

Courtyard houses: An overview

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Abstract

In old traditional residences, the courtyard was the focal point of the house. Most, if not all, rooms of the house had a direct connection with the courtyard. Courtyards served privacy purposes where they maximized interior relationships and openness while keeping the outside separate. Not only were courtyards used as social family gathering spaces, they were also a source of air flow and thermal comfort to the residence. Courtyard Houses have been most popular in residential architecture all over the world and in all climatic regions. Courtyard can be square, rectangular, round or amorphous, generated by placement of rooms or buildings around it. In hot arid climates such houses provide a greater measure of comfort. The courtyards supply light and cool air to the rooms around it. Air circulation within this confined space relies largely on the proportions of the surrounding walls and positioning of window openings in the surrounding rooms. Breeze and shading in the courtyard help in creating comfortable living conditions during day and sleeping conditions during night. In this paper various attributes of courtyard houses are discussed. The degree of enclosure, the size and orientation of courtyard in terms of the bioclimatic significance is discussed.

Keywords: Courtyard houses, Traditional residences, Bioclimatic significance

INTRODUCTION

Courtyard typology has existed for thousands of years since Neolithic settlements. Initially used as a protective barrier against the climate, human and animal invasion, it developed as primary typology. As one of the most primordial forms of architecture, "courtyard styles" had been relevant for all types of buildings, be it residential, commercial, institutional or industrial. Historically this style has been most popular in residential architecture all over the world and in all climatic regions.

Based on accounts of "*The Historic Evolution Of Courtyards*" compiled by Hinrichs, Oliver, Schoenauer and Sullivan (1989) it may be said that the earliest form of courtyard architecture has either evolved from the encampments of the nomadic tribes or the fenced compound dwellings of the first agrarian communities. However, the form remains equally prevalent in all the countries and climatic regions of the world. Hinrichs (1989) observes that, "*Time, civilizations and even climatic conditions seem to have very little effect on the courtyard style house as evidenced by history*".

The dwellings of the four ancient urban civilizations of Mesopotamia, the Indus Valley, Egypt and China, along with the dwellings of the Classical Roman and Greek periods, all bear evidence to the fact that the "courtyard form" is rather timeless in the history of architecture.

Around 2000–1500 B.C., houses were being built in Indus valley apparently on the same philosophy. The houses were planned as a series of rooms opening on to a central courtyard. The

courtyard served the multiple functions of lighting the rooms, acting as a heat radiator in summer and absorber in winter, as well as providing an open space inside for community activities. Even after the demise of the Indus Valley Civilization around 900 B.C., courtyard dwelling has continued in the Indian subcontinent to the present day.

The courtyard act as the focal point of the house. Most, if not all, rooms of the house have a direct connection with the courtyard, approached through the verandah around it. The cultural aspects also drove the genealogy of the typology, as the cultures that it thrived in had cultural requirements for privacy and separation from the public realm, as well as grades of the attributes within the family. Reynolds (2002) refers to courtyards as, "... *special places that are outside yet almost inside, open to sky, usually in contact with the earth, and surrounded by rooms*". Courtyard houses in India can be found in every part of the country, from the North to the South. This typology is not only found in vernacular houses but this is equally prevalent in traditional houses of higher economic groups. The different regional forms of the courtyard house in India are as under:

Haveli : The havelis of northern and north-western India are perhaps the most popular types of courtyard houses in India whether in Gujarat, Rajasthan or Punjab.

Wada : The wadas which were popularized as a form of residential architecture by the Marathas under the patronage of Peshwas, in Maharashtra.

Nalukettu : This typical residence form of Kerala is also known as tarawad. Nalukettu means a single courtyard with four sides. The compact structure which is comprised of four blocks around a courtyard with sloping tiled roofs on all sides.

Chettinad : Typical residence of the Chettiar Brahmins of Tamil

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Nadu. The primary plan of this house is elongated and rectangular in shape, similar to the havelis in the north. However, a basic difference in the plans is the transparency in design of chettinads which allows uninterrupted views from front to the back door.

Rajbari: Courtyard houses of Bengal, Influenced by the Western architectural styles but also retaining the traditional inward courtyard form.

Badas: Courtyard houses of Chhattisgarh generally also having a rear court used for agricultural or gardening purposes.

Though the basic courtyard form of dwelling is rectangular or cubic in shape, it may be round or curvilinear too. The form has been modified to adapt to the topography, site restrictions, building orientation and functions to create new shapes.

