

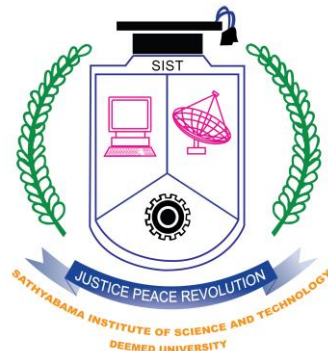
OFF THE GRID COMMUNITY FOR NARIKURAVARGAL- CHENNAI

A Thesis

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

by

KAUSHIKA PERUMAL (40890007)



**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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DEPARTMENT OF ARCHITECTURE BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **Kaushika Perumal (40890007)** who carried out the Thesis entitled "**OFF THE GRID COMMUNITY FOR NARIKURAVARGAL- CHENNAI**" under our supervision from January 2022 to May 2022.

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Internal Examiner

External Examiner

DECLARATION

I **KAUSHIKA PERUMAL** hereby declare that the Thesis Report entitled “**OFF THE GRID COMMUNITY FOR NARIKURAVARGAL- CHENNAI**” is done by me under the guidance of Guide **AR. CATHERINE** (Internal) and **AR. KRITHIKHA MUTHUKRISHNAN** (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: 03-05-2022

PLACE: CHENNAI

A handwritten signature in blue ink, appearing to read 'Kaushika', with a long horizontal stroke extending to the right.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this Pre-Thesis project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. Devyani Gangopadhyay, Dean and Head of the department, Dept. of Architecture, School of Building and Environment**, for providing me necessary support and details at the right time during the progressive reviews.

My special thanks to **Dr. Suresh Kuppusamy**, our Design chair and **Ar. Krithikha Muthukrishnan**, (External guide) and **Ar. Sheetal Amraotkar** (Thesis Coordinator) for their valuable comments and guidance during the project work.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Ar. Catherine** for her valuable guidance, suggestions and constant encouragement which paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Architecture who were helpful in many ways for the completion of this Thesis.

ABSTRACT

As per the Paris climate agreement, India is committed to increase the share of non-fossil fuel sources to 40 percent of the power generation capacity and reduce the emissions intensity of the economy by 33 to 35 per cent compared to 2005 levels.

The building sector in India consumes about 30% of the total electricity produced from non- renewable sources and out of which 75% is in the residential buildings. Thus, giving a opportunity to design residential communities that are independent from the grid, generating energy and attaining self efficiency.

With the current scenario of consumption and life style growth accounts to production of waste that are incapable of eliminating from the environment, Thus enabling to look at such material and see its applicability in the construction industry.

The aim of the thesis is to design a self sustainable OFF GRID COMMUNITY in an warm and humid climate which can be replicable elsewhere. The community is designed for an indigenous tribe called Narikuravar who falls into EWS housing scheme.

The intent is to attain comfort, healthy living standards, better neighborhood, positive energy consumption through the uses of passive strategies, energy designed from renewable resources, sensible usage of materials from waste generated.

The outcome of the thesis will help to understand possibilities of passive technology and strategies and result in replication and improvisation of strategies across warm and humid climate region.

Keywords – Warm and humid climate, Off the grid community, Passive strategies, Energy generation, renewable energy.

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CHAPTER 1

INTRODUCTION

1.1 Background

An expanding economy, population, urbanization and industrialization sees the largest increase in energy demand. Around 1.2 billion lack access to basic energy and other services.

The impact of building sector on India's energy scenario is very striking. Building industry demands 30% of the total electricity consumed annually of which about 75% consumed by residential buildings. The gross consumption rose to about 260twh in 2019-2020 from about 55TWh in 1996-97, which is an increase of more than four times in 2 decades. Projection shows a further rise between 630 to 940Twh by 2032.

India consists of around 66.77% of electricity produced by non-renewables creating a huge stress on energy plants coming from fossil fuels like thermal power plants which translates to greater environmental impact and climate change. To grow in sustainable manner, India plans to achieve 30% of its energy demand by using renewable energy by 2030.

Demand for affordable housing across India is another major concern. It is estimated that around 10 million houses are still required to face the housing crisis of which majority consists of EWS and LIG segment. Thus, holds a greater need and potential for optimization of usage of energy from renewable sources.

The cost, reliability, and sustainability of energy services are fundamental for human, social, and economic development. The crucial role of reliable and affordable energy services for economic growth and wellbeing of people has been widely acknowledged. Off-grid renewable energy technologies (RETs) can have dramatic benefits for under privileged families and communities.

1.2 Statement of problem

To address the growing energy demand in the residential building sector using energy positive design approach, appropriate alternate technologies and by using renewable sources of energy.

1.3 AIM

To develop an off-the-grid community for a group of native tribe called Narikuravar. To use materials of minimum impact on environment and create a community incorporating passive design strategies for a healthy living conditions.

1.4 Objective

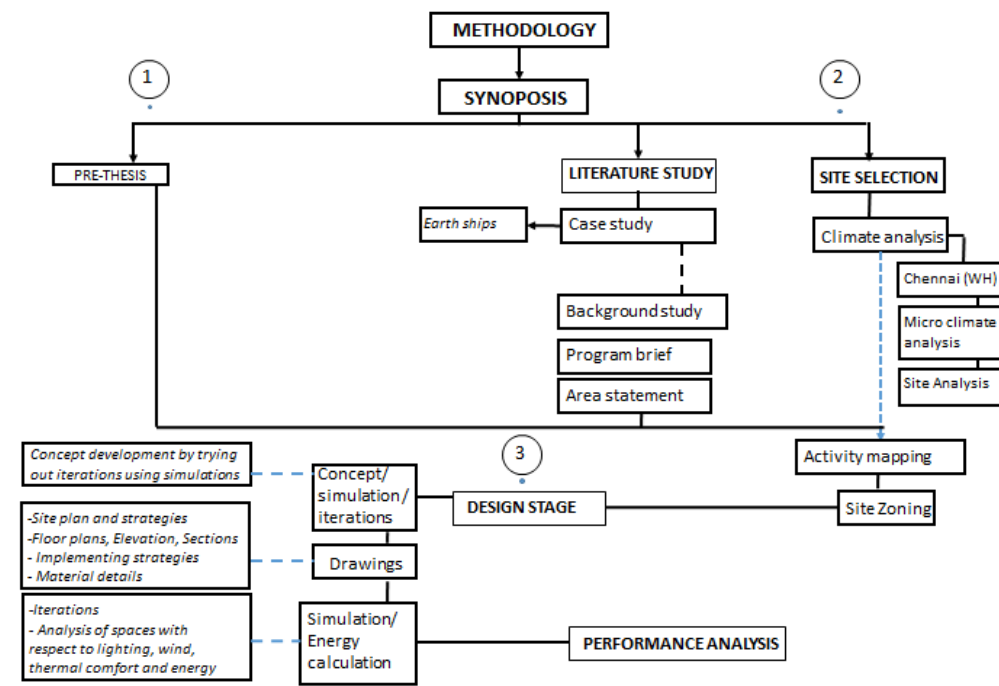
- To explore ways to create off the grid community
- To explore the use of recycled materials for the built structures
- To minimize energy consumption through passive strategies primarily focusing
 - Thermal Comfort (Temperature and Ventilation control)
 - Visual Comfort (Lighting control)

- To explore multi-functional spaces through design intervention.
- To explore on-site energy harvesting systems for a residential unit so as to harvest more energy than consumption.

1.5 Research questions

- What is the purpose of creating off the grid community?
- Why choosing Narikuravar community?
- What materials can be used in designing the community?
- How to improve the lifestyle of the community people by design?
- How can using recycled materials in construction will address the current problem?

1.6 Methodology matrix



B CHAPTER 2 CASE STUDIES

2. The Greater World Earthship community, New Mexico

2.1 Introduction

The Earthship is a completely independent globally oriented dwelling unit made from materials that are indigenous to the entire planet. The major structural building component of the Earthship is recycled automobile tires filled with compacted earth to form a rammed earth brick encased in steel belted rubber. This brick and the resulting bearing walls it forms is virtually indestructible. In an Earthship, there is usually no need for electricity nets, sewers, or heating systems

This means there are no costs (for electricity, water, heating and so on) other than maintenance of equipment. Using recycled materials for construction (typically vehicle tires) an Earthship. The Earthship concept homes are built using various strategies of sustainable housing. These homes are more than just a structure, they are a system of materials used together to perform the task of providing a home for people. They are flexible in design and use recycled building materials from local sources.

The entire system working together is called a Biotope.



Fig 01 – Elevation of Earthship dwelling

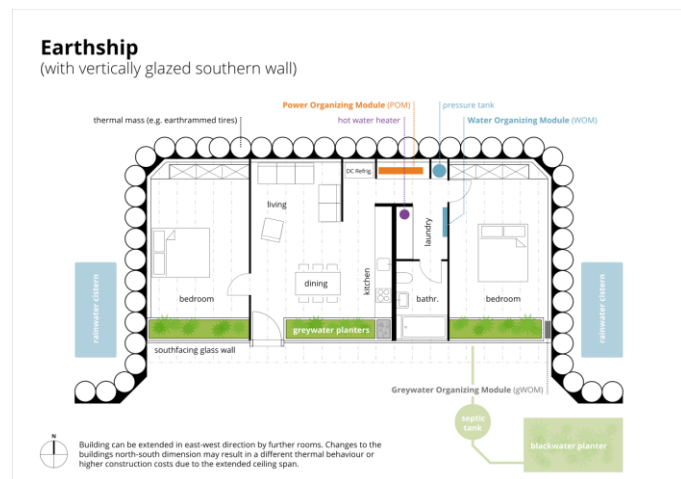


Fig 02 – Plan of Earthship dwelling

- They do not need to depend on **municipal services** such as **electricity, water or sewage**.
- Electricity and back-up heating are produced from **renewable energy sources such as the wind and the sun**.
- Passive solar and thermal mass architecture are combined for self-contained heating without the use of fossil fuels. In addition, Earthship building techniques are low-tech and easy to learn.

- **Rainwater is collected** for the water supply from the roof. **The water is stored in cisterns buried next to the house.** The water is then pumped and pressurized from the cistern through a filtration system before it is used for drinking, bathing or cleaning.
- **Hot water is obtained through a solar hot water heater**

