

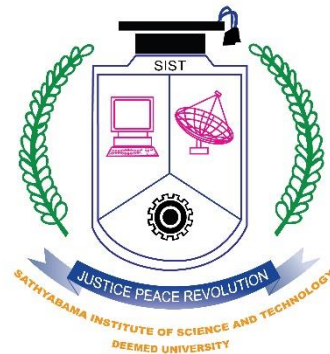
CENTER FOR SUSTAINABLE RESEARCH & TECHNOLOGY

A Thesis

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

by

RAKESH KUMAR M J (39890013)



**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

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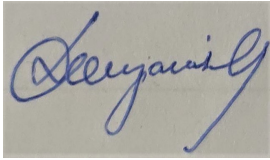
BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **MJ RAKESH KUMAR (39890013)** who carried out the Thesis entitled “**CENTRE FOR SUSTAINABLE RESEARCH AND TECHNOLOGY**” under our supervision from January 2021 to May 2021.

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I **MJ RAKESH KUMAR** hereby declare that the Thesis Report entitled “**CENTRE FOR SUSTAINABLE RESEARCH AND TECHNOLOGY**” done by me under the guidance of **Ar.SANGHAVI**(INTERNAL) and **Ar. P.S. GANESH, Principal Architect – GREENVIRON / Ar. BALAMURUGAN RAJKUMAR, Principal Architect -Proton Ateliers** (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:

PLACE:

SIGNATURE OF THE CANDIDATE

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ABSTRACT

As humans we have always been dependent on nature for our growth this is a critical time for the world. At UNDP, they see this period as a huge opportunity to advance the global sustainable development agenda. UNDP stands for United Nations Development Programme. In September 2015, world leaders adopted the 2030 Agenda for Sustainable Development to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. Thus, this Sustainable development goals helps in creating a place which create balance in pillars of sustainability in nation. The study will be evaluating the various challenges in the Location, Energy, Water, Comfort and Material of the Building which plays a role in maintaining harmony in ecological, environmental and social sustainability. We live in an ecosystem consists of Buildings, Roads and Pollution not with Biotic and Abiotic components. The study is to analyse and understand how building can perform as an ecosystem. This study deals with Location, Energy, water, Comfort and Material of the Building. The study will be evaluating the various challenges associated with building performing as an ecosystem.

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LIST OF SYMBOLS AND ABBREVIATIONS

T_a	-	Air Temperature
T_{mrt}	-	Mean Radiant Temperature
V	-	Wind Speed
RH	-	Relative humidity
PET	-	Physiological equivalent temperature
SVF	-	Sky view factor
U value	-	Thermal Transmittance
R value	-	Thermal Resistance
CSEB	-	Compressed Stabilized Earth Blocks

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The design is to analyse and understand how building can perform as an ecosystem. This design deals with Location, Energy, water, Comfort and Material of the Building. The design will be evaluating the various challenges associated with building performing as an ecosystem.

1.2 AIM

Designing a building which can perform as an ecosystem contributing in a positive way to the environment..

1.3 OBJECTIVE

- To design a centre that will take to consideration the Social , Economical and Ecological impact.
- To design in response to context , conserve resources and generate renewable energy.
- An approach towards sustainable environment and provides healthier spaces for occupants using sustainable materials and technology.
- Educating people and occupants about green building concepts while minimizing resources consumed by the building during its construction and lifetime.

1.4 SCOPE

- Designing a building and challenges associated in creating a “centre that can perform as an ecosystem”.
- To identify a site which has a scope for regeneration.
- Designing research centre which generate its own energy requirement and adapting passive strategies.

1.5 LIMITATIONS

- This project is limited to designing a single structure adapting all the strategies.
- This design is restricted to warm and humid climate.

1.6 TYPOLOGY

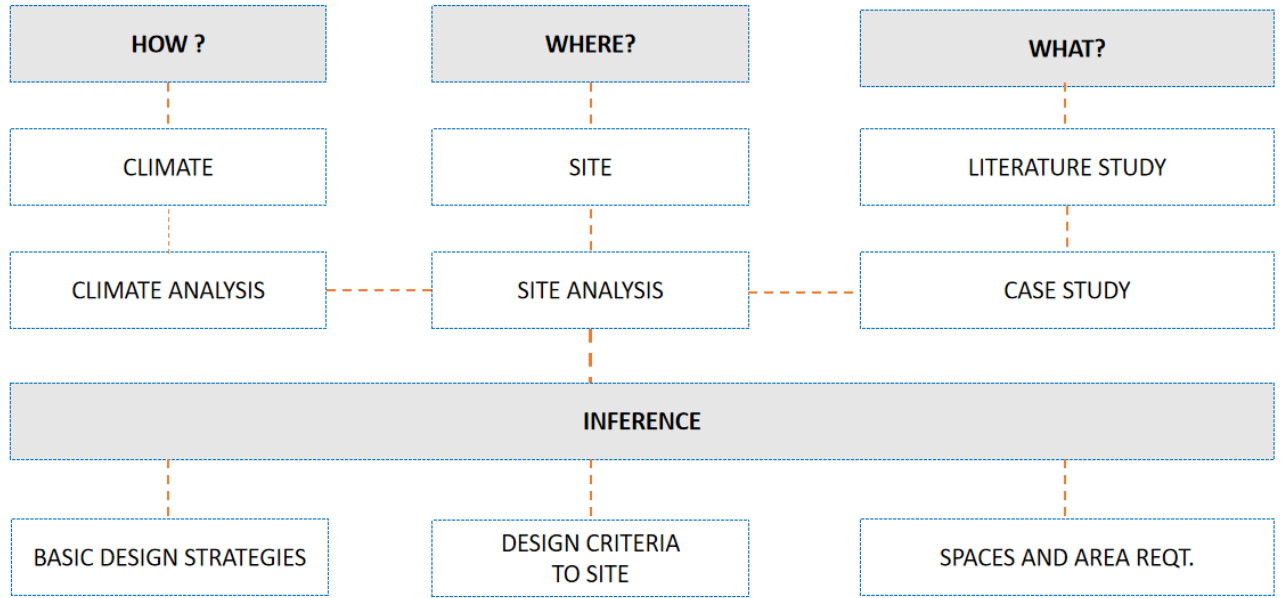
Institution - CENTRE FOR SUSTAINABLE RESEARCH AND TECHNOLOGY.

1.7 METHODOLOGY

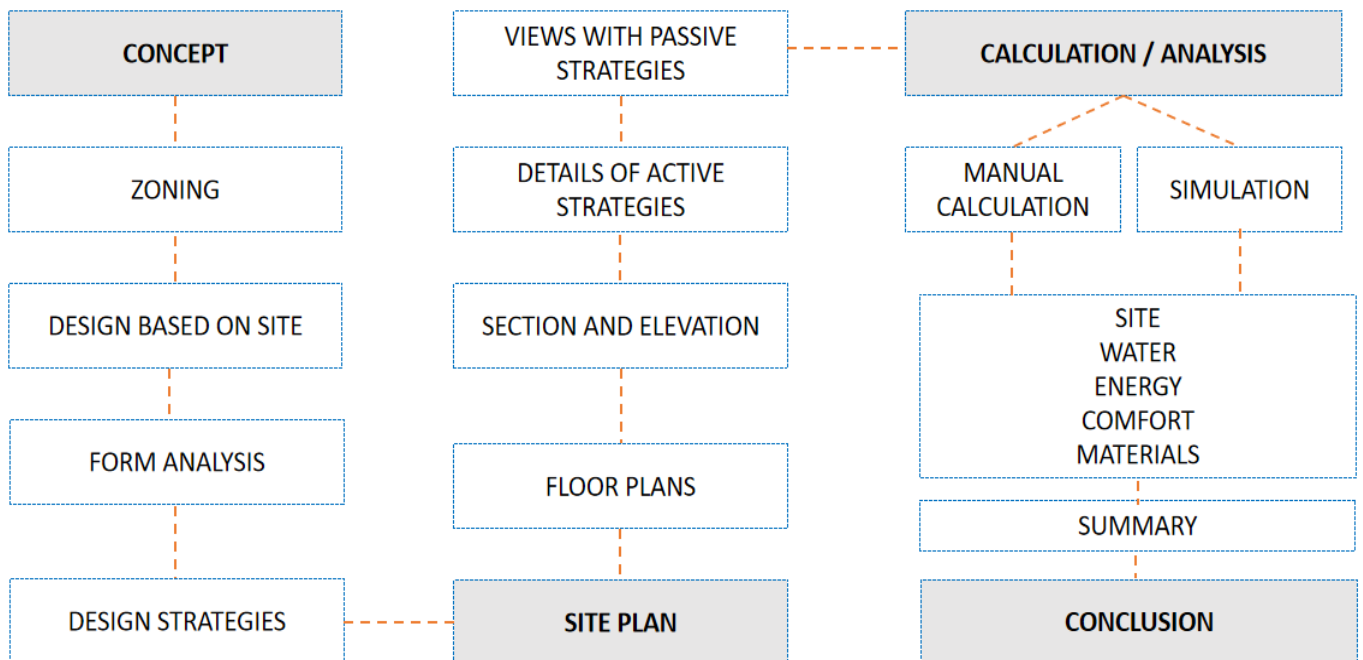


Fig:1.7.Methodology

1.7.1. METHODOLOGY | PHASE 1 - STUDY



1.7.2. METHODOLOGY | PHASE 2 AND PHASE 3 - DESIGN AND ANALYSIS



CHAPTER 2 LITERATURE REVIEW

2.1.CLIMATE ANALYSIS

Tab:2.1.1.

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	357	418	400	422	450	448	426	450	428	359	317	331	Wh/sq.m
Direct Normal Radiation (Avg Hourly)	275	320	230	239	308	309	248	286	268	190	168	218	Wh/sq.m
Diffuse Radiation (Avg Hourly)	181	195	235	247	217	215	236	225	225	225	206	195	Wh/sq.m
Global Horiz Radiation (Max Hourly)	936	984	962	954	1058	1050	985	1104	1092	870	763	778	Wh/sq.m
Direct Normal Radiation (Max Hourly)	1399	1021	965	948	1017	999	843	990	974	812	698	892	Wh/sq.m
Diffuse Radiation (Max Hourly)	405	455	497	510	508	501	504	509	504	480	425	385	Wh/sq.m
Global Horiz Radiation (Avg Daily Total)	4053	4834	4786	5199	5678	5722	5402	5592	5177	4207	3620	3728	Wh/sq.m
Direct Normal Radiation (Avg Daily Total)	3117	3700	2754	2940	3889	3946	3143	3551	3242	2226	1919	2458	Wh/sq.m
Diffuse Radiation (Avg Daily Total)	2054	2262	2814	3048	2744	2747	2998	2800	2715	2638	2353	2193	Wh/sq.m
Global Horiz Illumination (Avg Hourly)													lux
Direct Normal Illumination (Avg Hourly)													lux
Dry Bulb Temperature (Avg Monthly)	24	25	28	30	31	31	30	29	29	27	25	24	degrees C
Dew Point Temperature (Avg Monthly)	19	19	24	24	24	23	24	23	23	24	22	20	degrees C
Relative Humidity (Avg Monthly)	76	72	79	72	69	68	70	71	74	82	84	76	percent
Wind Direction (Monthly Mode)	90	90	140	140	180	270	270	270	270	90	0	50	degrees
Wind Speed (Avg Monthly)	1	2	2	2	3	3	2	3	2	1	1	2	m/s
Ground Temperature (Avg Monthly of 3 Depths)	26	25	25	26	27	29	30	30	29	29	27	26	degrees C

