Traditional breathing spaces in built forms – Review and Comparison of courtyards in Athangudi village, Chettinad and Contemporary Context

Ar. B. Surya Prakash[1], Ar.P. Sitha Mahalakshmi[2]

[1]Student, M.Arch[Sustainable Architecture],School of Planning and Architecture, Vijayawada, Andhra Pradesh, India,
[2]Assistant Professor, Department of Architecture, School of Planning and Architecture, Vijayawada, Andhra Pradesh, India.

Abstract – *of all the evolving styles of architecture that are used in India, there is one architectural trend or style that is continuing to be followed repeatedly – Courtyards. It had been used as a major component of the built-up spaces in India throughout the past even till now. A block which has punctured holes in either curvilinear, spherical or cubic forms at the center which will acts as the main breathing space with in an proper enclosed box is how the term courtyard generally is defined to be. The courtyard's configuration will be always varying according to the typology of the spaces around the courtyard. The courtyards always tend to show different characteristic features along with varied cultural, economic, social, psychological aspects of the society, location and also climate. This paper proceeds understating the role of the courtyard in providing comfort levels in terms of ventilation, lighting, thermal comfort and also indoor air temperature.*
The objective of this study is to understand the courtyards in terms of sustainability by analyzing the historic evolution of the courtyard forms, elements, grid systems through site specific studies, with the typical example of 75 years old Chettinad house, Athangudi village, Karaikudi in Tamil Nadu comparing with an 8 years old courtyard house at medavakkam, Chennai, Tamil Nadu.

***Key Words*: LIGHTING, VENTILATION, OPENINGS AND COURTYARDS COMFORT LEVEL, THERMAL COMFORT.**

1. INTRODUCTION

Set in middle of universe, human needed place of seclusion, peace, as a part of amorphous, hostile, greater world outside, a space which receives its share of sun, moon, day, night, heat, cold and rain [1]. As courtyard is one of the primordial forms of architectural styles, "courtyard styles" can be relevant for all types of buildings [2]. Reynolds says, "…a special place that are actually outside but yet almost inside to the building, open to the sky, usually in touch with the earth in many cases, but fully surrounded by the rooms" [ref.fig.1] [2].

The simple definition of the courtyard is it is the opening to the sky that is present inside a building. It is one of the most efficient features of the traditional houses of India. Researches on courtyard houses in the traditional societies have already proved to be useful in the contextual level which responds to the cultural and the climatic response [3]. Courtyard has gained a proper identity in the residential planning in India started from the past till now. The ideology of the courtyard is handed over from one generation to another generation as a cultural heritage, symbolically or conceptually [3]. Since certain psychological, biosocial and cultural characteristics of the human beings continue to be influencing certain characteristics of the built environment throughout the past, courtyard survived in the history and also continuing to be acknowledged in the field of architecture.

In the early 1950s, Hassan [4] reintroduced the term courtyards and divided it into two divisions, say, smaller courtyards for light and ventilation and larger courtyards for living and entertainment [4] [ref.fig.2]. The courtyard's function will depends on its location in the building. Courtyard has either direct or indirect effect on the behavioral and psychological aspects of the residents of the building by bringing in sun, wind, rain, sky as a part of the interior of the building, throughout the year [5].

The position of the courtyard along the main central axis of the building and also its small sunken floor level of up to 0.3m with the roof from the first floor sloping towards the courtyard from 0.26-0.6m for the self-shading purposes is the important passive techniques adopted to maintain indoor air temperature and to ensure a better air circulation through the openings at lower level by creating proper cross ventilation and also ventilating all the habitable spaces that are around the courtyard, otherwise called stack effect as the hot air will passes through the courtyard and also caters natural light inside the building throughout the day[6].