IMPLICATIONS OF COURTYARDS: Courtyards play an important role in shaping the physical, psychological and climatic environment in the courtyard houses. The implications of courtyard are listed hereunder:

PSYCHO-SOCIAL IMPLICATIONS

The primary benefit of the courtyard is a result of its inward form, which provides a sense of enclosure and privacy to the residents of the house. The court is the heart of the house, where different functions can take place during different parts of the day. This "outdoor room" can be used as an extension of the kitchen during mornings or as an extension of the living room during evenings to entertain guests.

The court acts also as a space for interaction for all family members. Generally, all the rooms face the courtyard, creating a direct relationship between the inside and outside. This arrangement encourages family members to use the courtyard as a group. Privacy is one of the main concern of courtyard type dwellings. Therefore, in most of the courtyard houses the court is visually secluded by screened or walled entrances. In places where the climate is conducive to outdoor activity, the parapet walls on the roofs are high enough to provide a private sleeping area during the night.

Besides the visual privacy provided by the courtyard form, it also provides acoustical privacy. The courtyard house absorbs the noise of the house within itself. Also the surrounding rooms provide a noise barrier between the inner heart of the house and the street outside. This helps in providing a quieter and private outdoor space to enjoy

CULTURAL IMPLICATIONS

Use of more than one courtyard is found in many cases. This is usually to segregate the public and private spaces within the house. The public domain is mainly for the guests and is mostly used by the male members of the family. The inner court is more restricted to the family and is usually an outdoor space enjoyed by the female members of the house.

The courtyard planning decreases interior-exterior connections but increases interior connections; they maximized interior relationships and openness while keeping the outside separate. Courtyards help to create an interior space while respecting privacy values of the culture by having no exterior or street view from the courtyard itself.

ACCESSIBILITY AND CIRCULATION

Courtyards generally function as locus in the house, connecting the different areas and functions within the house. This emphasis on the use of the ground plane minimizes the requirements for stairs, which helps in making the different parts of the house easily accessible by even those with limited mobility. Courts function successfully for the older generations in the house. The practical solution of courtyard design combines the advantages of compact design and easily maintained living quarters. The courtyard design accommodates communal outdoor places for public contact, encouraging those with mobility disabilities to enjoy the outdoors.

RELIGIOUS IMPLICATIONS

The courtyard is both symbolically and religiously significant. This open-to-sky yet enclosed space within the surrounding walls of a house has been considered as a spatial symbol of inwardness and femininity in the house. The courtyard may symbolize many things: the central focus of interest in the house; a concentration of light, wind, sound and water; a private, safe and life-sustaining refuge.

Courtyards have been accepted as a secular form in almost all the religions of the world. Most Hindu courtyards are distinguished by the placement of a Tulasi (basil) plant which is watered and worshipped. The most universal religious application of the open courtyard is perhaps congregation for religious festivals.

ECONOMIC IMPLICATIONS

Some financial benefits are closely associated with the courtyard form and construction. Courtyard house designs show efficiency in land use. When adjoining courtyard houses share walls, the cost of construction is significantly reduced. The minimization of walls also leads to fewer surfaces for either heat gain or heat loss, which may help in economizing the cooling load inside the house.

Another financially beneficial aspect of the courtyard form is its generally flexible interior spaces. In courtyard houses, each room can be modified into serving multiple purposes. This helps the easy adaptability of new functions for the courtyard house.

CLIMATIC IMPLICATIONS

Courtyards have been generally referred to as a microclimate modifier in the house due to their ability to mitigate high temperatures, channel breezes and adjust the degree of humidity. The properties of self-shading and thermal lag is used to reduce heat gain in courtyard houses by using the right proportions and building materials. Not only courtyards serve the purpose of social family gathering spaces, they are also a source of air flow and thermal comfort to the residence. The courtyard floor and surrounding walls are usually a good radiator of heat depending on the material used.

Thus, the courtyard acts like a cool air reservoir especially in hot-arid climates where clear sky conditions favor the heat radiation property of surface materials. This helps in maintaining lower temperatures in the court and especially ground floor rooms. Use of light-colored highly reflective surface materials in courts help to bring more daylight into surrounding rooms.

Using plants and water elements in courtyards helps to add moisture to the air and enhance comfort conditions in hot-dry climates. The courtyard is a space in the house that is less affected by the annual, seasonal and diurnal weather changes. When the conditions inside the room become uncomfortable and stuffy, then the activities of the rooms spill out in the courtyard.