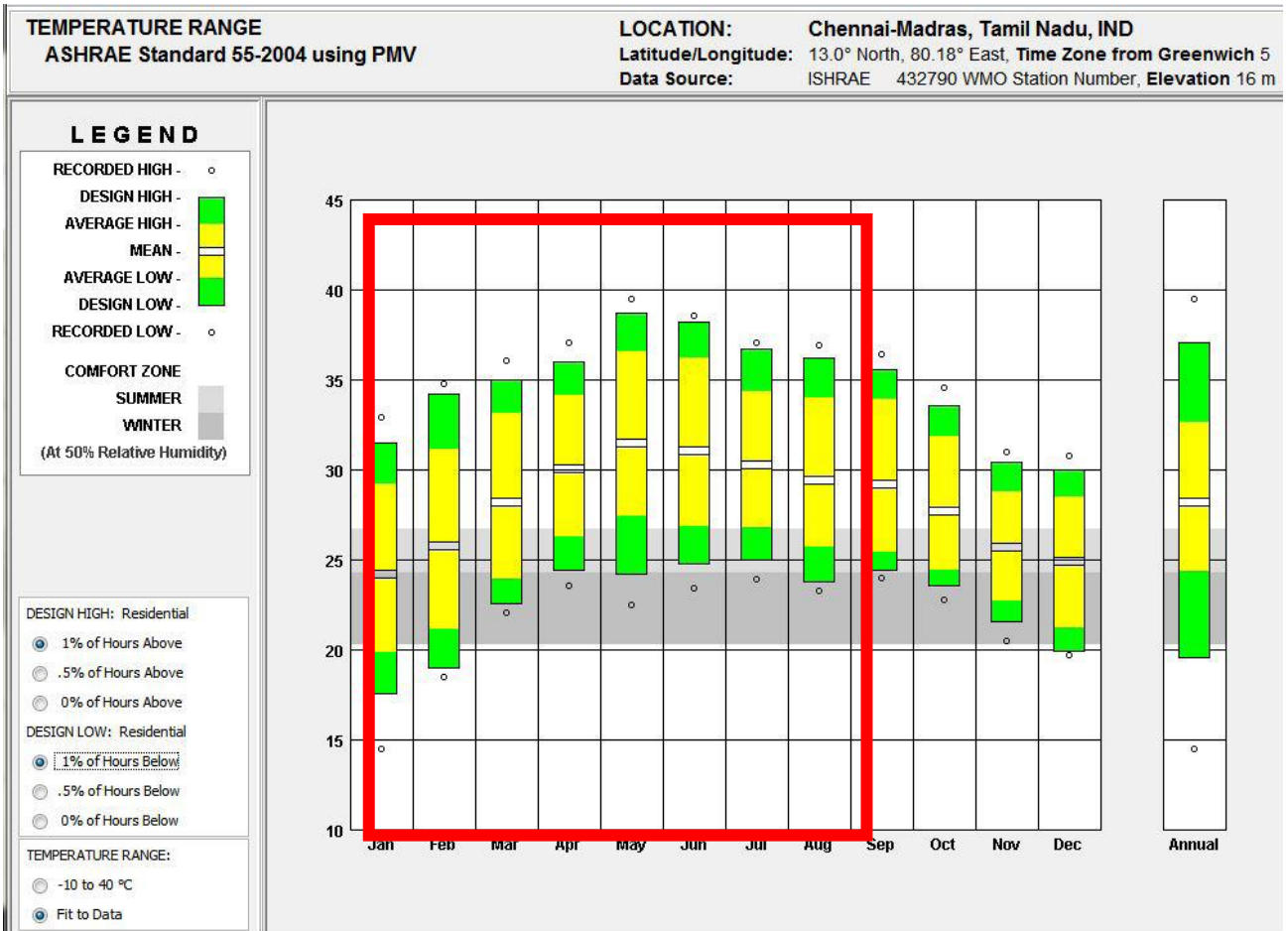


Fig.2.1.1.

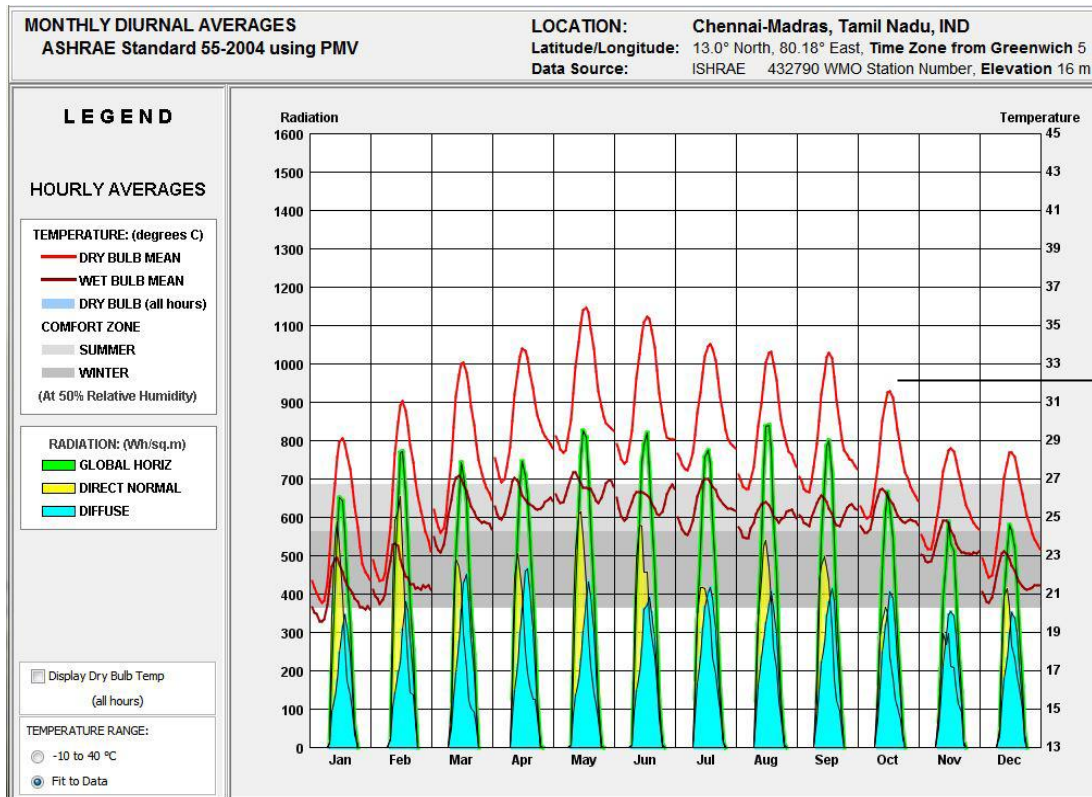
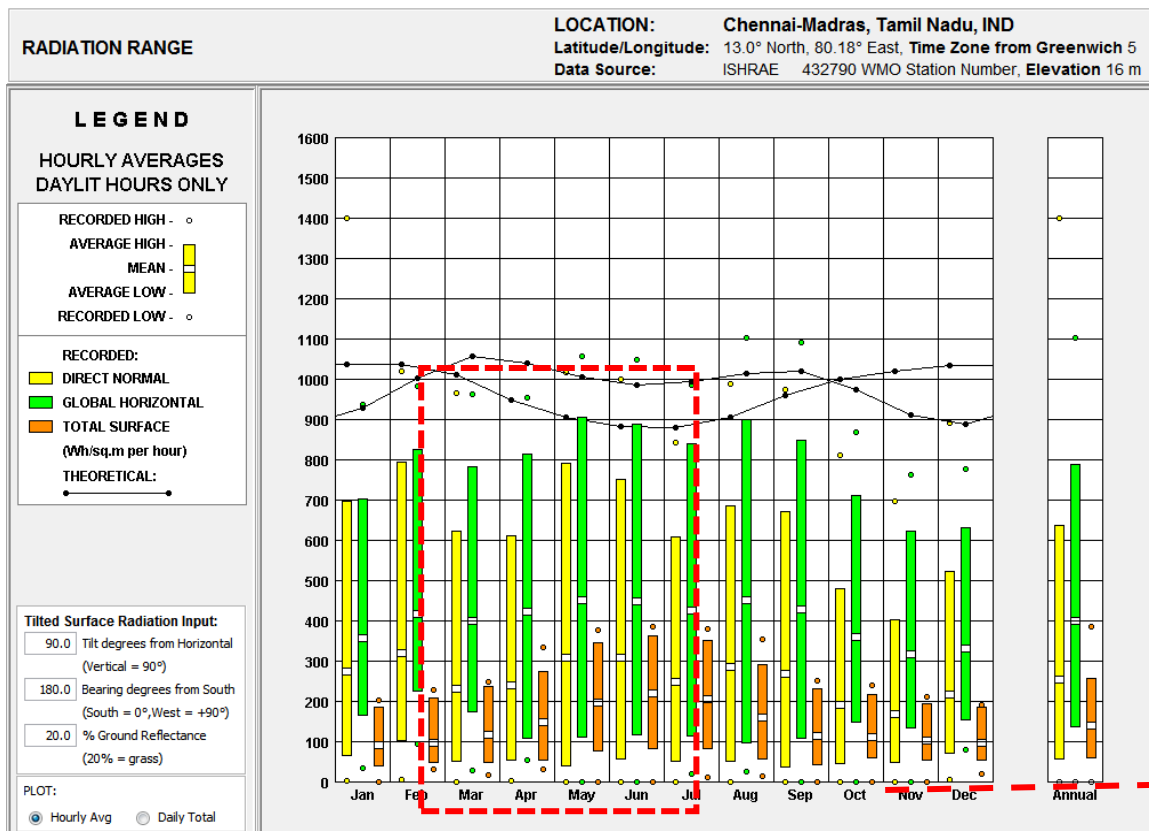


Fig:2.1.2.

Minimal gap between the dry and wet bulb plotting denote high humidity levels in November.

High amounts of Global Radiation (Direct and Diffused radiations combined) to be countered with appropriate shading devices

High amounts of Direct Radiation to be countered with appropriate shading devices



High amounts of Global

Radiation During the Months

from May to September.

This has to be countered with

appropriate shading devices.

The dry bulb temp of May and June lie completely outside the comfort width. The wind speed is not enough for providing passive comfort. Other design strategies, say shading device to cool the air outside and promote induced ventilation and cross ventilation, are to be considered.

Fig:2.1.4.

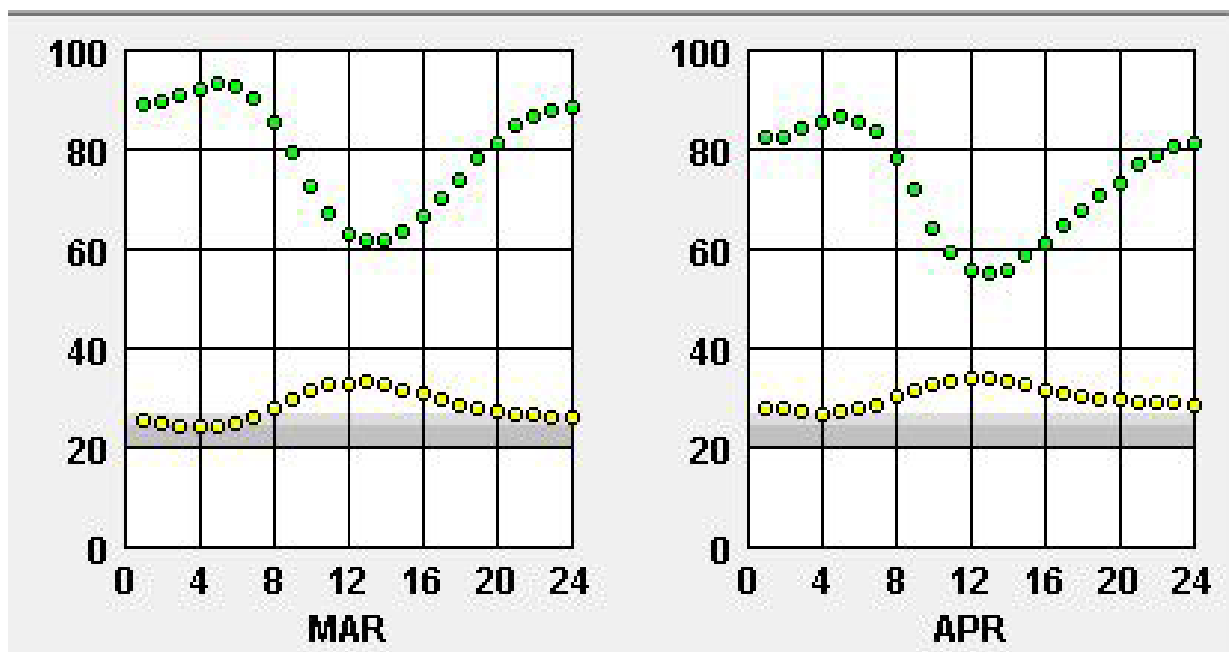


Fig. 4.13.

