Study about Courtyard Spaces – Understand its Significance, Values, Benefits & Analyze its Micro Climatic Performance in Two Different Regions of Tamil Nadu

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ABSTRACT

Courtyard houses, an architectural concept with roots in diverse cultures and historical periods, feature a central open space surrounded by living quarters. This concise abstract explores the essence of courtyard houses, highlighting their role in fostering connectivity, privacy, and a harmonious integration of indoor and outdoor living. Examining its cultural significance and analyze its Thermal Comfort , this abstract underscores the enduring appeal of courtyard designs as versatile and enriching elements in residential architecture.
Courtyard houses exemplify a timeless architectural concept that transcends cultural and historical boundaries. The values associated with courtyard spaces extend beyond aesthetics, encompassing social, environmental, and psychological aspects. Embracing the positivity derived from courtyard living can inform contemporary residential design, fostering sustainable, community-oriented, and emotionally fulfilling spaces. This abstract explores the multifaceted values and positivity associated with courtyard spaces in residential design.

Key Words: Courtyard architecture, Microclimatic performance, Environmental performance of courtyards, Courtyard benefits, Passive cooling techniques, Energy efficiency in courtyards.

CHAPTER – 1

INTRODUCTION :

Courtyard typology residences has existed for **thousands of years**. Historically as well as currently, Courtyard plays an important role at residential buildings in **tropical climatic zones** and other parts in the world. They perform a wide range of functions – from the **climatic to the socio-cultural**.
In addition to its socio-cultural role as **family gathering spaces**, the courtyard provides **daylight** from the shade, **airflow and thermal comfort** inside the rooms of the house, factors that help to create more or less comfortable living conditions during the day and sleeping conditions at night. Factors influencing for this disappearance/transformation of courtyards include increasing demand for compact and cheaper buildings, change in people's lifestyle, climatic/ecological problems, insecurity.

1.1 AIM

The aim of this study is to explore the courtyards benefits, values and analyze its micro climate, this leads to practice / design energy efficient Architectural Residences in tropical climates by incorporating these positive courtyard elements into a new modern context housing.

1.2 OBJECTIVE:

The objectives is to study about the Courtyards origin, function, benefits and its microclimatic role at traditional residences and its transformations / negligence at contemporary houses.

To Analyze the design principles, materials, and spatial configurations employed in contemporary courtyard architecture.

Courtyards in houses is one of the eco-friendly practices that we should carry forward / transfer to our future generations, to make sustainable environment.

1.3 SCOPE :

Studying courtyard pshycho-social factors and microclimate factors at residences involves analyzing various elements within the enclosed outdoor spaces of homes.
This includes understanding how factors such **as sunlight exposure, wind patterns, vegetation, and building layout impact temperature, humidity, and air quality** within the courtyard.
It explore ways to optimize these factors to enhance comfort, energy efficiency, and overall well-being for residents.

1.4 LIMITATIONS :

The limitation is to studying courtyard spaces at residence level and make the study in traditional houses about their functions & use , aesthetic values and analyse their microclimatic performance **(Findings: Thermal comfort)** of courtyard spaces.

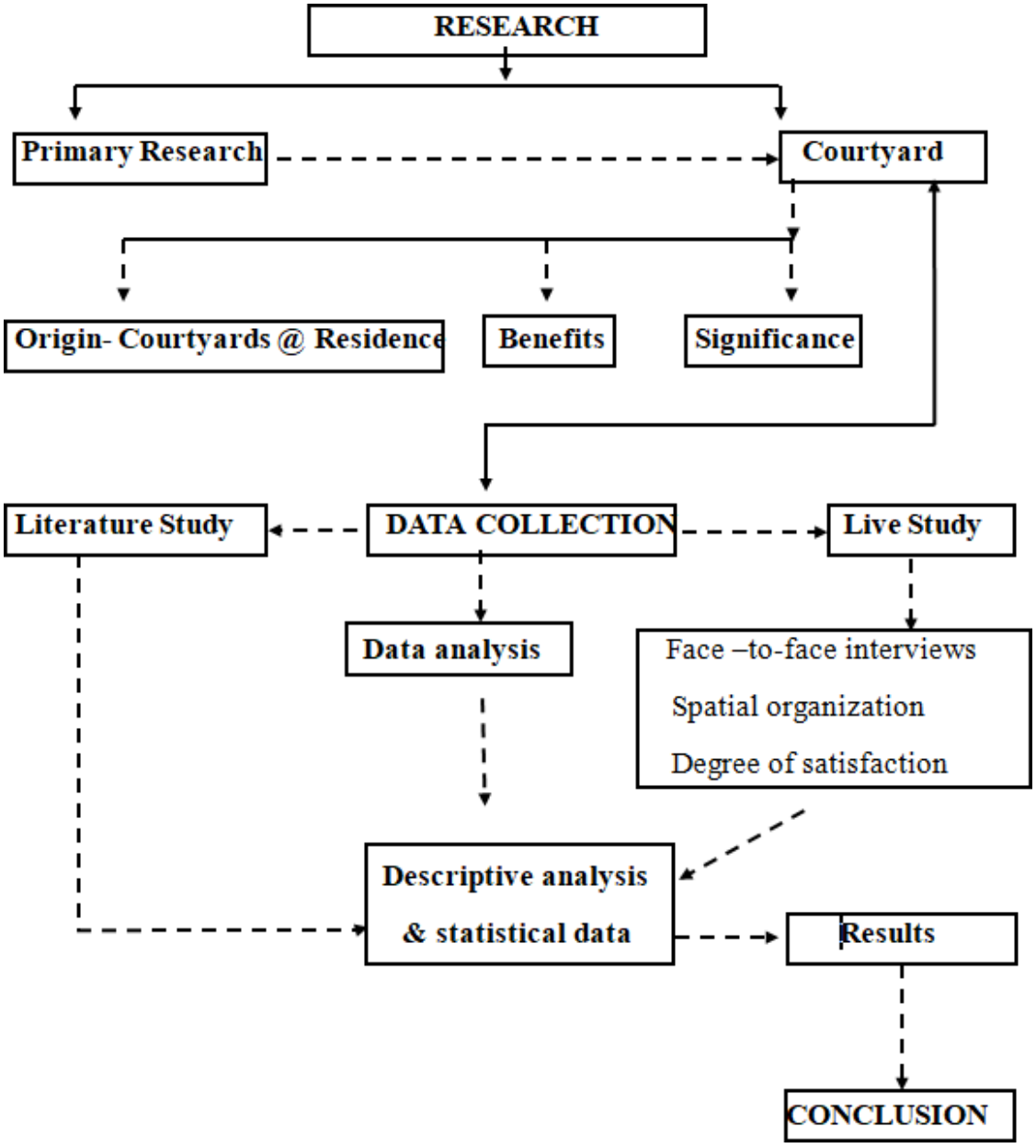
1.5 NEED OF THE STUDY:

The focus of this research is to Study about its **benefits** of the courtyard that describes the social and ecological functions of the courtyard. These benefits are **psycho-social, cultural, religious, climatic** benefits and study about the optimization of courtyard's **microclimate performance.**

1.6 RESEARCH QUESTION

What is the significance of courtyard at residential buildings? How its impact to the residence in micro climate study aspects?

1.7 METHODOLOGY :



CHAPTER – 2

DATA COLLECTION

2.1 INTRODUCTION - OVERVIEW :

- Courtyard housing known as the **oldest form of residence**. Courtyards have been integral elements of residential buildings(mainly in southern part of India) across various cultures and time periods.
- The historical evolution of courtyard is from **ancient civilization** such as **Mesopotamia, Egypt, Greece, and Rome,** courtyards were **central to architectural designs**. They often served **multiple purposes**, such as providing **natural light, ventilation,** and space for **communal activities.**
- The characteristics of courtyard housing depend on the **environment and culture** of a group of the specific region.
- Most **Hindu courtyards** are distinguished by the placement of a **Tulasi (basil)** plant which is **watered and worshipped**
- 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.

2.2 COURTYARD & ITS TYPES

Various types of courtyard houses can be found across states like Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, and Telangana. Here are some types of courtyard houses in Southern India:

2.2.1 CHETTINAD HOUSES:

Chettinad, a region in Tamil Nadu, is known for its distinctive architecture, and Chettinad houses often feature large courtyards. These houses have spacious rooms arranged around the central courtyard, and they are characterized by ornate woodwork, intricately carved pillars, and colorful tiles.

2.2.2 AGRAHARAM COURTYARD:

Agraharam courtyard houses are traditional dwellings found in South Indian Brahmin communities. Characterized by a linear layout, these houses feature a central courtyard, known as "Agraharam," surrounded by homes facing the street. The courtyard serves as a communal space for social activities, religious ceremonies, and community gathering.

