

DESIGN INTERVENTION OF A HOSPICE CARE WITH A FOCUS ON LOCAL BUILDING MATERIALS IN WARM – HUMID CLIMATE

A Thesis

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

by

PRIYANGA P (39890012)



**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 2021



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DEPARTMENT OF ARCHITECTURE

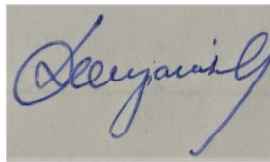
BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **PRIYANGA P (39890012)** who carried out the Thesis entitled “ **DESIGN INTERVENTION OF A HOSPICE CARE WITH A FOCUS ON LOCAL BUILDING MATERIALS IN WARM – HUMID CLIMATE** ” under our supervision from January 2021 to May 2021.

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Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I **PRIYANGA P** hereby declare that the Thesis Report entitled “ **DESIGN INTERVENTION OF A HOSPICE CARE WITH A FOCUS ON LOCAL BUILDING MATERIALS IN WARM – HUMID CLIMATE** ” done by me under the guidance of **Ar. SANGAVI** (Internal) and **Ar. BALAMURUGAN RAJKUMAR, Principal Architect -Proton Ateliers** (External) at Satyabhama 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: 28.05.2021

PLACE: CHENNAI

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 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. Balamurugan Raj Kumar**, (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. Sangavi** for her valuable guidance, suggestions and constant encouragement which paved way for the successful completion of my project work.

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ABSTRACT

Environmental protection and determination of the state of “health” of our planet has become an important topic for our society. Building materials largely determine building’s energy consumption and environmental impacts, and have a significance impact on sustainability on buildings. Studies have shown alarming realities: human activities around the world produce too much polluting emissions, leading to the progressive and rapid deterioration of nature and the climate of the earth.

This research will include the detailed study on the Vernacular materials which was used in the past and also its thermal properties, composition, durability. Different materials such as cement, concrete, wood, bricks etc., were analyzed in detail. Next comes the contemporary materials and their detailed study. A quantitative analysis on release of CO₂ when these materials are used in the building will be researched. Also, the study of implementation of construction techniques using these materials will be discussed in brief. Some supporting literature / case studies will be discussed in detail for both vernacular and contemporary materials.

A comparison of materials will be analyzed with respect to all of its properties. The simulation analysis is done on OPAQUE and CARBSE for the criteria of selection of building materials. Based on the analysis of the research findings, considering the cost & thermal properties , it concludes by suggesting the selection criteria of building materials and also a proposal for futuristic building materials and its applications which were not in use at present for the climate researched.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

- Hospice care mainly focuses about the cancer patients or persons who are terminally ill which can't be given treatment to cure.
- By taking the census of Cancer patients in INDIA, Kerala was one of the major State consisting of cancer patients at different stages.
- Since the site is facing towards the lake nearby, all the patients would have very peaceful environment with all the sustainable technologies incorporated.
- Now at the present situation of COVID-19, these patients would require a hospice care for their peace before death.
- HOSPICE – HOME + HOSPITAL

1.2 AIM:

To propose a sustainable design for a hospice care in warm – humid climate emphasizing on integrated design solution with sustainable material technologies.

1.3 Objectives:

1. To analyze the factors that will affect the user's perception of a space and its contribution to the physical well-being in terms of construction and local building materials.
- 2 To establish the need for the design of a Sustainable architectural design in health care environment with a focus on the relationship between open - built and close - built spaces.
- 3 Suggestions of futuristic building materials and its applications.
- 4 To plan and design a center which is also considered to be a home care blending with nature.

1.4 Research Scope :

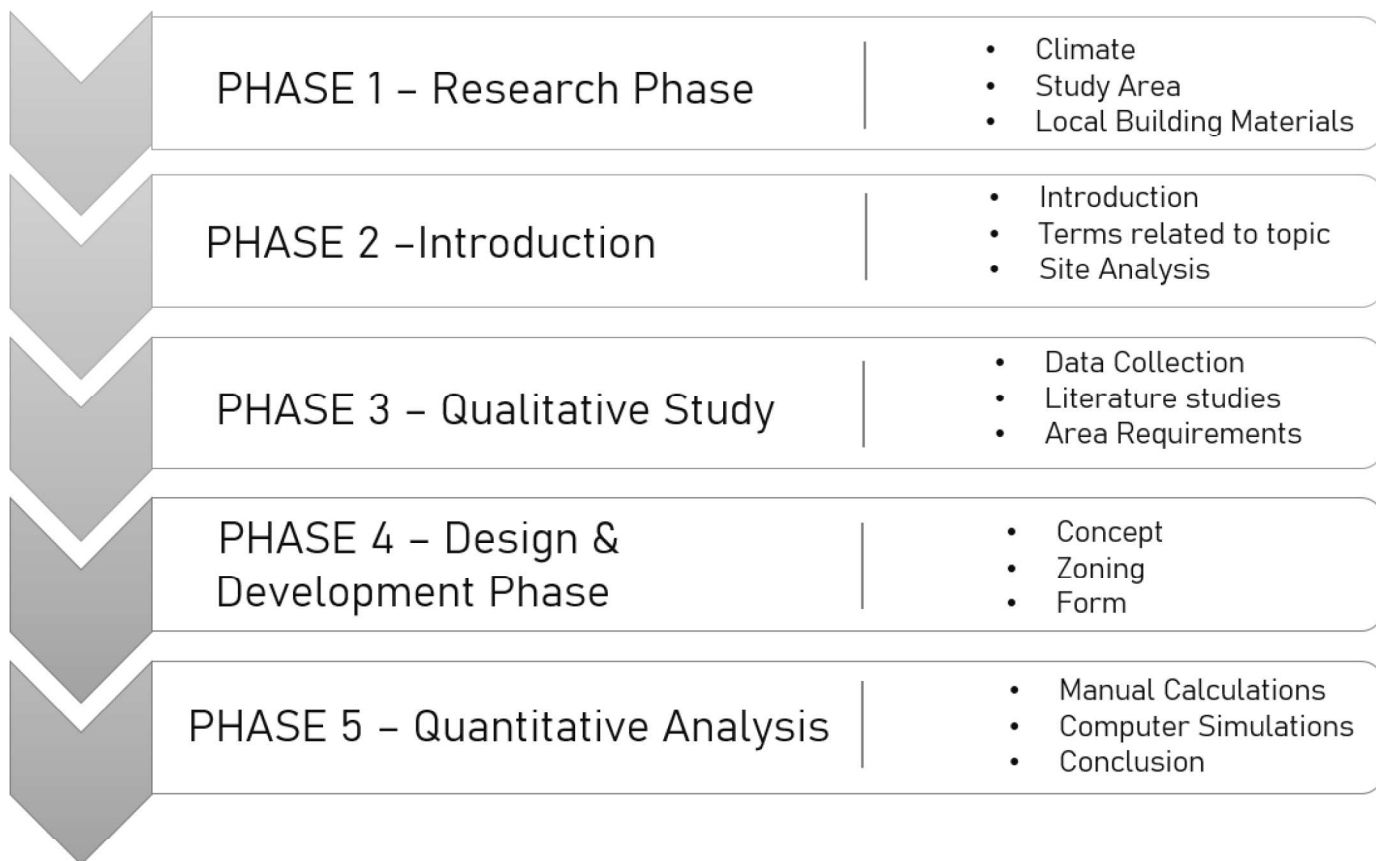
2. Since hospice care is a type of health care that focuses on the palliation of a terminally ill patient's pain and attending to their emotional and spiritual needs at the end life, there is a scope on experimenting with sustainable building materials.

3. There is a need to achieve the benefit in the basis of energy, material availability, thermal comfort, ambience etc., since the hospice care connects the people towards nature .

1.5 Limitations:

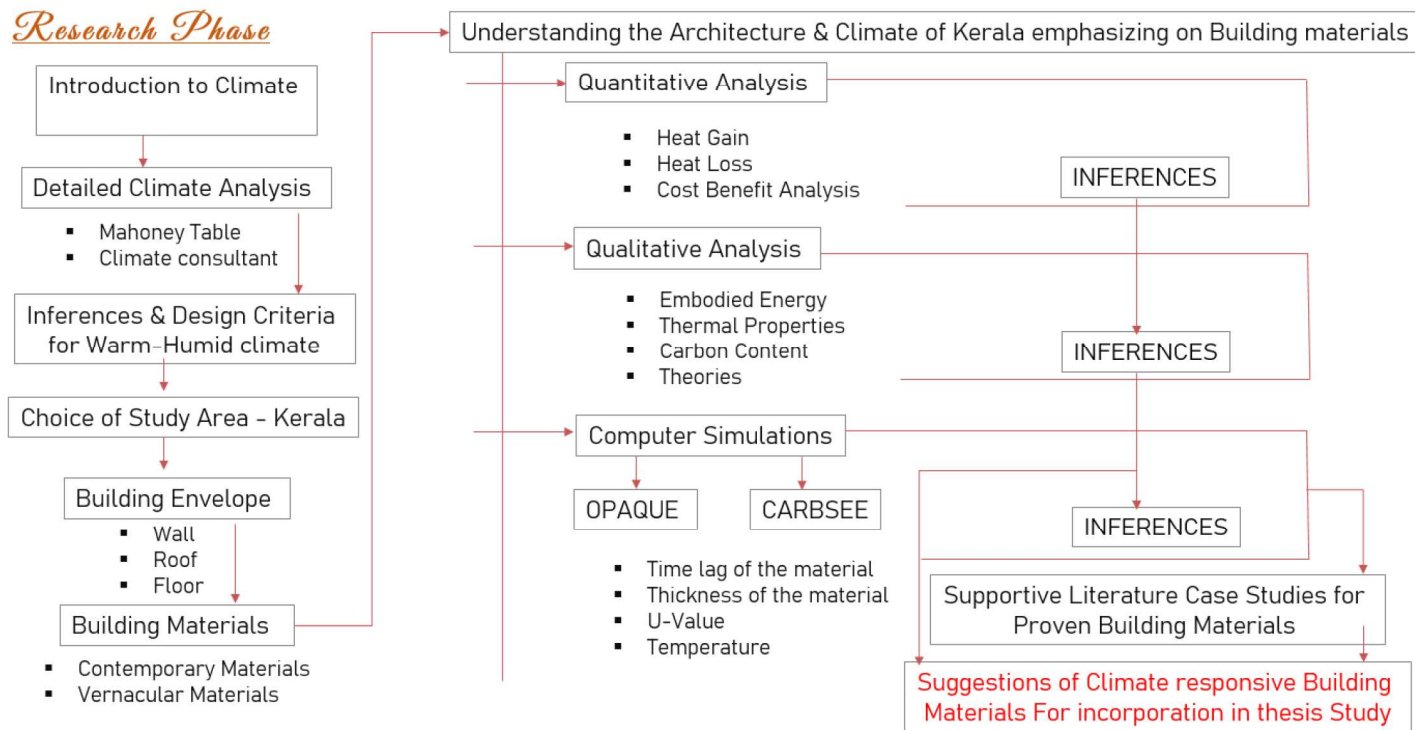
1. The design of the building is limited to Warm – Humid Climate with the focus of the Local building materials.
2. This Topic focuses only on the integration of sustainable technologies in a hospice building.
3. All the interventions would be implemented on the design part with reference to case studies/ literature studies / materials research.
4. The design scope does not include active strategies.
5. The Floors are limited to 2 in numbers.

1.6 METHODOLOGY :



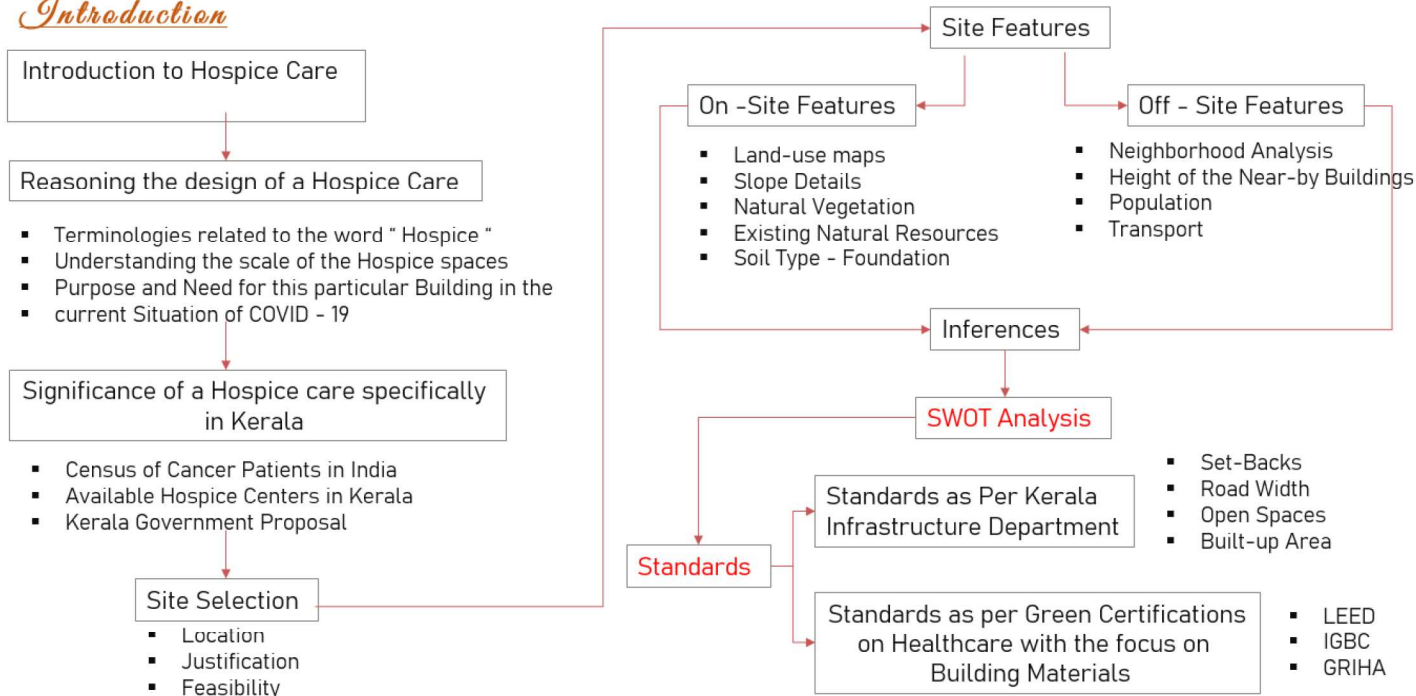
PHASE 1:

Research Phase



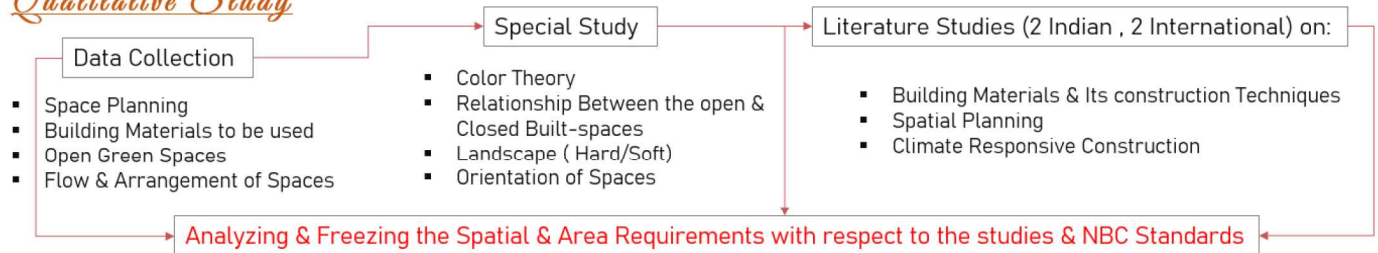
PHASE 2 :

Introduction

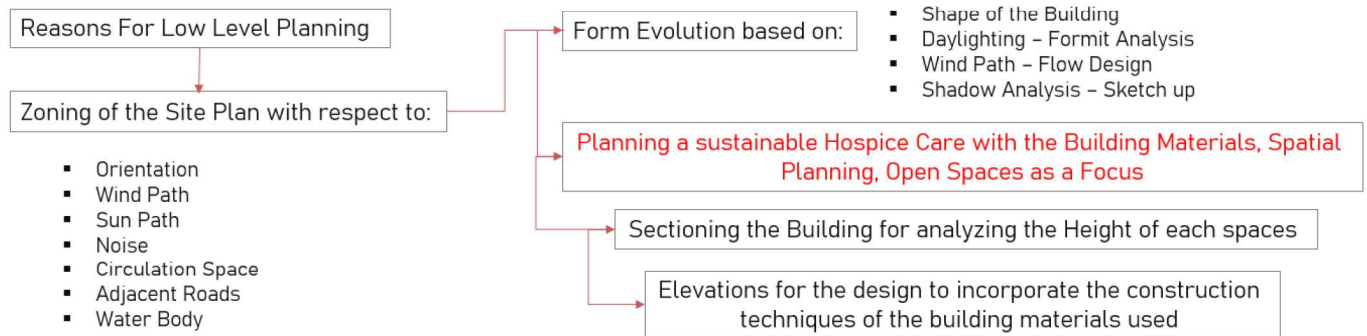


PHASE 3 & 4 :

Qualitative Study

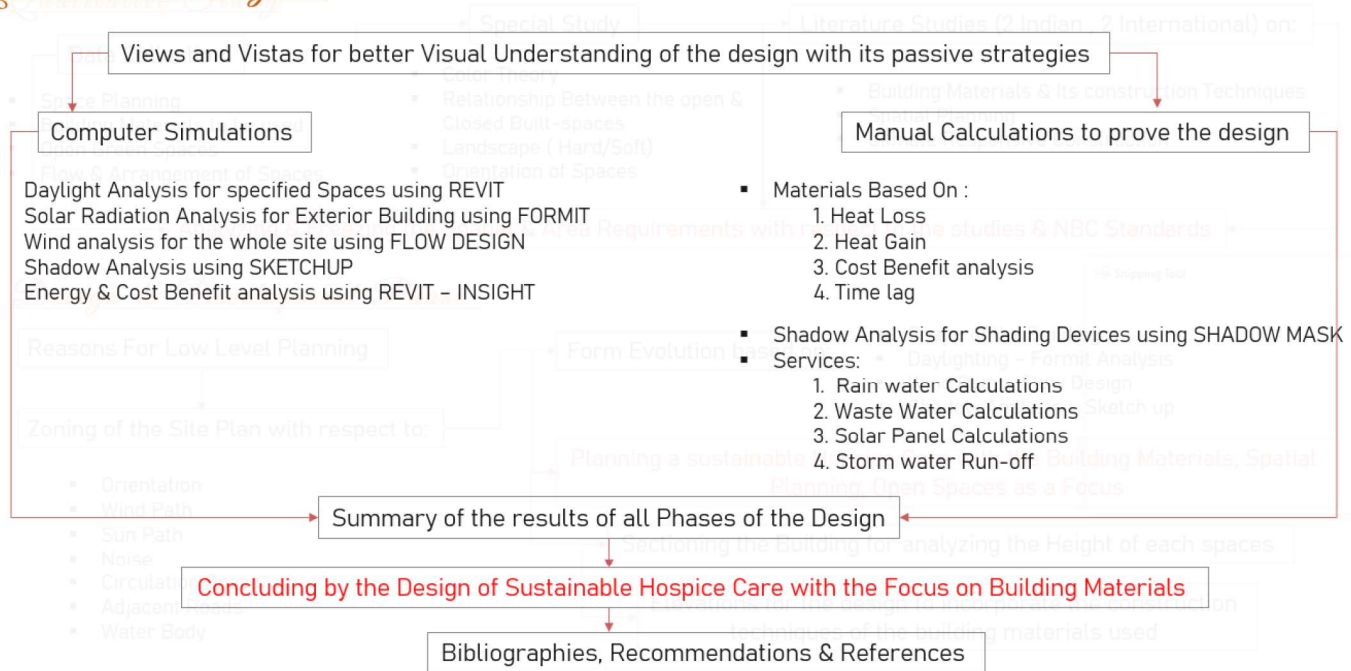


Design & Development Phase



PHASE 5:

Quantitative Analysis



CHAPTER – 2

CLIMATE & SITE STUDY

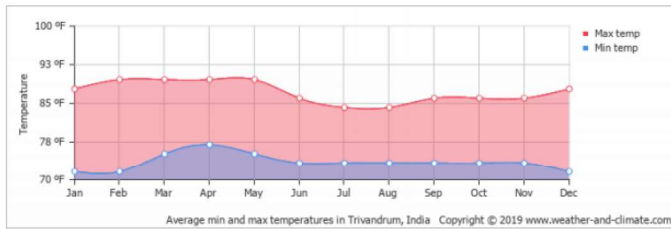
2.1 Location – VARKALA, KERALA:

Varkala, also known as The Pearl of the Arabian Sea, is a municipality in the Thiruvananthapuram district, situated in the Indian state of Kerala. Varkala is home to 3% of the total urban population and most densely populated municipality of the district. It is the headquarters of Varkala Taluk and one among the oldest municipalities of Kerala established in 1980. It is the second largest coastal city in the district after the state capital and northern suburb of Trivandrum City.

2.2 CLIMATE:

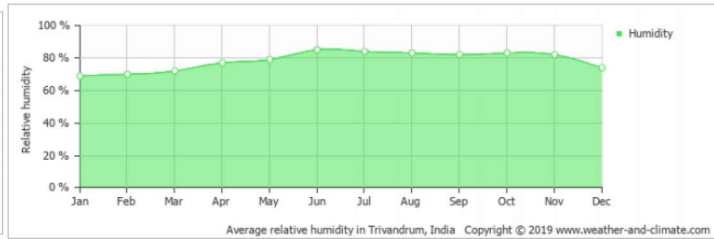
- Varkala has a Warm - humid climate, with temperature ranging from 30 to 36 degree Celsius.
- It experiences heavy rains from June to August (Southwest Monsoon) and the average rainfall is 310cm. with heavy rains during June-August due to the southwest monsoon.

TEMPERATURE



The warmest month (with the highest average high temperature) is **April** (28.3°C). The month with the lowest average high temperature is **December** (25.7°C).

HUMIDITY:



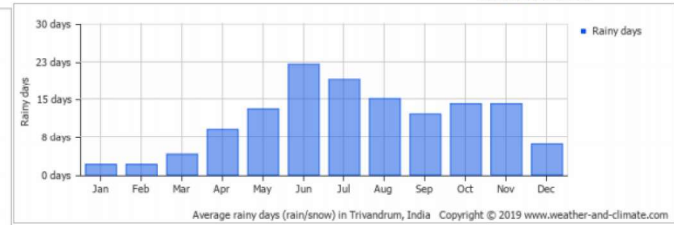
The month with the highest relative humidity is **June** (83%). The month with the lowest relative humidity is **January** (70%).

SUNSHINE HOURS:



Months with most sunshine are **January** (Average sunshine hours for a year: 260h). The month with least sunshine is **June** (Average sunshine hours for a year : 138h).

RAINFALL:



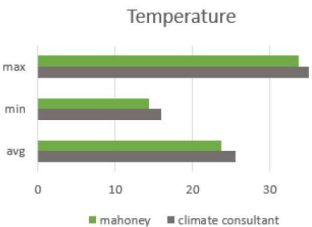
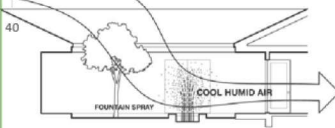
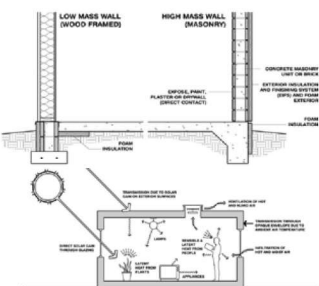
The wettest month (with the highest rainfall) is **June** (23 days/month). The driest month (with the lowest rainfall) is **January** (4 days/month).

Kerala, the southern most state of India, which extends from 8°18' to 12°48" N latitude, 74°52' to 72°22' E longitude, lying between the Arabian Sea on the West and the world famous Western Ghats with its ever green rain forests on the East has a characteristic Warm-Humid climate. ♣ The presence of high amount of moisture in the atmosphere for major part of the year causes thermal discomfort as there is less evaporation, resulting in sweating. ♣ This is more acute in summer when the air temperature is close to or higher than the body temperature. ♣ Climate responsive design is the one that would provide a comfortable indoor environment in response to the seasonal variations of the climate.

2.3 COMPARITIVE ANALYSIS OF CLIMATE STUDY:

PARAMETERS	MAHONEY TABLE	CLIMATE CONSULTANT	BAR CHART	INFERENCE
DRY BULB TEMPERATURE (Day)	Max Temperature – March & April (31.5 degc) Min Temperature – July (28.6 degc)	Max Temperature – April (32.5 degc) Min Temperature – November (29 degc)	Relative Humidity % max min 0 20 40 60 80 100 ■ mahoney ■ climate consultant	Day temperature is moderate throughout the year hence a mixed use ventilation strategies & have to use the minimum Or eliminate west glazing to reduce Heat and fall Afternoon heat gain.
WET BULB TEMPERATURE (Night)	Max Temperature – April (25 degc) Min Temperature – November (17.8 degc)	Max Temperature – April (25.2 degc) Min Temperature – November (18.5 degc)	Wet Bulb Temperature (Night) max min 0 10 20 30 ■ mahoney ■ climate consultant	For passive solar Heating, face most of the Glass area towards South to maximize winter exposure.
WIND VELOCITY	No data	Max wind velocity – May and June (12 mph) Min wind velocity – November- January (4 mph)	Wind velocity (mph) max min 0 5 10 15 ■ mahoney ■ climate consultant	Use open plan interiors to promote natural ventilation or use louvered doors or use jump Ducts for privacy If needed.

PARAMETERS	MAHONEY TABLE	CLIMATE CONSULTANT	BAR CHART	INFERENCE
TEMPERATURE	Max Temperature – March & April (31.5 degc) Min Temperature – July (28.6 degc)	Max Temperature – April (32.5 degc) Min Temperature – November (29 degc)	Temperature max min avg 0 10 20 30 40 ■ mahoney ■ climate consultant	The climate has warm summers and cool winters. Window Overhangs or operable sunshades can reduce the air conditioning.
RAINFALL	Max Rainfall – June (319mm) Min Rainfall – Jan (25 mm)	Max Rainfall – June (325mm) Min Rainfall – Jan (26 mm)	Rainfall (mm) max min 0 50 100 150 200 250 300 ■ mahoney ■ climate consultant	Kerala experiences heavy rainfalls due to its relatively altitude. Hence precautions have to be taken to avoid storm water runoff and save water through rain water harvesting.

PARAMETERS	MAHONEY TABLE	CLIMATE CONSULTANT	BAR CHART	INFERENCE
RELATIVE HUMIDITY	Max Humidity – Jun – Nov (Above 83%) Min Humidity – Jan (70%)	Max Humidity – June, Dec (80% – 90%) Min Humidity – Jan (75%)		Annual average relative humidity is 82.5% . Moderate humidity is recorded during winter & summer months. Passive heating & cooling strategies have to be followed. 
PASSIVE STRATEGIES	• Compact courtyard planning. • Heavy External and Internal walls • Medium openings (25% – 40%)	• Open plan interiors to increase cross ventilation • Plant materials on the west to reduce heat gain. • Window overhangs and operable sun shades to reduce air conditioning.	Orientation should be such that benefits can be gained from the winter sun. Thermal insulation is beneficial. Semi compact built form. 	