2. COURTYARD BRIEF

2.1 Historic evolution of courtyards

The first courtyard houses across worldwide reference according to the historical evidence provided, appears to be originated probably around 6500-6000 BC, the best evidence will be the earliest village from Mehergarh [7]. Paul Oliver wrote in his book Dwellings: "The House Across the World" says that, "Courtyard houses have an ancient history: examples have been excavated at Kahun, in Egypt, are believed to be 5000 years old, while the Chaldean City of Ur, dating from 2000 BC, was also houses of this form". [8]. But the precise evolutionary path is still remains undetermined.

Generally, the courtyard house is which has rooms around an open-to-sky court and evolved to evade the harshness of the arid climates in the Middle Eastern countries [8]. However, Hinrichs observes that, "Time, civilizations, even climatic conditions seem to have very little effect on the courtyard style house as evidenced by history" [8]. Mesopotamia, Indus Valley, Egypt and China, Rome and Greek, the dwellings of these ancient urban civilizations all were bearing the evidence of the fact that the "courtyard form" is timeless in the historical course of the architecture.

2.2 Courtyard forms and elements

The basic courtyard form of dwelling is rectangular or cubic, round or curvilinear but it's not fixed. The courtyard form have been particularly modified to adapt to the building orientation, site restrictions, topography and also to create formal shapes to increase the adaptability and flexibility in planning, such as the L, U, H, T, V or Y.

Sullivan observes that "The size and scale of a courtyard can vary from intimate to quite spacious. In each and every case, the courtyard creates a wonderful frame of light and air [9]. Based on the literature study, most of the courtyard houses worldwide are restricted to 1-5 floors. The maintaining of the proportion and scale of the building is important to allow the courtyard with ample lighting and ventilation.

2.3 Indian architecture

Though hybridization and metamorphosis of architecture and society is taking place day by day, there has been a good flow in the vernacular buildings. In the evolving range of the architectural styles in India, there has been one trend that has continued to be expressed in the field of architecture– the courtyard type. At present the courtyard forms may be alive but not growing and also been replaced by many Westernized-box architectural types in India. Randhawa [10] says that courtyard types have been historically not only a style of architecture but also a "way of life", coated with the reference to the residential architecture in Indian context.

2.4 Courtyard houses

The courtyard house is the one that had rooms arranged all around the central courtyard on which the openings will be opened out into the corridor that is connected with the courtyard and covered with the roof projections. The courtyard can be ideal for hot and humid climate regions as it draws in cool air and circulating it within the interior of the building and also replacing foul air and increasing the comfort. [11]. The courtyard form will satisfy the needs for the traditional joint family systems in India [ref.fig.3].

The courtyards throughout the history functioned well as a thermostat to the rooms surrounded by it and it gave protection against the extreme conditions of weather *by* moderating the effects of summers and winters of the Indian country and helped in averaging the diurnal temperature differences [11]. It varied from being a narrow opening to a larger one in the interior zone of the house, with perhaps another or more near the entrance and the rear section. In one residence there may be 5-6 numbers of courtyards [11].

3. CLIMATIC PRINCIPLES: CASE OF 75-YEAR-OLD ATHANGUDI/CHETTINAD HOUSE

3.1 Climate of the region

The type of the weather that is prevailing in karaikudi region is hot and humid with the average relative humidity of 63% and the average temperature of maximum of 37 degrees and minimum of 24 degree [12]. The monthly average rainfall for this region will be 75mm [12]. The day temperature is high during the summer season. The soil found here is red forum soil. The terrain is mostly flat [12].

3.2 Site selection and analysis

Contextual location and the site will form the first steps towards the process of the building design. The religious rules were followed on the process of the site selection [12]. Any grid plans engulf the site, which is useful to design the house with courtyards in the center. [12]

3.3 Orientation of the courtyard in the house

The entrance of the house is faced towards east. Through central courtyard only more light will enter the house. The garden on the west side provides fresh cool air into the house in the day and in the night the heat absorbed during the day is radiated out by the courtyard [12]. The temperature of the house is controlled by the courtyard through its thermostatic nature [12].

