

3. Daily Routine and Religious Practices of Hindu in Kerala

Traditional courtyard houses called 'nalukettu' are taken into consideration for enlisting the daily activities (Fig.1).

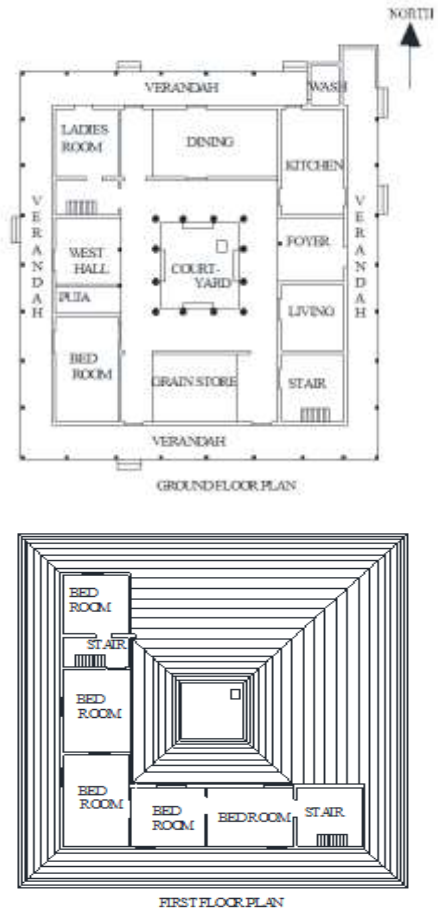

Fig1: A Rough Sketch Of Internal Layout Of Typical Nalukettu

Normally women get up earlier than the men at home before sunrise. Bedrooms are located in the southwest or the west. During the night time predominant wind in summers happens in this direction unless any other microclimatic element change its direction. Toilet is normally a detached structure outside the house on the northwest corner. Brushing teeth is done normally in and around northern verandah. Few houses have a pond and bathrooms on the property of the site (Fig.2).

Fig. 2: Pond along with Bath houses in the compound of a Nalukettu of Kerala

After bathing it is time for prayers. The room for worship is located on the western side of the courtyard. This is normally small and remains closed when not used. The lady of the house lights up the oil lamp and brings it to the front verandah on the eastern side and sometimes kept near the basil plant in the inner courtyard.

Men use the front verandah for sitting and reading in the morning. These verandahs face east side where the mild sunrays hit in the early morning. At around eight o'clock in the morning all the members in the family move to the dining room which is on the north or north western side very close to the kitchen which is on the north eastern side. Another small room will be on the north western side exclusively for ladies to use during special occasions like birthing etc. This has access leading outside. This orientation is as stated in Ayurveda [3]. North or north eastern side more or less remain cool in hot summers and therefore this area is best suited for ladies to spend and work during the daytime.

Living room is normally on the south-eastern side where the guests are entertained. Some bedrooms are placed on the upper floor which can be accessed by wooden staircases on southern and northern side. Men use the southern staircase and ladies use the northern one.

The courtyards are generally planted with either basil or jasmine plant in the centre on a raised platform, the leaves or flowers of which is used by ladies to keep on their hair after bathing (Fig. 3).

Fig. 3: Courtyard of a typical traditional Nalukettu of Kerala

Another room is the 'ara' or granary which is used for storing crops like rice inside a wooden tank called 'pathayam' after harvesting (Fig. 4). This is normally placed on the western or southern side of the courtyard. Due to this orientation the stored food do not get affected by fungus due to the proper temperature and air flow. 'Onam' and 'Vishu' are the two harvest festivals during which the main activities or art forms take place in the courtyards as well as outer yards around the high plinth where people sit down and enjoy.

Fig. 4: Pathayam or granary to store rice

The southern side of the house plot is for cremation of any member in the family after death. A raised platform called 'thara' will be constructed where the dead body has been cremated. This is because it is believed by Hindus that the God of death situates

on the south side. The south end of the plot is always left unbuilt of any structures and gets more sunshine. Normally after cremation of the dead body the ashes are buried only on the third day. Therefore due to the availability of favourable solar radiation, south side is most suited.
The author lived throughout her life in the village of Thalassery in northern Kerala where she acquired this knowledge listed above since childhood. Nonetheless the same was found recorded by Melinda A. Moore in her papers [4,5]. These houses functioned as explained above nearly three decades ago. Later due to carrying out proper education, every member in the family started migrating to towns in search of better jobs other than agriculture. So this natural setting has started completely vanishing from the scene including the demolition of these traditional houses.