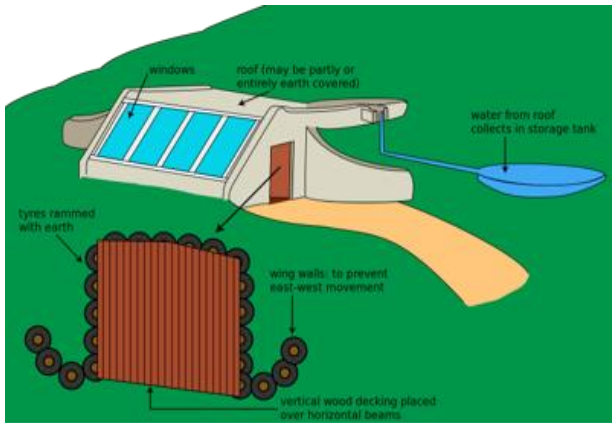


Fig 03 – Rainwater harvesting illustration

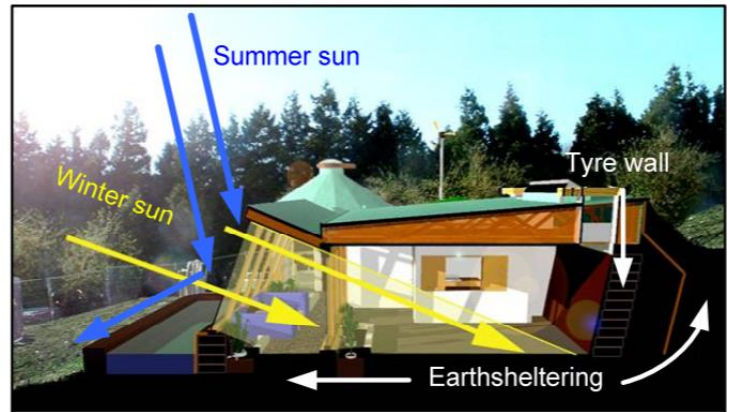


Fig 04 – Sun path illustration

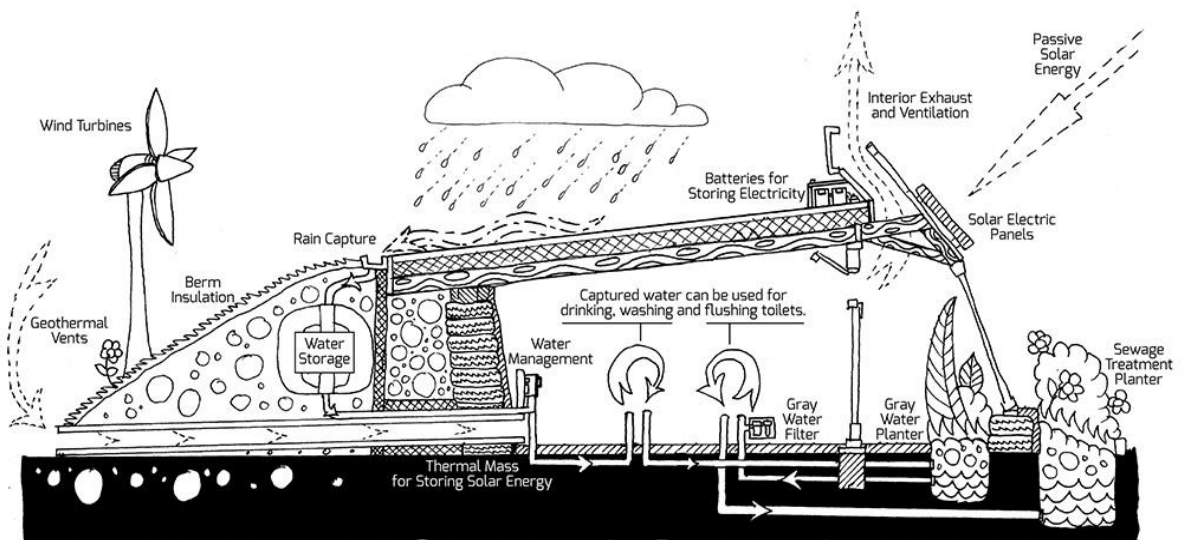
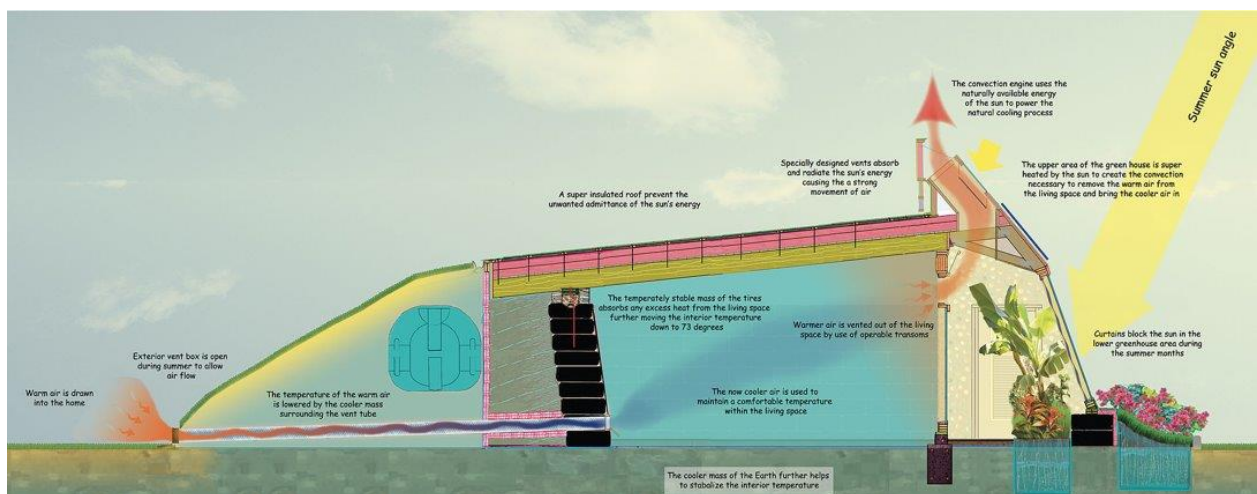
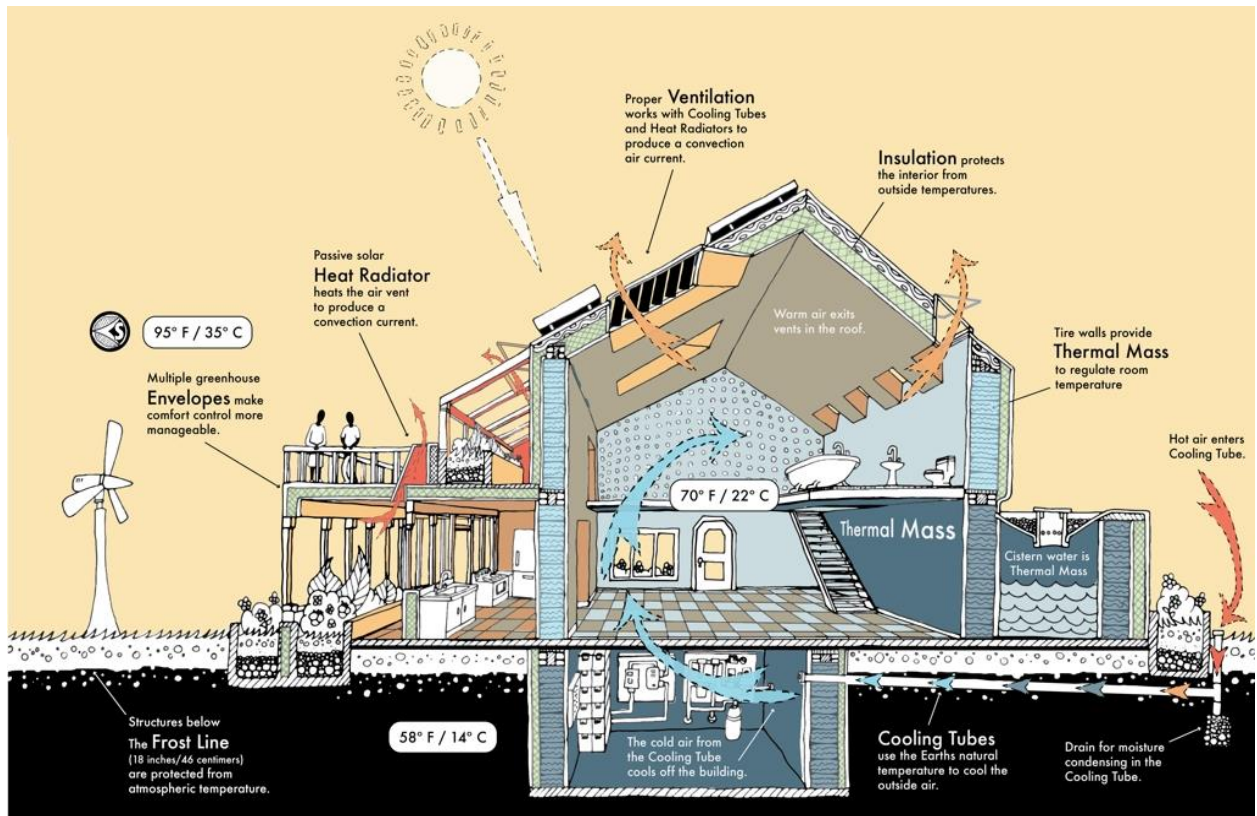


Fig 05 – passive strategy illustrations

- Passive Earthship buildings allow for heating and cooling related energy savings of up to 90% compared with typical building stock and over 75% compared with average new builds. In terms of heating oil, Passive Houses use less than 1.5 litres per square meter of living space per year, far less than typical low-energy buildings. Similar energy savings have been demonstrated in warm climates where buildings require more energy for cooling than for heating.



- Passive solar and thermal mass architecture are combined for self-contained heating without the use of fossil fuels. In addition, Earthship building techniques are low-tech and easy to learn.
- Thermal mass strategy incorporated,
 - Cooling tube

- Thick walls to protect heat gain
- Glass is provided in the south for heat gain to happen during the winter
- Sloped roof for easy rainwater runoff, which is collected in rainwater harvesting tank
- Vents for stack effect

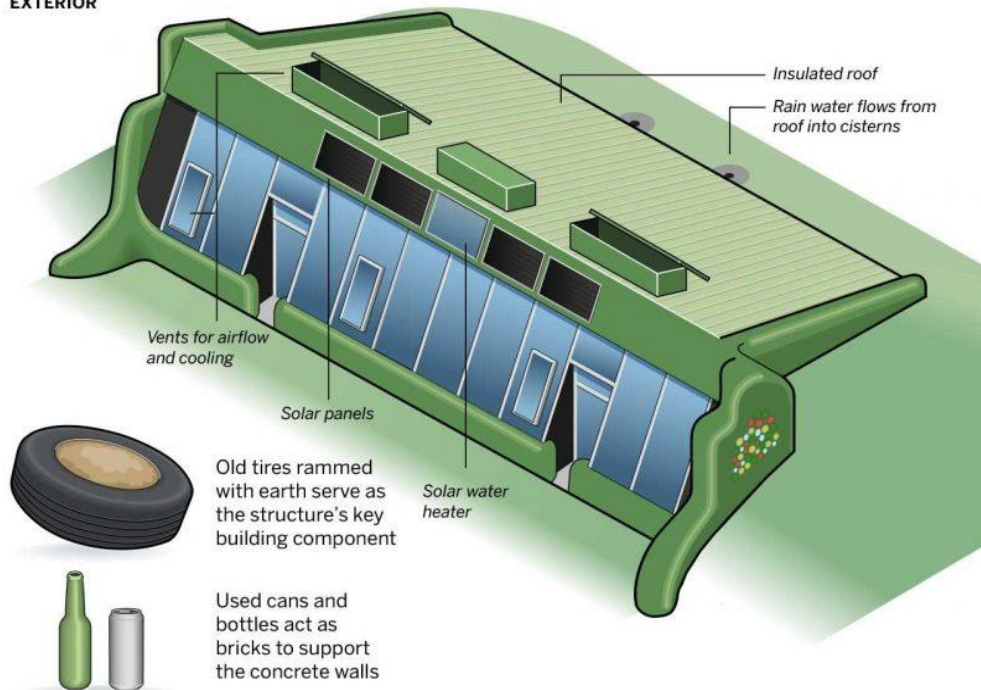
2.2 Material Study

The major building component of the Earthship is used **automobile tires**. These tires are filled and **compacted with earth** to form a **rammed earth brick encased in steel belted rubber**. This **method** creates a nearly indestructible frame allowing the use of **thermal mass to heat and cool the interior**

BETTER LIVING THROUGH GARBAGE

Earthships are self-sustaining homes constructed from as much locally-sourced, reclaimed material as possible.

EXTERIOR



Additionally, concrete and wood are used extensively

BRICE HALL/POSTMEDIA NEWS
SOURCES: EARTHSHIP BIOTECHTURE

Fig 08 – Material used illustration

- A sustainable home must make use of indigenous materials, those occurring naturally in the local area, For thousands and thousands of years, housing was built from found materials such as rock, earth, reeds and

logs. Today, there are mountains of by-products of our civilization that are already made and delivered to all areas.

- These are the **natural resources of the modern humanity.**
- An Earthship makes use of these materials via techniques available to the common person. These materials and the techniques for using them are accessible to the common person in terms of price and skill required to use them. The less energy required to turn a found object into a usable building material the better. This concept is also called **embodied-energy**.



Fig 09 – Construction using upcycled material

A. Rammed-Earth encased in Steel Belted Rubber:

The major structural building component of the Earthships is recycled automobile tires filled with compacted earth to form a rammed earth brick encased in steel belted rubber. This brick and the resulting bearing walls it forms is virtually indestructible.

B. Aluminum Cans and Glass/Plastic Bottles:

These little bricks' are a great, simple way to build interior, non-structural walls. Aluminum [walls actually make very strong walls. The 'little bricks' create a cement-matrix that is very strong and very easy to build. Bottle can create beautiful colored walls that light shines through.

2.3 Earthship as community

By partnering with members to buy land and build sustainable homes, They have create an affordable, off-grid living community. The community is exclusively Earthship homes. Members own lots which vary in size depending on home square footage and overall shared land acreage. Annual dues for the community are for road maintenance, sanitation, and the community improvement fund. Property taxes are assessed per member by Santa Barbara County. Community members agree to a Land User's Code which is governed by the Board of Directors.



Fig 10 – Earthship as community

Off-grid, community living, in the Santa Barbara/Central Coast region, through a proven 40+ year scalable and adaptable unique property model founded on sustainable principles.

2.4 Why: A Unique Off Grid Living Community Experience

- Connect and live intentionally with likeminded people
- Completely off-grid, fossil fuel free modern living for any design aesthetic
- On site wastewater treating system repurposing water use 4x
- Integrated food production via greenhouse botanical cells
- **To reduce** the economic and institutional barriers between humans and their habitat.
- **To reverse** the overall negative effect that conventional human housing has on this planet.
- **To create** a less stressful plane of existence for humans in an effort to reduce the stress that they in turn place on the planet and each other.
- **To interface** economics and ecology in a way that immediately and tangibly affects current pressing problems with life on earth.
- **To provide** a direction for those who want to live in peace with each other and their environment.
- **To empower** individuals with the unarguable forces of nature as opposed to incapacitating them with the smothering forces of politics and bureaucracy.
- **To find & distribute** the appropriate soil from which the flower of humanity can blossom.
- **To evolve** humanity into an earthen harmony already exemplified by more evolved structures such as plants, animals and water.