More air was drawn towards the courtyard due to this low pressure [12]. The orientation of the building is by the cardinal directions [12]. For example, in the North or East walls more openings were given to get abundant light and air but in the western side only less openings were provided as the West side will gain more heat, which is not required for this hot and humid climatic condition [ref.fig.4] [12].

3.4 Day and night analysis of the courtyard

As the temperature is higher during the day time, some little amount of the heat is absorbed during the day time by the central courtyard's floor as it is as open to sky and the reflection of the light will tend to be in different directions [ref.fig.5] [12]. As the roof is sloped, heat from the sun will travels towards the central courtyard which will creates a negative energy [12]. The negative pressure created inside during the daytime will escapes out during night time [12].

3.5 Window projections and courtyard

There is more than one type of projection used depending on the length of the window. It is made by wooden shutters as U value of wood is less. The windows projections are opened to

the corridors around the central courtyard so that they can be able to prevent the direct entry of light which will helps in reducing the glare and radiation without obstructing the airflow and also to maintain the IAQ [12] [ref.fig.5]. The windows are mostly closed during the day and opened during the night to prevent excessive heat gain.

3.6 Roof projections and courtyard

The roof is projected from 0.26-0.6m into the courtyard so all the rainwater can be collected to the drain in the courtyard and also provide shade to the corridor surrounded by the courtyard reducing heat intensity [12] [ref.fig.6,7].

3.7 The grid and the courtyard

The grid system was followed regardless of the site. The grid was flexible so that it accommodates any site condition [ref.fig.8] [12]. Grid system is sustainable in terms of economy and also the speed of the construction. The grid was not always simple or symmetric. Curvilinear grids and complex geometry were also adopted [12]. Ayugma or the odd grid is the grid where the center is a square and used for larger scale houses and also called as the *'lung space'* of the house. To ensure there is a courtyard in every house, the center is never built and is called as the Brahmastana, the genius loci of the house [12].

3.8 Energy axes and cross ventilation in the courtyard

Energy axis is a row of openings aligned in the same line. The East-West energy axis is called as the Brahmasutra and the North-South energy axis is called as the Somasutra [12]. Both of these axes should meet perpendicularly in the center of the courtyard so that the cross-ventilation axes would intersect in the courtyards center [12]. In some houses however, the axis runs parallel to the courtyard [12].

4. CASE OF A 8-YEAR-OLD CONTEMPORARY COURTYARD HOUSE IN MEDAVAKKAM, CHENNAI, TAMIL NADU

This building is 8 years old, which is built in the year 2007, in Medavakkam, Chennai, and Tamil Nadu. It is a single storey house, west facing and the entry is detached from the road. The house is a typical 2bhk with living cum dining with a semi-open space in one corner where the living cum dining opens up to connect visually to the garden through the jalli work on the wall. This space is initially planned for building courtyard with the wall on three sides and a low-level seating on the fourth side.

After two years, this space was covered on top with beams to form an atrium. It was built in a way to avoid the dust but only to allow light. The shape of the courtyard is rectangular and it is comparatively smaller in size to the size of the courtyard in the Chettinad house. The major axis of the house will be along the north-south direction avoiding the east-west direction to reduce heat gain and to follow up vastu. The entrance to the house is from the western side. The semi open space faces southern side.

Apart from the hot air rising up to the top, there are no other significant air movement and it is considerably less and stagnant on the living cum dining place even though there is fenestrations. The jali wall reduces the heat gain but it does not facilitate cross ventilation. There were some diurnal temperature variations happening over a period of time.

The courtyard functions as a light well and provides some aesthetic counterpart and it serves for a variety of purposes. It is not separated from the living cum dining room and also used as a store room [ref.fig.9, 10]. The space is mostly used by the females in the house. The space is being used more as an additional room in the house rather than a transitional space connecting the indoors and the outdoors. The proportion is the main thing that contributed to this effect.

5. ANALYSIS AND INFERENCE

In the traditional house, the activities are connected towards the courtyard due to the central position of the courtyard, as it is the central breathing space of the house and becomes center of life within. Since there is no rigidity in planning, the courtyard can be called as the space that generates a lot of activities.

