ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

THERMAL COMFORT IN VERNACULAR COURTYARD HOUSES: CASE STUDY -CHHATTISGARH

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DOI: 10.5281/zenodo.1130828

ABSTRACT

The paper firstly introduces vernacular architecture and defines thermal comfort. The second section of this paper gives an account of the way vernacular houses respond to climate and achieve thermal comfort. Vernacular houses of Chhattisgarh, a central state of India are selected for this study to find the evidence that vernacular architecture is likely to be passively comfortable. Courtyards play a vital role in creating thermal comfort along with other social and cultural roles. Vernacular houses are more environment- friendly because they are evolved through a continuous process.

KEYWORDS: Vernacular Architecture; Thermal Comfort; weather; courtyard houses.

I. INTRODUCTION

Vernacular architecture is influenced by a great range of different aspects of human behavior and environment, leading to differing building forms for almost every different context. The way of life of building occupants, and the way they use their shelters, is of great influence on building forms. The size of households, who shares the spaces, way of food preparation, the way of interaction within and between the families and many other cultural considerations affect the layout and size of dwellings.

II. VERNACULAR ARCHITECTURE

Vernacular buildings record lifestyles of the past when people had to find a sustainable way of life or perish. The new importance of vernacular building is that it has vital ecological lessons for today [1]. Vernacular architecture also embodies the local lifestyle and its process of evolution is completely unconscious [2]. These quotes describe some of the salient attributes of vernacular buildings. Vernacular is strongly tied to cultural and social traditions. It responds to ambient environmental conditions, and it is, in a way, a naturally evolving process.

Vernacular architecture comprises all buildings, not just dwellings and relates to environmental contexts and available resources. These are customarily owner or community built and use traditional technologies. Vernacular architecture is built to meet specific needs, while accommodating the values, economies, and ways of life of the cultures that produce them [3]. The word 'vernacular' derives from the Latin word 'vernaculus' which means native. Hence vernacular architecture refers to 'native science of building.' Vernacular architecture is both regionally and socially specific. Each community over the years develops a prototype that responds to local needs and carries it forward through generations [4].

Vernacular architecture is a replica of its surrounding social, cultural and environmental needs. In 1969, Rapoport introduces vernacular architecture as a folk tradition that is a 'direct and unself-conscious translation into physical form of a culture, its need and values – as well as the desires, dreams and passions of the people.' There are two type of categories for these folk traditions; (i) Pre-industrial vernacular and (ii) Modern/Post-industrial vernacular.

Pre-Industrial Vernacular Architecture

It is a direct reaction of the community that understands its own spatial needs and requirements; solutions to these problems are handed down through verbal transfer of knowledge through generations. Mostly these houses are built by their owners with very simple construction technique and details of construction are easy to understand and accept with minimum alien requirement. It can be taught by one generation to another. The

outcome of there response tends to be very tradition oriented, and the houses follow a uniform model. Thus, it refers to buildings built by the community and involves no specialized trades[5].

Post-Industrial Vernacular Architecture

After industrial revolution vernacular architecture changed its shape to develop something new that has use of new building material and its techniques. These new material and techniques required specialized skills. A new set of considerable conception, design, and construction evolve in this era. As specialized building trades emerged, the occupants sought help from them to construct buildings. The occupants of these kinds of houses, although not active participants in the construction, are not just mere users but provide inputs to the design and construction of the house. Individual variability is thus witnessed in these houses; however, because a society is bound by traditions, the differences fall within a frame of common heritage and values. These often lack ostentatious aesthetic display as they try to solve problems in the simplest possible manner, working with the site and micro-climate, respecting other members of the community and the environment [5].

From the very beginning, shelters have been guided by the climate of the region. Vernacular solutions show a variety of designs related to the conditions that surround it, responding to the nature, culture, symbolic interpretations, and definition of comfort in that area [5]. These solutions vary from place to place, usually being governed by culture even while responding to the similar conditions: the definition of comfort changes from culture to culture. Hence, considerate thermal comfort is significant because it varies from one another [6].