In general favorable outdoor conditions can be attained in the courtyard at least at one part of the day or the year. The right proportions and orientation of courtyard may block higher summer sun angles while allowing lower winter sun angles. The courtyard functions as a convective thermostat and gives protection from extremes of weather. The courtyard moderates the extreme effects of the hot summers and freezing winters of the Indian sub continent, and averages out the large diurnal temperature differences.

The size and orientation of the courtyard, the height of the surrounding structures play an important role in moderating the climate. They help in climate control by preventing the entry of summer sun while allowing the entry of the winter sun in hot aired climate

Air in Courtyards circulates, reducing the dampness inside during the monsoon and other periods of high humidity. In some arid regions the courtyards also functioned as rainwater collectors.

Thermal Comfort Analysis of courtyard

Thermal comfort is defined by ASHRAE Standard 55-2004 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 Fanger, the following variables affect the thermal comfort most:

- Activity level (heat produced in the body)
- Thermal resistance of the clothing (clo-value)
- Air temperature
- Mean radiant temperature
- Relative air velocity
- Water vapor pressure in the ambient air

Vitruvius in his Book VI of *“Ten Books on Architecture”* explains the fundamental relationships among climate, comfort, and architecture using the *‘tri-partite model of environment’*. He states that the comfort, climate, and architecture are all closely linked to each other and architecture can create comfortable spaces in uncomfortable climatic conditions.

“Strategies that work with the climate rather than against it, have always existed in vernacular buildings.”

These passive design strategies vary from the region to region. These strategies keep the building warm in cold regions, cold in hot seasons

Thermal performance

The courtyard shape, proportions, size, orientation, finishing materials, landscape, as well as the design of windows opening onto it, internal spaces enveloping it, and the housing cluster around it integrate to constitute the thermal performance of the courtyard house.

Courtyard Geometry: Geometry of courtyard, the enclosure around it, and the orientation affects the thermal performance of the courtyard. Orientation of the courtyard (or its thermal performance) is determined by the solar orientation, Annual and Seasonal Thermal

Variation.

Aspect Ratio: Aspect Ratio (AR) is defined as “the degree of openness to sky”. Therefore, the greater the aspect ratio, the more exposed the courtyard is to the sky. This factor is considered for the daylight, and is calculated as.

$$\text{Aspect ratio} = \frac{\text{area of the courtyard floor}}{(\text{average height of the surrounding walls})^2}$$

If the courtyard is wide and shallow (high aspect ratio), it performs as sun collector. On the other hand, the narrow and deep courtyard (low aspect ratio) performs as a sun protector, in which orientation has a weak effect on the house.

Surface Area to Volume Ratio: Surface Area to Volume Ratio is an indication of the rate at which the building heats up during the day and cools down at night. This ratio is obtained by dividing the total surface of the building including facades and roofs by their volume.

$$\text{Surface Area to Volume Ratio} = \frac{\text{Total Surface Area of Building}}{\text{Volume of Building}}$$

A higher ratio leads to a higher heat gain during the summer and heat loss during the winter. Additionally, a high ratio provides an increase in the potential ventilation and day lighting, which may offset the disadvantage of the larger surface area.

Solar Access and Shading: The solar performance of courtyard depends upon solar access and shading achieved in the courtyard. A shady courtyard in winter may turn up to an open courtyard in summer due to change in altitude angle of sun.

The Solar Shadow Index: The Solar Shadow Index (SSI) is another factor described by Reynolds (2002) which deals with winter sun exposure. The greater the solar shadow index, the deeper the wall formed by the courtyard and thus the less winter sun reaches the floor or the south wall.

$$\text{Solar Shadow Index} = (\text{South wall height})/(\text{North-South floor width})$$

Natural Ventilation: The ventilation and air movement through courtyard is determined by prevailing wind direction, average wind velocity and position and size of fenestrations.

Air circulation within this confined space relies largely on the proportions of the surrounding walls and positioning of window openings in the surrounding rooms. The proper proportioning of the building in relation to the courtyard allows a cool breeze within the courtyard. Breeze and shading in the courtyard help in creating comfortable living conditions during day and sleeping conditions during night. Courtyard can control temperature, daylight and air movement in the rooms around it. Orientation, depth, height all are critical attributes to achieve the same.

The air movement into a building affects the thermal comfort of occupants and influences heat gain or loss through its envelope. Airflow and natural ventilation through buildings can be achieved in two ways:

Temperature-generated pressure differences (stack effect): Based on the fact that hot air rises and exits through the top opening, and cool air replaces it.

Wind-generated pressure differences (cross ventilation): where air travels from the openings across the space.