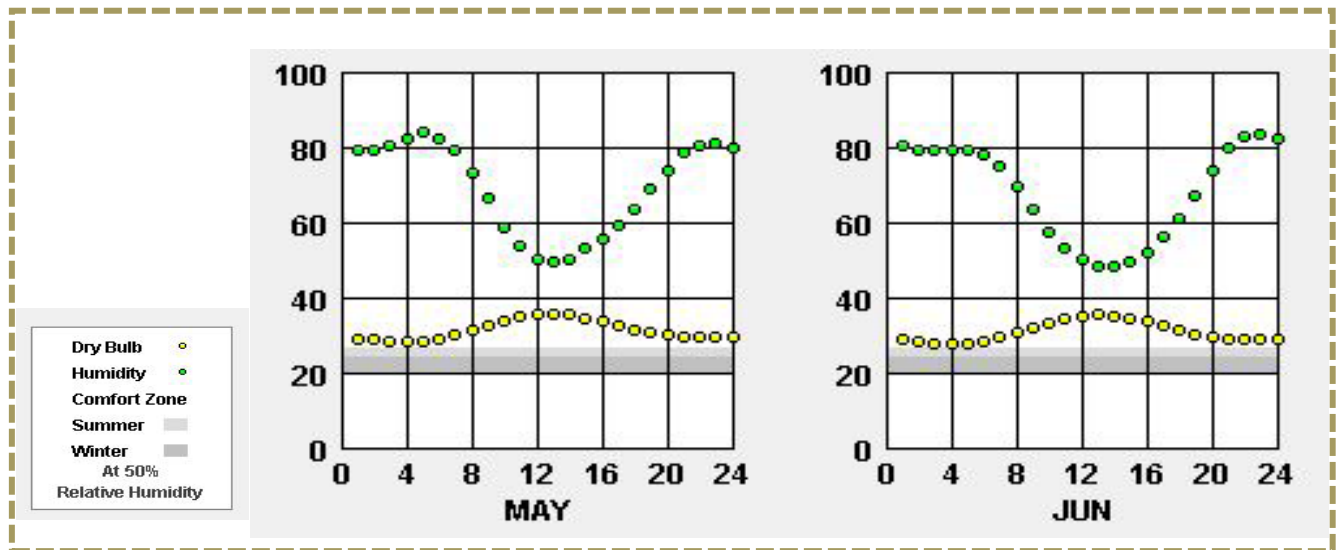
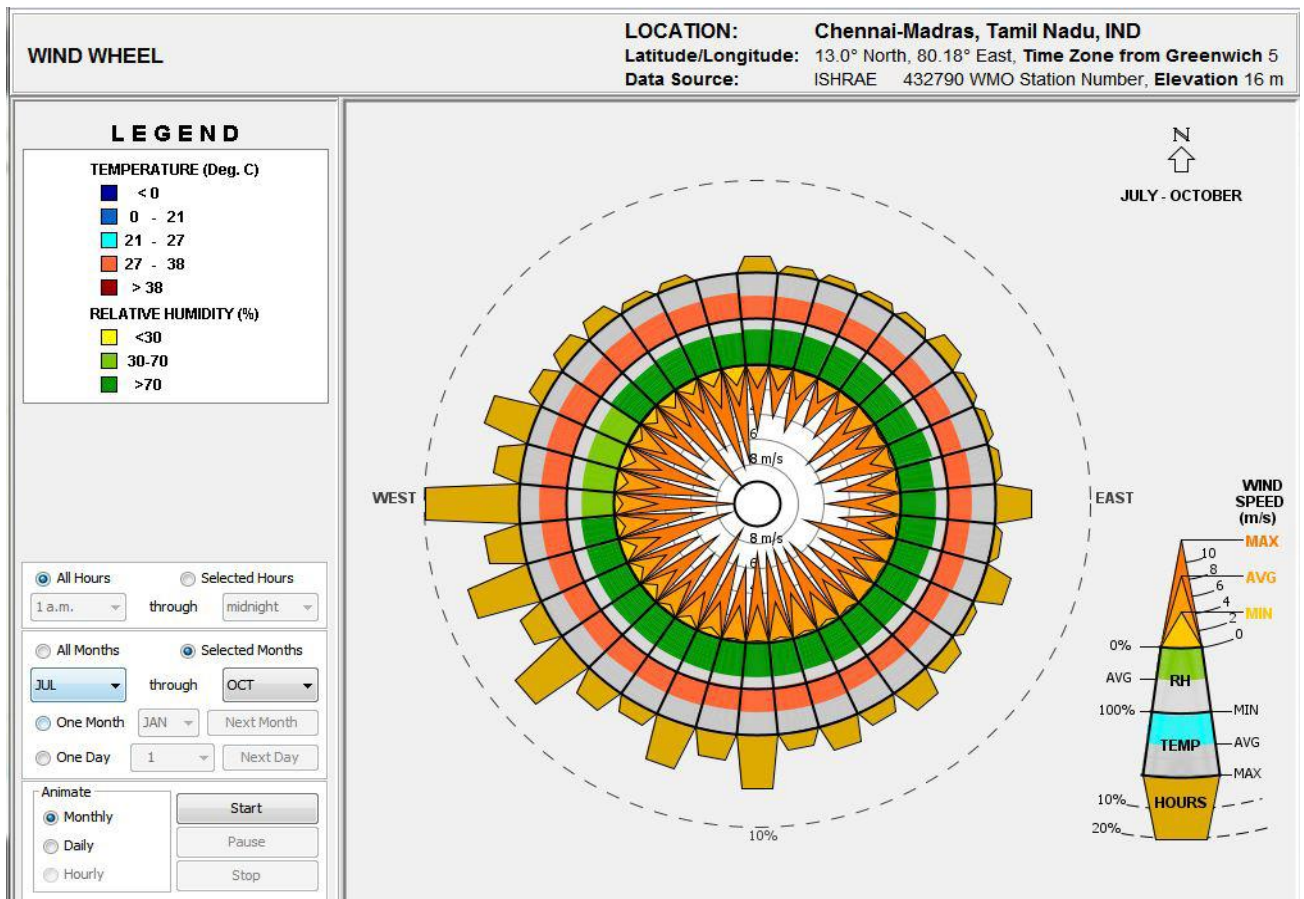


Fig:2.1.6



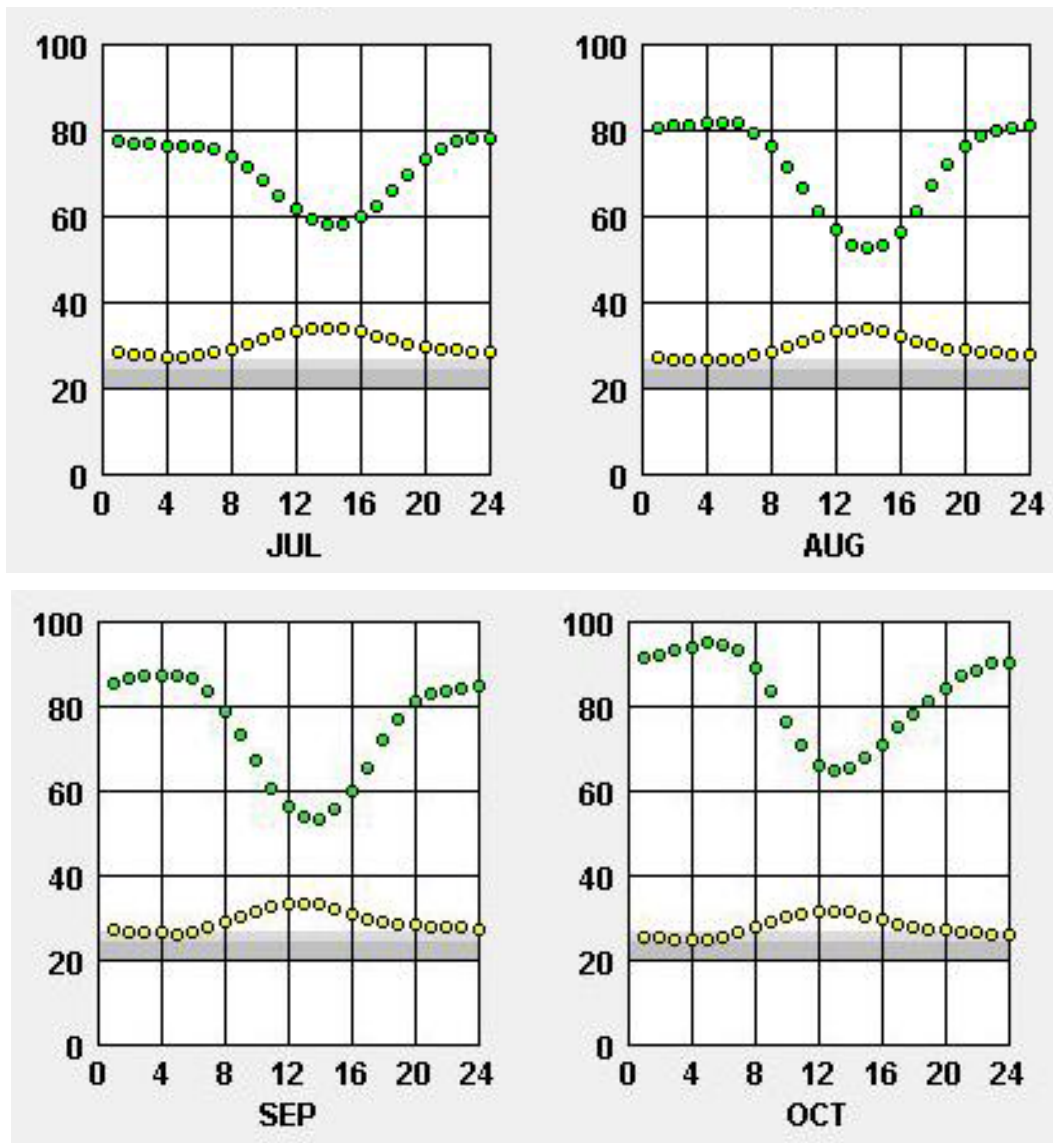


Fig:2.1.8.

Monsoon (July-October)

The humidity level in October is 61%, as seen from the chart below. Cross ventilation is essential as the lack of it will cause moisture and dampness on the inside.