2.4 SITE STUDY:

THIS STORY IS FROM MARCH 27, 2018

Kerala govt wakes up to hospice concept

Preetu Nair | TNN | Mar 27, 2018, 05:48 IST

✉ 🖨 A- A+



Representative image

people.

KOCHI: State government is planning to set up a [hospice](#) facility in all district hospitals. It has also asked all district hospitals and medical colleges to improve their geriatric wards. This has become a necessity as [Kerala](#) is about to witness a demographic transition – rise in the aged population and a decline in the growth rate of population – that necessitates care for more

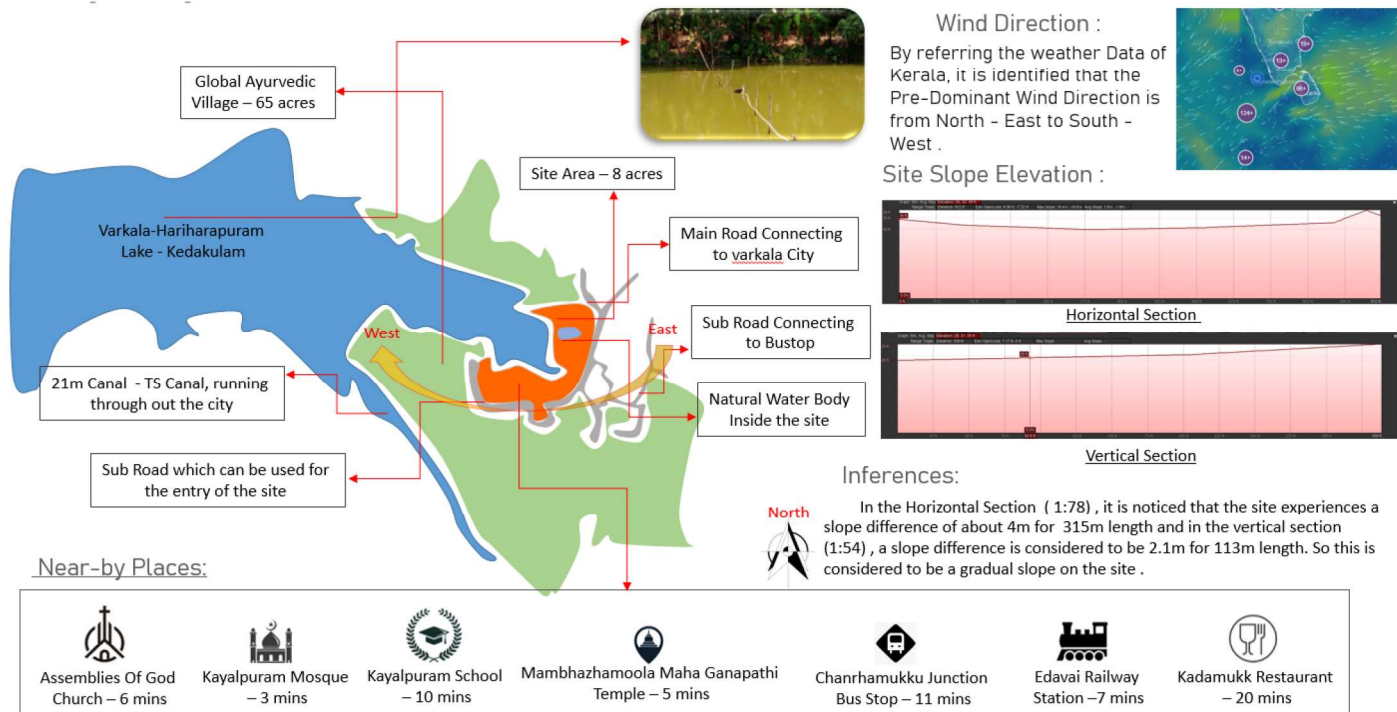
- Kerala Government has signed an agreement 2 years before for implementing Hospice & Palliative care in Kerala and the budget process was going on till now.
- Live Proposal - Proposed by Kerala Infrastructure department.
- Location – Varkala, Kerala
- Total Site allocated by Kerala: 65 acres.
- Site Limited for up to 8 acres for a design.
- Site is assigned at the North-east corner of the site allocated facing the lake near-by.

Why a sustainable Hospice care @ Kerala?

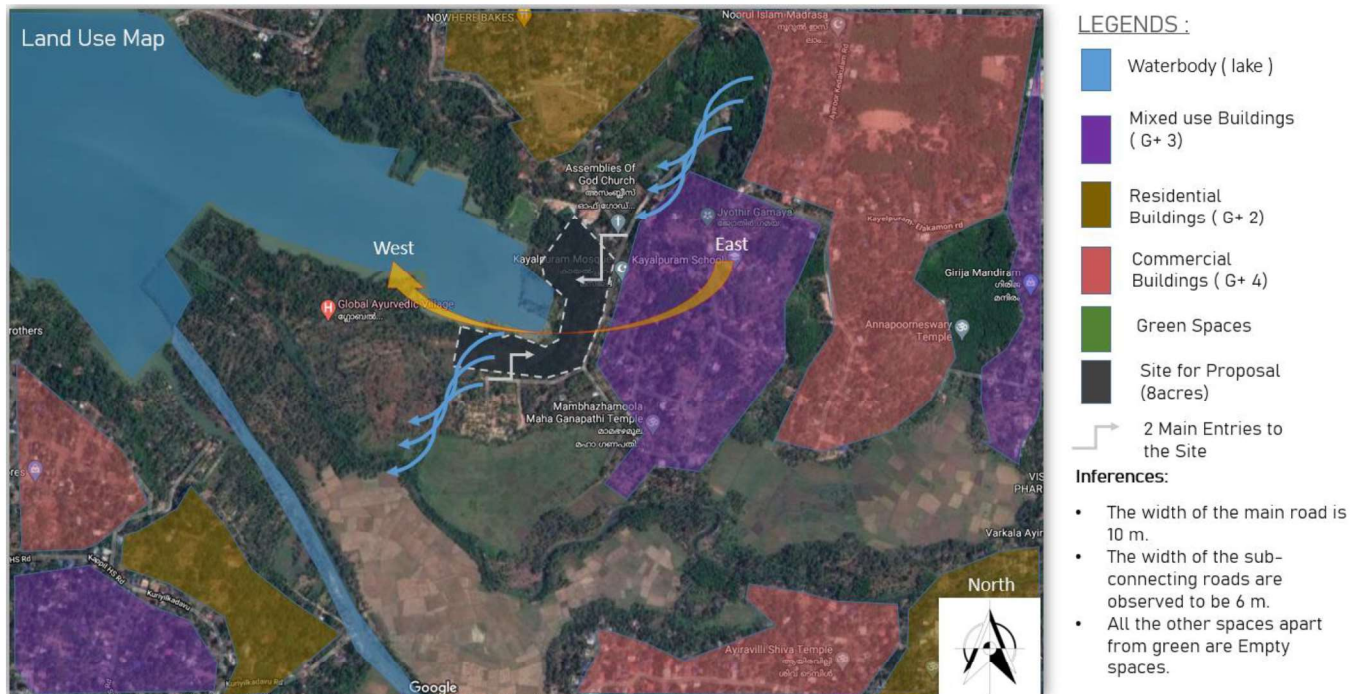
- Hospice care mainly focuses about the cancer patients or persons who are terminally ill which can't be given treatment to cure.
- By taking the **census of Cancer patients** in INDIA, Kerala was one of the major State consisting of cancer patients at different stages.
- Since the site is facing towards the lake nearby, all the patients would have **very peaceful environment** with all the sustainable technologies incorporated.
- Now at the present situation of **COVID-19**, these patients would require a hospice care for their peace before death.
- **HOSPICE – HOME + HOSPITAL**



2.5 SITE FEASIBILITY & FEATURES:



2.6 LAND-USE MAP:



2.7 STATISTICAL DATA:



Statistical data for land use

@ 2003 : No land is developed.
The site is full of vegetation
surrounded by a water body.



@ 2009 : The density of the
vegetation is gradually reducing
and becoming a vacant land .



@ 2011 :The land got vacant and
the surroundings started to get
developed. The density of the
greenery is reduced and the
roads towards the site is
accessed.



@ 2020 : A lots of residential
buildings were developed
surrounding the site. But the
waterbody remains the same as
in the site.

2.8 SOIL TYPE & NATURAL VEGETATION:

Soil Type – Red Laterite Soil :

- This Soil is good for the construction on the site.
- But not too many floors are recommended.
- Since It is going to be G+2 for the maximum in this design, sustainable construction is recommended.
- Test results showed that the addition of 40% clay in **lateritic soil** was the optimum for the production of **bricks** from **lateritic soil**.
- The addition of 30% sand in clay was optimum for the production of **bricks** from clay.

Native vegetation of Kerala:



Pteridophytes



Gymnosperms



Angiosperms



Bryophytes

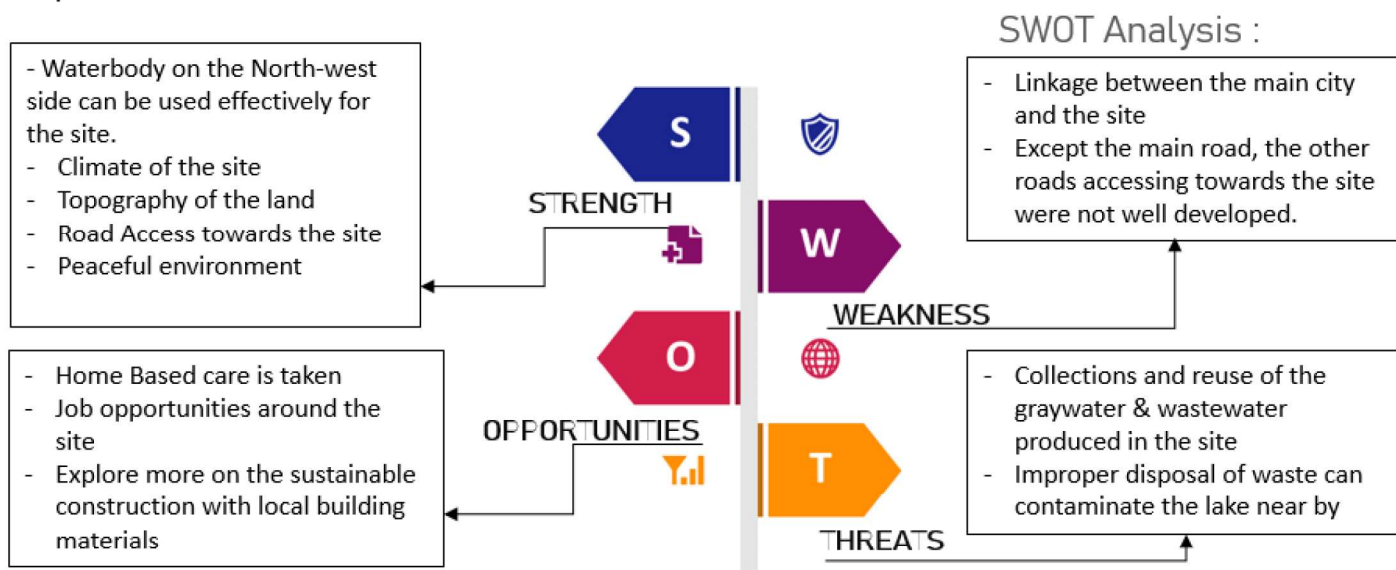


Lichens



Cloud Algae

2.9 SWOT ANALYSIS:



2.10 AREA REQUIREMENTS :

Hospital sites with high degree of sensitivity to outside noise should be avoided, but may be compatible with other considerations, such as, accessibility and availability of services. • The buildings should be so planned that sensitive areas, like, wards, consulting and treatment rooms and operation theatres are placed away from the outdoor source of noise. • While planning the hospital building, the importance of landscape elements, such as, open areas, horticulture to increase the comfort conditions within the recommendations contained in IS 7662 (Part 1), may be kept in view.

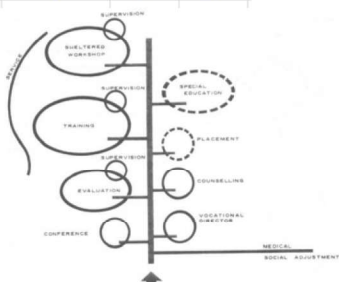
Block	S.No.	Spaces	No. s	/ room	Sq. m								
ADMIN	1	Reception	2	6	12	BACK SERVICES	1	Linen Storage	3	10.25	30.75		
	2	Waiting Lobby	2	10	20		2	Laundry Rooms	1	5.57	5.57		
	3	Common Toilets	6	47.75	286.5		3	Clothes Dry Area	1	23.45	23.45		
	4	Pooja Space	3	20	60		4	HVAC Services Area	2	16.84	33.68		
	5	CCTV Rooms	1	13	13		5	Medical Gas Storage Rooms	3	120.3	360.9		
	6	Locker Room	2	13	26		6	Generator Room	2	5.89	11.78		
	7	Server Rooms	4	13	52		7	House keeping Rooms	5	6.3	31.5		
	8	Volunteer Offices	5	5.5	27.5		8	Medicinal Storage	6	201.7	1210.2		
	9	Interview Rooms	5	8	40	PARKING	1	Car Parking	200	11.8	2360		
KITCHEN	1	Staff dining	1	119.4	119.4		2	Two-wheeler Parking	150	4	600		
	2	public Dining	2	350	700		3	Floating Parking	175	13.5	2362.5		
	3	Service Bay	1	500	500		4	Car Service Areas	3	53.41	160.23		
	4	Dry Storage	1	300	300		5	Entry / Exit	2	2.8	5.6		
	5	Wet Storage	1	200	200		6	Security Check	2	5	10		
	6	Wash Area (Private)	1	27.87	27.87		7	Security Rest rooms	2	13	26		
	7	Wash Area (Public)	1	14.68	14.68	RESIDENCES	1	Single - Bedded Private Rooms	15	12	180		
	8	Toilets	8	2.8	22.4		2	Double - bedded Private Rooms	25	6.8	170		
	9	Servants Restrooms	3	7.8	23.4		3	Four - Bedded Private Rooms	10	5	50		
	10	Pantry	1	5.4	5.4		4	Dormitory Block	25	2.5	62.5		
	11	Kitchen	1	8.45	8.45		5	Staff Accomodation	45	5	225		
	12	Beverage Area	1	82.35	82.35		6	Doctor's Accomodation	35	6.8	238		
	13	Servant's Rest Equipment Store	2	15.4	30.8		7	Nursing Stations	5	70.2	351		
							8	Family Overnight Accomodations	6	7.2	43.2		
							9	Common Toilets	10	47.5	475		
							10	Driver's Accomodation	50	4	200		
							11	Swimming Pools (Private / Public)	3	74.45	223.35		

SERVICES	1	Day Care Rooms	12	43.2	518.4	AMENITIES	1	Libraries	2	32.68	65.36	
	2	Cabin For Doctors	5	13	65		2	OAT	2	162.04	324.08	
	3	Hydrotherapy Pool	2	52.98	105.96		3	Indoor Play Area	1	232	232	
	4	Bath Assistance Room	2	50	100		4	Crafts Zone	2	126	252	
	5	Breavement Rooms	4	125	500		5	Outdoor Activity area	4	142.87	571.48	
	6	Multi-Purpose Hall	3	190	570		6	Local Grocery Shops	3	94.2	282.6	
	7	Conference Rooms	4	35	140		7	Pharmacies	5	167.2	836	
	8	Workshop Area	8	68	544	OPEN SPACES	1	Gardens (Hard/Soft)	20% of site area		6474.98	
	9	Student's Class Rooms	3	55.7	167.1		2	Gazebos				
	10	Seminar Auditoriums	1	190	190		3	Water Body				
	11	Spa Room	6	36.7	220.2		4	Day Lounge				
	12	Meditation Rooms	3	55	165		5	Restorative Landscapes Lawns				
	13	Sun Rooms	5	20	100	Total - Built up area excluding the open spaces (4.6 acres)						18926.3
	14	Physio- Therapy Rooms	12	41.8	501.6	Total Site Acres (8 acres)						32347.9
	15	Tub Rooms	4	20.48	81.92	As per Kerala Development Authority: Construction of 5000 sqm of site						
	16	Clinical Labs	6	56.6	339.6							
	17	Quiet Rooms	4	8	32							

Sources :

37.106.2311 : MINIMUM STANDARDS FOR A RESIDENTIAL HOSPICE FACILITY - Administrative Rules of the State of Kerala (ktrules.org)

- A **Residential Hospice** is a home like environment where adults and children with life - threatening illnesses receive end-of-life services.
- A **residential hospice** provides individuals who cannot be cared for at home with compassionate care and comfort in the last stages of their life.



As per Kerala Development Authority:

- Set backs: **5m** minimum on all sides
- Road width: **12 M**
- FAR: **2**
- Ground coverage: **40%**
- Parking : **1 car park for every 50 sq.m** of built-up area
- Height of the building: up to **12M**
- SITE AREA: **32347.9 SQ.M (8 ACRES)**
- MAX. Ground coverage: 40%
- Built-up area: **18926.3 (4.7 acres)**
- 35% min circulation area of built-up = 6624.5 SQ.M

•Hospitals shall make provisions for sufficient open space in and around the hospital building to facilitate the free movement of patients and emergency/fire vehicles. •These open spaces shall be kept free of obstructions and shall be motor able. •Adequate passage way & ramp; clearance for fire fighting vehicles to enter the hospital premises shall be provided. •The width of such entrances shall be not be less than 4.5 mtrs with clear head room not less than 5 mtrs. •The width of the access road shall be a minimum of 6 mtrs. •A turning radius of 9 mtrs shall be provided for fire tender movement. •The covering slab of storage/static water tank shall be able to withstand the total vehicular load of 45 tone equally divided as a four point load (if the slab forms a part of path/drive way). •The open space around the building shall not be used for parking and/or any other purpose. •The width of the main street on which the hospital building abuts shall

not be less than 12 mtrs, when one end of that street shall join another street, the street shall not be less than 12 mtr wide. •The roads shall not be terminated in dead ends

KMBR (Kerala Municipality Building Rules) :

National Highway, State Highway, District Roads, other roads notified under section 383A of the Kerala Municipality Act 1994, other un-notified roads with width 6 m and above	Other un-notified roads with width less than 6 m
3 m	2 m

Sl. No. Road Width (in metres) Splay / Offset (in metres)

- | | | |
|-----|-------------------|-----------|
| (1) | Less than 12 | 3 X 3 |
| (2) | Above 12 up to 21 | 4.5 X 4.5 |
| (3) | Above 21 | 6 X 6 |

HEIGHT :

- The maximum height of the building or part thereof shall not exceed twice the width of the street abutting the plot plus twice the width of the yard from the building to the abutting street;
- If a building plot abuts on two or more streets of different width, the building plot shall be deemed to abut the street that has the greater width for the purposes of this rule and the height of the building shall be regulated by the width of that street and shall be continued at this height along the narrower street.

PROJECTIONS PERMISSIBLE

Sl.No.	Mandatory open space/yard as per these rules.	Width of projection permissible
1	below 0.60 metres	No projection
2	0.60metres or more but below 1 metre	0.30 metres
3	1metre or more but below 1.50 metres	0.60 metres
4	1.5metres and above	0.75 metres

- Medical or Hospital Building shall include any building or part thereof, exceeding 200 sq. meters of built up area which is used for purposes such as medical or other treatment or care of persons suffering from physical or mental illness, disease or infirmity, care of infants, hospitals, sanatoria, clinics, homes for the infirm, convalescent homes, mental hospitals etc, are included in this group.

YARDS FOR BUILDINGS UNDER DIFFERENT OCCUPANCIES

PARTS FOR BUILDINGS UNDER DIFFERENT OCCUPANCIES											
Yards	Buildings in Group A1 & A2 of any built-up area and Buildings in Group F with built up area not exceeding 200sq.metres	Buildings in Small plots under Group A1 and F (built up area not exceeding 200 sq. metres and plot area not exceeding 125 sq. metres)	Buildings in Group B, C & D of built-up area exceeding 200 sq. metres		Group E & F built up area exceeding 200 sq. metres	Group G1 built up area upto 200 sq. metres	Buildings in Group G1 of built up area exceeding 200 sq. metres	Group G2	Buildings in Group H of built up area exceeding 200 sq. metres	Group I	Group J
			200 – 500 sq. metres	Above 500 sq. metres							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Front(in metre)	3	2	5	7.5	3	3	3	7.5	6	7.5	10
Rear (in metre)	1.5	1	2	3	1.5	2	3	5	3	7.5	5
Sides(in metre)	1	0.6	2	3 and 5	1	2	3	3	2	7.5	5

Provided that for single family residential buildings the front yard of plots abutting un-notified roads with less than 6 m , shall not be less than 2 m.

Basic Space requirements required for a Hospice Care :

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> Restorative Landscapes Meditation Rooms Worship area Lobby Spaces Reception Admin Block Common Toilets Nursing Stations Back Services Residential Areas Clinic Dining Spaces Staff Breakrooms Gazebo Day Care Healing Gardens Multi Purpose Hall Water Body Patient's Room Family Overnight Accomodation Kitchen Medication Room Pantry Day Lounge Out Patient's Waiting Spaces Cabins for Doctors | <ul style="list-style-type: none"> Parking Office spaces Hydrotherapy Alcoves Conference Rooms Quiet Rooms Trellis Support services Clinical Labs Library Linen Storage Medicinal Storage Sunroom Volunteer Office Terrace Gardens Local Grocery Shops Tub Room Play Area Craft Room Indoor Games Room Physio Therapy Rooms Spa Room Rest Rooms Locker Rooms Security Check Security Rooms Driver's Residences | <ul style="list-style-type: none"> Laundry Services Workshop Area Student's Classrooms Interview Rooms Conference Rooms House – Keeping Medical Gas Storage Visitor Rooms Seminar Auditoriums OAT Greenscapes (Hard/soft) Server Rooms CCTV Rooms Staff Bedrooms Study Rooms Bereavement room Generator Room Preparation Room Hydrotherapy Pool Swimming Pools (Private / Public) Servant's Rest Area Equipment Store HVAC Service areas Beverages Area Bath Assistance Room (Private / Public) |
|---|--|--|

MAJOR DIVISIONS

ADMINISTRATION

KITCHEN

OPEN GREEN SPACES

SERVICES

BACK OFFICES

CLINIC

SECURITY ROOMS

THERAPY ROOMS

REST ROOMS

ACCOMODATION

WORKSHOP AREA

The maximum height of the building or part thereof shall not exceed twice the width of the street abutting the plot plus twice the width of the yard from the building to the abutting street; • If a building plot abuts on two or more streets of different width, the building plot shall be deemed to abut the street that has the

greater width for the purposes of this rule and the height of the building shall be regulated by the width of that street and shall be continued at this height along the narrower street.

CHAPTER 3

LITERATURE CASE STUDIES

3.1 LITERATURE STUDY 1:



Indian Literature Case study – 1

KARUNASHRAYA, Bangalore

Location : Marathahali, Bangalore
 Typology : Hospice Care
 Major Influencing Factor : **Space Planning**
 Total Site (in acres) : **7**
 Climate : Moderate Climate

Project Description:

- Architect : **Ar. Sanjay Mohe**
- Location : Marathahalli, Bangalore
- Plot Area : **8200 sq. m**
- Total built-up area : 3400 sq.m
- Climate : Moderate climate
- Topography : Flat Land
- FAR : 0.416
- Nearby buildings : Ashitha Hospital, Shankar Eye Hospital
- Total landscape & open areas : **30% of the total site**

About the Project:

Karunashranya meaning – “**Adobe of Compassion**”, a non-profitable organization. This organization offers patients the flexibility of alternating between **hospice care and their home care**.