2.2.3 KERALA NALUKETTU:

In Kerala, the traditional Nalukettu house is characterized by a central courtyard called the "nadumuttam." The term 'Nalukettu' is derived from two Malayalam words - 'Nalu,' meaning four, and 'kettu,' meaning built-up sides. They are constructed in accordance with Thachu Sasthra and Vastu Shastra principles and are also known by different names depending on the caste, such as tharavadu, kovilakam, kottaram, meda, or illam.

TYPES OF NALUKETTU

NALUKETTU - 1 courtyard with 4 blocks

ETTUKETTU - 2 courtyard with eight blocks, where

PATHINAARUKETTU - 4 Courtyards with sixteen blocks, respectively.

2.3 COURTYRAD PLANNING IN AGRAHARAM

Temple played a vital role in the Brahmin communities, Agraharam means being temple on either side. The settlements were based on the aspects of Vedic town planning and lifestyle.

2.3.1 IMPORTANCE OF VASTHU SHASTRA

- Sri Chakra is the Yantra of the Cosmos.
- Courtyard represents the four corners of the Universe.
- Brahmasthan is the main centre of any plot
- Plot should be fixed for open space.
- Construction in the centre of plot means blocking the main energy.

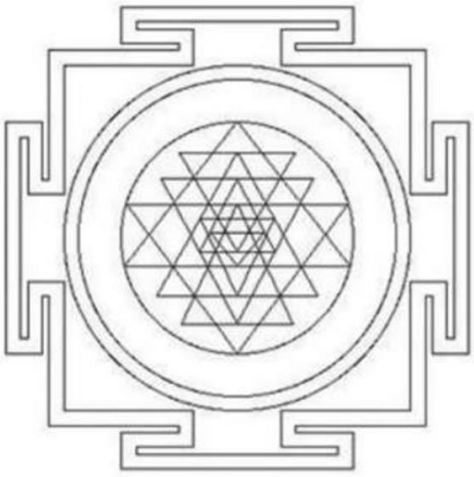


Fig-2.3.1 Vasthu Shasthra

2.3.2 COURTYARD PLANNING IN CHETTINAD STYLE

Mudhal kattu : Receiving section The mudhal kattu as the receiving section consists of thinnai (plinth) and rezhi (passageway). The street edge of each house has a semi-open space covering the entire front edge of the house, which is known as **thinnai**—a place for interaction on the street.
Talvaram is a part of the interior courtyard, and thinnai becomes the transition from the street. Thus, in this space, one experiences being part of the interior as well as the exterior.
Irandam kattu: Living section As one **passes through rezhi,** the large space opens up in the front. This space is an amalgamation of multiple functions, consisting of **mutram (courtyard), talvaram (semi-open space), koodam (semi-open space), and nadai arai (enclosed room).**

2.3.3 COURTYRAD PLANNING IN KERALA STYLE

The basic form: The basic module of vernacular residential building of Kerala is known as nalukettu with four blocks built around an open courtyard. In the case of repeated modules, the nalukettu becomes ettukettu (eight blocks building) or a group of such courtyards.

The roofs have steep slopes up to almost 458 and the gables (mughappu) are provided at the ends of roof to enhance ventilation and to allow the warm air to escape.

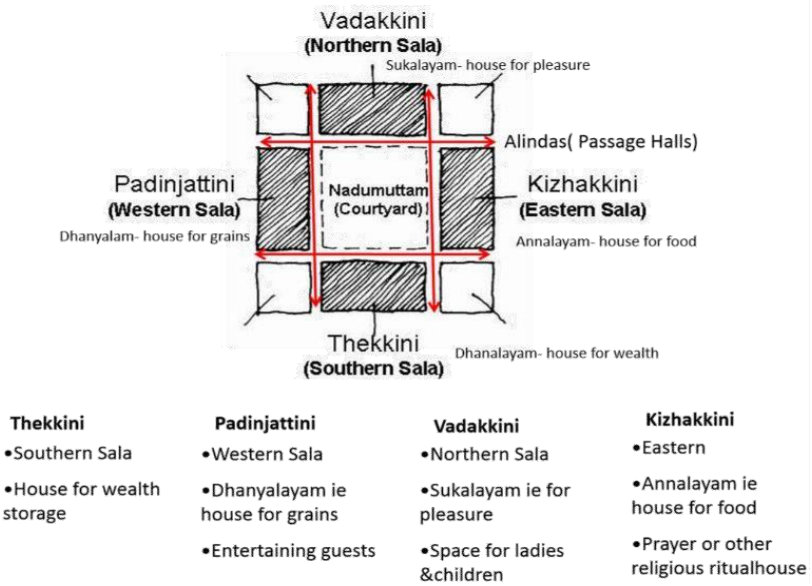


Fig-2.3.3 Zoning based on Vasthu Shasthra

2.4 COURTYARD ELEMENTS

The elements of a courtyard can vary based on cultural, architectural, and functional considerations. However, there are common features that are often found in courtyards across different traditions. Here are some key elements of a courtyard:

ELEMENTS

CENTRAL OPEN SPACE

WALL ENCLOSURE

PAVING AND FLOORING

WATER FEATURES

FUNCTIONAL AREAS

ORIENTATION, SIZE & SHAPE

COURTYARD NATURAL ELEMENTS

GARDENS AND GREENERY

ARCHITECTURAL ELEMENTS

CULTURAL & RELIGIOUS SYMBOLS

2.4.1 CENTRAL OPEN SPACE

courtyards typically have a central open area that serves as the focal point. This space can be used for various activities and may be left open or adorned with decorative elements.

Fig-2.4.1 Central Open Space

2.4.2 ORIENTATION, SIZE & SHAPE

The orientation of the courtyard, ensuring that the space is not only aesthetically pleasing but also **functional and comfortable** for the residents.

Building **layout** plays an important part in the **orientation** of the courtyard, The orientation of a courtyard in a residential building refers to **its positioning.** Thus the **sun location, shading performance, solar gain and wind direction,** all these can **effect** of the **microclimate condition**

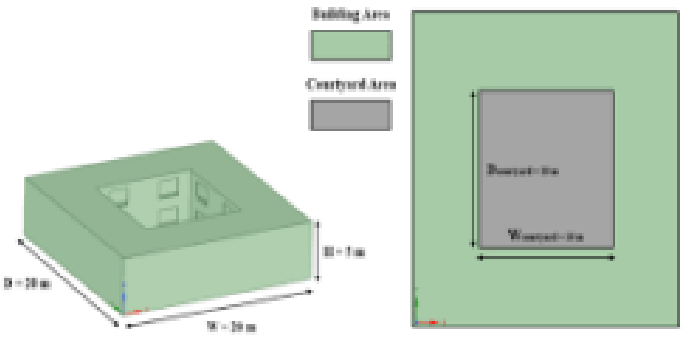


Fig-2.4.2 ***Orientation, Size & Shape***

2.4.3 WALL ENCLOSURE

wall enclosure refers to elements, which have significant roles of microclimate condition such as **walls, windows and door** these components define the form of a courtyard with the building. Furthermore, designers during the design stage can manipulate by these elements to provide positive impact of the courtyard.

Fig-2.4.3 Wall Enclosure

2.4.4 COURTYARD NATURAL ELEMENTS

The natural elements in courtyard increases the **thermal comfort**. The significant effects of courtyard's as elements is to modify the surrounding environment through **reducing solar radiation, lower the air temperature by landscaping shading and other function**, which will provide **thermal comfort for users'.**

Fig-2.4.4 ***Courtyard Natural Elements***

2.4.5 PAVING AND FLOORING

Courtyards may have paved or tiled surfaces. The choice of materials often reflects the local climate and architectural traditions.

Fig-2.4.5 Paving And Flooring

2.4.6 GARDENS AND GREENERY

Many courtyards incorporate gardens with native plants, trees, and sometimes even small vegetable patches. Greenery enhances the visual appeal and may provide shade.

Fig-2.4.6 Gardens And Greenery

2.4.7 WATER FEATURES

Fountains, reflecting pools, or small water features are common in traditional courtyards.

Water elements not only add a decorative touch but also contribute to a sense of tranquility.

Fig-2.4.7 Water Features

2.4.8 ARCHITECTURAL ELEMENTS

Depending on the architectural style, courtyards in traditional houses may feature colonial elements such as arches, columns, and verandas.