III. THERMAL COMFORT

ASHRAE Standard 55-2004 defines thermal comfort as "*the condition of mind that expresses satisfaction with the thermal environment.*" The thermal environment is those characteristics of the environment which affect a person's heat loss or gain. According to [7]the variables that affect the thermal comfort most are (i) Activity level (heat produced in the body) (ii) Thermal resistance of the clothing (clo-value)(iii) Mean radiant temperature(iv) Air velocity (v) Humidity. Activity level is directly related to the metabolism of the body, which in turn produces heat. For example, the body of an exercising person will be hotter than a sleeping person. Hence, the activity directly relates to the thermal level of the body and to the thermal comfort temperature. Clothing also affects body temperature and exposure to air. All other things being equal, a person wearing a woolen jacket will be warmer-than someone wearing a t-shirt; i.e., the jacket has a higher clo-value, a measure of clothing insulation. Apart from keeping the body warm, the clothing also affects evaporative cooling by preventing convective air from moving over the body surface. Air temperature refers to the sensible temperature of the air, i.e., temperature that the sensory mechanism of humans can recognize. Radiant temperature refers to the area-weighted mean temperature of all the objects surrounding the body. Even though not in direct contact with body, hot or cold objects affect the perception of temperature as they exchange radiant energy. Air movement is very important for comfort. It can either create comfort or discomfort depending on climatic conditions. In hot enclosed spaces, no air movement leads to stuffiness; while in cold conditions, even the slightest air movement may cause discomfort (draftiness). Humidity is another major variable that affects the comfort condition. Humans automatically sweat to maintain body temperature; higher humidity reduces the ability of sweating to maintain homeostasis; sweat no longer evaporates to cool the body.

Thermal comfort indoors depends on various factors such as temperatures, humidity, wind speed and thermal sensation. It differs from place to place according to the location, requirements of the people and the use of the particular space. Another definition of thermal comfort is the absence of thermal discomfort, that is to say, that an individual feels neither too warm nor too cold [8]. For indoor conditions, comfort zones are typically implemented to satisfy 80% of people. The comfort zone is often expressed as a temperature range around the neutral temperature.

Our modern solutions to climatic problems often do not work, and our homes are made bearable by means of mechanical means whose cost sometimes exceeds that of the building shell. Primitive and pre-industrial builders cannot take this attitude, since they lacked in the technology to allow them to ignore climate in design. They solve their problems by collaborating with nature.- (Rapoport, 1969). The quote emphasizes that comfort conditions are achieved in vernacular houses without using mechanical means.[9] and [10] state that vernacular architecture evolves over time after trial and error, and the final form that emerges in a particular culture is highly responsive to climate and available resources. These successful solutions to the problems of the climate did not come from deliberate scientific reasoning but from countless experiments and accidents and the experience of generations of builders who continued to use what worked and rejected what did not [11]In many

regions, vernacular forms can be traced back over hundreds or thousands of years, providing occupants with comfortable conditions. Dr.Walter B. Cannon stated "*the development of a nearly thermo-stable state in our buildings should be regarded as one of the most valuable advances in the evolution of buildings.*" [12]

Studies show that vernacular architecture uses less energy than contemporary architecture.[13] studied the principles of traditional Indian architecture. After examining different cases from different regions of the Indian subcontinent for their climatic context, he concluded that vernacular buildings have less need for energy than contemporary buildings. [14]whose study in Ethiopia on the differences between traditional, vernacular, and modern buildings in material used, concluded that contemporary buildings neglect some essential environmental human requirements. He suggests variables that could be used in modern architecture to lower external energy requirements in the house. Some studies have suggested that vernacular architecture has high thermal performance, creating comfortable indoor conditions. Studied climatically responsive indigenous buildings and settlements in the two desert conditions of India, i.e., hot-dry desert of Jaisalmer and cold-dry desert of Leh. Their study found high thermal performance among these buildings. Another study showed that traditional mud houses create thermal comfort[15]. The study investigates thermal comfort attitudes of those dwelling in traditional mud houses. Their survey shows that 90.6% inhabitants of mud houses find them to be comfortable without artificial cooling and ventilation.
Studies have even showed that vernacular homes use various passive strategies to create comfortable conditions inside them. For example, courtyard homes in Kolkata use geometry to capitalize on shade and ventilation[6]. Conducted a study in Kolkata on the courtyard houses specifically focusing on the roles of solar shading and natural ventilation in courtyards