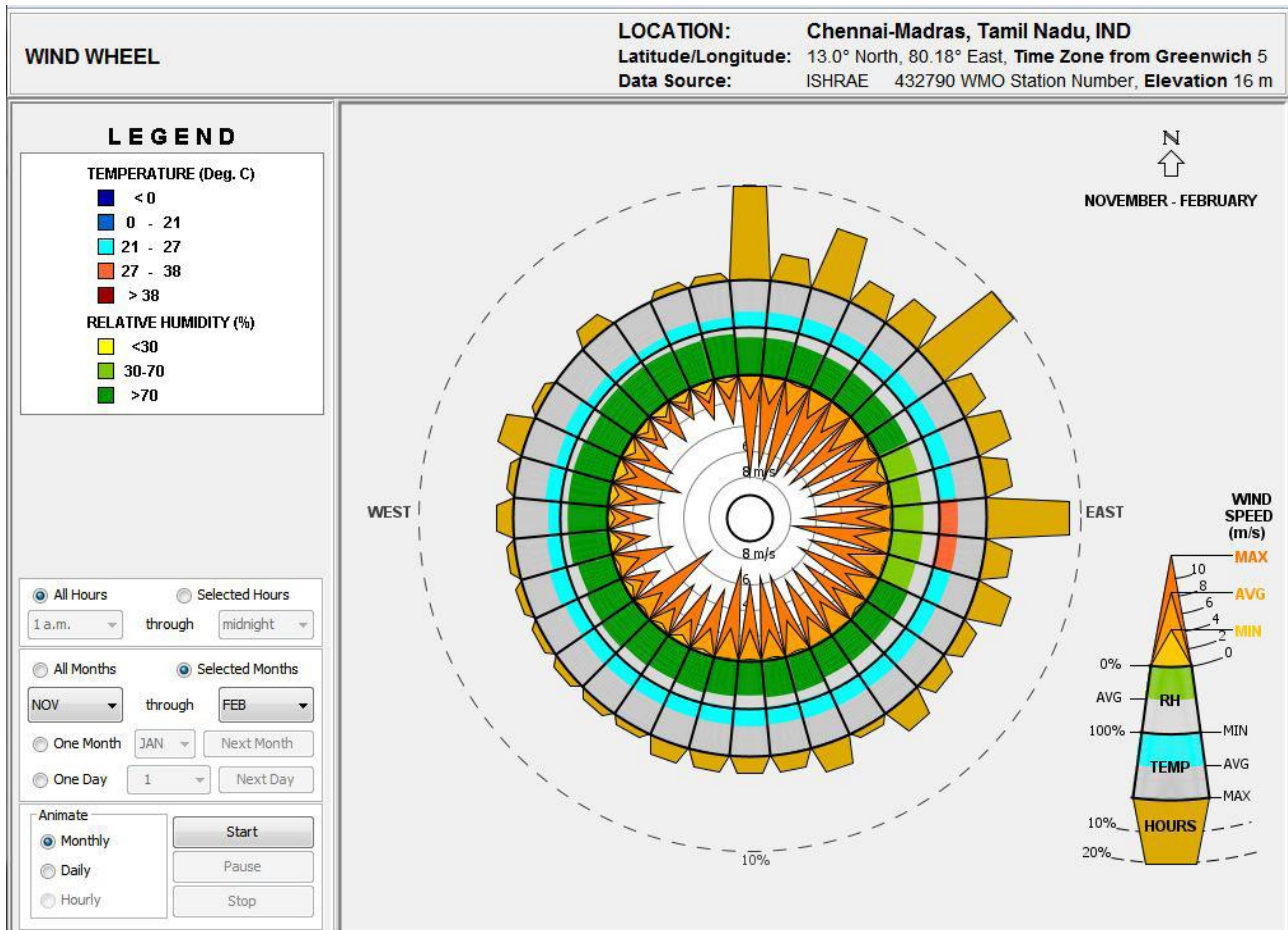
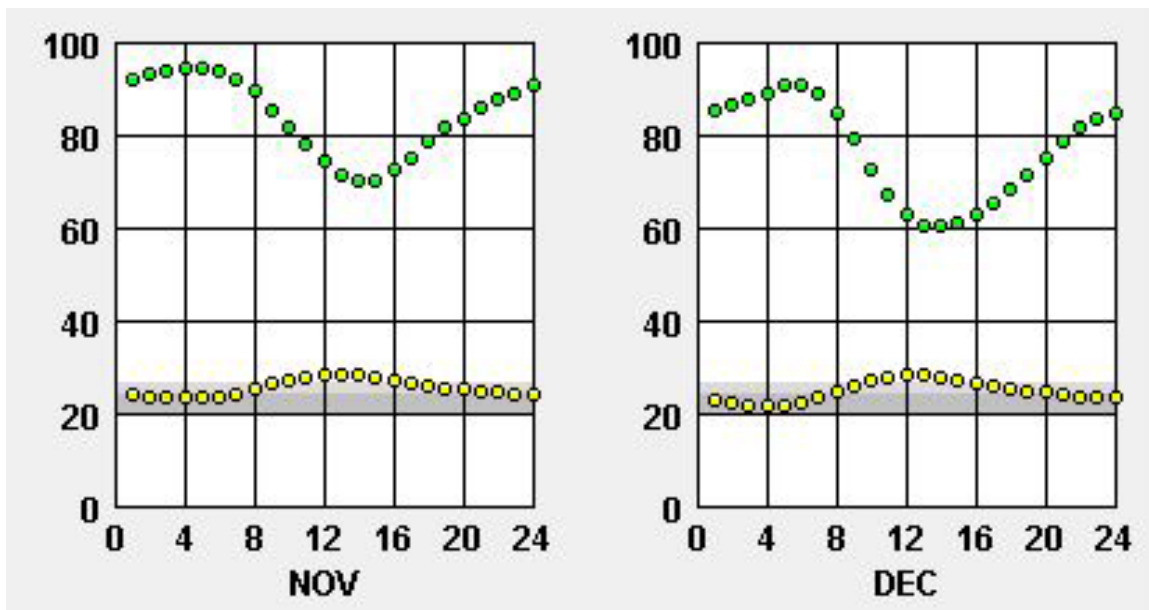


Fig:2.1.9.



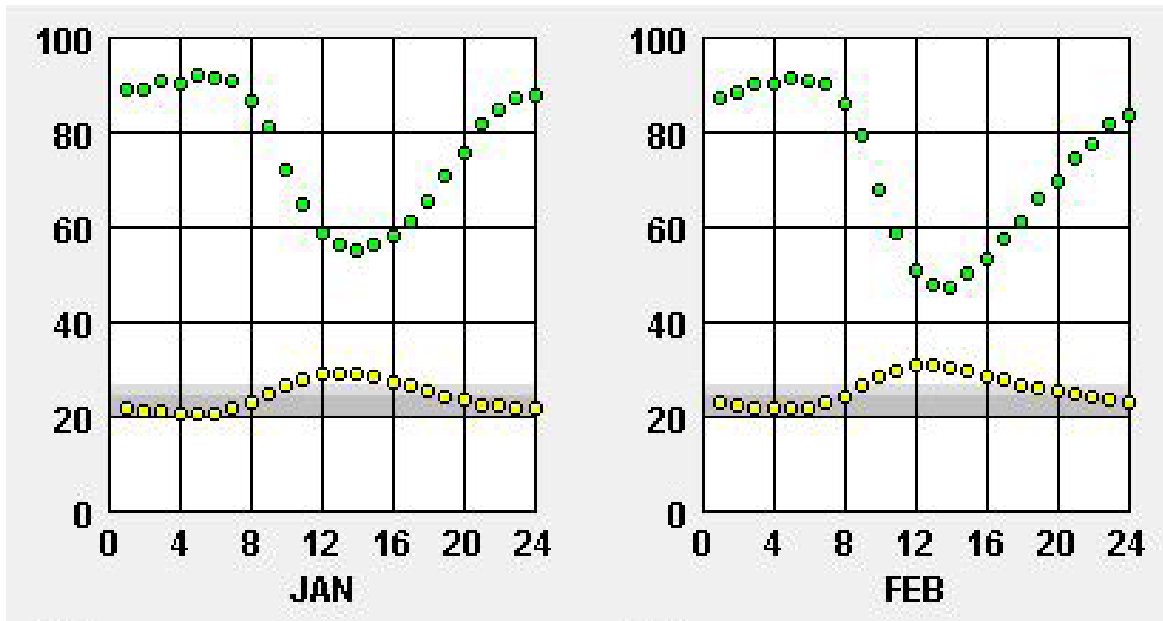


Fig:2.1.11.

Winter (November- February)

As could be seen from the charts below, the humidity level November and December are very high and there is a drastic drop in February. The temp also rises on February. Cross ventilation's during Nov-Jan to prevent dampness and strategic shading during Feb to lessen the impact of radiation is essential

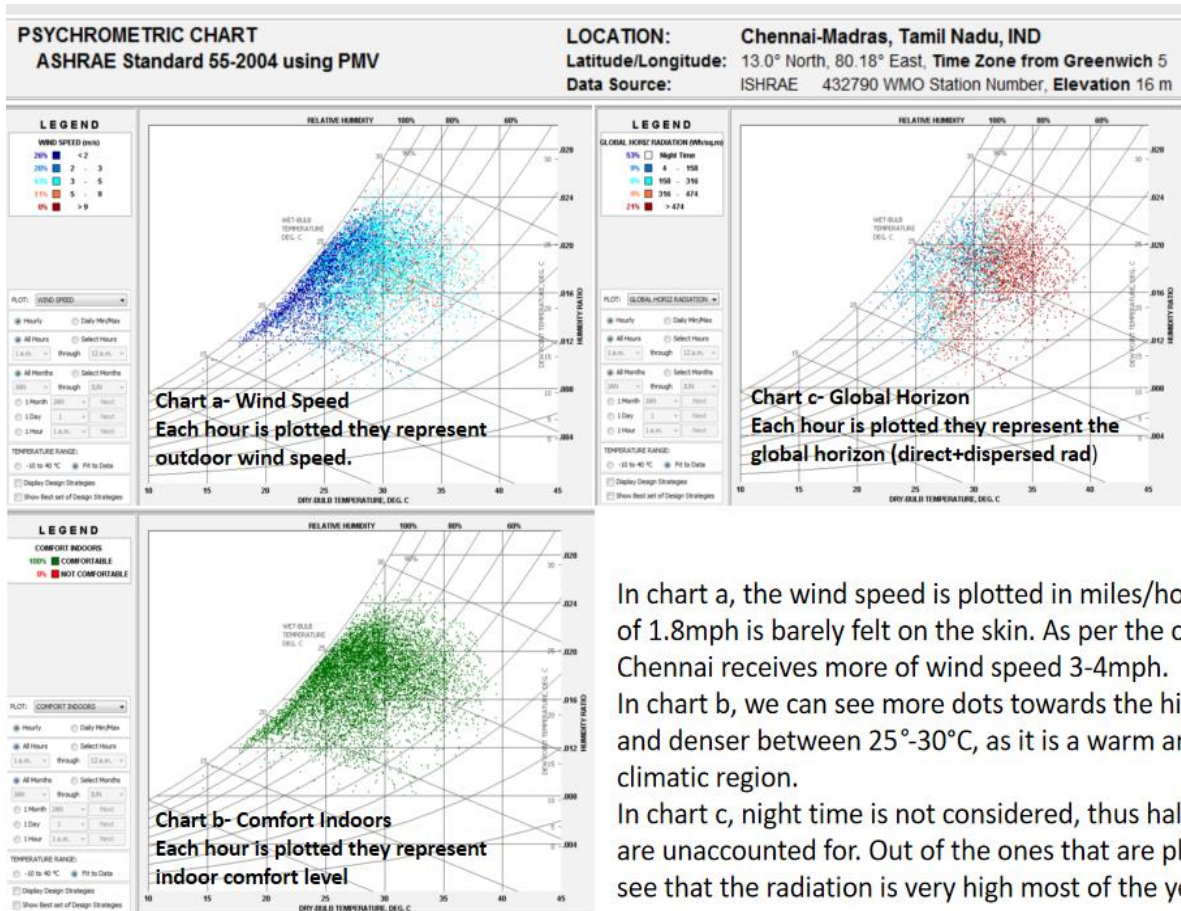


Fig:2.1.12.

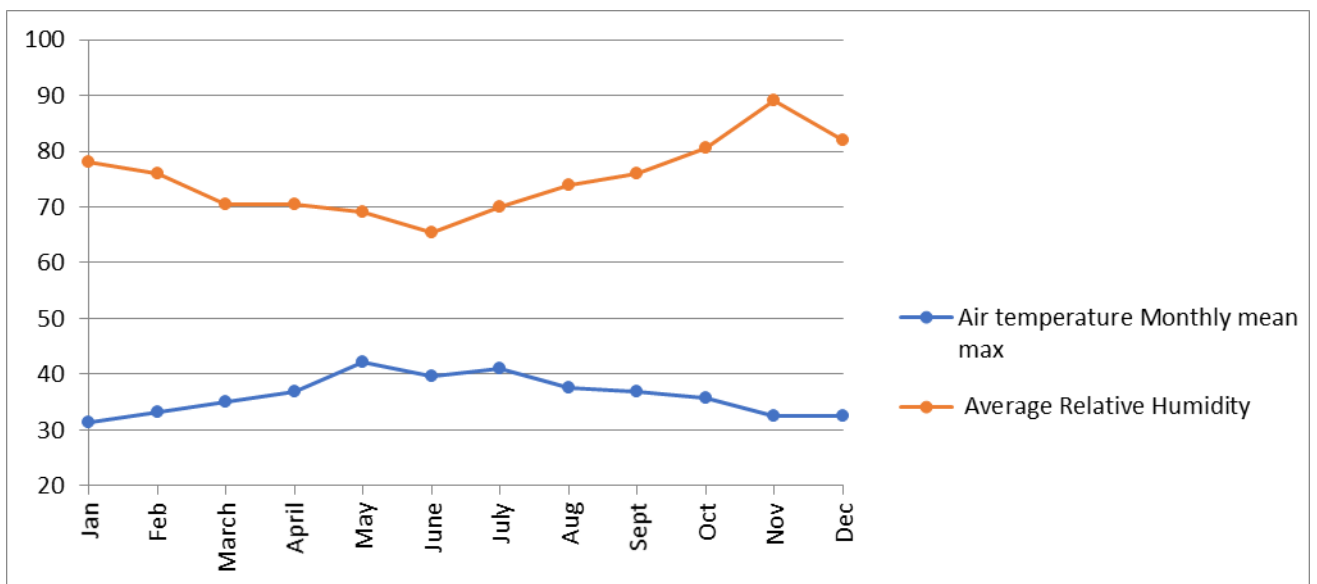


Fig:2.1.13.MAHONEY TABLE GRAPH

OBSERVATIONS AND INFERENCES USING MAHONEY TABLE:

- The Mahoney table graph displays for temperature and relative humidity in Chennai.
- The max. temperature reaches 42.2°C and RH 69% in the month of may
- The max. temperature and min RH is observed in the months of may and June.
- Similarly min. Temperature and max. RH is observed in the months of November and December.

INFERENCE FOR CLIMATE ANALYSIS WARM AND HUMID:**DESIGN OBJECTIVES:**

Resisting heat gain

- a) Decreasing surface area of building exposed to outside.
- b) Using that material that take longer time to heat up.
- c) Increasing shading of the building in general.
- d) Using material that reflect heat.