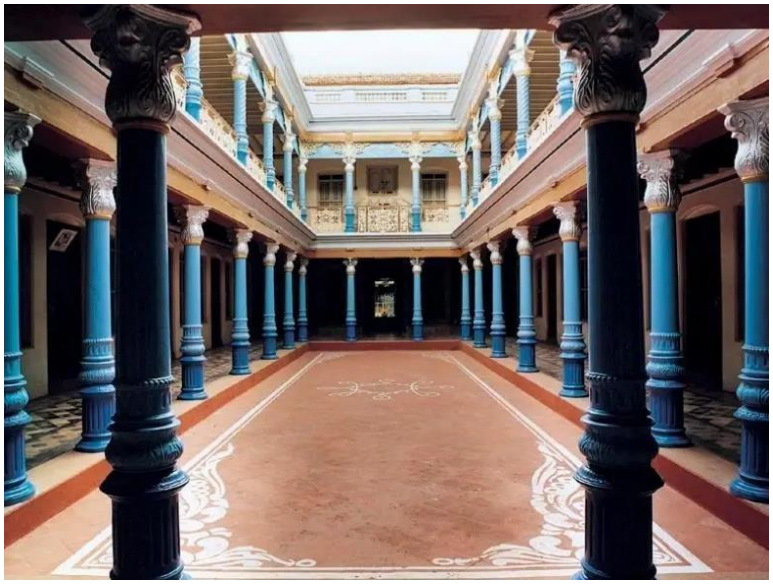


Fig-2.4.8 Architectural Elements

2.4.9 FUNCTIONAL AREAS

Courtyards can serve different functions, and therefore, may include functional areas like cooking spaces, play areas for children, or spaces for communal gatherings or events.

Fig-2.4.9 Functional Areas

2.4.10 CULTURAL AND RELIGIOUS SYMBOLS

Depending on the culture and traditions, courtyards may feature statues, religious symbols, or other cultural artifacts that hold significance for the inhabitants.

Fig-2.4.10 Cultural And Religious Symbols

2.5 COURTYARD-BENEFITS

2.5.1 CULTURAL BENEFIT

Residential courtyards play a vital role in **preserving, promoting, and celebrating** cultural diversity within communities, **enriching** the lives of residents by fostering social bonds and a strong sense of cultural identity. 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.

Fig-2.5.1 Cultural Benefit

2.5.2 ECONOMICAL BENEFIT

Some financial benefits are closely associated with 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

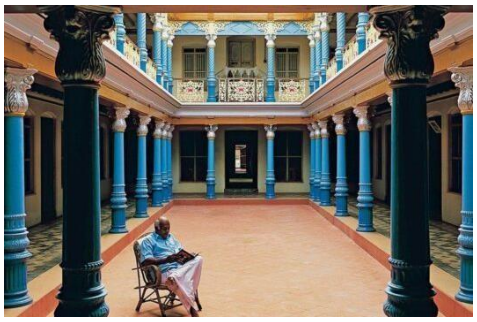


Fig-2.5.2 Economical Benefit

2.5.3 CLIMATIC BENEFIT

Courtyards referred as a **microclimate modifier** in the house due to their ability to **mitigate high temperatures, channel breezes and adjust the degree of humidity.** It has a properties of **self-shading and thermal lag** that **reduces heat gain.** It also a source of **air flow** and **thermal comfort**. The courtyard floor and surrounding walls are usually a **good radiator** of heat depending on the **material used**. It acts like a **cool air reservoir.**

Fig-2.5.3 Climatic Benefit

2.5.4 PSYCHO-SOCIAL BENEFIT

The court is the heart of the house , acts as a space for **interaction for all family members.** In most of the courtyard houses the court is visually secluded from outdoor and gives **visual privacy.** It also give **acoustical privacy,** by absorbing 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**.

Fig-2.5.4 Psycho-Social Benefit

CHAPTER – 3

LITERATURE STUDY

3.1. TITLE:

PASSIVE ENVIRONMENT CONTROL SYSTEM OF KERALA VERNACULAR RESIDENTIAL ARCHITECTURE FOR A COMFORTABLE INDOOR ENVIRONMENT: A QUALITATIVE AND QUANTITATIVE ANALYSES

3.1.1 INTRODUCTION:

- Environmental architecture, means architecture adjusted to its surroundings or in harmony with nature creating a **healthy environment for human beings** by maximizing the utilization of natural energies.
- It provide physiologically comfort & comfortable indoor environment in response to the seasonal variations of the climate.
- The modern day practice, materials and technology, results in high energy consumption, in an attempt to provide thermal comfort indoors.
- The vernacular architecture at any place on the other hand has evolved through ages by consistent and continuous effort for more efficient and perfect solutions.
- The authors have conducted a qualitative analysis , passive methods for a comfortable indoor environment.
- A quantitative analysis was also carried out based on field experiments by recording thermal comfort parameters in a selected building.
- The study has provided positive results confirming that the passive environment control system is highly effective in providing thermal comfort indoors in all seasons.

Monthly normal climate of Kerala [18].

Months		January	February	March	April	May	June	July	August	September	October	November	December
Temperature (°C)	Max	32	32	33	33	32	29	28	28	29	30	31	32
	Min	21	22	24	25	25	24	23	23	23	23	23	21
Rainfall (mm)		14	15	31	108	247	556	502	304	208	277	172	49
No. of rainy days		1	1	2	6	11	21	20	16	11	12	8	3
Relative humidity (%)		65	70	75	80	77	85	90	90	86	83	80	65

Table - 3.1

3.2 MAJOR PROBLEMS IN KERALA:

Major problems in the traditional houses of Kerala are:

Excess of moisture in the atmosphere - Makes indoors very humid & prevent evaporation, proper orientation helps in regular airflow.
Heavy rainfall - prevented by pitched roofs covered with burnt clay roofing tiles, thatch… **Intense solar radiation** - prevents by Large roof overhangs that protects walls from sun & shaded verandahs
Effect of high temperature - use of walls with jalli, prevents the direct sunlight entry.

Use of insulative materials like laterite for external walls, timber for ceiling and roof protects interior from excessive heat

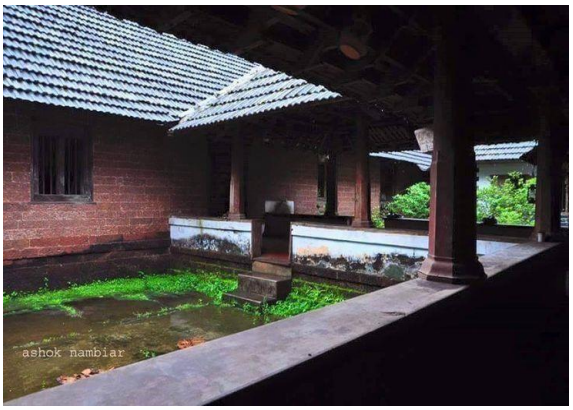


Fig-3.2 Excess Moisture

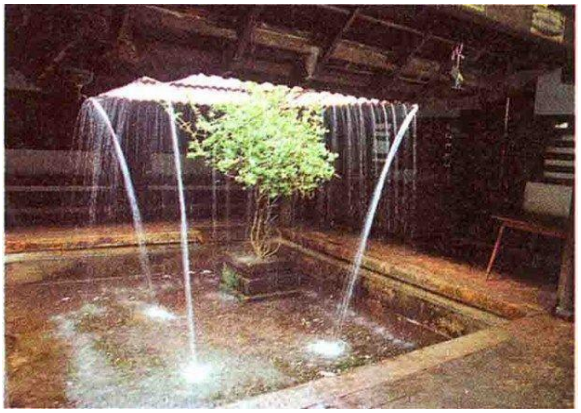


Fig-3.2 Heavy Rainfall

Fig-3.2 Intense Solar Radiation

Fig-3.2 High Temperature

3.3 QUALITATIVE ANALYSIS :

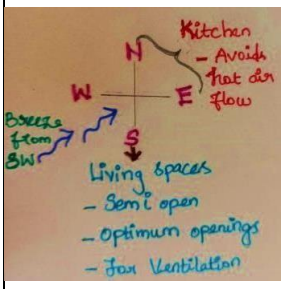
Orientation of building	**Internal space arrangement**	**Internal courtyard**	**Openings & ventilation**	**Thermal protection**
Buildings are strictly oriented to thecardinal directions as per **vasthusasthra., controls environment with maximum comfort in all seasons** Cardinal directions **determined by** traditional techniques based on **solar path** and **shadows** Building entry: **S or E** Day time spaces placed on : **N & S** Night time spaces placed on : **W**	The positioning of spaces is very much important in spatial planning.  ***Fig-3.3-Internal Space Arrangement*** All other spaces including bedrooms are arranged around the courtyard so its easy to permit adequate **air movement** in all season	Internal courtyard are opened fully or partially.It acts as Micro climate Modifiers. It is a excellent thermal regulators. Smoke study was conducted to under -stand air movement.  ***Fig-3.3-Smoke study***	Open planning and free spaces helps in good ventilation windows, ventilators is scope for air movement. Roof -open gables (mughappu) & external walls - (azhi) wooden jalli helps to draw air movement.	**Thermal Insulation** achieved by Materials + Construction techniques in walls ,roofs. It also achieved by, wooden ceiling (tattu) - beneath the roof Jalli openings - air Ventilation It has reverse effect & its overcome by constant air exchange between outdoor and indoor with the help of openings provided on the external wall.

