

A TOWNSHIP IN CHENNAI- WITH CHETTINADU DESIGN PRINCIPLES AND MATERIALS

A Thesis

Submitted in partial fulfillment of the requirements for the award of
Master of Architecture degree in Sustainable Architecture

by

A S SAI SARANYA (40890014)



**DEPARTMENT OF ARCHITECTURE
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY 2022



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This is to certify that this Report is the bonafide work of **A S SAI SARANYA (40890014)** who carried out the Thesis entitled "**A TOWNSHIP IN CHENNAI- WITH CHETTINADU DESIGN PRINCIPLES AND MATERIALS**" under our supervision from January 2022 to May 2022.

Internal guide

(Ar MADHUMITHA)

Internal Panel Member

(Ar. SHEETAL
AMRAOTKAR)

External guide

(Ar R BALAMURUGAN)

DR. DEVYANI GANGOPADHYAY
Dean, School of Building and Environment
Head of Department

Submitted for Viva voce Examination held on 06- May- 2022

Internal Examiner

External Examiner

DECLARATION

I **A S SAI SARANYA** hereby declare that the Thesis Report entitled “**A TOWNSHIP IN CHENNAI- WITH CHETTINADU DESIGN PRINCIPLES AND MATERIALS**” is done by me under the guidance of **AR.MADHUMITHA** (Internal) and **AR.R.BALAMURUGAN** (External) at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Master of Architecture degree in Sustainable Architecture

DATE: 06/ 05/2022

PLACE: CHENNAI



SIGNATURE OF THE CANDIDATE

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ABSTRACT

There are different townships; living communities are raised in the past years of urban development in Chennai. That has to be more meeting the standards and adhering to the thermal comfort of the occupants. The initial study is focusing on different townships which are of community living, sustainable, following passive strategies say Belapur housing and kanchanjunga apartments are studied. Further study is carried out focusing on Chettinadu history, culture, tradition, architecture and lifestyle of the people as the study area is going to be on amalgamation of chettinadu planning principles and vernacular materials into the township in Chennai. The choice of site has been made based on live proposal and in which different typologies of houses that is low rise, mid rise and high rise are designed implementing chettinadu design and planning principles and along with few alterations adhering to Codes and standards. The main aim is to provide a comfort space for LIG and EWS without any compromise towards the quality of living standards. This township with chettinadu planning and vernacular materials is a fusion of traditional style and contemporary living standards and lifestyle. The site for the project has been chosen as a live site located near Chennai, which is already a developing satellite township, in which residential area of different typologies would be recommended and proposed. The recommended township would be a chettinadu township with different typology of housing, with vernacular materials and passive strategies in order to make it more user comfort.

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF TABLES	xii
	LIST OF FIGURES	xiii
1	INTRODUCTION	1
1.1	INTRODUCTION	1
1.2	AIM	1
1.3	RESEARCH QUESTIONS	1
1.4	OBJECTIVE	1
1.5	NEED FOR THE STUDY	1
1.6	LIMITATIONS FOR THE STUDY	2
1.7	METHODOLOGY	2
2	BACKGROUND STUDY	3
2.1	INTRODUCTION	3
2.2	LITERATURE REVIEW	3
2.2.1	Chettinadu Architecture	3
2.2.2	Eco-friendly materials used in traditional buildings	5
2.2.3	Development of Sustainable Urbanized township	6
2.2.4	Sustainable Building design for warm-humid climate	8

3	LITERATURE CASE STUDY	10
3.1	METHOD OF STUDY	10
3.2	BELAPUR HOUSING COMMUNITY- Ar Charles Correa	11
3.2.1	Introduction	11
3.2.2	Site Location	12
3.2.3	Architecture and Planning	12
3.2.4	Services	16
3.3	KANCHANJUNGA APARTMENT - Ar Charles Correa	17
3.3.1	Introduction	17
3.3.2	Site, Approach and orientation	17
3.3.3	Program and Typology	18
3.3.4	Ventilation Strategies	21
3.3.4	Simulation considerations	22
4	LIVE FIELD STUDY	23
4.1	METHOD OF STUDY	23
4.2	CHETTINADU HOUSE-1	25
4.2.1	Introduction	25
4.2.2	Field readings and analysis	26
4.2.3	Micro-climate analysis (ENVIMET)	28
4.2.4	Material Study	29
4.3	CHETTINADU HOUSE-2	31
4.2.1	Introduction	31
4.2.2	Field readings and analysis	32

4.2.3	Micro-climate analysis (ENVIMET)	34
4.2.4	Indoor Lighting and solar insolation simulation	34
4.2.5	Material Study	35
5	SITE	37
5.1	IDENTIFICATION AND JUSTIFICATION	37
5.2	SWOT Study	38
5.3	Site Analysis	39
6	SHEETS	42
	REFERENCES	66

LIST OF TABLES

TABLE No.	TITLE	PAGE No.
2.1	Research paper-1 inference	4
2.2	Research paper-2 inference	6
2.3	Research paper-3 inference	7
2.4	Income group	7
2.5	Service Group and Area	7
2.6	Research paper-4 inference	9
3.1	Literature case study-1 inference	11
3.2	Literature case study-2 Inference	17
4.1	Design parameters of chettinadu houses	24
4.2	Occupants survey and activity's timeline	26
4.3	Envimet simulation values	29
4.4	Material Study	29
4.5	Occupants survey and activity's timeline	32
4.6	Envimet simulation values	32
4.7	Material Study	35
5.1	Envimet results	40

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
1.1.	Methodology of the Study	2
2.1	Chettinadu House plan	5
2.2	Baked brick wall	6
2.3	Wall plastering with chunnam	6
2.4	Layout plan of the township	8
2.5	Passive strategies for warm-humid climate	9
3.1	Flow chart	10
3.2	Project timeline	11
3.3	Site location and settlement	12
3.4	Site Plan	13
3.5	Formation of the module	14
3.6	Spatial planning and formation	14
3.7	Floor plan of each type dwelling	15
3.8	Services and Amenities	15
3.9	Service line	16
3.10	Site approach and Location	17
3.11	Massive tower with big and small gaps	18
3.12	Typology A and B	19
3.13	Site plan	19

3.14	Types of units	20
3.15	Ventilation and wind movement	21
3.16	Service layout	22
4.1	Flow chart	23
4.2	Traditional houses details	25
4.3	House-1 ground floor plan	25
4.4	Temperature graph	26
4.5	Relative humidity graph	27
4.6	Illuminance lux	27
4.7	Wind speed	27
4.8	08.00 am – 04.00 pm simulation	28
4.9	Simulation value graph	29
4.10	Material analysis in each space	30
4.11	Surface temperature graph	30
4.12	House-2 ground floor plan	31
4.13	Temperature graph	32
4.14	Relative humidity graph	33
4.15	Illuminance lux	33
4.16	Wind speed	33
4.17	08.00 am – 04.00 pm simulation	34
4.18	Simulation value graph	35
4.19	Material analysis in each space	36

4.20	Surface temperature graph	36
5.1	Site Location	37
5.2	Swot analysis	38
5.3	Site envimet simulation	39
5.4	Site analysis and features	40
5.5	Slope analysis latitudinal	41
5.6	Slope analysis longitudinal	41

LIST OF SHEETS

FIGURE No.	TITLE	PAGE No.
1.	Principles of township	42
2	Principles of Athangudi village	43
3	Principles of Athangudi village	44
4	Summary	45
5	Zoning evolution	46
6	Conceptual site planning	47
7	Conceptual site planning : Iterations	48
8	Low Rise Type-A Planning and iterations	49
9	Low Rise Type-A Planning and iterations	50
10	Low Rise Type-A Planning and iterations	51
11	Low Rise Type-B Planning and iterations	52
12	Low Rise Type-B Planning and iterations	53
13	Low Rise Type-B Planning and iterations	54
14	Mid Rise - Planning and iterations	55
15	Mid Rise - Planning and iterations	56
16	Mid Rise - Planning and iterations	57
17	Mid Rise - Planning and iterations	58
18	Mid Rise - Planning and iterations	59
19	High Rise - Planning and iterations	60

20	High Rise - Planning and iterations	61
21	High Rise - Planning and iterations	62
22	Comprehensive analysis	63
23	Materials and Alterations	64
24	Landscaping and vegetation	65

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In the fast growing world, there are several townships and residential complex raised with different amenities in Chennai and other urban development due to population growth and shift. There is a need and scope for a township with traditional chettinadu design principles and vernacular materials which is a well-found solution for Warm- Humid climate of Chennai. Due to increase of population in urban settlements for various reasons like industrialization and employment opportunities. There are eye witnessed settlements, townships and jungle of structures constructed over a period not meeting the minimum requirements and comfort of the occupants. It is also evident there has been a negligence towards climate change and effects, causing physiological issues and discomfort among users of any space. It is important to rely on old traditional design principles, as which are already a well-found solution and the vernacular materials which are climate responsive providing comfort for the user and performance of the building.

1.2 AIM

To propose a township with design principles and vernacular materials of Chettinadu for Warm-Humid climate.

1.3 REASEARCH QUESTIONS

1. What are the user comfort- climate factors in a township?
2. What are the different typologies in residences in a township?
3. How can we implement Chettinadu principles in both Macro and micro level planning of a township?
4. What are the vernacular materials of Chettinadu that could be used for mid-rise or high rise buildings in Chennai?

1.4 OBJECTIVE

To focus on implementation of the chettinadu design principles from micro to macro level of planning.

To propose a complex of residences of mixed typologies (low to high) with chettinadu design principles and vernacular materials.

To focus on the comfort factors and parameters of the occupants.

1.5 NEED FOR STUDY

There are several townships raised with different amenities in Chennai and other urban developments, due to population growth and shift.

“The effects of climate change cannot be ignored. Over the past few years, Chennai has witnessed extreme weather events — from historical flooding to more recently, acute water scarcity. As the city continues to grow and expand in myriad ways, how sustainable this

expansion is will determine if the city can mitigate the effects of climate change. Chennai isn't unique here and the size of a city and/or its available resources needn't be a predictor in terms of being better prepared.”

-As of problems addressed above, the townships or residential complexes need to focus on sustainable features, planning for future and environment.

-Providing people a new definition of township, amalgamating traditional planning principles, vernacular materials of Tamil Nadu leading onto a new township.

1.6 LIMITATIONS FOR THE STUDY

-Spatial organization or analysis is carried out only for residential units.

-Life cycle cost or Embodied energy of materials are not focused.

- Design and analysis focuses only on climate parameters and comfort of the occupants or users.

1.7 METHODOLOGY

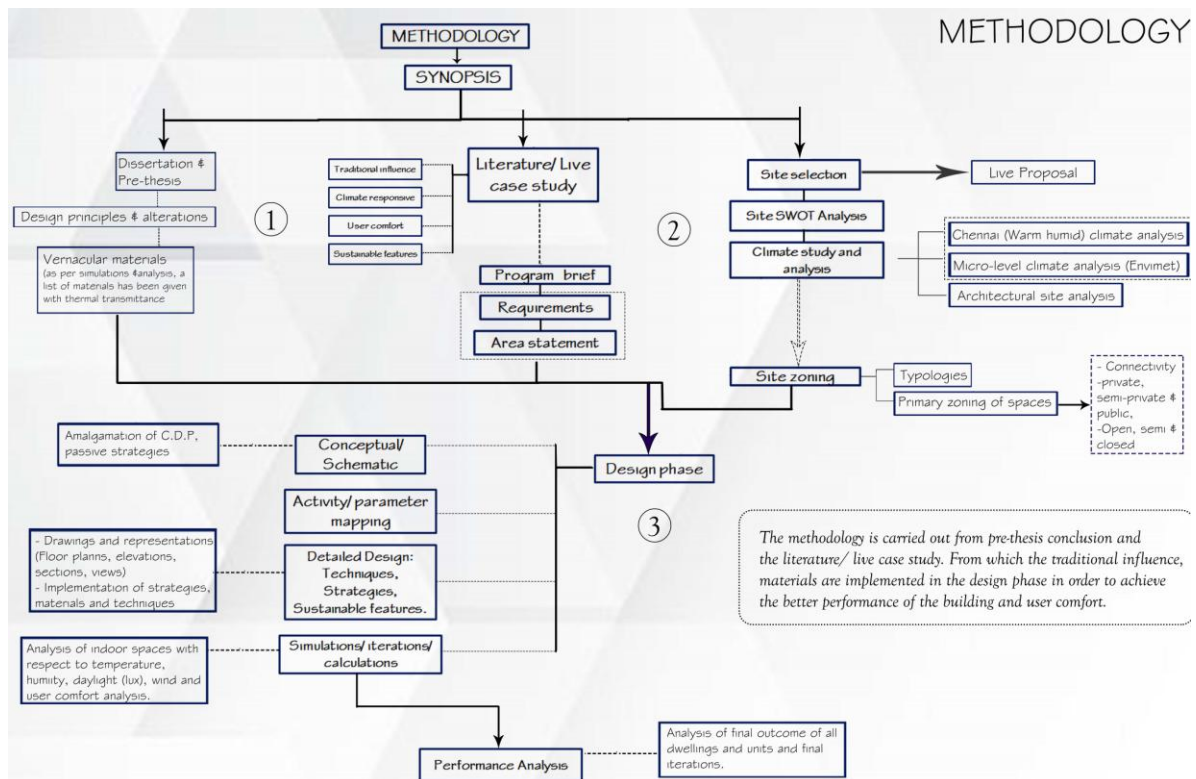


Fig: 1.1: Methodology of the Study

CHAPTER 2 BACKGROUND STUDY

2.1 INTRODUCTION

As the area of focus is on township in Chennai with chettinadu design and planning principles with vernacular materials. The background study is based on the chettinadu planning, housing design principles, climate parameters responsible for thermal comfort of the occupants, spatial organization, strategies followed for warm humid climate, vernacular materials and the typologies of township and services.

The initial study is carried out based on the Chettinadu region's history, culture, occupation and lifestyle of the chettiyars. The study of chettinadu region is based on the evolution of their residence planning, activities in different spaces and critical spaces based on issues and recommendations. The chettinadu houses are studied with respect to their design principles, orientation, courtyard, room's alignment, building components and materials. Different literature reviews are focused by choosing papers, case studies and field houses for validation of the study.

The study on township, different sustainable housing communities are studied in order to get an idea of communities or townships designed based on climate principles, vernacular materials and a social space providing better living standards. Different case studies and papers are analyzed to understand the concept of township, community living, approach, spaces, amenities and mixed residential units.

For further validation on field study readings, simulations are carried out in micro level and neighborhood of the chettinadu houses through envimet and revit (solar insolation and Illuminance)

2.2 LITERATURE REVIEW

The literature review is carried out based on papers written on chettinadu architecture, vernacular materials, sustainable urbanized township and building strategies for warm-humid climate.

2.2.1 CHETTINADU ARCHITECTURE

The "chettiyar" is a name derived from "chetti" which represents business groups or communities of Santhyapuri town in Naganad which is the northern part Tamil Nadu. The Chettinadu region is settled around nine clan temple.

The Nattukottai chettiyars played an important role in developing the Tamil country, language, culture and tradition. The chettiyars community was divided into nine groups based on the nine temples they believe and worship, namely, Ilayatrangudi, Martrur, Vairavan, Iraniyur, Pillayarpatti, Nemankovil, Iluppaikudi, Sooraikudi, and Velangudi.

As decades passed, number of new villages were formed due to increase in population by various set of chettiyars, as of chettinadu occupies about 1,554 Sqkm central

Tamil Nadu. The Rayavaram is one of the affluent settlements which has 150 years old Architecture and tradition.

The villages were contrived following appropriate rules of Urban planning such as Orthogonal streets, artistic elements, proper water management and practical innovations. The settlements are in consonance with Tamil culture and traditions such as rectangular sites, interior courtyards. The houses and common spaces are discovered independent of each other with no visible interrelation between the two. The settlements are grid form counting 120m*60m, in which every grid has 4 houses measuring 60m*30m. All the houses are analogous and self-reliant.

The compound wall is an important feature which is specific to landscape of the chettinadu settlement. Each house has peripheral wall running around the boundaries and is aligned with the axis of the street from North to South with important arches or main doors facing each other on an East to West axis. These arches act as the main entrance of the houses and represents wealth. The compound wall gives an overall continuity with different villages of the region. Inside the compound the houses and its facades are designed on a common alignment with the other buildings of the street. The area between the main gate and the façade is for visitors who can sit in the outdoor thinnai. The height of the structure is only of 2 levels, the ground floor and the first floor.

Table 2.1: Research paper-1 inference

TITLE OF THE PAPER	AIM	METHODOLOGY	INFERENCE
Chettinad Architecture: Lifestyle, Architecture and planning concepts.	The paper gives an insight on the history, settlement pattern, early planning principles, materials and architectural elements of Chettinadu houses and region.	The research has been carried out following a qualitative method of collecting information related to Chettinadu people's history, lifestyle, occupation, culture and how these influence the architecture and planning of Chettinadu houses.	The settlement of chettiyars in villages of Ramnad and thirumangalam district extended up to pudukottai is studied. The planning principles are based on climate, lifestyle, usage of spaces, culture and desires of people. The spatial planning is also based on Hierarchy and multi-courtyard planning is followed. The locally available and manufactured materials like aathangudi tiles, red soil bricks, rubble work etc.

The concept of planning is originated from historic trading town of Kaveripoompattanam. The planning principles were based on

- Occupation of the residents,
- Culture,
- Climate,
- Lifestyle and Desires.

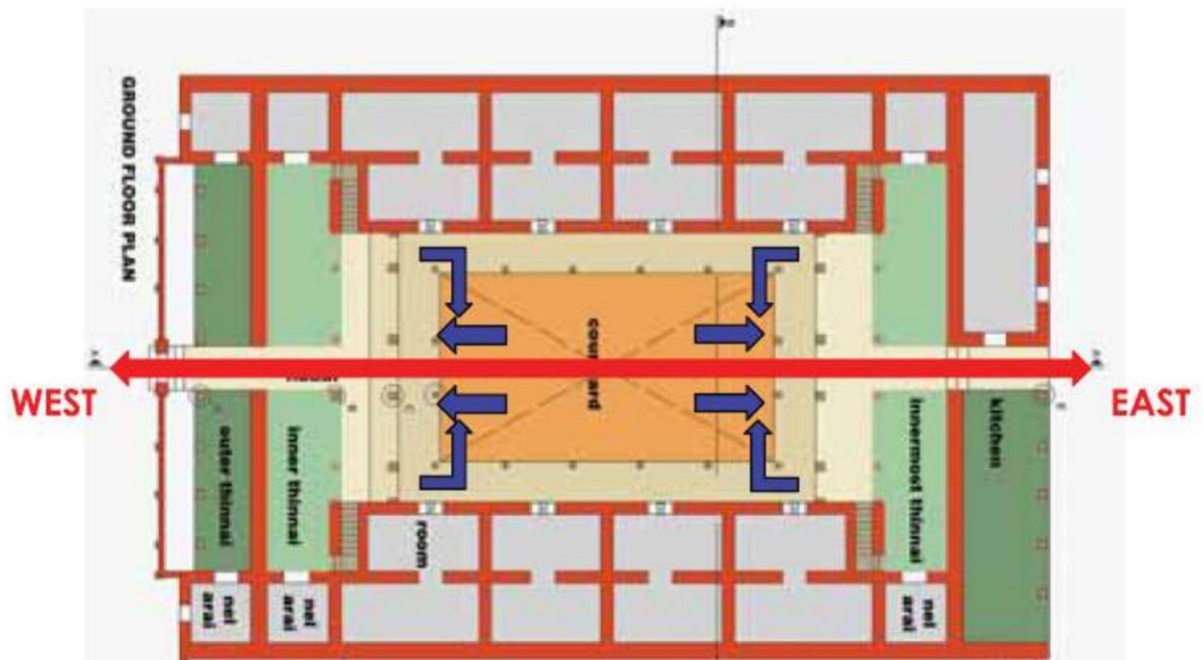


Fig: 2.1: Chettinadu House Plan

The main axis is oriented west/ east facilitating air flow and bringing light and shadow to the central courtyard. The rain water is collected from the central courtyard and diverted to storage water tanks. The courtyard acts like a thermostat which controls the temperature of the house. Negative pressure is created in the courtyard as it is surrounded by rooms and less exposed. This low pressure helps to draw more air towards it.

The spatial planning, usage and organizing has always been related to their lifestyle, culture and occupation. The planning is done to ensure ventilation, promotes natural light and comfort to the users or occupants. Ullarai (concept of inner rooms as secured rooms as they into banking and business. Veliarai (concept of rooms which acts as outer room and restricts people entering ullarai)

2.2.2 ECO-FRIENDLY MATERIALS USED IN TRADITIONAL BUILDINGS

The material for each space differs in chettinadu residences. The chettiars want the best in everything. They did trade in whole of the Southeast Asia and thus the western influence is well predominantly seen in these houses.

This research paper is based on the eco friendly and vernacular materials used in chettinadu houses which are best suitable for warm-humid climate, providing comfort for the occupants.

Table 2.2: Research paper-2 inference

TITLE OF THE PAPER	AIM	METHODOLOGY	INFERENCE
Eco Friendly materials used in traditional buildings of Chettinadu in Tamil Nadu, India	This paper focuses on Eco-friendly materials and its properties of chettinad housings and which can be provided as an alternative to contemporary building materials and reduce energy consumption inside the building.	The properties of materials such as embodied energy is analyzed and then is compared with contemporary materials for which alternates are given.	The ecological properties of local materials is studied, which has been given as an alternative to contemporary materials, materials like aathangudi tile flooring, wall plastering, terracotta roof tiles, courtyard roofs etc are studied based on manufacturing, performance and embodied energy.

The brick size is: 8 "x3"x2". Thickness of the wall – outer wall - 1 3/4" to 2", inner wall – 16".

Foundation: Step, Rubble work- stone with mud and mortar

Flooring- Red oxide, Athangudi and Natural stone.

Walls- Baked bricks, finishing with sand and lime mortar (chunnam)

Roof- pitched country tiles over wooden bars.



Fig: 2.2: Baked bricks wall



Fig: 2.3: Wall plastering with chunnam

2.2.3 DEVELOPMENT OF SUSTAINABLE URBANIZED TOWNSHIP

The development of sustainable urbanized township is based on the typologies and residential units in a township development. This focuses on township development in pongalur in Tirupur. Which is a proposal started with choosing a barren land and also accommodating 1 lakh people by giving a classification of income groups.

Table 2.3: Research paper-3 inference

TITLE OF THE PAPER	AIM	METHODOLOGY	INFERENCE
Development of sustainable urbanized township .	The aim is to develop a sustainable urbanization and the solutions through design and sustainable practices.	The research has been carried out by choosing a barren land in pongalur in Tirupur district, which is satellite township planned and approximately 1L people with all the basic necessities and which will be transformed into a Smart city.	The paper gives a study on inhabitable township with all urban facilities, focusing on human comfort, creates a infrastructure for the people meeting their needs. The design is a sustainable economic development and quality living.

The connectivity plan designed is radial connective, fast movement for vehicular traffic is ensured by round about at centre of city and peripheral ring road connecting the outer city. New technique named District cooling system is implemented for maintaining controlled temperatures inside building. Surface run-off water and roof top water are collected in percolation pits and harvested for future use. Use of pervious concrete on side walls also helps in rain water harvesting. Fly ash bricks are used as an alternative for conventional bricks, which are also eco-friendly. A centralized office is provided for maintenance works for each department including monitoring GPS and labor.

Table 2.4: Income group

INCOME GROUP	NO. OF PERSONS	NO. OF HOUSES	RESIDENTIAL AREA REQUIRED(m ²)
EWS	30,000	7500	1,80,000
LIG	25,000	6250	3,43,750
MIG	25,000	6250	6,75,000
HIG	20,000	5000	15,00,000
TOTAL	1,00,000	25,000	26,98,750

Table 2.5: Service group and Area

SERVING PURPOSE	AREA (km ²)
Residential area	2.698
Road	0.405
Parks & Playgrounds	0.296
Commercial purposes	0.0679
Agriculture	0.506
Future development	0.607
Total area	4.5799

The total number of houses required is 25,000. As per HUDCO, the allocation percentage for EWS, LIG, MIG, HIG is 30%, 25%, 25%, 20% respectively. As per NBC norms, minimum dimension of site required for EWS, LIG, MIG, HIG is 4m x 6m, 5m x 11m, 9m x 12m, 15m x 20m respectively. Based on the assumption that 15% and 10% of the total residential area is constituted by road facilities, park and play-ground respectively, 2% of other areas is allotted for shops and commercial purpose. For agriculture and future

development, the area required is 5,05,857 m² and 6,07,028 sqm respectively. The total area for open spaces is 1.882 Sqkm . Therefore, the total land area is 4.580 Sqkm.