Promoting heat loss

- a) Appliances used are well ventilated.
- b) Proper ventilation occurs throughout the day.
- c) Humidity levels are reduced as much as possible.

Recommendations for building design in warm & humid climate:**SITE****Landform**

For flat sites, for design consideration for the landform is immaterial.

In case of slopes and depressions, the building should be located on windward side or crest to take advantage of cool breeze.

Open spaces & build form

- a) Buildings should be spread out with large open spaces in between for unrestricted air movement.
- b) In cities, buildings on stilts can promote ventilation and cause cooling at ground level.

Water bodies

Water bodies are not essential as they would tend to further increase in humidity.

Street width & orientation

- a) A north-south direction is ideal from the point of view of blocking solar radiation.
- b) The width of street should be such that the intense solar radiation during late morning and early afternoon is avoid during the summers.

2. Orientation & Platform

As temperature is not very high, free plants can be evolve as long as house is under protective shade.

An obstructed air path through the interiors is important to ensure proper ventilation.

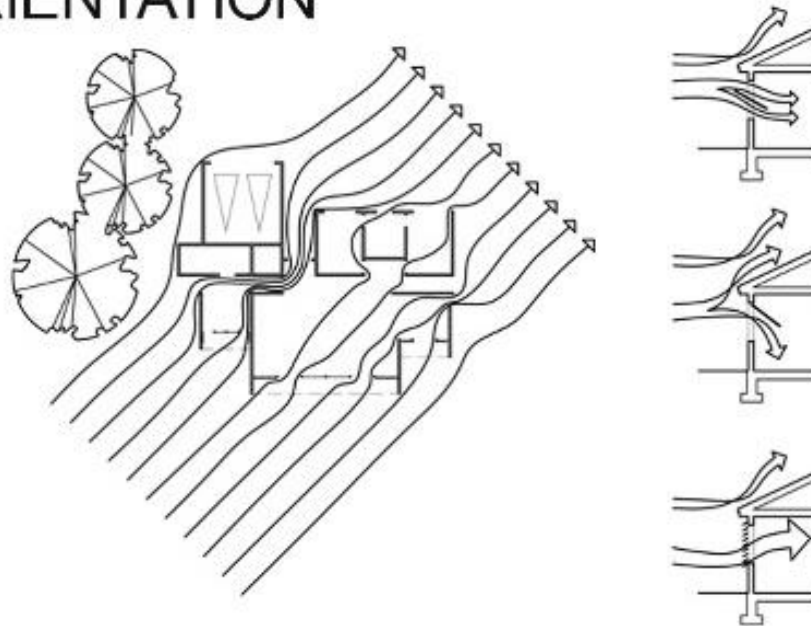
The buildings could be long and narrow to allow cross-ventilation. A singly loaded corridor plan.

Heat and moisture producing areas like toilets and kitchens must be ventilated and separated from the rest of structure.

Semi open spaces such as balconies & porches can be used advantageously for day time activity.

In multi storied building a central courtyard can be provided with vents at higher level to draw away rising hot air.

ORIENTATION



To facilitate cross ventilation, locate door and window openings on opposite sides of building with larger openings facing up-wind if possible

Fig:2.1.14.Orientation

3. Building Envelope

a)Roof

In addition to provide shelter from rain and heat, the form of roof should be planned to promote air flow.

Vents at the rooftop effectively induce ventilation and draw hot air out.

Insulation doesn't provide any additional benefit.

A double roof with a ventilated space in between can also be used to promote air flow.

b) Walls

The walls must also be designed to promote air flow so as to counter the prevalent humidity.

Baffle walls, both inside and outside the building can help to divert the flow of wind inside. They should be protected from the heavy rainfall prevalent in such areas.

c) Fenestration

Cross ventilation is of utmost importance in warm and humid climatic regions.

All doors & windows should preferably be kept open for maximum ventilation for most of years.

These must be provided with Venetian blinds to shelter the rooms from the sun and rain, as well as for control of movement.

The opening should be shaded by external overhangs.

Outlets at higher level serve to vent hot air.

4. Colour & Texture

The walls should be painted light pastel shades or white washed, white surface of the roof be of broken tile to reflect sunlight back to the environment, and hence reduce heat gain.

The surface finish should be protected from effects of moisture.

The use of appropriate colors & surface finishes is a cheap & very effective technique to lower indoor temperature.

PASSIVE DESIGN STRATEGIES:

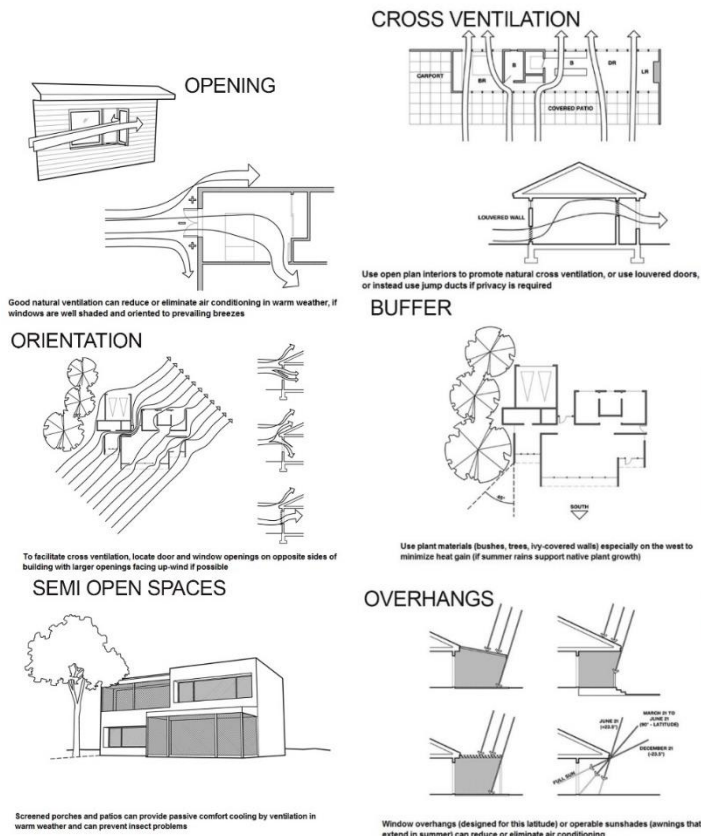


Fig:2.1.15.passive design strategies

SHADING DEVICES:

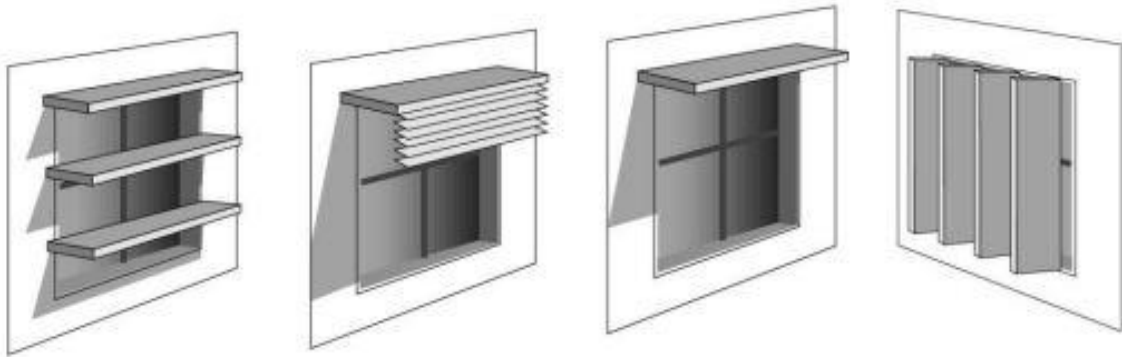


Fig:2.1.16.Shading devices

WIND TOWER:

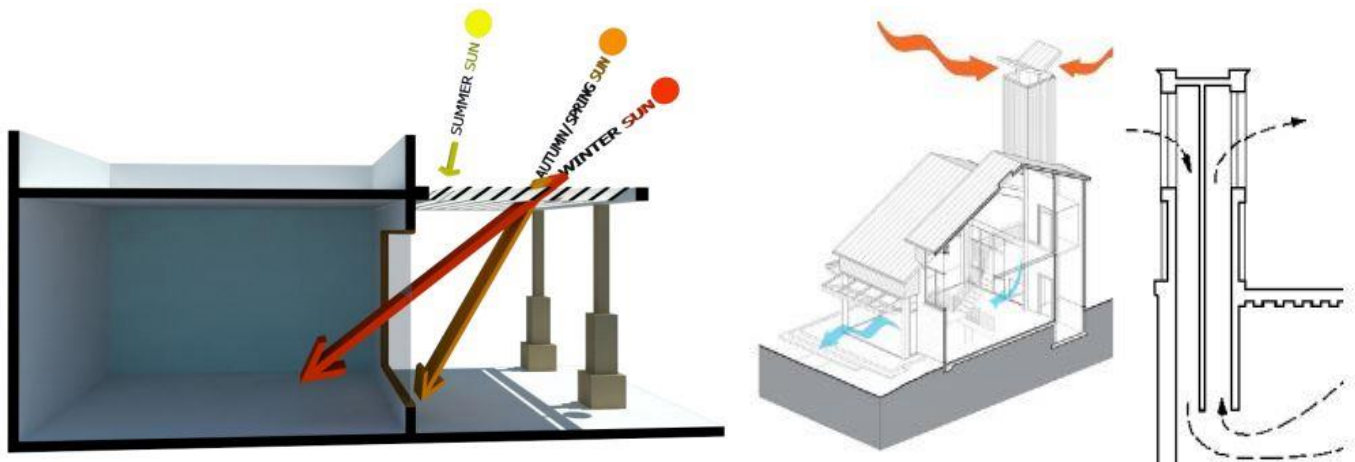


Fig:2.1.17.Wind towers

CLIMATE STUDY INFERENCE:

S.No	Design Parameters	Design Recommendation as per MAHONEY table
1	Layout	Orientation North and South, Long axis E-W
2	Spacing	Open spaces for wind penetration
3	Air movement	Rooms single banked, permanent provision for air movement
4	Openings	Minimum opening of 25% – 40%
5	Position of openings	In windward side
6	walls	Heavy walls, over 8 hrs time lag
7	Roofs	Heavy roofs, over 8 hrs time lag
8	Rain protection	Protection necessary for heavy rain
9	External features	Space for outdoor activities

2.2. To make a building perform as an ecosystem:

To make a building perform as an ecosystem meeting the following primary needs by UNDP in 2015.

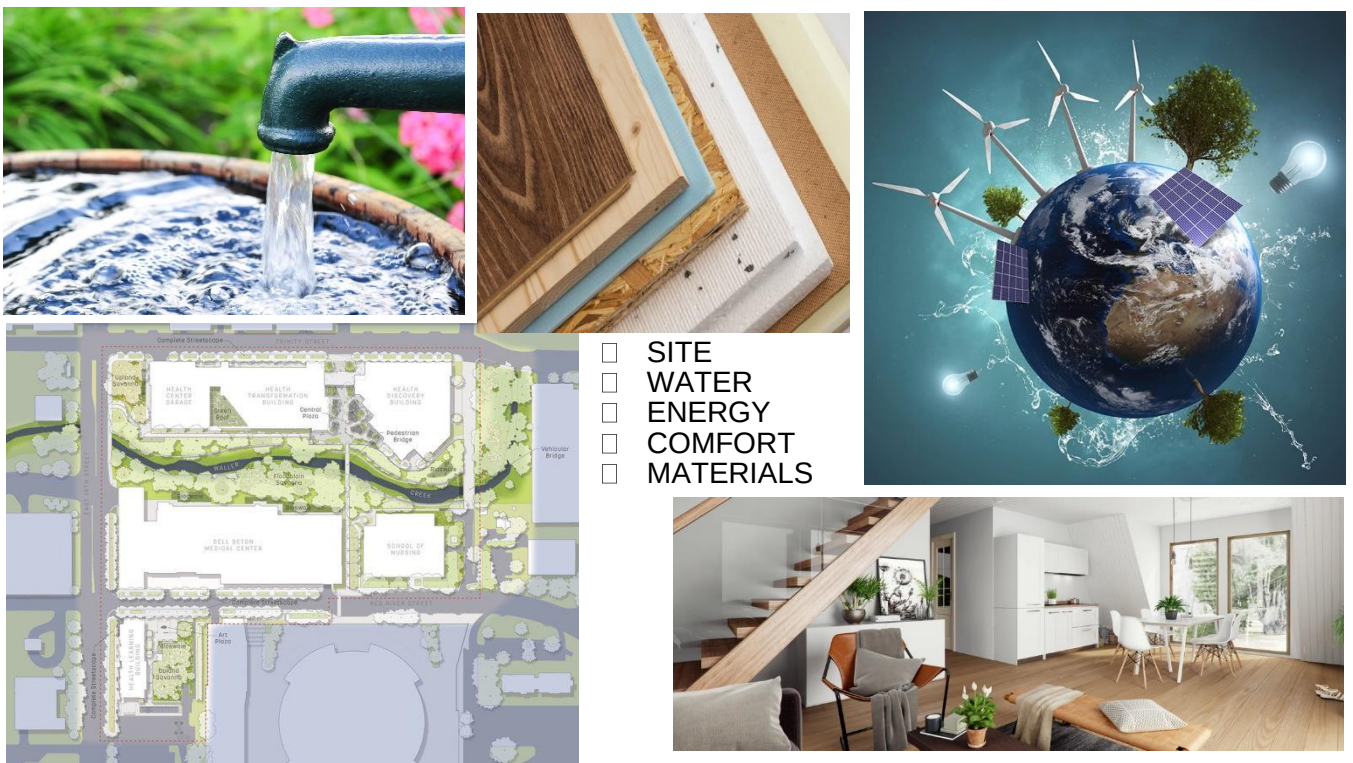


Fig:2.2.1.