When any outcome that's evolving over a point of a period, a very much sensible adoption and way too careful amalgamation of the form that evolved in to the planning of residential building is done, it will definitely contribute more sense to architecture, which clearly justifies why vernacular architecture is still an example to learn from the past for the present and the future.

In the typical traditional Chettinad house, the courtyard will be the primary element of the house as it is in the center and all the other rooms were built around the central courtyard and the connection between the inside and outside of the house provided by this space, functioning as both the light well and ventilation shaft. The courtyard is the element that is moving vertically from ground floor to roof and it should be open to sky to fulfill its basic requirements [13].

The main goal for providing courtyard is to provide an escape point for the heat gained by the house during the day time and to create a stack effect, as the hot air always tends to move upwards. And to make sure that the inside and outside of the house can be clearly defined in the hotter months.

The house with courtyard functions as a protective shell by keeping the outside heat at some distance and providing a micro climate for the house with proper shading and cooler surfaces, which will be basic requirements of the occupants as a response to the daily temperatures due to the solar radiation [13].

Though the thermal capacity of the materials used in the building will hold the primary key to achieve the thermal comfort of the building, by adding the courtyard as one of the design element, which will only improve the thermal comfort of the building [14].

During the summer season the capacity of the building to reradiate the heat gained during the day to the night sky will definitely not equal to the daily radiations that the building received [14]. Due to this the required thermal comfort will not be achieved. So, by adding courtyard, efficiency for achieving this will be increased.

The courtyard is often the place for washing clothes, dishes etc., and also the residents of the chettinad house washing the courtyard few times a day to keep the dust away. Thus the pattern for providing evaporative cooling within the house will counteracts the heat gain increasing from the solar radiation over the summer months [14].

Since the thermal capacity of the carved wooden pillar facings in the corridor around the courtyard is low that will reduce the incident solar radiation up to an extent [15]. Although the horizontal openings create more heat gain in the building by heating up the larger open interior mass throughout the summer season, but it have been kept from too much heating by the daily house hold activities.

The house is flushed with cool air during the night time and the hot air will be sucked away through the stack effect. Courtyards function can be both ways. It can act as an air funnel by the stack effect concept and it can also act as suction zone sucking the air from the open to sky [16].

The courtyard will improve the thermal conditions of its surrounding spaces at night time, if provided sufficient openings on those spaces. The rooms facing the courtyards should have double sided ventilations; otherwise the speed of the air will be reduced [16]. Larger window opening towards the main courtyard will improve the cross ventilation.

Occupants in the courtyard houses will feel comfortable due to the regular intervals air exchanges [16]. But in the house itself the effect of the courtyard is more on the ground floor only since the rooms surrounded by the courtyard are nearer to it than to the first floor [16]. This is due to the direct solar radiation on the roof surface.

Research shows that the rooms in the ground floor than the first floor adjacent to the courtyard can actually efficient enough to maintain lesser temperature than the outdoor temperature [16]. The courtyards can be used for passive cooling, to improve the IAQ and natural lighting. Thus, courtyards have been playing a role of major built component since the past in creating better lighting, ventilation and thermal comfort.

It also acts as a space to gather, a space to interact and a space with lot of activities [17]. Creating better living solutions with the way of adapting and learning the lesson from the past, to create the sustainable solutions is the need of the hour.

6. CONCLUSIONS

The position of courtyard or any open space decides the users and its pattern of use. There are no other derivatives of the courtyard that can replace the feel and porosity like that form itself can give although it satisfies some of the functional requirements of courtyard like may be lighting. Major alterations to the courtyard can completely give a different sense of space and utility, not the one that can be achieved from proper courtyard form. By doing that change it will only give more sense of a room rather the feel of an open space. Courtyard is the *"key element"* that has established its vital role of importance in the society and in the field of architecture according to time.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to all those who provided me the possibility to complete this paper. A special acknowledgement I give to our faculty, Asst.Prof.P. Sitha MahaLakshmi, whose contribution in stimulating suggestions and encouragement, helped me. I would like to mention that her continuous support, guidance, comments and advices has helped me improve.