Table - 3.3

3.4 QUANTITATIVE ANALYSIS :

Building selection criteria	**Building description**	**Experimentation setup**	**Field measurements**
The typical traditional building ,remain in its **Original form without Any alterations** or modifications is selected A region with **more temperature fluctuation** is selected by comparing the climatic data of Kerala.	Type: 300 years old Residential Building(ettukattu) Location: Nilambur, Malappuram, Kerala Shape: Rectangular Character: 2 courts, 1 is single storied & other is 2 storied	AES is a Combination of electronic sensors to Record RH, Temperature , air movement, a high speed data logger, a memory module to record data from the various sensors and Computer interface to view & download	Temperature, RH Sensors fixed in verandah, bottom And top of courtyard, and a bedroom. Continuous data From June to October 2009. Data From various Sensors taken at interval of 15 min

Fig-3.4-PLAN

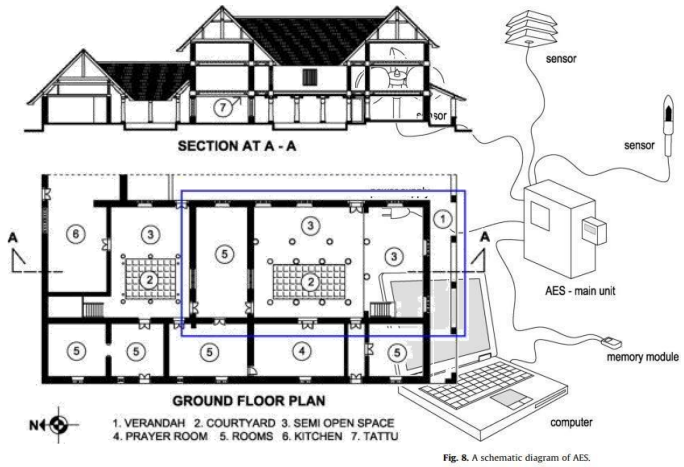


Fig. 8. A schematic diagram of AES.

Fig-3.4-Experiment setup

Fig-3.4-Field study

Table - 3.4

3.5 RESULTS & ANALYSIS:

3.5.1 TEMPERATURE

The indoor temperature -very low diurnal variation - high thermal insulation property on envelope. No conductive heat gain in building envelope. Absence of time lag between outdoor & indoor air temp. proves thermal insulation property of materials & high degree of natural ventilation maintained in building. when outdoor hot air transmitted into indoor by wind, reduces intensity of heat. The outdoor air at a higher temperature looses the heat in indoor. Because of continuous heat exchange. This is because the cooler air settles at the bottom as explained in the qualitative analysis.

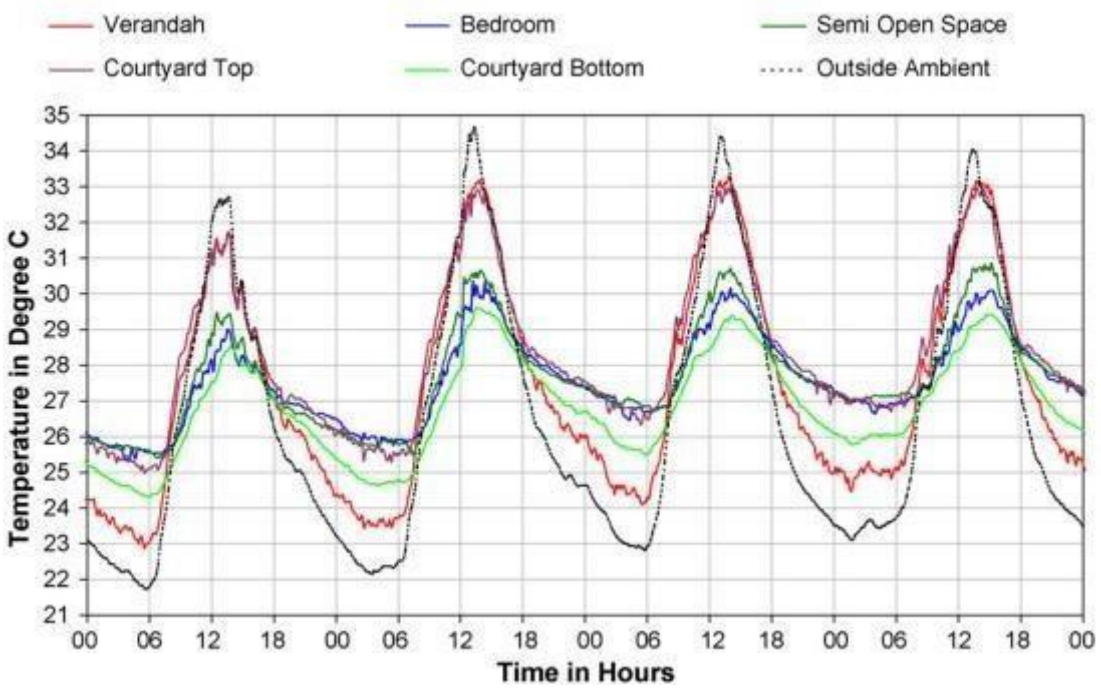


Fig-3.5.1- Temperature vs Time

3.5.2 WIND MOVEMENT

- Figs.3.5.2 clearly show that building system is maintaining a continuous and controlled air flow indoors.
- This actually helps to accelerate the **evaporative cooling by continuous exchange of air** that is in contact with the occupant's body especially when the **RH is higher along with high temperature.**
- In this case the white area is bigger than in the west graphs and the sun rays hit the glass during all the year from 6.00am to 10.00am.
- Air movement @ regular interval 5min for 3 days
- Outdoor wind velocity – max – 3.5 m/s
- Indoor wind velocity – min – 0.5 m/s
- Air movement recorded by High speed Data Logger

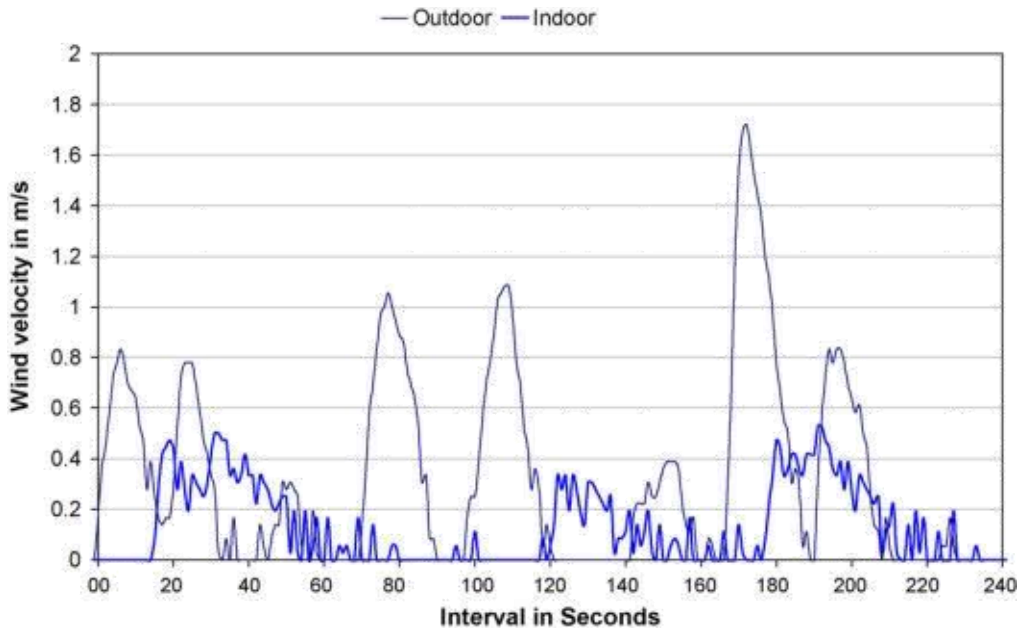


Fig-3.5.2- Wind velocity vs Time

3.5.3. RELATIVE HUMIDITY

DAY: Min-58% - Outdoor RH –Max. Temp Min-77% - Indoor RH –Max.Temp30 Deg
NIGHT: Outdoor RH –Max (97-100%)
Indoor RH –Fluc – (84-88%)
Diural Variation: Outdoor RH-40% ; Indoor RH-10%

Fig. 3.5.3 shows control over the RH within the building system.