4. Analysis of Food Habits of Hindu with Reference to Ayurveda

The four Vedas describe about the food habits applicable for different seasons and it has been found that traditional dishes of India are based on this knowledge [6]. According to the ancient sacred book, the Bhagavat Gita, foods are classified into three divisions such as Satvika, Rajasika and Thamasika [7]. Satvika foods contain vegetables, fruits, milk products etc. Hot, sour, spicy and salty foods are categorised under Rajasika foods. Meat, liquor etc. fall under Tamasika foods which are mentioned as unhealthy and intoxicating [6]. Meanwhile Ayurveda classifies foods as wholesome and unwholesome. According to this, certain non vegetarian foods such as meat of antelope, quail etc. and fish as Rohita come under wholesome variety along with cereal, pulses, milk products etc. and are considered as best foods [3].
The food habits followed in Kerala have some seasonal variations so as to suit the prevailing climate. This is as specified in the texts of Ayurveda [3] and is handed over traditionally through generations. Majority of Hindus in Kerala consume meat and fish. Nonetheless for all functions and festivals, Hindus consume only vegetarian food. The main course of meal in Kerala which is called Sadya (Fig. 5) in its present form was instituted by King Marthandavarma of Travancore Dynasty in the 18th Century AD [8].

Fig. 5: Sadya, Kerala lunch (feast)

The food intake consumed by a Keralite per day consists of good amount of cereals and pulses along with vegetables, fruits and spices. Dairy products are inevitable among them. When the nutritive value is taken into account we see that these items are rich in carbohydrates and provides a lot of energy [9]. The primary items of fermented food and beverages are also very vital and healthy [7].

5. Traditional Domestic Buildings in Kerala: Analysis with Respect to Vastusastra

5.1 Construction Materials and Methods

It has been observed that the walls are generally lime plastered. The traditional flooring is of red oxide. The roofing comprises of clay tiles laid over beautifully crafted strong wooden members. The plinth (basement) is a raised platform around 45-90 cm. above ground level and projects outward the wall line all around the exterior. The plinth is polished with red oxide on the vertical and extended floor surface. The wall surface is whitewashed unless made of exposed laterite or at times is decorated with wooden panelling.
The materials used for construction normally depend upon the availability of resources in that particular region of the houses. Sometimes the materials chosen are according to the property of surviving the adverse effect of microclimate. For example, the timber walls of residences in Kuttanad in South Kerala feature how the decay due to dampness is tackled [10].
The residences, especially those which were built before the first half of 20th century AD, were built on sites having good topography and firm, strong soil conditions. The foundation and plinth are made of dry packed random rubble masonry or laterite masonry in mud mortar (Fig. 6). The materials for walls were mostly laterite masonry or clay brick.