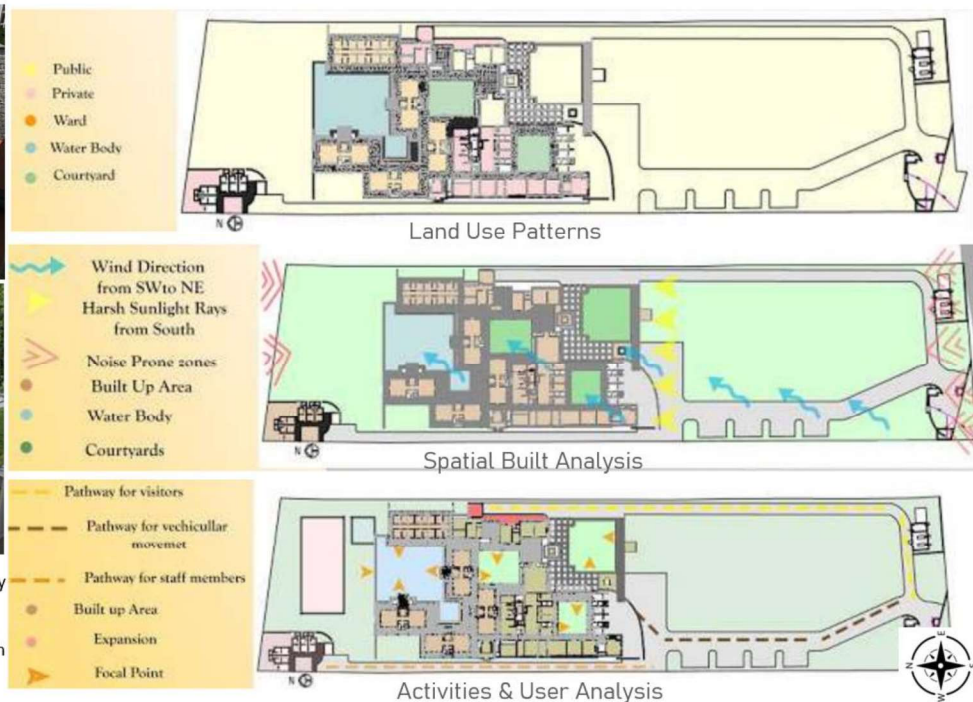
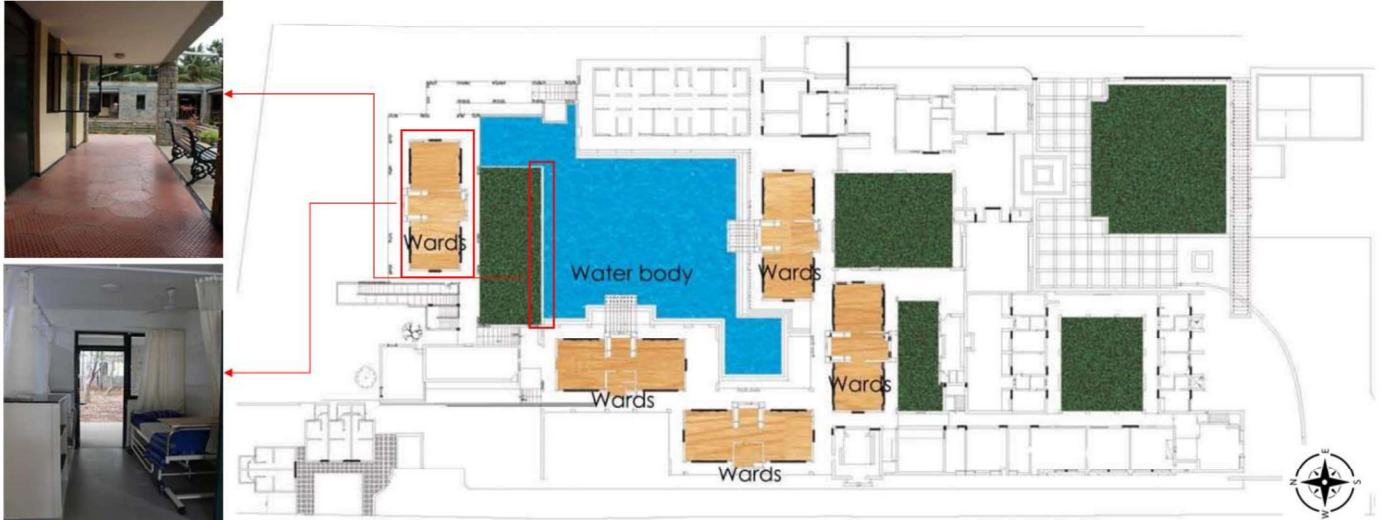


Site Planning:

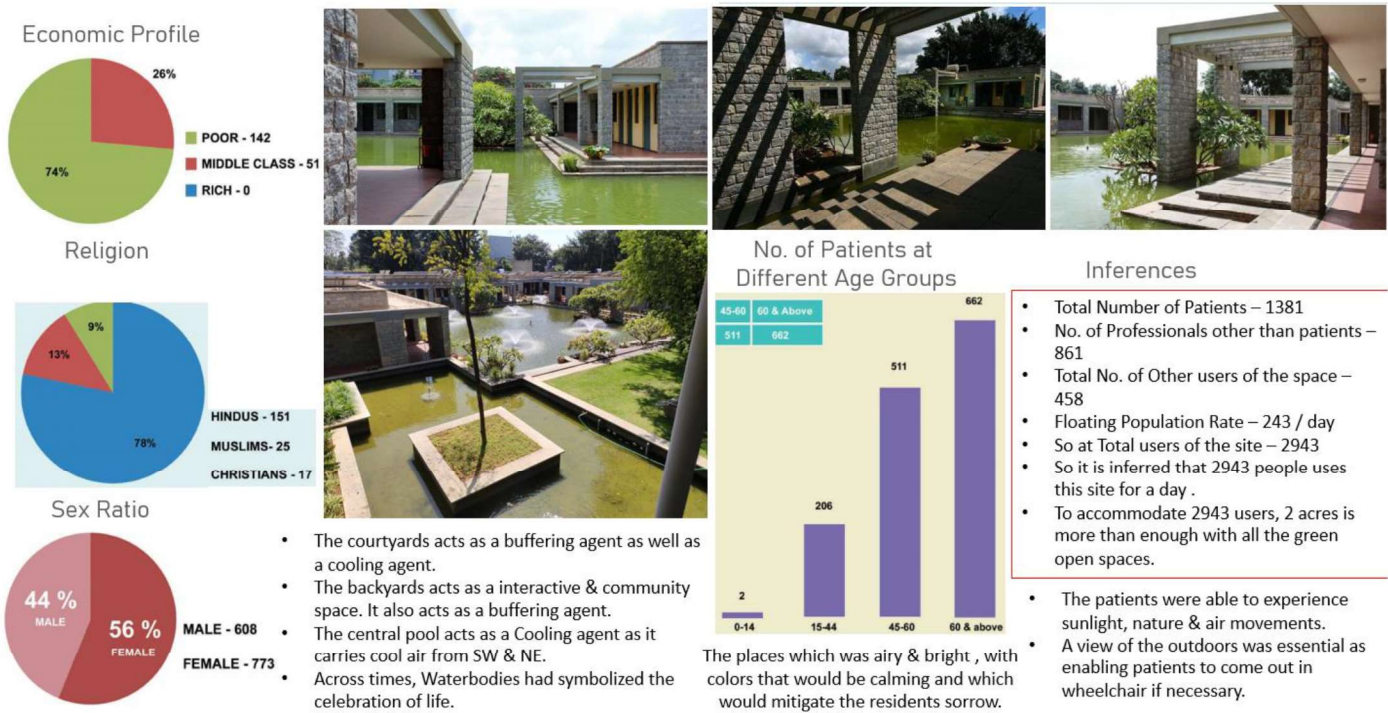
- Clustered organizations relies on physical proximity to relate its spaces to each other.
- Often consists of repetitive, cellular spaces having similar functions & share a common visual triat such a shape and orientation.
- Karunashranya as a 5 wards & each ward as 12 beds Each and either each ward having the common washroom.
- Each ward focusses the waterbody which is at the North – east Corner of the site .

Study of open Spaces:

- Open Spaces are merged with the whole composition.
- Activities surrounding focused with the open spaces in between with the waterbody and the courtyards.
- Open spaces are providing experience of a pleasant stay , mental & physical relief to the user and also a place for gathering.
- Use of courtyard in design to aid the ventilation of the internal spaces . To create the meeting places for interaction.
- The design makes the extensive use of landscape elements such as a fountain, pond, rockeries & statuary greenery & pavers to the facility is shrouded with heavily shaded trees to the right of entrance.



- There were 55 beds provided earlier, but recently due to the expansion here are 75 beds.
- Prayer Room is placed at the center so that both entry & exit of the patient can be passed through it.
- The entrance provides a funnel effect.



3.2 LITERATURE STUDY -2 :

Indian Literature Case study – 2

BENZIGER HOSPICE HOME

Location : Trivandrum, Kerala
 Typology : Hospice Care
 Major Influencing Factor : **Climate, Local Building Materials**
 Total Site (in acres) : **2**
 Climate : Warm _ Humid Climate

Design Challenge :

- Thiruvananthapuram-based architect **Srijit Srinivas** had **two major challenges** ahead of himself when he was commissioned the project for building a rest house for underprivileged cancer patients.
- Firstly, it should not reflect the eeriness of the disease.
- Secondly, it should be comfortable enough to make the inmates forget that they are struggling.
- The young architect spent many fortnights thinking up a plan, finally **materializing** his concept with **meticulous detailing**.
- Fortunately, his efforts didn't go to waste.
- The Benziger Hospice Home, an **elegant brick structure** situated at Edapazhanji in the city, is far from being a **sick home**.

Area – 1636 sq.m
Year of completion - 2020

The design remit was to deliver a place of **temporary stay for cancer patients** which sensitively addresses their special needs and emotional vulnerabilities.

The location in a crowded semi-urban setting, called for **adequate privacy measures** to screen neighboring residents' views.



The external façade utilizes a double-slanted louvered brickwork feature wall covering the Recreation Rooms across two floors and cantilevering over the ground floor, whilst poignantly showcasing the architectural possibilities of the humble brick.

The 'Benziger Hospice Home' project in the South Indian city of Trivandrum with the vision of providing **free accommodation for cancer patients** visiting local hospitals.

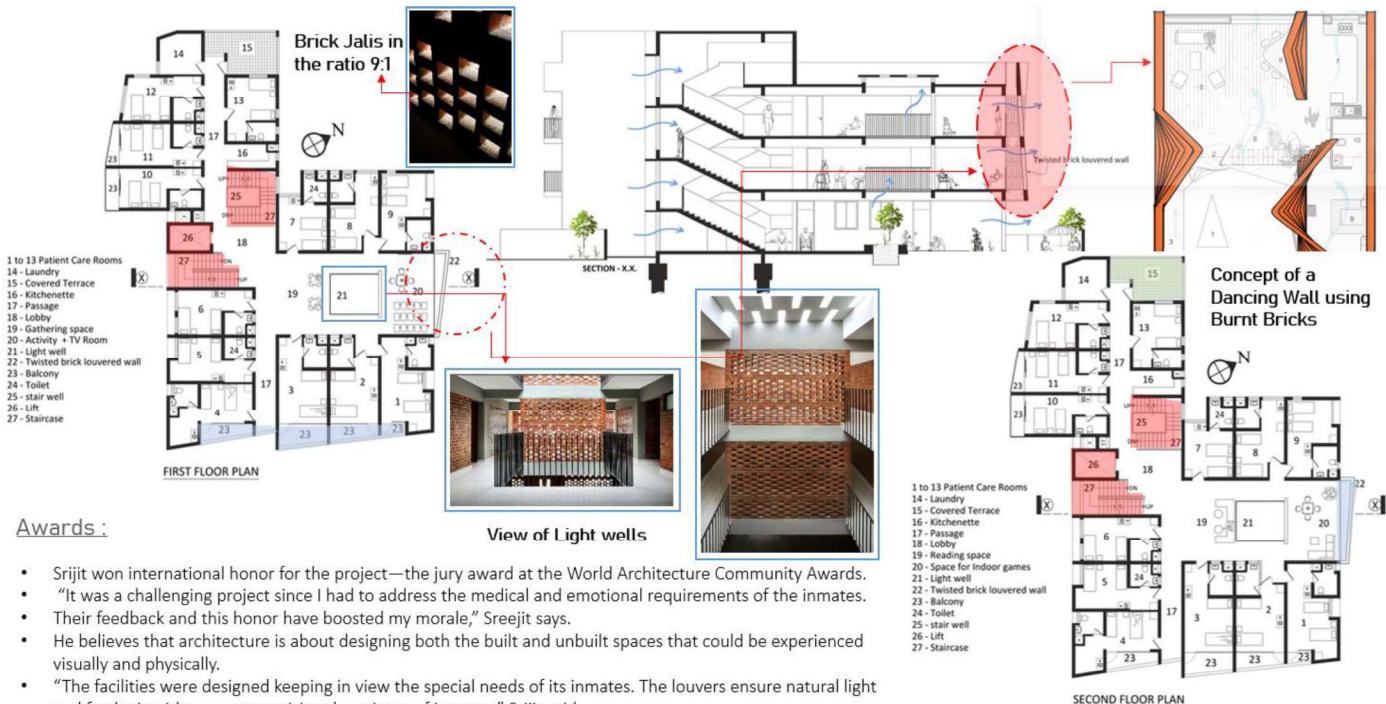
The project's original brief was for five floors, which was reduced to **three storeys** encompassing **26 Patient Suites** during project development.



Views and Vistas

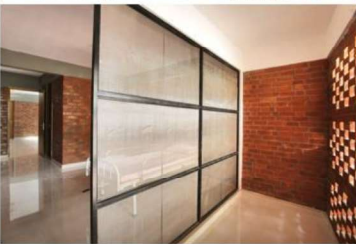
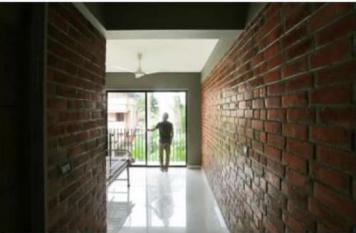


GROUND FLOOR PLAN



Awards :

- Srijit won international honor for the project—the jury award at the World Architecture Community Awards.
- "It was a challenging project since I had to address the medical and emotional requirements of the inmates.
- Their feedback and this honor have boosted my morale," Sreejit says.
- He believes that architecture is about designing both the built and unbuilt spaces that could be experienced visually and physically.
- "The facilities were designed keeping in view the special needs of its inmates. The louvers ensure natural light and fresh air without compromising the privacy of inmates," Srijit said.



Site Planning :

- The site was **oddly shaped** – with a square front portion markedly tapering to the rear with an offshoot to the left housing an existing building earmarked for future demolition.
- An Ambulance entry was provided from the front main gate leading up to the entry ramp, which was girded by a **veranda with inbuilt brick seating** integrated with trough planters containing **high oxygenating plants**.
- The **Service Gate to northern side** allowed supply path to the kitchen plus maintenance access to the **Plant room**.
- The **Ground Floor lobby** opens to an enclosed **northerly landscaped area** for **patients' relaxation**.
- The Lobby with its cool, soothing **micro-climate** effected by its landscaped central courtyard - replete with brick seating and **louvered screen walls** permitting horizontal and **vertical cross ventilation**, also facilitates visual lines of sight across the cross-sections of two floors above along with the attendant emotional connectivity for the residents.
- The **natural texture and color of brick**, enhanced by the deliberate proportioning of spaces, and accentuated by the interplay of **light and shadows (through brick louvers)**, endows the Lobby area with a sense of **warmth and calmness**, which is simultaneously welcoming and cathartic for patients.
- A common congregation space has been provided on every floor, along with an Activity Room and a Recreation (or TV) room.

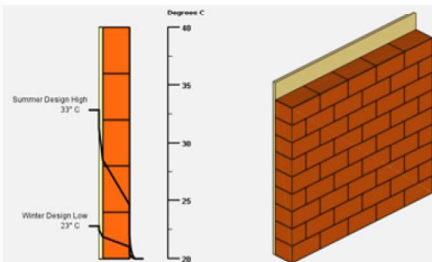
Burnt Bricks		Concrete Wall		Hollow Blocks	
Area	1636	Area	1636	Area	1636
U-value	0.31	U-value	0.61	U-value	0.39
Temp. Diff.	5	Temp. Diff.	5	Temp. Diff.	5
Heat gain	2535.8	Heat gain	4989.8	Heat gain	3190.2

Burnt Bricks		Concrete Wall		Hollow Blocks	
Area (a)	1636	Area (a)	1636	Area (a)	1636
k-value (b)	0.64	k-value (b)	0.6	k-value (b)	0.56
Temp. Diff. (c)	5	Temp. Diff. (c)	5	Temp. Diff. (c)	5
a x b x c	5235.2	a x b x c	4908	a x b x c	4580.8
thickness (d)	9	thickness (d)	9	thickness (d)	8
Heat loss	581.69	Heat loss	545.33	Heat loss	572.60

Comparison for the Local building materials of Kerala :

While comparing the building materials the manual calculation proves that Burnt Bricks receives **less heat gain and high heat loss**.

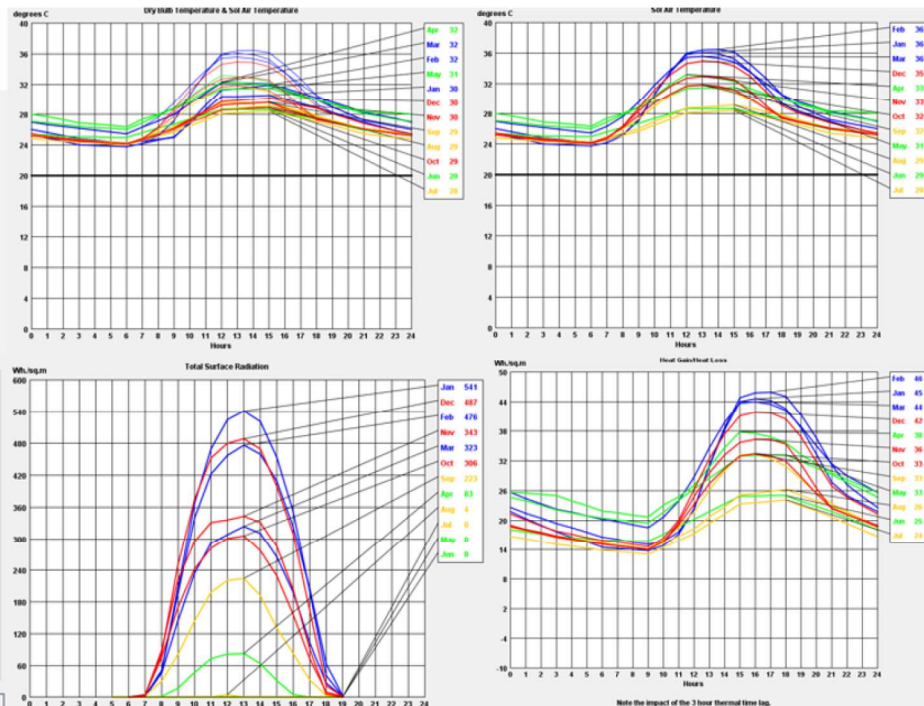
Simulations : Local Building Materials: (Burnt Brick)



Wall Section Properties

Orientation (Degrees from South):	0.0
Tilt (Degrees from Horizontal):	90.0
Surface Absorptivity (%):	26.0
Ground Reflectance (%):	20.0
Total Thickness (mm):	101.6
Total R Value:	0.33
Total U Value:	3.026
Decrement Factor:	0.83
Time Lag:	-2.82

Material	mm	R ...
Inside Air Film (wall)	0.0	0.12
Brick	88.9	0.1
Plaster (light weight)	12.7	0.07
Outside Air Film	0.0	0.04



Inferences :

- Apart from all the contemporary materials used in Kerala, Burnt bricks seems to be the most sustainable building materials which is concluded through manual calculations .
- The time lag for Burnt Brick is 3 hrs.

SOFTWARES INVOLVED : OPAQUE

Simulations :
Local Building Materials: (Burnt Brick)

Thermal Properties of Individual Layers					
	Material Name	Conductivity (W/m-k)	Specific Heat (MJ/m³K)	Density (kg/m³)	Sample Source
Layer 1	Brick - Kiln Fired Country	0.59	0.27	1660	
Surface Heat Transfer Coefficient Calculations					
Calculation Method	State	City	Internal Surface Resistance (m²-k/w)	External Surface Resistance (m²-k/w)	
Static	All	All	0.13	0.04	
Dynamic	Kerala	Trivandram	0.14	0.06	
Thermal Properties of Assemblies					
Assembly	Surf Heat Trans Coeff Calc Method	Surface to Surface U-factor (w/m²-k)	Overall U-factor (w/m²-k)		
Layers 1	Static	2.5	1.8		
Layers 1	Dynamic	2.5	1.7		

SOFTWARES INVOLVED : CARBSE

3.3 LITERATURE STUDY – 3:



International Literature Case study – 3

Ulaman Retreat

Location : Bali, Indonesia.
Typology : Hospice Care
Major Influencing Factor : **Climate,**
Local Building Materials
Total Site (in acres) : **4**
Climate : Warm _ Humid Climate

Ulaman Retreat / Inspiral Architecture and Design Studios :

Location : Bali, Indonesia

Area: 980 m²

Year: 2020

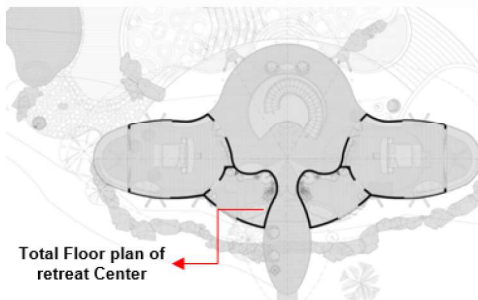


Retreat Center as a Sustainable Environment :

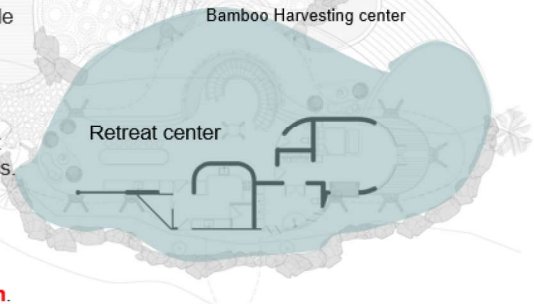
- Located inland in Bali, this wellness retreat has been integrated into a forest that borders luscious rice fields on one side and a dramatic river on the other.
- The river converges water from the whole area creating a junction of small waterfalls that produces enough flow to power a **hydro electric generator** that can sustain the power of the buildings within the complex.
- Merging with nature has been at the forefront in the approach to the design, not just by its operation but by using materials found directly on the site and the immediate locality, therefore enabling the resort to become fully **carbon zero**.

Levels of Retreat Center:

- The first instigation of this can be seen in the dramatic use of **rammed earth for all ground level walls**.
- Being located on a hill required significant ground works, therefore with much excess soil, creating these significant mass of **curved walls** was easily justified.
- Along with being able to connect the occupant to the beauty of **rammed earth** with its physicality and layered coloring, it also maintains **superior insulation** and structural properties.
- Being very intensive to build we were able to recruit the nearby village to work on what has become the most substantial **rammed earth project** in Indonesia.



- The rest of the structure has been made with **bamboo**, much of which was harvested from the site.
- Not only is this fast growing material **incredibly sustainable**, its flexibility means were able to create spaces that echo the abundance of life in the tropics.
- Built objects have been created which seek to biologically morph from the surrounding elements, **in effect growing from the ground and sprouting among the rich vegetation**.

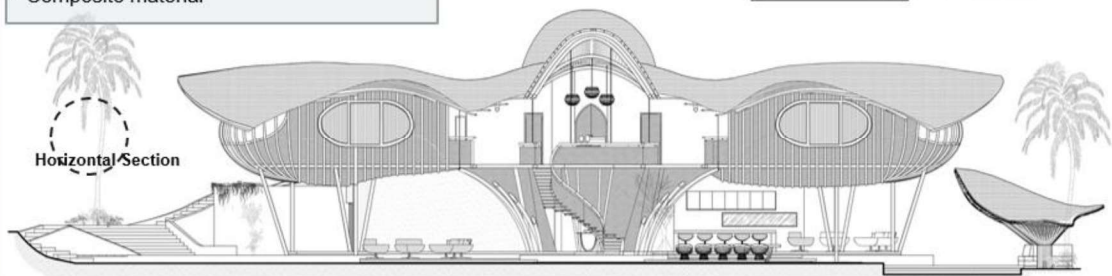
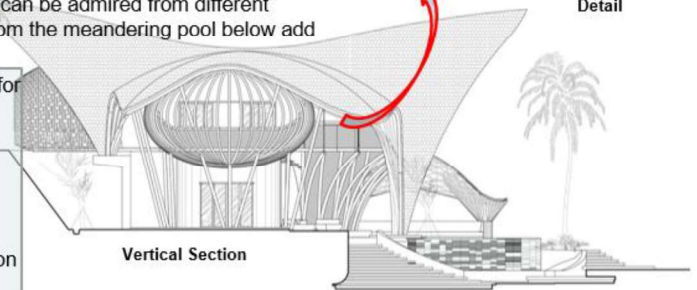


Spaces of Retreat Center:

- One such building is the yoga studio which literally floats from the cliff's edge with a cantilevered structure supporting a **parabolic bamboo pavilion**.
- The rooms themselves provide the **eco luxury** that is required for this up market project, with a feeling that is nurturing and in some feature bedrooms, almost cocoon like.
- The **guest villas** too look towards a unique design, yet with the common denominator of **bamboo architecture** and the warming tones of rammed earth that make up the resort.
- The **curvilinear formations of the roofs** can be admired from different heights and angles while the reflections from the meandering pool below add to the effect.

Bamboo is **low weight material** to be used for construction.

- It can be **transported and worked** easily.
- The use of cranes is mostly unnecessary.
- It is a very **flexible** plant.
- Grows back very rapidly once harvested.
- Bamboo has a higher tensile strength.
- Usage of **bamboos** will reduce deforestation
- Composite material

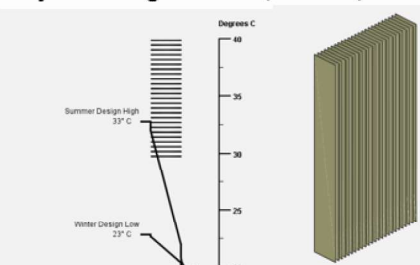


Simulations

Local Building Material - Bamboo:

Thermal Properties of Individual Layers					
	Material Name	Conductivity (W/m-k)	Specific Heat (MJ/m³K)	Density (kg/m³)	Sample Source
Layer 1	Bamboo	0.2	0.64	913	
Surface Heat Transfer Coefficient Calculations					
Calculation Method	State	City	Internal Surface Resistance (m²-k/w)	External Surface Resistance (m²-k/w)	
Static	All	All	0.13	0.04	
Dynamic			0.14	0.06	
Thermal Properties of Assemblies					
Assembly	Surf Heat Trans Coeff Calc Method	Surface to Surface U-factor (w/m²-k)		Overall U-factor (w/m²-k)	
Layers 1	Static	2		1.5	
Layers 1	Dynamic	2		1.4	

Simulations : Major Building Materials (Bamboo)

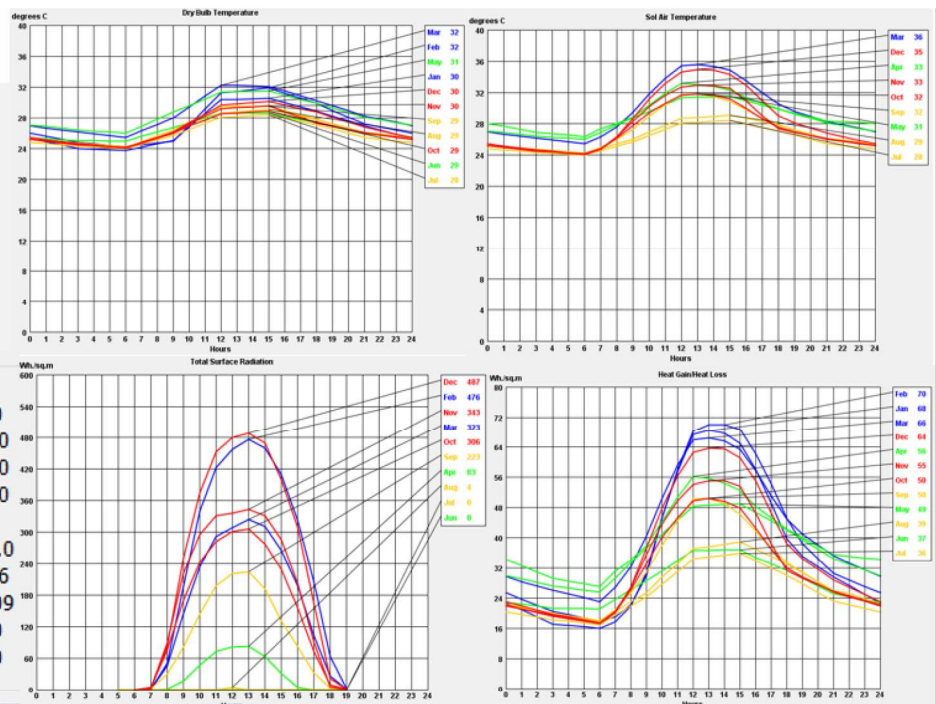


Wall Section Properties

Orientation (Degrees from South): 0.0
Tilt (Degrees from Horizontal): 90.0
Surface Absorptivity (%): 26.0
Ground Reflectance (%): 20.0

Total Thickness (mm): 100.0
Total R Value: 0.76
Total U Value: 1.309
Decrement Factor: 1.0
Time Lag: 0.0

Material	mm	R ...
Inside Air Film (wall)	0.0	0.12
Bamboo	100.0	0.6
Outside Air Film	0.0	0.04



Inferences :

- Apart from all the vernacular materials used, Bamboo seems to be the most sustainable building materials next to mud blocks which is concluded through manual calculations .
- The time lag for Bamboo Wall is 2 hrs.