While the outdoor RH reaches its saturation point, the indoor RH is maintained around 85%. This is achieved due to the presence of air volume indoors, maintained at optimum temp eratu re.

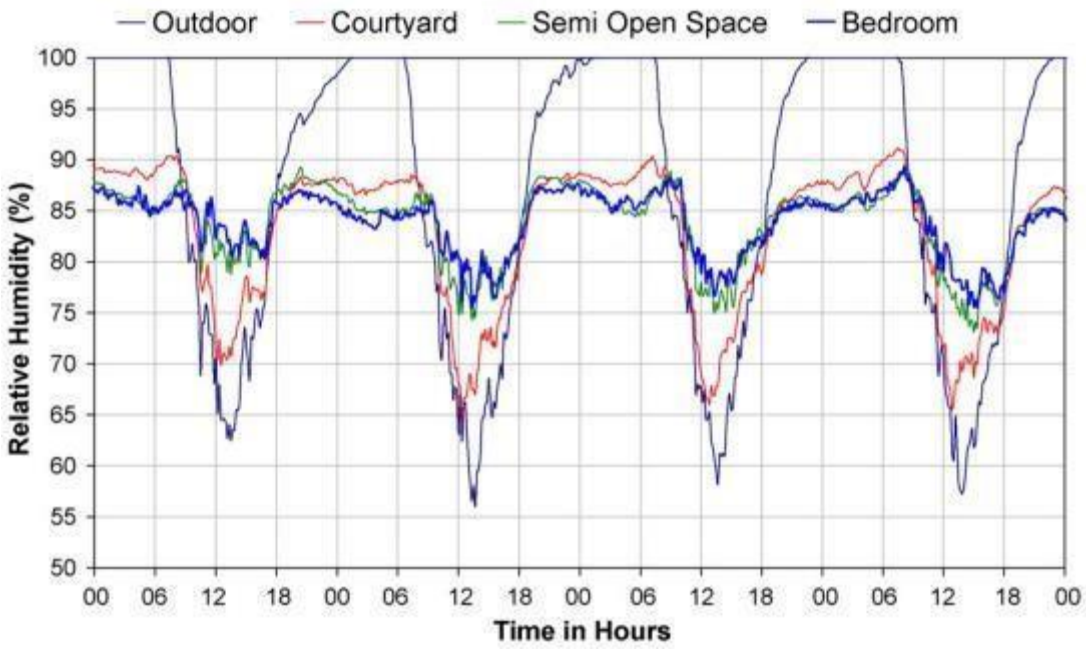


Fig-3.5.3RH vs Time

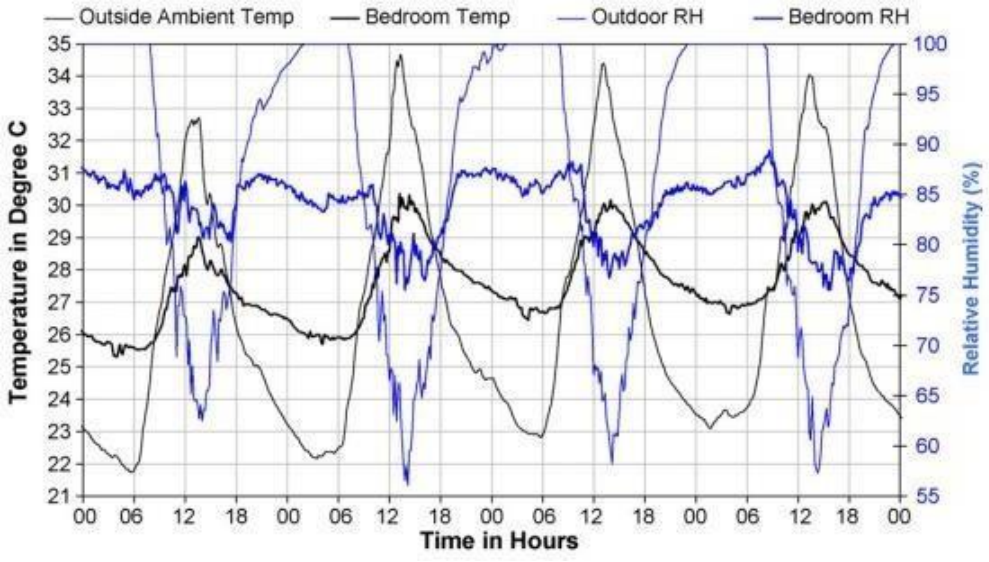


Fig-3.5.3-Temperature & RH Vs Time

3.6. INFERENCE

- Thermal comfort of the interiors determines the energy consumption. Diurnal variation of indoor air temperature is less compared to outdoor air temperature. Decrement factors winter, summer, monsoon is 0.22 ; 0.28 ; 0.33. Decrement factors effectively controls the indoor temperature in all seasons
- Natural ventilation has the potential to save energy use in buildings. Hence it is recommended to improve the indoor environmental quality (IEQ) by natural ventilation to reduce energy consumption.
- Continuous air flow is maintained inside building and in most of the time it is around 0.5 m/s. This has been re-affirmed by the observations from Smoke Study . This study shows that air movement is maintained inside the building. Also, experimental and numerical studies reported that a controlled airflow in and around a building by utilizing cross ventilation is helpful in order to improve indoor thermal comfort.
- The findings from the quantitative analysis are very much in agreement with the inferences drawn from the qualitative analysis. So Concluded from investigation that the passive environment control system is very effective in providing thermal comfort to the occupants.
- During the day time , indoor temperature is high- 30.8C, the relative humidity is low - 77%. This falls well within the comfort region. the wind velocity is around 0.5 m/s and it is very near to the comfort zone. During the night, since temperature is about 26.8C, the increase in humidity (up to 88%) does not really affect the indoor comfort condition.

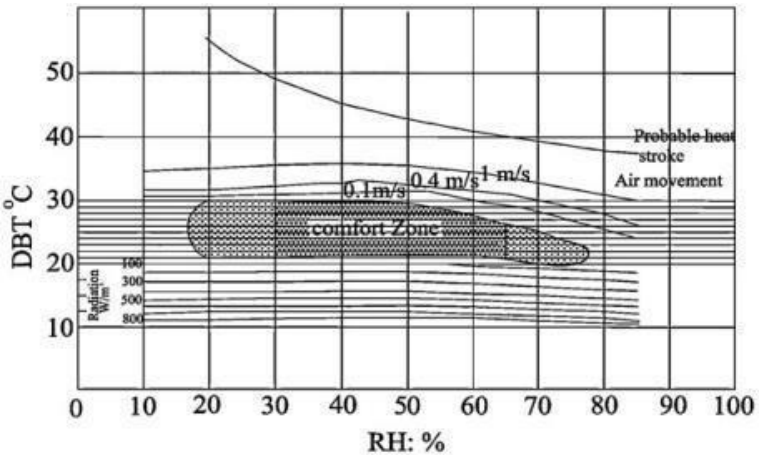


Fig-3.6-Olgyay Bioclimatic Chart

CHAPTER – 4

CASE STUDY

4.1 COURTYARD HOUSE AT THIRUPAZHANAM, LOCATION: THIRUVAIYARU (TALUK), THANJAVUR (DT)

4.1.1 INTRODUCTION:

House 1 in Thirupazhanam, Thiruvaiyaru taluk, and Thanjavur district was built in the 1940s.It is housed in agrahram-style housing and connects to the popular Arulmigu Aabathsahaayar Temple at one end, which is one of the oldest temples built for Lord Shiva.

AREA – 28m X 8.42 = 236 Sq.m ; FACING - SOUTH

Fig-4.1.1

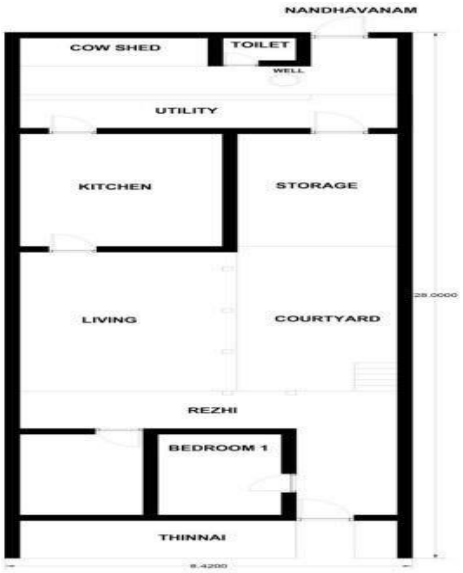


Fig-4.1.3

Fig-4.1.2

4.2 SPATIAL PLANNING

4.2.1. THINNAI

Thinnai is the first **raised platform** which is

still used and kept in this house it is covered with cement sheet as the olden clay barrel tiles were restored due to damage it also has a **pirai** to light lamps in the entrance.