CHAPTER 3

Site and Context

3.1 Location



Fig 11 – Site location

A hypothetical site is chosen in the climatic zone of Chennai (Warm and humid Zone, as per NBC 2016)

Location: Gypsy Colony Kotturpuram,
Chennai, Tamil Nadu 6000085

Latitude: 13°00'56.2"N

Longitude: 80°14'38.1"E

Site Area: 3.1 Acres
12,892.47 Sqm

Zone: Residential Zone

Strength

- Existing settlement of native community
- Easy access to all public transportations

Weakness

- No connection to the Main/Power grid
- Poor storm water drainage causing health problems

Opportunities

- Site is located in EWS settlement, off-the-grid community development gives an idea and awareness to other people

Threats

- Unhealthy living conditions could lead to health problems
- Dark spaces in night leading to social security problems

3.2 Climate Study

• Inference

- Critical months: March to September
- During critical months usage of artificial cooling will increase

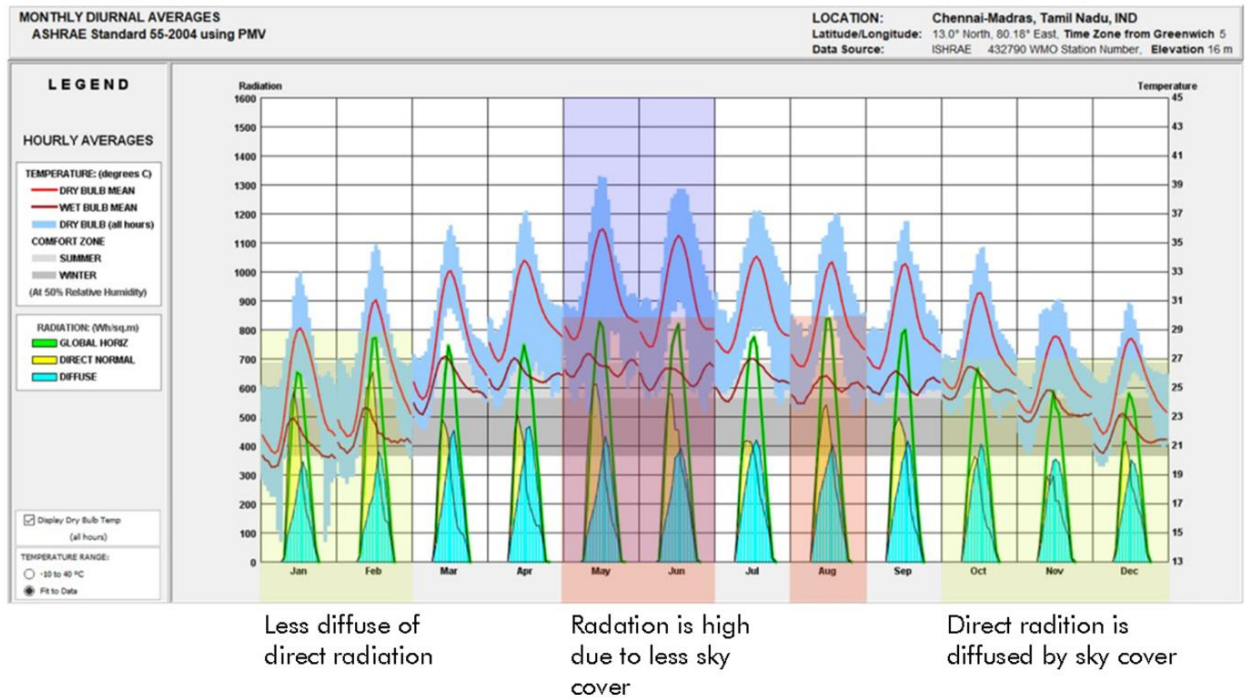


Fig 12 – Monthly diurnal averages

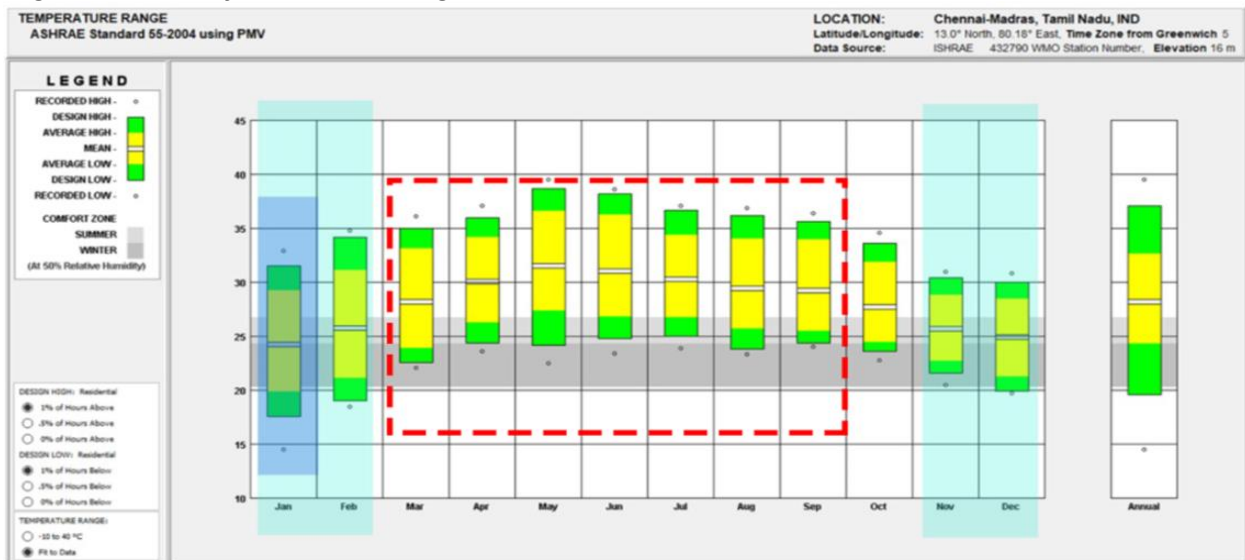
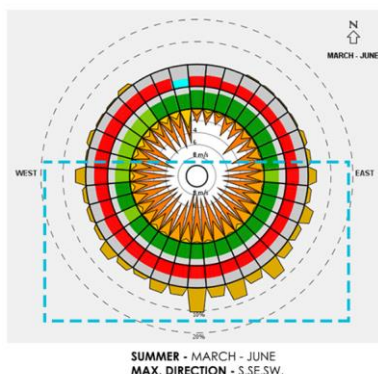


Fig 13 – Monthly Temperature range

3.3 Wind Analysis

- Summer – March to June
- Maximum direction – S,SE,SW
- Inference

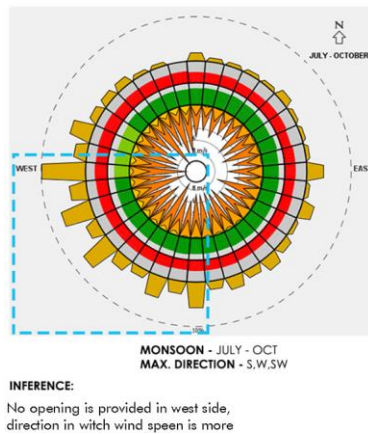


INFERENCE:

Since there is no opening in west hot wind is avoided
 Opening in east and north side experiences less wind

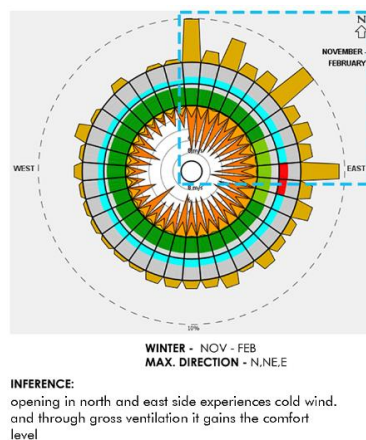
- Since there is no opening in west, hot wind is avoidable. Opening in east and north side experiences less wind

Fig 14 – Wind analysis (a)



- **Monsoon** – July to October
- **Maximum direction** – S, W, SW
- **Inference**
 - Less opening is provided in west side, direction in which wind speed is more.

Fig 15 – Wind analysis (b)



- **Winter** – November to February
- **Maximum direction** – N, N.E, E
- **Inference**
 - Opening in north and east side experiences cool wind and through cross ventilation it gains comfort level

Fig 16 – Wind analysis (c)

WIND SPEED (m/s)

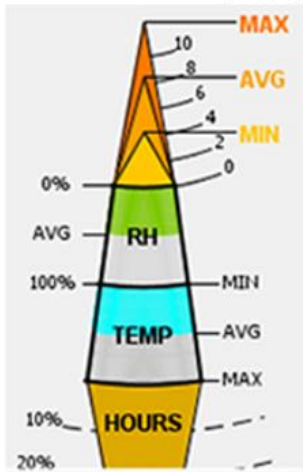


Fig 17 – Wind speed

LEGEND

TEMPERATURE (Deg. C)

- < 0
- 0 - 21
- 21 - 27
- 27 - 38
- > 38

RELATIVE HUMIDITY (%)

- <30
- 30-70
- >70

Fig 18 – Legend

3.4 Site Sun path Analysis

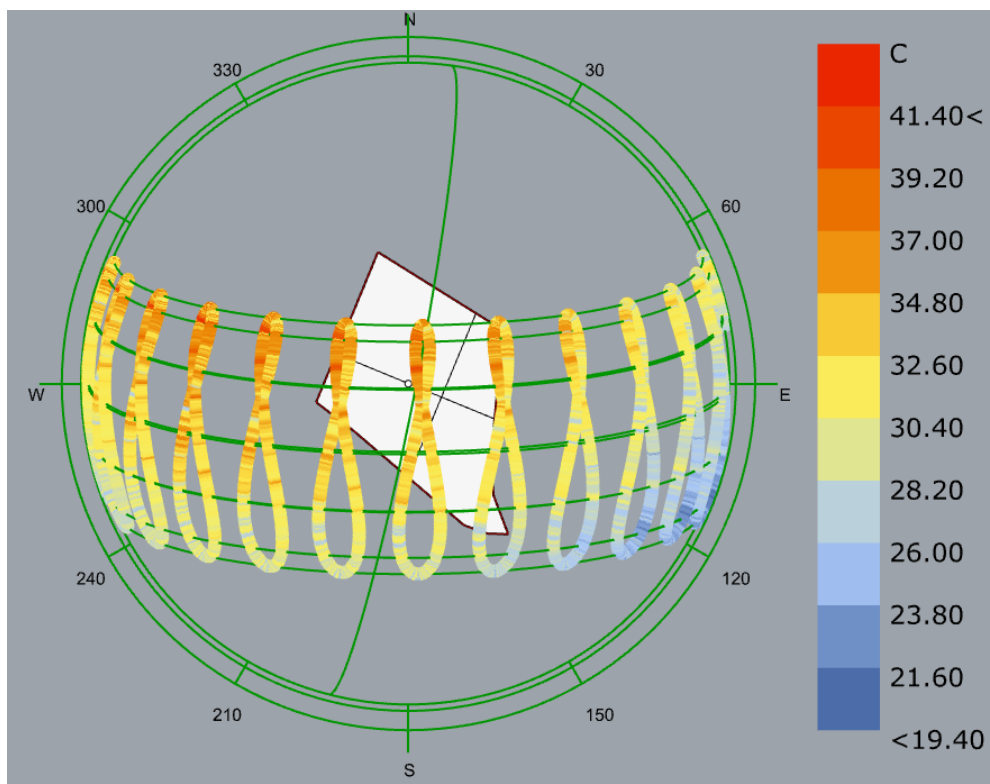


Fig 19 – Sun path analysis

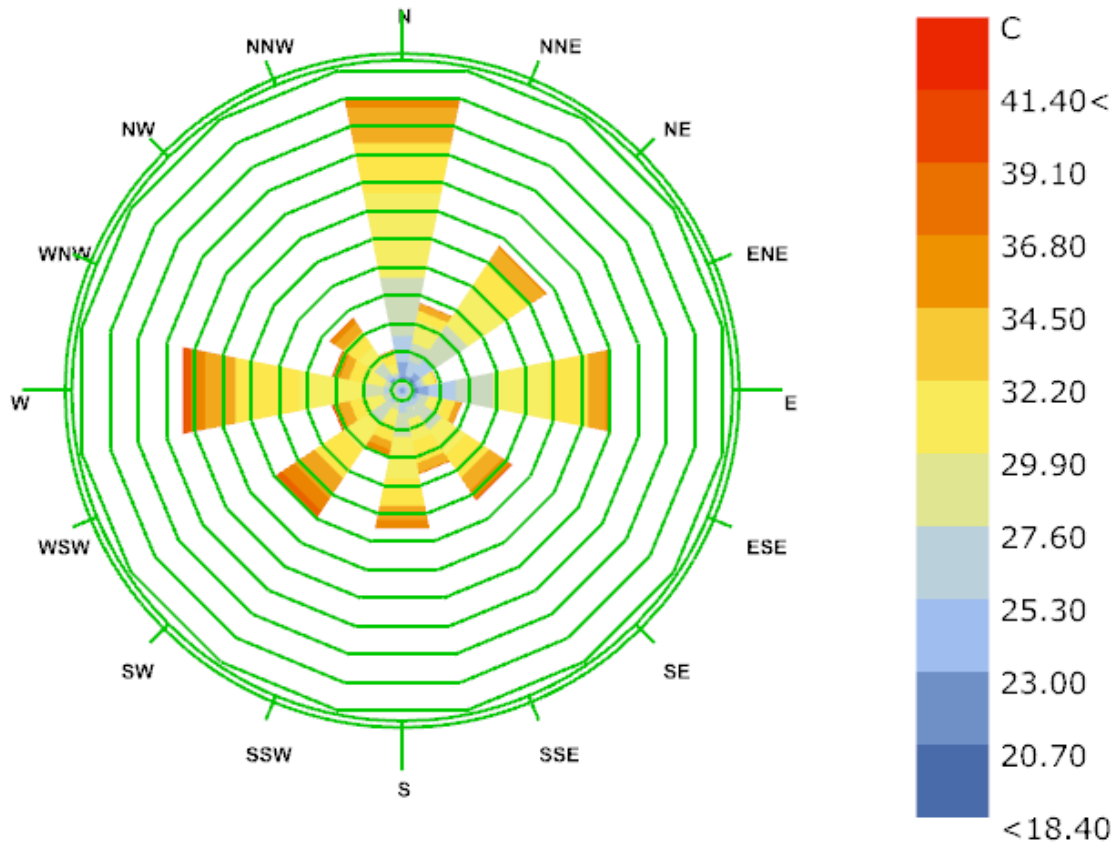


Fig 20 – Dry bulb temperature (C)

- Prevailing wind direction from south east.
- Maximum temperature of hot wind annually recorded is 40degrees minimum is 30 degrees.
- Maximum radiation is achieved during the month of March in south direction.
- Throughout the year site receives maximum diffuse radiation from south and north direction.
- Direct radiation is higher in the south direction.