This are the primary needs for the building to perform as ecosystem.
 This followed by Govardhan Eco village in india and many other countries around the world.

Criteria to be followed to achieve building perform as an Ecosystem , how this criterion's can be achieved by following the examples given in this study.

SITE	ENERGY	WATER	MATERIALS	COMFORT
LIMITS TO GROWTH.	NET POSITIVE ENERGY.	NET POSITIVE WATER.	RED LIST.	HEALTHY INTERIOR ENVIRONMENT.
DESIGN SHOULD INCLUDE URBAN AGRICULTURE.	NO NON RENEWABLE ENRGY RESOURCE.	RAIN WATER HARVESTING.	RESPONSIBLE INDUSTRY.	INDOOR AIR QUALITY.
HABITAT EXCHANGE.	100% RENEWABLE ENERGIES.	GREY WATER TREATMENT.	MATERIAL SOURCING.	CIVILIZED ENVIRONMENT.
HUMAN POWERED LIVING.	SOLAR ,WIND , BIOMASS.	SURFACE RUNOFF TREATMENT.	NET POSITIVE WASTE.	BIOPHILIC ENVIRONMENT.

CHAPTER 3 STUDY OVERVIEW

3.1. CASE STUDY 1 - R.W. KERN CENTRE:



Fig:3.1.1.

Tab. 3.1.1.

Certification Status	Living Certified
Version of LBC	2.1
Location	Amherst, MA, USA

Project Area	16,940 SF
Start of Occupancy	April 2016
Owner Occupied	Yes
Number of Occupants	36

The R.W. Kern Centre is the 17th certified Living Building in the world, an embodiment of Hampshire's values in practice and ideas in action. It meets the stringent requirements of the world's most advanced green building standard, the Living Building Challenge: it generates its own electricity, collects and treats its own water, and is built with local, non-toxic, and low-carbon materials. The 17,000-sq-ft building is a major piece of Hampshire's broad sustainability initiatives to make campus operations carbon neutral. This multi-functional building also serves as a living laboratory where students and the public study its innovative systems and performance.

3.1.2.SITE :



Fig:3.1.2.

SITE INFO

The Kern Centre is located on a previously developed master-planned college campus surrounded by campus development. Originally, the site had some level of contaminated soil due to pesticide use in the 1960s and 70s. The land is not considered a sensitive ecological habitat.

Together, the college and design team outlined project goals, including:

The building should be a comfortable and engaging place that encourages community, collaboration, and conversation.

The building should convey Hampshire College's values and help tell the story of a unique, progressive, & experimenting intellectual community.

The architecture of the building should relate to its context and reflect its natural setting. It should be striking and new; impressive, but not pretentious; vibrant; connected to the outdoors.

The design of the portal should be accessible, flexible, and adaptable.

The design and construction processes should be a learning opportunity for the entire community. All should understand how and why the building signals "a new age of design," and be inspired to apply what they've learned.

Following these goals, the Kern project creates a positive impact on social, economic, and environmental boundaries. Inspired by Kern's single rooftop array, the college scaled up to install a campus-wide PV system, saving money on utilities and improving community resilience. The project helped strengthen the local and global markets for sustainable and regional products and minimized the building's life-cycle costs with durable, low carbon materials. The creation of the Kern Centre has also inspired a new series of curricula using the building as a living lab, with subjects including software engineering, biological studies, and social, economic, and political justice. The result is a building that connects fully to its place and exemplifies the college's commitment to the highest level of environmental sustainability

INFERENCE:

The intent of the SITE is to realign how people understand and relate to the natural environment that sustains us. The built environment must reconnect with the ecology of place.

3.1.3.WATER :



Fig:3.1.3.

NET ZERO WATER IMPERATIVE

The Kern Centre employs a net-positive water system, capturing, treating, and disposing of all its own water on site.

Rainwater is collected from the roof and stored in two 5,000-gallon reservoirs adjacent to the building; from there it is UV treated, stored in a potable water tank, and pumped to sinks and drinking fountains.

The storage reservoir includes an overflow; when the reservoir is full, water is discharged and treated as site storm-water. Kern's composting toilets use no water, reducing the overall water consumption to just 150 gallons per day.

Six straight-drop dry composting toilets connect to two composting chambers in the basement. These are sealed chambers that separate urine leachate from faeces.

ECOLOGICAL WATER FLOW.

At the Kern Centre, greywater is collected and filtered through indoor planters in the building's central common space, and through an on-site constructed wetland of native plantings. First, greywater is pre-filtered and captured in a storage tank. From there it is pumped to the indoor planter system where it evapotranspires and undergoes an aerobic treatment process.

Water that cannot be absorbed by the planters continues outdoors to a constructed wetland, where its volume is further reduced through evapotranspiration and aerobic action. Finally, water exiting the wetland enters a chamber; this chamber controls the water level of the wetland, pumps treated greywater to the disposal leach field, allows for sampling of treated water, and recirculates greywater back to the indoor planters. Runoff from the site, including overflow from the harvesting system, will be collected in rain gardens, this innovative system has already made an impact on environmental water policy in urban cities.

INFERENCE:

The scarcity of water is a serious issue, as many countries around the world face severe shortages and compromised water quality due to global climate change. Even regions that have avoided the majority of these problems to date due to a historical presence of abundant fresh water are at risk

3.1.4. ENERGY :



Fig:3.1.4.

Kern's sustainable design begins with strategies: passive solar orientation, robust insulation, an air-tight envelope, exterior shades, and triple glazed windows help mitigate against large swings in temperature and humidity typical of the New England climate. The Kern Centre's envelope maximizes thermal efficiency, incorporating both low-carbon and LBC-compliant materials. The double-stud cavity wall and roof are filled with cellulose to achieve assembly values of R-40 and R-60, respectively. Tall operable windows help achieve a full daylight building with a window to wall ratio of 30%. An inverter-driven heat pump system provides heating and cooling to the spaces, separate from the heat recovery ventilation system.

By reducing the building's design energy use, a 118 kilowatt rooftop solar array can generate more than enough energy on an annual basis.

Kern's rooftop PV system is connected to the campus and local grid, and benefits from the storage and delivery capacities of both. Inspired by the Kern system, the College has installed a large solar array with the capacity to power all of campus.

A small array of batteries provides on-campus resilience and help accommodate peak power demands. The design team took advantage of the public nature of the welcome centre by making the building an educational statement. The exposed electrical conduit, ductwork, and piping express the active and passive systems that combine to create a net zero energy building.

INFERENCE:

The intent of the Energy Petal is to create new sources of renewable energy that allow projects to operate year-round in a resilient, pollution-free manner. In addition, the Energy Petal prioritizes energy efficiency as a means to reduce wasteful spending, of energy, resources, and capital.

3.1.5. COMFORT :



Fig:3.1.5.

CIVILIZED ENVIRONMENT IMPERATIVE

In designing the Kern Centre, the team sought to empower both users and occupants with a high level of control over their environment, while also taking advantage of available responsive technology.

The building's floor plates were designed so that every occupied space has access to daylight, views, and fresh air. Operable and roller-blind shaded windows in both the private and open office spaces allow for individual control over their spaces; shades are mounted at the transom level to allow a baseline level of light in even when the blinds are down.

In the common areas, exterior shaded curtainwalls provide controlled daylight. The exterior shades are automated according to data from the rooftop weather station but can be overridden by any user or occupant using wall-mounted controls. Operable windows in the common spaces enable users to regulate temperature and air flow as needed.

HEALTHY AIR

The design team sought to ensure that the building maintained healthy air quality while minimizing the amount of energy expended. This strategy began with a two-part track-off system to keep dirt and particulates out of the building, which helps maintain healthy air and reduce maintenance needs. External metal grates provide the first level of dirt capture, backed up by secondary grates in each vestibule. Ventilation in the building is provided by an Energy Recovery Ventilation system, which operates independently of temperature control and is activated according to CO₂ sensors in each space. When CO₂ levels in a space rise above 1300 ppm, the unit in that area is activated; otherwise, the units remain off to save energy. The College planned the café as a prepared food vendor, so no cooking takes place in the café or kitchen spaces in the building; this eliminated the need for additional ventilation at these spaces.

INFERENCE:

The intent of the comfort is to create healthy spaces that allow all species to thrive by connecting people to nature and ensuring that our indoor spaces have healthy air and natural daylight.

3.1.6. MATERIAL :



Fig:3.1.6.

The Kern Centre exemplifies a values-based approach to materials selection, achieving a balance between durability, easy maintenance, local sourcing, responsible industry, and avoidance of “red list” substances. The team sought out versatile, low-impact, and proven materials, and designed the building around this palette. Materials were selected to meet the intersecting Imperatives for local sourcing, responsible industrial practices, and avoidance of Red List substances which have adverse effects on human health and the environment. The design team chose carbon-sequestering wood as the major structural material. Minimal use of energy-intensive steel and concrete, and use of local and salvaged materials, reduced the project’s carbon footprint dramatically.

RED LIST:

The intent of this Imperative is to foster a transparent materials economy free of toxins and harmful chemicals.

All projects must avoid the following Red List chemical classes in 90% of the project’s new materials by cost.

EMBODIED CARBON FOOTPRINT.

Early on, the design team evaluated several structural systems and primary materials based on their relative carbon impacts. For a project of Kern’s size, both timber and steel structures were feasible, but the design team chose carbon-sequestering wood as the

major structural material. Minimal use of energy-intensive steel and concrete helped keep the project's carbon footprint down. The design team also made a conscious effort to "concentrate" the carbon impact of the building in the most permanent and important aspects of the building. The raw beauty of the palette of wood, concrete, and stone allowed the team to forego unnecessary finishes and instead spend their "carbon budget" on high-impact but high-performance components, like the triple-glazed windows, mechanical systems, and insulations. By area, the windows, foundation, exterior walls, and roof—the most critical components for energy efficiency and longevity—contribute 93% of the project's global warming potential. Interior partitions contribute just 5%. The use of local and salvaged materials also reduced the overall carbon footprint relative to new or international materials.

INFERENCE:

This is to help create a materials economy that is non-toxic, ecologically restorative, and transparent.

By analysing red list and carbon foot print of material helps in reducing impact from materials to environment

HAMPSHIRE COLLEGE'S R.W. KERN CENTER

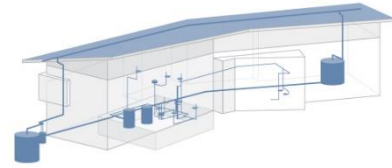
The 16,000-square-foot building is designed to make its own energy, harvest its own water, and treat its own waste. Some features:

Landscape

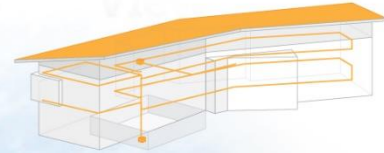
Restored with native plantings and low maintenance meadows.

Multi-functional roof

A roof reservoir collects all rainwater. It is then filtered to produce drinking water.



Roof solar panels generate all of the building's energy.



Insulation

Roof insulation rated R60; walls are R40

Windows

High performance windows with triple-pane glazing

Materials

Sustainable, non-toxic; are sourced within a 300-mile radius.



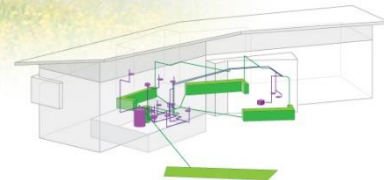
Handling waste

The building captures and treats 100 percent of its gray and wastewater on site.