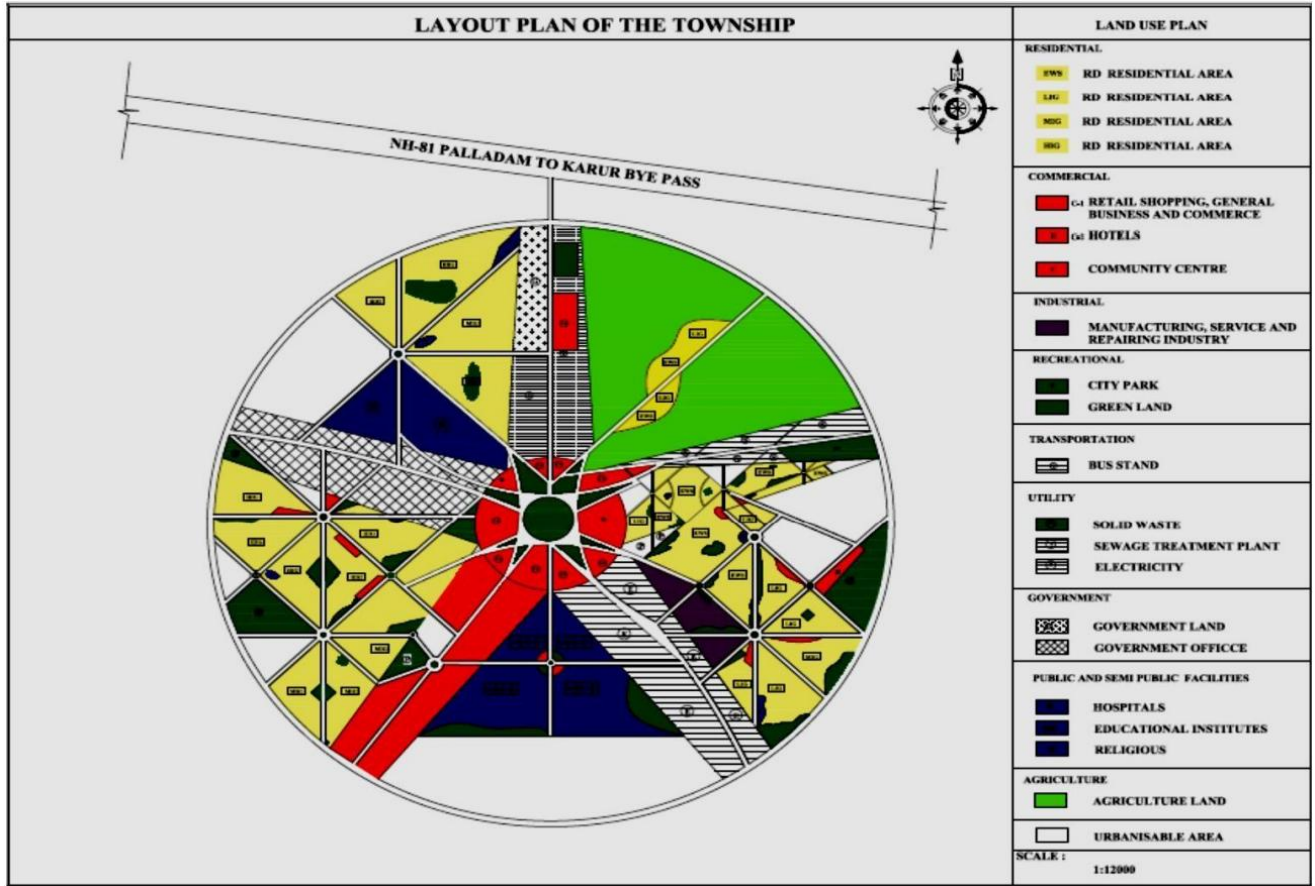


Fig: 2.4: Layout plan of the township

2.2.4 SUSTAINABLE BUILDING DESIGN FOR WARM-HUMID CLIMATE

As the township focuses on design principles, strategies of warm-humid climate and vernacular materials, this paper focuses on possible passive strategies of warm-humid climate and their contribution towards the indoor thermal comfort of the occupants.

Different passive strategies like orientation, building form, courtyard, stack and cross ventilation, shading devices suitable for the climate etc have been discussed in order to make it more comfortable and suitable for housing cluster for low income group also. The climate responsive architecture and design in residence are more helpful in maintaining the indoor comfort of the house and also the passive strategies are a good alternative for artificial cooling methods and also cost effective.

Table 2.6: Research paper-4 inference

TITLE OF THE PAPER	AIM	METHODOLOGY	INFERENCE
Sustainable Building Design for Affordable Housing in Warm-Humid Climate Region of India.	The aim is to study on passive strategies and materials suitable for warm-humid climate region of India.	The paper focuses on different passive strategies which help in maintaining the comfort. These techniques can also be used by low and mid income groups and also by EWS for better and more comfortable living standards.	Climate responsive architecture helps in maintaining the indoor environment quality and helps us adopt traditional building methods using materials like <u>laterite</u> blocks, hollow concrete blocks, hollow clay blocks along with some energy-efficient passive design strategies. These strategies are a good alternative for artificial cooling methods and are cost-effective.

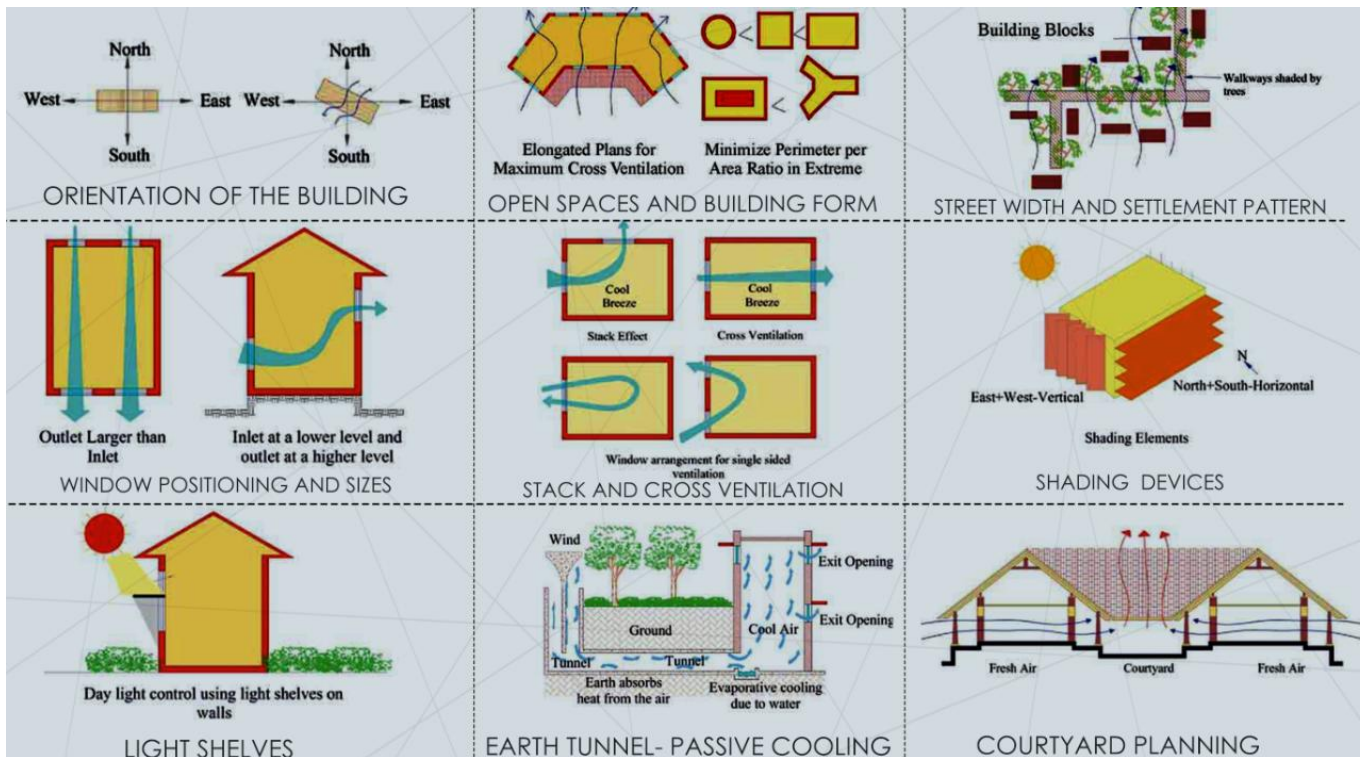


Fig: 2.5: Passive Strategies for Warm-Humid climate

CHAPTER 3

LITERATURE CASE STUDY

3.1 METHOD OF STUDY

The Literature case study is chosen based on the typology of the project which is a community living or a township with various residential units and different types of user groups. These case studies are focused on analysis of planning, spatial organization, climate responsive factors, mid-rise and high-rise typologies and usage of vernacular materials.

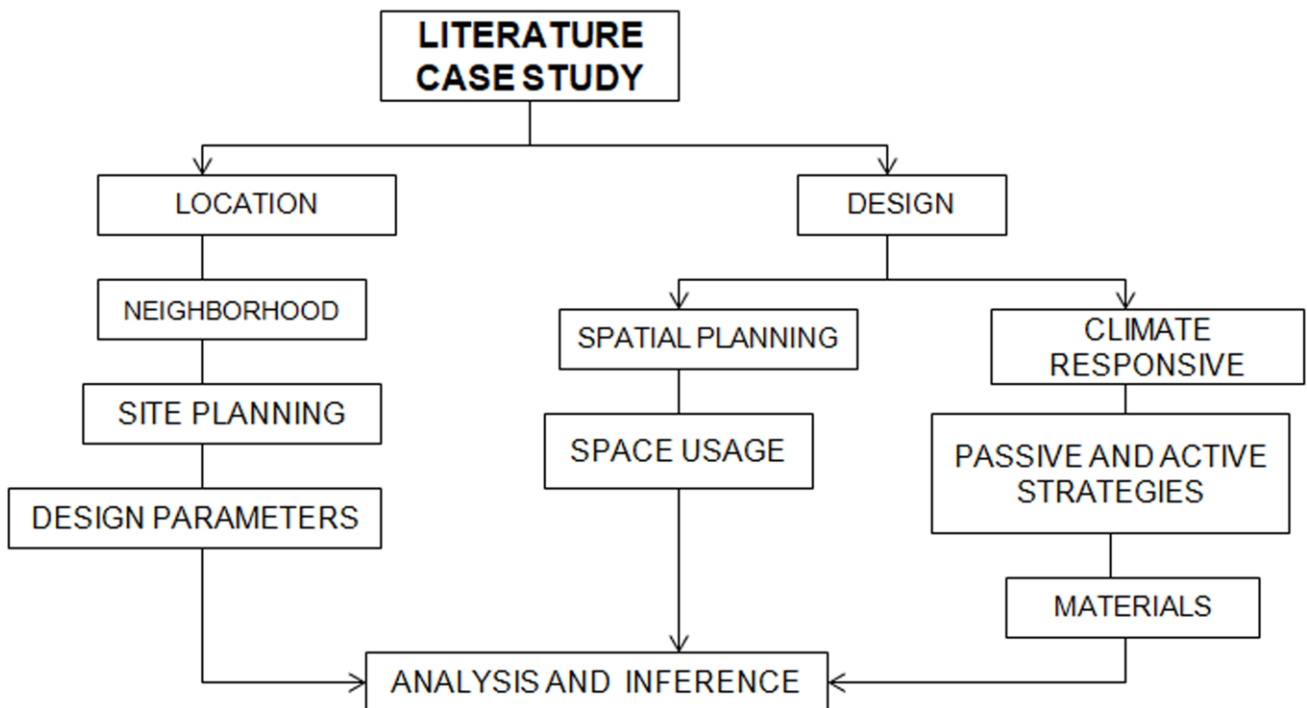


Fig: 3.1: Flow chart

3.2 BELAPUR HOUSING COMMUNITY- Ar Charles Correa

3.2.1 INTRODUCTION

The Belapur housing was a project done by cidco in navi Mumbai. It is called as artists village proposed to be a Residential complex for mainly the artists. The project was designed by Charles Correa around one principle: Each unit is on its individual site to allow for incrementation.

He uses and re-interprets traditional Indian Urban spatial syntax. Correa's social and economic ideals which derive from traditionally incremental method of the building.

Table 3.1: Literature case study-1 inference

TITLE OF THE PAPER	ARCHITECT	AIM	METHODOLOGY	INFERENCE
BELAPUR HOUSING COMMUNITY	Ar CHARLES CORREA	MUMBAI	WARM AND HUMID	Belapur housing project is a proposal for mass climatic responsive and vernacular architecture housing in Mumbai, which demonstrated how high densities could be achieved with low-rise courtyard homes built with slope roofs, simple materials.

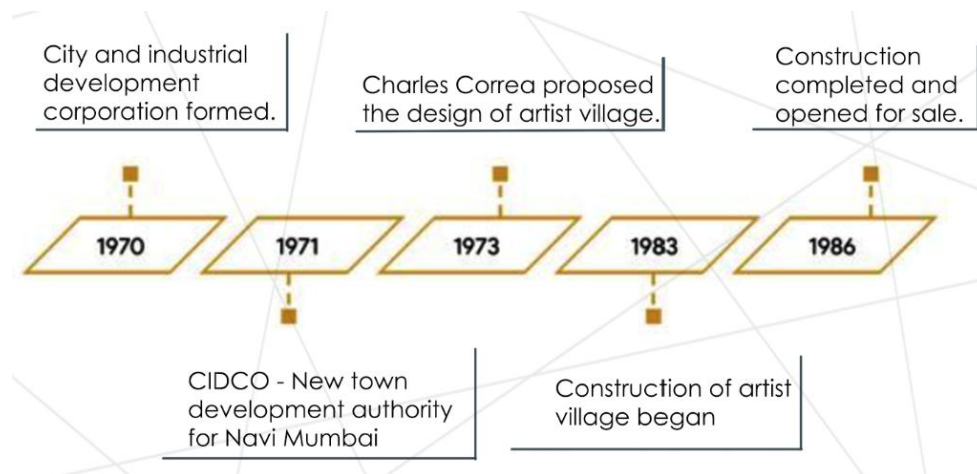


Fig: 3.2: Project timeline

3.2.2 SITE LOCATION

The site is located on Eastern coastline of Mumbai harbor. This was selected as a means of reducing pressure on the city and work-hungry people. The total area of the site is 5.4 Ha that is 13.34 acres and the built-up area is 33,000 sqm. There are about 550 houses in the community and each plot size is 45-75 Sqm (which is marginal variation to maintain equity). The FLOOR SPACE INDEX followed is 0.5-0.6.



Fig: 3.3: Site location and settlement

3.2.3 ARCHITECTURE AND PLANNING

The architecture and design focuses on the low rise development, high density, affordable and incremental housing. Being a native of India, Correa understood the nuanced relationship between culture, traditions and architecture better than any top-level international architect ever could. Belapur housing makes a statement which combines the principles of Correa who believed to be most important in housing: incrementality, open-to-sky spaces, equity and a strong sense of community. The movement within the development is entirely pedestrian, with parking spaces allotted on the fringes. The open spaces flow from small court to large community space with ease.

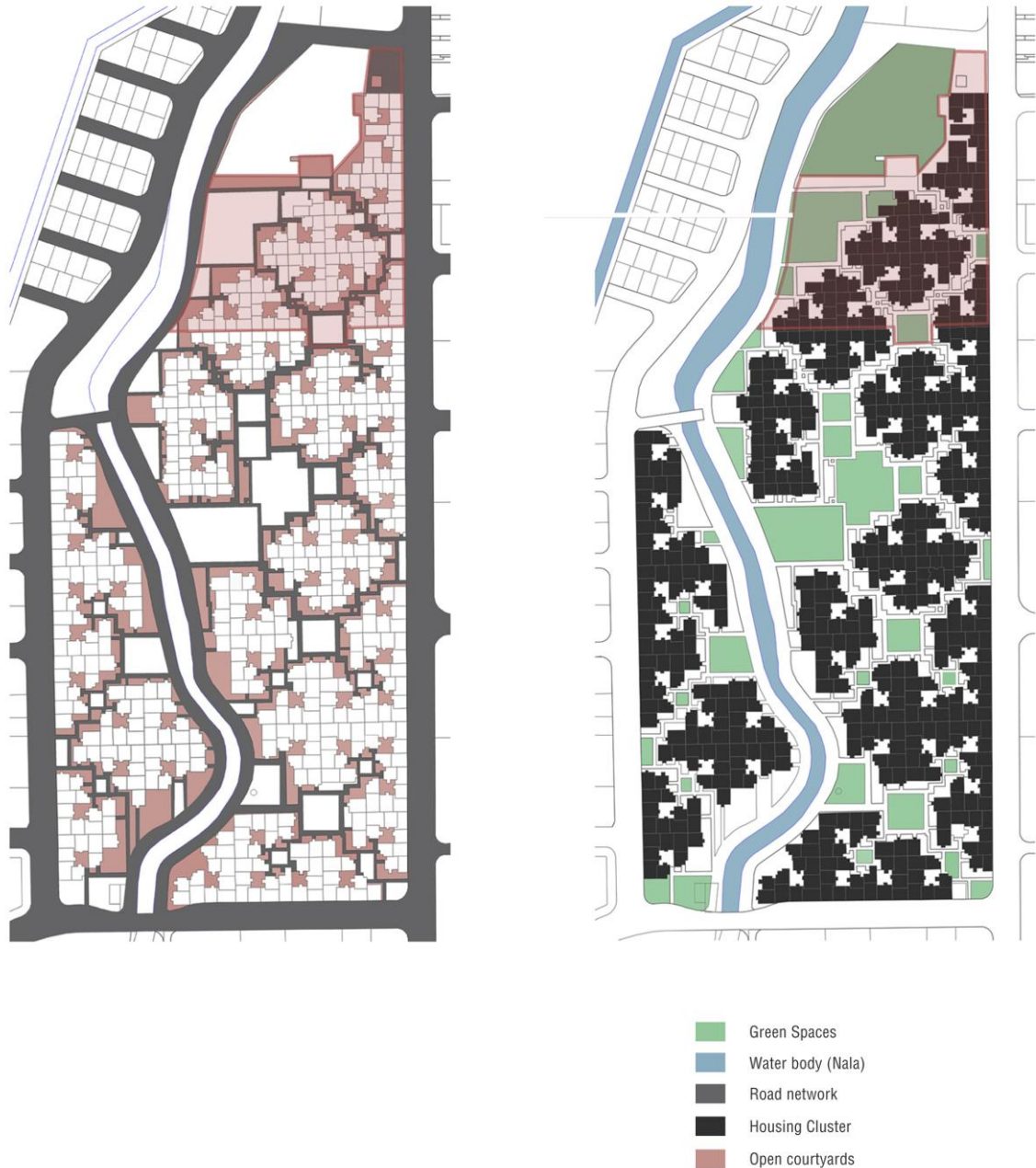


Fig: 3.4: Site plan

The major characteristics of planning in the community is hierarchy, cluster arrangement, private “open-to-sky”, toilet blocks, communal spaces and informal character to roads. The planning of spaces, where the plan is generated by a hierarchy of spaces. The first is private courtyard of single dwelling used as a space for outdoor activities during most of the time. And the seven dwellings or units are grouped to form a small courtyard town of 8m*8m. Three of these groups form a module of ‘21’ homes or dwellings that gives a collective space of the next scale.

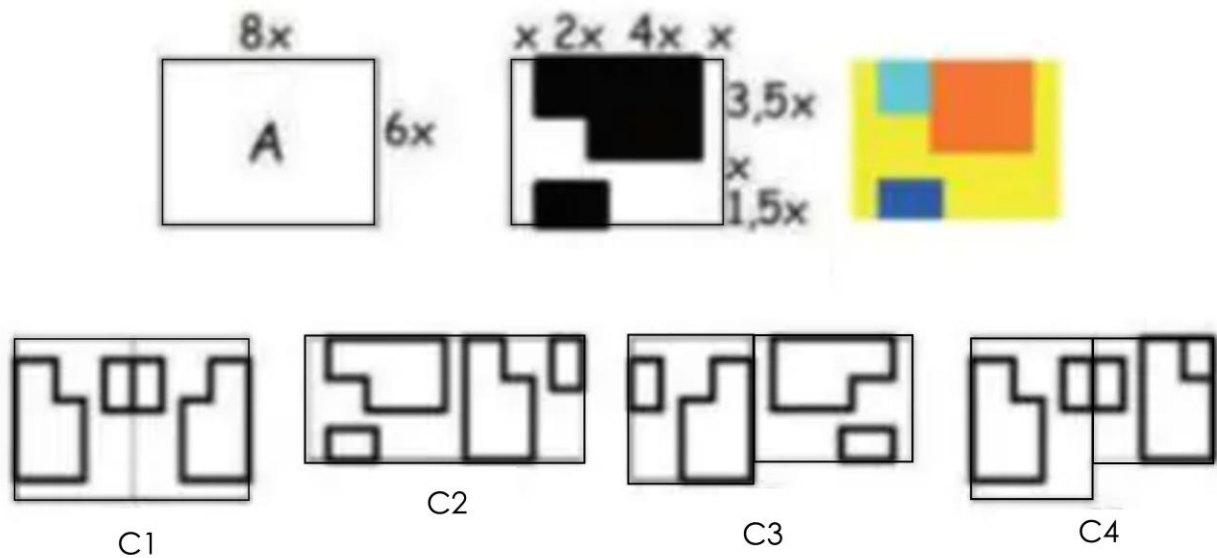


Fig: 3.5: Formation of the module

The planning expresses how high density housing can be achieved in lo-rise typology and services. Overriding principle is to give each unit its own site and allow for expansion. The footprint of each plan varies little in size from 45 sqm to 70 sqm, maintaining the equity in the community. The planning of the community is in such a way that allows for alteration and expansion for future. Correa ingeniously uses his trademark hierarchical open spaces to create a sense of home and community. The smallest open space is the individual yard of each house. Seven dwellings are grouped around an intimate courtyard of about 8m*8m.

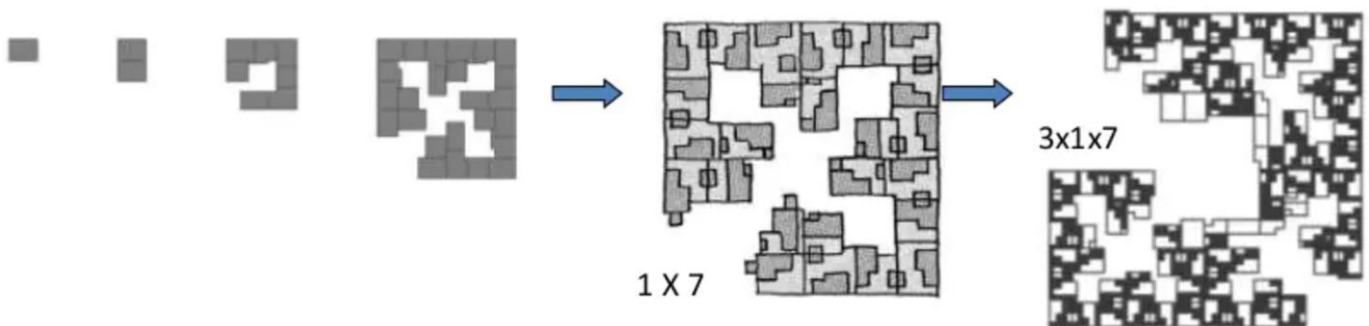


Fig: 3.6: Spatial planning and formation

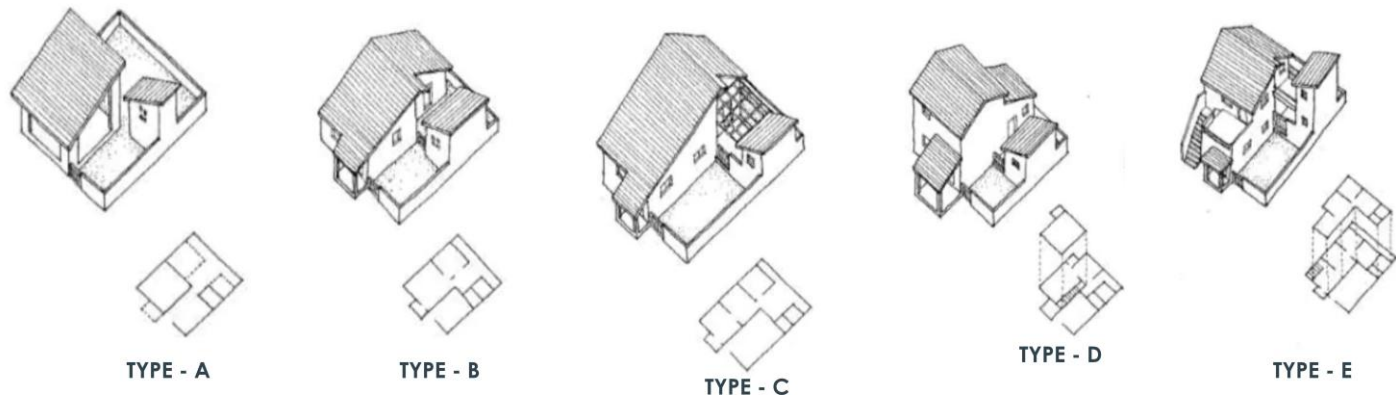


Fig: 3.7: Floor plan of each type dwelling

3.2.3 SERVICES



Fig: 3.8: Services and Amenities

The basic amenities are provided along with private open spaces, play ground for kids and parking allotment.