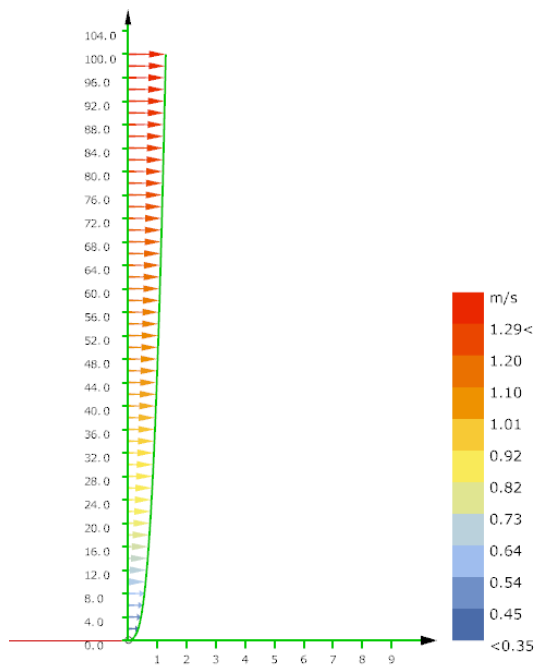


Fig 21 – Radiation graph

- The wind boundary profile orients in the prevailing wind direction. Orienting the buildings perpendicular to the wind direction it helps in cross ventilation

CHAPTER 4

Community and context

4.1 Background

Narikurvargal native tribble people who settle down in groups, one of these tribble groups are settled down in kotturpuram area Chennai around the area 1930s. The main occupation of these people is hunting, weapons crafting, and bead jewelry selling. Due to the ban officiated by the government on hunting, they were forced to surrender their arms.

As a result, they migrated to different places in search of a new livelihood. They now follow different trades ranging from rag picking, selling bead jewelry, medicines, fox horns, honey, etc., their occupation depends on the place now they're settled in.

For people who are settled in Kotturpuram their main occupation is rag picking and bead jewelry selling. People found themselves unhappy due to discrimination prevailing in the society against them so they are not given any jobs in the society so they are pushed to go for rag picking for a living

Kotturpuram gypsy colony:

- No of Families: 150
- No of Permanent structures: 5
 - Community hall
 - 4- brick houses with temporary roof

During natural disaster and flood times people tend to accommodate themselves in the community hall

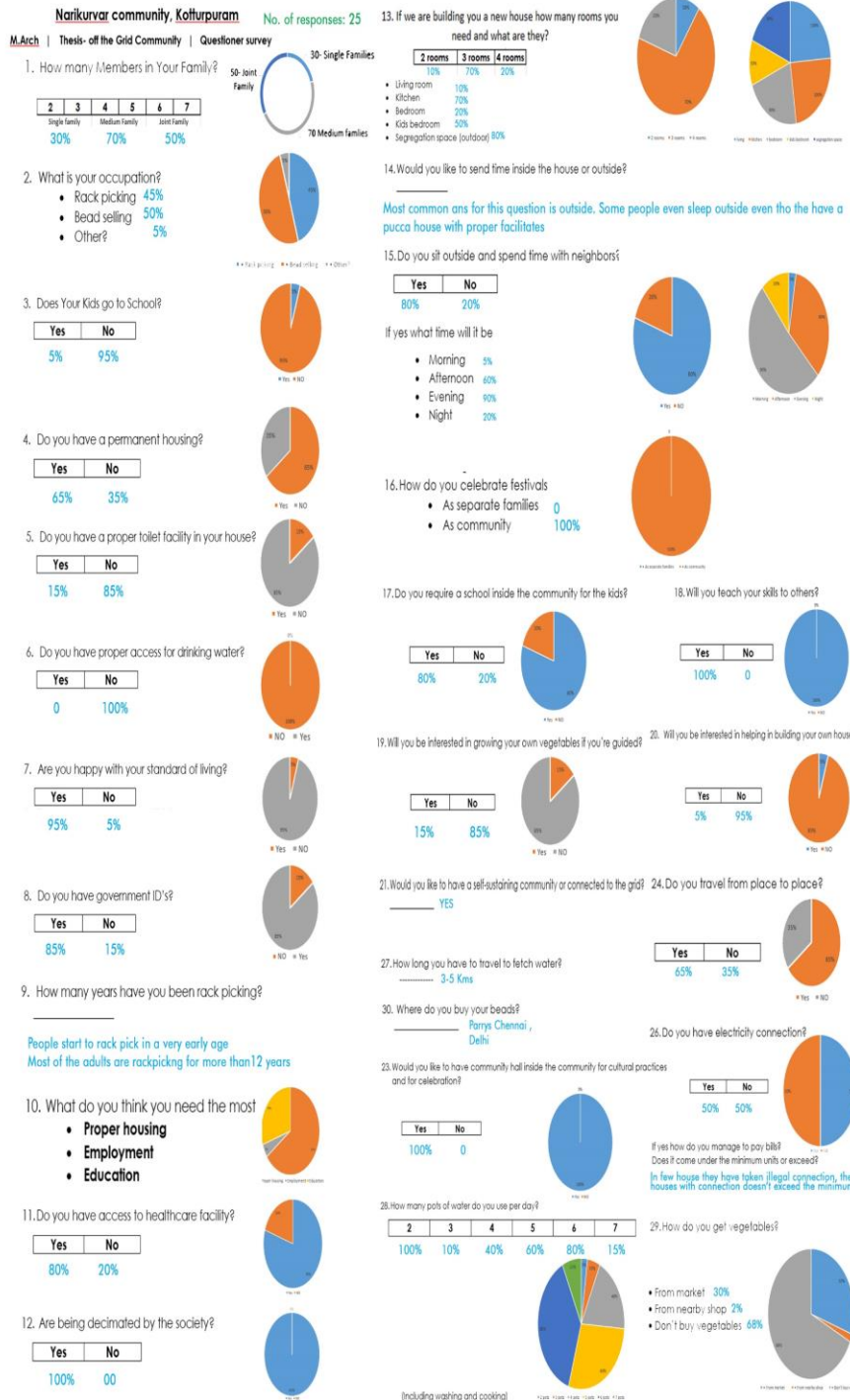
4.2 Questioner survey

Narikurvar community, Kotturpuram
M.Arch | Thesis- off the Grid Community | Questioner survey

1. How many Members in Your Family? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table> 2. What is your occupation? • Rack picking • Bead selling • Other? 3. Does Your Kids go to School? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 4. Do you have a permanent housing? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 5. Do you have a proper toilet facility in your house? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 6. Do you have proper access for drinking water? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 7. Are you happy with your standard of living? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 8. Do you have government ID's? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> If yes in which address do you have it? _____ 9. How many years have you been rack picking? 10. What do you think you need the most • Proper housing • Employment • Education 11. Do you have access to healthcare facility? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 12. Are being decimated by the society? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table>	2	3	4	5	6	7	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	13. If we are building you a new house how many rooms you need and what are they? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>2</td><td>3</td><td>4</td> </tr> </table> • Living room • Kitchen • Bedroom • Kids bedroom • Segregation space (outdoor) 14. Would you like to spend time inside the house or outside? 15. Do you sit outside and spend time with neighbors? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> If yes what time will it be • Morning • Afternoon • Evening • Night 16. How do you celebrate festivals • As separate families • As community 17. Do you require a school inside the community for the kids? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 18. Will you teach your skills to others? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 19. Will you be interested in growing your own vegetables if you're guided? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 20. Will you be interested in helping in building your own house? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 21. Would you like to have a self-sustaining community or connected to the grid? 22. Will you still go for rack picking even after your livelihood is improved? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 23. Would you like to have community hall inside the community for cultural practices and for celebration? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 24. Do you travel from place to place? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table>	2	3	4	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	If yes what is the mode of transport? • Own vehicle • Bus • Train 25. Would you like to have a movable house while traveling? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> 26. Do you have electricity connection? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Yes</td><td>No</td> </tr> </table> If yes how do you manage to pay bills? Does it come under the minimum units or exceed? 27. How long you have to travel to fetch water? 28. How many pots of water do you use per day? <table border="1" style="width: 100%; text-align: center;"> <tr> <td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table> (Including washing and cooking) 29. How do you get vegetables? • From market • From nearby shop • Don't buy vegetables 30. Where do you buy your beads? _____	Yes	No	Yes	No	2	3	4	5	6	7
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Yes	No																																																				
Yes	No																																																				
Yes	No																																																				
2	3	4	5	6	7																																																

Fig 22 – Questioner survey

From the survey, basic social data was collected by door to door questioning.



AFFORDABLE HOUSING IN PARTNERSHIP SCHEME GUIDELINES

(GOVERNMENT OF INDIA MINISTRY OF HOUSING AND URBAN POVERTY ALLEVIATION)

2.1. **Affordable Houses:** Dwelling Units (DUs) with Carpet Area shall be between 21 to 27 Sqm. for Economically Weaker Section (EWS) category and 28 to 60 Sqm. for Lower Income Group (LIG) category (LIG-A: 28-40 sq. m. and LIG-B 41-60 Sq.m.). The sale price of these houses would be determined by States/UTs with due consideration to affordability of targeted segment.

2.2. **Affordable Housing Project:** Projects using at least 60 percent of the FAR/ FSI for dwelling units of Carpet Area not more than 60 sqm. will be considered as Affordable housing projects. In addition, 35 percent of the total number of dwelling units constructed should be of carpet area 21-27 sqm for EWS category. Such projects can have a mix of EWS/LIG/Higher Category DUs and commercial units. Provision of servant's quarters along with the main dwelling unit will not be counted as dwelling units for EWS/LIG under Affordable Housing (AH) project.

REF: [HTTPS://MOHUA.GOV.IN/UPLOAD/UPLOADFILES/FILES/6AHP-GUIDELINES.PDF](https://moHUA.GOV.IN/UPLOAD/UPLOADFILES/FILES/6AHP-GUIDELINES.PDF)

INFERENCE: People in the community comes under EWS category, So area per dwelling unit will be between 21 to 27 sq.m as per the family size.

STANDARDS FOR COMMUNITY HALL

Table 1 Minimum floor areas for various activities

Function	Area per person (m ²)
Main hall:	
Closely seated audience	0.46 (based on movable seats, usually armless, 450 mm centre to centre; with fixed seating 500 mm centre to centre will increase to 0.6 m ²)
Dances	0.55 to 0.9
Dining	0.9 to 1.1
Creche, day nursery or pre-school playgroup	0-2 years 3.75 2-3 3 3-5 2.5
Children 5-8 years (out of school and holiday schemes, open access projects)	2.5
Meeting rooms	2.25 up to 4 people 2 6 people 1.55 8-12 people 1.25 20 people

INFERENCE: There are 150 families in the community, So am designing a community hall for 250 people capacity. According to the standards 450mm per person- Total area for the community hall 1200sq.m

Fig 23 – Survey result in representation.

- Community falls under EWS category as per Government of India ministry of housing and urban poverty alleviation.
- For 150 families in the community, proposed design is a community hall for 250 per people.

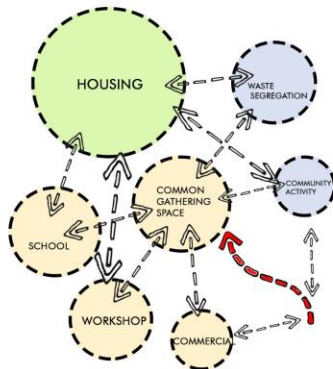
ACTIVITY MAPPING

Activity mapping		
Housing	Single family	Private
	Multi family	
	Big family	
Community	Festival celebration/ Open Ground	Semi-Private
	Community hall	
	Work Farming	
Waste segregation	Storage	Public
	Segregation	
	Segregated waste	
Work shop	Bead storage	Public
	workshop area	
	Exhibition	
Middle School/ Play school	Classroom Space	Public
	Activity space	
	Small Library space	
Commercial	Small petti shop	Public
	Few Temp sop for selling beads and other artifacts	

AREA STATEMENT

S.NO	SPACE	ACTIVITY	AREA
1	Housing: Single family, Medium sized famil , Join family	Single family	Total no of single family= 30 per house= 21 sq.m Area 630 sq.m
		Medium Family	Total no of single family= 70 per house= 27 sq.m Area 1890 Sq.m
		Join family	Total no of single family= 50 per house= 30 sq.m Area 1500 Sq.m
2	Central gathering space	Festival, Community time	800 Sq.m
3	Community school	Classroom's, Play school	Classroom= 8 No.s X 40 Sq.m =320 sq.m
			Play school= 60 sq.m
			Circulation= 50 sq.m
			Toilet= 20 sq.m
4	Community hall	Functions	250 capacity / inclusive kitchen 1200 sq.m
5	Workshop	Workshop / Display	800 Sq.m
6	Commercial space	Petti Shops	2-3 No.s 50 sq.m
7	Storage	Waste storage	100 X 3 no.s 300 sq.m

BUBBLE DIAGRAM USING ACTIVITY MAPPING



ZONING

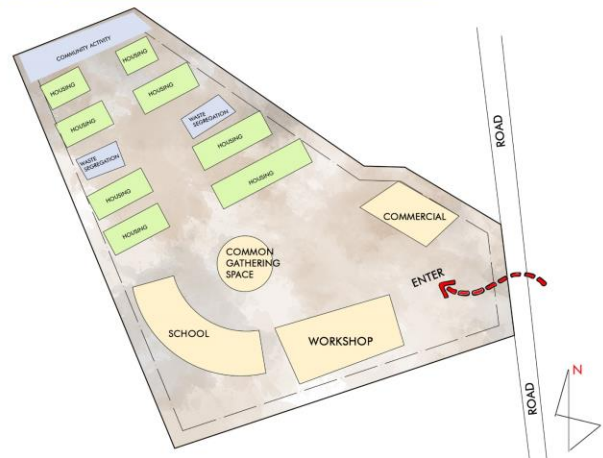


Fig 24 – Process of zoning from Activity mapping to Area statement to Bubble drawing and site zoning.