Nowadays it is used as a **seating space** but also it is used for **drying clothes** and a portion of thinnai is broken for the purpose of **two wheeler parking** requirement in this house.

Fig-4.2.1

4.2.2. NADAI ARAI

The **rezhi leads to the Nadai arai**, which was once used to **store grains**, and a hole in the roof with a cover, which was once used as a **mechanism for drying paddy** on the roof and pushing it into the hole to be stored in the Nadai arai.

Nadai arai is currently used as two portions one acts as **bedroom** and partition made in between Nadaiarai. As usual the nadai arai is
open one side at thinnai and the entry is through Rezhi

Fig-4.2.2

4.2.3. REZHI

Entry door leads to the rezhi which is a semi open space connecting outer and inner spaces which is always a transition space the space is dedicated for farmworkers to enter and use it for grain lifting.

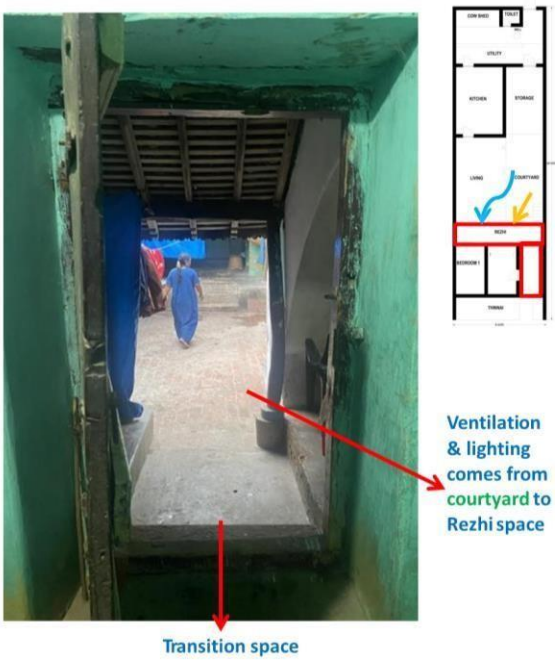


Fig-4.2.3

4.2.4. KOODAM

Koodam is a semi-open space that is used as a living area and also for gatherings, daily prayers, and as a sitting area. This place is also used for entertaining guests and sleeping at night. There is a series of wooden columns located on the semi-open side collecting the muttram with exposed wooden rafters, which gives it an aesthetical look.

4.2.5. TALVARAM

Talvaram is next to rezhi, which is a semi-open space around the muttram. It is used for sitting and acts as a family gathering space. A series of columns and a leaning roof with exposed wood make this space the most aesthetic one in the house.

4.2.6. COURTYARD – "MUTTRAM"

The courtyard (muttram) is located in the center, adding to the character of the living space; it is lower than other spaces and is
surrounded on three sides by semi-open spaces; it brings sunlight and ventilation to the adjoining spaces, providing Thermal Comfort.

The courtyard (muttram)

Area 3.3m X 7.5m = 24.75sq.m

Depth – 1ft

Induced Ventilation takes place in courtyard

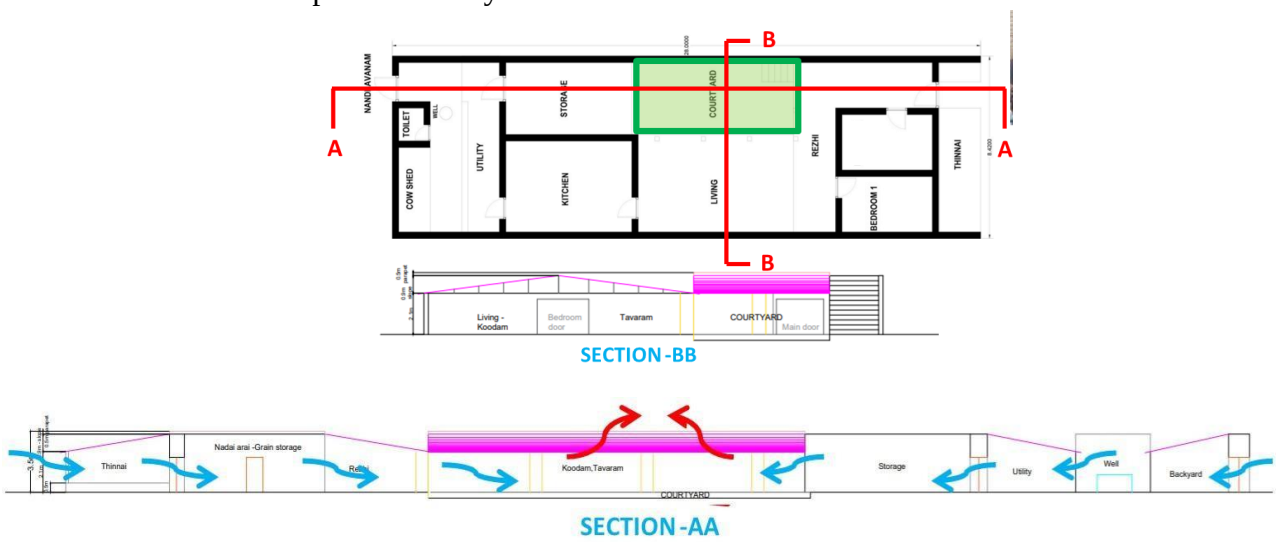


Fig-4.2.6-Plan & Section

Muttram was used for drying food materials in the sun. Nowadays, it is also used for drying clothes. The repetition of rectangular plots, positioned in accordance with the major axes East/West and North/South, the organization of the houses in successive courtyards, and the hierarchy of the pavilions with sloping and terrace roofs have created a specific "roofscape" unique to this house.

Fig-4.2.6

Fig-4.2.6

Dated on-10th Nov 23

Thermal comfort parameters	**Indoor Values Obtained**	**Outdoor Values Obtained**	**Range**
Temperature	25 dec C	28 dec C	Comfort
Humidity	80%	80%	High
Wind movement	11km/hr	12km/hr	Normal flow

Table - 4.1

4.2.7. KITCHEN

Koodam connects to the samayal arai, which specifies space for cooking with a well and a skylight. This house was renovated, and typical low-lying platforms and slab drains were removed and replaced with kadappa stone according to their preferences.

Kadappa

stone shelves

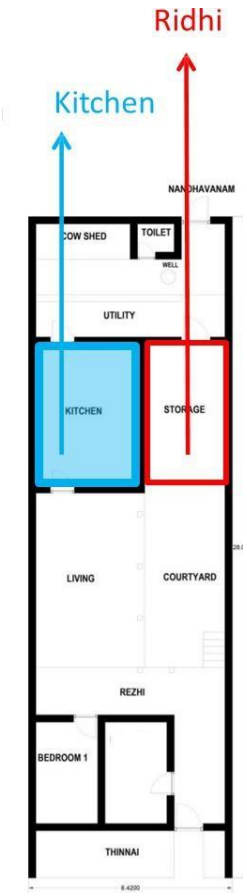


Fig-4.2.7

4.2.8. STORE AREA – RIDHI

Muttram on the other side has this ridhi, which is specifically used for storage purposes, and the arches are the pirai, which was originally used as an aesthetic wall but is currently converted into storage by placing stone slabs in the pirai.

Fig-4.2.8

4.2.9. NANDHAVANAM: As usual the back compound wall gives access to nandhavanam which is a open space which interconnects all agraharams and acts a place for growing needful vegetables and flowers

4.2.10. UTILITY: There is the thodanadai (utility) which connects ridhi and samayal aria (kitchen) this place is used as outdoor storage as well a for washing vessels. This space is semi-covered and in olden days it is also used for cooking

Fig-4.2.10

4.2.11. BACKYARD: Then there is kollai pakkam (backyard) in which there is a well located within it and a specified space for cattle are provided and there is also a toilet placed in the backyard.