Water supply – There is no UGT for the project. Each building has its own over head tank either RCC. Separate UGT for some bungalows. Water treatment plant is located at sector one. Timings of water is two to three hours during mornings and evenings.

Drainage- Storm water is drained into the main rivulet. No separate Sewage treatment plant. Chaotic drainage system. Filled with water during monsoon or else dry rest of the year. Waste water is directly drained into the municipal sewer.

Electricity- Chaotic electric connection. Substation and meter room is located in cluster 1. No gas pipe line and no rain water harvesting provision.

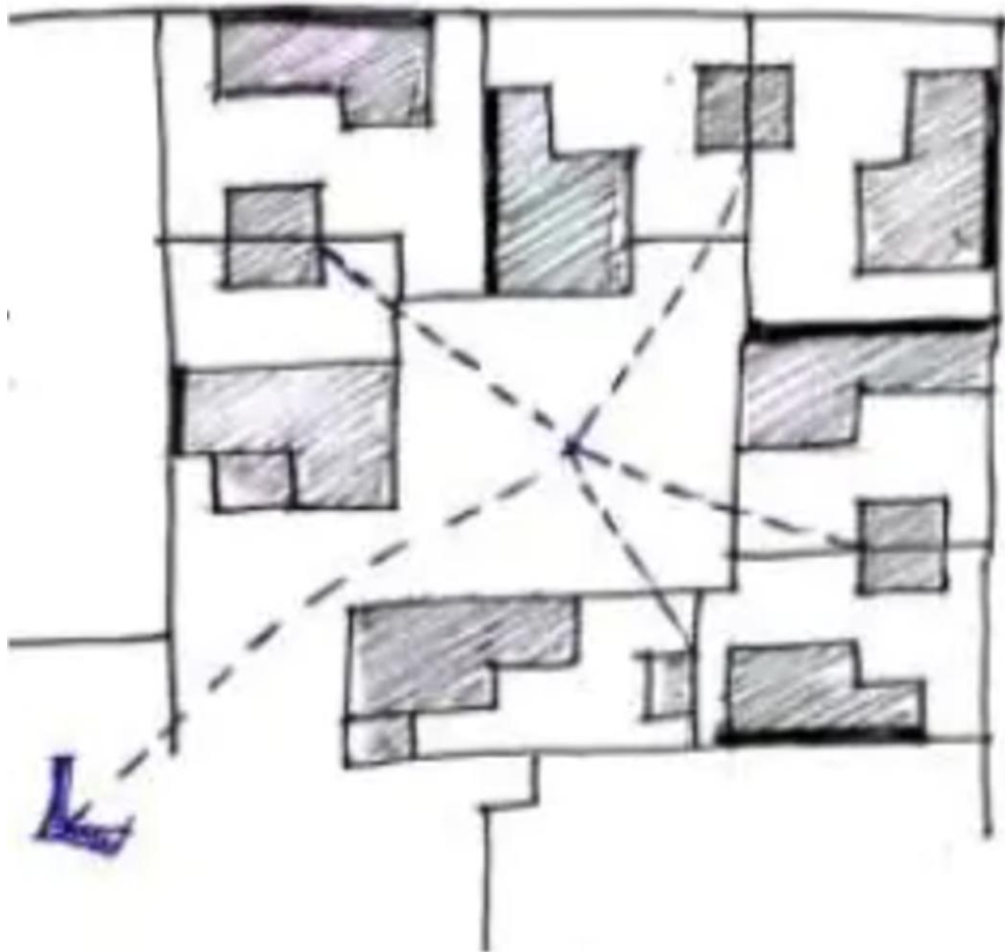


Fig: 3.9: Service Line

3.3 KANCHANJUNGA APARTMENT - Ar Charles Correa

3.3.1 INTRODUCTION

The kanchanjunga apartments are a direct response to the present culture, the escalating urbanization and the climatic conditions for the region. They have vernacular architecture that once stood on the site before the development in a number of ways. This apartment is located in Mumbai which has warm-humid climate. It was constructed during 1970-1974. It's a residential apartment and a modern structure. The material that has been used majorly is concrete in terms to express the modernism and brutalism.

Table 3.2: Literature case study-2 inference

TITLE OF THE PAPER	ARCHITECT	AIM	METHODOLOGY	INFERENCE
KANCHANJUNGA APARTMENTS	Ar CHARLES CORREA	MUMBAI	WARM AND HUMID	The Kanchanjunga Apartments are a direct response to the present culture, the escalating urbanization, and the climatic conditions for the region.

3.3.2 SITE, APPROCAH AND ORIENTATION

The area or neighborhood is majority residential and with required commercial and public outlets and is located on peddler road. The site has a separate road for individual approach which is connected to the main road .

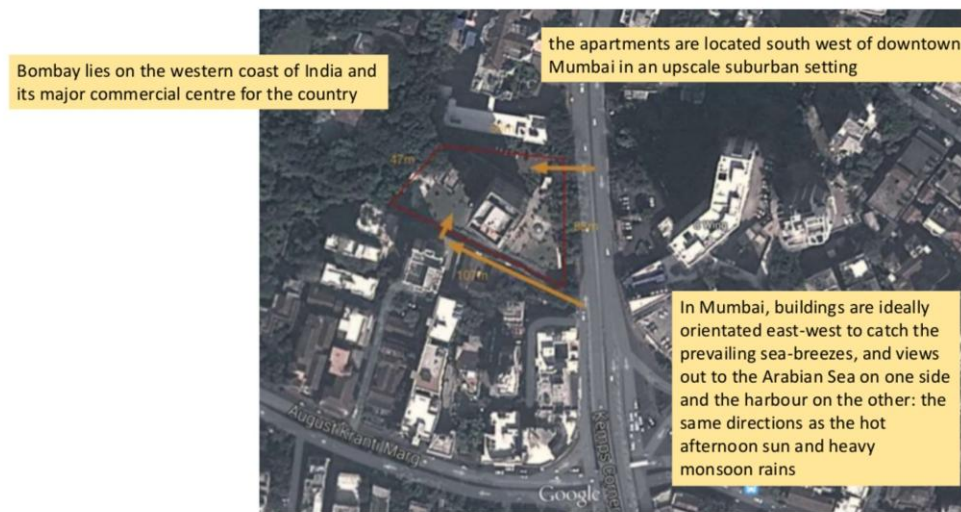


Fig: 3.10: Site approach and location

Building is approachable from two opposite sides, one from East and one from west. In Mumbai, buildings are ideally oriented east-west to catch the prevailing sea-breezes, and views out to the Arabian sea on one side and the harbor on the other: the same directions as the hot afternoon sun and heavy monsoon rains.

Old bungalows solved these problems by wrapping a protective layer of verandahs. Kanchanjunga apartments are located south-west.

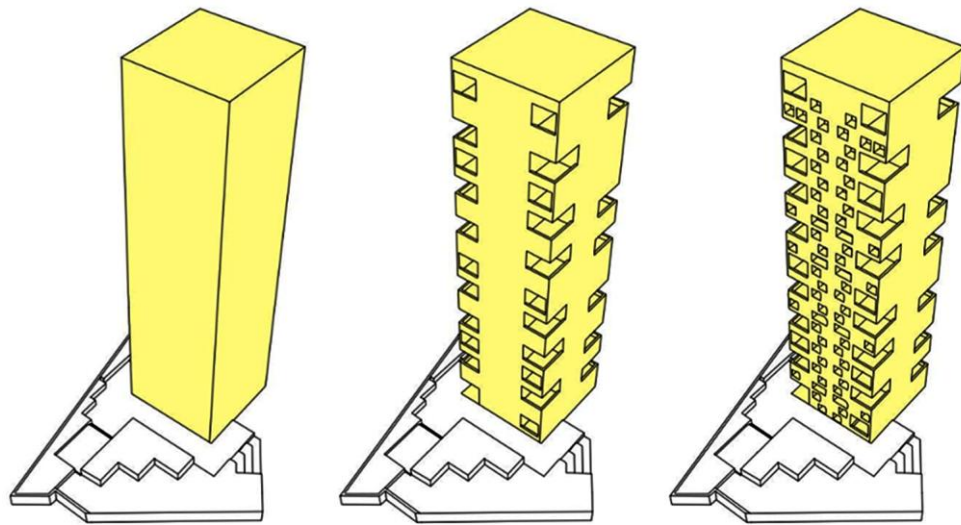


Fig: 3.11: Massive tower with big and small gaps

The building is a square tower; Charles Correa created gaps in between the towers. The two floors high loggias are created to keep out the sun and take in the cool breeze. The apartment concentrates mainly on the sectional displacement by bringing changes in the floor surfaces. The architect applied cellular planning by using interlocks in one and half story 3 and 4 bedroom units with two and half story 5-6 bedroom units. Small displacements in levels differentiated the external earth filled terraces with internal elevated living volumes.

3.3.3 PROGRAM AND TYPOLOGY

The Kanchanjunga apartment building provide two different typologies, type A and Type B which are marked as yellow and red respectively. Interlock of four different apartment typologies varying from 3 to 6 bedrooms each. Smaller displacement levels. Differentiated between the external earth's filled terraces and the internal elevated living volumes. Effectively shield these high rise units from the effects of both the sun and monsoon rains. Achieved by providing the tower with respectively deep, garden verandahs and is suspended in the air.

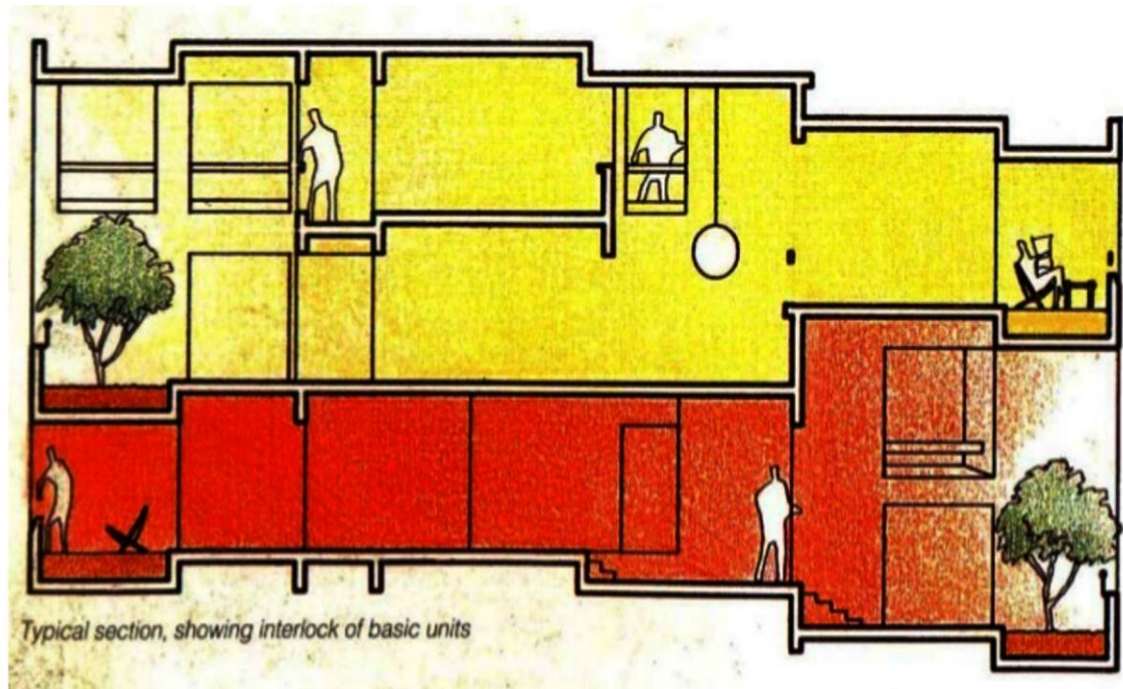


Fig: 3.12: Typology A and B



Fig: 3.13: Site Plan

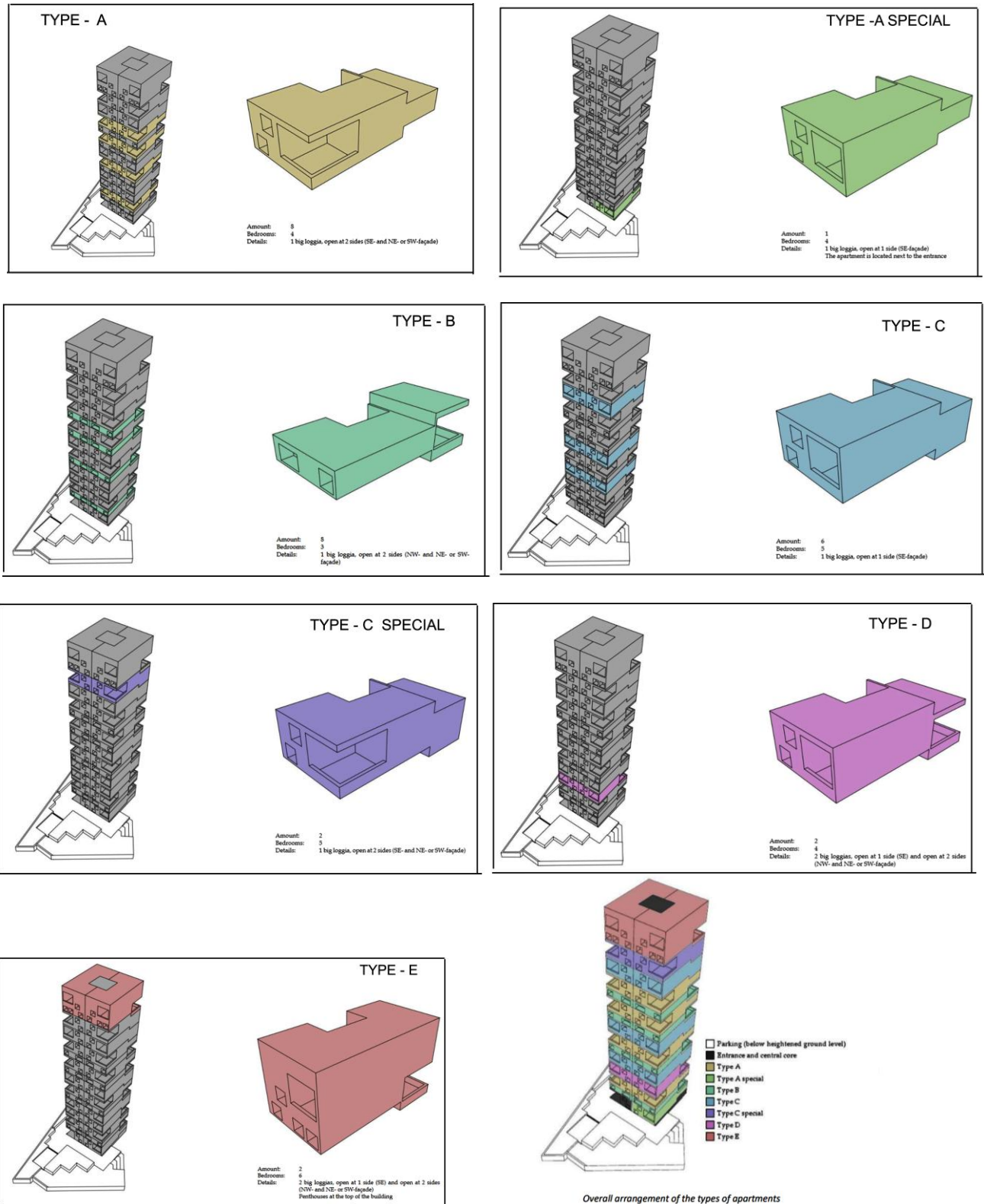


Fig: 3.14: Types of units

3.3.4 VENTILATION STRATEGIES

The building has been planned in east and west orientation. West side of the building has sea and east side have view of the city which playing dynamic role from the building. But orientation toward hot sun and heavy rain, the orientation can be rotated, which might give positive value. This can also be considered because the verandahs cover-up and lets in cool breeze and giving comfort in the living. Also the building have good access of day light and breeze through terrace garden and window, the building have 4 different types of houses, that is of variations expressed extremely by shear end walls that hold up the cantilevers.

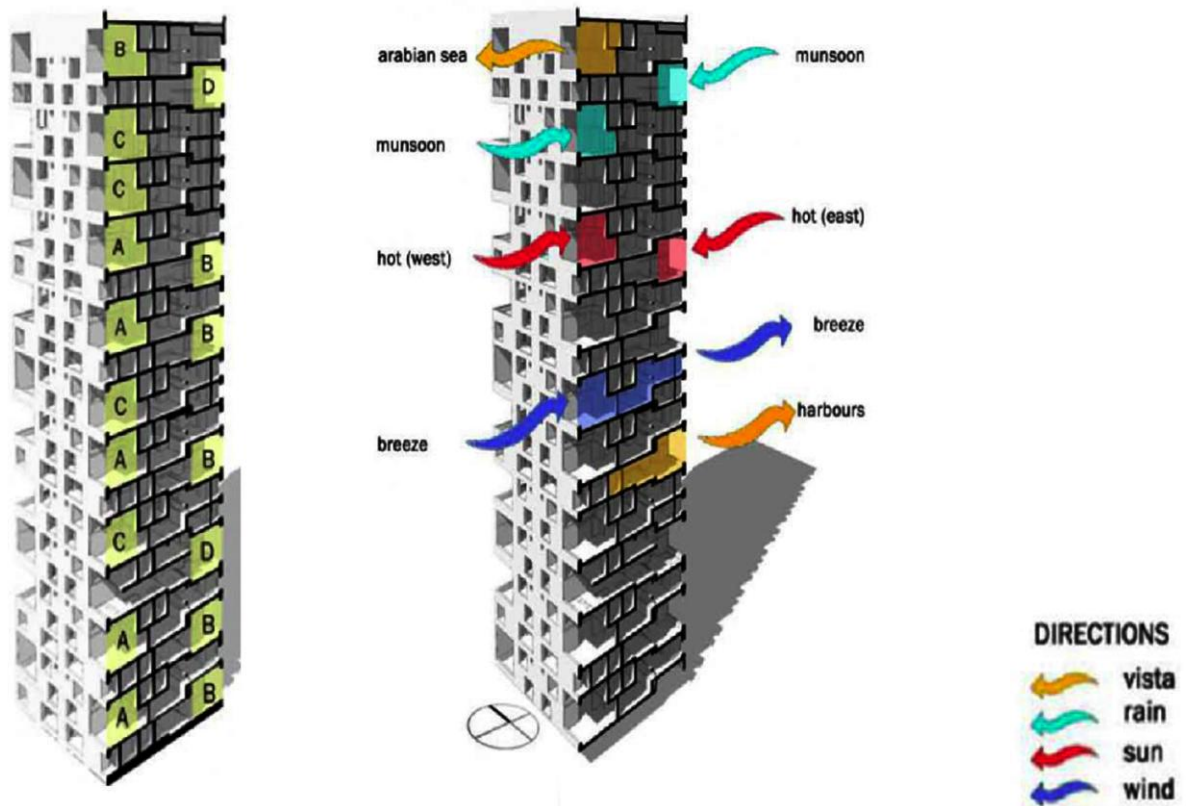


Fig: 3.15: Ventilation and wind movement

3.3.5 SIMULATION CONSIDERATIONS

The following criteria were used for selection of the rooms to be simulated:

- The highest solar gain receiving rooms are selected. The rooms, which are used most of the time by the occupants.
- To check the variation in airflow rate with respect to height, the living and dining space and North west bed room (receive high solar gain) of ground floor, 12th floor and 24th floor.

- To check the variation in airflow rates according to change in orientation, both the living And dining space in each flats on ground floor, 12th floor and 24th floor (since two flats in one floor are facing opposite to each other) Southeast bedroom on upper floors such as 1st, 4th, 7th, 10th, 13th, 16th, 19th, 22nd and 25th.

SCHEDULE OF USAGE

The living and dining space:

- morning - 7 AM to 10 AM
- Evening - 6 PM to 11 PM
- North West bedroom: 11 PM to 07 AM
- South East Master bedroom: 11 PM to 07 AM

RANGE OF THERMAL COMFORT

Mean minimum and mean maximum

Temperature in the summer: 27°C, 34 °C

- Indoor comfort Temperature (summer): 24 °C - 30 °C
- Mean minimum and mean maximum temperature in the Winter: 16 °C, 26 °C
- Indoor comfort temperature (winter): 22°C - 27 °C.

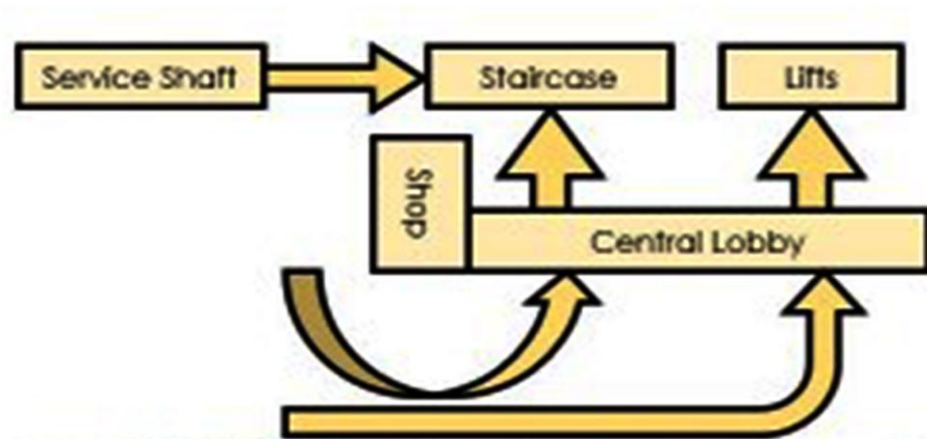


Fig: 3.16: Service Layout

CHAPTER 4 LIVE FIELD STUDY

4.1 METHOD OF STUDY

The live field study is carried out by analyzing the spatial planning, user group and their activities with respect to the comfortable and critical spaces. Which is recorded and compared based on temperature, relative humidity, day lighting and surface temperature. The surface temperature is recorded for walls, floor and roof to make a note on material performance and its impact on indoor thermal comfort.

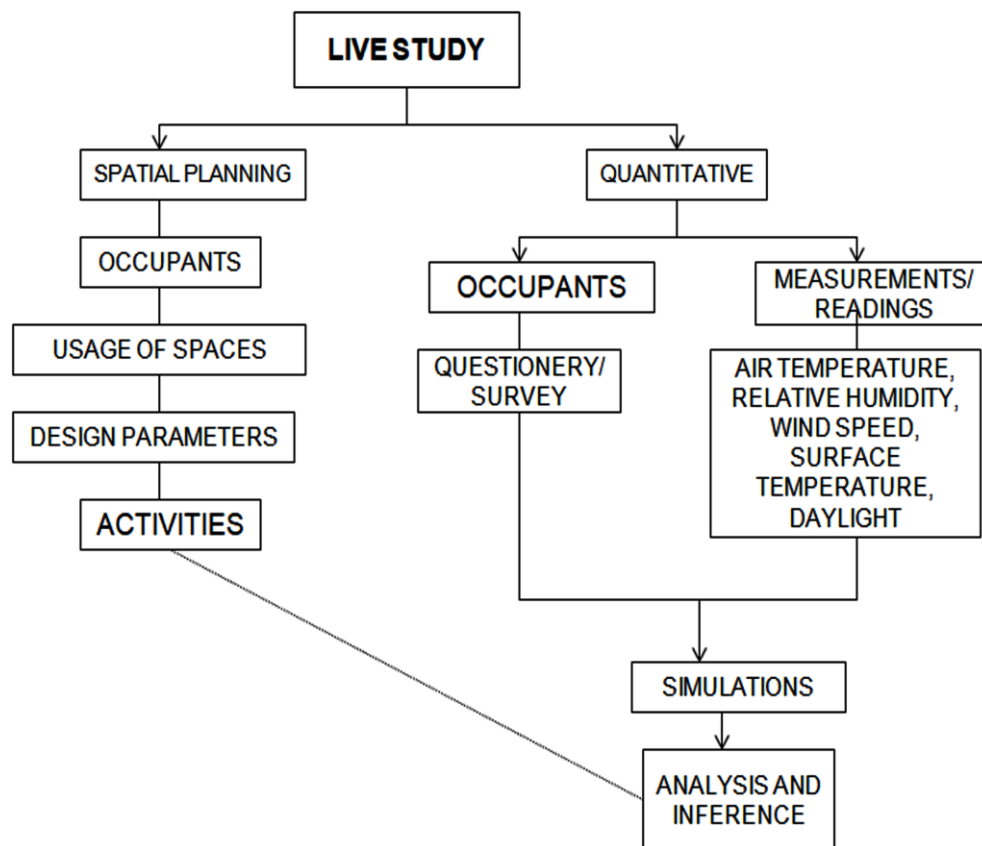


Fig: 4.1: Flow chart

The questionnaires and surveys are conducted to analyze the activities and timeline. The spatial planning is observed based on orientation, room alignment, thinnai, courtyard etc. Through live field study, spatial arrangement, how people use the space and activity timeline would be found and analyzed. The reason behind the usage of space and the comfort which will be analyzed with readings in different spots and simulations will be carried.