SOFTWARES INVOLVED : OPAQUE

CHAPTER 4

SPECIAL STUDIES

4.1 TERMINOLOGIES RELATED TO HOSPICE CARE :

CLINIC :

- An establishment or hospital department where outpatients are given medical treatment or advice, especially of a specialist nature.
- It means a conference or **short course** on a particular subject.
- **Clinics** are seen to be “taking the service to the patient”, instead of making patients come to the service.
- The work that the doctor does at the **clinic** ensures continuity of care for the patients.
- A **clinic** is a building where people go to **receive medical advice** or treatment.

HOSPITAL:

- **Clinics** typically provide non-emergency outpatient care that's routine or preventive.
- Although **hospitals** can also provide outpatient services, they focus more on providing inpatient care.
- You'll typically go to a **hospital** for specialist care, surgery, or for more serious, life-threatening conditions.
- It is said to be an institution providing medical and surgical treatment and nursing care for sick or injured people.
- There are different kinds of **hospitals**, general and specialized.

PALLIATIVE CARE :

- Anyone with the serious illness would be treated with the palliative care.
- This can be **cured completely** if possible.
- The time taken for the care depends upon the patient's need.
- The patients can **continue the treatments** and take medications once he/she is discharged from the hospital.
- No need of a home care in spite of it is specially required.

- It can be a **typical Hospital** and functions as the same.
- Not necessary for the residential buildings for caring.
- It may have **rooms for floating population** of patients.

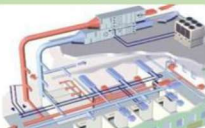
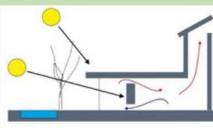
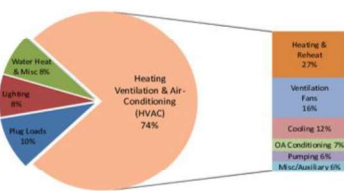
HEALING ARCHITECTURE:

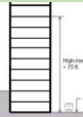
- **Healing architecture** for healthcare facilities describes a physical setting that supports patients and families through the stresses that develop as a result of illness, hospitalization, medical visits, the **healing** process or bereavement.
- The operational **definition** that emerged from the **concept** analysis: **Healing** is a holistic, transformative process of repair and recovery in mind, body, and spirit resulting in positive change, finding **meaning**, and movement toward self-realization of wholeness, regardless of the presence or absence of disease.

HOSPICE:

- Hospice is an approach to care, so it is **not tied to a specific place**.
- Anyone with a serious illness whom doctors think has only a short time to live, often less than **6 months**.
- It can be offered in two types of settings—at **home** or in a facility such as a nursing home, hospital, or even in a **separate hospice** center.
- Everyone **works together** with the person who is dying, the caregiver, and/or the family to provide the medical, emotional, and spiritual support needed.

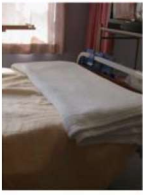
4.2 DIFFERENCES BETWEEN HOSPICE / HOSPITALS :

S.No.	PARAMETERS & its Applications	HOSPITAL	HOSPICE CARE
1	Definition	A hospital is an institution providing medical and surgical treatment and nursing care for sick or injured people.	Hospice care is a type of health care that focuses on the palliation of a terminally ill patient's pain and symptoms and attending to their emotional and spiritual needs at the end of life .
2	Understanding the spaces with respect to Daylighting	 Mostly, Daylighting is not concentrated in hospitals. Artificial Lighting plays a major roles instead of natural Lighting. Less amount of windows were given functionally when compared to hospice care .	All the patients rooms were exposed to a lot of outdoor and green spaces which prioritizes comfort and quality of life by reducing pain and suffering. 
3	Understanding the spaces with respect to Ventilation	Minimal Maintenance related to ventilation. HVAC systems are concentrated more. All the rooms would be air – conditioned. 	 Natural Ventilation plays an important role with window – wall ratio as a major aspect.
4	Energy & water Savings	 Since it is functionally designed , the major concentration of the spaces would be related to spaces not the systems.	Since all the spaces in this building were mainly related to the health of the occupants , the whole structure is designed to be more sustainable with recycled materials in addition to energy and water savings . 

S.No.	PARAMETERS	HOSPITAL	HOSPICE CARE
5	Conserving Natural Resources	Not every spaces in the hospitals were connected to open green spaces . Since it is a multi level building, the upper floor occupants could not access these open green spaces	Open green spaces are the most attracting element. So all these spaces are given facing the wards for mind relaxation.
	1. Courtyards		
	2. Effect of Water Element in site	 The biggest challenge is the water element in the site. In most of the hospitals all the waste were collected and poured into the water and pollute it.	Since the scale is low when compared to hospitals, the waste water can be used in an effective way in the site. 
	3. Building Materials	 The building materials would be used for the construction in terms of Structural Ability	The textures of each and every materials plays an important role 
6	4. Effective Waste Recycling	All the Bio- medical waste are collected and not treated in a proper way in hospitals because they were considered to be in a larger scale.	All the Bio- medical waste can be collected and treated in a proper way in hospitals because they were considered to be in a smaller scale.
	Height of the building	 The heights of the building would be very high because the vertical movement of the occupants are very high in all the spaces . The flow of occupants is also at higher rate.	The heights of the building would be very low because the vertical movement of the occupants are very less in all the spaces 
7	Aesthetical Appeal	The interior elements would be very heavy attracting the people with the extensive use of colors and finishes. 	The natural materials are more concentrated for all the aesthetical appeal because it connects the people towards environment 

4.3 COLOUR THEORY :

1. Color theory:



Staff that were interviewed wanted more colorful bed linen. It would make wards more interesting for both patients and staff relieving monotony.



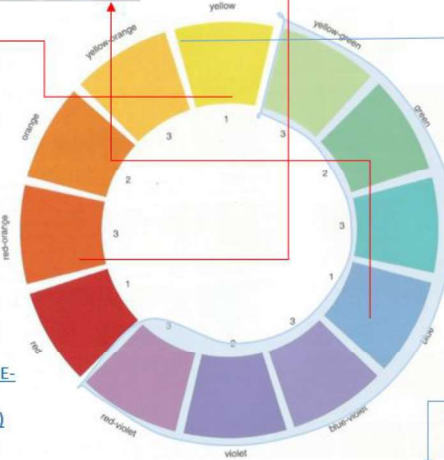
A clever use of color is to keep most of a patient's room cool or neutral and then use something bold behind the patient's bed. "If someone is coming to visit, they'll walk in the room and have the sense of something a little more colorful instead of neutral color walls."



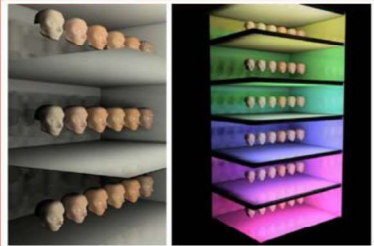
Strong colors for coding or zoning may look successful on paper but are not so easy to implement without confusing users..



Purple on yellow signify radiation hazards like radioactive materials, and containers, burial grounds, and storage areas for radioactive materials.



They are said to be the warm colors . So it is preferred to be used in the common spaces in which the patients would not spend more time.



The wide range of patients and pigmentation is certainly a challenge to find the 'ideal' colored background for Spaces . Neutral grey is ideal for observation and assessment but not a very appealing interior color.

SOURCES:

1. [THE-ROLE-OF-COLOURS-IN-THE-HEALTH-AND-WELLBEING-OF-THE-BUILT-ENVIRONMENT-IN-THE-TROPICS.pdf](#) (idpublications.org)
2. [The-Application-of-Colour-in-Healthcare-Settings.pdf](#) (ads.org.uk)
3. [How Architecture Affects Your Emotions | Designblendz](#)
4. [Color Psychology: The Psychological Effects of Colors](#) (arttherapyblog.com)

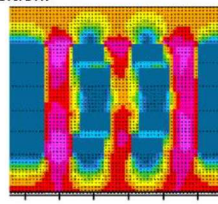
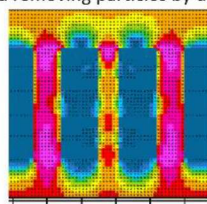
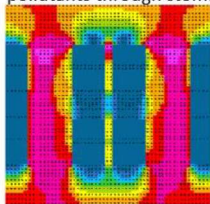
They are said to be the cool colors . So it is preferred to be used in the bed spaces in which the patients would spend more time.

4.4 OPEN SPACES :

2. HUMAN BEHAVIOUR IN CLOSED SPACES VERSUS OPEN SPACES :



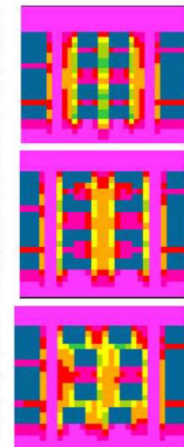
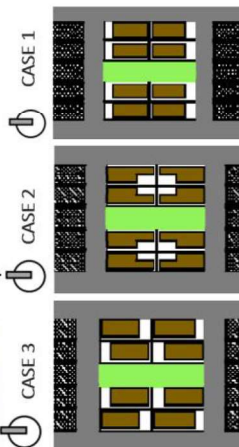
Urban vegetation has positive effects on mitigating high local temperature through shading and evapotranspiration as well as on wind flow blocking during cold windy days. It removes pollutants more efficiently than artificial surface, absorbing gaseous pollutants through stomata and removing particles by deposition.



Wind speed Analysis :

In 1 (Front yard), the wind speed in the park was highly disrupted as there is no passage way between the buildings. There was insufficient air flow (under 0.35 m/s) in the area which created an uncomfortable situation. It is seen in Case 3 that wind speed has much increased with the staggering of buildings.

Impact on park area by adjacent building geometry:



Temperature analysis : Simulations show the result at 03:00 a.m. on 15April, 2015

In Case 1 (Front yard), it is observed that the cooling effect of the park was enhanced by the availability of more green open spaces . In Case 3 (Staggering of buildings), a lower temperature is observed at the park area than at the street level.

Several studies have shown that ENVI-met is able to simulate both spatial and temporal temperature and wind speed for the evaluation of microclimate in both simple and complex urban areas

SOURCES:

1. [A Simulation-Study-on-Urban-Open-Spaces-of-Dhaka-Bangladesh.pdf](#) (researchgate.net)
2. [Urban Open Spaces - Google Books](#)

4.5 SCIENCE WITH SUSTAINABILITY:

3. SCIENCE WITH SUSTAINABILITY :

HORTICULTURAL THERAPY IDEAS IN PAVEMENTS – REFLEXOLOGY PATH :

Creates a deep layer of different colored pea gravel for visual and sensory enjoyment

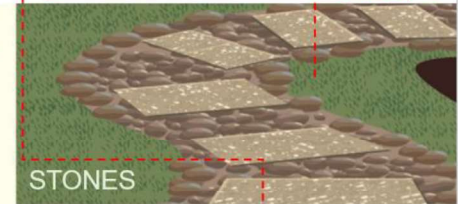
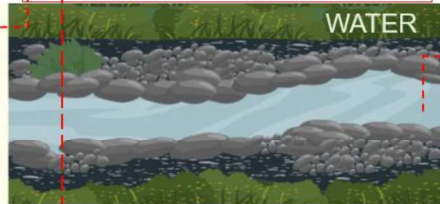
Absorbs a large amount of water and can be used for the overall site

Making a plank path by laying logs horizontally with a vertical log to create balance

Added stream or Fountain, pond, or small pool as a retreat for barefoot

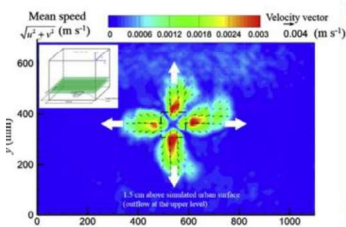
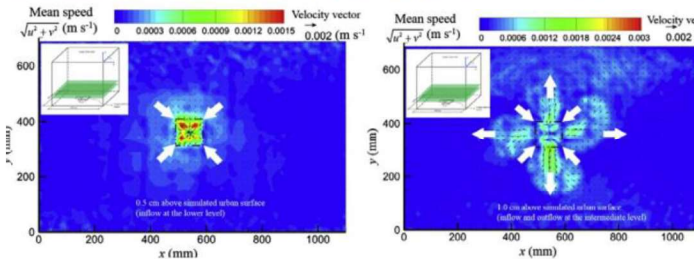
Placed in Sunny area to collect sun's Heat

Edge paths with logs , wood, stone, or upcycled materials



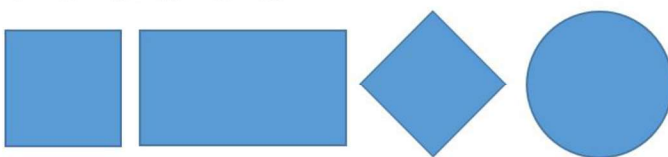
4.6 BUILT – FORMS WITH SUSTAINABILITY :

4. SCIENCE BEHIND CIRCULAR SHAPES IN RELATION WITH SUSTAINABILITY:

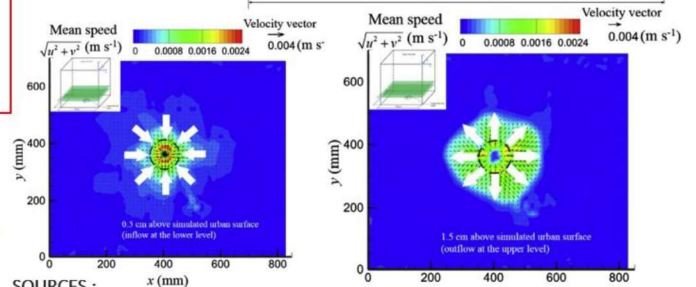
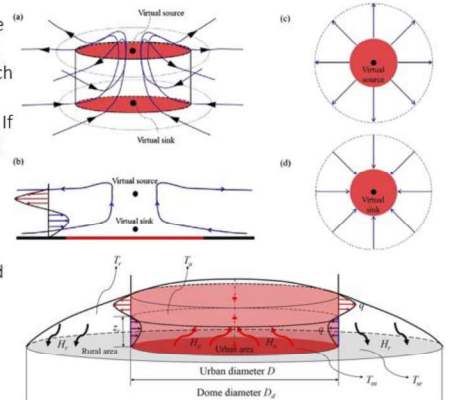


Advantages :

- Less Expensive
- Energy Efficiency
- Earthquake and wind Resistance
- Less Expensive
- Intangible Qualities
- Better Acoustics



A circular forms are the most efficient shape at holding something (such as air) with the least amount of energy lost. If one side of the inflated object were expanding more than the other, more energy would be exerted unevenly on that one side. Rounded shapes occur in nature all of the time because the dome shape provides strength.



SOURCES :

Non-uniform ground-level wind patterns in a heat dome over a uniformly heated down-

4.7 PATIENT TYPOLOGY:

WHO NEED TO ACCESS A HOSPICE RETREAT?

- heart failure,
- chronic lung problems,
- kidney disease,
- stroke,
- AIDS,
- neurological conditions like Parkinson's disease, the last stages of Alzheimer's and similar conditions, and other serious, terminal illnesses.

Cancer .

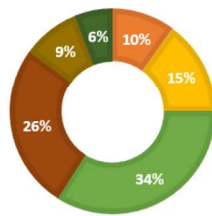
IS CANCER CONTIGENEOUS?

- Cancer is not a contagious disease that easily spreads from person to person.
- The only situation in which cancer can spread from one person to another is in the case of organ or tissue transplantation.

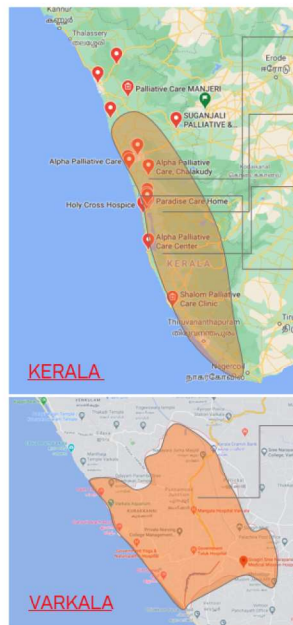
HUMAN PARTS AFFECTED BY CANCER:

CANCER RATE (%)

- Breast
- Lung
- Brain
- Throat
- Stomach
- Uterus



WHY THIS DESIGN CONCENTRATES ON CANCER PATIENTS EXCLUSIVELY?



Alpha Palliative Care
(1 acre)

Major concentration
of **Physiotherapy Treatments**

Paradise Care Home
(0.9 acre)

Major concentration of **Old age problems & Skin diseases**

Holly Cross Hospice Care
(0.5 acre)

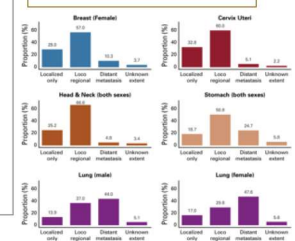
Major concentration
of **AIDS & Cancer Patients**

Shalom Palliative Care Clinic
(1.5 acre)

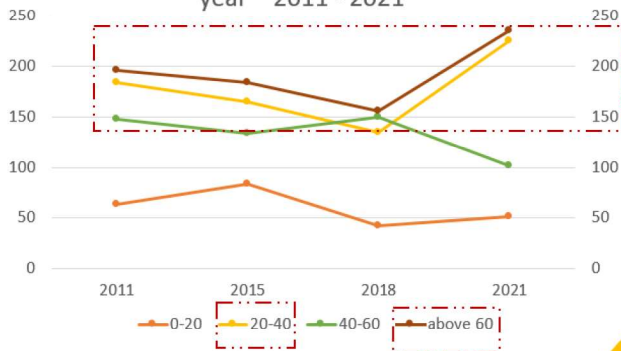
Major concentration
of **Palliative treatments**

There are only 3 Hospitals in Kerala . But Hospice is not concentrated in Kerala . So, at Varkala there is a place called " Global Ayurvedic Village " of 65 acres facing " Varkala-Hariharapuram Lake - Kedakulam ". Kerala Infrastructure Department join hands to develop a Hospice care at this place.

Proposal for exclusively Cancer Patients



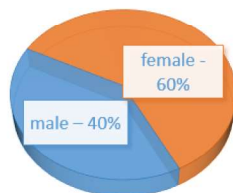
Age Groups affected by Cancer from the year – 2011 - 2021



SEPERATION OF NUMBER OF BEDS AS PER AGE GROUPS WITH THE REFERENCE OF THE BAR CHARTS & PIE CHARTS:

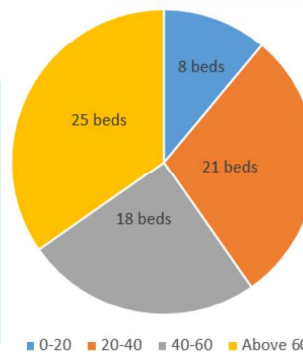
- Total Number of Patients – 72 BEDS (as per the kerala govt. proposal)
- ASSUMPTION with the reference of literature case studies :**
- No. of Professionals other than patients – 26-30
- Doctor's Accommodation – 20 villas/ flats
- Total No. of Other users of the space (which includes house keeping also) – 150
- Visitor's Population / day – app. 50
- Floating Population Rate – 250 / day**
- So at Total users of the site – 400 people
- So it is inferred that 400 people uses this site for a day .
- To accommodate 400 users, 4.5 acres is more than enough excluding all the green open spaces.

SEX

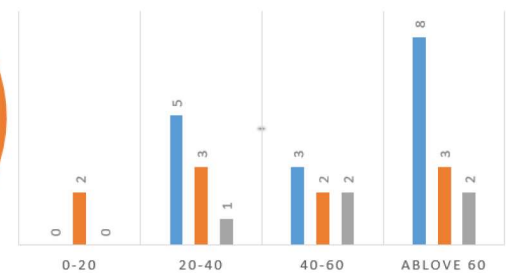


Inference :

By the bar graphs and pie charts , it is inferred that the female is affected more than that of the male. And also the design should concentrate more for the people at age groups of 20-40 and above 60. The minor part of the design can be concentrated with children.



Single occupancy 4 occupancy Dormitory

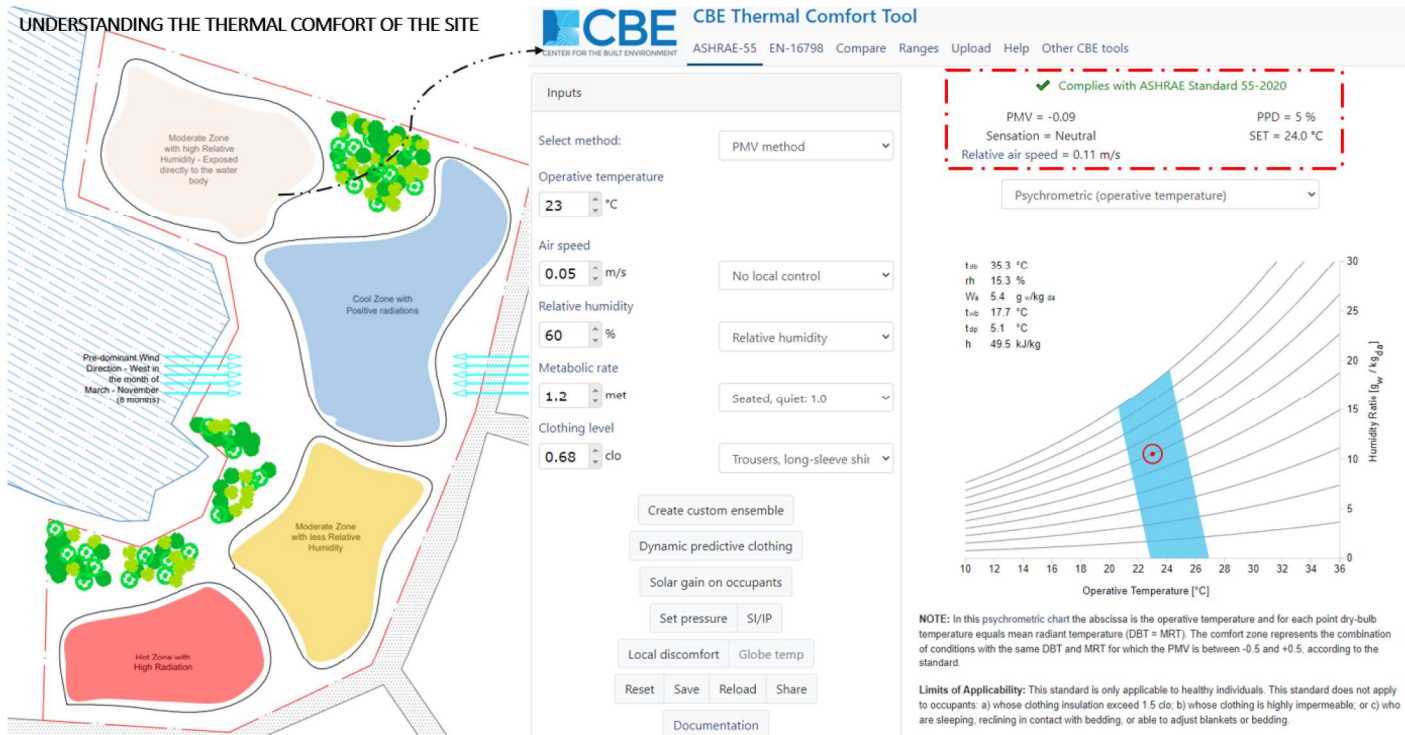


FINAL NUMBER OF BEDS AS PER AGE GROUPS

CHAPTER – 5

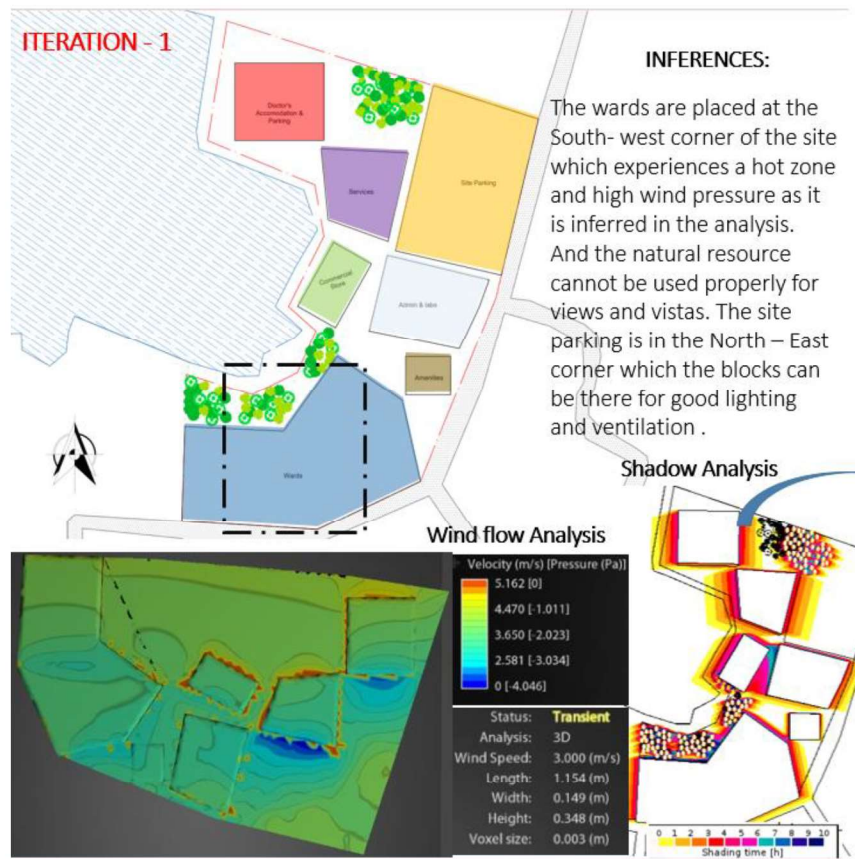
MASSING & ZONING

5.1 SITE ANALYSIS :

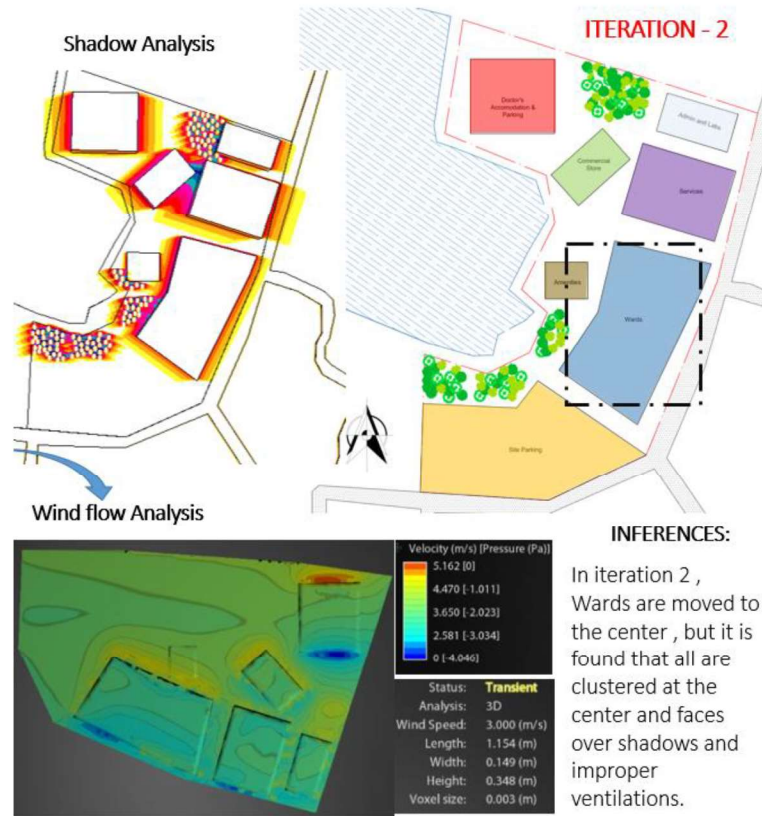


5.2 ZONING :

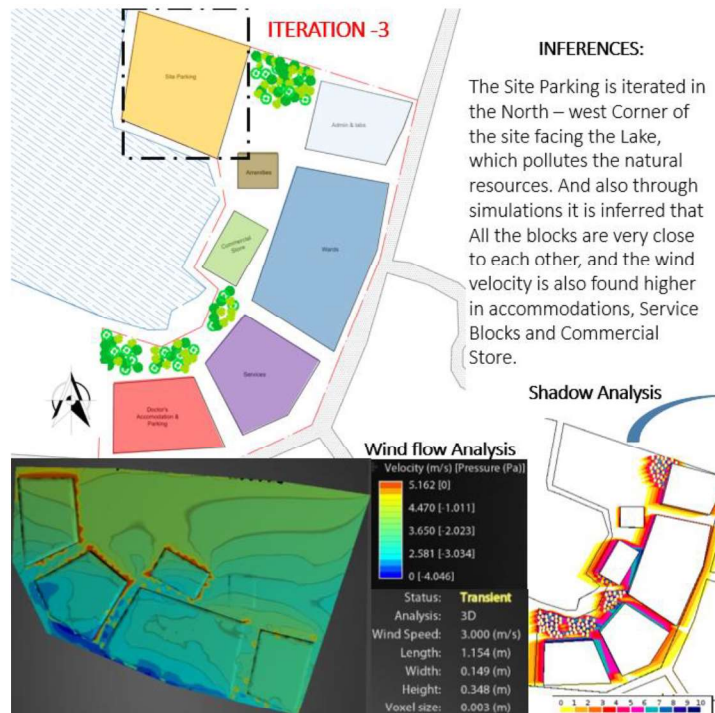
ITERATION – 1 :