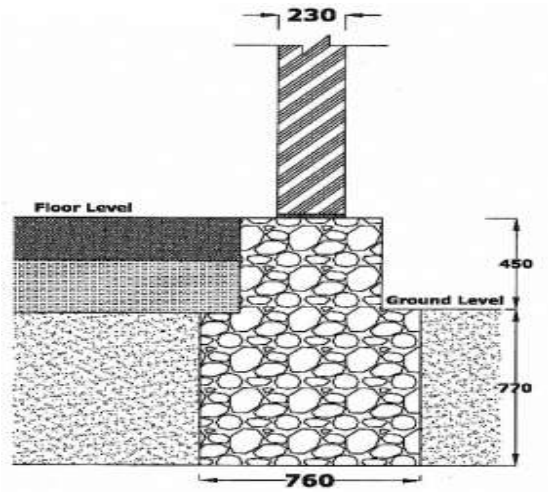

Fig. 6: Foundation and plinth in random rubble

Laterite is an abundantly available material in most parts of Kerala which contains iron oxide content. After the top soil is removed, the laterite stones are cut into desired sizes from the quarry which are again chiselled and polished at the time of construction. When these cut stones are left in contact with air its strength is increased [11].
The mud used for making the bricks is good, clean, clayey soil. After the removal of dirt and debris, soil is treated with vegetable extracts as per the traditional knowledge of localites. It is set in wooden moulds of proper sizes and then baked in kiln for 15 days. This was done as specified in ancient Sanskrit texts such as Silparamam and Vastusastra [11].
All openings such as doors, windows etc. and jally works near balcony (Fig. 7) [12], roof support for tiles, false ceiling and panelling on the walls are always made of wood in traditional houses in Kerala. Big sapless trees like Teak, Jack wood, Deodar etc. which are strong throughout the cross section are used for all these woodwork [13]. After felling the tree, it undergoes yearlong seasoning before the carpentry work is started.

Fig. 7: Wooden screen-jalli work (Source: Thirumaran, 2017)

The roof tiles and tiles for false ceiling are made out of clay which was regionally called 'thamraphulla'. The clean clay is extensively treated with series of application of vegetable extracts for almost 90 days. After this it is baked in kiln by making into required size and designs. Some of the designs are given in Fig. 8 [14].

Fig. 8: Various Roofing Tiles (Source: www.designclinicsmsme.org)

Different types of calcium containing shells and strong pebbles are powdered and made into a paste using jaggery water, sand and vegetable extracts to make mortar to apply on the walls [11].

5.2 Planning Principles According to Vastusastra

Any shape of site is checked for the maximum size of square it can hold, as shown in Fig. 9. A size between 3.84 m.x3.84 m. to 7.68mx 7.68m is considered to be small. Such sites need not be divided again, instead the whole area can be utilised for house construction [15].

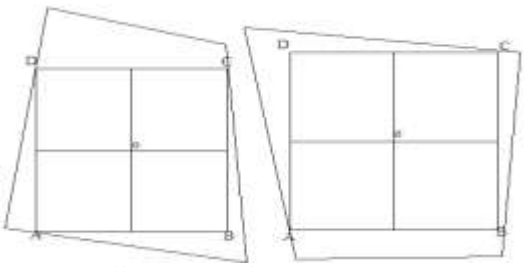

Fig. 9: Different shapes of sites with the squares marked in it

The maximum possible size of square is marked on the plot. This can extend over 46.08 mx 46.08 m. and can exceed upto 92.16 m. x 92.16 m. Depending on the size of this square, it needs to be again divided by 4x4 columns or 9x9 columns as shown in Fig. 10. The central portion of the plot towards north east which is marked PQRS is the ideal location for buildings. Sometimes in large plots the building can be extended inside PTUV in large plots. This ideal location for house construction is called Vastukshetra [11].

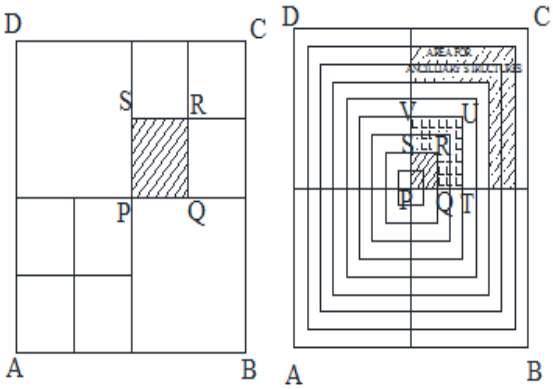

Fig. 10: Methods of dividing the plot to find the buildable area

Area of Vastukshetra is again divided into either 4x4 or 8x8 or 9x9 or 10x10 as shown in Fig. 11. This is to find the exact location of the houses. The hatched portions in the figure are considered to be suitable for building houses [11].

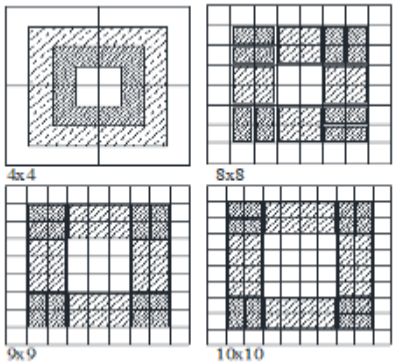

Fig. 11: Division of Vastukshetra showing house locations

5.3 Types of Traditional Houses with Reference to Vastusastra

Inside Vastukshetra, house can be constructed only along the paths as shown hatched in Fig. 11. Single hall structure or Ekasala as shown hatched in Fig. 12 can be given on any one of the cardinal direction.