REFERENCES

[1] Al–Tamimi NA. Toward sustainable building design: Improving thermal performance by applying natural ventilation in hot-humid climate. Indian Journal of Science and Technology. 2015 Oct.

[2] Blaser, Werner. Atrium: Five Thousand Years of Open Courtyards.

[3] Lee SH. Continuity and consistency of the traditional courtyard house plan in modern Korean dwellings.

[4] Salama A. A typological perspective: the impact of cultural paradigmatic shits on the evolution of courtyard houses in Cairo.

[5] Myneni KK. "Courtyard as a Building Component". Its role and application in developing a traditional built form creating comfort: A case of Athangudi Village, India. IJCEBS. 2013; 1[4]:633–9.

[6] Jayasudha P, Dhanasekaran M, Devadas MD, Ramachandran N. A study on sustainable design principles: A case study of a vernacular thanjavur region of Tamil Nadu, India.

[7] Sanjeev Maheswari, "An Ancient Indian Architecture.", 2001.

[8] Hinrichs, "The Courtyard Housing Form as Traditional Dwelling". CEDR, University of California, Berkeley.

[9] Sullivan, Chip. 2002. Garden and Climate.

[10] Randhwa, T.S, World IQ.com. Indian Architecture. Downloaded on Sep. 14th, 2005, Indian Courtyard House.

[11] D.K.Bubbar, "The Spirit of Indian Architecture, Vedantic Wisdom of Architecture for Building Harmonious Spaces & Life." Rupa & Co.

[12] Kranti Kumar Myneni "Courtyard as a Building Component" - its Role and Application in developing a traditional Built form: A case of Athangudi Village, India.

[13] M.Susan ubbelohde, George Loisos "The ahmedabadi pol house. Courtyard strategies in a hot dry and hot humid climates".

[14] Vivek Nanda "Urban Morphology and the concept of type" Dipoloma thesis, school of architecture, CEPT, Ahmedabad.April, 1989, P.168.

[15] K.B.Jain "wooden houses" by George Michelle and Snehal Shah, Bombay, Marg ublications, 1988. P.157.

[16] Mihir Vakharia, "Impact of presence of courtyard on the thermal characteristics of vernacular residential buildings" CEPT.

[17] "Contextual comparison of the courtyard houses in Tamil Nadu" Article in Indian Journal of Science and Technology· February 2016 DOI: 10.17485/ ijst/ 2016/ v9i5/ 87268.

ANNEXURE FOR FIGURES

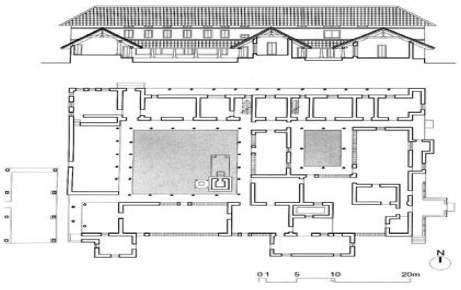

Figure 1 "Courtyard as a Building Component" - its Role and Application in developing a traditional Built form: A case of Athangudi Village, India. Kranti Kumar Myneni.

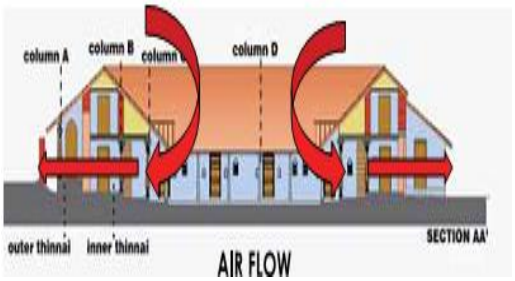

Figure 2 Indian heritage passport programme on the Chettinad trail in Tamil Nadu. IN/2010/CL/31.