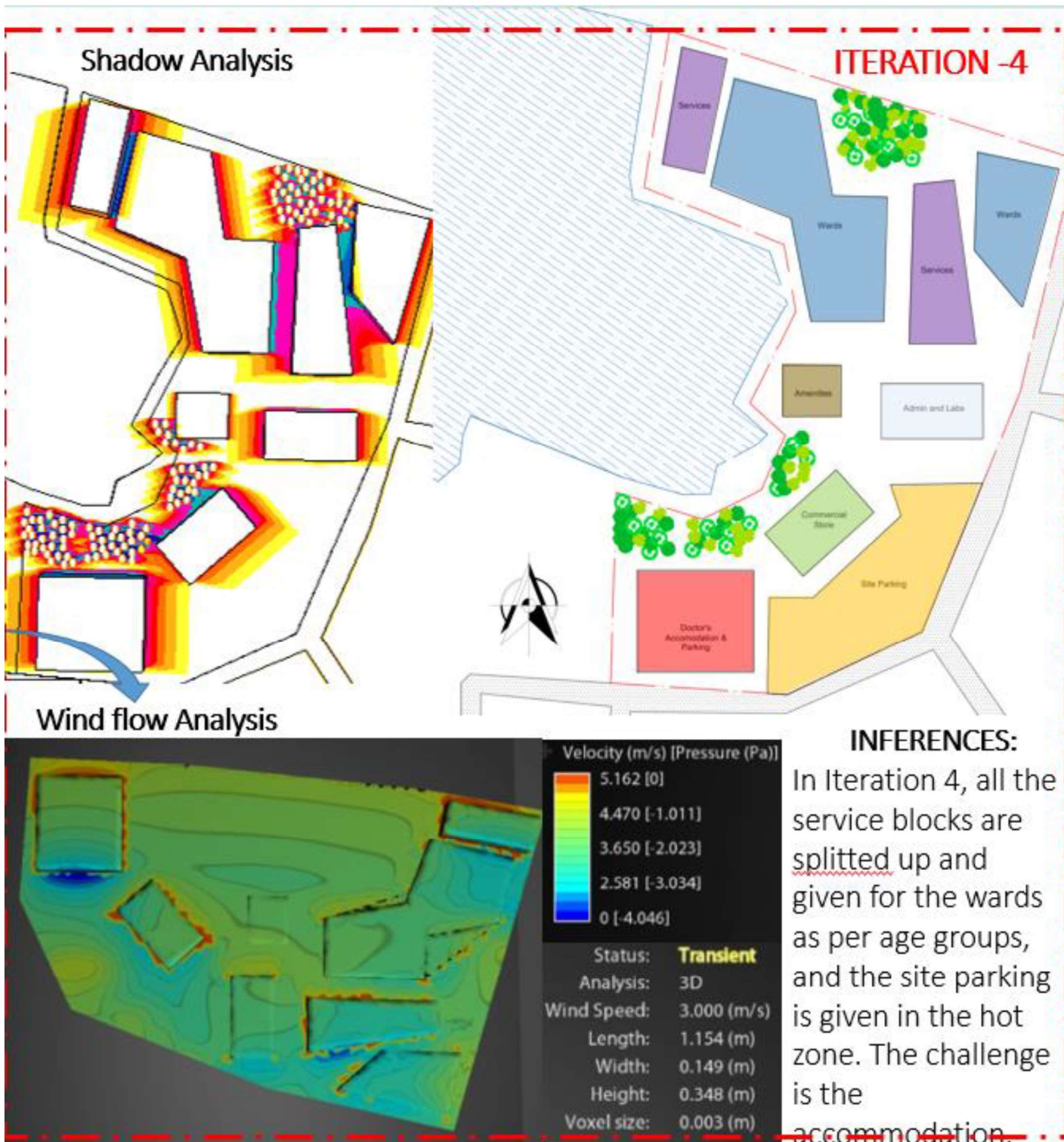
ITERATION – 2 :



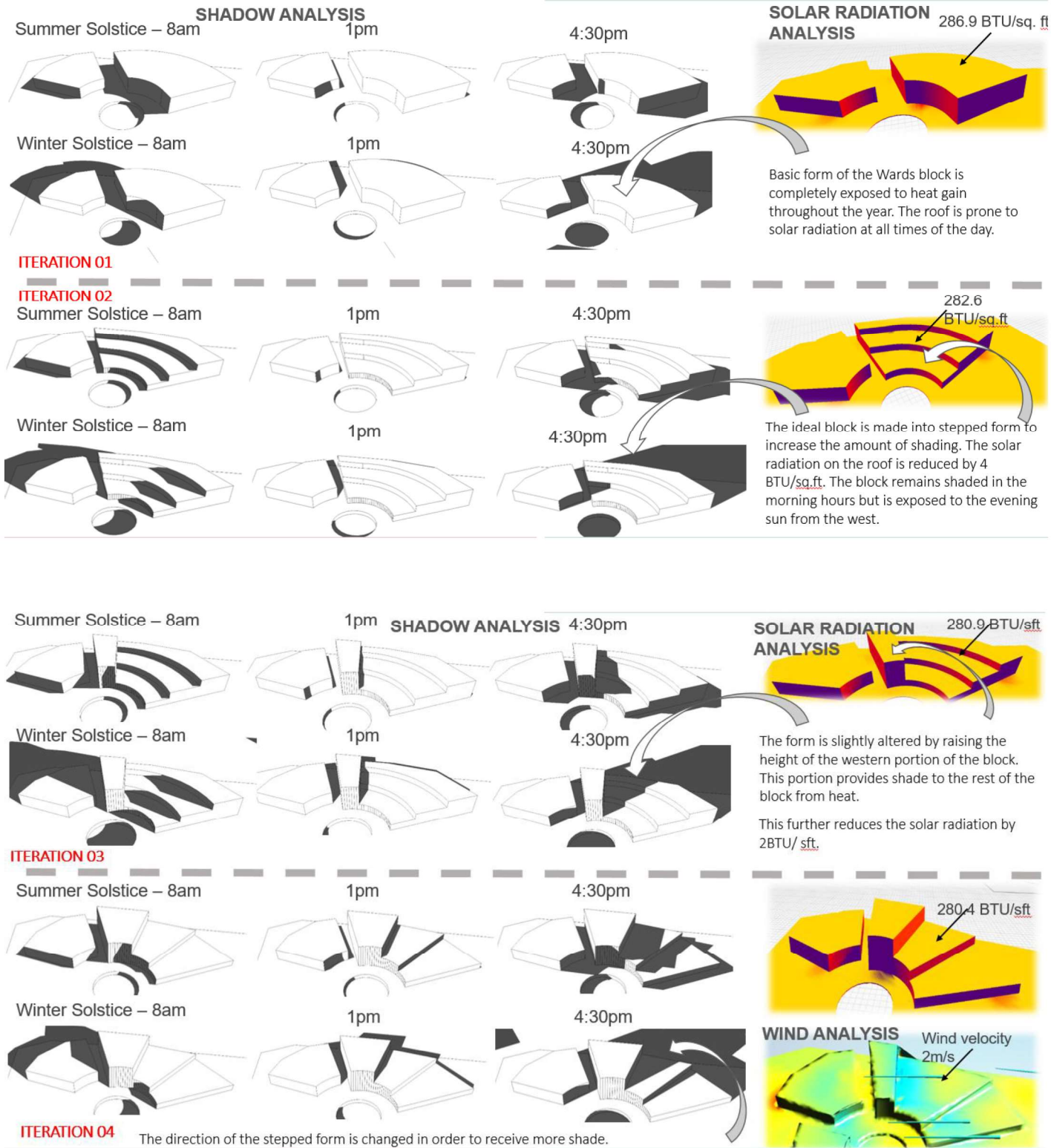
ITERATION – 3 :



ITERATION – 4 :



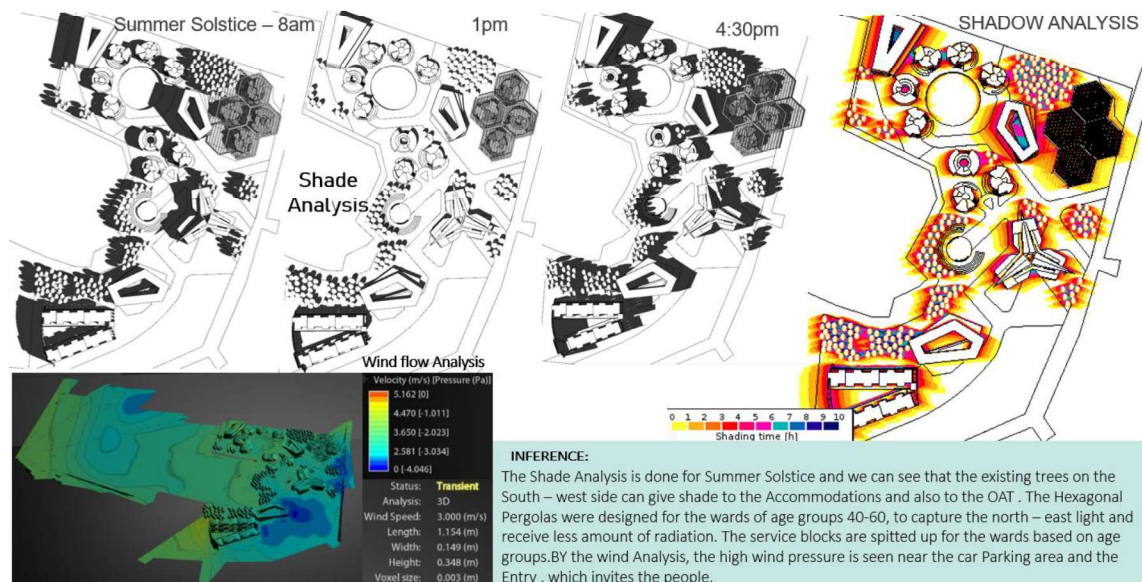
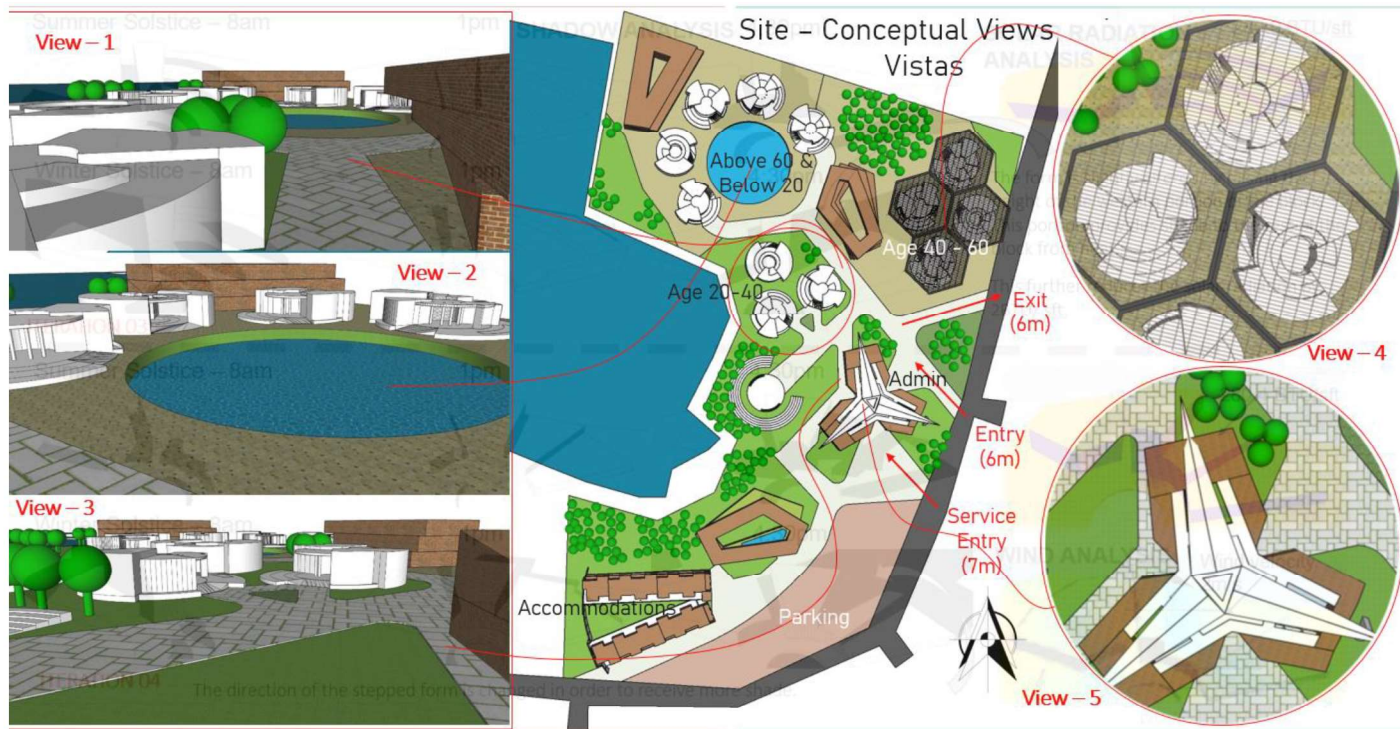
5.3 MASSING:



CHAPTER – 6

DESIGN & SUSTAINABLE STRATEGIES APPLIED

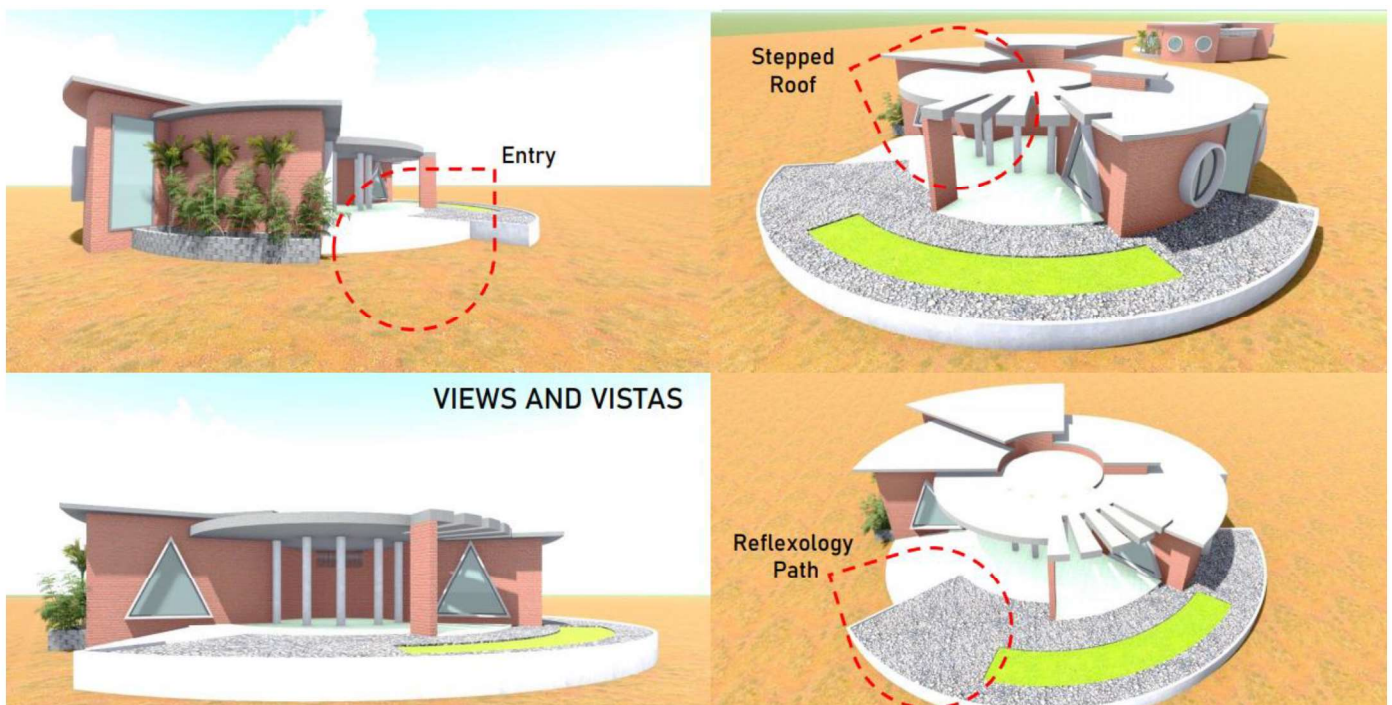
6.1 SITE PLAN :



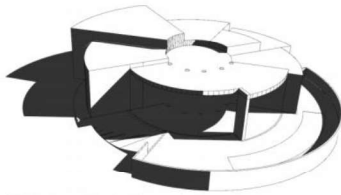
6.2 BLOCKS DETAILED :



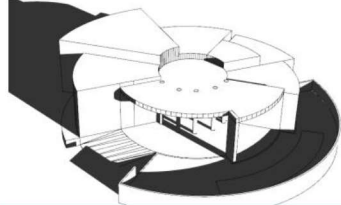
6.2.1 DORM:



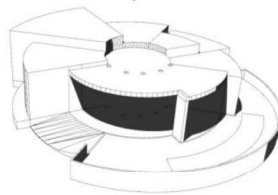
Summer Solstice – 8am



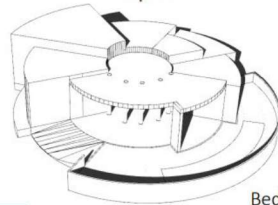
Winter Solstice – 8am



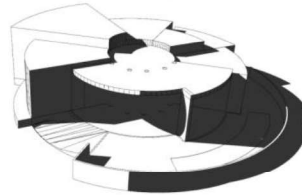
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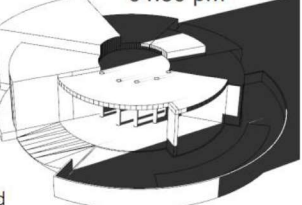
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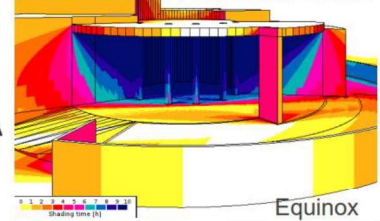
04.30 pm



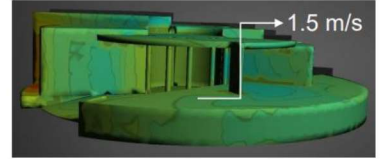
04.30 pm



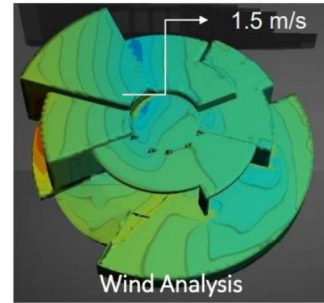
SHADOW ANALYSIS



Equinox



1.5 m/s

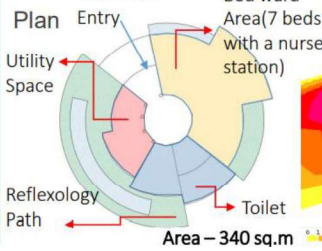


1.5 m/s

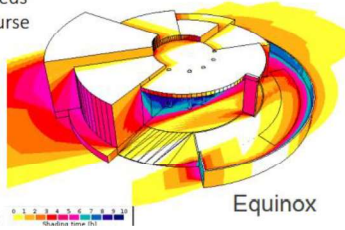
Wind Analysis

INFERENCE:

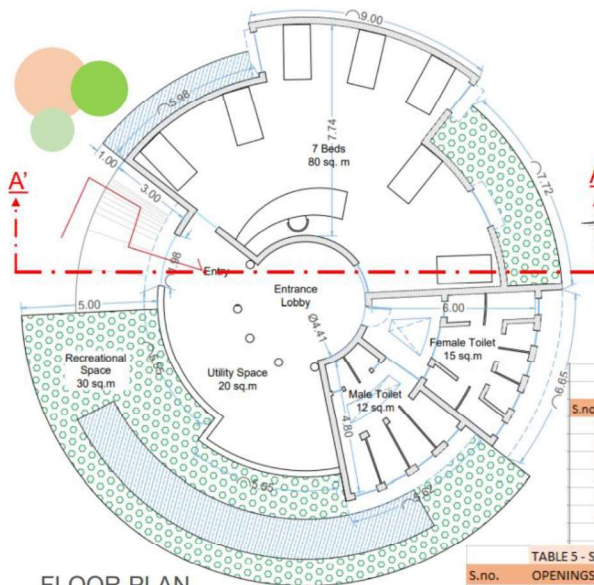
By looking the shadow analysis of summer, winter solstices, it is inferred that all the portions are shaded properly according the occupant's activities throughout the day. The Entry is defined with the ramp. The West side is defined with the reflexology path which is used at early mornings and evenings which is faced by the semi-covered utility spaces.