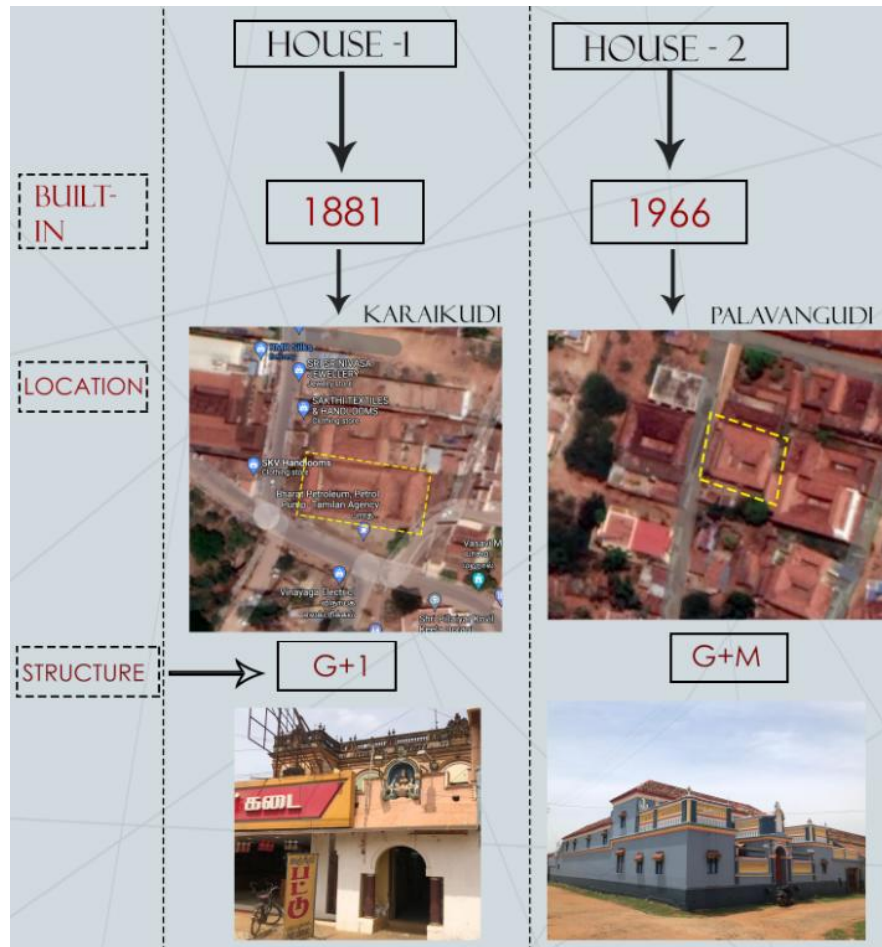


Fig. 4.2: Traditional houses details

The field study of chettinadu houses is done based on design parameters (Table 4.1), spatial analysis, planning evolution through years, occupants survey, neighborhood analysis, climate parameters such as air temperature, relative humidity, day light (Illuminance), material observation and surface temperature.

Table 4.1: Design parameters of chettinadu houses

HOUSE	ORIENTATION	ENTRANCE	THINNAI	NO. OF COURTYARDS	COURTYARD RATIO (L : W)	BEDROOM ALIGNMENT
HOUSE - 1	NORTH- SOUTH	WEST	SINGLE	1	2.6 : 1	NORTH & SOUTH Linear, series of rooms
HOUSE - 2	NORTH- SOUTH	WEST	NO	1	1.2 : 1	NORTH & SOUTH Linear, series of rooms

4.2 CHETTINADU HOUSE-1

4.2.1 INTRODUCTION

The Shakthi vilas is one of the oldest houses in the chettinadu region located in Karaikudi dates back to 1881, which is the period of original chettiyars living evidence even before the invasion of Britain's and Europeans. This house (*fig: 4.3*) exhibits an original authentic Nattukottai chettiyars house with typical planning of spaces along with courtyard, outdoor thinnai, front yard and backyard.

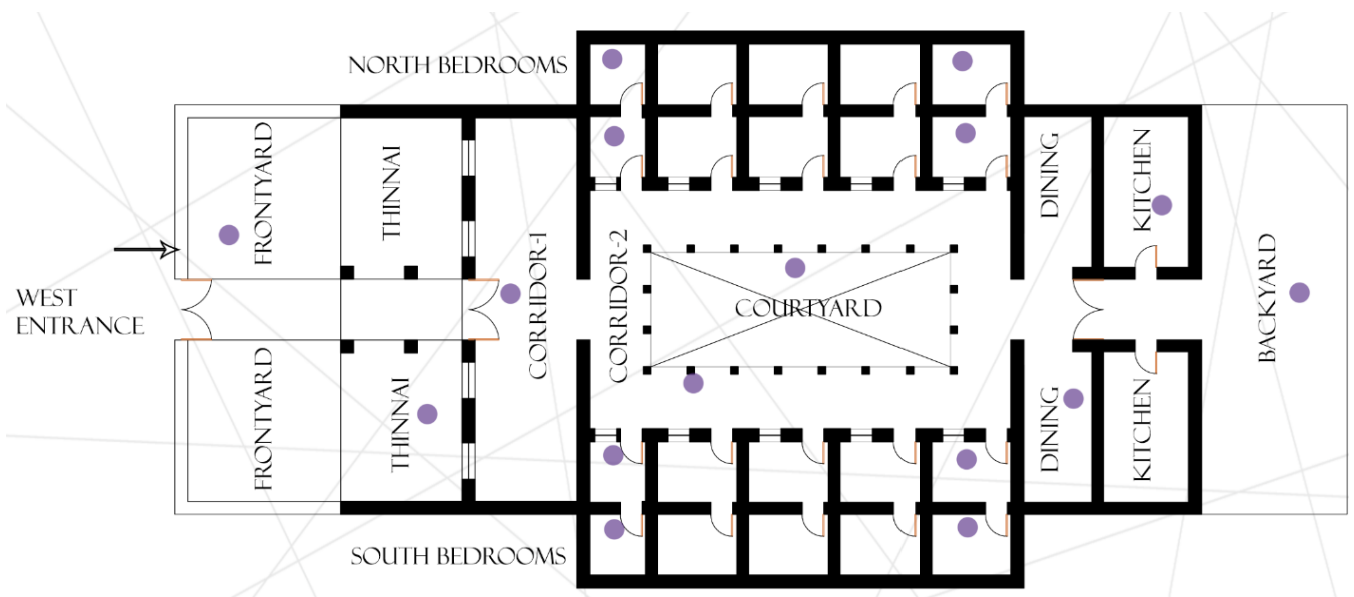


Fig: 4.3: House-1 Ground floor plan

The field study is conducted on 15th, August, 2021 followed by survey (*Table 4.2: Occupants survey and activity's timeline*) and spatial analysis. The spatial analysis gives an insight on the planning, spatial organization, room alignments and area of spaces. The survey was taken based on questioners and observation. The comfort level of the spaces and reason of usage of spaces at a particular time is asked to the occupants. The activities during different time of the day in observed and recorded. The recorded activities and its timeline shows the most used spaces, critical spaces which isn't used by the occupants because of the discomfort.

Table 4.2: Occupants survey and activity's timeline

SPACES	Type of Space	06:00 AM	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM	08:00 PM	User group
Front yard	Open									Men
Thinnai	Semi-Open									Men
Corridor-1	Semi-Open									Men, Women
Corridor-2	Semi-Open									Women
Courtyard	Open									Men, Women
North Ullarai	Closed									Men, Women
North Veliarai	Closed									
South Ullarai	Closed									Men, Women
South Veliarai	Closed									
Kitchen	Closed									Women
Dining	Closed									Men
Back yard	Open									Women

4.2.2 FIELD READINGS AND ANALYSIS

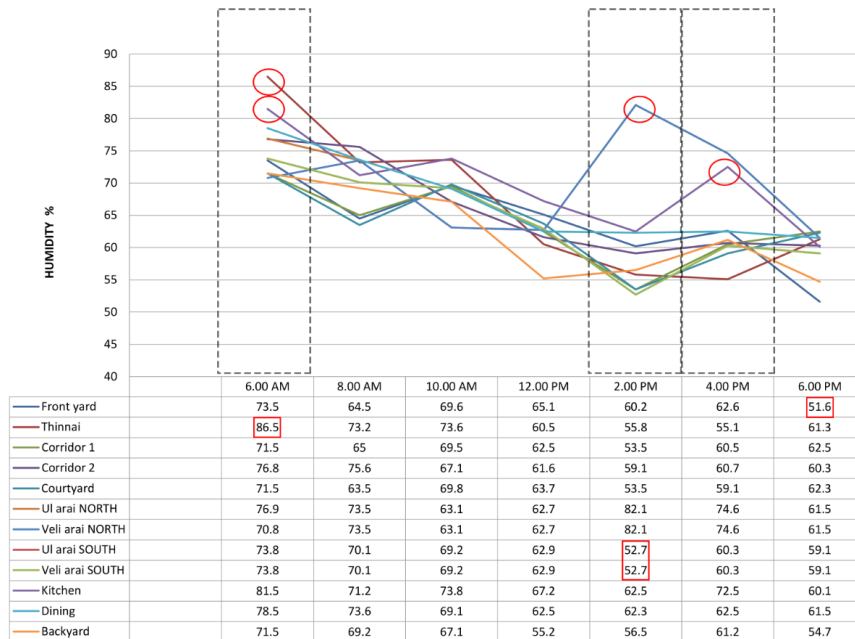


Fig: 4.4: Temperature graph

Beyond comfort band - Temperature in a closed space “kitchen” at 6.00 am is 27 deg c and the maximum is 34.6 deg c in south bedrooms (ularai and veli arai).
Critical Spaces: Corridor-1 (34.6 deg c) 2:00pm, Courtyard (35.6 deg c) 2.00 pm, Kitchen (32.5 deg c) 2.00 pm, South rooms (34.6 deg c) 2.00pm.

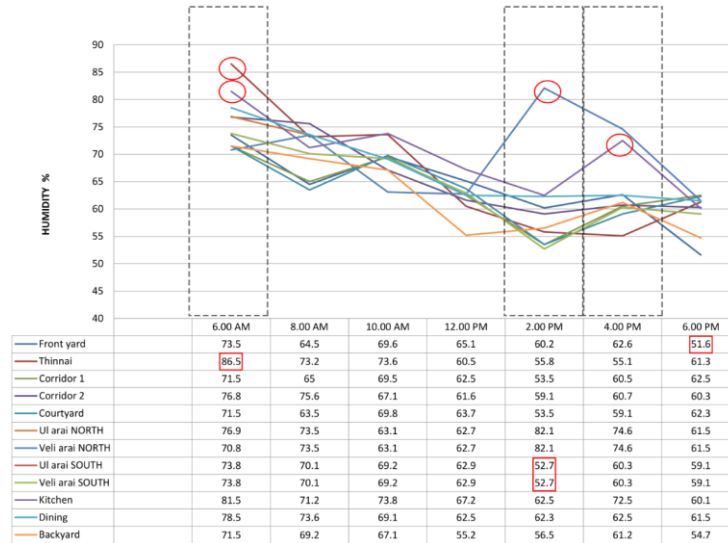


Fig: 4.5: Relative Humidity graph

The Relative Humidity is high during 06.00 am to 2:00 pm of maximum recorded is 86.5% in thinnai and the minimum humidity recorded is 52.7 % in a closed space i.e South Bedroom (Ullarai) and 51.6 % in Front yard (Open) at 6:00 pm.

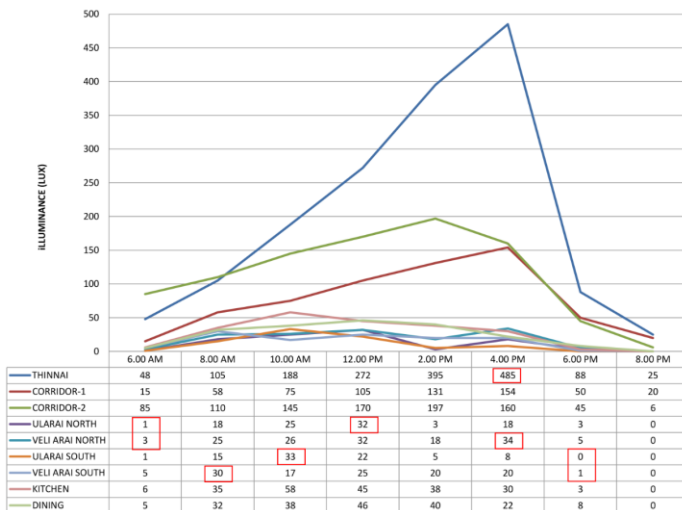


Fig: 4.6: Illuminance lux

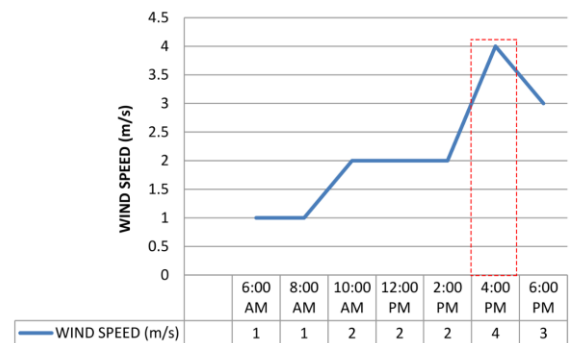


Fig: 4.7: Wind speed

As per survey, the occupants were comfortable with natural lighting without any electrical or mechanical supply from 6 am to 6 pm, except in North and South ularai which receives no natural light, as there are no openings on North and South walls.

CRITICAL SPACES;

North Ullarai - Min= 1 lux (6 pm) to Max = 32 lux (12 pm)

North Veliarai - Min= 3 lux (6 am) to Max = 34 lux (4 pm)

South Ullarai - Min= 0 lux (6 pm) to Max = 33 lux (10 am)

South Veliarai - Min= 1lux (6 pm) to Max = 30 lux (8 am)

As per observations, field readings and analysis, the comfortable and critical spaces are identified and will be addressed as issues and for which the recommendations will be given and validated in next phase as proposals.

4.2.3 MICRO-CLIMATE ANALYSIS (ENVIMET)

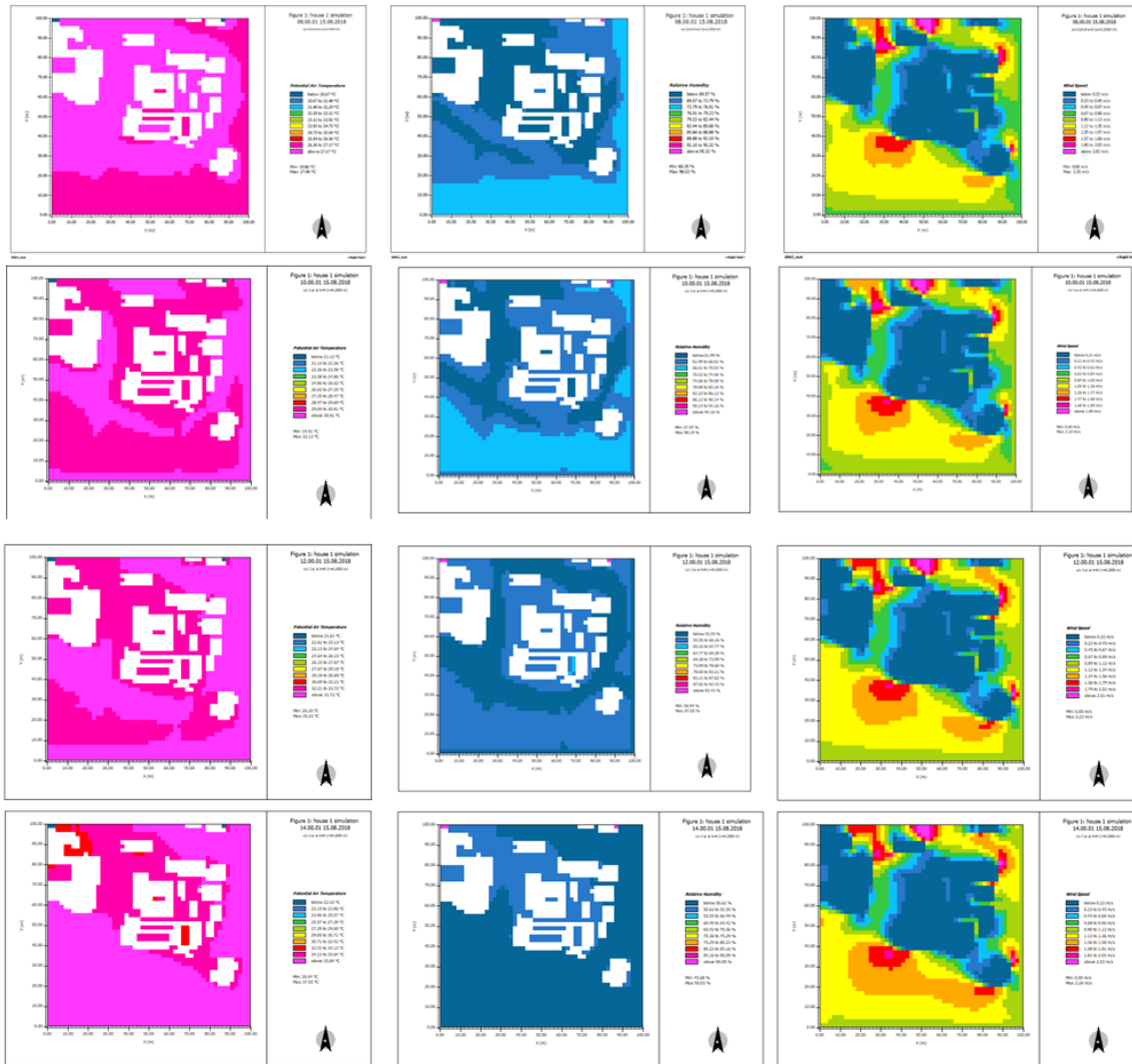


Fig: 4.8: 08.00 am – 04.00 pm simulation

Table 4.3: Envimet simulation values

TIME	FIELD STUDY RECORDINGS		
	TEMPERATURE (deg C)	RELATIVE HUMIDITY (%)	WIND SPEED (m/s)
08:00 AM	27.98	66.35	2.25
10:00 AM	32.13	70.03	2.10
12:00 PM	35.23	64.77	2.23
02:00 PM	37.55	55.55	2.26
04:00 PM	37.36	55.08	2.22

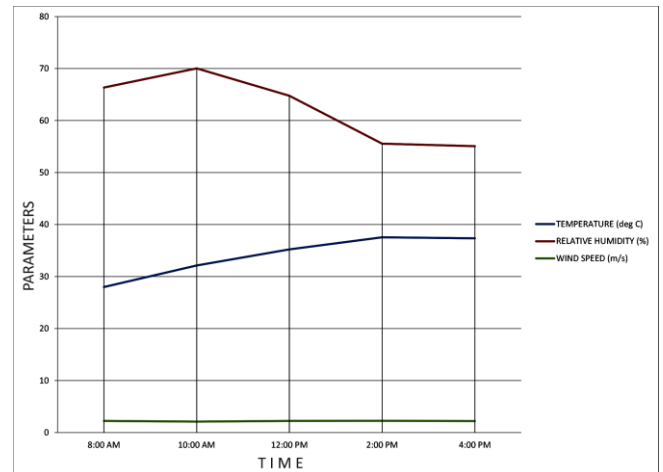


Fig: 4.9: Simulation value graph

The temperature gradually increases from morning 08:00 am to 04:00 pm , and the humidity drops gradually from morning 08:00 am to 04:00 pm.

The wind speed varies between 2.1 m/s to 2.26 m/s.

Maximum wind speed: 2.26 m/s : 02:00 pm

Minimum wind speed: 2.10 m/s : 10:00 am

4.2.4 MATERIAL STUDY

The material study is carried out based on building components that s walls, roof and floor. This is related with surface temperature and the U-value.

Table 4.4: Material study

HOUSES	SPACE	COMPONENT	COMPONENT MATERIAL	COMPONENT THICKNESS	U-VALUE (w/m ² -k)
1	OVER ALL	WALL	SUN DRIED BRICKS	0.53 m	1.7
	A	FLOOR	TRADITIONAL CEMENT	0.2 m	
	B	FLOOR	RED OXIDE	0.15 m	
	C	FLOOR	CEMENT	0.2	
	D	FLOOR	KARUNGAL OR NATURAL STONE	0.04 m or 40 mm	
	OVER ALL	ROOF	BAKED CLAY MANGLORE TILES	0.012 m or 12 mm	5.3

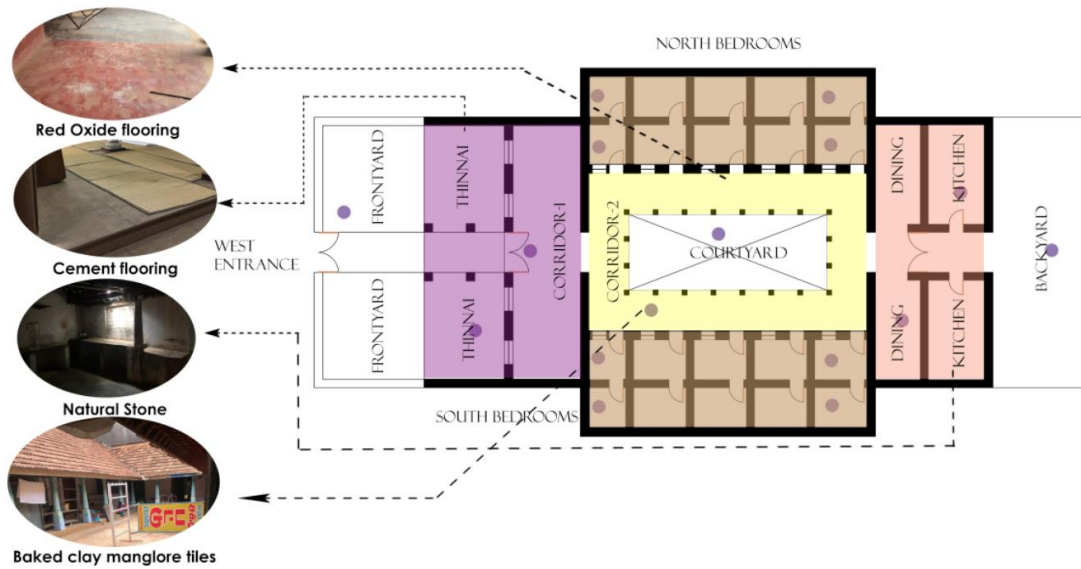


Fig: 4.10: Material Analysis in each space

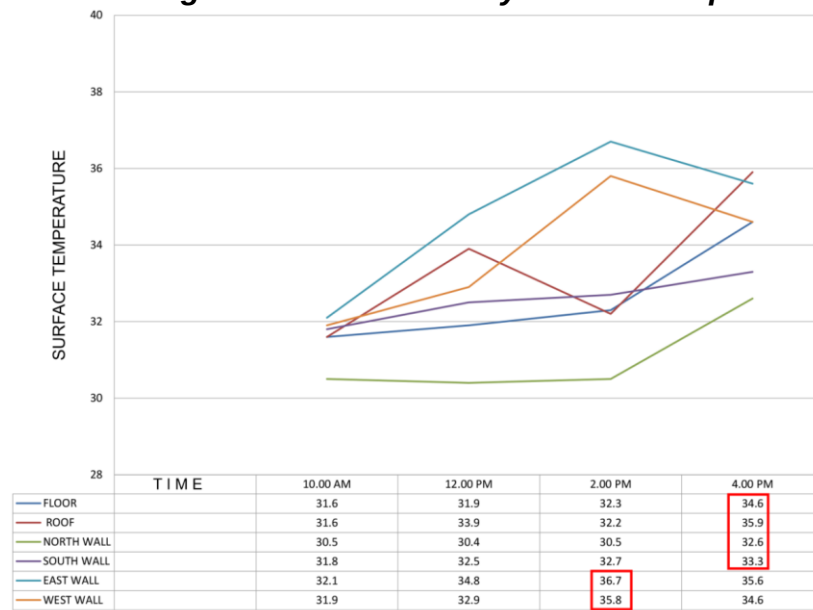


Fig: 4.11: Surface temperature graph

The Surface temperature:

Wall: Maximum (East wall) = 36.7 deg C (02: 00 pm)

Minimum (North wall) = 30.4 deg C (12: 00 pm)

Floor = Maximum: Corridor = 34.6 deg C (04: 00 pm),

Minimum: N.Br = 31.6 deg C (10: 00 am)

Roof = Maximum: Courtyard = 35.9 deg C (04: 00 pm),

Minimum: N.Br = 31.6 deg C (10: 00 am)

4.3 CHETTINADU HOUSE-2

4.3.1 INTRODUCTION

This house is one of the recent houses in the chettinadu region located in palavangudi constructed in 1966. This house (*fig: 4.12*) exhibits a new add-on in the town with typical planning of spaces along with courtyard, outdoor thinnai, front yard and backyard.