Figure 3 Indian heritage passport programme on the Chettinad trail in Tamil Nadu. IN/2010/CL/31.

Figure 4 Chettinad Architecture, Lifestyle, Architecture and planning concepts, Samyukthaa.

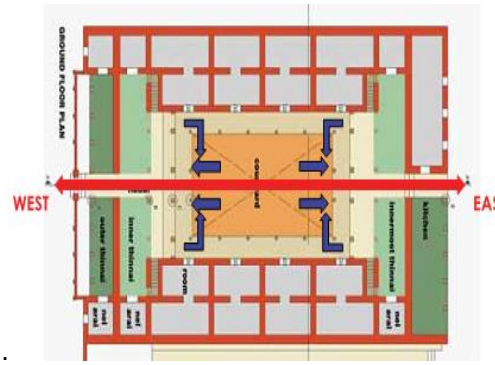

Figure 5 Chettinad Architecture, Lifestyle, Architecture and planning concepts, Samyukthaa.

Figure 6 Priya RS, Sundarraja MC, Radhakrishnan S, Vijayalakshmi.L. Solar passive techniques in the vernacular buildings of coastal regions in Nagapattinam, Tamil Nadu, India – A qualitative and quantitative analysis. Energy and Buildings. 2012 Jun; 49:50–61.

Figure 7 Chettinad Architecture, Lifestyle, Architecture and planning concepts, Samyukthaa

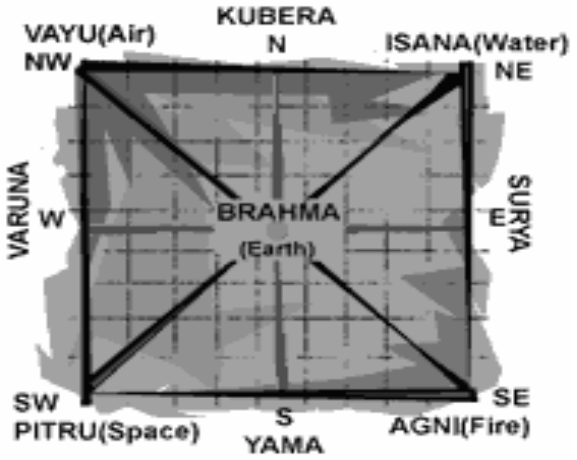

Figure 8 Climatic architectural tradition of India, V. Padmavathi Glasgow School of Art, May 2005, Santorini, Greece

Figure 9, 10 contemporary courtyard houses in Chennai Tamil Nadu by B.Vedhajanani.

BIOGRAPHIES

I, B. Surya Prakash, was born in 1994, in kancheepuram, TN. I had acquired my B.Arch. in 2016, from ACE, Krishnagiri, TN and joined in SPA, Vijayawada, AP for PG in Sustainable architecture and I'm also doing my M.Sc. in Real Estate valuation in correspondence in AU, Chennai, TN, simultaneously. I have a year of practical experience during internship period that comes along with the bachelor's degree and I have oral knowledge about the construction field since I'm the third generation in my family following the path in the construction field. I pursued architecture b'cause; I want my own style of designing, out of the box thinking yet still appreciating the essence present in the normal life without being rigid to one corner pool of ideas. I'm pursuing M.Arch, so as a responsible citizen and an Architect I can erect my future built forms by avoiding energy wastage and reduce the environmental impact the M.Sc. course offered me to see the lands potential in the past, present and the future.

P. Sitha Mahalakshmi, born in palvoncha, a town in Telangana, completed her B.Arch. from JNAFAU, Hyderabad, and her M. Arch in Sustainable Architecture from SPA, Vijayawada, AP. She has six years of experience in both teaching and professional sector. Her hardcore passion, nonstop thinking and strong interests towards sustainable architecture made her career path interesting by choosing on working innovative research topics like Climate Responsive spaces, Traditional Wisdom in Architecture, Regenerative design strategies, Energy harvesting techniques. Her tremendous knowledge towards sustainable architecture reflects all through this paper.