Area – 340 sq.m

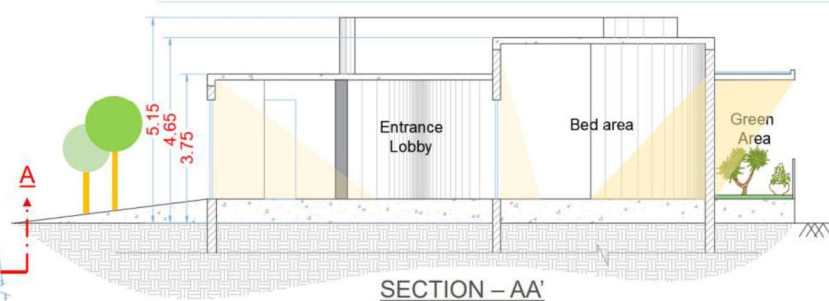


Equinox



FLOOR PLAN

TOTAL NON- OPAQUE AREA	8.6916
WWR	8.69/ 2608.5
	0.03318
MIN. VLT	27% NON- OPAQUE AREA



SECTION – AA'

Calculation of the Window Wall Ratio :

Calculation of window-to-wall ratio

TABLE 4 - NORTH DIRECTION

S.no.	OPENINGS	AREA (m2)	GLASS AREA	NO.s	OPENING AREA	TOTAL NON-OPAQUE AREA
1	W1	2.16	1.7596	1	2.16	1.7596
2	W2	2.16	1.7596	0	0	0
3	W3	1.44	1.1236	0	0	0
4	V	0.36	0.2116	0	0	0
5	D1	2.52	0	1	2.52	0
6	D2	2.52	2.0776	0	0	0
TOTAL					4.68	1.7596

TABLE 5 - SOUTH DIRECTION

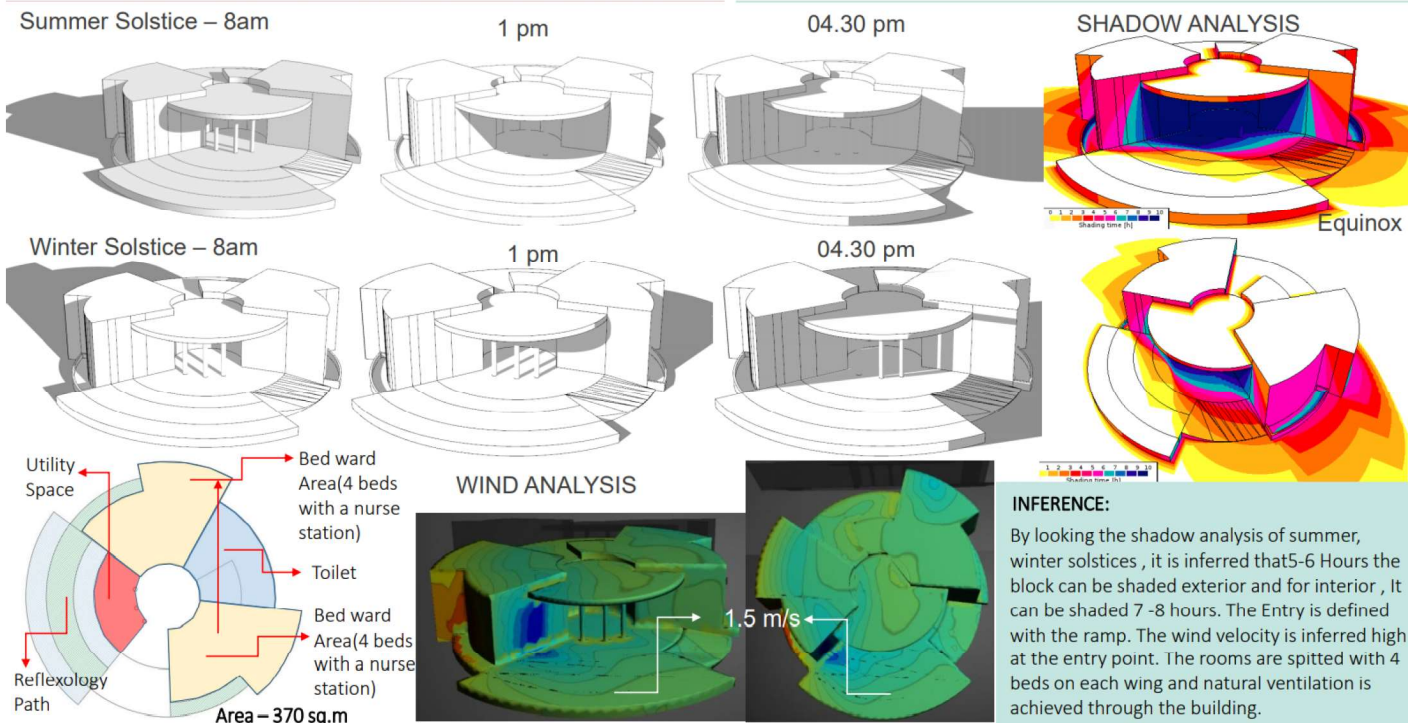
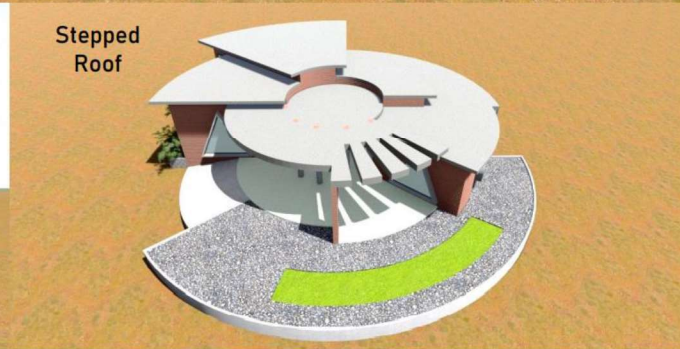
S.no.	OPENINGS	AREA (m2)	GLASS AREA	NO.s	OPENING AREA	TOTAL NON-OPAQUE AREA
1	W1	2.16	1.7596	0	0	0
2	W2	2.16	1.7596	2	4.32	3.5192
3	W3	1.44	1.1236	1	1.44	1.1236
4	V	0.36	0.2116	1	0.36	0.2116
5	D1	2.52	0	0	0	0
6	D2	2.52	2.0776	1	2.52	2.0776
TOTAL					8.64	6.932

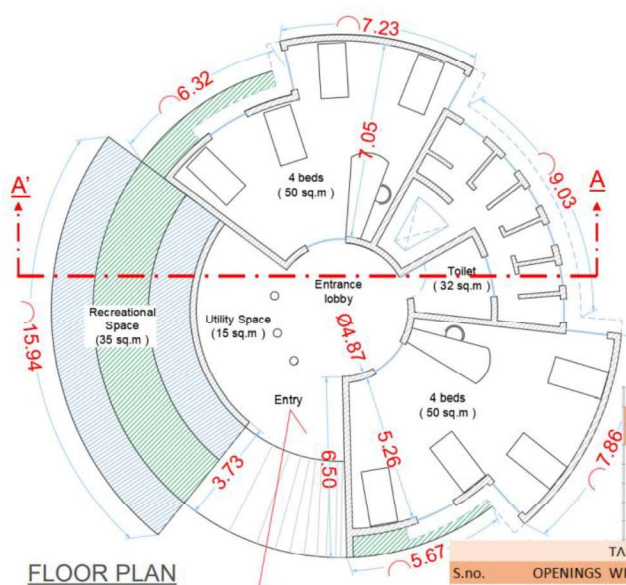
Since the WWR is achieved as per ECBC, it is followed through out the design which provides a good Daylighting and Ventilation.



Key plan

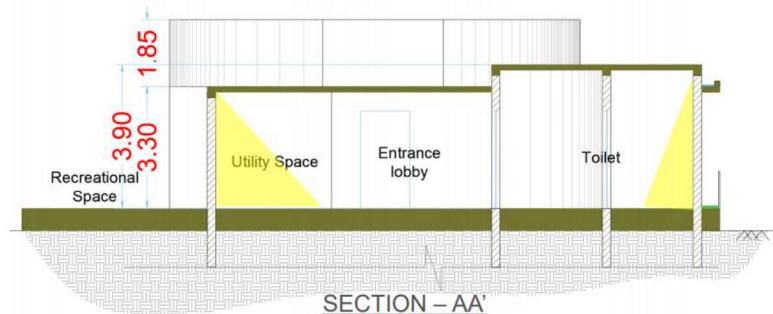
6.2.2 4 – BEDDED WARD :





FLOOR PLAN

The WFR is achieved as per ECBC. All the wings are provided with a nurse station for an emergency.



SECTION – AA'

Calculation of the Window Floor Ratio :

S.no.	DIRECTIONS	TOTAL WALL LENGTH EXPOSED TO	TOTAL WALL HEIGHT EXPOSED TO	ENVELOPE AREA (m2)
1	North	54.1	20	1082
2	South	54.1	10	541
3	East	22.2	15	333
4	West	43.5	15	652.5
TOTAL AREA				2608.5

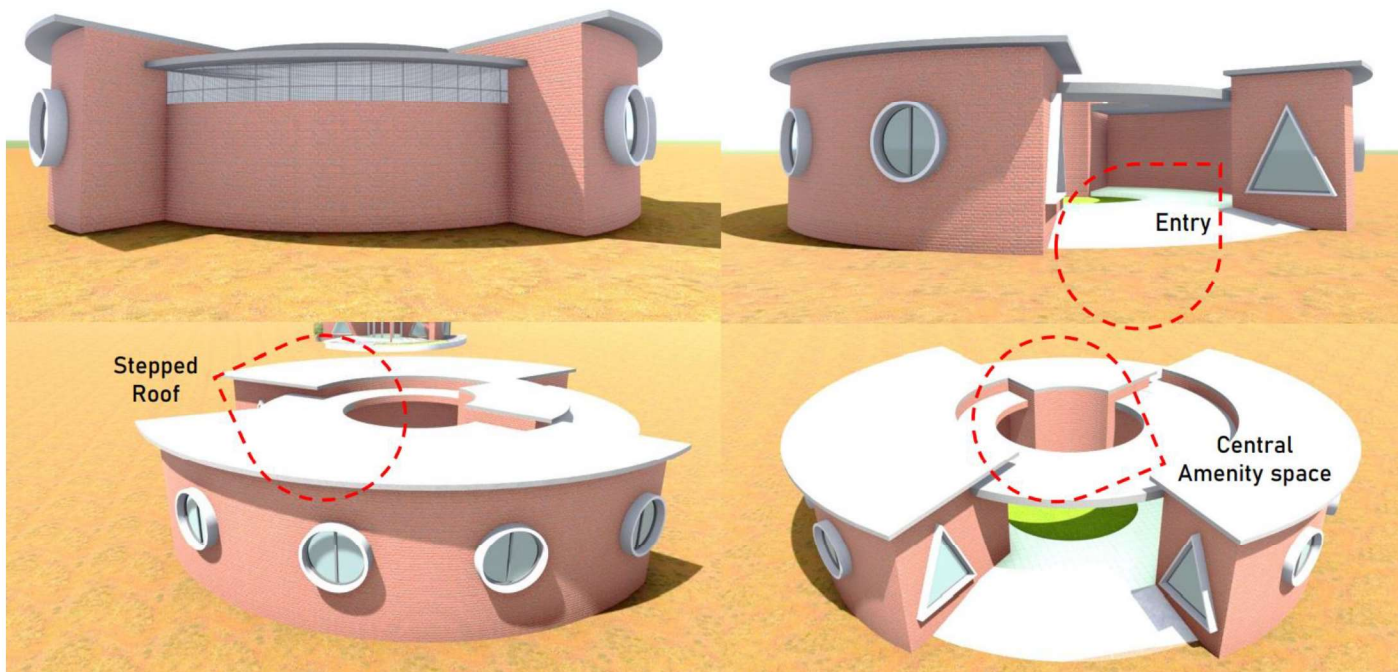
S.no.	OPENINGS	WIDTH (m)	HEIGHT (m)	AREA (m2)	GLASS	WIDTH (m)	HEIGHT (m)	AREA (m2)
1	W1	1.8	1.2	2.16	W1	1.66	1.06	1.7596
2	W2	1.2	1.8	2.16	W2	1.66	1.06	1.7596
3	W3	1.2	1.2	1.44	W3	1.66	1.06	1.7596
4	V	0.6	0.6	0.36	V	0.46	0.46	0.2116
5	D1	1.2	2.1	2.52	D1	0	1.96	0
6	D2(balcony)	1.2	2.1	2.52	D2	1.06	1.96	2.0776



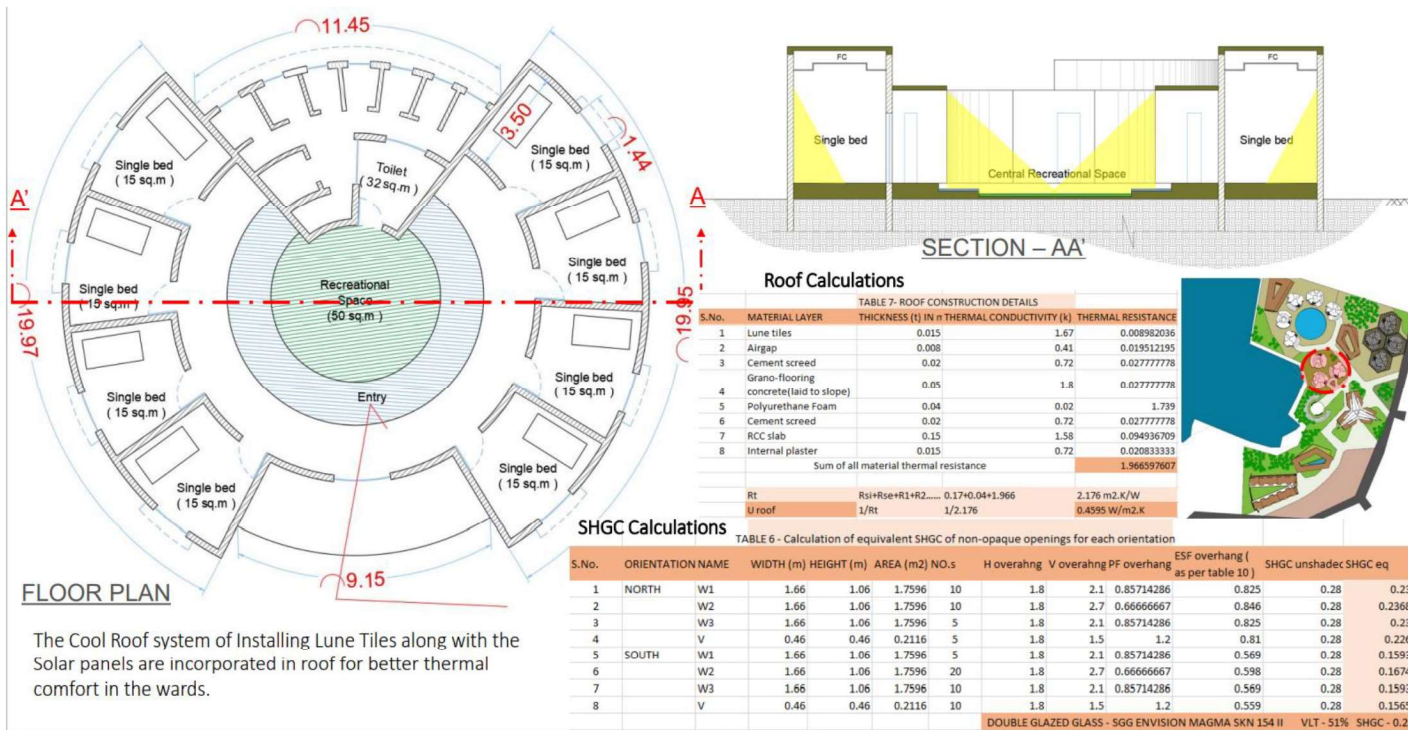
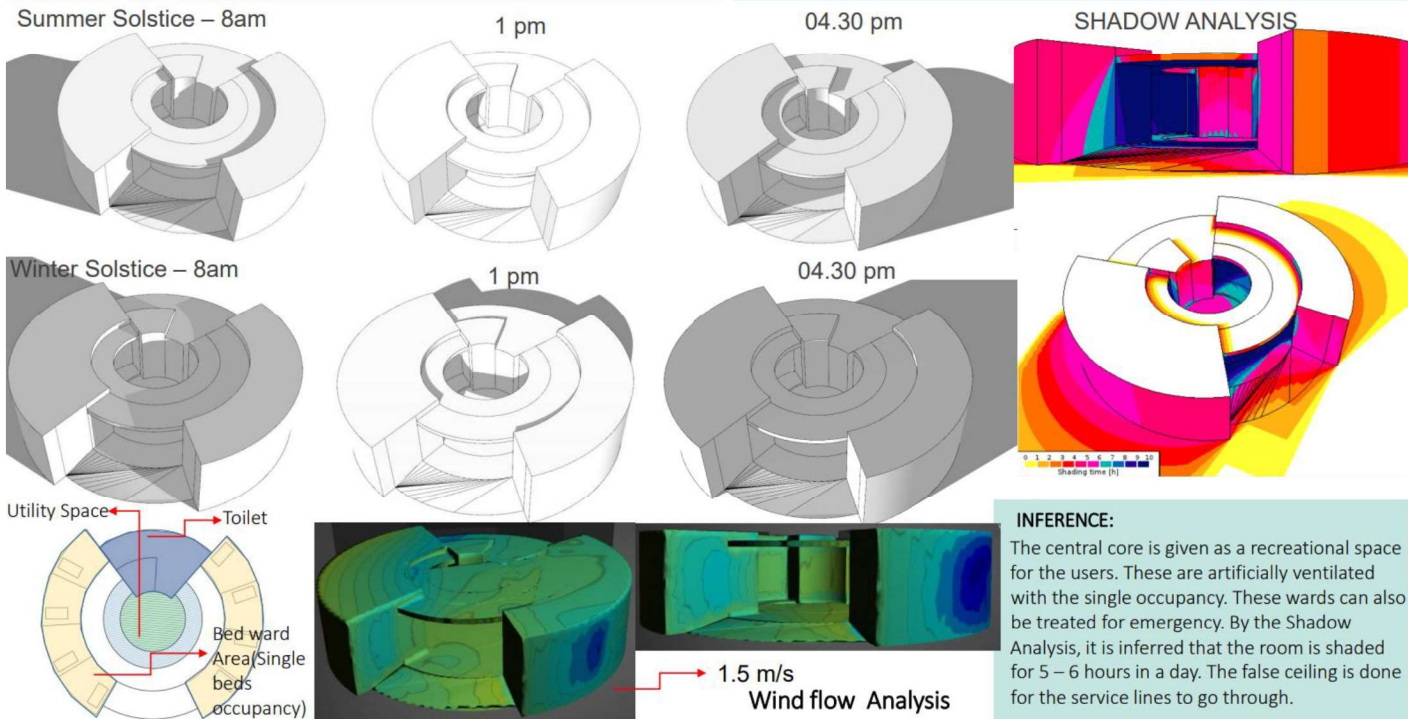
Key plan

6.2.3 1 – BEDDED WARD :

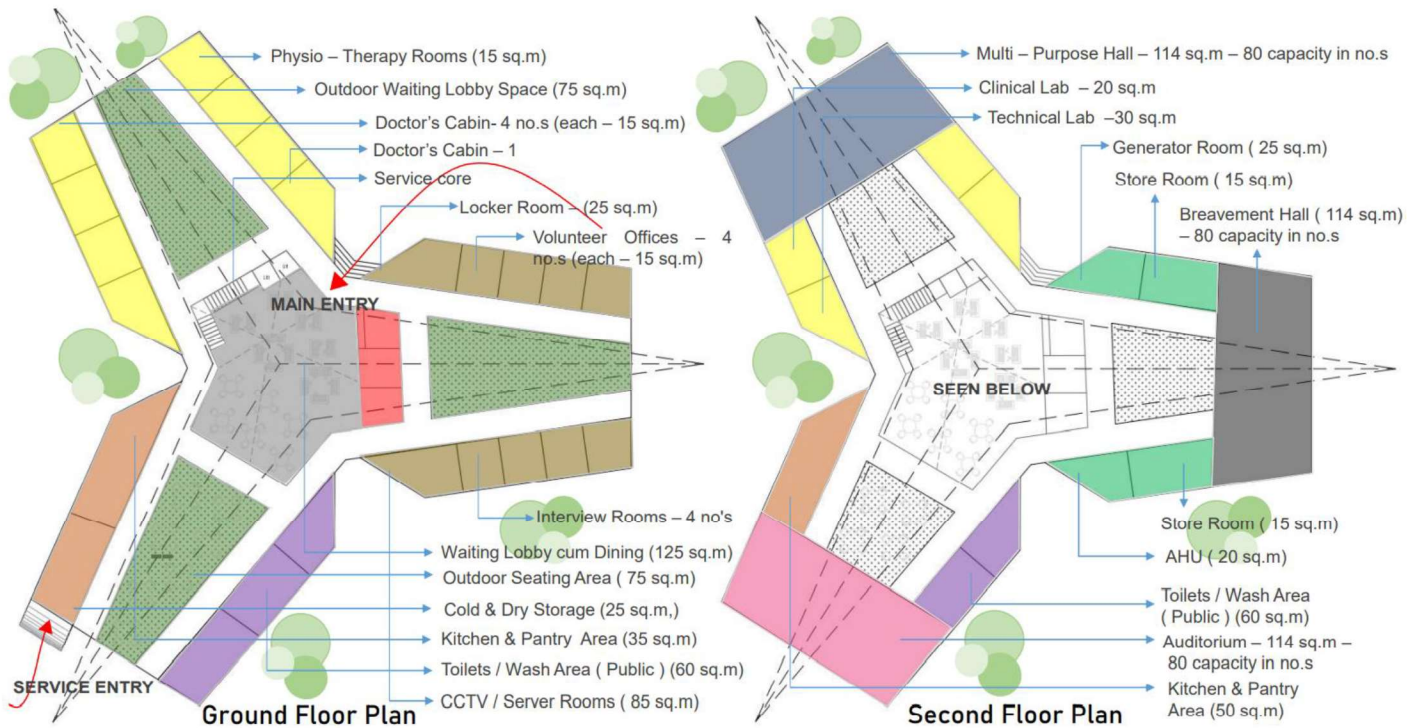
VIEWS AND VISTAS



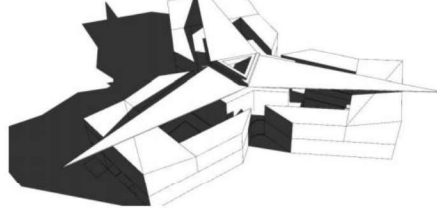
The central core is given as a recreational space for the users. These are artificially ventilated with the single occupancy. These wards can also be treated for emergency. By the Shadow Analysis, it is inferred that the room is shaded for 5 – 6 hours in a day. The false ceiling is done for the service lines to go through.



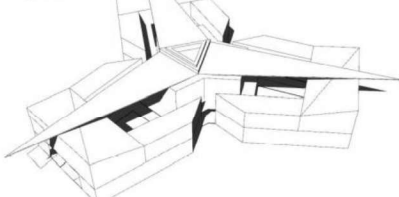
6.2.4 ADMIN BLOCK:



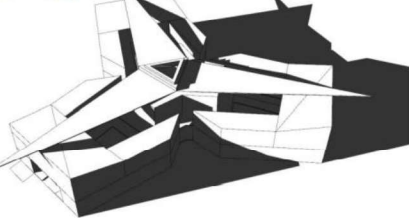
Summer Solstice – 8am



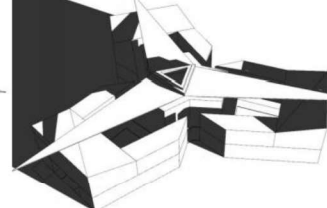
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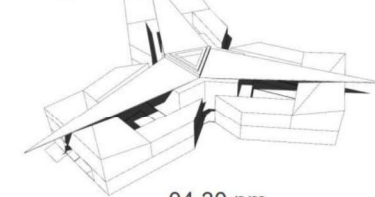
04.30 pm



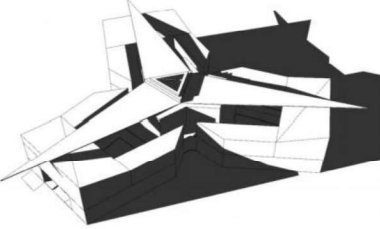
Winter Solstice – 8am



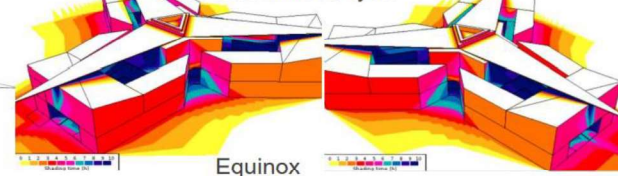
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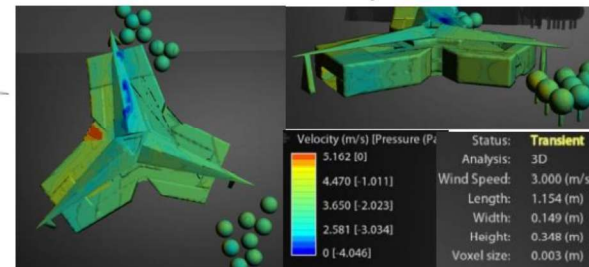
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Shadow Analysis

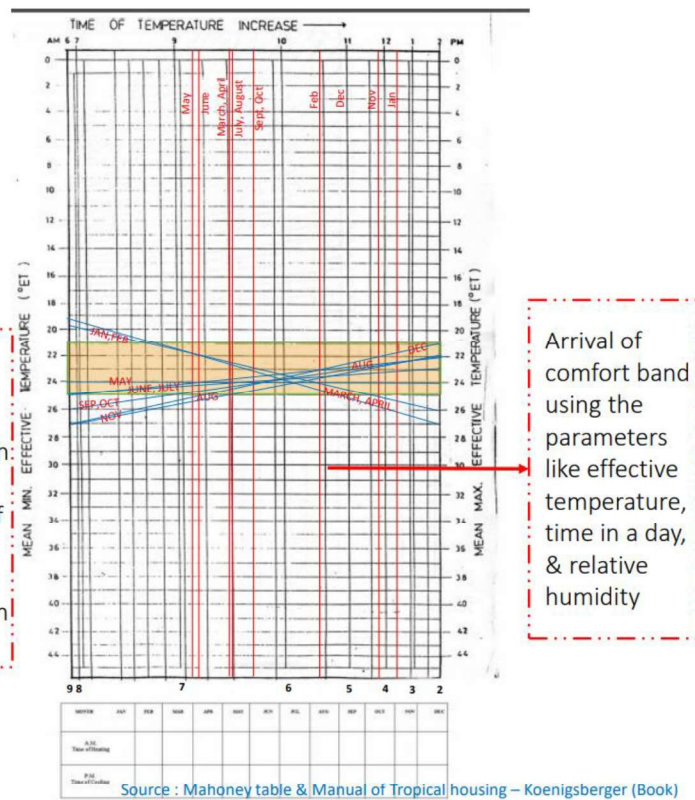
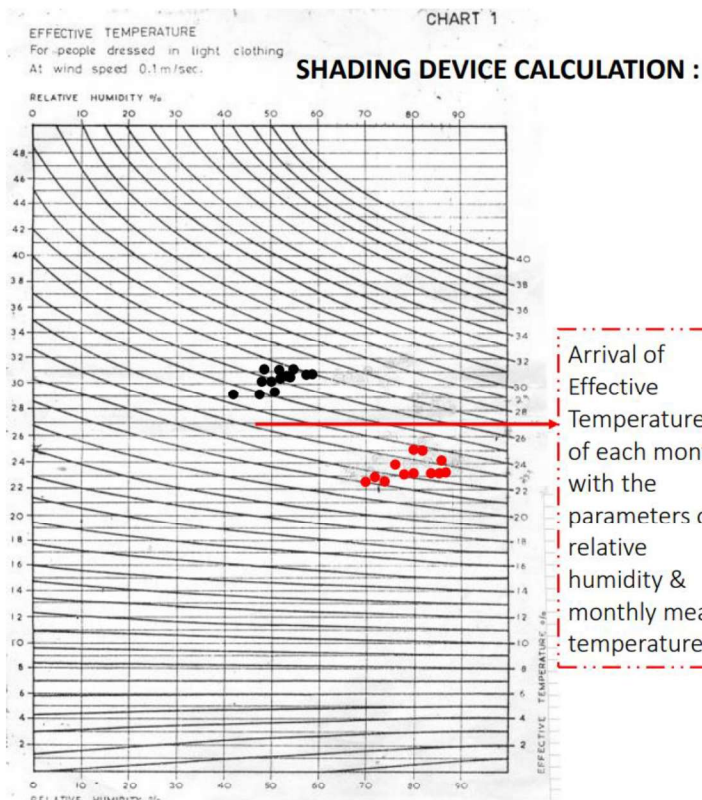


Wind Flow Analysis

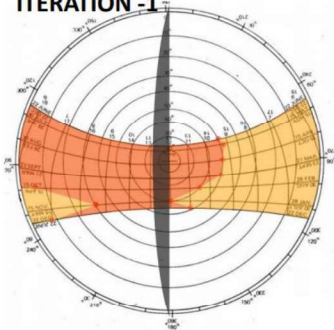


INFERENCE:

In the Admin block, the meeting Rooms, Clinic labs, waiting rooms and kitchen in is designed. The South – west corner is said to be the Kitchen and the loading and unloading will be happened at the service entry of the site. The roof is designed as a fan to give shade to interior courtyards with the installation of the solar panels to produce electricity.



ITERATION -1



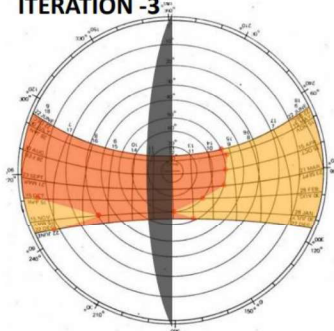
INFERENCE:

4 Iterations are evaluated at different sizes of the shading devices .

When comparing all the four iterations, the fourth one seems to be shaded for the needed portion of the building .

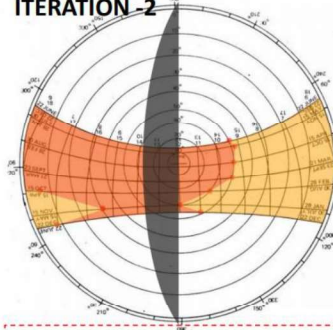
The fourth iteration is the mix of both Horizontal and vertical shading device .