Compost
toilets

Compost toilets deposit their waste into large basement digesters that break it down and convert it to fertilizer.



SOURCE: Hampshire College

JAMES ABUNDIS/GLOBE STAFF

Fig:3.1.7.

INFERENCE:

TO MAKE A BUILDING PERFORM AS AN ECOSYSTEM UNDP and LBC MADE A PRIMARY NEEDS TO BE FOLLOWED.

SITE,ENERGY,WATER,MATERAIL AND COMFORT THIS NEEDS HELPS BUILDING MAINTAIN A BALANCE IN ENVIRONMENT.

SITE: How choosing site can affect the environment for certain typology.

ENERGY: New ways to generate alternate energy for building.

WATER: Water conservation , Rain water harvesting , and recycle of water.

MATERIAL: Less carbon foot print , low embodied energy , material sourcing within certain kms from site.

COMFORT: Indoor air quality , Ventilation and Usage of materials.

3.2. CASE STUDY 2 :



CII - IGBC

Location: hyderabad, india

Building type: office

Type: extensive

System: custom

Site area: 18210.85 sq.m

Slope: 6%

Year: 2003

Designers/manufacturers of record:

Architect: karan grover & associates

Energy consultants: tata energy research institute

Structural consultants: comten engineers

Consultant: spectral consultants

Landscape architect: arati chari & associates

Court yard acts as the energy center, also the communication center.

It act as "light wells", illuminating adjacent work areas.

Fig:3.2.1.

This is India's greenest building and one of the most eco-friendly buildings in the world.

Futuristic and energy-efficient, this unique building represents the changing face of an eco-friendly India.

Located in Hyderabad, the cii-sohrabji godrej green business centre received the prestigious LEED (leadership in energy and environmental design) platinum rating in 2003.

The first LEED platinum rated building in India – cii godrej gbc.

This is the first platinum rated green building outside the united states and the third building in the world to receive this rating.

CII- SOHRABJI GODREJ GREEN BUSINESS CENTER

WHY?

India's platinum rated green building. Analysing the passive and active strategies in the space helps to understand how well they designed according to Indian context

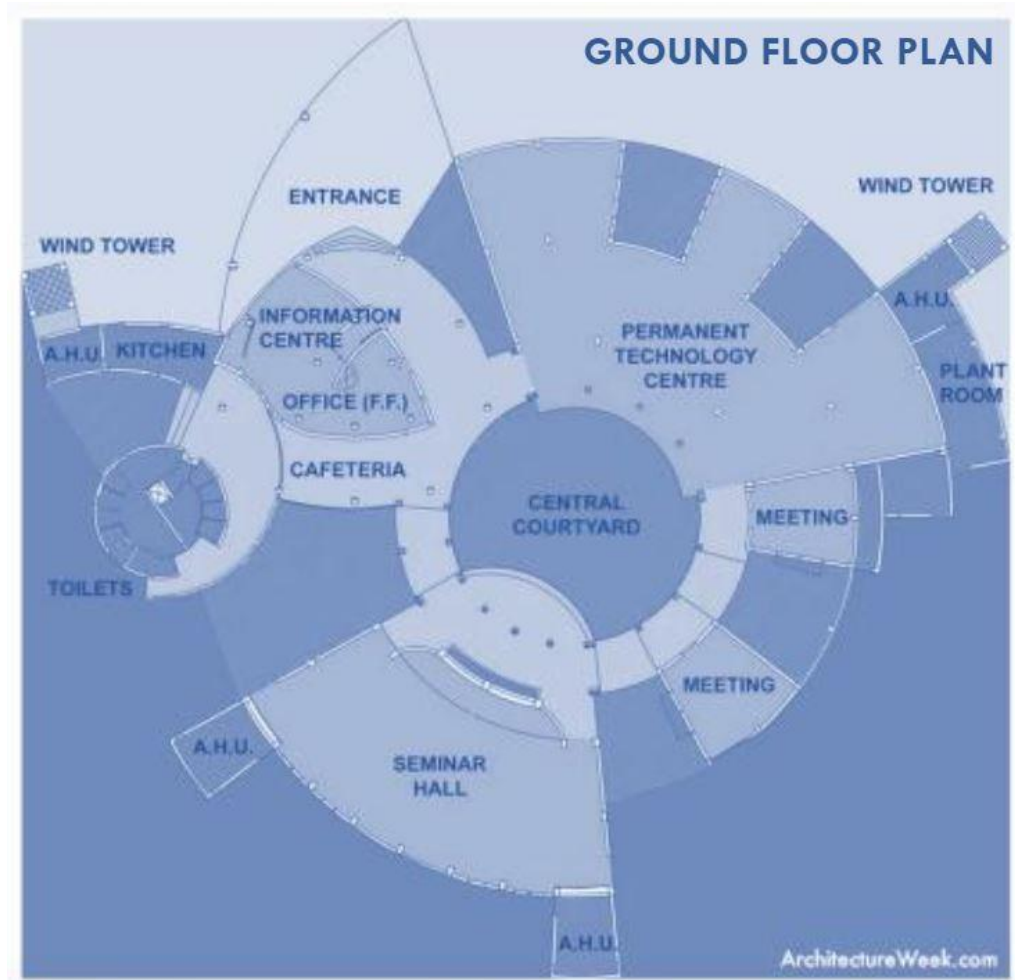


Fig:3.2.2.

ENERGY EFFICIENCY:

ENERGY MODULATION DERIVATION
 ENERGY SAVING – 120000 KWH/ YEAR
 EMS WITH SIMULATION SOFTWARE – 84 KWH/SQ.M/YEAR (EPI)
 AUTOCLAVED AERATED CONCRETE (BLOCK FOR FAÇADE REDUCE 15-20% LOAD ON AC)
 FURNITURE RECYCLABLE DEGRADABLE FURNITURE
 ISO LUX SENSORS

RESOURCE EFFICIENCY

MATERIAL FROM WASTE OF FACTORY
 NATURAL ROCK FORMATION (CONTEXTUAL ELEMENTS PRESERVATION)
 BIO DEGRADABLE PLASTIC FREE AND RECYCLABLE RESOURCE

GREEN

WATER EFFICIENCY / CONSERVATION

BIO DEGRADABLE PLASTIC FREE
 FRAGRANCE TREE
 PHYTOREMEDIATION – TREATMENT PLANT (ZERO WATER DISCHARGE)
 RAIN WATER HARVESTING

PREPARATION AND DESIGN

RESUSE AND ADAPTIVE USE OF ENVIRONMENTAL ELEMENTS ALMOST ZERO WASTE AND ENVIRONMENTAL IMPACT
 USE OF SUSTAINABLE CONSTRUCTION TECHNIQUES

Fig:3.2.3.

CIl also known as godrej CBC in hyderabad is constructed out of recycled material and recycled all the used water without discharging even a single drop. The structure has two AC towers which reduces the temperature on the incoming air by spraying water thus reducing load on energy consumption. The roofs are covered with gardens and solar PV which further reduces the energy consumption.

3.3.CASE STUDY 3: CEPT Ahmedabad WHY?

The architecture of the building is site oriented and climate responsive. Analyzing this Centre can help me understand spaces and how architecture help institution and also climate responsive.

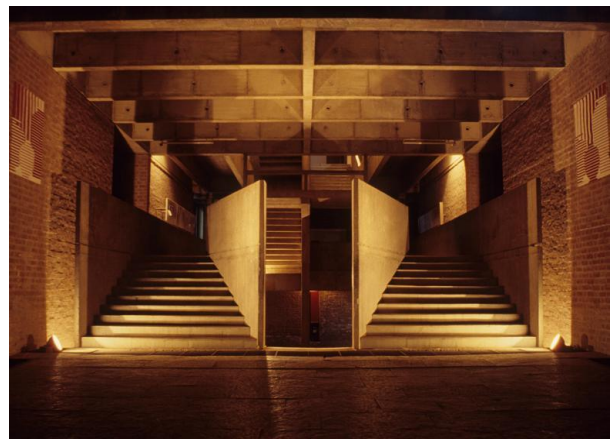
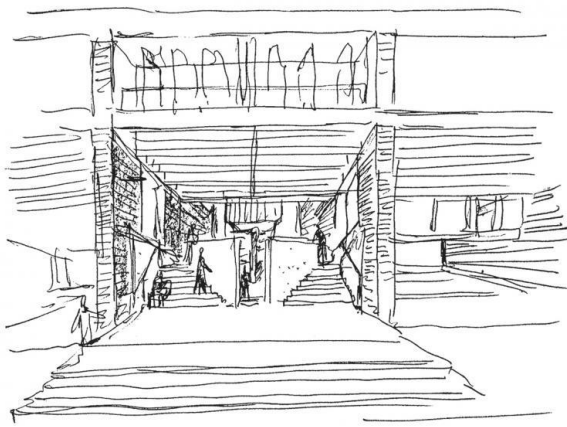


Fig:3.3.1.

A funnel shaped entrance is designed to direct the breeze through the building.



Fig:3.3.2.

To cut down on sunlight while admitting natural ventilation, he designed a structure of parallel brick walls and deep concrete columns that recall Corbu's brise-soleil but also Kahn's rigorous order.

Fig:3.3.3.



CAMPUS WITHOUT WALLS LEARNING WITHOUT BOUNDARIES

The founders of the School of Architecture had a most daring and unusual perception of their task. They emphasized learning rather than teaching, and saw the place of learning as one where there were no boundaries, no hierarchies and a complete atmosphere of free and unhampered inquiry. Naturally, they thought of a campus that demonstrated and facilitated that outlook.

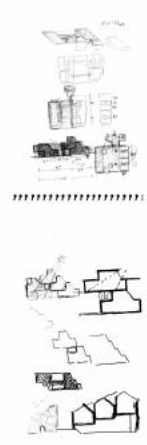
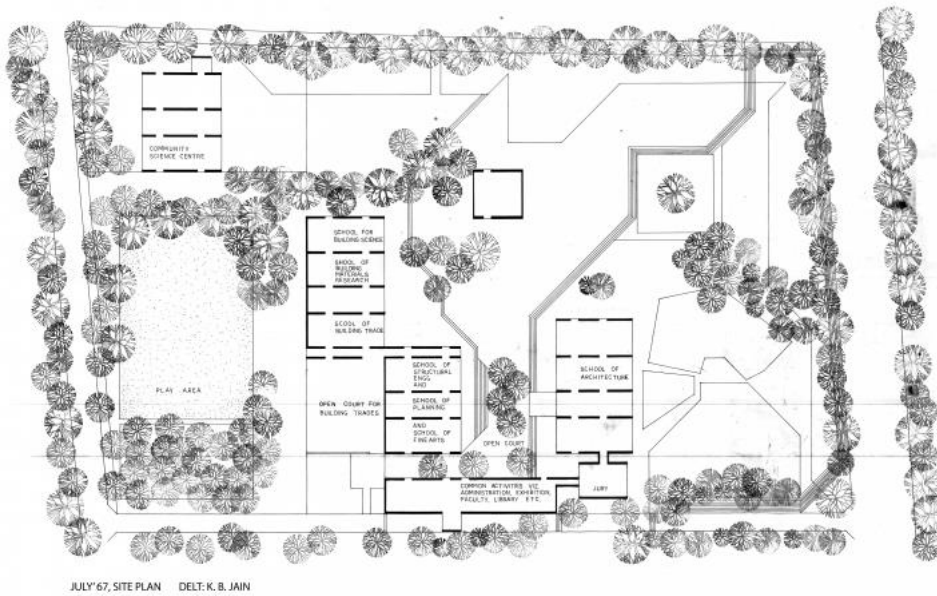
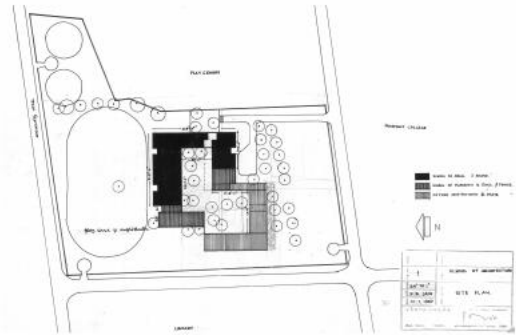
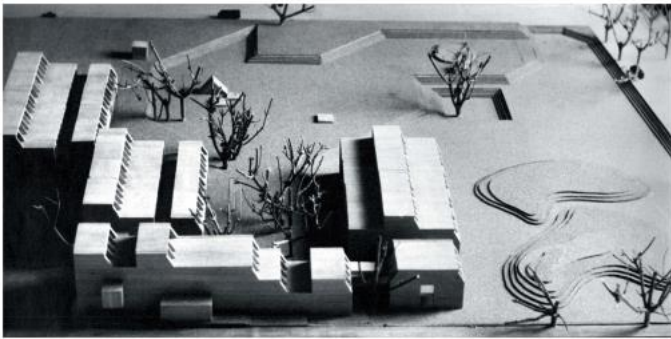
This exhibition documents a dual movement : a search for a model of education, and the simultaneous search for an architecture appropriate to the idea of learning.