During the day, the courtyard heats up quickly, which enhances the stack effect due to high air temperature differences. However, this happens when outside temperature is cooler than inside.

Thermal Mass: Thermal mass is a concept in building design which describes how the mass of the building provides "inertia" against temperature fluctuations, sometimes known as the thermal flywheel effect.

When outside temperatures are fluctuating throughout the day, a large thermal mass of a house can serve to "flatten out" the daily temperature fluctuations. Thermal admittance: Thermal admittance quantifies a material's ability to absorb and release heat from a space as the indoor temperature changes through a period of time. Admittance values can be a useful tool in assessing heat flows into and out of thermal storage.

Admittance is measured in $W/(m^2K)$. So that

$$h = \Delta Q / A \times \Delta T$$

Where: h = heat transfer coefficient, $W/(m^2K)$

ΔQ = heat input or heat lost, W

A = heat transfer surface, m^2

ΔT = difference in temperature between the solid surface and the adjacent air space.

Higher admittance values indicate higher thermal mass.

CONCLUSION

Various implications of courtyard in terms of psycho social, religious, economic and climatic significance this form has proved as one of the best plan forms in residential architecture since ages. Thermal implication of courtyard in courtyard houses can be evaluated in various parameters as discussed in the paper. Using these parameters further study can be done to derive guidelines to design climate sensitive residences.

REFERENCES

- [1] Al Masri, Nada Rafic. 2010. Courtyard Housing in Midrise Building an Environmental Assessment in Hot-Arid Climate. Dubai :British University in Dubai.
- [2] Kanaan, Serene S. 2010. Traditional influence on the contemporary single family courtyard house. Illions: Illions School of Technology.
- [3] Das, Nibedita. 2006. Courtyard houses of Kolkata: Bioclimatic, Typological and Socio-Cultural Study. Kansas: Kansas State University Manhattan.
- [4] Bagneid, Amr. 2006. The creation of a courtyard microclimate thermal Model for the analysis of courtyard houses, Texas: Texas A M University.
- [5] Lwamayanga, Cyriacus. 2008. Constancy and change: the living processes and skills in vernacular architecture of Kagera Region – Tanzania. Oslo: The Oslo School of Architecture and Design.
- [6] Rapoport, Amos. 2007. The nature of the courtyard house: a conceptual analysis. T D S R18(02).
- [7] Myneni, Kranti Kumar. 2013. "Courtyard as a Building Component" its Role and Application in Developing a Traditional Built form, Creating Comfort: A case of Athangudi Village, India, International Journal of Chemical, Environmental & Biological Sciences (IJCEBS) Volume 1, Issue 4.
- [8] Mohammadzadeh, N. and Cho, S. Thermal Comfort Analysis Of A Traditional Iranian Courtyard For The Design Of Sustainable Residential Buildings. 13th Conference of International Building Performance Simulation Association, Chambéry, France.
- [9] Yu, Nancy. 1999. The Urban Courtyard Housing Form as a Response to Human Needs, Culture and Environment. Canada: National Library of Canada.
- [10] Asfour, Omar S. 2008. A Study of Thermal Performance of Traditional Courtyard Buildings Using Computer Simulation. AHRCP.
- [11] Masri, Nada Rafic Al. 2010. Courtyard Housing in Midrise Building An Environmental Assessment in Hot-Arid Climate. Dubai: The British University in Dubai.
- [12] Taleghani, M. 2013. Optimisation of Heating Energy Demand and Thermal Comfort of a Courtyard - Atrium Dwelling. PLEA 2013 - 29th Conference, Sustainable Architecture for a Renewable Future, Munich, Germany..
- [13] Shahim, Abdurahiman M. Hvac And Climatic Design In The Arab Courtyard Houses. Calicut: , National Institute Of Technology Calicut, Ind.
- [14] Zhiqiang ,Zhai and Previtali, Jonathan M. 2010. Ancient Vernacular Architecture: Charac. Teristics Categorization and Energy Performance Evaluation. Energy and Buildings 42 :357–365
- [15] Hinrichs, Craig. 1989. "The Courtyard Housing Form as Traditional Dwelling". The Courtyard As Dwelling. AISayyad, Nezar and Jean-Paul Bourdier .ed. Traditional Dwellings and Settlements Working Paper Series, Volume six, IASTE, WP06-89. Center for Environmental Design Research, University of California, Berkeley. (p 2-38).
- [16] Schoenauer, Nibert and S. Seeman. 1962. The Court Garden House. Montreal McGill University Press.
- [17] Sullivan, Chip. 2002. Garden and Climate. New York: McGraw-Hill.