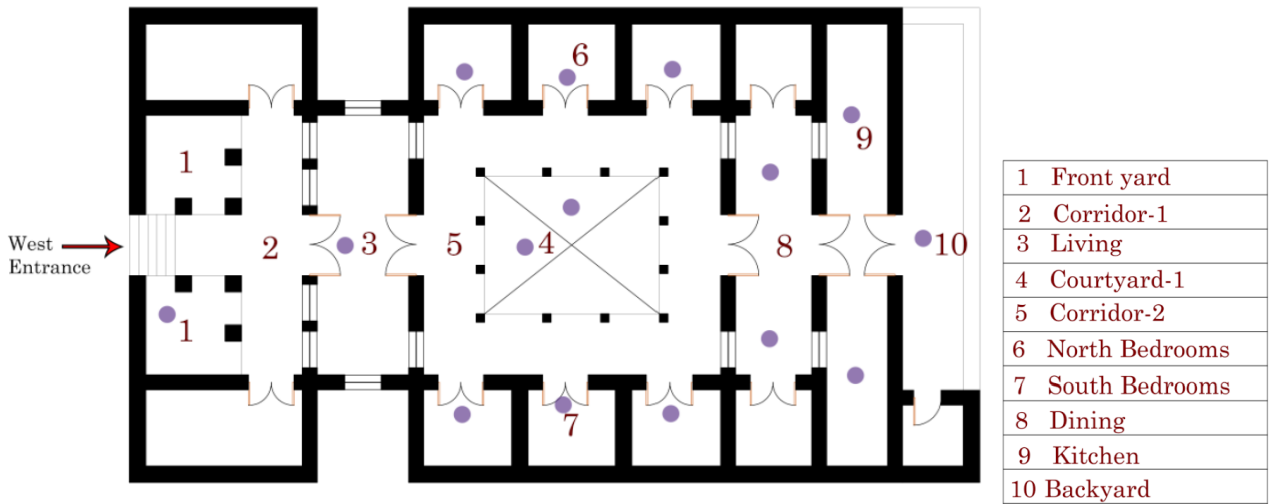


Fig: 4.12: House-2 Ground floor plan

The field study is conducted on 17th, August, 2021 followed by survey (*Table 4.2: Occupants survey and activity's timeline*) and spatial analysis. The spatial analysis gives an insight on the planning, spatial organization, room alignments and area of spaces. The survey was taken based on questioners and observation. The comfort level of the spaces and reason of usage of spaces at a particular time is asked to the occupants. The activities during different time of the day in observed and recorded. The recorded activities and its timeline shows the most used spaces, critical spaces which aren't used by the occupants because of the discomfort.

Table 4.5: Occupants survey and activity's timeline

SPACES	Type of Space	06:00 AM	08:00 AM	10:00 AM	12:00 PM	02:00 PM	04:00 PM	06:00 PM	08:00 PM	User group
Front yard	Open									Men
Corridor-1	Semi-Open									
Living	Closed									Men, Women
Courtyard-1	Open									Men, Women
Corridor-2	Semi-Open									Men, Women
North Bedrooms	Closed									Men, Women
South Bedrooms	Closed									Men, Women
Dining	Closed									Men, Women
Kitchen	Closed									Women
Backyard	Open									Women

→ Used -leisure time,newspaper reading

→ Not in use - no comfort (all months)

→ Watch tv, regular activities

→ Used -leisure time,sit and talk

→ Kids play

→ Used only during nights

→ Used only during nights

→ Domestic work and eating

→ Cooking, cleaning

→ Washing, drying clothes

4.2.2 FIELD READINGS AND ANALYSIS

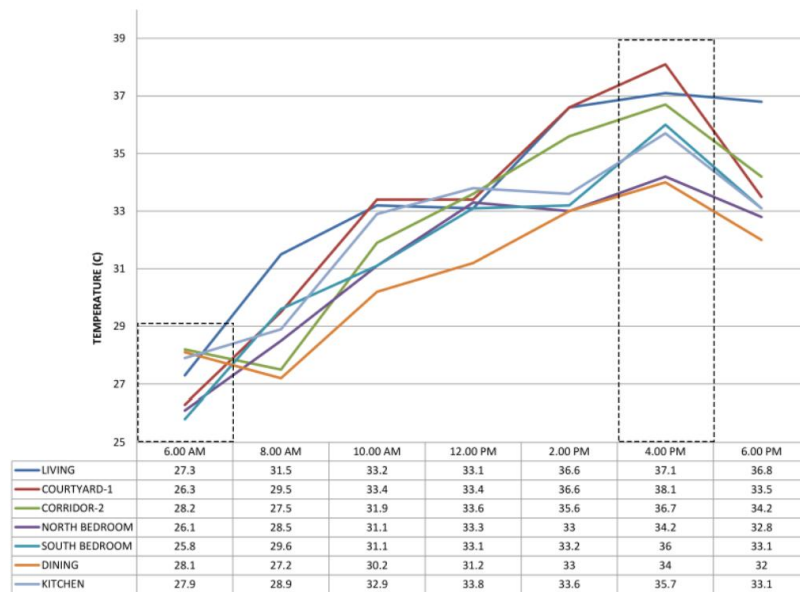


Fig: 4.13: Temperature graph

North bedrooms = Min: 26.1 deg C (6:00 am), Max: 34.2 deg C (4:00 pm) Comfortable
 South Bedrooms = Min: 25.8 deg C (6:00 am), Max :36.0 deg C (2:00 pm) Slightly Warm
 Dining = Min: 27.2 deg C (8:00 am), Max: 34.0 deg C (2:00 pm) Comfortable
 Kitchen= Min: 27.9 deg C (6:00 am), Max :35.7 deg C (4:00 pm) Warm

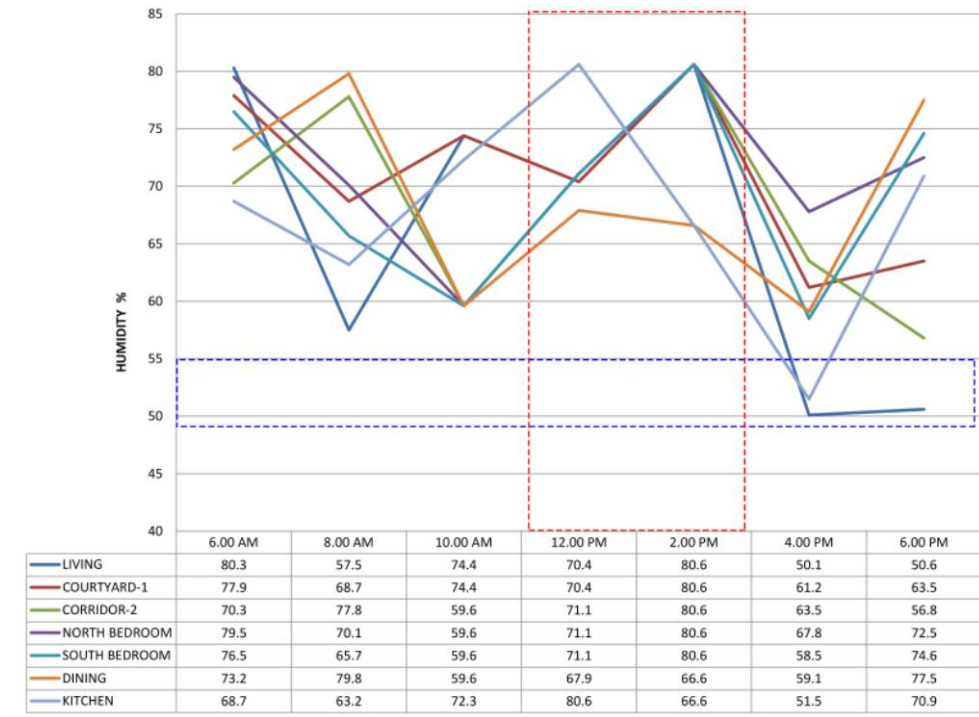


Fig: 4.14: Relative Humidity graph

Drops around 4.00 pm - 50.1% in living and 51.5% in kitchen increases at 6.00 am in Living to 80.3%, and at 8.00 am in Dining space to 79.8%.

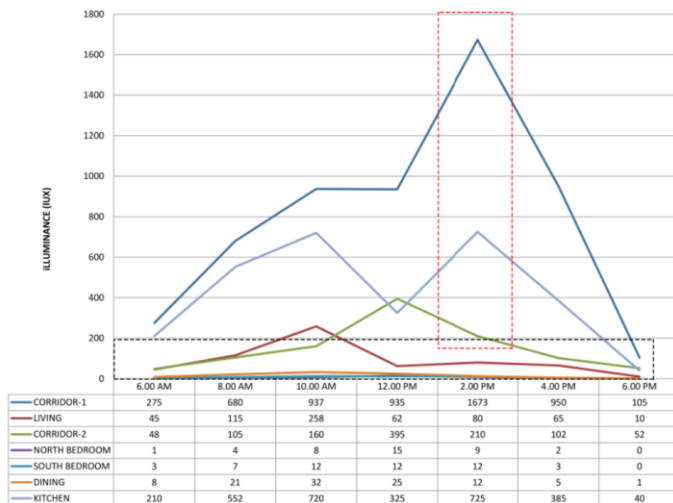


Fig: 4.15: Illuminance lux

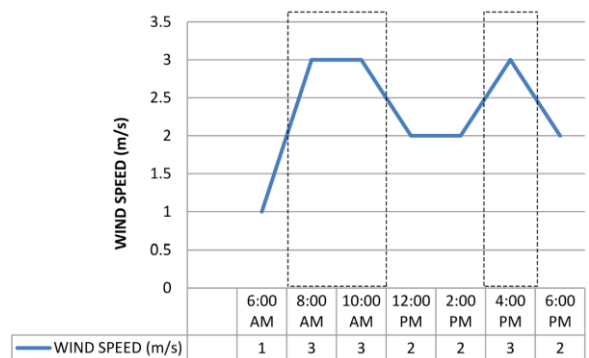


Fig: 4.16: Wind speed

As per survey, occupants are comfortable with the openings and the indoor air flow, except in Dining and kitchen, and also North and south bedrooms, but they experience comfort due to courtyard, even during daytime during summer.

The wind speed is from 1 m/s at 6:00 am, which is maximum of 3m/s during 8:00 and 10:00am.

CRITICAL SPACES;

Open spaces - not considered (as they receive maximum light)

North Bedrooms: Min lux= 0 (6.00 pm), Max lux= 15 (12.00 pm)

South Bedrooms: Min lux= 0 (6.00 am), Max lux= 32 (2.00 pm)

Living: Min lux= 10 (6.00 pm), Max lux= 258 (10.00 am)

Kitchen: Min lux= 40 (6.00 pm), Max lux= 725 (2.00 pm)

4.2.3 MICRO-CLIMATE ANALYSIS (ENVIMET)

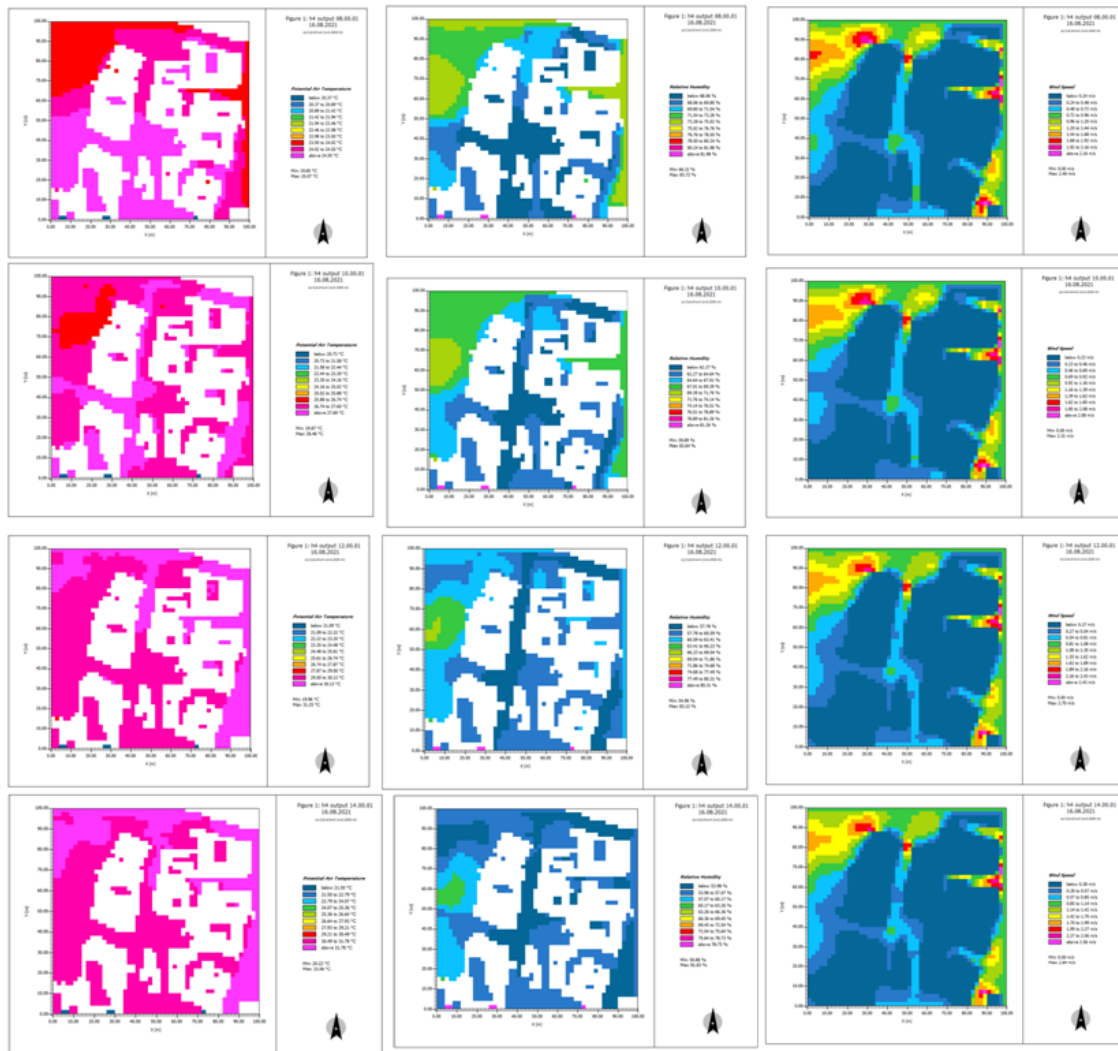


Fig. 4.17: 08.00 am – 02.00 pm simulation

Table 4.6: Envimet simulation values

TIME	SIMULATION VALUES		
	TEMPERATURE (deg C)	RELATIVE HUMIDITY (%)	WIND SPEED (m/s)
08:00 am	25.07	83.72	2.40
10:00 am	28.46	83.64	2.31
12:00 pm	32.99	61.19	3.33
02:00 pm	31.25	83.12	2.70

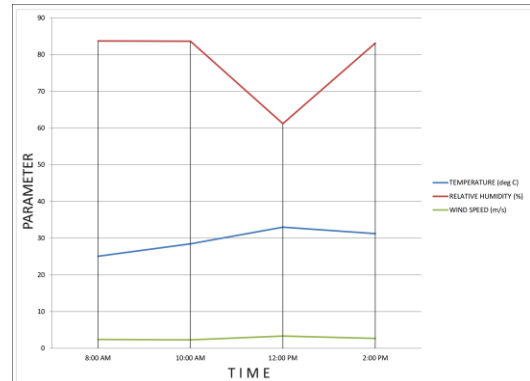


Fig: 4.18: Simulation value graph

The temperature gradually increases from morning 8.00 am to 02:00 pm, and the humidity drops gradually from morning 08.00 am to 12:00 pm.

The wind speed varies between 2.31 m/s to 3.33 m/s.

Maximum wind speed: 2.31 m/s: 08:00 am

Minimum wind speed: 3.33 m/s : 12:00 pm

4.2.4 MATERIAL STUDY

The material study is carried out based on building components that s walls, roof and floor. This is related with surface temperature and the U-value.

Table 4.7: Material study

HOUSES	SPACE	COMPONENT	COMPONENT MATERIAL	COMPONENT THICKNESS	U-VALUE (w/m ² -k)
HOUSE -4	OVER ALL	WALL	BURNT CLAY BRICKS	0.40 m	1.8
	OVER ALL	ROOF	BAKED CLAY MANGLORE TILES	0.012 m or 12 mm	5.3
	A	FLOOR	REDOXIDE TILES	0.15 m	
	B	FLOOR	ITALIAN MARBLE	0.2 m or 20 mm	
	C	FLOOR	KARUNGAL OR NATURAL STONE	40 mm	
	D	FLOOR	TRADITIONAL CEMENT	0.2 m	

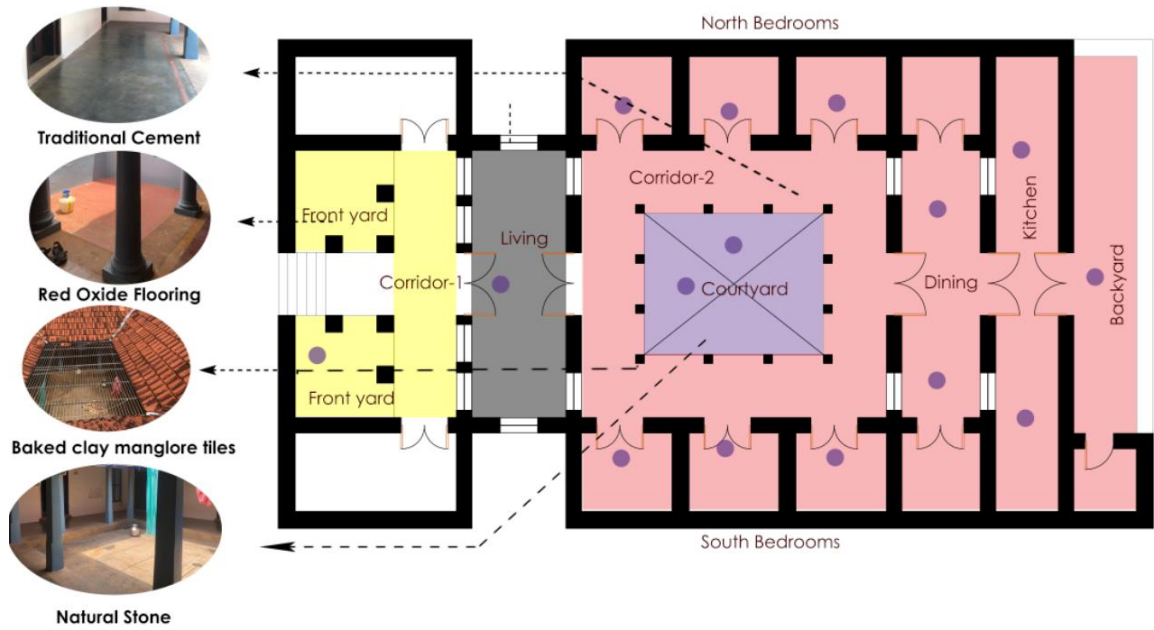


Fig: 4.19: Material Analysis in each space



Fig: 4.20: Surface temperature graph

The Surface temperature:

Wall: Maximum (East wall) = 44.3 deg C (02: 00 pm)

Minimum (South wall) = 30.0deg C (10: 00 am)

Roof = Maximum: flat = 41.2 deg C (12: 00 pm),

Minimum: Slope = 29.6 deg C(10: 00 am)

Floor = Maximum: Courtyard = 36.8 deg C (04: 00 pm),

Minimum: Corridor = 32.9 deg C(10: 00 am)

CHAPTER 5 SITE

5.1 IDENTIFICATION AND JUSTIFICATION

For a big metropolitan city Chennai, the ideal ST option became Thirumazhisai which is located near Poonamalle Town about 30kms from Chennai. It falls under the Tiruvallur District. The area is a connecting point from the south of Chennai (GST), gateway to southern Tamilnadu, to the north of Chennai, gateway to Andhra Pradesh and Telengana and West of Chennai, gateway to Karnataka and beyond. The area has fast grown into a leading commercial hub far west of Chennai, adjacent to Chennai Bangalore Highway, the busiest highway catering to business and leisure travel between two of the top IT hubs of India.

For a big metropolitan city Chennai, the ideal ST option became Thirumazhisai which is located near Poonamalle Town about 30kms from Chennai. It falls under the Tiruvallur District. The area is a connecting point from the south of Chennai (GST), gateway to southern Tamilnadu, to the north of Chennai, gateway to Andhra Pradesh and Telengana and West of Chennai, gateway to Karnataka and beyond. The area has fast grown into a leading commercial hub far west of Chennai, adjacent to Chennai Bangalore Highway, the busiest highway catering to business and leisure travel between two of the top IT hubs of India.

The proposed state of the art infrastructure includes earth quake proof high definition concrete roads, storm water drains, spacious avenues, culverts, minor bridges, solar powered street lights and road markers, sustainable energy solutions, rain water harvesting, etc. The township will have high quality basic amenities for a comfortable living viz., Schools, Hospital, Commercial Complex, Office Spaces, Mall, Cinema Hall, Gymnasium for all genders and ages, Parks, Walkways, Public Rest Rooms, Health Center, Ambulance services, Fire Station and robust Security system for safe and comfortable living.



Fig: 5.1: Site Location

5.2 SWOT STUDY



Fig: 5.2: SWOT Analysis

5.3 SITE ANALYSIS

The site analysis is carried out for the allotted residential pocket by the TNHB. The site analysis is done climatically and architectural analysis. The climatic analysis is carried based on Envi-met simulations for critical months of Chennai i.e May which is the critical month recording high temperature and the architectural analysis focusing on Neighborhood context, Natural physical features, Manmade features, Drainage pattern, Topography etc.

SITE: TNHB Acquired land for satellite township development.

District: Thiruvallur

Area: 135 acres – township

Residential area (chosen for proposal): 9.3 acres

Software Used for simulation : Envimet- beginner version

Simulation Date: 21/ March/ 2022

Simulation Hours: 10:00 am, 12:00 pm, 02:00 pm (peak hours)

PARAMETERS STUDIED: Potential air temperature, Relative humidity, wind speed and wind direction.