CHAPTER 5

Design and Analysis

5.1 Recommendations

- **Cool roof** – Using reflective materials and light colored materials
- **Orientation** – Most preferred direction is East and west
- **Cross ventilation** – Having windows placed in parallel walls which helps in indoor air movement through the class room
- **Courtyard** – One of the important strategy used in warm and humid climate to keep the indoor environment comfortable
- **External shading** – These devices reduces solar heat gain through glazing up to 80%
- **Vertical garden** – Shaded walls and surface may be 11-25 Degree cooler than unshaded surface. Temperature under shaded trees may reduce 1-5 compared to open terrain.

5.2 Site zoning

SITE PLAN

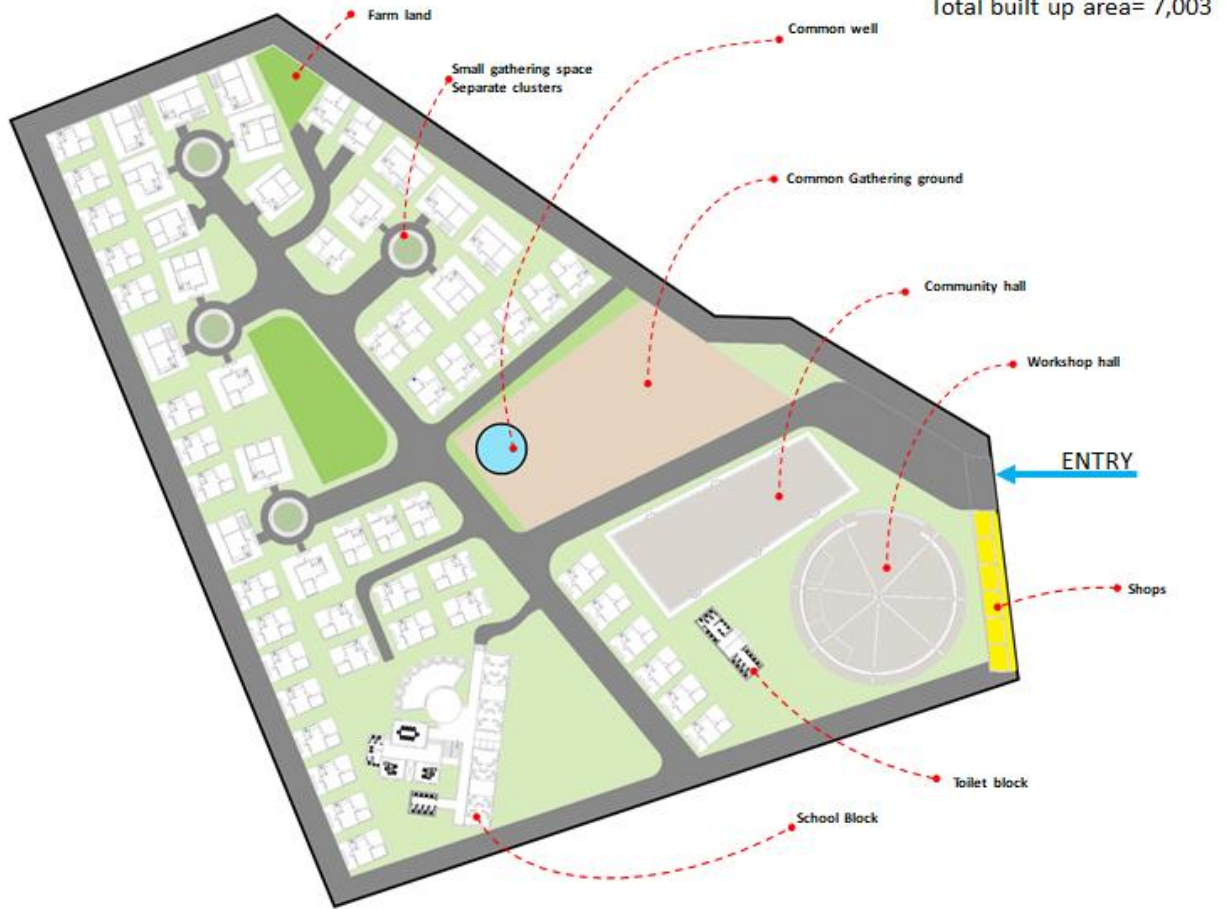


Fig 25 – Proposed site plan

5.3 Form evolution

- **Housing block**

- Building mass is interplayed to get mutual shading, allow cross ventilation across buildings.

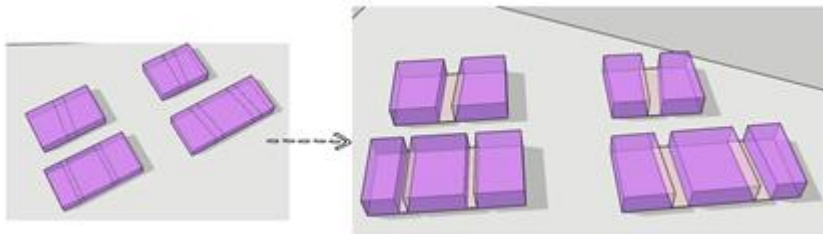


Fig 26 – Iteration stage 01, housing block

- Housing blocks area oriented in east west direction and rotated 45 Degree to avoid sun radiation, open spaces are added in between the blocks to make the block efficiency.

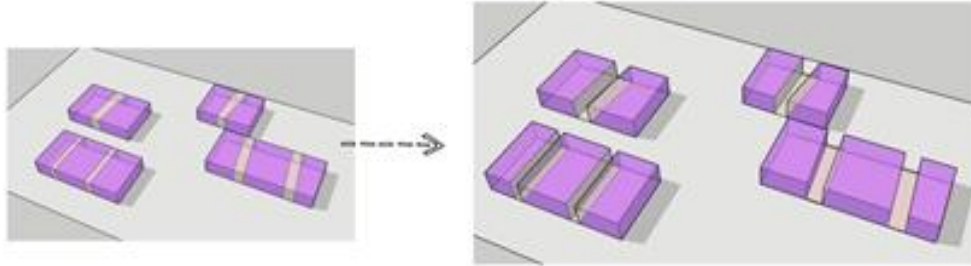


Fig 27 – Iteration stage 02, housing block

- Housing blocks area oriented in east west direction. As to avoid sun radiation, open spaces are added in between the blocks to make the block efficiency.

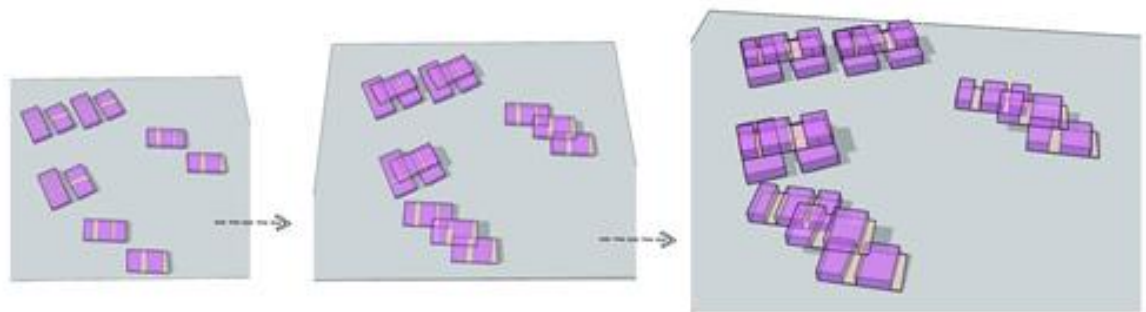


Fig 28 – Iteration stage 03, housing block

- The blocks are stacked one above the other helps in over shading and cut down radiation.

• **School block**

SCHOOL BLOCK EVOLUTION

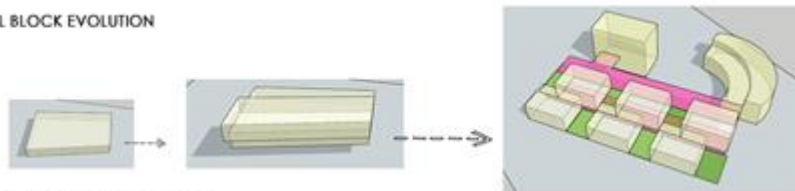


Fig 29 – School block form evolution

- The element of curvilinear is added to the kindergarten block to cut down the radiation and also its located strategically on west side since kindergarten are only upto 12pm.
- The open courtyard allows cross ventilation and allows visual connection.

5.4 Shadow analysis

• **Housing block**

- Housing Blocks are oriented in east west direction and rotated to 45 deg.

- In month of May the block dose mutual shading during the peek hours.
- In month of August, average day light duration is maximum and tend to have no diffused light in north side.
- In month of January, the northern side tends to receives less or minimum light.
- The open courtyards in between blocks help in mutual shading.
- The blocks are stacked over other creating mutual shading which cuts down the direct radiation and the courtyard created allows air movement.

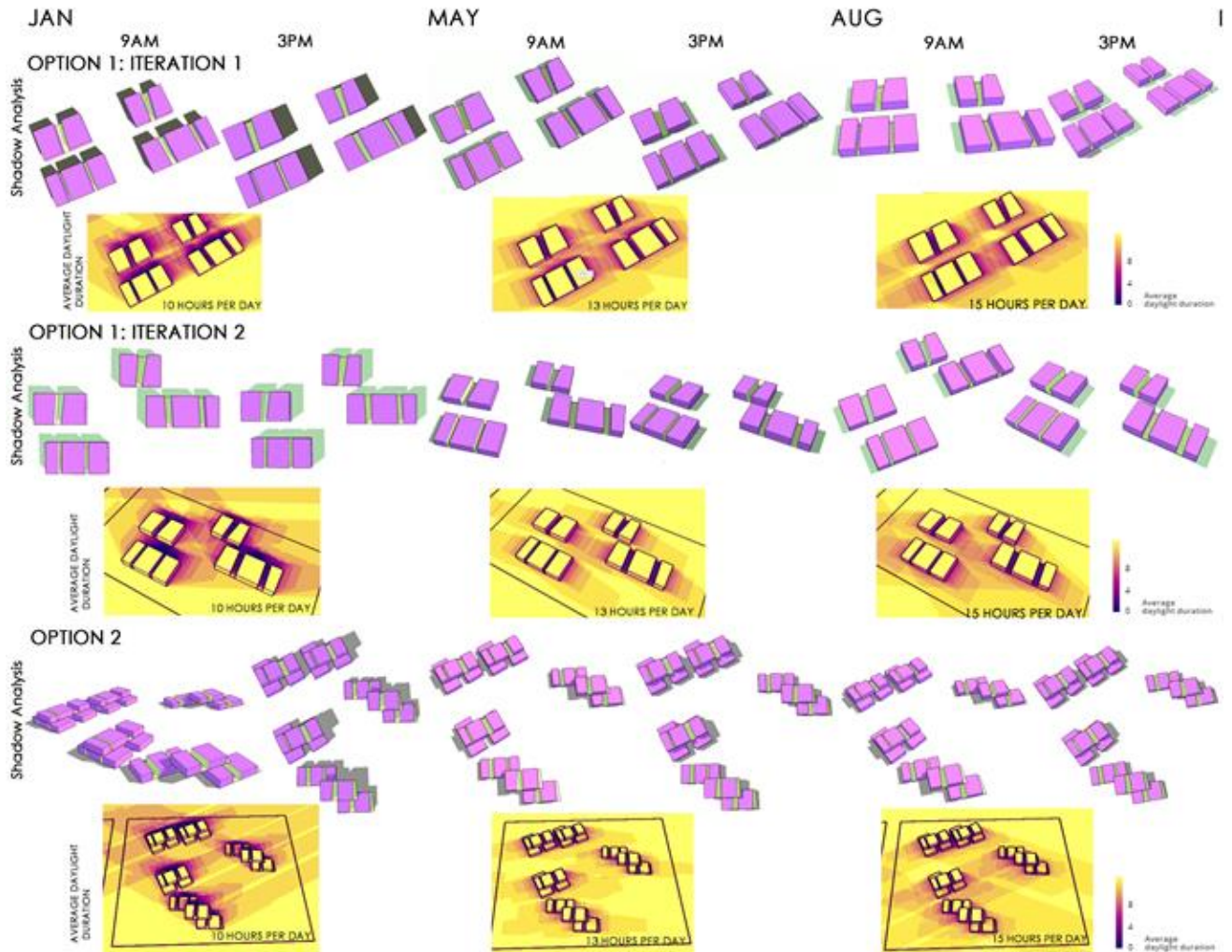


Fig 29 – shadow analysis of housing unit.