ITERATION -3

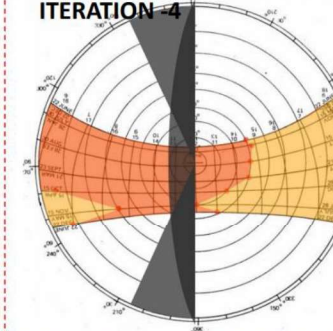


S.No.	MONTH	MIN ET	MAX ET
1	JAN	14	22
2	FEB	15	24
3	MARCH	18	25
4	APRIL	18	25
5	MAY	18	27
6	JUNE	19	25
7	JULY	19	24
8	AUG	19	24
9	SEP	18	24
10	OCT	18	24
11	NOV	16	22
12	DEC	15	23
END RESULTS		AMT	23.7
		TCC	23.13
		AMR	18.8

ITERATION -2



ITERATION -4

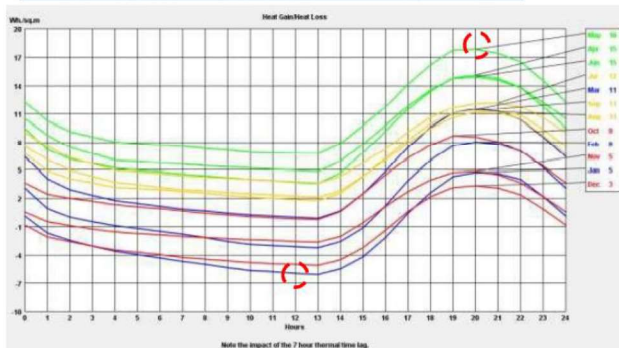


ITERATIONS	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Sunshade depth (m)	0.6	1.5	1	1
Window Height (m)	2.1	2.1	2.1	2.1
Window Width (m)	2.1	2.1	2.1	2.1
Angle of shading	77 degree	54 degree	65 degree	65 degree
Types of shading device	(only horizontal)		(horizontal & vertical)	

FILLER SLAB DETAILS:

FILLER SLAB Construction Details			
Material Layer	Thickness t (m)	Thermal Conductivity	Thermal Resistance
Outside film			0.038
Manglore tiles	0.02	0.798	0.02
Air space	0.025	5.88	0.529
Reinforced concrete	0.15	1.75	0.57
Cement plaster	0.015	0.72	0.014
Inside film			0.0136
Sum of all material thermal resistance			1.186

THERMAL TRANSMITTANCE OF FILLER SLAB ROOF
 $RT = R_{si} + R_{se} + R_1 + R_2 + R_3 + \dots$
 $= 0.17 + 0.04 + 1.186 = 1.395 \text{ m.K/W}$ $U\text{-VALUE} = 1/RT = 0.71 \text{ W/m.K}$ **THERMAL CONDUCTIVITY:**
 $K = K_1 + K_2 + K_3 + K_4 + \dots$
 $= 1.16 + 0.7 + 9.148 \text{ W/mK}$
 This is less than the maximum Uroof value of 1.2 W/m.K as per ECBC.
 Hence it does complies with the requirement.



TIME LAG:

FILLER SLAB	
Area	35
U-value	0.71
Temp. Diff.	7
Heat gain	173.5 Btu/hr

FILLER SLAB	
Area	35
conductivity	9.148
Temp. Diff.	7
Thickness(INCHES)	8.3
Heat loss	270 Btu/hr

Due to the air space present in-between the Mangalore tiles, the heat gain and loss factor are happening parallelly, TIME LAG for the filler slab is 7hours.
 The maximum heat gain enter into the building at 8PM. The heat loss at its fullest is achieved by 12 noon.

6.2.5 ACCOMODATION :

ITERATION 1

If the block is oriented in this way , the shorter wall in the western fazard recieve large solar radiation, so that the thermal comfort of the total block is not achieved

ITERATION 2

If the block is oriented in this way , the western fazard recieves high radiation and it acts as a blockage for direct radiations. the north & south fazards recieves good ventilations.

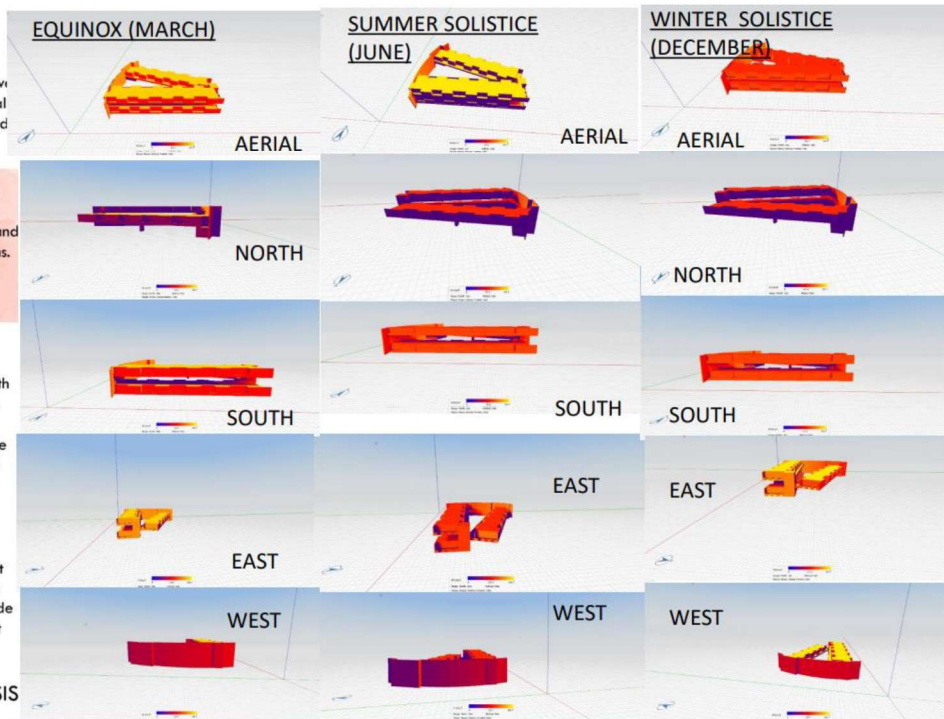
ITERATION 2

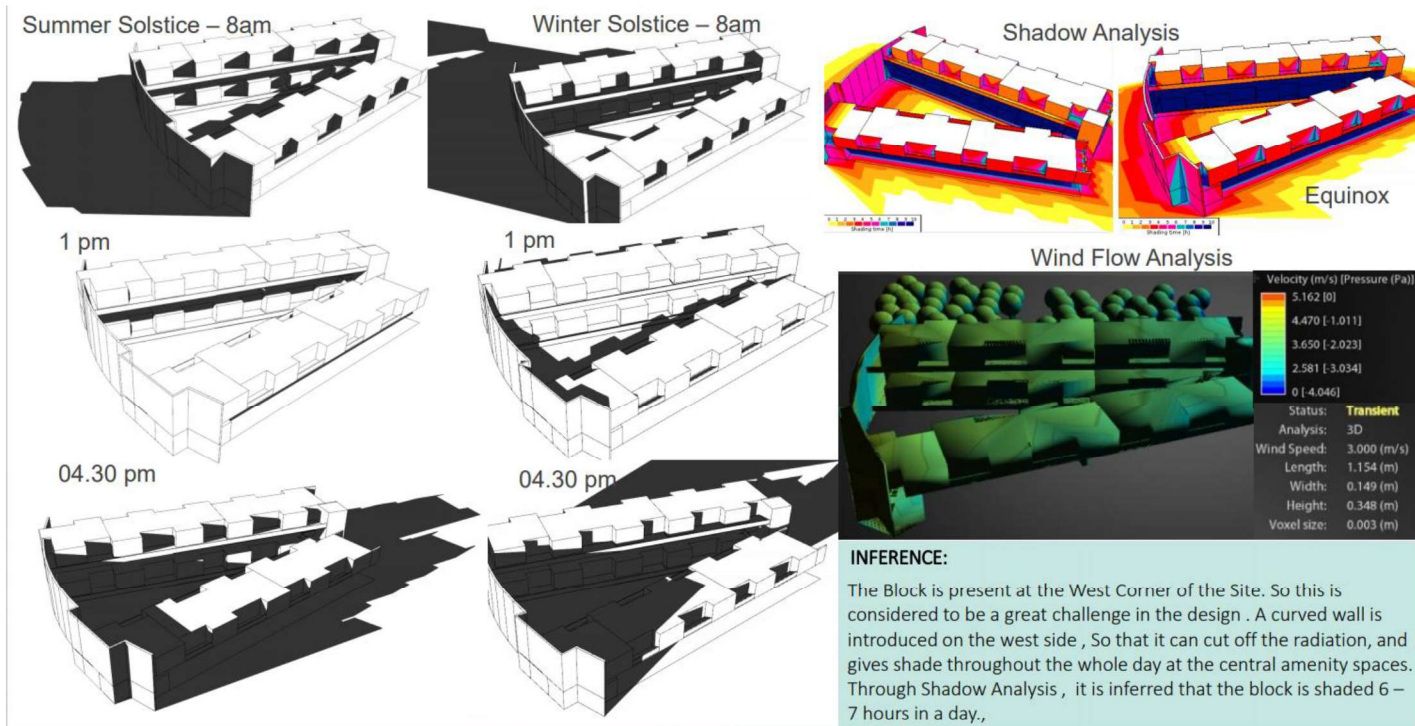
If the block is oriented in this way , the north east winds will be blocked by the northern wall and the cold humid winds are not allowed inside the building. The shorter side is facing towards south and recieves heavy radiations.

ITERATION 4

If the block is oriented in this way ,the west side will recieve heavy radiations, and the south sun will be blocked. since the west side and east side have fenestrations, it will not be a good design to achieve thermal comfort.

ORIENTATION ANALYSIS





OBLIQUE approach to each unit is used, since the anti-space between each unit can be used as a foyer space or an interaction spaces.

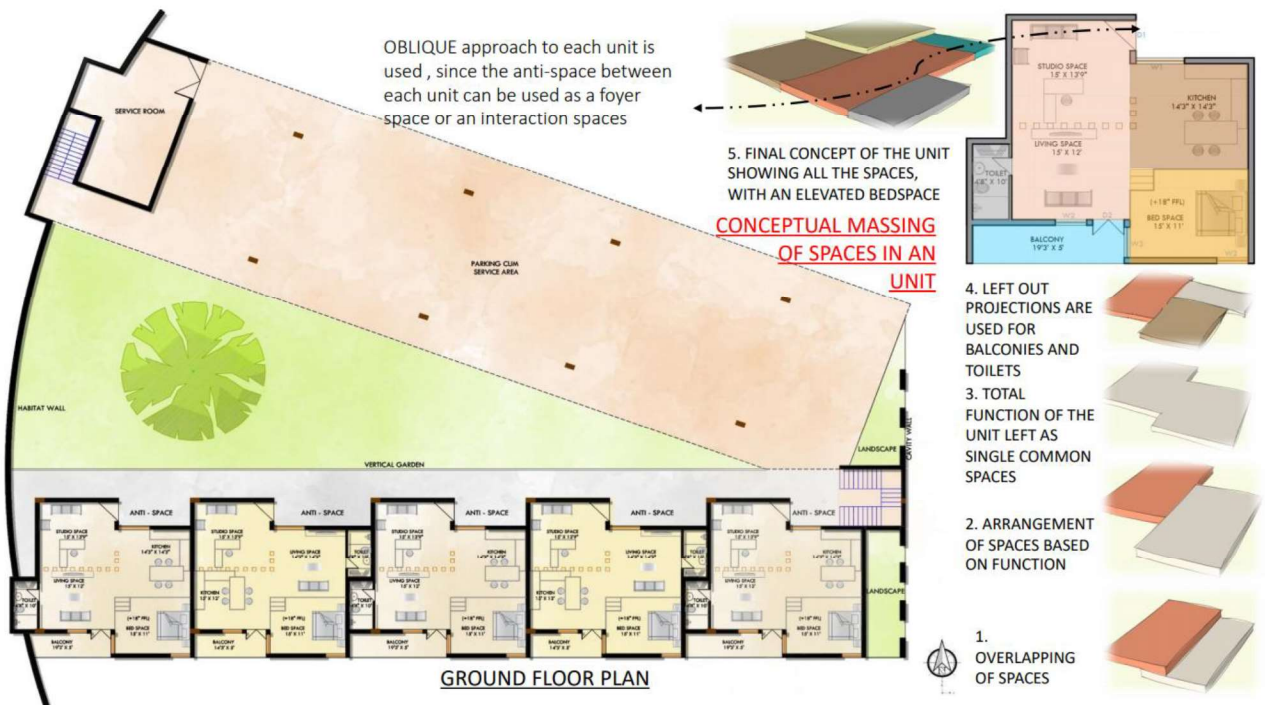




TABLE 4 - NORTH DIRECTION						
S.no.	OPENINGS	AREA (m2 GLASS AREA	NO.s	OPENING AREA	TOTAL NON-OPAQUE AREA	
1	W1	2.16	1.7596	1	2.16	1.7596
2	W2	2.16	1.7596	0	0	0
3	W3	1.44	1.1236	0	0	0
4	V	0.36	0.2116	0	0	0
5	D1	2.52	0	1	2.52	0
6	D2	2.52	2.0776	0	0	0
TOTAL				4.68	1.7596	

The plan is tilted to 30 degree towards east , so that the cross ventilation through the building is achieved. If it is not tilted the NE winds will not be utilized through the building.

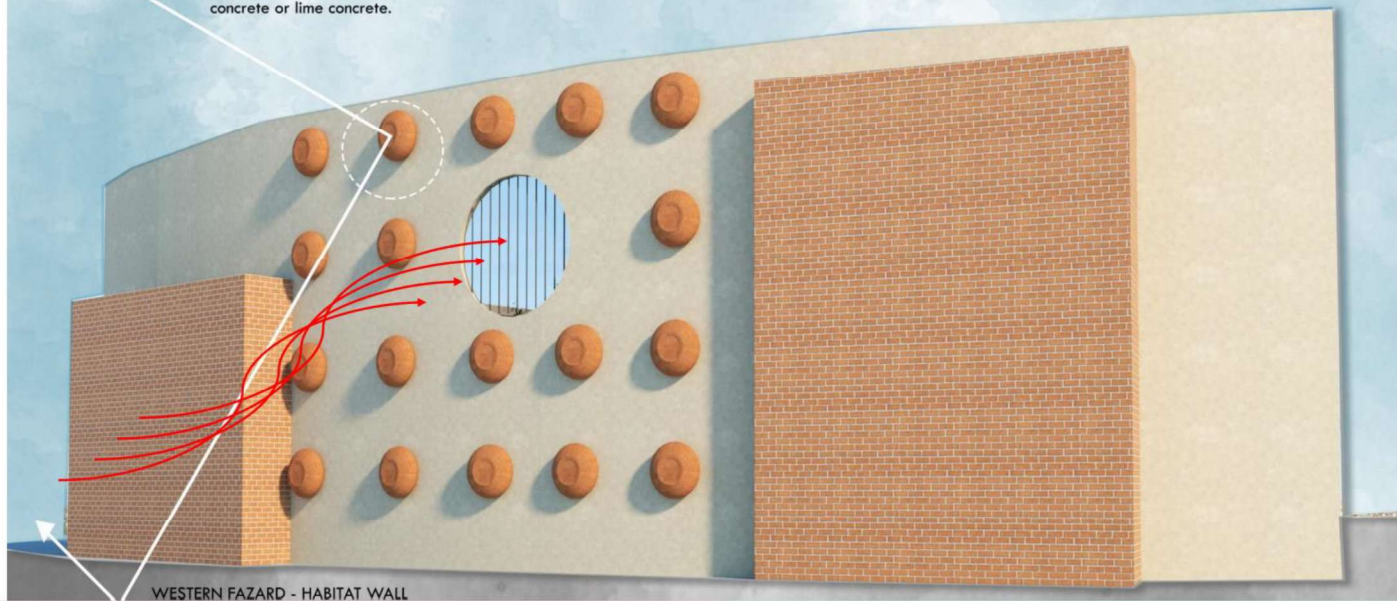
This is designed as an temporary accommodation for the Doctors to stay. It can also be used for the family accommodations . The service core is present at the east of the tower. The tower has 3 floors. The present floor is studio units floor . It is the first floor plan. The central courtyard plays as a gathering spaces . On the west side , a habitat wall is designed to block the western sunlight which enters into the building .



FIRST FLOOR PLAN

EARTHEN POTS CONSTRUCTION :

The earthen pots are used on the western hazard to achieve thermal comfort. The exposed sunlight is reduced and reflected to the internal central courtyard. The exposed brick and the earthen pots helps during the summer sun and brings cool air into the building. e proposal is an attempt to innovate the traditional method and provide a usable habitat wall with greater thermal comfort. A thick layer of mud was among the simplest of solutions. In the technique, inverted earthen pots are laid on the roof and the spaces formed in between are filled with plain cement concrete or lime concrete.



This is designed as an temporary accommodation for the Doctors to stay. It can also be used for the family accommodations . The service core is present at the east of the tower. The tower has 3 floors. The present floor is studio units floor . It is the first floor plan. The central courtyard plays as a gathering spaces . On the west side , a habitat wall is designed to block the western sunlight which enters into the building .

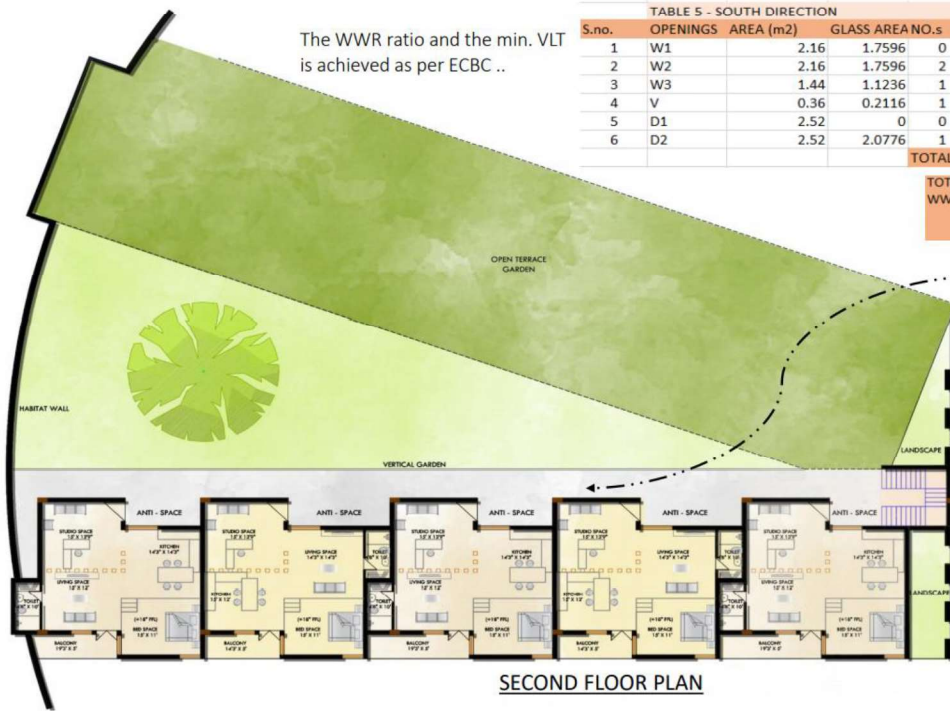


TABLE 5 - SOUTH DIRECTION							
S.no.	OPENINGS	AREA (m2)	GLASS AREA NO.s	OPENING AREA	TOTAL NON-OPAQUE AREA		
1	W1	2.16	1.7596	0	0		
2	W2	2.16	1.7596	2	4.32	3.5192	
3	W3	1.44	1.1236	1	1.44	1.1236	
4	V	0.36	0.2116	1	0.36	0.2116	
5	D1	2.52	0	0	0	0	
6	D2	2.52	2.0776	1	2.52	2.0776	
TOTAL				8.64	6.932		
TOTAL NON- OPAQUE AREA						8.6916	
WWR						8.69/ 2608.5	
MIN. VLT						0.03318	
						27% NON- OPAQUE AREA	

The 2 meter corridors are designed as an interaction spaces from one floor to the other floor. This improves the social sustainability of the building. Since it is design for IT people for about three studio units floors , only bachelors are occupied. So no lift core is designed. The staircase is considered for the vertical movements.



TABLE 6 - Calculation of equivalent SHGC of non-opaque openings for each orientation

S.No.	ORIENTATION	NAME	WIDTH (m)	HEIGHT (m)	AREA (m2)	NO.s	H overahng	V overahng	PF overahng	ESF overhang (as per table 10)	SHGC unshaded	SHGC eq
1	NORTH	W1	1.66	1.06	1.7596	10	1.8	2.1	0.85714286	0.825	0.28	0.231
2		W2	1.66	1.06	1.7596	10	1.8	2.7	0.66666667	0.846	0.28	0.23688
3		W3	1.66	1.06	1.7596	5	1.8	2.1	0.85714286	0.825	0.28	0.231
4	SOUTH	V	0.46	0.46	0.2116	5	1.8	1.5	1.2	0.81	0.28	0.2268
5		W1	1.66	1.06	1.7596	5	1.8	2.1	0.85714286	0.569	0.28	0.15932
6		W2	1.66	1.06	1.7596	20	1.8	2.7	0.66666667	0.598	0.28	0.16744
7		W3	1.66	1.06	1.7596	10	1.8	2.1	0.85714286	0.569	0.28	0.15932
8		V	0.46	0.46	0.2116	10	1.8	1.5	1.2	0.559	0.28	0.15652
DOUBLE GLAZED GLASS - SGG ENVISION MAGMA SKN 154 II											VLT - 51%	SHGC - 0.28

The 2 meter corridors are designed as an interaction spaces from one floor to the other floor. This improves the social sustainability of the building. Since it is design for IT people for about three studio units floors , only bachelors are occupied. So no lift core is designed. The staircase is considered for the vertical movements.

TABLE 7- ROOF CONSTRUCTION DETAILS				
S.No.	MATERIAL LAYER	THICKNESS (t) IN m	THERMAL CONDUCTIVITY (k)	THERMAL RESISTANCE
1	Lune tiles	0.015	1.67	0.008982036
2	Airgap	0.008	0.41	0.019512195
3	Cement screed	0.02	0.72	0.027777778
4	Grano-flooring concrete(laid to slope)	0.05	1.8	0.027777778
5	Polyurethane Foam	0.04	0.02	1.739
6	Cement screed	0.02	0.72	0.027777778
7	RCC slab	0.15	1.58	0.094936709
8	Internal plaster	0.015	0.72	0.020833333
Sum of all material thermal resistance				1.966597607
Rt	Rsi+Rse+R1+R2.....	0.17+0.04+1.966	2.176 m2.K/W	
U roof	1/Rt	1/2.176	0.4595 W/m2.K	



GREEN ROOF DETAILS: (thickness of soil can vary)

Green Roof Construction Details			
Material Layer	Thickness t (m)	Thermal Conductivity	Thermal Resistance
Soil	0.1	1.16	0.09
Gravel	0.15	0.7	0.21
Permeable Geotextile	0.02	0.1	0.20
Drainage layer	0.02	0.27	0.07
Insulation	0.3	0.04	7.50
Anti root layer	0.01	OR 0.7	0.01
Waterproofing	0.01	0.17	0.06
RCC slab	0.15	1.58	0.09
Internal Plaster	0.02	0.72	0.02
Sum of all material thermal resistance			8.26

GREEN ROOF- HEAT LOSS		GREEN ROOF	
Area	45	Area	45
conductivity	5.44	U-value	0.12
Temp. Diff.	7	Temp. Diff.	7
Thickness(inches)	30.7		37.8
Heat loss	55.8 Btu/hr	Heat gain	Btu/hr

TIME LAG for green roof is **11 hrs**, this helps in cooling the building through out the day and it gets heated up at midnight that too **7.5Wh/sq.m**, which is low on overall.

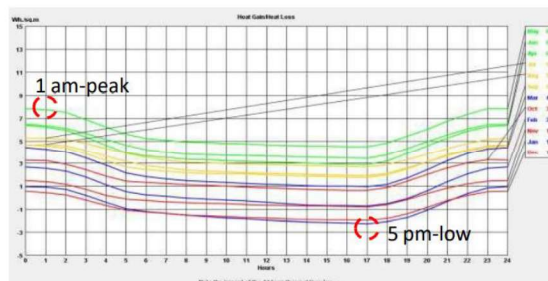
CALCULATION:

THERMAL RESISTANCE:
 $RT = R_{si} + R_{se} + R_1 + R_2 + R_3 + \dots$
 $= 0.17 + 0.04 + 1.249$
 $= 8.26 \text{ m.K/W}$ **THERMAL**

CONDUCTIVITY:
 $K = K_1 + K_2 + K_3 + K_4 + \dots$
 $= 1.16 + 0.7 + 0.1 + 0.27 + 0.04 + 0.7 + 0.17 + 1.58 + 0.72$
 $= 5.44 \text{ W/m.K}$

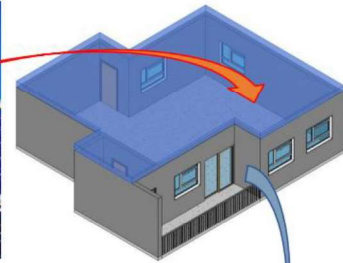
U-VALUE CALCULATION:
 $U_{roof} = 1/RT = 0.12 \text{ W/m.K}$

- This is **less** than the maximum U_{roof} value of **1.2 W/m.K** as per **ECBC**.
- Hence it **does** complies with the requirement.

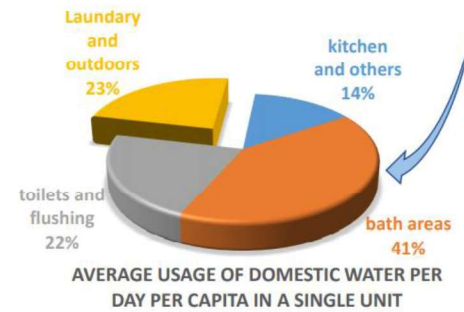


INSTALLATION OF SOLAR PANELS :

- Kerala has average daily sunshine of 5.5 hours.
- If we assume loss of 30 days due to rains and clouds every year, then total annual sun hours are $5.5 \times 335 = 1843$.
- Ideally **1843 kWh of energy** can be produced.
- But the actual performance will be less than 100 percent because the outdoor conditions are different from standard test conditions of the panels.
- So, for a 80 percent system performance the annual power production will be **1474 kWh** (i.e. 1843×0.8).
- In locations where there are shadows and panel tilt is not towards true south, it is often advisable to consider loss of another 10-15%.