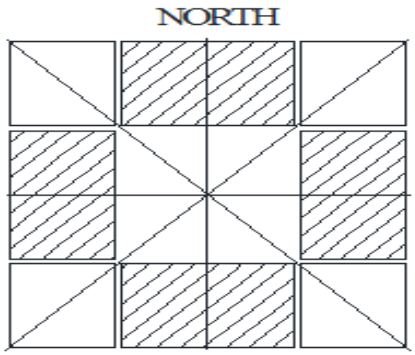

Fig. 12: Options of position of Ekasala

Layouts of Dvisala (two halls) are as shown in Fig. 13. Out of the options shown, South west is most preferred due to spiritual beliefs. This is also found suitable due to proper availability of wind which is favourable in warm humid climate.

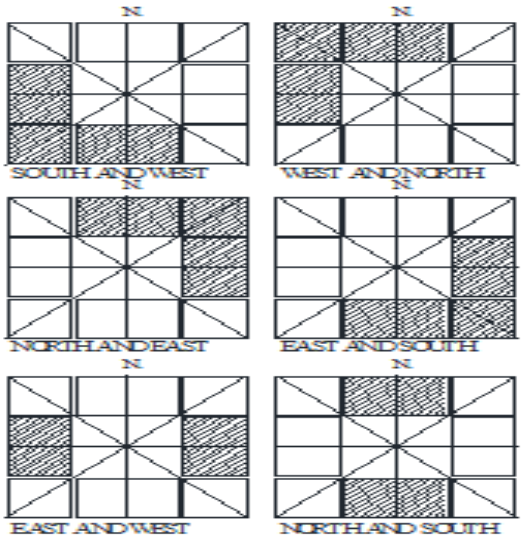

Fig. 13: Arrangements of position of Dvisala

Trisala is combination of 3 halls on any three directions of the open court as shown in Fig. 14.

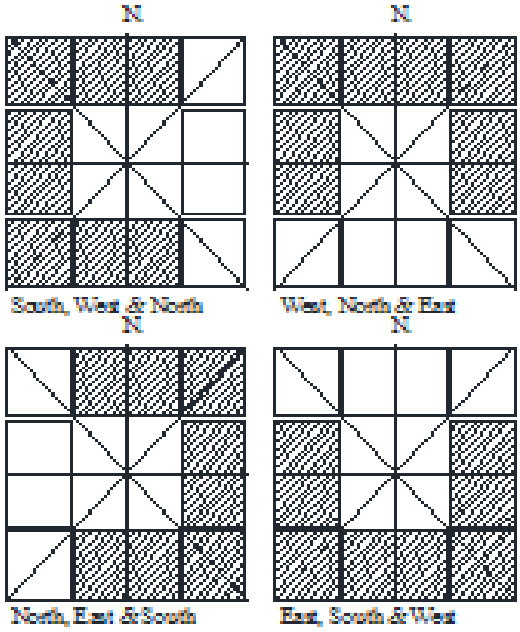

Fig. 14: Arrangements of position of Trisala

Catusala or nalukettu is house around an inner courtyard which belonged to the wealthier sections of the society. The arrangement of the house can be as shown in Fig. 15. Layout of rooms is more or less similar to the layout shown in Fig.1. According to the ancient Sanskrit text Mayamata, north side is for house of pleasure, east side for food, south and west for wealth and grains [10]. Sometimes these nalukettu houses, if built on vast site, will have additional ancilliary structures such as grainhouse, bathhouse, temple, toilet and gatehouse in the form of Ekasala [16]. The location of these ancilliary structures is shown hatched in Fig. 10 in the 9x9 division of large plots.