- **School Block**

- In shadow analysis, stacking of blocks alternatively helps in mutual shading and also helps in cross ventilation it cuts down the radiation.

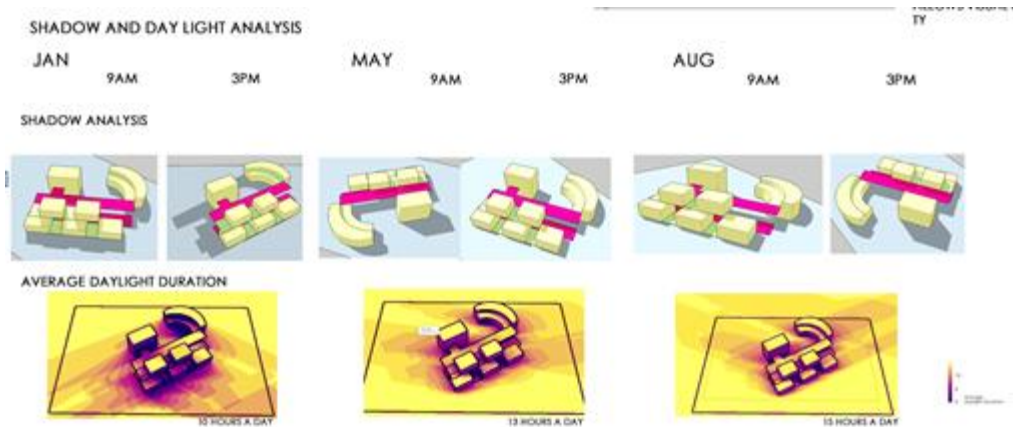


Fig 30 – shadow analysis of school block.

- **Classroom analysis**

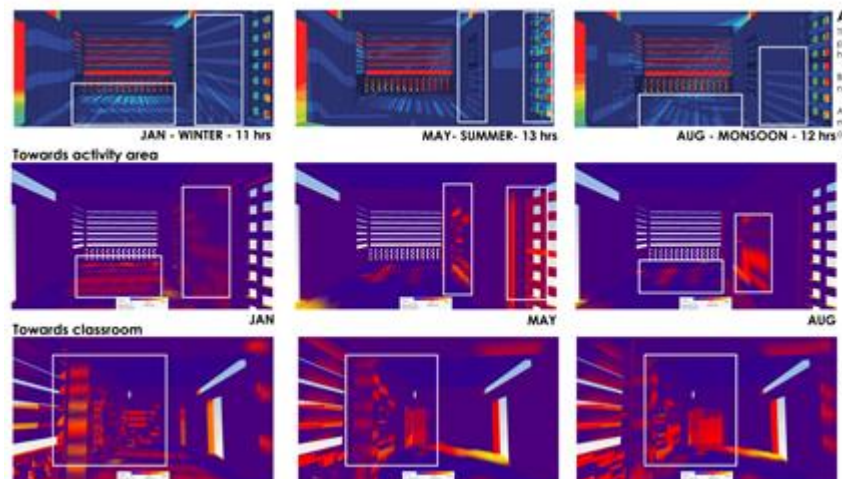


Fig 31 – Daylight and radiation analysis of classroom

- **Average daylight duration**
 - The analysis is carried for every one hour per day.
 - Month of May receives more day lighting hours
 - January receives more daylight through North openings given
 - Although summer month of May receives more daylight hours, the more amount of daylight is achieved in the month of January and August
- **Sun radiation analysis**
 - Month of May receives maximum radiation.
 - Observation to note is that whenever more radiation is achieved more daylight is also achieved.
 - More radiation is seen from door opening and jalli window
- **Strategies used**
 - Tiled brick jalli window, for cutting down direct radiation and sunlight
 - Clerestory window, for stack effect and diffused lighting

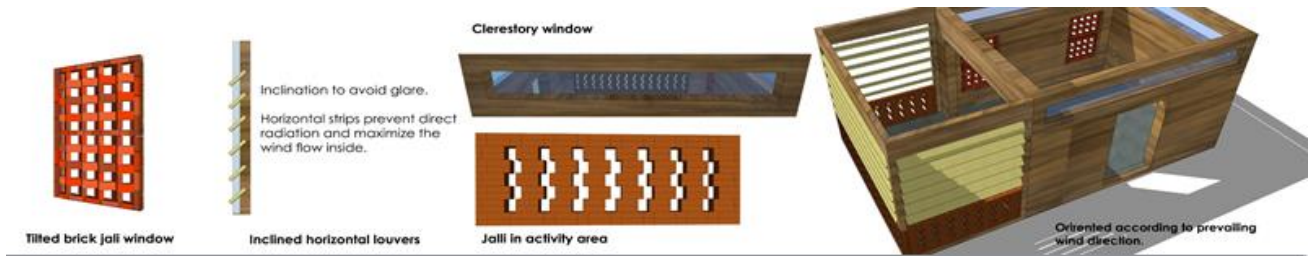


Fig 31 – strategies used for better ventilation and radiation

5.5 Block wind analysis

- As observed wind flow is from south west to north east. By placing the blocks perpendicular and by spreading out there is air movement through the site. And wind velocity differs between (0 to 22 m/s). While planting the trees it should be noted and placed accordingly without blocking the flow.

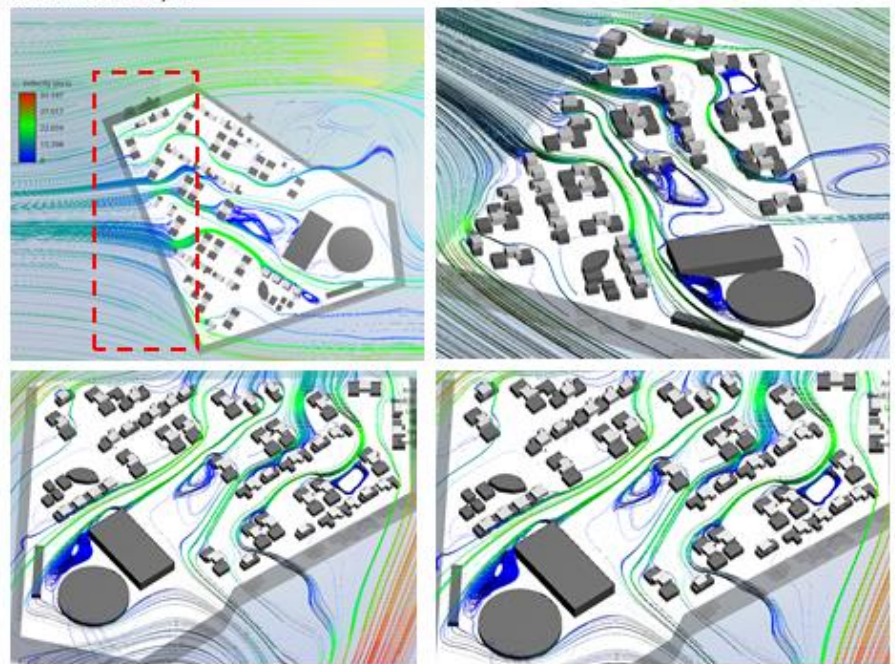


Fig 32 – Block wind analysis

Ground floor plan – Cluster model wind analysis

- By spread out planning wind flow is achieved in-between the blocks and hence cross ventilation is achieved



Fig 33 – Cluster model wind analysis, Ground floor

First floor plan – Cluster model wind analysis

- Same way in the 1st floor by placing the blocks alternatively and detached from one and another helps in air movement. the central spaces allows in creating Bernoulli's effect that helps in circulating the flow.

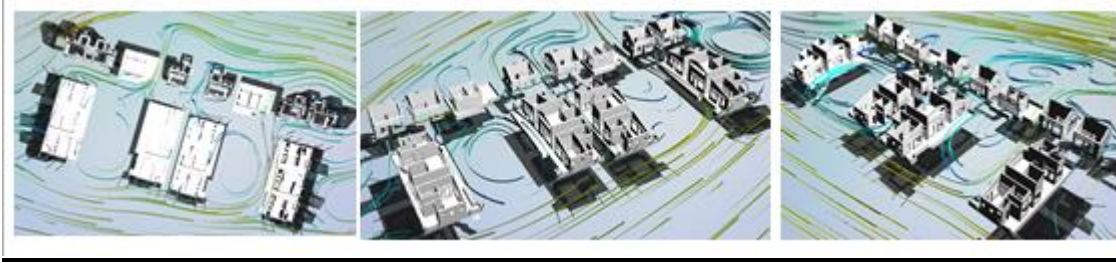


Fig 34 – Cluster model wind analysis, First floor

5.6 Wind analysis, through housing units

- House 01

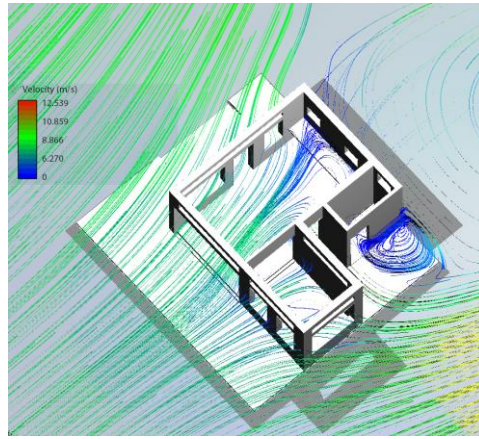


Fig 35 – house 01 wind analysis

- House 02

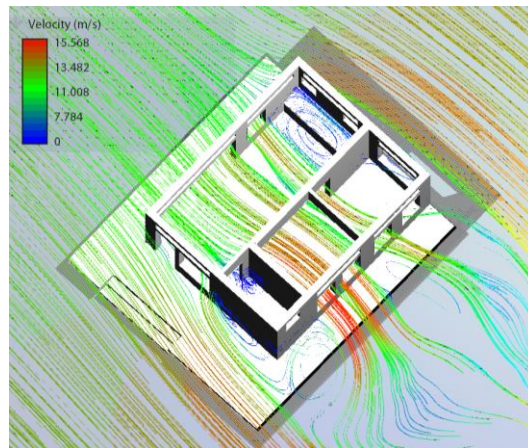
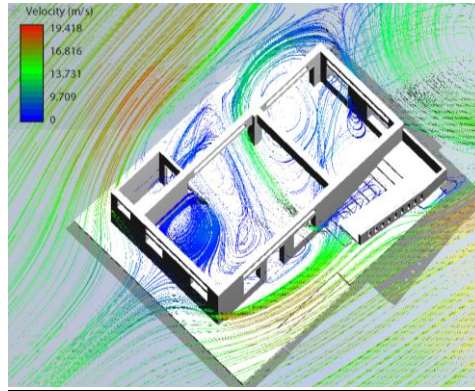


Fig 36 – house 02 wind analysis

- House 03

- Ground floor



- First floor

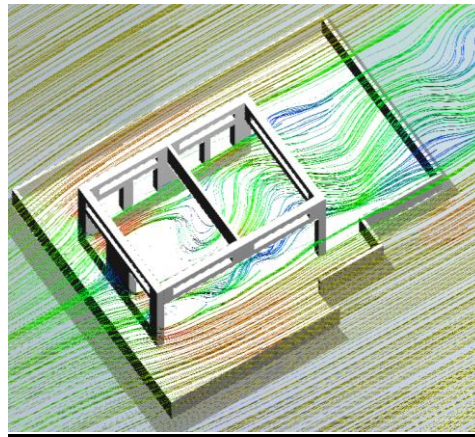


Fig 37 – house 03 GF,FF wind analysis

In all three modules cross ventilation is achieved.