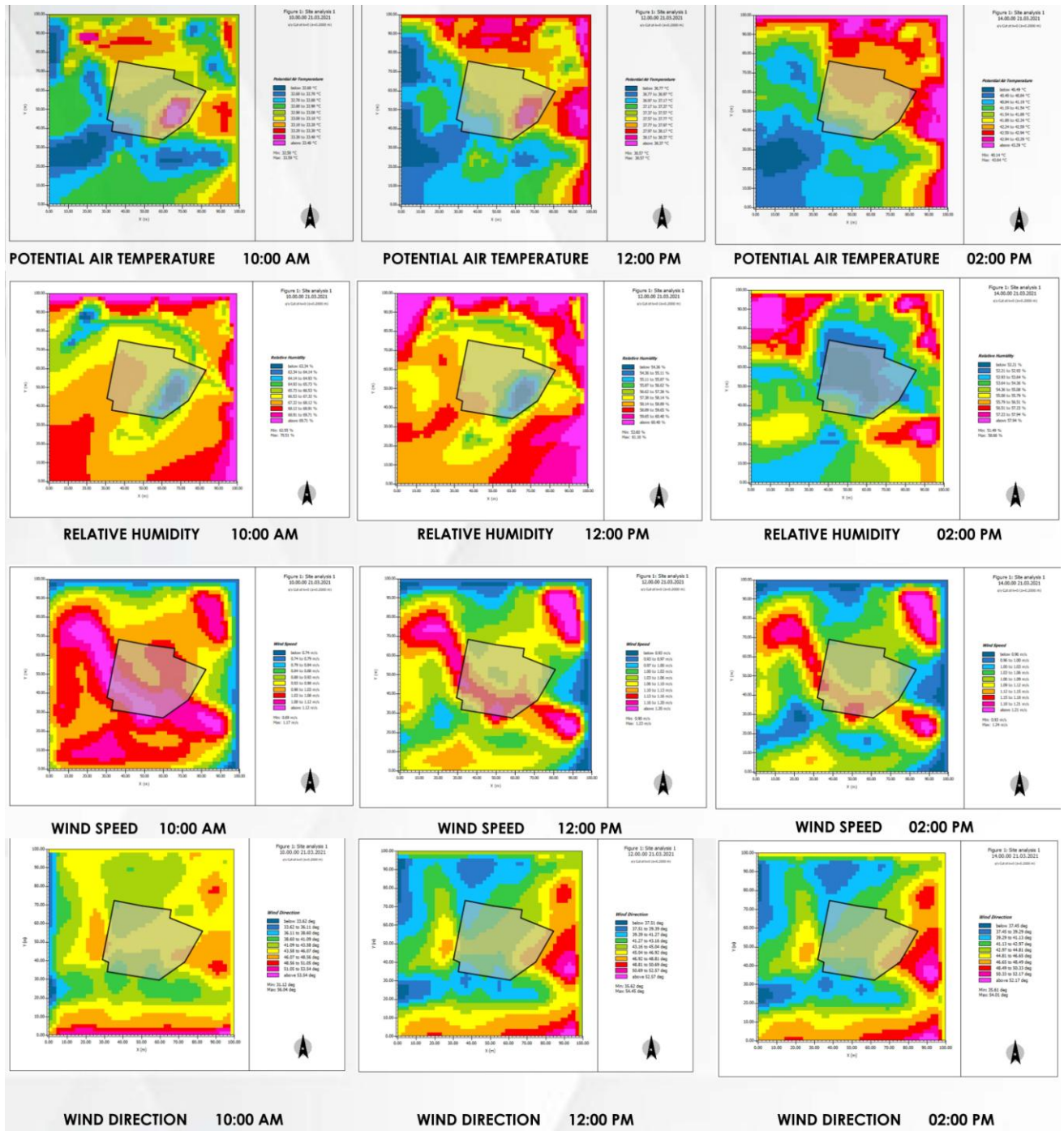


Fig. 5.3: Site envimet simulation

The simulation is run-on for the critical period of Tiruvallur district with high temperature and humidity to analyze the ideal and suitable zone for designing the proposed residential community with respect to existing vegetation and features. The zone selected for residential community is an ideal and suitable spot than any other corner as it record moderate temperature and humidity in critical month of Chennai. The wind speed is also moderate varying from 0.98 m/s to 1.15 m/s from 10:00 am to 02:00 pm and the prevailing wind direction is North-East.

Table 5.1: Envimet results

PARAMETERS	TIME		
	10:00 am	12:00pm	02:00 pm
Potential Air temperature	32.98-33.18	37.37-37.97	41.89-42.59
Relative humidity	65.73-67.32	56.62-58.14	52.21-54.36
Wind speed	0.98-1.08	1.03-1.13	1.06-1.15
Wind direction	North-East	North-East	North-East

The neighborhood of the context is occupied with industries, Kuthambakkam bus terminus, Agricultural fields, future development sites, schools, colleges, hospitals, commercial etc. The site is under Tamil Nadu Housing Board controls and regulation. The site has two access road having a width of 15ft (4.6 m). The drainage pattern is dendritic pattern.

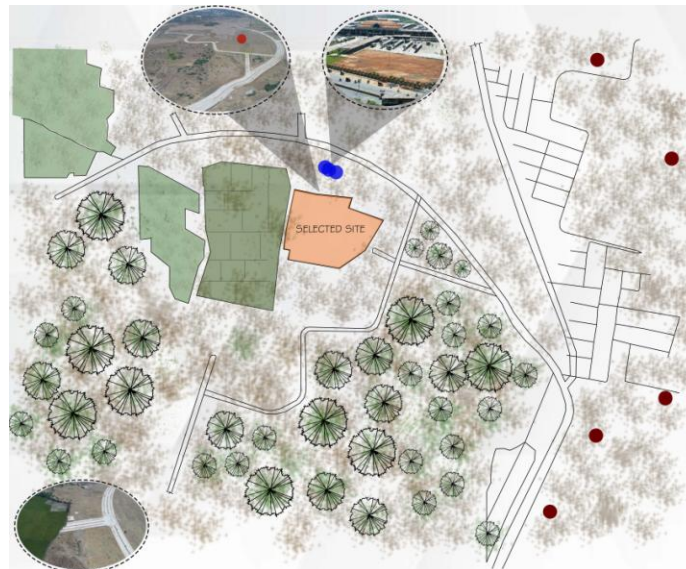


Fig: 5.4: Site analysis and features

The slope or the topography is checked through latitudinal and longitudinal percentage calculation method.

Slope 1: Latitudinal

Rise= 1 ft, Run= 200 ft

Slope %= Rise/ Run = 1/ 200= 0.5%

Slope 2: Longitudinal

Rise= 1 ft, Run= 283 ft

Slope %= Rise/ Run = 1/ 283= 0.35%

According to “Site development and slope modification regulations, 2014” 50cms of depth/ slope is negligible or need not consider.



Fig: 5.5: Slope analysis Latitudinal



Fig: 5.6: Slope analysis Longitudinal

Water Direction: The water direction in the site is analyzed through the existing local river flow and its course. The major water source is Kosathalaiyur River whose direction is towards poondi, chittor and origins from pallipattu. The direction is from East to West.

CHAPTER 6 SHEETS

PARAMETERS TO BE OBSERVED IN TOWNSHIP PLANNING :



ZONING : With respect to climate, rules and regulations, commercial, education, recreation etc.



GREEN ZONE : Agriculture/ farming with particular area with water facilities and green pockets.



PUBLIC BUILDINGS : Accessibility, not disturbing the private or residential zone .



ROAD NETWORK : Hierarchy, connectivity, junctions, pattern and layout.



RECREATION CENTRES : Accessibility, connecting private & semi-private, security.



TRANSPORT FACILITIES: Pedestrian/ jogging track, cycle spots etc.

OBJECTIVES OF A PLANNING :

HEALTH : Right use of land, right purpose called proper zoning.

CONVENIENCE :The object of convenience is meant in the form of various needs of the community such as social, economic, cultural and recreational amenities etc.

BEAUTY: To preserve the individuality of the town by developing it on its most suited natural conditions. To preserve the aesthetics in the design of all elements of township plan, which includes preservation of trees, natural greenery, improved types of domestic buildings and buildings of civic dignity and beauty, architectural control on public as well as semi-public building, ancient architectural buildings, temples, churches, mosques and buildings of cultural and historical importance.

ENVIRONMENT: It is an important factor in town planning. The environment of the town should be in such a way that people can lead their normal activities with least difficulty.

BACKGROUND STUDY AND LITERATURE CASE STUDIES

BACKGROUND STUDY : ATHANGUDI VILLAGE

The background study is on Athangudi village to analyse the planning, landuse and traditional concept and to implement in macro-level township planning.

The literature case study is on different typologies such as low-rise, mid-rise and high-rise. Where they are climate responsive, traditional involvement in designing, sustainable features, passive strategies and focussing on thermal comfort of the occupants.

TOWNSHIP/ COMMUNITY :

~ BELAPUR HOUSING
~ BEDOK COURT

LOW RISE RESIDENCE :
~ THE COURTYARD HOUSE

HIGH RISE :
~ KANCHUNJUNGA APARTMENT



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials

Background study ~~~ Township planing



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VILLAGE CHOSEN : ATHANGUDI

FROM ATHANGUDI TO KONAPATTU

Reason : Oldest settlement
Live Visited
Centre of the region

The Chettiars took into consideration the climatic aspects of the region, which is hot and arid. The town planning activity included this knowledge in order to effectively establish a self-sufficient system. Materials were put to use after careful consideration in order to be sustainable.



Layout :
Grid- iron pattern

Streets :
Run north-south direction

Utility streets parallel to each other

Temples : Not centre of the town alike other Tamil Nadu villages and towns.

TO ATHANGUDI FROM
SOKALINGAPUDUR



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
Background study ~~~ Village planning ...



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VILLAGE CHOSEN : ATHANGUDI

Reason : Oldest settlement

Live Visited

Centre of the region



Schematic sketch of street layout around temple

POPULATION = 1600+

MALE : 840 FEMALE : 860

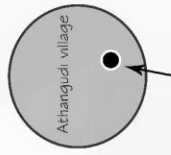
HOUSES : 470

AREA : 1680 acres

Houses are separated by narrow gaps by 1 m in North- South direction.

Houses are oriented along East - West axes.

Every single house is considered as cosmos and their daily rituals are based on the movement of the sun.

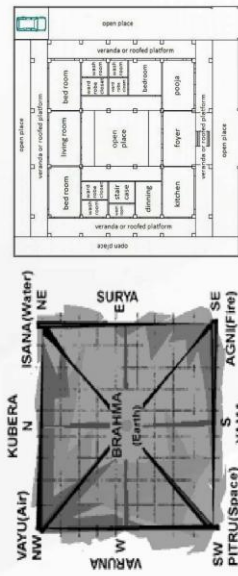


This kind of orientation facilitates the wind flow inside the house.

Central courtyard provides shade, light and coolness.

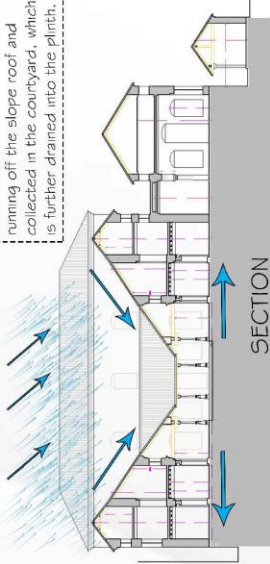
Houses are planned with respect to usage of spaces and street access.

Houses are individual but give a sense of connectivity through symmetrical planning, row concept and visual sense as a community together.



The organization of spaces is planned with respect to the usage, climate and which indirectly points out to the vastu.

The section shows the rain water running off the slope roof and collected in the courtyard, which is further drained into the plinth.



SECTION

Water, a precious commodity was efficiently tapped and stored. Run off from roofs was collected in gutters that fed wells and tanks. Rainwater was diverted through channels of drainages to empty into tanks or ponds created for storage purposes. Slopes of the roofs were also critically managed to facilitate collection of water.

This water system is comprised of two types of inter-connected networks. One is inside the villages comprising drainages and ponds (or ooranis). The other one is made of crys (or Kanmois), traditional surface water storage reservoirs, spread over the countryside around the villages.



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials

Background study ~~~ Village planning ...



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DISSERTATION : The study is carried out on chettinadu design and planning principles and their vernacular materials by choosing 5 houses in different timelines from early 1800s to late 1900s.

Through which the planning, strategies, activity of the users, spatial organization and material (u-value) is studied and is cross verified with micro-climate analysis through software simulations and field study measurements of Air temperature, Relative humidity, Daylight (lux) and surface temperature of wall, floor and roof.

The critical points & spots of the houses are identified through analysis. Further recommendations and alterations are given for better performance & efficiency.

PARAMETERS	CHETTINADU HOUSES	PASSIVE STRATEGIES FOR WARM-HUMID CLIMATE
ORIENTATION		
ENTRANCE		The East and north opening or entrance for better daylight and air movement.
THINNAI	Acts as a transition between the road/street & the interior of the house.	The thinnai concept as a buffer or transition isn't listed into passive strategies.

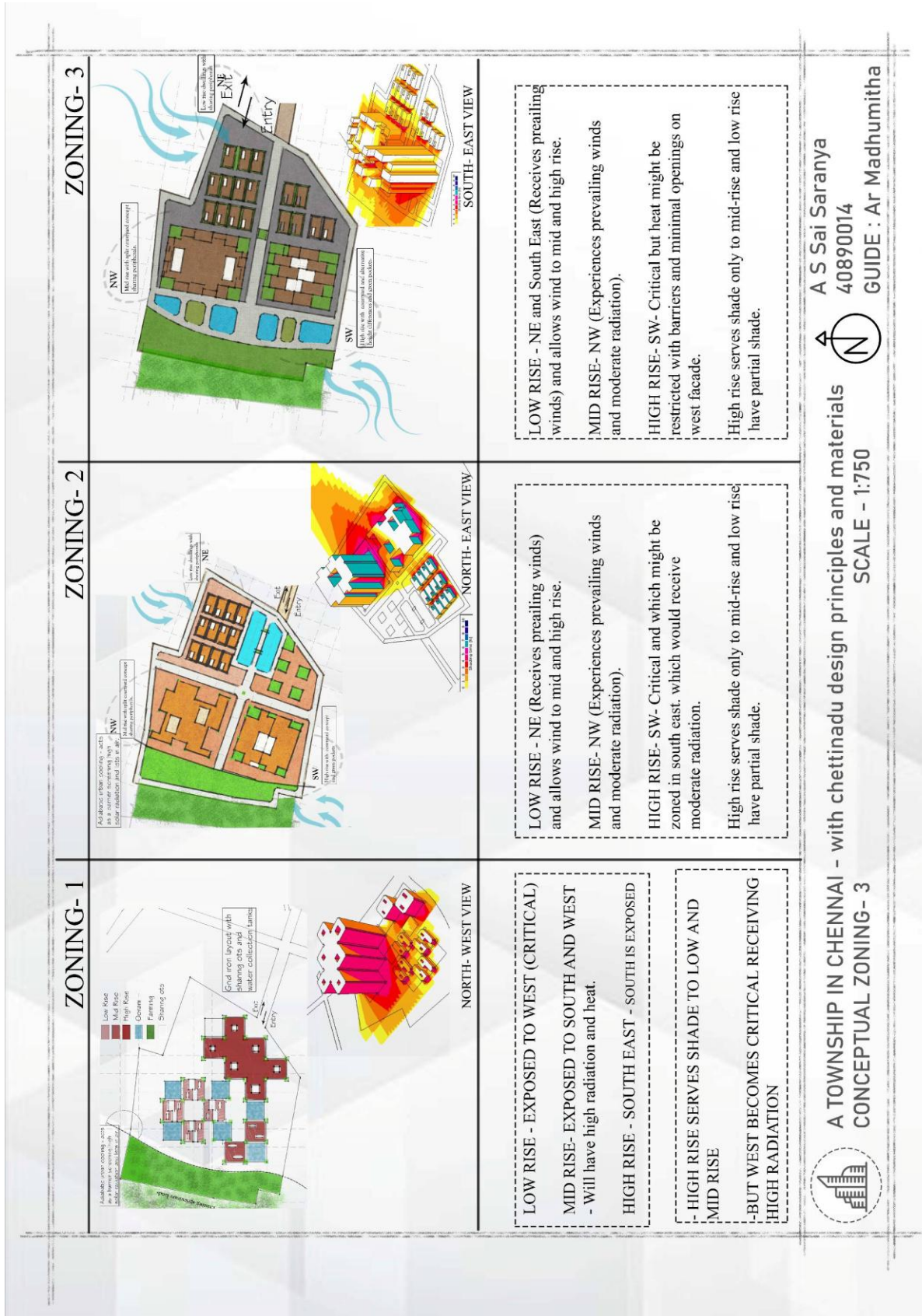
PARAMETERS	CHETTINADU HOUSES	PASSIVE STRATEGIES FOR WARM-HUMID CLIMATE
COURTYARD	Improves micro climate and air movement in the house with natural lighting.	Improves micro climate and air movement in the house with natural lighting.
BUILDING FORM AND PLANNING	Linear planning and building with lot of openings and semi-open spaces and recessions.	Elongated plan with several openings to allow air movement. Less the surface to volume ratio, less is the heat gain in a building. Minimize Perimeter per Area Ratio in Extreme.
OPENINGS	Long and huge openings in all spaces except North and South facade bedrooms.	Window size is kept smaller on the windward side and bigger openings are given in leeward side for regular ventilation.
STACK EFFECT AND CROSS VENTILATION	Gross ventilation with parallel windows and symmetrical planning works well in chettinadu houses.	The stack effect promotes cross ventilation with temperature difference.
SHADING DEVICES	Horizontal shading members with support	Aims in reducing the solar heat gain through opaque operable window with louvers acting as individual shading device.
EARTH TUNNEL	Water collected in plinth, cools surface and space	The tunnel is made with 2m-3m below the earth surface at that depth it is cooler than outside. (thermodynamics)

COMPREHENSION OF CHETTINADU PRINCIPLES AND PASSIVE STRATEGIES



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
BACKGROUND STUDY- SUMMARY

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A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
CONCEPTUAL ZONING - 3

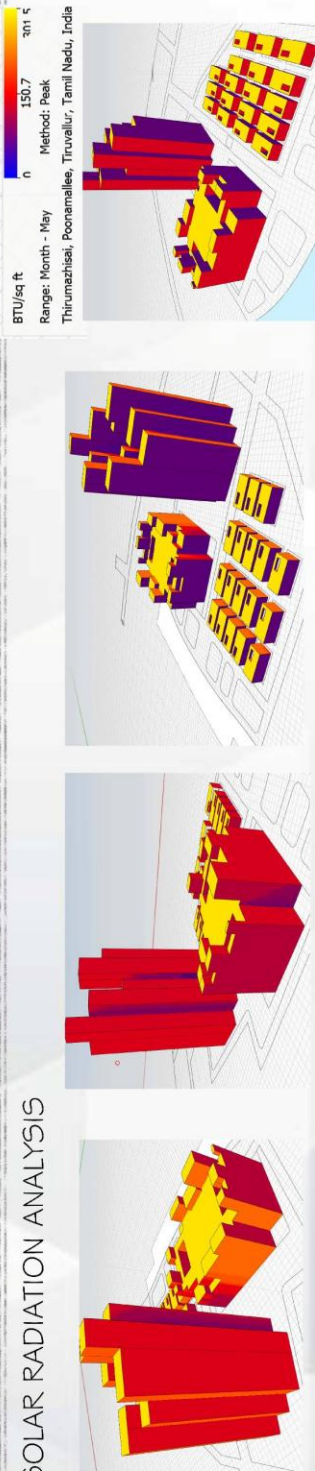


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SCALE - 1:750



SOLAR RADIATION ANALYSIS



NORTH EAST

Radiation values : Minimum: 92.47 BTU/ Sqft (N)
Maximum : 198.1 BTU/ Sqft (E)

NORTH WEST

Radiation values : Minimum: 92.47 BTU/ Sqft (N)
Maximum : 118.1 BTU/ Sqft (W)

SOUTH EAST

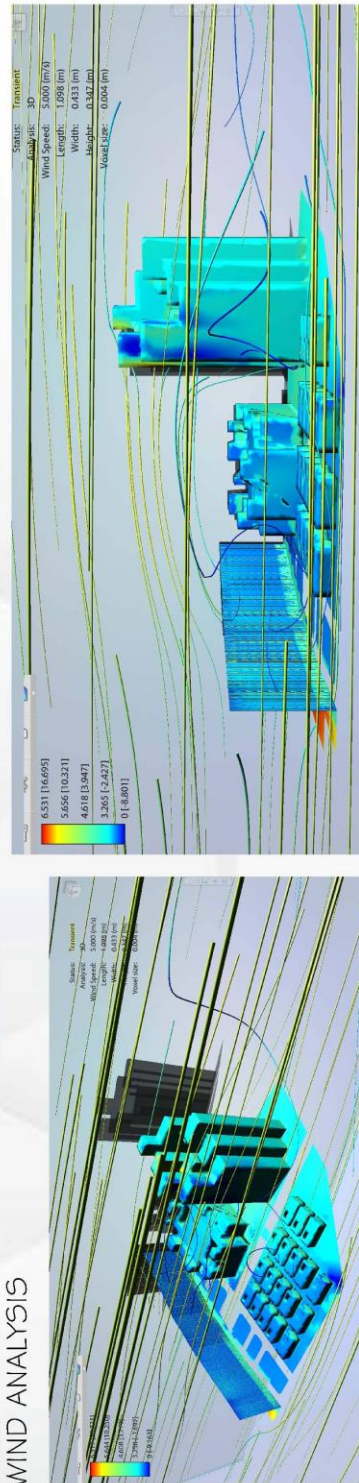
Radiation values : Minimum: 26.11 BTU/ Sqft (S)
Maximum : 198.1 BTU/ Sqft (E)

SOUTH WEST

Radiation values : Minimum: 26.11 BTU/ Sqft (S)
Maximum : 118.1 BTU/ Sqft (W)

In the month of May, at it's peak, East and west receives the highest radiation and the high- rise's facades receive radiation of 92.47 BTU/ Sqft. And the mid and low receive 26.11 and 198.1 BTU/Sqft.

WIND ANALYSIS



The average wind flow is high in south- east and north as per simulation and the wind speed is between 3.265 m/s and high in West with 5- 6 m/s which passes through low-rise to high and mid rise.

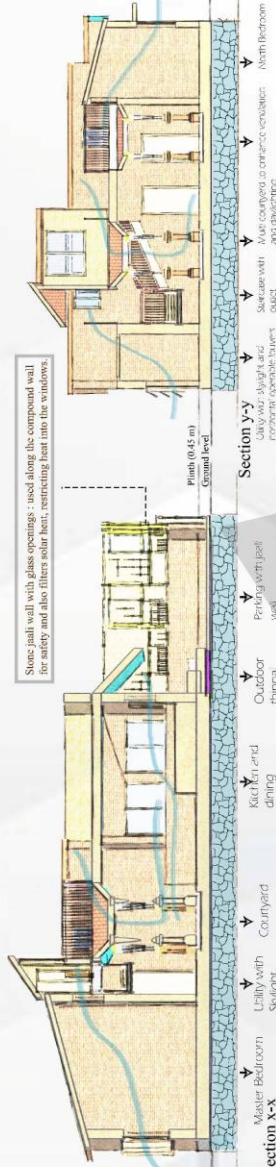
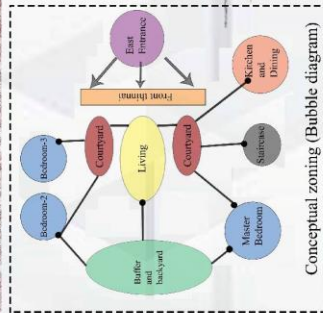


A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
CONCEPTUAL ZONING- 4 (ITERATIONS)

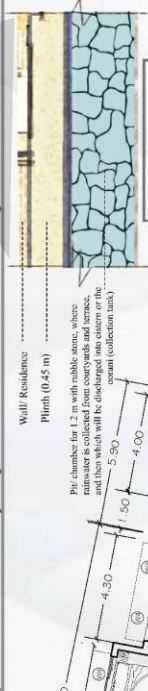


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- Orientation factor
- External Shading Factor
- Entrance factor
- Courtyard and ratio
- Thinnai concept
- Window-Wall- ratio
- SHGC factor
- Stack effect and Cross ventilation
- Interpreted air- tunnel concept



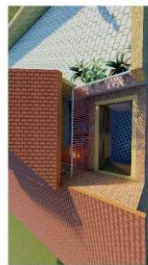
The levels are designed in a way to ensure daylighting and ventilation with appropriate inlet and outlet oriented towards the primary and secondary courtyard. The openings are designed with Horizontal shading in North facade, Vertical louvers in South and west facade. The operable skylight lets in lighting and ensures ventilation and where the vents or openings in lintel level acts as outlets ensuring cross ventilation and stack effect.