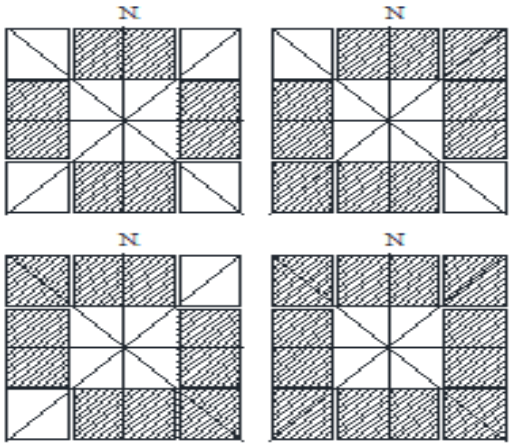

Fig. 15: Arrangements of position of Catusala

6. ENERGY Efficiency Aspect of Specifications in Vedas

When chemical compositions of each of the traditional foods of Kerala are considered every item is rich in moisture, carbohydrates, protein, fat, fibre, Calcium, Iron, Sodium, Potassium and Vitamin C [17]. Coconut is a main ingredient in almost all dishes in Kerala. Every 100 gm of fresh coconut gives an energy value of 444 Kcal. [9].

In Kerala the main discomfort parameters due to climate are high humidity, high temperature and cyclones. The design elements which increase favourable situations for indoor climate are high thermal walls, low thermal roof, high opening ratio, high shading coefficient, stack ventilation in courtyard, evaporative cooling due to vegetation etc. [18].

The traditional building materials and methods in Kerala provide high insulation value due to low conduction. There is an air gap which sometimes acts as an attic between false ceiling and roofing tiles. This gives additional thermal insulation indoors [19].

While in summer the diurnal variation in temperature was noted 12^0C, the corresponding indoor temperature was noted as only 4^0C. According to the experiment conducted by A.S. Dili et. Al, while there was a high air movement outdoors equivalent to 3.5 m/s, the indoor air movement was found at a comfortable level of 0.5 m/s. Relative humidity is also found as maintained much lower than outdoor RH [20].

Burnt brick wall and laterite masonry along with plastering and without any insulation were found to have high decrement factor (0.45-0.46) and lower time lags (6.93h & 6.37h) [21].

Table IIi: Qualitative Aspects of Design strategies in Traditional Houses

Climatic Feature	Description of Strategies Used	Images
Heavy rain in the months of June to September	Steeped roof of 22.5^0 slope keeps the rain away from the building. Deep eaves provide high shading coefficient. High bases of walls prevent humidity.	
High Solar Radiation on West and South side	Wide verandah all around the building to keep away direct sunlight Air gap/ Attic in roofing	
High Average Temperature in summer months and high humidity	Brickwall masonry of time lag (6.93h to 6.37 h)and decrement factor (0.45 to 0.46). Courtyard that enhances stack ventilation Tall trees around the building with high foliage which aids evaporative cooling Overall colour of the building kept light for minimizing heat absorption. Lime plastering and red oxide flooring for low conductivity.	
Comfortable wind (3.5m/s) and Harsh sun in the South West side	Kitchen in the North East for easy dissipation of cooking heat. Grain store in the South West to avail more breeze to avoid fungal attack. Sufficient number of openings and courtyard enhance proper ventilation by capturing the wind.	 

		
Bright daylight	Lots of openings provided for natural lighting.	

7. Comparison of Traditional and Modern Houses

In an experimental study conducted by Vijayalakshmi Akella on thermal performance of traditional and modern residences in Kerala it was found that there is an increase of almost double the value of heat load per watts indoors in modern houses[22]. The following table shows the positive design aspects of traditional houses which are advantageous over common concrete modern houses in thermal comfort point of view.

Table IIIi: Built elements in Traditional houses for Climatic Comfort

Built Elements	Traditional Houses	Modern Houses
Wall thickness	Up to 45 Cm.	Generally 23 Cm.
Roofing Materials	Clay Tiles over Wooden Purlins	Reinforced Cement Concrete
Roof overhangs	Wide	Small sunshades
Openings	More in number	Less in number
Other Relevant Design Features	Wide Verandah and Courtyard	Almost nil

Surface colour of traditional houses is always given light or white which has higher emissivity [23]. East west orientation of traditional houses with wide verandahs keeps away the intense solar radiation and house remains cool. In modern times the daily routine of people have completely changed and the lesser trend in the market to follow the traditional construction techniques have brought concrete buildings which elevates the atmospheric temperature.

8. Discussion on Comfort Aspect in Traditional Houses of Hindus in Kerala

The buildings situate on more or less flat sites which avoid the occurrence of ill effect of natural calamities to a great extent. The plots for house construction were selected only if there is vegetation in the site so that there is abundant supply of water when a well is dug.