5.7 Format analysis for cluster

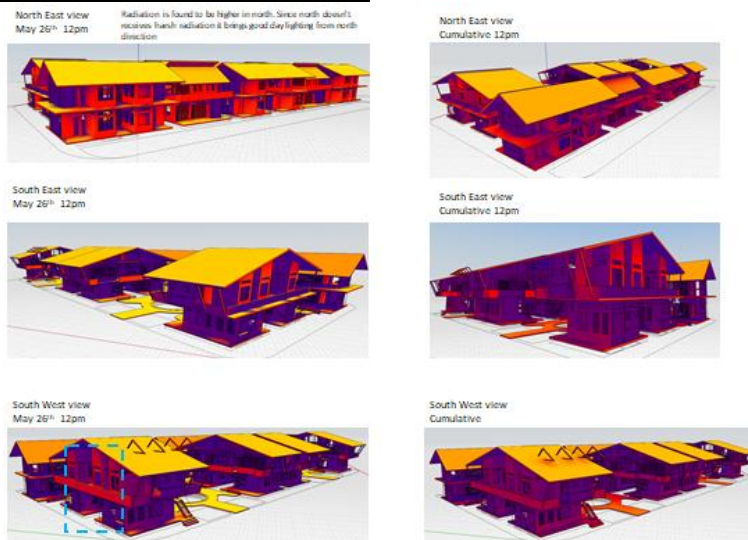


Fig 38 – Format analysis for cluster

5.8 Design of housing units

• Residence type 01

- Plinth area – 21 Sqm
- Total wall area = 78.12 sqm
- Total fenestration area = 12.6285 sq.m
- WWR = $12.6285 / 78.12 = 0.16 = 16\%$

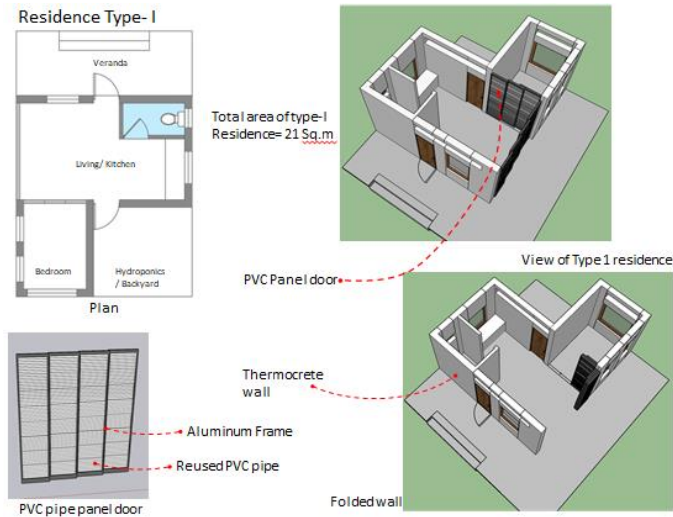


Fig 39 – Residence type 01

• Residence type 02

- Plinth area – 27 Sqm
- Total wall area = 73.32 sq.m
- Total fenestration area = 14.961 sq.m
- WWR = $14.961 / 73.32 = 0.204 = 20.4\%$

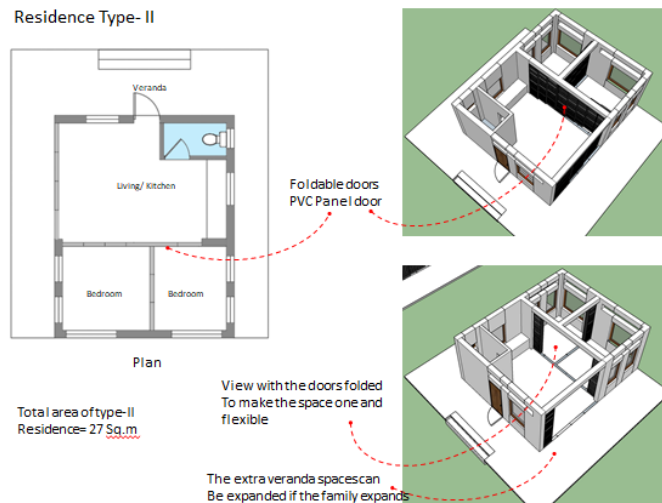


Fig 40 – Residence type 02

- **Residence type 03**

- Ground floor wall area = 82.16 sq.m
- First floor wall area = 56.58 sq.m
- Total wall area = 138.74 sq.m
- Ground floor fenestration area = 10.648 sq.m
- First floor fenestration area = 11.052 sq.m
- Total fenestration area = 21.7 sq.m
- $WWR = 21.7 / 138.74 = 0.156 = 15.6 \%$

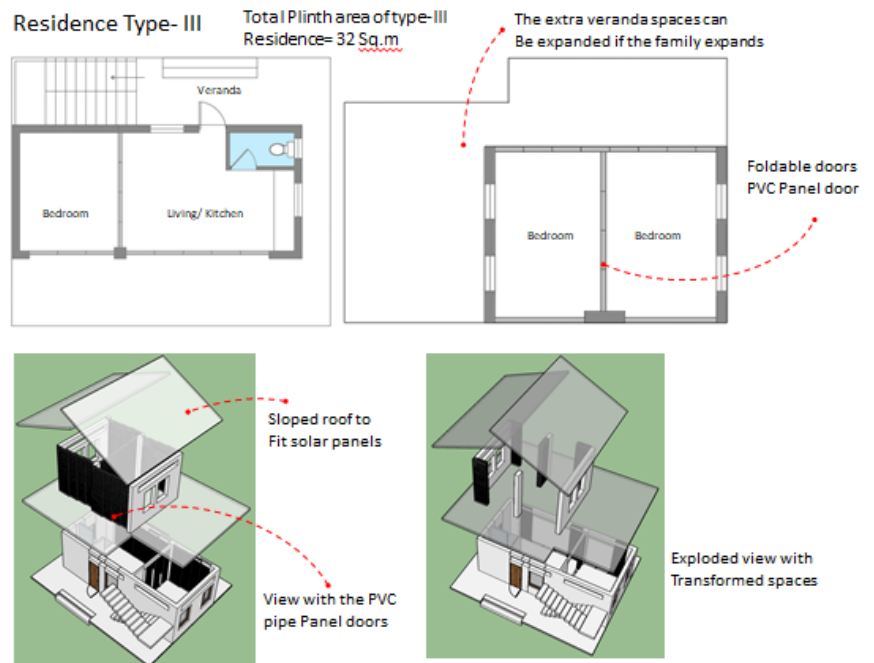


Fig 41 – Residence type 03

5.9 Energy Analysis

- **House type 01**

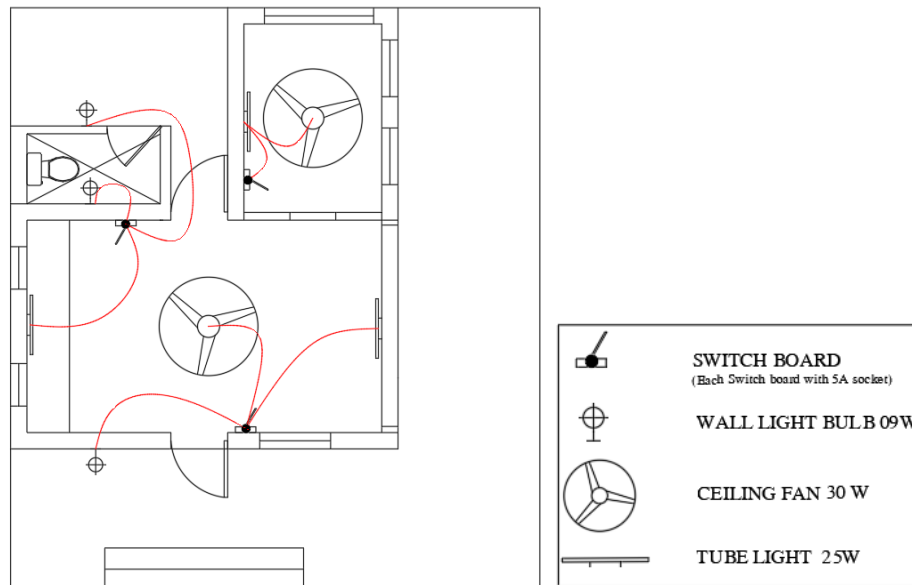


Fig 42 – House type 1 Electrical drawing

Annual Energy Consumption						
Sl. No	Electrical devices	Watts	No.Of	Time of usage per day in hrs	No. of days operated	Annual Energy Use kWh
DWELLING						
UNIT 1						
1	LED Batten light	18	3	5	365	98.5
2	Philips- 9 Watt LED Bulb	9	3	7	365	68.9
3	Orient- Ecoquasar Energy Efficient Ceiling Fan	30	2	15	365	328.5
Total Energy Consumed						495.9

Fig 43 – House type 01 Energy consumption chart

- House type 02

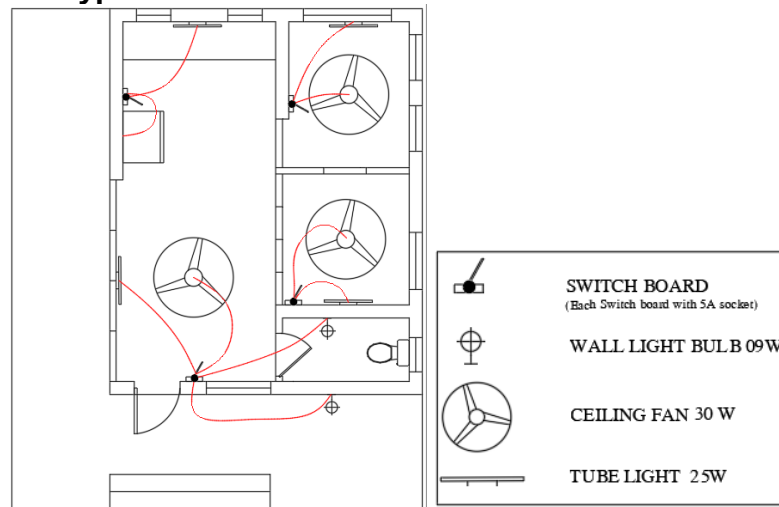


Fig 44 – House type 02 Electrical drawing

Annual Energy Consumption						
Sl. No	Electrical devices	Watts	No.Of Devices	Time of usage per day in hrs	No. of days operated	Annual Energy Use kWh
DWELLING						
UNIT 2						
1	LED Batten light	18	3	5	365	98.5
2	Philips- 9 Watt LED Bulb	9	2	7	365	45.9
3	Orient- Ecoquasar Energy Efficient Ceiling Fan	30	3	15	365	492.75
4	Fridge					110
5	30" LED TV	50	1	4	365	91.25
6	Mixer Grinder	550	1	0.25	365	50.1875
Total Energy Consumed						888.9

Fig 45 – House type 02 Energy consumption chart

- House type 03

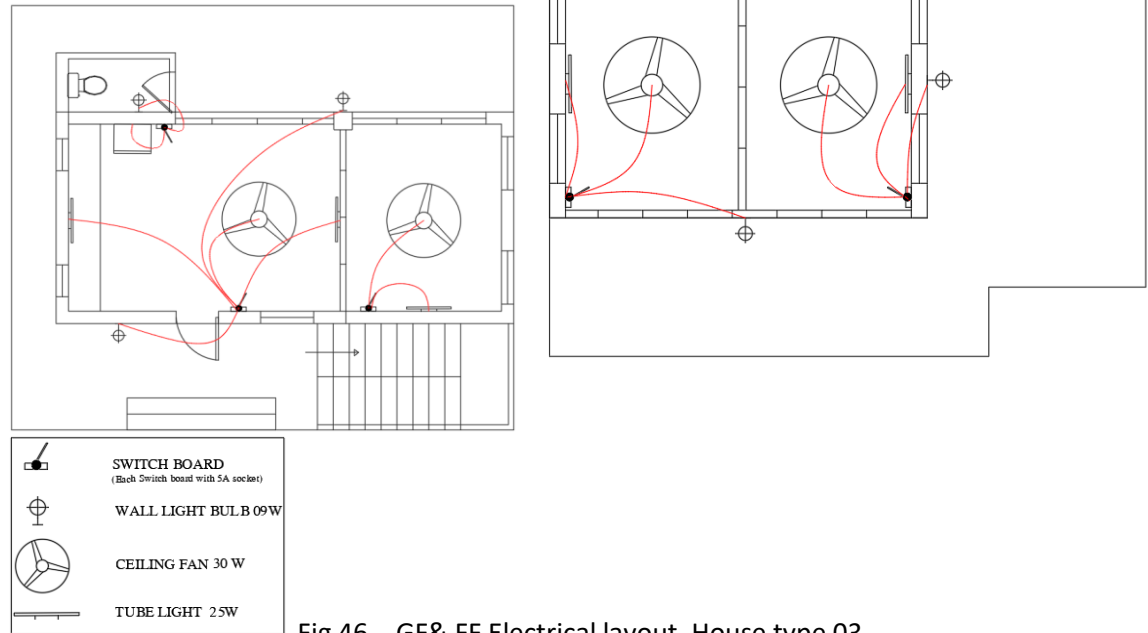


Fig 46 – GF& FF Electrical layout, House type 03

Annual Energy Consumption						
Sl. No	Electrical devices	Watts	No.Of Devices	Time of usage per day in hrs	No. of days operated	Annual Energy Use kWh
DWELLING						
UNIT 3						
1	LED Batten light	18	5	5	365	165.4
2	Philips- 9 Watt LED Bulb	9	5	7	365	114.9
3	Orient- Ecoquasar Energy Efficient Ceiling Fan	30	4	15	365	657
4	Fridge					110
5	30" LED TV	50	1	4	365	91.25
6	Mixer Grinder	550	1	0.25	365	50.1875
7	WET Grinder 1.25lt (ULTRA)	85	1	0.5	73	3.1025
Total Energy Consumed						1191.84

Fig 47 – House type 03 Energy consumption chart

- **Energy demand in Housing unit**

Sl.No	Residence	No of residence	Amount of power generated kW/ year	Total energy demand kW/ year
1	type 1	80	495.9	39640
2	type 2	60	888.9	53334
3	type 3	25	1191.84	29795
			Total	83129

Fig 48 – Energy demand in Housing unit chart

RESULTS

88,881 kWh/Year*

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)
January	6.82	9,438
February	6.86	8,476
March	7.26	9,782
April	6.61	8,556
May	5.67	7,683
June	5.04	6,670
July	4.60	6,353
August	4.57	6,343
September	5.07	6,749
October	4.89	6,664
November	3.73	5,119
December	4.99	7,049
Annual	5.51	88,882