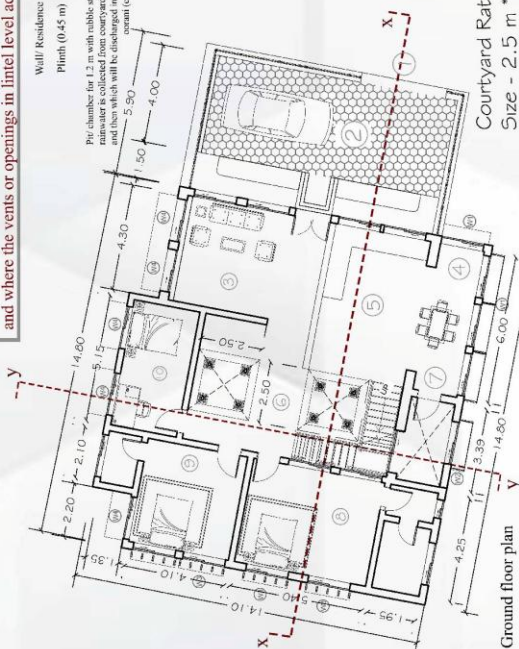
BUILDING	ORIENTATION	Wall area (sq.m)	Window area (sq.m)	WWS (%) (20%, 40%, max) (ECBC 2017)
LOW RISE A	North	50.387	18	35.72%
	South	44.334	13.05	29.435%
	East	55.81	15	26.876%
	West	48.638	14.1	29.08%

Sl. No.	Spaces
1	Dwelling Entrance
2	Parking & outdoor thinnai
3	Living area
4	Dining
5	Kitchen
6	Courtyard
7	Utility
8	Master Bedroom
9	Bedroom- 1
10	Bedroom- 2

SKYLIGHT RATIO :



BUILDING	Skylight	Area	Orientation	Frame	Glass
Low rise A	1	3.2 m x 1.8 m = 5.76 sqm (2.5%)	South	Wood	Double glazing
ECBC 2017 Table 10-1		Total surface area : Gross exterior roof area = 5%			U-Factor = 3.4 W/sqm. K



Courtyard Ratio - 1 : 1
Size - 2.5 m x 2.5 m



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
LOW RISE - Type- A (Planning and iterations)

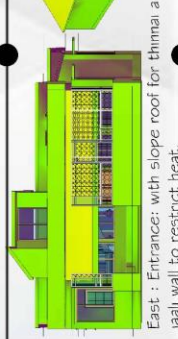


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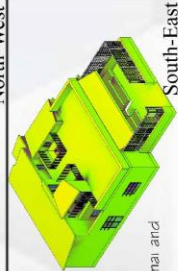
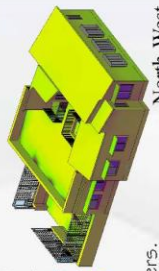
- ☒ Orientation factor
- ☒ Entrance factor
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- ☒ Thinnai concept
- ☒ Window-Wall- ratio
- ☒ SHGC factor
- ☒ External Shading Factor
- ☒ Openings (Inlet and outlet)
- ☒ Stack effect and Cross ventilation
- ☒ Interpreted air- tunnel concept

SOLAR ANALYSIS : CUMULATIVE INSOLATION
01/01-2022 - 31/12/2022

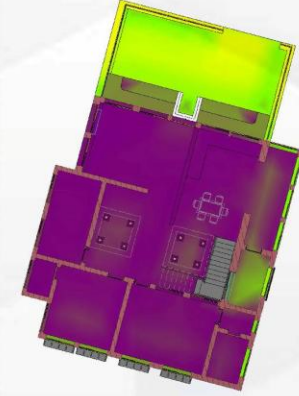
EXPOSED FACADES



ITERATION-2



GROUND FLOOR

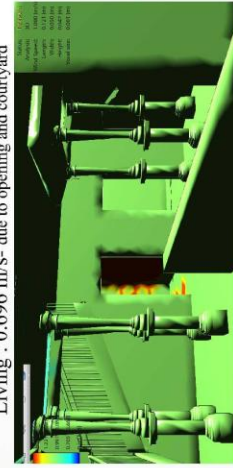


The plan shows the low radiation impact on interior spaces (living, kitchen, dining, staircase, bedrooms and toilet). Only minimum radiation is observed in

- Utility (due to skylight)
- Courtyards (ots)
- Parking and thinnai (partially)

Most of the radiation is cut-off and daylighting is achieved to optimal level in iteration-2

WIND ANALYSIS : AVERAGE



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
LOW RISE - Type- A (Planning and iterations)



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- | | | | | | | | | | | | |
|-------------------------------------|-------------------------|-------------------------------------|-----------------------------|-------------------------------------|------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|---------------------------------|-------------------------------------|-------------|
| ☒ | Orientation factor | ☒ | Entrance factor | ☒ | Courtyard and ratio | ☒ | Thinnai concept | ☒ | Window-Wall- ratio | ☒ | SHGC factor |
| ☒ | External Shading Factor | ☒ | Openings (Inlet and outlet) | ☒ | Stack effect and Cross ventilation | ☒ | Stack effect and Cross ventilation | ☒ | Interpreted air- tunnel concept | ☒ | |

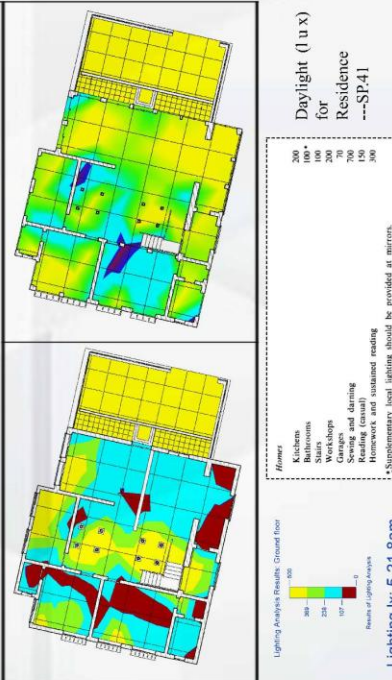
DAYLIGHT ANALYSIS (illuminance: lux)

SUITABLE SHADING DEVICE

ITERATION-1

ITERATION-2

Simulated month : critical : May; Date : 21st/ 2022



SPACES	illumiance (lux)
Living	369-500
Kitchen	369-500
Dining	369-500
Staircase	239-369
Master bedroom	239-369
Bedroom-1	239-369
Bedroom-2	239-500
M. Br Toilet	239-500
B2 Toilet	239-500

Iteration- 1: with suitable sunshades but with different opening and non-vents so the daylighting is quite less than the optimal range in utility and bedrooms.

Iteration-2: with suitable shading devices and openings, where there is an increase in lux level in utility and bedrooms. And they meet the optimal level according to **Sp41** standards.

According to IGBC, 50% of passing daylight through any space is optimal.

The shading devices in chettinadu house is an horizontal shading with supports, which was a issue in letting solar radiation but still with low lux in critical spaces like kitchen, bedrooms and corridors. The only source of light was courtyard.

Whereas in Low rise, the openings and shading devices are designed as per ECBC but the style and material of chettinadu architecture is used to improve the performance of the spaces.

The designed shading devices are blocking the solar radiation but lets it sufficient light and is efficient.



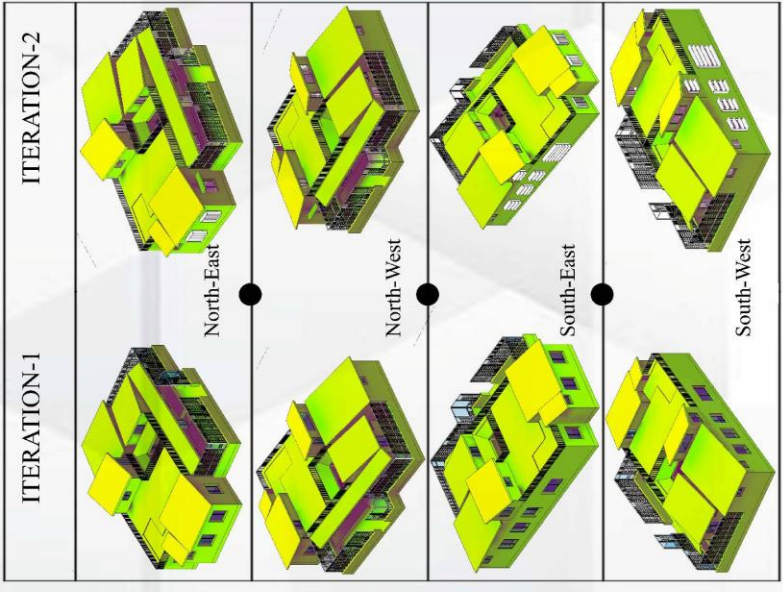
A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
LOW RISE - Type- A (Planning and iterations)



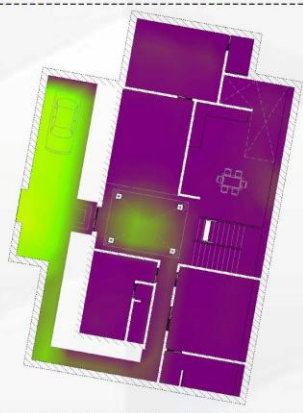
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- ☒ Orientation factor
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SOLAR ANALYSIS : CUMULATIVE INSOLATION
01/01-2022 - 31/12/2022



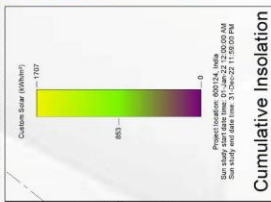
GROUND FLOOR



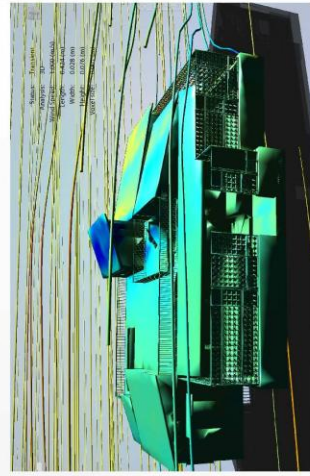
Iteration-2 : with designed shading devices

The plan shows the low radiation impact on interior spaces (living, kitchen, dining, staircase, bedrooms and toilet). Only minimum radiation is observed in

- Utility (due to skylight)
- Courtyards (ots)
- Parking and thinnai (partially)



Most of the radiation is cut-off and daylighting is achieved to optimal level in iteration-2



Average wind speed
0.598 m/s - 1.037 m/s

The average wind speed is optimal in spaces due to the courtyard, cross ventilation and hi-level vents which acts as outlets.



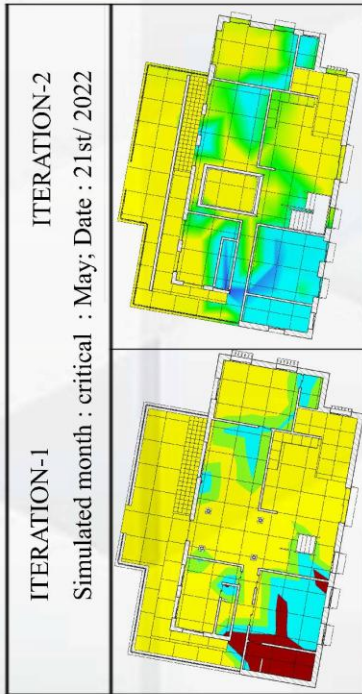
A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
LOW RISE - Type- B (Planning and iterations)



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- ☒ Orientation factor ☒ Entrance factor ☒ Courtyard and ratio ☒ Thinnai concept ☒ Window-Wall- ratio ☒ SHGC factor
☒ External Shading Factor ☒ Openings (Inlet and outlet) ☒ Stack effect and Cross ventilation ☒ Interpreted air- tunnel concept

DAYLIGHT ANALYSIS (illuminance: lux)



SPACES	illuminance (lux)
Living	107-369
Kitchen	369
Dining	369
Staircase	238-369
Master bedroom	107-300
Bedroom-1	107-300
Bedroom-2	238-369
M.B.T Toilet	0-107
B2 Toilet	238

Iteration- 1: with suitable sunshades but with different opening and non- vents so the daylighting is quite less than the optimal range in utility and bedrooms.

Iteration-2: with suitable shading devices and openings, where there is an increase in lux level in BATHROOMS. And they meet the optimal level according to **Sp41 standards**.

According to IGBC, 50% of passing daylight through any space is optimal.

Daylight (l u x) for Residence ---SP41

SPACES	illuminance (lux)
Living	238-369
Kitchen	369-500
Dining	238-369
Staircase	238-369
Master bedroom	107-238
Bedroom-1	369-500
Bedroom-2	238-369
M.B.T Toilet	107-238
B2 Toilet	107-369
B3 Toilet	107-238

SUITABLE SHADING DEVICE

BUILDING	Window	Window size (m)	Window orientation	Shading device	SP- 41 : STANDARD	DESIGNED DEVICE
Low rise B	W1	1.5*1.8	North	Horizontal shading	Table 10 : angle=0 Projection = 0.7 m	
	W2	1.5*1.8	East	Vertical louvers (cuts-off both summer and winter sun)	Table 10 : angle=45deg Spacing between louvers= 0.53 p Projection = 0.4 m Spacing= 6, 7 members	
	W3	1.5*1.8	South- East	Combination (cuts-off summer sun and allows winter morning sun partially)	Table 10 : angle=0 Projection = 0.4 m H= 5 members, V= 7 members	
Low rise B	W4	1.5*1.5	South	Horizontal louvers (Cuts-off all summer from 15th march to 30th September)	Table 10 : angle=0 deg Projection = 0.5 m Spacing= 3, 4 members	
	W5	2.5*2.5	South		Table 10 : angle=0 deg Projection = 0.5 m Spacing= 5, 6 members	

The shading devices in chettinadu house is an horizontal shading with supports, which was a issue in letting solar radiation but still with low lux in critical spaces like kitchen, bedrooms and corridors. The only source of light was courtyard.

The designed shading devices are blocking the solar radiation but lets it sufficient light and is efficient.

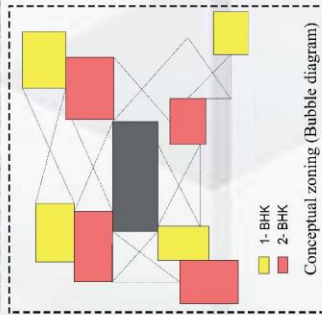


A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
LOW RISE - Type- B (Planning and iterations)

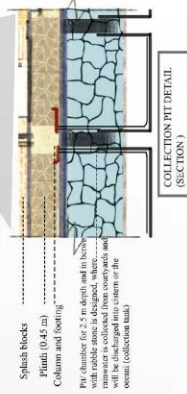
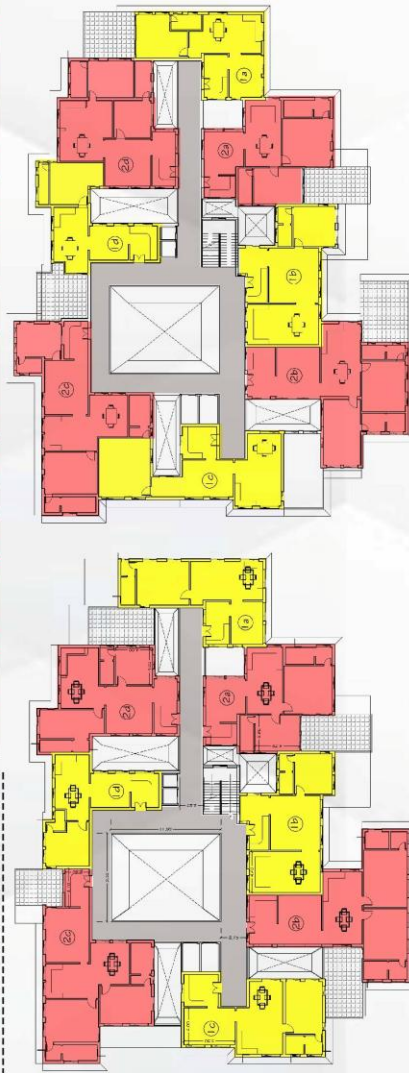


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- ☒ Stack effect and Cross ventilation
- ☒ Interpreted air- tunnel concept



The mid rise is designed around a central courtyard which acts as a common area in ground floor with thinnai and surrounded with stilt parking. The stilt parking is an interpretation of high raised plinth in "chettinadu houses" in order to be a responsive towards heavy and floods. The residential units are designed from first floor with 1bhk and 2bhk, each having a huge open loggias and sharing courtyards enhancing the ventilation and wind movement. Every house as a indoor thinnai instead of foyer.



FIRST AND THIRD FLOOR PLAN

SECOND AND FORTH FLOOR PLAN

Non- typical floors with 2:3 courtyard ratio is planned with 8-units in each floor, where there are 4- 1BHKs and 4-2 BHKs, each of 1BHK and 2 BHK share a terrace from their respective bedrooms which acts as loggias. These loggias are self shaded with counter floor projected spaces. Which protect the interior of bedrooms from high radiation and heat providing thermal comfort.



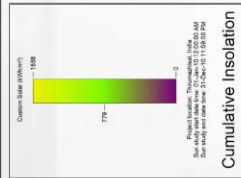
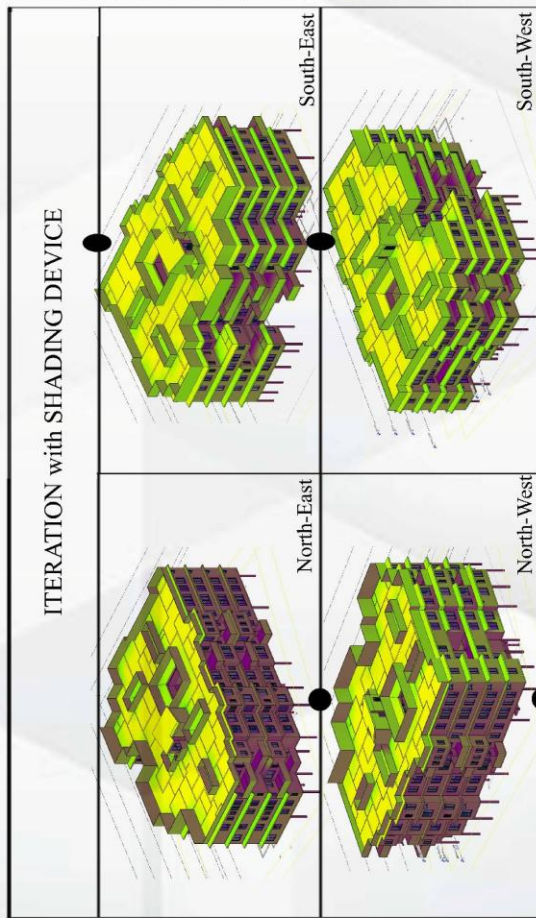
A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
MID RISE (Planning and iterations)



A S Sai Saranya
40890014
GUIDE : Ar Madhumitha

- ☒ Orientation factor
- ☒ Entrance factor
- ☒ Courtyard and ratio
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- ☒ Openings (Inlet and outlet)
- ☒ Stack effect and Cross ventilation
- ☒ Interpreted air- tunnel concept

SOLAR ANALYSIS : CUMULATIVE INSOLATION
01/01-2022 - 31/12/2022

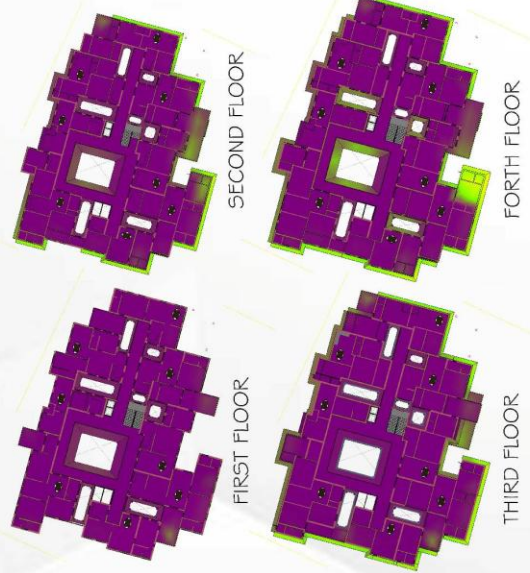


The plan shows the low radiation impact on interior spaces of all units except in sharing terrace or loggias since they are open to sky and also radiation is observed in courtyards.

The recessed portions receive no radiation facade. The projections and courtyards receive moderate to high radiation. The west and south receives high radiation.

The suitable sunshades used have also cut of the radiation entering the space and providing shade.

Radiation analysis in floor plates

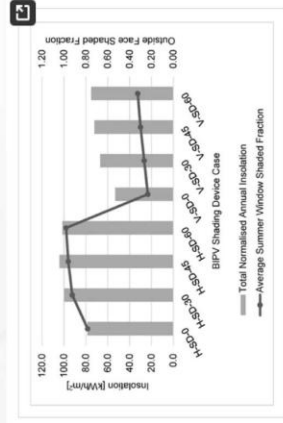
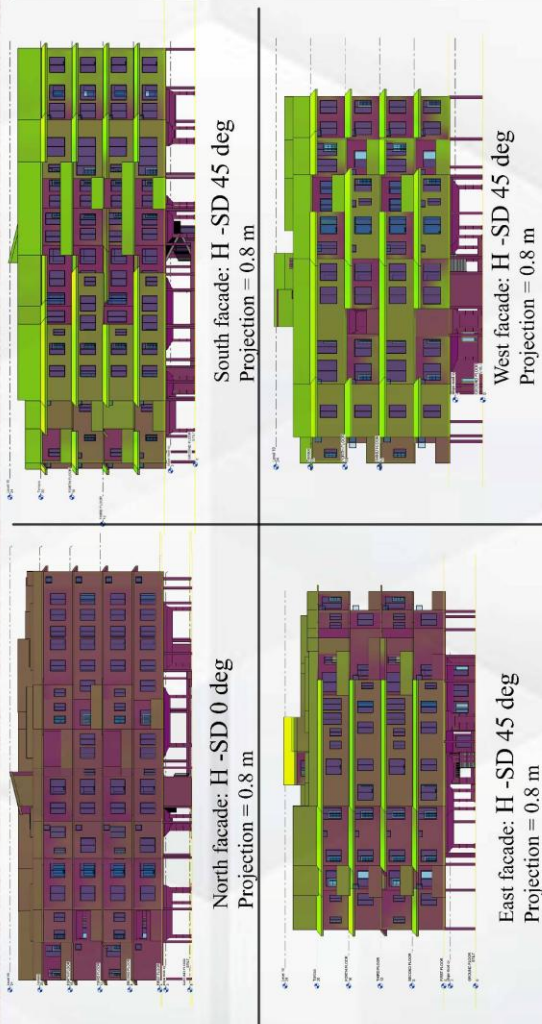


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The case H-SD-45 received the highest amount of annual total insolation (104 kWh/m²) on the eastern, southern, and western facades. This was followed by case H-SD-60 (101 kWh/m²). Both cases offered effective window shading in summer by an average of 96% and 98% of the window area, respectively. On the contrary, the case V-SD-0 received the lowest amount of annual total insolation (53 kWh/m²), preceded by the case V-SD-30 (67 kWh/m²).



Building-integrated photovoltaic's (BIPV's), as opposed to building-applied photovoltaic's (BAPV's), are simply photovoltaic (PV) systems that are used as integral parts of the building envelope.

BIPV modules develop the PV system's role from a mere electrical device to a construction element that could be used to enrich the architectural design instead of disturbing it.

BIPV may replace conventional construction materials in parts of the building envelope using different forms, including panels, foils, tiles, and glazing.

This renewable energy could be used for generating electricity and for heating water.

Provides an on-site renewable energy source that is silent, produces no hazardous emissions during operation, and requires relatively little maintenance during its expected lifetime of 20-25 years.