Fig-4.2.11

4.3 COURTYARD HOUSE AT CHOLANGANALLUR, LOCATION: THIRUVARUR (DT)

4.3.1. INTRODUCTION:

House 2 in Cholanganallur, Thiruvarur district was built in the 1950s.It is housed in courtyard-style housing and connects to the sree vishvanathar Temple at one end, which is one of the oldest temples built for Lord Shiva.
AREA – 19.7m X 14.01 = 276 Sq.m ; FACING - NORTH

Fig-4.3.1

Fig-4.3.1

4.4. SPATIAL PLANNING:

4.4.1. THINNAI & THALVARAM

Thinnai is the first raised platform(3ft) from thalvaram(2ft)which is still used and kept in this house it is covered with roof tiles it also has a 2 pirai @ entry wall to light lamps in the entrance. Early times Thinnai was used as Padasalai.(25 Years before)
Nowadays it is used as a seating space. And its enclose with wooden frame jalli for privacy screening

Fig-4.4.1

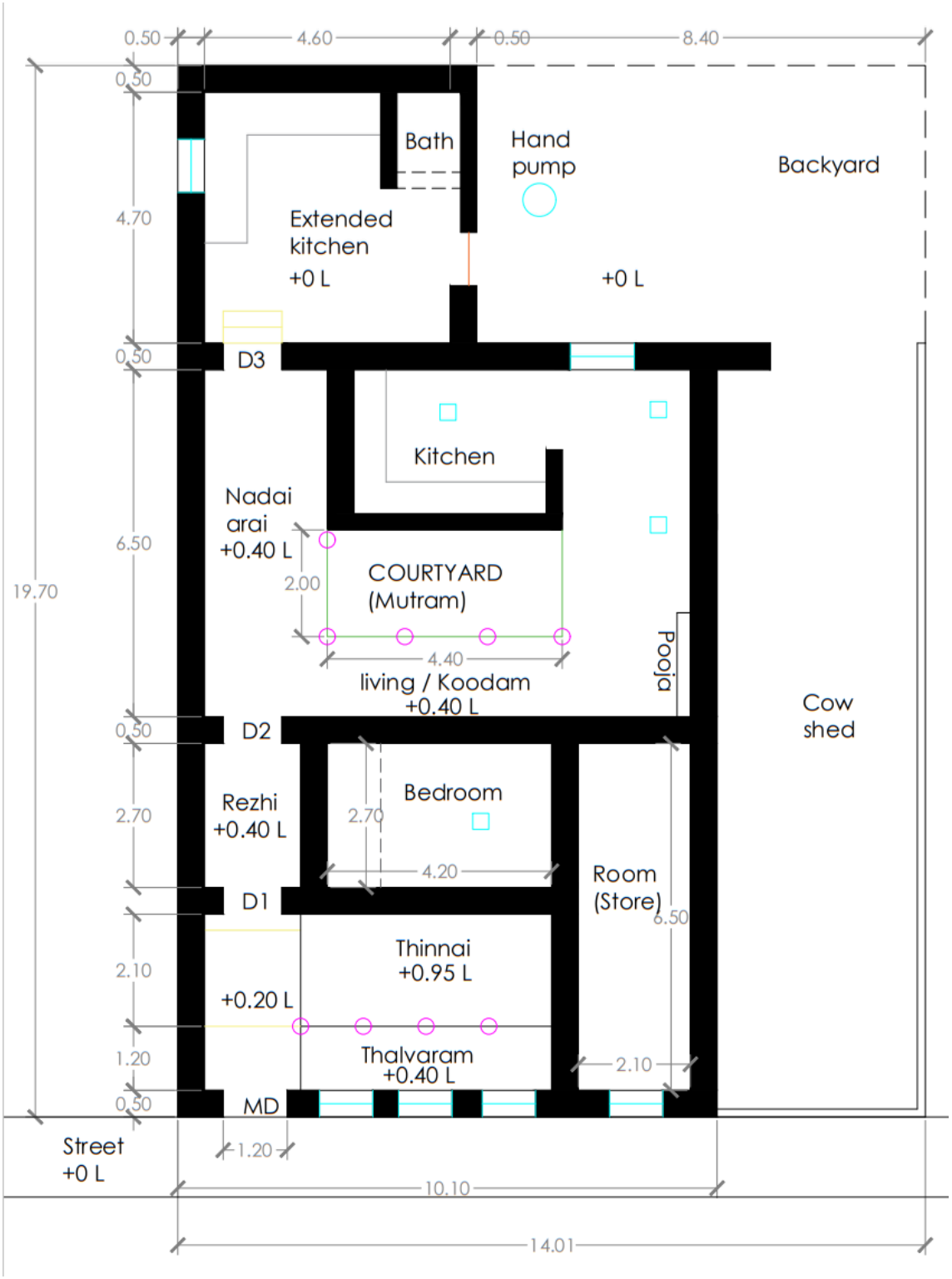

0.50
4.60
0.50
8.40
0.50
Bath
Hand pump
Backyard
4.70
Extended kitchen
+0 L
+0 L
0.50
D3
Kitchen
Nadai arai
+0.40 L
6.50
2.00
COURTYARD
(Mutram)
19.70
4.40
Pooja
living / Koodam
+0.40 L
Cow shed
0.50
D2
Rezhi
+0.40 L
2.70
Bedroom
2.70
4.20
Room
(Store)
6.50
D1
2.10
Thinnai
+0.95 L
+0.20 L
1.20
Thalvaram
+0.40 L
2.10
0.50
MD
Street
+0 L
1.20
10.10
14.01

Fig-4.4 -PLAN

4.4.2. REZHI

Next to Thinnai, Entry door leads to the Rezhi which is a semi open space connecting outer and inner spaces which is always a transition space the space.

4.4.3. LIVING

Next to rezhi , the living spaces is surrounded by mutram space. Because of this, Living space is well litted and ventilated always. Pirai is place at regular intervals at living wall.

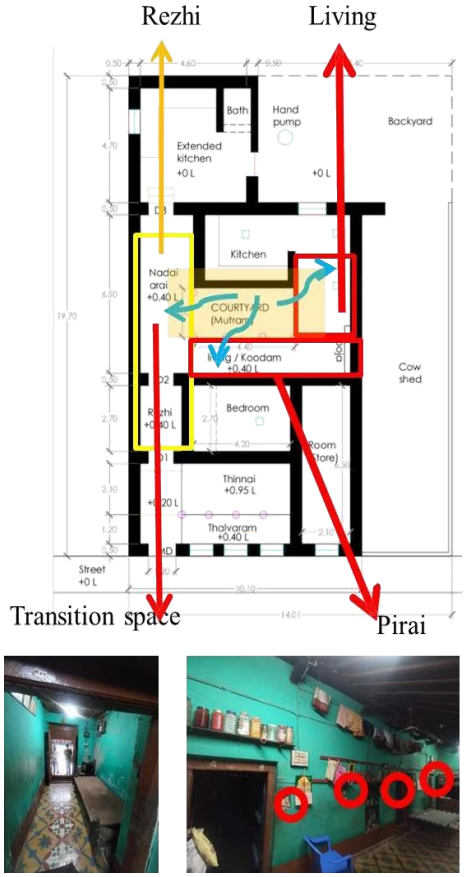


Fig-4.4.3

4.4.4. BED ROOM:

Beside to the living space, there is a room acts as bedroom, Before ,the half portion in this room is acts as for storing grains ,but after renovation, they demolished that and use fully as a single room.

Fig-4.4.4

4.4.5. STORE ROOM

The long room of the corner of the

house acts as a storage space for the whole house, which have kadappa shelves and almirah sections.

Fig-4.4.5

4.4.6. KITCHEN

The kitchen space is located back to the courtyard, One side counter part is covered under the courtyard roof section. It also has a skylights & Window view. The kitchen waste water & courtyard water are pass at back side to the extended kitchen area .

Fig-4.4.6

4.4.7. EXTENDED KITCHEN

The Extended kitchen space is located back side of the house, which is used for cooking ason old style (Viragaduppu Murai)

Fig-4.4.7

4.4.8. BACKYARD

Next to extended Kitchen, it opens to Backyard space. It is fully vegetated with green trees. And it has Hand pump water area. It also used for drying clothes

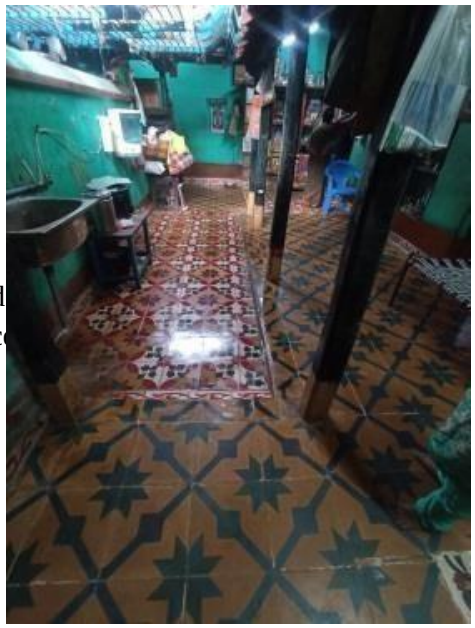
Fig-4.4.8

4.4.9. COWSHED

Next to Backyard, it opens to Cowshed space.