Fig 49 – Energy demand in Housing - Month wise

- A 2kW solar system is the ideal capacity solar system for small size homes and flats just like a 2BHK. This solar system can generate enough energy to power all your home appliances up to 1600 watt load, while being environmentally beneficial.
- This 2kW capacity solar panel needs 12 Sq. Mtr shadow free area for solar panel installation. Total area available on the roof 120 sq.m on each cluster module

5.10 Rainwater harvesting

Rainwater harvesting surfaces	Area m ²	Runoff coefficient	Effective catchment area m ²
Roof Surfaces	7219.14	0.85	6136.269
Hardscape area	8948	0.70	6263.6
Softscape areas	8000	0.30	2400
Other			0
			0
Total Effective catchment area			14799.869

Fig – 50 Rainwater catchement chart

End Use	Percent use	Use in LPD	Greywater in LPD	Blackwater in LPD
Bathing	30%	20378	20,378	
Washing	15%	10189	10,189	
Cleaning house	8%	5434	5,434	
Washing Utensils	16%	10868	10,868	
Others	2%	1359	679	679
Drinking	4%	2717		2,717
Cooking	3%	2038		2,038
Toilet Flushing	15%	10189		10,189
Total		63170	47,548	15,623

Fig – 51 Domestic water consumption chart

- 18,376.6 KLD of water is collected from the catchment area. Water is stored in underground tanks going through filtration process
- In case of water demand needed water will be collected from hand pumps provided in the site

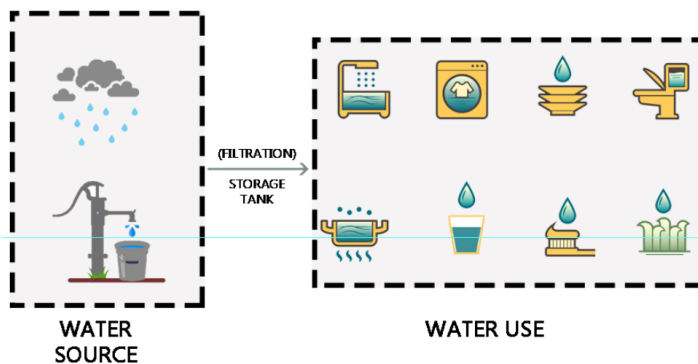


Fig – 51 Water use flow

Freshwater requirement thereby is 67,966 LPD

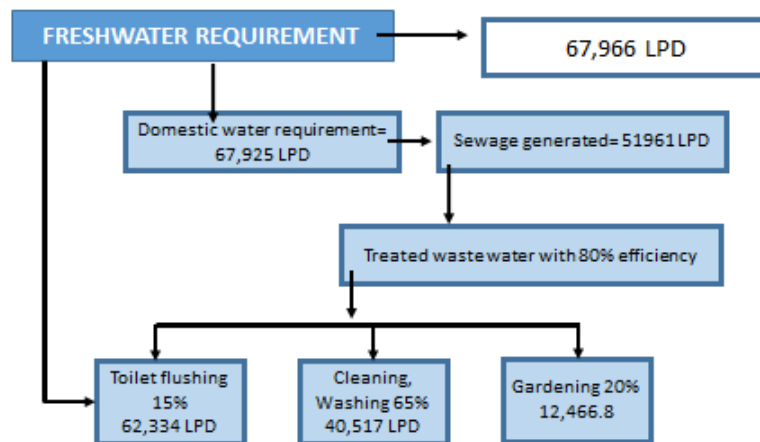


Fig – 52 Water balance table

5.11 Sewage treatment calculation

- Total domestic water demand (TWD)= 67,966 LPD
- Estimated sewage 50% of TWD
- Estimated sewage= 33,953 LPD (The sewage estimate is reduced to 50% because of eco-san toilets)
- Total space required for 33,953 LPD
- **4.5 X 4.5 X 2= 40.5 CUM**
- Three chambered septic tanks are designed. The filtered and treated water is

let out for recharge ground water

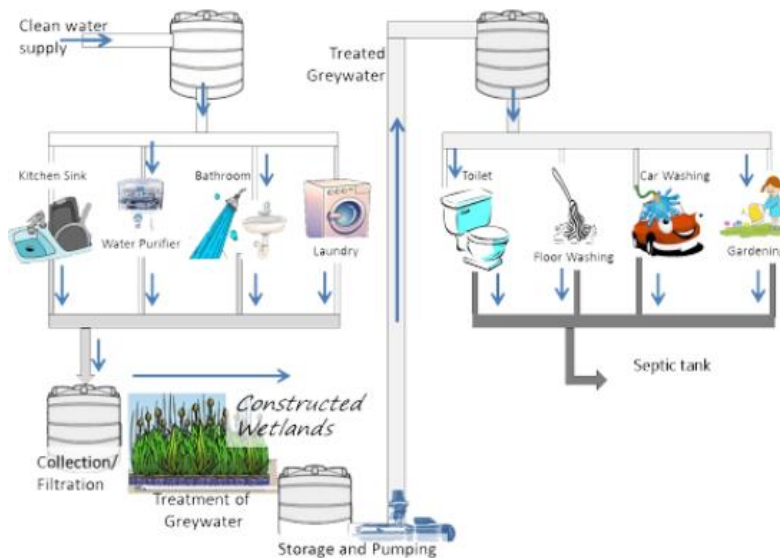


Fig 50 – Greywater treatment

5.12 Recharge pits

- Recharge pits are used to divert rainwater into an aquifer.
- The Recharge pit is covered with perforated concrete slab.
- The pit is filled with gravel/ pebbles followed by river sand for better percolation.
- The soft-scape runoff waters are diverted to recharge ground using **Recharge pits**.
- Using **100 X 16 X 0.3= 480 liters of water can be collected in the pit**. Multiple pits is provided according to site coverage

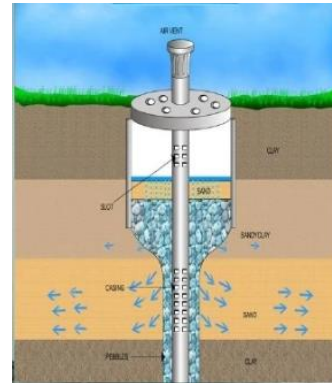


Fig 51 – Recharge pits

CHAPTER 6 DESIGN STRATEGIES

6.1 SITE STRATEGIES

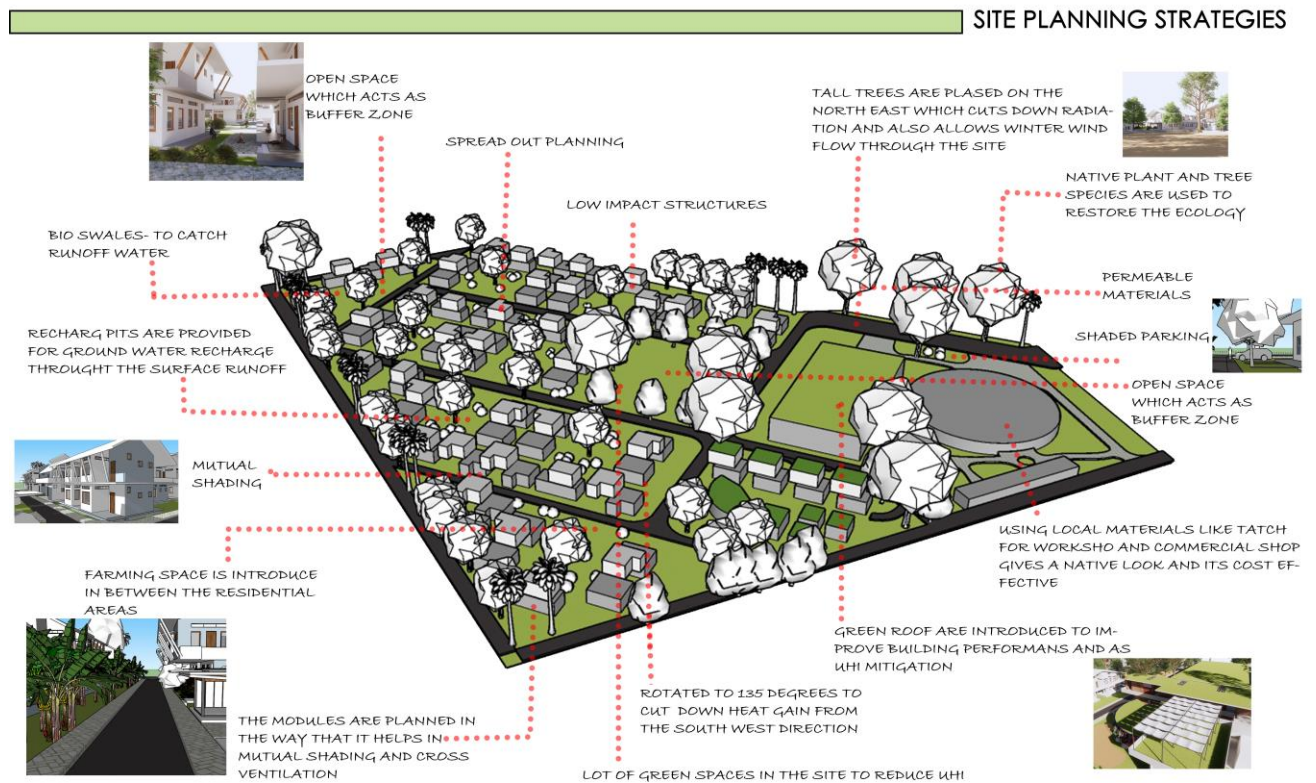


Fig 52- SITE STRATEGIES

6.2 CLUSTER PLAN AND ANALYSIS

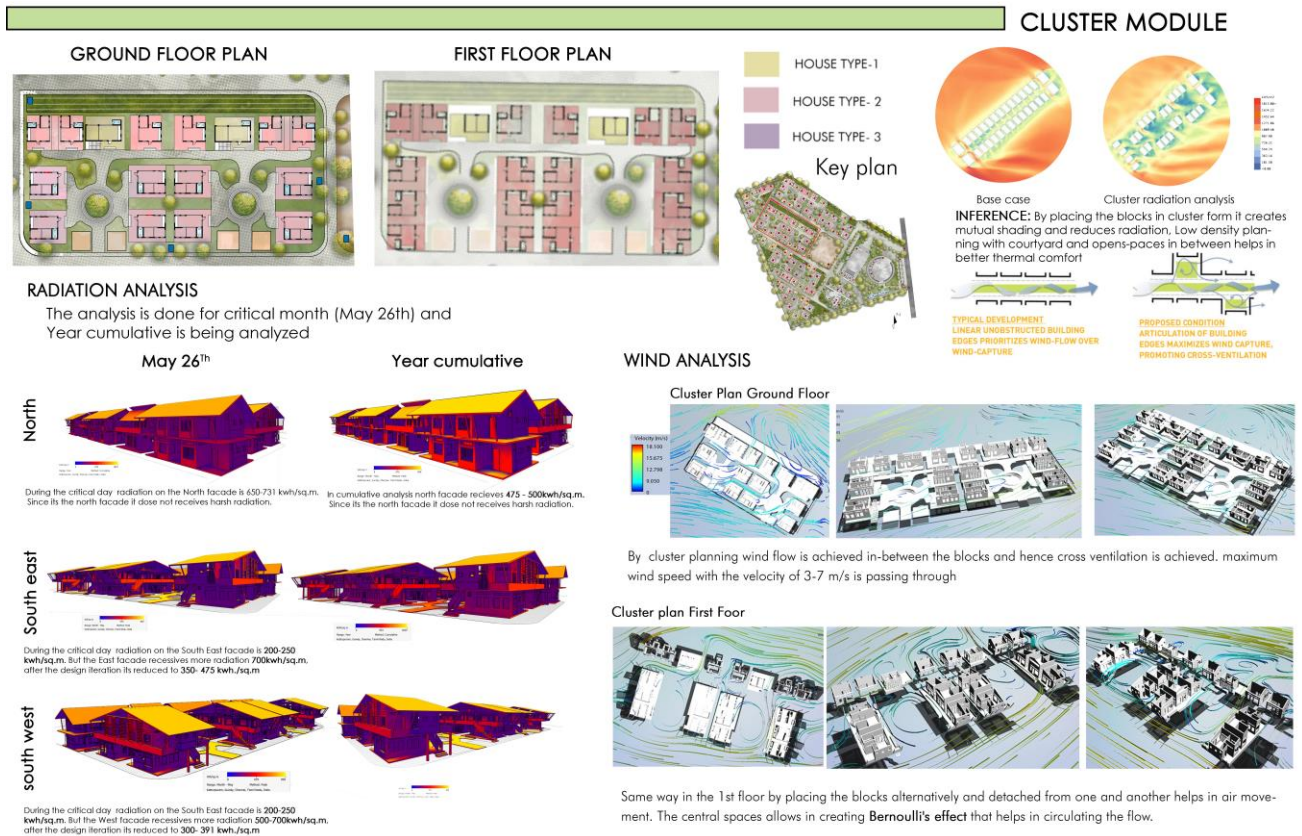


FIG 53- cluster plan and analysis

CHAPTER 7 CONCLUSION

Conclusion:

- tried to implement the pillars of sustainability
- Designed a self sustaining community for the community people
- By this design their standard of living will be improved
- By providing urban farming plots they will get to grow their food and can sell the excess
- The commercial space provided in the side acts as the connecting element between the community and people.
- By incorporating site strategies passive design is being achieved
- Energy demand is being addressed and the energy is minimized
- When there is water demand hand pumps are provided in the site where they get access to fresh water



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