IV. COURTYARDS IN TRADITIONAL HOUSES

Courtyards houses are one of the oldest typologies of shelter making. In all ancient civilizations we find Courtyard houses as most prevalent type. The courtyards offer multiple advantages ranging from climatic, social to multiple uses of spaces. In this type of houses, the courtyards are the focal point of all the activities. Most of the rooms of the house have a direct connection with the courtyard. Along with providing maximum interior relationship, Courtyards also served privacy purposes by helping to segregate indoors and outdoors.
The courtyards serve as important family gathering spaces. They also play an important role in allowing air flow and maintaining thermal comfort in living spaces. The shape of the courtyard is mostly generated by placement of rooms or buildings around it. Air circulation due to these courtyards relies largely on the proportions of the surrounding walls and positioning of window openings in the surrounding rooms. Shading in the courtyard helps in creating comfortable living conditions during day and sleeping conditions during night.

V. ROLE OF COURTYARDS IN TRADITIONAL HOUSES OF CHHATTISGARH

Courtyard plays an important role in the houses of Chhattisgarh, India. This state is situated in central part of India. The climate of Chhattisgarh is tropical. It is hot and humid. Summer temperatures in Chhattisgarh are very high. The monsoon season is from late June to October. The basic typology of traditional houses in Chhattisgarh is courtyard houses.
The courtyards have sometimes two three or all four sides' corridors and rooms. The size of courtyard and number of rooms depend mostly on the size of family and economic structure of the family. In the front façade of the house It has a lot of empty space known as "*Bayara*"
Verandah next to the front door is generally used for sitting purpose known as "*Baithak*". There is mostly mud flooring in veranda
h. The level of door at threshold is quite above the ground. From the verandah generally there is door to kitchen and bedrooms. Mud flooring or Cement flooring is used in courtyard. The courtyard is generally at centre of the house. Sometimes the verandah is also used as kitchen or for sitting purpose. There is a way like a corridor to the "*Gaushala*" or the cow shelter and store. Generally bamboo is used for roofing which also provides light to carry out day to day activities. Generally windows in the wall are very small handmade country tiles are used for roofing over wooden king post truss. Wooden binders, joists and planks were used to create separation between attic and leaving space.
A study was done in twenty houses of Bhaismuda village and the plan form, position of courtyard, it's relation with other rooms and usage pattern was studied. Major findings of the study are as under:

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

- Courtyards play an important role in allowing air flow and maintaining thermal comfort in living spaces.
- The shape of the courtyard is mostly generated by placement of rooms or buildings around it.
- Air circulation due to these courtyards relies largely on the proportions of the surrounding walls and positioning of window openings in the surrounding rooms.
- It was found that the courtyard turned into most active space of the house in the comfort hours.
- Shading in the courtyard helps in creating comfortable living conditions during day and sleeping conditions during night.
- Use of courtyard changes in different hours and it also changes in the seasons like in winter corner of courtyard start working as kitchen at day time but in summer it act as place of sleeping at night hours.
- Thermal Comfort in these houses can be seen through the pattern of usage of the spaces.

VI. CONCLUSION

Vernacular houses had been constructed with some underlying principles conveyed from one generation to other, to make it respond positively to the prevailing climatic conditions and thus helped to attain thermal comfort without using any mechanical means. These lessons are always contemporary in nature and these can help in designing contemporary buildings to behave thermally well. In broader perspective this can help in reducing energy requirements and thus contributing towards a more sustainable future.

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CITE AN ARTICLE

Sthapak, S., & Bandyopadhyay, A., Dr. (n.d.). THERMAL COMFORT IN VERNACULAR COURTYARD HOUSES: CASE STUDY -CHHATTISGARH. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *6*(12), 487-490.