The big trees planted all around the house give a total coolness to the site with complete shade and protection from solar radiation. According to the Vastuvidya there are some advices on types of trees to be planted on every cardinal directions of the house such as Ficus Religiosa and Astonia Scholaris on the western side, Ficus Racemosa and Tamarindus Indica on the southern side, Mimusops Elengi and Ficus Bengalensis on the eastern side and Messua Nagasarium and Ficus Microcarpa on the northern side which are planted for prosperity [24].

The external verandahs, which are the main activity centre during the daytime, give protection from rain and sun due to its low eaves.

The materials used for construction being provided from local resources reduce the embodied energy. Aesthetical comfort has been established by the overall proportion of the building and also each architectural element is set with proper scale and colour.

The arrangement of all rooms enhances the thermal comfort mainly due to its cardinal location and facilitates many functional advantages such as capturing the wind flow in verandahs; aiding cross ventilation in rooms due to proper position of openings; lowering the heat of fireplace since given in the north east; big shaded trees around the house especially on the western and southern sides etc.

For a modern man the house is not ergonomically comfortable who may find openings at lower level, rooms with low ceiling, smaller size of rooms etc. But in earlier times this was apt since the activities of occupants were happening near the floor level including cooking, sitting, dining, sleeping etc.

Courtyards present in the centre of the house provide cooling indoors due to stack effect. The air flow happening just beneath the roofing to and from outdoors due to an air gap along wall plate maintains moderate temperature and humidity indoors.

Materials such as timber, stone, red oxide, lime plaster etc. are visually and thermally pleasing.

Mean radiant temperature inside a traditional building in Kerala is maintained very low. Throughout the year these traditional buildings provide proper air flow indoors and aid to overcome the discomfort due to excessive humidity [19, 25].

During monsoon period people consume fenugreek porridge made in jaggery every day. Rasam is the other dish which is used along with rice meal during cold season. This peppery hot curry helps to withstand the chill climate. In the same season oil massage treatment is normally observed to maintain good health and vitality.

While in summer, a lot of local fruit which mainly are cultivated in the house garden, become an essential diet. Jack fruit, Mangoes, Cashew Apple, Guava etc. are abundantly available inside every house compound. Buttermilk is extensively used along with afternoon meal in summer which cools the body. All these food habits are exactly as specified in Ayurveda.

Sage Charaka says in Ayurveda about the importance of smoking; but it is not practised much. Nonetheless every morning and evening special herbs are burnt in a clay/bronze pan and every corner of rooms are smoked with it. Application of coconut oil on the head every day helps to bring inner coolness of the body. Ayurveda mentions about the necessity of consumption of meat and other aquatic items which are taken by Hindus except Brahmin community. According to the nature of the body such as Vata (airy element), Pitta (fiery element – bile etc.) and Kapha (watery element); different food habits have to be observed [3]. This common practice followed by Keralites are exactly as per Ayurveda.

9. Conclusions

Traditional houses of Kerala built in 19th century and first half of 20th century was built of sustainable materials and with proper understanding of microclimate of every region. Local artisans and carpenters were the main designers who strictly followed Vastusastra, the ancient Sanskrit text.

Appropriate use of materials and proper location of each room with correct position and sizes of openings give extreme comfort to overcome the disadvantages of high temperature and humidity.

Special food habits, rituals, clothing type and clothing style followed by the Hindus were additionally aiding thermal comfort.

These types of houses are disappearing from the scene mainly because of the lack of awareness of comfort and due to the blind imitation of the west. Some urgent measures have to be taken to promote this old construction methods before it is forgotten.

Courtyard design causes bigger footprint of building since the built structure is spread out surrounding the wide open space. Also this land of courtyard is another factor which increases the cost of the project. In today's world too much open spaces bring in security threat and maintenance issues. Keeping corrective measures to all these, there are a lot of design features and materials which has to be adopted in the modern dwellings. If any Energy Saving Legislation comes forward with strict design guidelines extracted from the traditional construction knowledge a considerate arrest of global warming can be brought in.

Acknowledgment

I am deeply indebted to Manipal Academy of Higher Education, Manipal for the constant support in carrying out quality research.

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