Fig-4.4.9

4.4.10 COURTYARD – MUTTRAM



Area – 4.4 X2.2 = 9.68sq.m

Depth before alter –(-0.90m) After alteration – (+0.30m)

Courtyard in this house is fully enclosed form.

The courtyard space gives thermal comfort to the surrounding rooms and
Air is ventilated over here & Light penetrates fro courtyard to other spac
Sourounding areas are fully green & vegetated ,

so the so the cool breeze always flows through the courtyard space

4.5. THERMAL COMFORT STUDY

Normal Comfort Temp. : 20-25 deg C Normal Humidy range : 30-55%

Instruments (Barometer(4.5(a), Anemometer4.5(b)) used to measure the thermal comfort ranges at the live site.
Measurements Dated on: 7th Nov 2023

Fig-4.5(a)

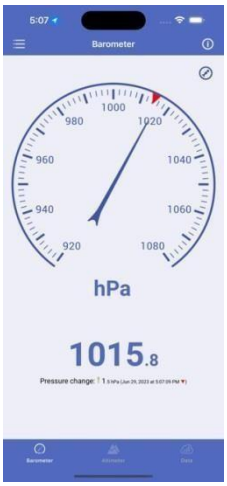


Fig-4.5(b)

Table - 4.2

Thermal comfort parameters	Indoor Values Obtained	Outdoor Values Obtained	Range
Temperature	20 dec C	22 dec C	Comfort
Humidity	73.2%	74%	High
Wind movement	10. 4.1 m/s	10. 6 m/s	Normal flow

CHAPTER – 5 ANALYSIS :

5.1	House 1 -Thiruvaiyau	House 2 –Thiruvarur
Location	Thiruvaiyaru is a town located in the Thanjavur district of the Indian state of Tamil Nadu. It is situated on the banks of the river Kaveri, which is one of the major rivers in southern India.	Thiruvarur is a town located in the Nagapattinam district, near the east coast of the Bay of Bengal. It is situated in the Cauvery Delta region and is known for its cultural, historical, and religious significance.
Topography	Topographically, Thiruvaiyaru is surrounding region are part of the fertile Cauvery Delta. It is well-suited for agriculture. The region benefits from the rich alluvial soil deposited by the Kaveri River.	The topography of Thiruvarur is characterized by the fertile plains of the Cauvery Delta. The region benefits from the alluvial soil deposited by the Cauvery River, making it highly suitable for agriculture.
Financial condition	It's a cultural rich Heritage zone, and it has many temples, it acts as a important Tourist places in Tamilnadu (for visiting temples)	Thiruvarur is also renowned for its cultural and religious heritage. The town is home to the Thyagaraja Temple, dedicated to Lord Thyagaraja, a form of Lord Shiva. The temple is an important pilgrimage site and a center for classical music and dance.
Shape	Rectangular	Rectangular
Form	Semi Enclosed – 3 sided	4 Side enclosed
Total area	236 Sq.m	276 Sq.m
Courtyard area	24.75 Sq.m	9.68sq.m
Height	3.5m	3.5m
Orientation	N - S	W-E
Shading devices	Cantilever sloped roofs	Cantilever sloped roofs
Occupant's nos.	6	4
User occupation	Archagar	Agriculture
Court depends on	Occupants Tradition, Culture & Occupation	Occupation
Usage	Drying clothes, foods, sleeping & recreational space	Recreational space

Table - 5.1

CHAPTER – 6
SUMMARY, CONCLUSION

6.1 POSITIVE ASPECTS OF COURTYARD:

6.1.1 NATURAL LIGHT AND VENTILATION:

The open space of the courtyard allows for ample natural light and ventilation to penetrate the interior of the house. This helps in reducing the reliance on artificial lighting and mechanical ventilation, contributing to energy efficiency and a more sustainable living environment.

Fig-6.1.1

6.1.1.1 LIGHTING

Lighting plays a crucial role in extending the use of the courtyard into the evening. Various lighting fixtures, such as lanterns, string lights, or embedded lights, can be strategically placed to enhance the atmosphere.

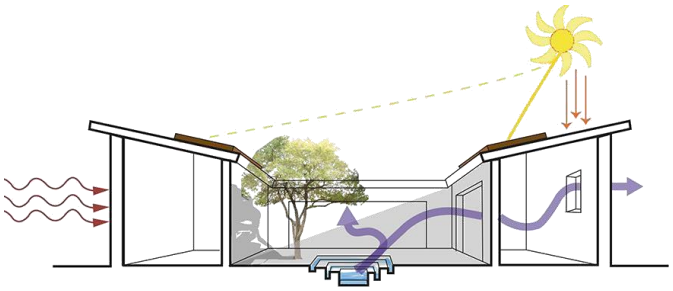


Fig-6.1.1.1

6.1.1.2 CROSS -VENTILATION

Designing the courtyard to allow for cross-ventilation is crucial. This involves creating openings on opposite sides of the courtyard to allow air to flow through.

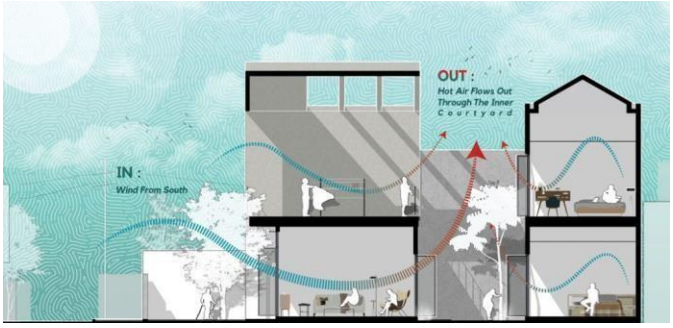


Fig-6.1.1.2

6.1.2 PRIVACY:

Courtyard houses often provide a sense of privacy and seclusion. The central courtyard is typically enclosed by the surrounding building, creating a private outdoor space that is shielded from the surrounding neighborhood or street.

Fig-6.1.2

6.1.3 TEMPERATURE REGULATION:

Courtyard houses often leverage natural elements to regulate temperature. The open space can act as a thermal buffer, helping to moderate temperatures within the house. The courtyard can also serve as a cooling mechanism, capturing breezes and providing a comfortable microclimate

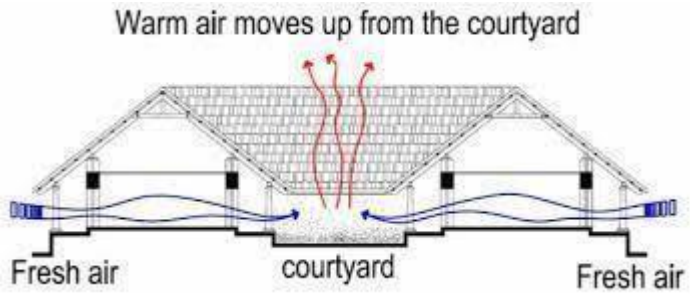


Fig-6.1.3

6.1.4 CONNECTION WITH NATURE:

The central courtyard serves as a link between the interior and the outdoors, fostering a strong connection with nature. Residents can enjoy the benefits of outdoor living while still maintaining a level of privacy and security.

Fig-6.1.4

6.1.5 AESTHETIC APPEAL:

Courtyard designs often have a timeless and aesthetically pleasing quality. The visual appeal of an open, green space in the center of the house can enhance the overall design and create a serene atmosphere.

Fig-6.1 .5

6.1.6 FLEXIBILITY AND VERSATILITY:

Courtyard spaces can be versatile and adaptable to different uses. They can function as outdoor living rooms, dining areas, gardens, or even small recreational spaces. This flexibility allows residents to customize the courtyard to meet their specific needs.

Fig-6.1.6

6.1.7 SECURITY:

The enclosed nature of the courtyard can contribute to the security of the property. The central space is often surrounded by the main living areas, providing a secure and controlled entry point to the house.


Fig-6.1.7

6.1.8 SOCIAL INTERACTION:

Courtyard houses can facilitate social interaction among family members. The central open space provides a shared area for activities, gatherings, or simply a place for family members to come together.

Fig-6.1.8

CHAPTER – 7

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