MATERIAL USED: SILICONE SEMI-CONDUCTORS

<https://www.mdpi.com/2071-1050/10/12/4373/htm>



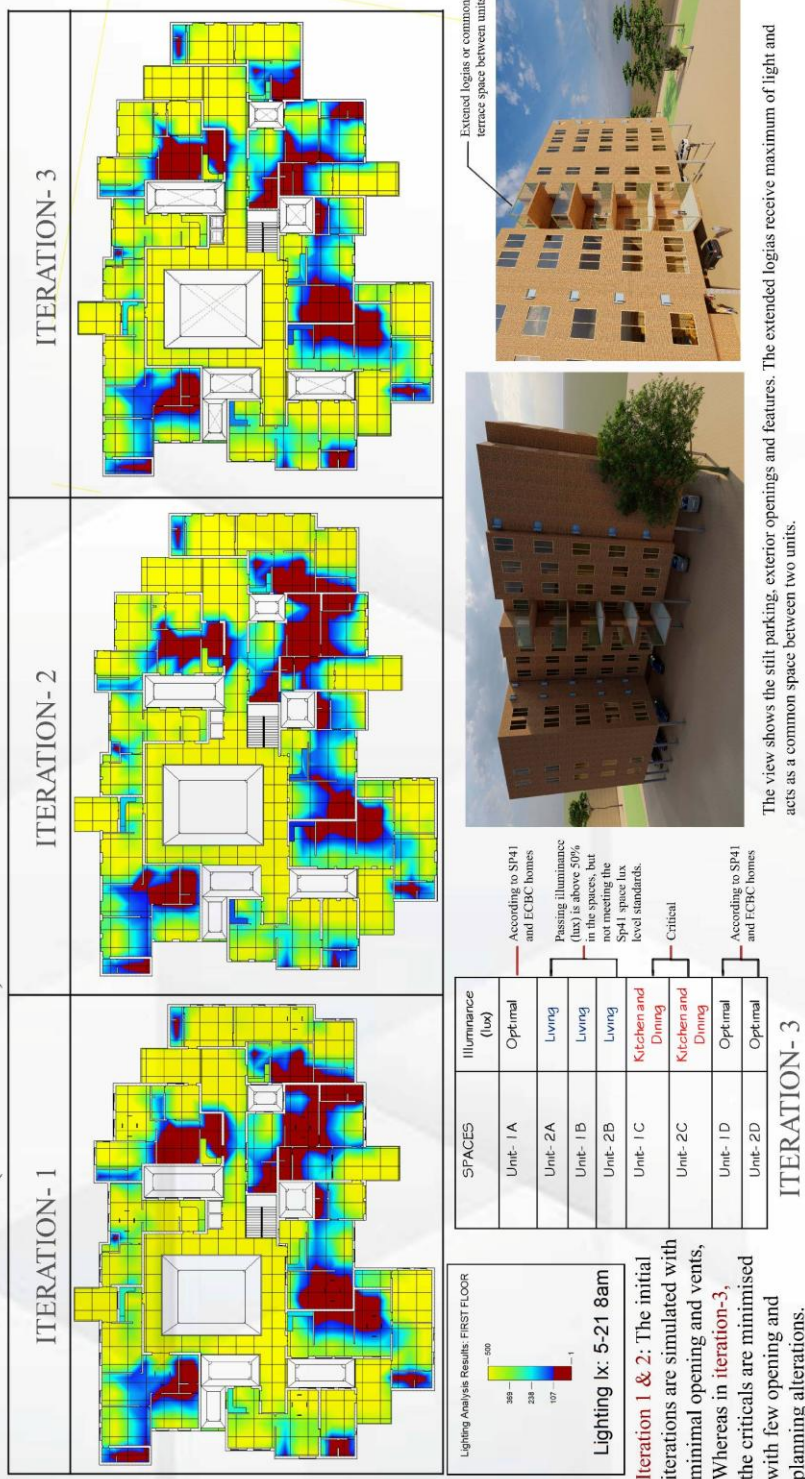
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MID RISE (Planning and iterations)**



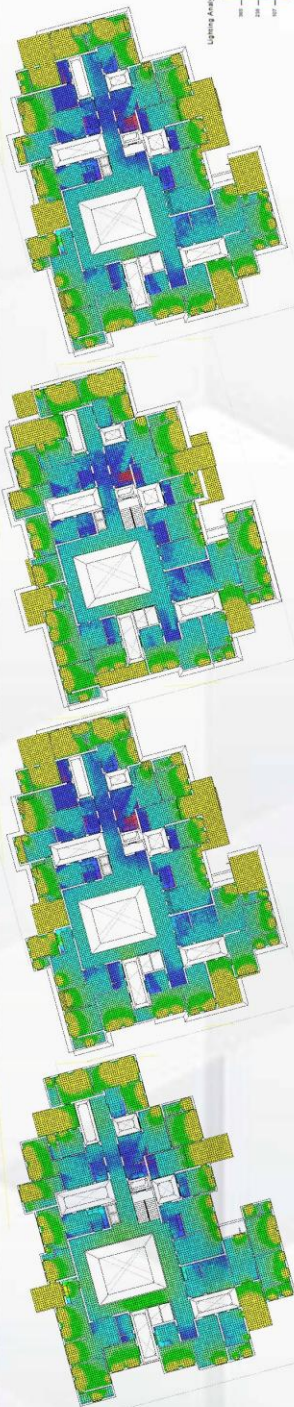
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DAYLIGHT ANALYSIS (illuminance: lux)



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FIRST FLOOR SECOND FLOOR DAYLIGHT (lux) Analysis THIRD FLOOR FORTH FLOOR Lighting lx: 5-21 8am

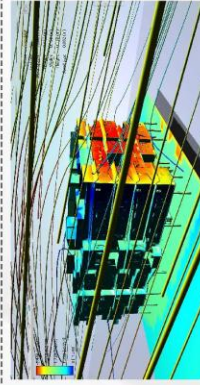
The non- typical planning and mutual shading floors with suitable courtyard ratio has provided sufficient daylighting to the spaces with minimal 107 lux to 369 lux in all units, and whereas in Unit- 2a in all floors the thinnai space receives low lux which is still optimal according to SP-41 standards as the whole unit receives more than 50%of passing daylight through provided openings.

BUILDING	ORIENTATION	Wall area (sq m)	Window area (sq m)	WWR (%) (20%- 40% max) ECBC_2017
Mid Rise (1 st and 3 rd floor)	North	195.96	66.52	33.94 %
	South	244.92	67.58	27.59 %
	East	200.32	44.54	22.2 %
	West	191.72	48.82	25.46 %
BUILDING	ORIENTATION	Wall area (sq m)	Window area (sq m)	WWR (%) (20%- 40% max) ECBC_2017
Mid Rise (2 nd and 4 th floor)	North	216.08	51.88	34.09 %
	South	233.62	59.08	25.28 %
	East	205.16	45.18	22 %
	West	205.8	57.08	27.73 %

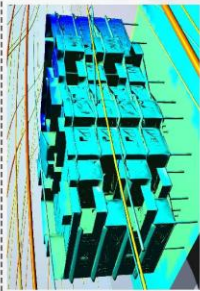
WIND ANALYSIS

North : 1.24 m/s
South: 1.24 m/s - 1.759m/s
East: 1.759 m/s
West : 2.154 m/s

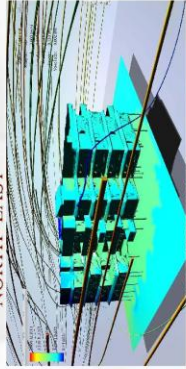
The wind tubes can be seen entering into the openings and the loggias or the projections.



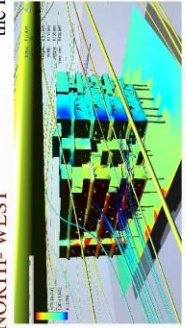
NORTH- EAST



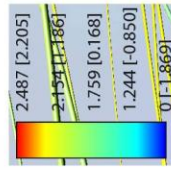
NORTH- WEST



SOUTH- EAST



SOUTH- WEST

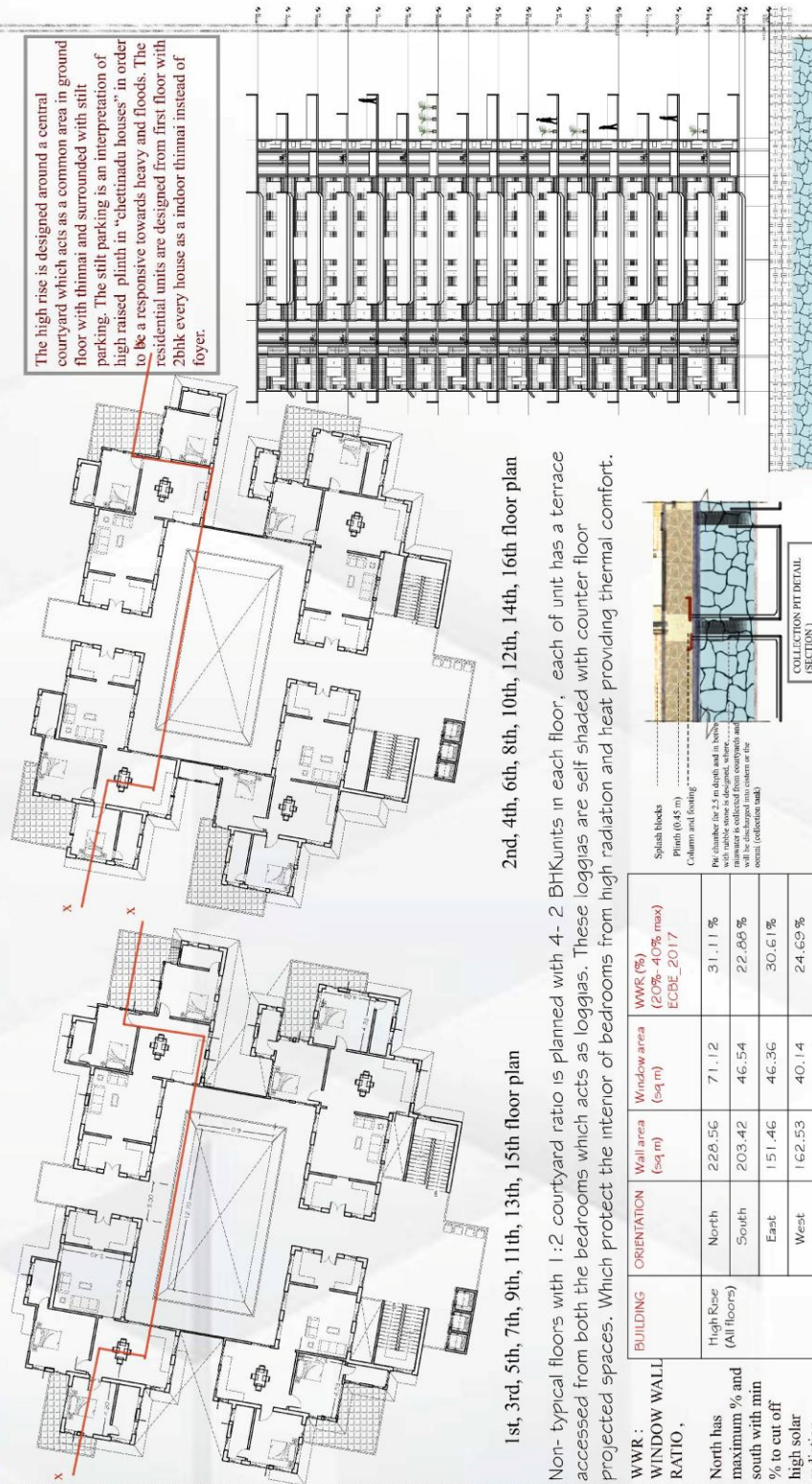


A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
MID RISE (Planning and iterations)



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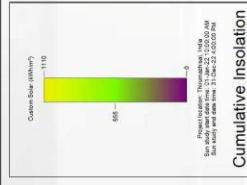
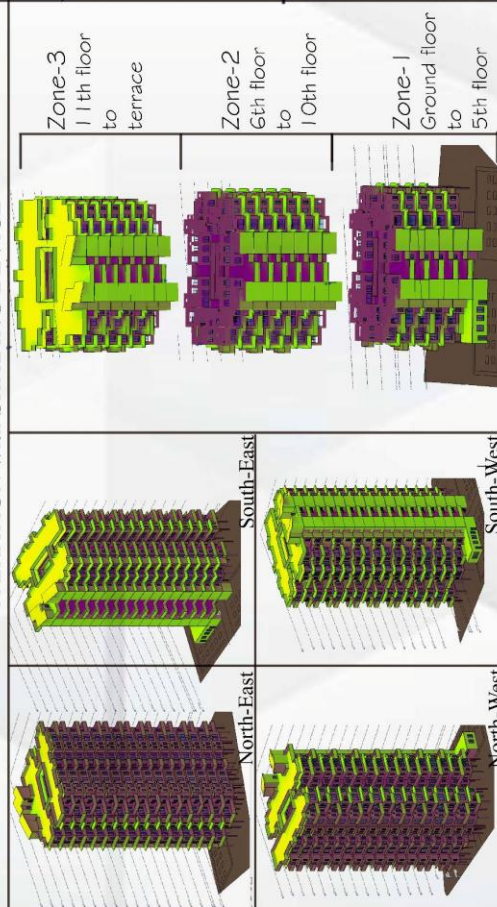


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SOLAR ANALYSIS : CUMULATIVE INSOLATION

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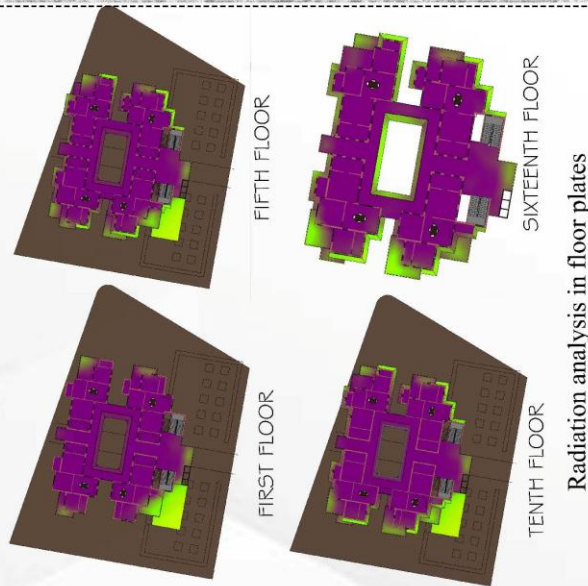
ITERATION with SHADING DEVICE



SOUTH: has less openings due to high radiation, WEST: has projected loggias and recessed openings where loggias and PV sun shading devices cut off the radiation.

EAST: has second maximum openings to receive prevailing wind and where radiation and heat is cut down with projected terraces and H-SD 60 deg shading device.

The planning of spaces is organised around the courtyard facilitating cross ventilation and stack effect, the projected loggias encourages mutual shading of floor-to-floor minimising usage of shading devices.



Radiation analysis in floor plates

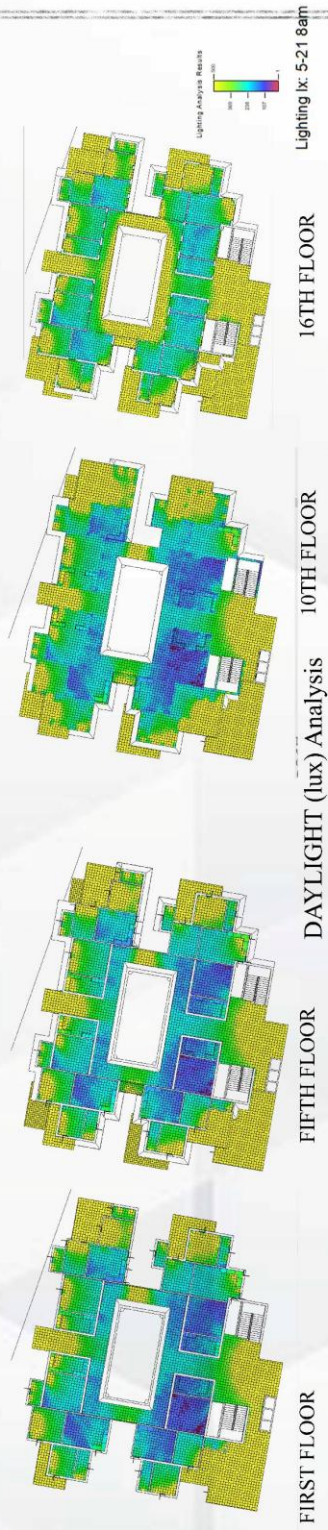


A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
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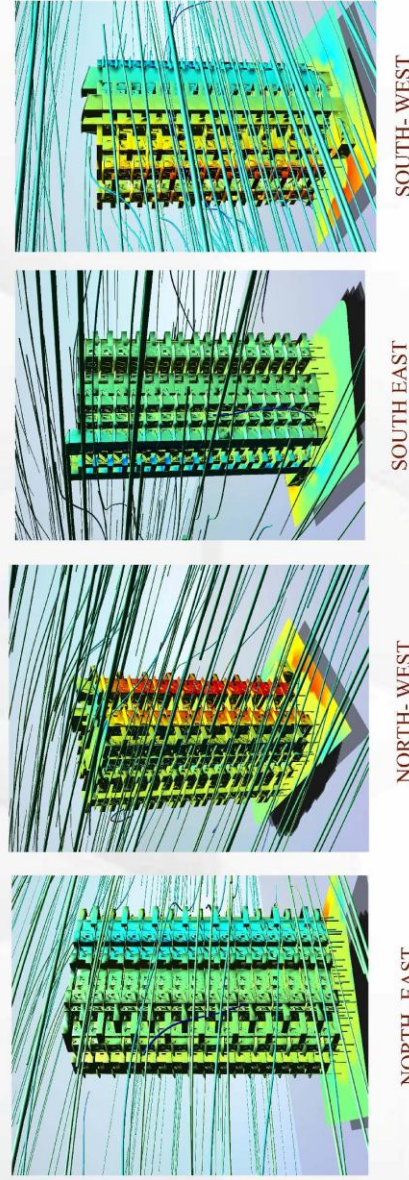
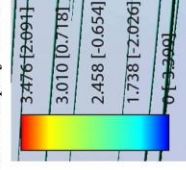


The non- typical planning and mutual shading floors with suitable courtyard ratio has provided sufficient daylighting to the spaces with minimal 107 lux to 369 lux in all units, and whereas in which is optimal according to SP-41 standards as the whole unit receives more than 50% of passing daylight through provided openings.

WIND ANALYSIS

North : 1.738 m/s
 South: 1.73 m/s - 2.458 m/s
 East: 3.010 m/s
 West : 2.154 m/s

The wind tubes can be seen entering into the openings and the loggias or the projections.



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
 MID RISE (Planning and iterations)



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PARAMETERS	BASE CASE (chettinadu principles)	DESIGN CASE
Orientation factor	North- South (Longer side)	North- South (Longer side)
Entrance factor	North, East or west	North and East
Courtyard Ratio	1:1, 2:3, 1:5 (central and multi split courtyard)	1:1, 2:3, 1:5 (central and multi split courtyard)
Thinnai concept	Indoor and outdoor thinnai with slope roof	outdoor thinnai with slope roof in Low rise Indoor thinnai in Mid and High rise
Window wall Ratio	14%- 18% (with no openings in the North and South facade)	20%- 40% (following ECBC 2017 standards)
Shading factor	Horizontal shading device with supports	Designed according to SP41 - climate and orientation requirements
Openings	Minimal, Inlet and outlet at same level	Inlets at lower level Outlets at higher level : Vents & clerestory
Cross ventilation and Stack effect	Openings are aligned opposite to each other and countering.	Openings are aligned opposite to each other and countering.
Air tunnel Concept	Rain water from courtyards is drained into plinth, where water is stored and keeps the floor and space cool.	Rain water from courtyards is drained using splash blocks into plinth, where water is stored and is then run-off into Cistern water tank.



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
COMPREHENSIVE ANALYSIS



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SELECTION OF MATERIALS :

Eco- friendly
Low embodied energy
Economical (low cost housing)
Represent the culture and tradition
Accessible from the site

FLOORING :
IN CHETTINADU HOUSES :
Oxide Flooring : easily available (dealers 20km radius, easy to process and durable)
Traditional stone (tandoor stones are available and are also economical has cooling properties)
Athangudi tiles
Italian marbles



WALL :

HOUSES	SPACE	COMPONENT	COMPONENT MATERIAL	COMPONENT THICKNESS	U-VALUE (w/m ² -k)
HOUSE 1	OVER ALL	WALL	SUN DRIED BRICKS	0.53 m	1.7
HOUSE 2	OVER ALL	WALL	SUN DRIED BRICKS	0.5 m	1.8
HOUSE 3	OVER ALL	WALL	SUN DRIED BRICKS	0.48 m	1.8
HOUSE 4	OVER ALL	WALL	BURNT CLAY BRICKS	0.4 m	1.8
HOUSE 5	OVER ALL	WALL	R C C	0.3 m	2.6

ALTERNATIVES :

Stabilised Soil bricks --- 0.72 w/m²-k (0.4 m)
Flyash bricks --- 1.95 w/m²-k (0.22 m)
Sand Lime clay bricks --- 2.5 (w/m²-k)

SHADING DEVICE :

PV- MEMBERS :available through dealers

Type: PV SUNSHADE
Total thickness: 0.2000 (Default)
Resistance (R): 4.6735 (h-ft²-°F)/BTU
Thermal Mass: 19.2351 BTU/°F

ROOF

HOUSES	SPACE	COMPONENT	COMPONENT MATERIAL	COMPONENT THICKNESS	U-VALUE (w/m ² -k)
HOUSE 1	OVER ALL	ROOF	BAKED CLAY MANGLORE TILES	0.012 m or 12 mm	5.3
HOUSE 2	OVER ALL	ROOF	TERACOTTA TILES	0.014 m or 14 mm	0.78
HOUSE 3	OVER ALL	ROOF	TERACOTTA TILES	0.014 m or 14 mm	0.78
HOUSE 4	OVER ALL	ROOF	BAKED CLAY MANGLORE TILES	0.012 m or 12 mm	5.3
HOUSE 5	OVER ALL	ROOF	CERAMIC ROOF TILES	0.015 m or 15 mm	5.6

ALTERNATIVES :

Ceramic tile --- 4.8 w/m²-k (l)
Concrete Clay tile --- 3.6 w/m²-k (l)

The differences are analysed through field readings (surface temperature) of different chettinadu houses.



DOORS AND WINDOWS : RECYCLED AND REUSED

- More effective, better alternative, economical, requires only cost of treatments if in case of any damage and gives cultural value.

Dealers supplying : pillai marudhu, gaana teak windows and doors available widely around thiruvallur and chennai.



A TOWNSHIP IN CHENNAI - with chettinadu design principles and materials
MATERIALS AND ALTERNATIVES



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The vegetation (trees, plants, groundcover species) are selected based on nativity, local species and following factors :

Requirement of the site

A raised platform with sacred fig tree symbolising a tradition of village center where people gather and talk.

West zone has 'Alstonia scholaris' helps in cut off the sun and gives shade.

Green pockets with thinnal space with sacred fig tree.

Low rise units could have their own indoor plants.

Green aloe are used as borders near parking and cycle track as a divider.

Cocos nucifera or coconut tree is used in South-East and North-East giving semi-shade.

Bamboo noddings and green aloe for hedges and borders near parking and seating area.

Height of the tree

Vegetation type

Growth of the tree

Tree Species	Type	Height	Diameter	Spacing	Soil	Maintenance
Ficus religiosa (Sacred fig)	Sacred tree	30 m	10m - 15m	Single planting	Loamy and alluvial	Semi deciduous tree requires medium water
Note: The Ficus religiosa is known as sacred tree could be found in village centers providing shade or planted on high raised platform where people gather and talk during their leisure time as a tradition since centuries.						
Tree Species	Type	Height	Diameter	Spacing	Soil	Maintenance
Bambusa nuda (Bamboo)	Avenue tree	6m - 15m	Thin poles	Placed next-next	Loamy sandy alluvial	Easy and annual rainfall is sufficient in coastal and hot regions
Note: The noddling bamboo is an aesthetic plant but certainly reduces the outdoor temperature and gives a difference in micro-climate. These are used near walls, lanes near dwelling units.						
Tree Species	Type	Height	Diameter	Spacing	Soil	Maintenance
Cocos nucifera (Coconut tree)	Avenue tree	25 m	2.5m - 3m	7.5m*7.5m	Loamy sandy alluvial	Easy and can tolerate more water.
Note: The Cocos nucifera is the coconut tree belongs to palmace family, suitable for South and East requiring semi-shade.						
Ground cover	Type	Height	Diameter	Spacing	Soil	Maintenance
Cynodon dactylon (Bermuda grass)	Evergreen	3 cms	-	-	Loamy sandy soil	Easy and drought resistant.
Note: The bermuda grass is one of the best local grasses grown in warm and humid climate with very less water; it is a fast grower and also is grown in drought areas too.						
Plant species	Type	Height	Diameter	Spacing	Soil	Maintenance
Furcraea gigantea (Green aloe)	Avenue plant	1m - 2m	1m - 2m	2.4 m	Well drained soil	Easy, both flood and drought resistant.
Note: The Green aloe is a very easy maintained plant species which are good for hedges and borders near parking lots in landscaping.						

Soil type

Maintenance

References

One author

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Two authors

- 1) S.Radhakrishna, R.Shanthi priya., "Eco Friendly materials used in traditional buildings of Chettinadu in Tamil Nadu, India", American Journal of Sustainable Cities and Society Issue 3, Vol. 1 January 2014 Available online on <http://www.rpublication.com/ajscs/ajsas.html> ISSN 2319 – 7277
- 2) U Vimal Kumar¹, J S Pavithraa¹, K Sakthi Prasanth² (2018) ; IJETSR: International Journal of Engineering, Technology, Science and Research | ISSN: 2394-3386

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2. Tamil Nadu Housing Board; <https://tnhb.tn.gov.in/project/thirumazhisai-satellite-town-project/77/>