GREY WATER TREATMENT :

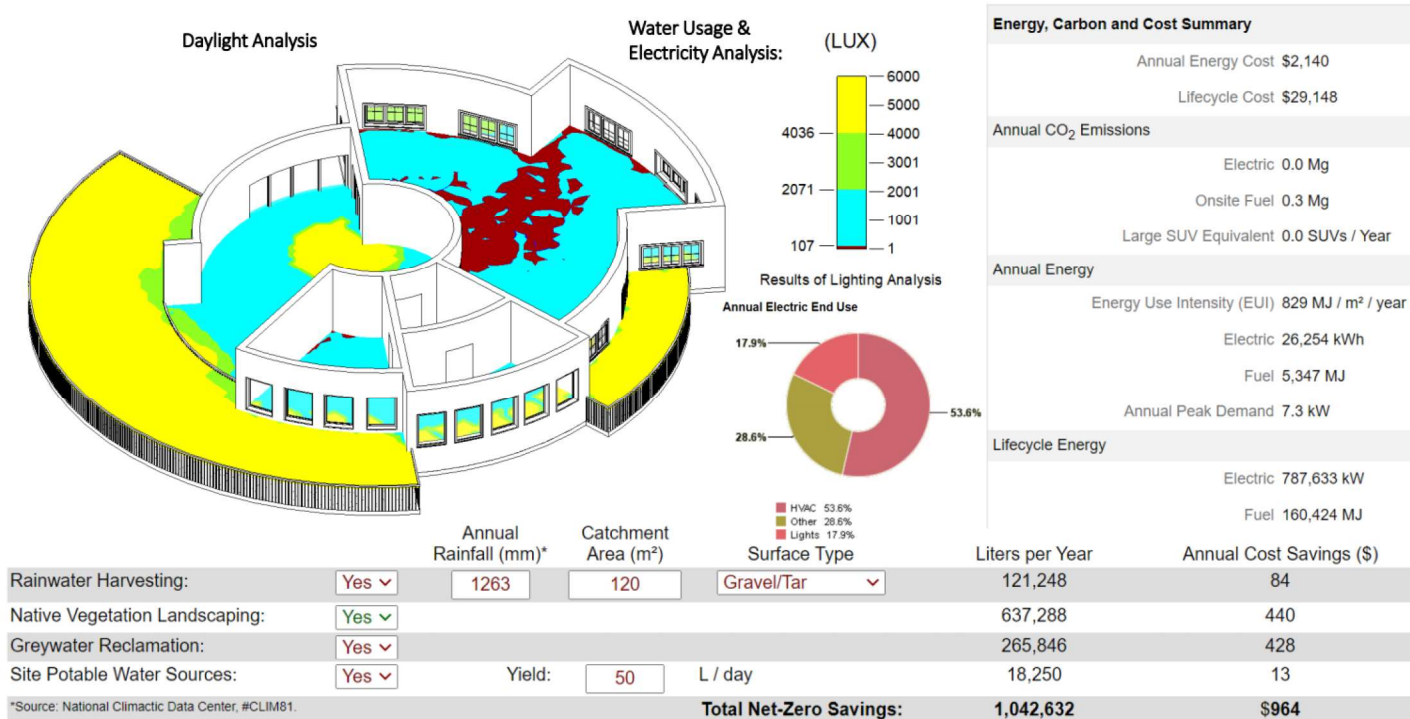


RAINWATER HARVESTING CALCULATIONS:

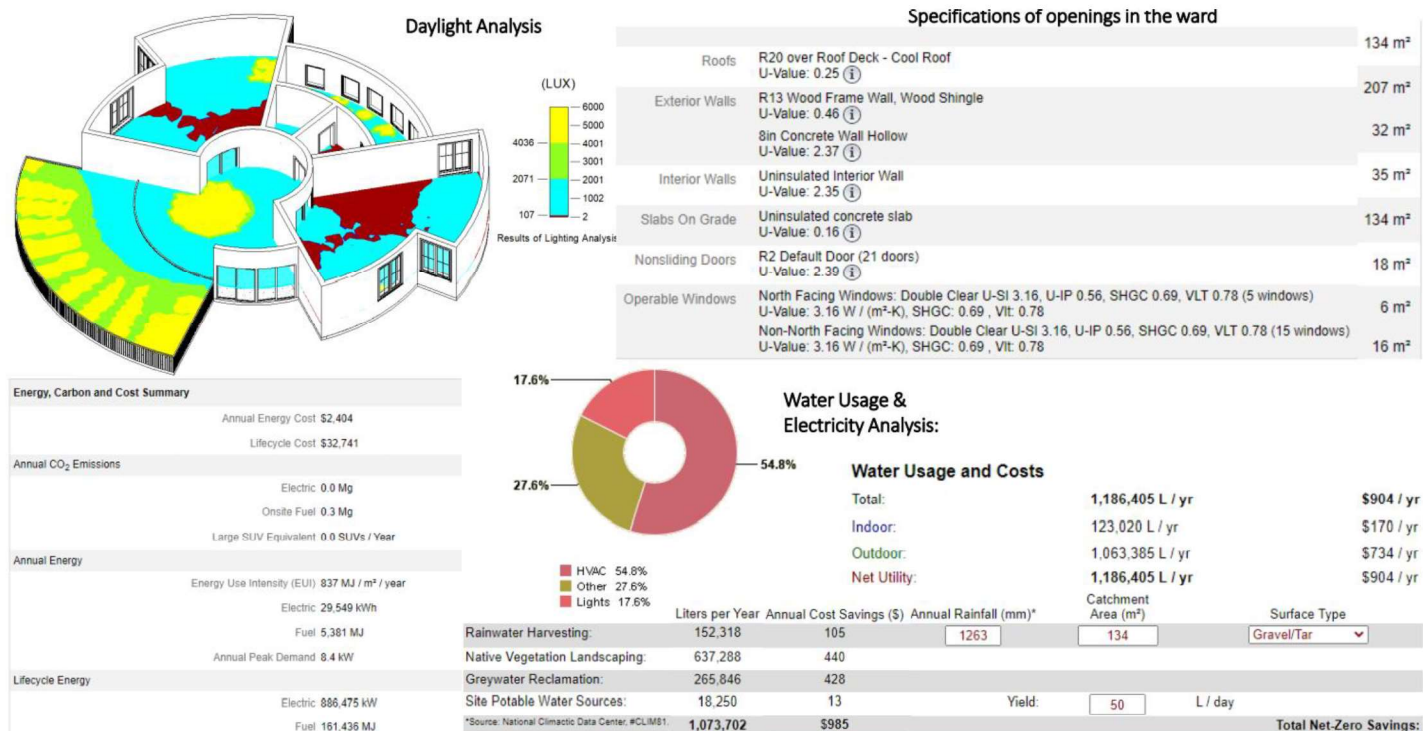
- Rain water harvesting from roof = Area of roof x co- efficient x annual rainfall (mm) x 1000
- Annual rainfall of Bhopal – 1126.7 mm
- Occupants in Studio – 3 persons
- Co efficient of roof run off – 0.3
- Area of roof – 1282.3 sq. m
- Rain water harvesting – $1282.3 \times 0.3 \times 1126.7 \times 1000$
_ 43343022 liters

6.3 DAYLIGHT & ENERGY SAVINGS :

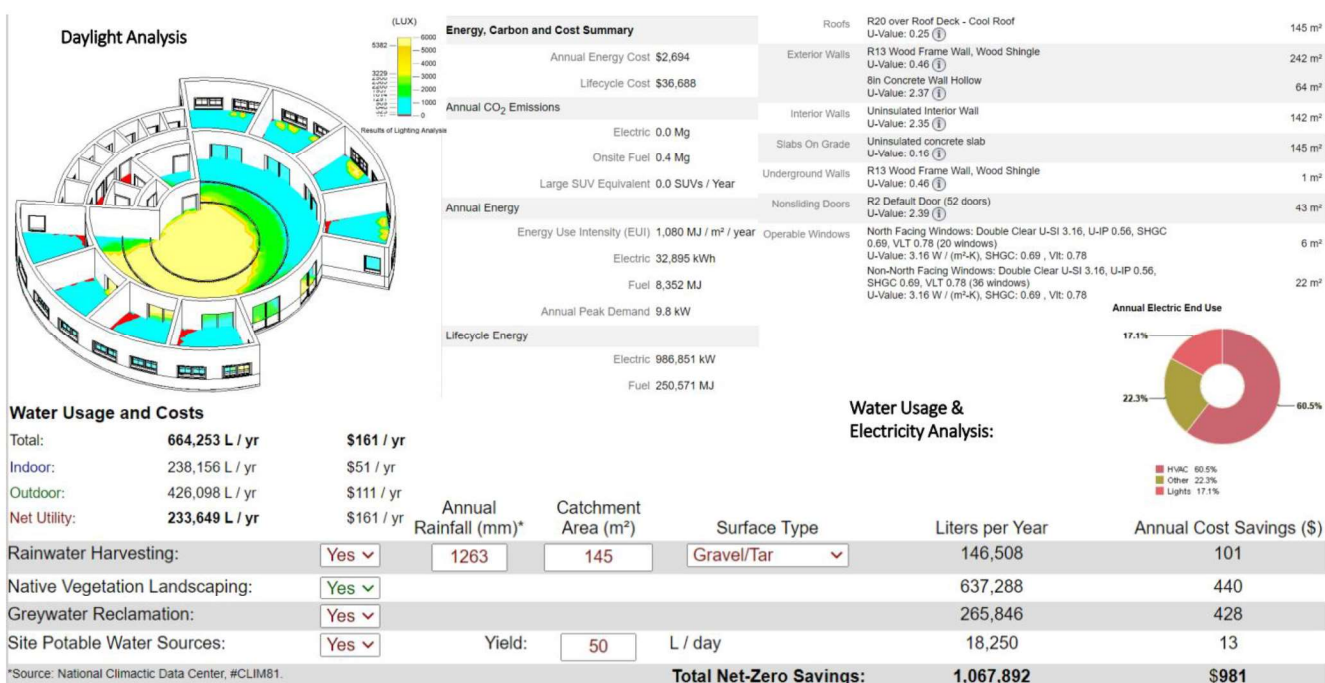
6.3.1 DORM:



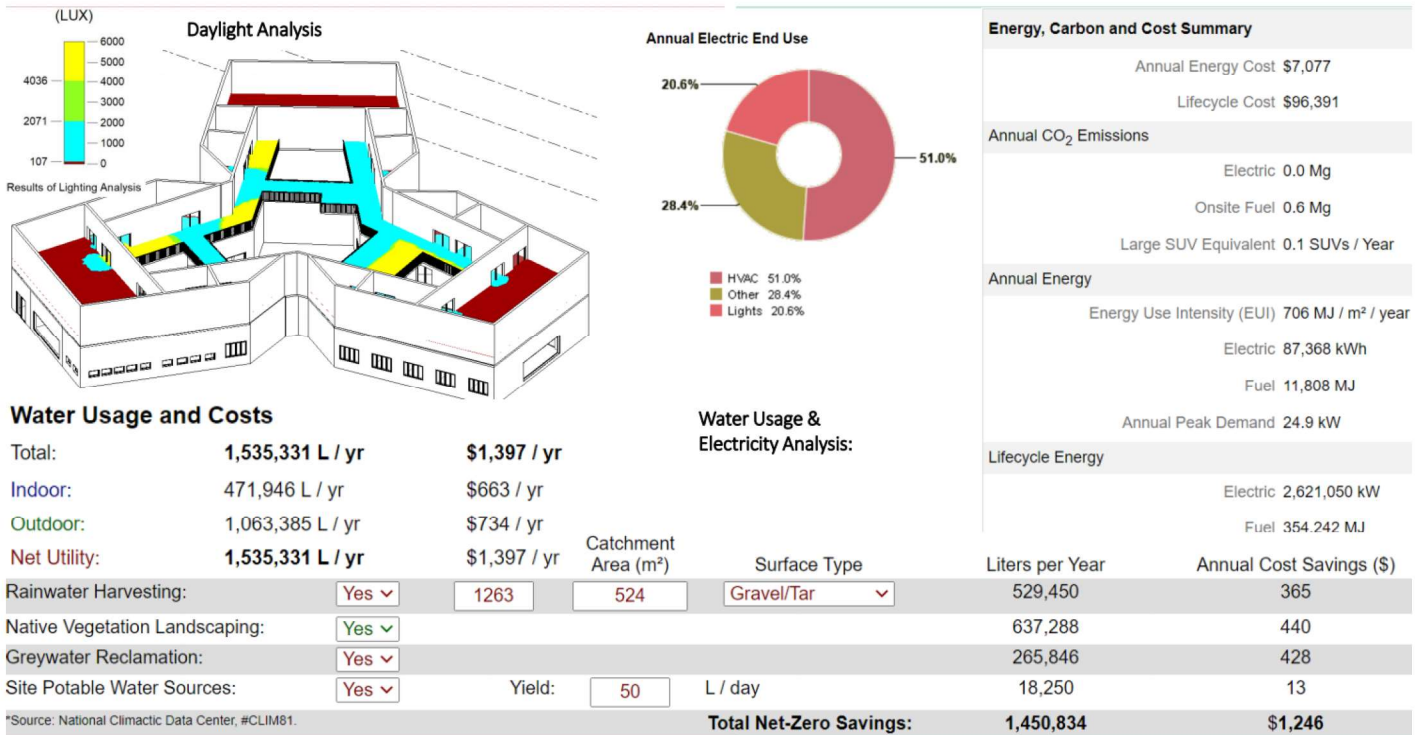
6.3.2 4 – BEDDED WARD:



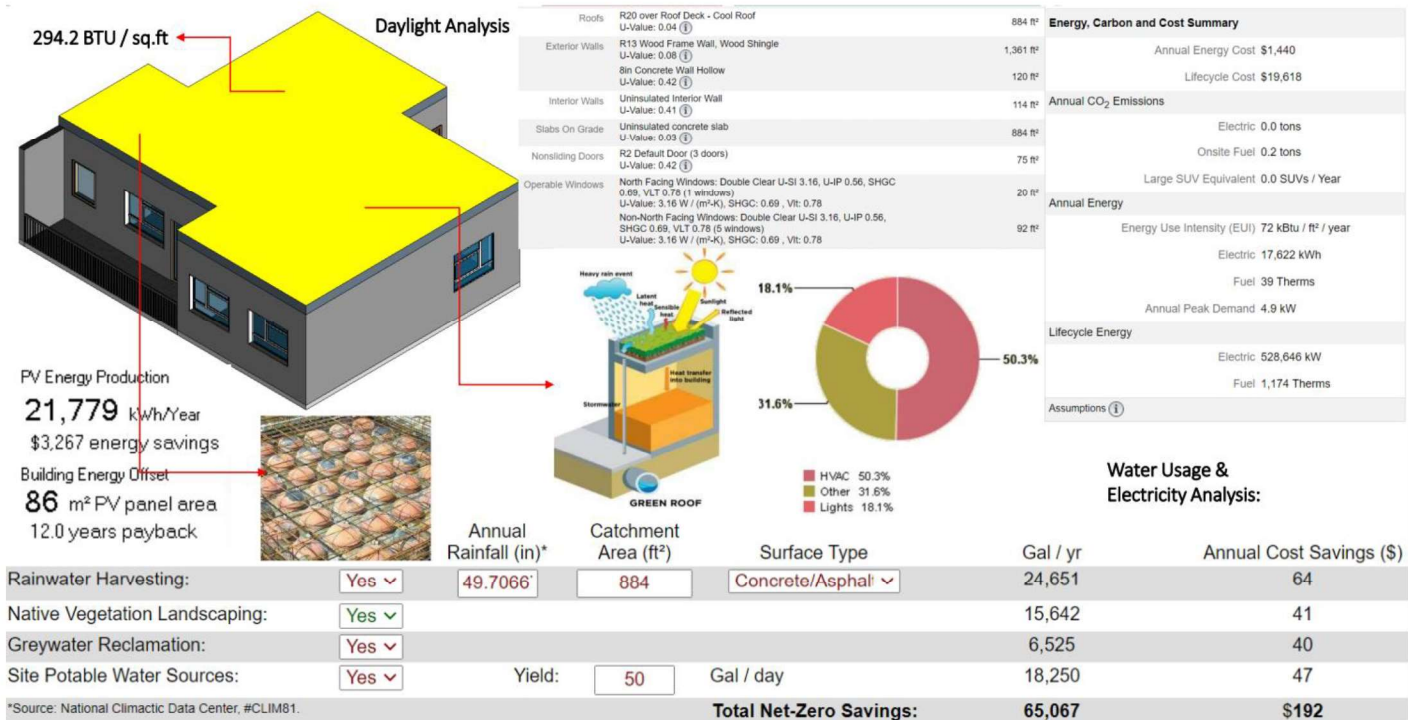
6.3.3 1 – BEDDED WARD:



6.3.4 ADMIN:



6.3.5 ACCOMODATIONS:



6.4 STORM- WATER MANAGEMENT & SOLAR PANEL CALCULATIONS FOR THE WHOLE SITE:

STORM WATER RUN - OFF CALCULATIONS THROUGHOUT THE 3 wards		
Qt =	C * It * A	
Qt: runoff rate for a T-year storm, in liters/second C: runoff coefficient, nondimensional IT: rainfall intensity for a T-year storm at a storm duration t, in liters/(second*hectare) A: area of the catchment area, in hectares		
C	0.8	(With the ref. to the table)
It	3,107	in mm(annual rainfall)
A	0.1943	in h.a(1943 sq.mts)
	0.09715	Considering 50% area
Qt =	241.47604	(240 liters / second)

STORM WATER RUN - OFF CALCULATIONS THROUGHOUT ADMIN		
Qt =	C * It * A	
Qt: runoff rate for a T-year storm, in liters/second C: runoff coefficient, nondimensional IT: rainfall intensity for a T-year storm at a storm duration t, in liters/(second*hectare) A: area of the catchment area, in hectares		
C	0.8	(With the ref. to the table)
It	3,107	in mm(annual rainfall)
A	0.0873	in h.a(873 sq.mts)
	0.04365	Considering 50% area
Qt =	108.49644	(110 liters / second)

SOLAR PANEL CALCULATIONS		
Dimension of single solar panel (standards for commercial purpose)	77" x 39" - 30030 sq.inch	1.93 sq.m
Electricity produced by a single solar panel	500 Wh/ day	
Roof Area of 1 bedded Wards	618	sq.m
Roof Area of 4 bedded Wards	600	
Roof Area of Dorm Wards	725	
Roof area of 3 wards	1943	
Considering 30% of Roof Area	582.9	
NO. of solar panels to be installed - Roof area / Area of single solar panel	302.07	300 panels
Total generation of electricity in the site through solar panels -Electricity produced by a single solar panel * NO. of solar panels to be installed	150000	Wh/day

3 WARDS

SOLAR PANEL CALCULATIONS		
Dimension of single solar panel (standards for commercial purpose)	77" x 39" - 30030 sq.inch	1.93 sq.m
Electricity produced by a single solar panel	500 Wh/ day	
Roof Area of Admin Block	873	135 panels
Considering 30 % of Roof Area	261.9	
NO. of solar panels to be installed - Roof area / Area of single solar panel	135.70	
Total generation of electricity in the site through solar panels -Electricity produced by a single solar panel * NO. of solar panels to be installed	67500	Wh/day

ADMIN

S.no.	Description	kw/ year	Wh / day
1	Electric usage as per Revit Simulation for 1 bedded ward	986851	64888.83288
2	Electric usage as per Revit Simulation for 4 bedded ward	886475	58288.76712
3	Electric usage as per Revit Simulation for Dorm ward	787633	51789.56712
4	No. of 1-bedded Wards		3
5	No. of 4-bedded Wards		4
6	No. of dorm Wards		5
7	Total Electrical Usage of 1 bedded ward		194666.4986
8	Total Electrical Usage of 4 bedded ward		233155.0685
9	Total Electrical Usage of Dorm ward		258947.8356
Total Electrical Usage of all the 3 wards through simulations			686769.4027
Total Electrical Usage of all the 3 wards through solar panels			150000
			21.80%

S.no.	Description	kw/ year	Wh / day
1	Total Electric usage as per Revit Simulation Admin	2621050	172343.0137
Total Electrical Usage of all the 3 wards through solar panels			67500
			35%

60

6.6 ANALYSIS ON SPECIFICATION OF LOCAL BUILDING MATERIALS:

The **time delay** due to the thermal mass is known as a **time lag**.
The thicker and more resistive the material, the longer it will take for heat waves to pass through.

TIME LAG FOR WALL		
Base case		
Brick wall	230 mm	3 hrs
Cement Plastering	25 mm	0.26 hrs
Time lag	3.26 hrs	
Thickness of wall	255 mm	

TIME LAG FOR WALL		
Iteration - 1		
Cement Plastering	25 mm	0.26 hrs
AAC blocks	200 mm	7 hrs
Cement Plastering	25 mm	0.26 hrs
Time lag	7.52 hrs	
Thickness of wall	250 mm	

TIME LAG FOR WALL		
Iteration - 2		
Cement Plastering	25 mm	0.26 hrs
Insulated Brick veneer	50 mm	5 hrs
Cement Plastering	25 mm	0.26 hrs
Time lag	5.52 hrs	

TIME LAG FOR WALL		
Iteration - 3		
Brick wall	230 mm	3 hrs
Cement Plastering	25 mm	0.26 hrs
Adhesive	10mm	0.15 hrs
XPS Board	75 mm	4.5 hrs
Cement Plastering	25 mm	0.26 hrs
Exterior Finish	10mm	0.15 hrs
Time lag	8.58 hrs	
Thickness of wall	375 mm	

INFERENCE :

TIME LAG FOR WALL		
Iteration - 4		
Double Brick	250 mm	8 hrs
Air cavity	25 mm	1 hr
XPS Board	25 mm	1.5 hrs
Glazing	12.7mm	0.75 hrs
Adhesive	10mm	0.15 hrs
Interior Finish	10mm	0.15 hrs
Time lag	11.55 hrs	
Thickness of wall	370 mm	



Brick wall construction



AAC block Construction

By analyzing the 4 iterations of wall, 4th iteration has least thickness of wall and has maximum time lag. So this is benefited for the less amount of heat passing through the building. By giving the insulated wall, the occupants experiences thermal comfort by the reduction of heat gain and loss during summer and winter respectively

Admin		Wards		Accommodation	
Burnt Bricks		Burnt Bricks		Burnt Bricks	
Area (a)	873	Area (a)	1943	Area (a)	5046
k-value (b)	0.64	k-value (b)	0.64	k-value (b)	0.64
Temp. Diff. ©	5	Temp. Diff. ©	5	Temp. Diff. ©	5
a x b x c	2793.6	a x b x c	6217.6	a x b x c	16147.2
thickness (d)	9	thickness (d)	9	thickness (d)	9
Heat loss	310.40	Heat loss	690.84	Heat loss	1794.13
Vitrified Tiles		Vitrified Tiles		Vitrified Tiles	
Area (a)	873	Area (a)	1943	Area (a)	5046
k-value (b)	0.62	k-value (b)	0.62	k-value (b)	0.62
Temp. Diff. ©	5	Temp. Diff. ©	5	Temp. Diff. ©	5
a x b x c	2706.3	a x b x c	6023.3	a x b x c	15642.6
thickness (d)	0.7	thickness (d)	0.7	thickness (d)	0.7
Heat loss	3866.14	Heat loss	8604.71	Heat loss	22346.57

S.No.	Building materials	Area(sq.m)	Qty	Units	Rate	Amount (Rs)
Admin	Wall	Burnt Bricks(7.4" x 3.5"x3.5")	381387	m2	Rs. 5.5 / block	2097628.5
	Floor	Vitrified Tiles	Nil	m2	Rs. 308/ sq.m	268884
	Roof	F. S + Green Roof + Bamboo	Nil	m2	Rs. 604/ sq.m	527292
Total Amount in INR						2893804.5
S.No.	Building materials	Area(sq.m)	Qty	Units	Rate	Amount (Rs)
Wards	Wall	Burnt Bricks(7.4" x 3.5"x3.5")	848838	m2	Rs. 5.5 / block	4668609
	Floor	Vitrified Tiles	Nil	m2	Rs. 308/ sq.m	598444
	Roof	Lune Tile + Green Roof	Nil	m2	Rs. 562/ sq.m	1091966
Total Amount in INR						6359019
S.No.	Building materials	Area(sq.m)	Qty	Units	Rate	Amount (Rs)
Accommodation	Wall	Burnt Bricks(7.4" x 3.5"x3.5")	848838	m2	Rs. 5.5 / block	4668609
	Floor	Vitrified Tiles	Nil	m2	Rs. 308/ sq.m	598444
	Roof	F.S + Green Roof	Nil	m2	Rs. 453/ sq.m	880179
Total Amount in INR						6147232

Admin		Wards		Accommodation	
Burnt Bricks		Burnt Bricks		Burnt Bricks	
Area	873	Area	1943	Area	5046
U-value	0.31	U-value	0.31	U-value	0.31
Temp. Diff.	5	Temp. Diff.	5	Temp. Diff.	5
Heat gain	1353.15	Heat gain	3011.65	Heat gain	7821.3
Vetrified Tiles		Vetrified Tiles		Vetrified Tiles	
Area	873	Area	1943	Area	5046
U-value	0.42	U-value	0.42	U-value	0.42
Temp. Diff.	5	Temp. Diff.	5	Temp. Diff.	5
Heat gain	1833.3	Heat gain	4080.3	Heat gain	10596.6

HEAT LOSS through wall, floor / HEAT GAIN through wall, floor / COST BENEFIT ANALYSIS:

1. Admin Block
2. Accommodation Block
3. Ward Blocks
 - 1 bedded wards
 - 4 – bedded Wards
 - Dorms

CHAPTER – 7

RESULTS & INFERENECES

7.1 SITE BREAKUP AREA:

S.No.	Major Concentrations		NO.s	Area sq.m
1	Admin Block		1	873
2	Wards	1 bedded	3	618
		4 bedded	4	600
		Dorm	5	725
3	Acomodations		1	1682
	Supporting Blocks			
1	Service Blocks		2	720 / each
2	Commercial Complex		1	830
3	Guard Rooms		3	50 / each
4	OAT & Supporting Services		1	900
5	Public Parks		3	150 / each
Net Pervious Area				1554
Net Impervious Area				942
Green Area (Korean Grass) with Native Plants				1666
Existing Vegetation in the site				95
Newly Planted vegetation				120

7.2 FINAL INFERENCES & QUANTIFICATION FROM THE TOTAL SITE :

S.No.	Description	Wards	Admin	Accommodations
1	Electricity through solar Panels (kWh)	150000	67500	672695
2	Storm water Run Off (l/s)	240	110	542
3	Green Roof	Done	Done	Done
4	Material Used for Building Envelope(Roof)	Lune Tiles + Green Roof	Filler Slab + Green Roof + Bamboo	Filler Slab + Green Roof
5	Material Used for Building Envelope(wall)	Exposed Brickwork (inferred from Pre- thesis)		
6	Material Used for Building Envelope(Floor)	Vitrified Tiles (inferred from Pre- thesis)		
7	Heat Gain through walls	3011.65	1353.15	7821.3
	Heat Gain through Floors	4080.3	1833.3	10596.6
8	Heat Loss through Walls	690.84	310.4	1794.13
	Heat Loss through Floors	8604.71	3866.14	22346.57
9	Material Cost Benefit Analysis (INR)	6359019	2893804.5	6147232
10	Disposal Method	Bio - Medical Waste + Domestic waste		
		Autoclave Disposal Method		