It is rare that there is such a close relation between programmatic development and architectural evolution. CEPT is fortunate to have been such a process the same minds think of the quality of an institution and its architectural form.

In the 50 years between 1962 and 2012, the School of Architecture grew into CEPT University, and its founders, many faculty members and students played an active role in designing and making the campus. All this was done under the direction of Balkrishna V. Doshi, founding member, first Director, Dean Emeritus as well as Architect of the Campus Planning, under the banner of his architectural practice known at various times as Vastu Shilpa, Stein Doshi Bhalla Architects and Sangath.

**MAKING
THE
CREATIVE
CAMPUS
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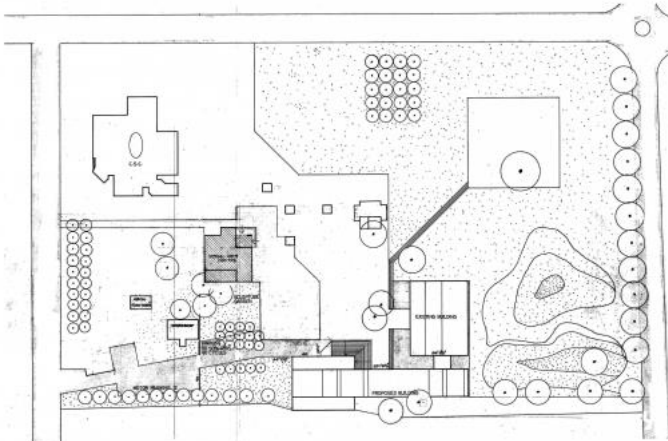
Fig:3.3.4.



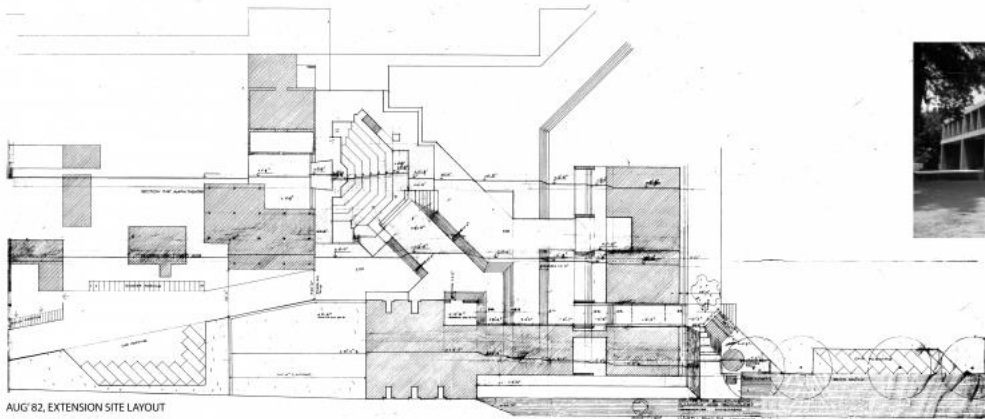
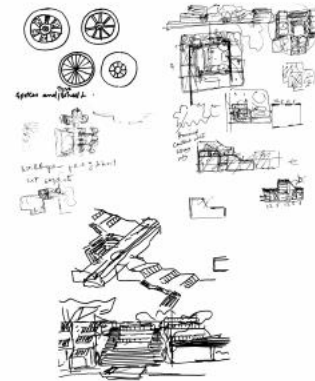
MAKING THE CREATIVE CAMPUS 5



Fig:3.3.5.



AUG '91, SITE PLAN

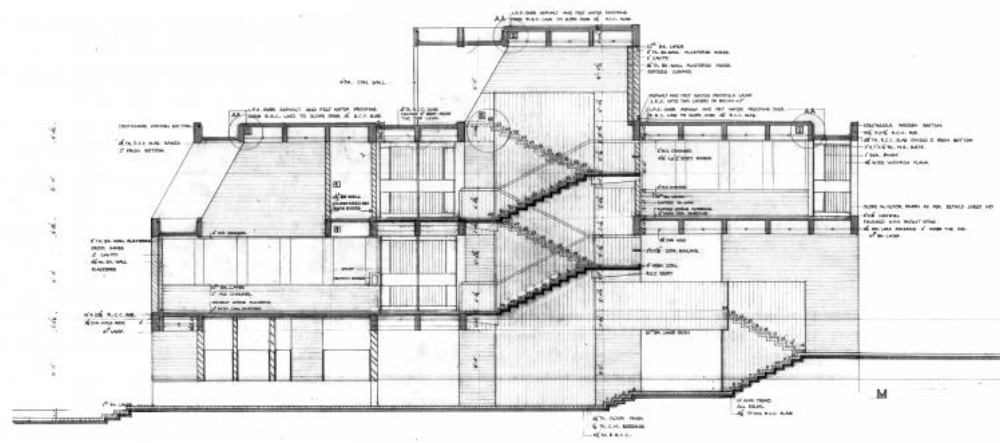
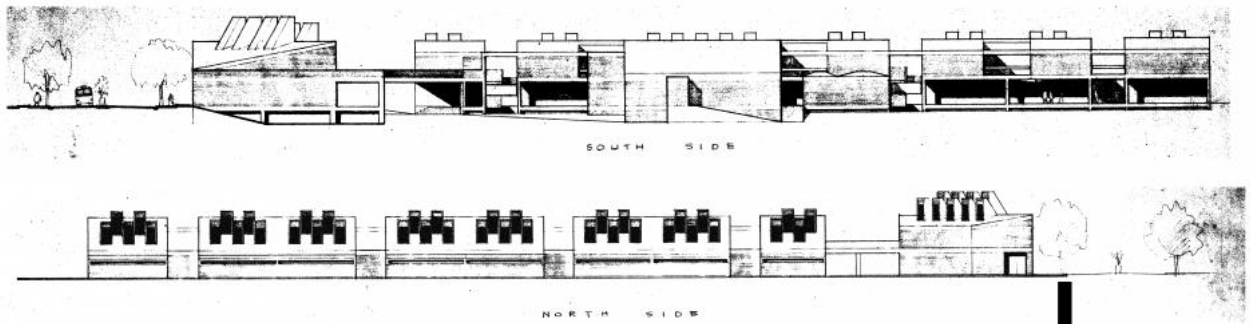


AUG '82, EXTENSION SITE LAYOUT



MAKING THE CREATIVE CAMPUS 6

Fig:3.3.7.



On the other hand Kahn made me more aware of the breeze, structural clarity, the stark brutal strengths of surfaces, the beauty of the geometry, and the profound meanings of words and sentences. His language made me realise my ancestral heritage, the *upanishads*.

Le Corbusier and Louis Kahn
The acrobat and the yogi of
Architecture

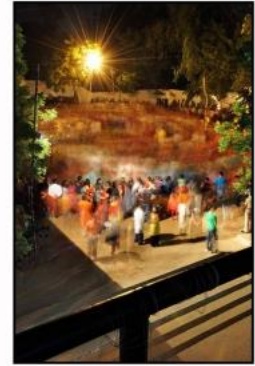


SCHOOL OF ARCHITECTURE



**MAKING
THE
CREATIVE
CAMPUS**
BB

Fig:3.3.9.



CEPT AS A HUB OF CULTURE DEVELOPING AN OASIS OF LEARNING IN THE CITY.

The 1962 vision of an integration of the arts, the sciences, technology and architecture was assiduously pursued and proposal after proposal envisioned such a place of culture.

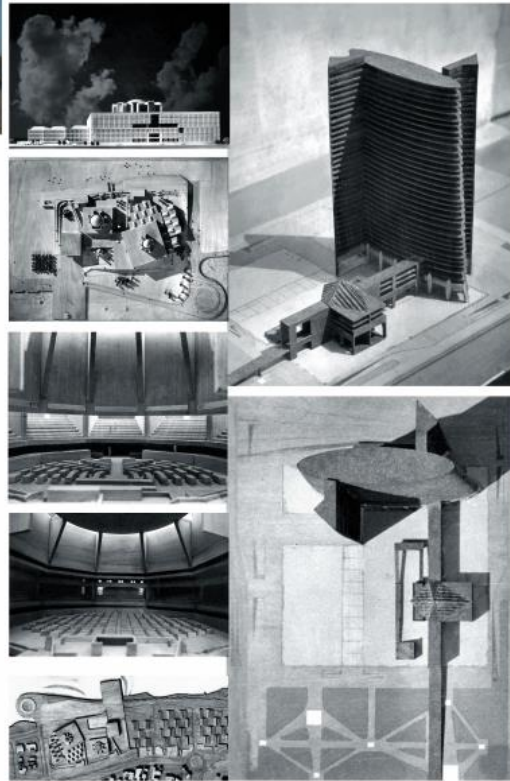
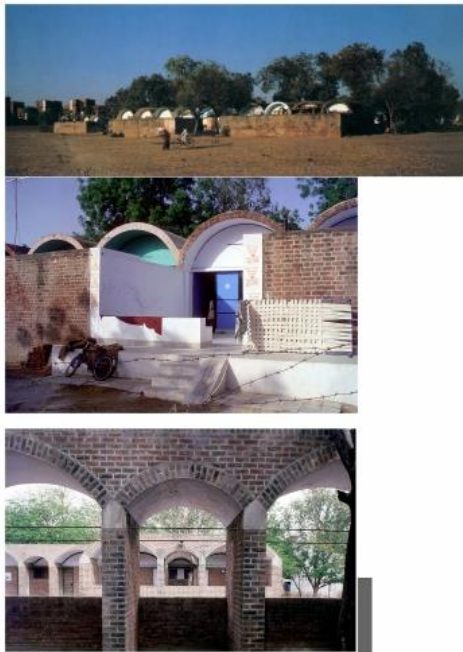
An imaginative and bold vision complemented by enlightened patronage saw the building of the Community Science Centre (built through a student competition), the Hutheesing Visual Arts Centre, the Kanoria Centre for the Arts and the Amdavad-ni-Gufa (originally named Hussain-Doshi Gufa). Thus what the early vision promised was fructified by continuous efforts, and designed by Doshi.

Still further possibilities were foreseen and imagined, and thus CEPT is now seen to be a vibrant cultural hub.



**MAKING
THE
CREATIVE
CAMPUS
20**

Fig:3.3.10.



- Geometry - Forceful - minimalist
- Looked for fragments that
characterize the local ethos



expanding
expanding
expanding
problem



Fluidlike movement
from below the earth
beyond sky



Left: ATIRA Peons' Housing, 1960;
Middle: Competition Entry for the
Parliament Building at Beirut, Kuwait, 1970;
Above: Competition Entry for a skyscraper
at Totonto, Canada

Above: Study Sketches and models of the CEPT campus, 1968 onwards.

MAKING THE CREATIVE CAMPUS 13

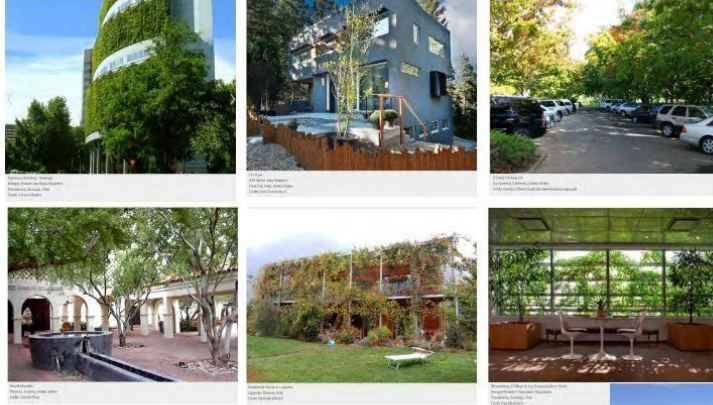
PARALLEL INVESTIGATIONS IN ARCHITECTURE IN DOSHI'S WORK OF THE PERIOD.

The School building and its further extensions are but one of this prolific architect's works in the 1960's and 70's. The architectural imagination and the educational engagement went hand in hand, and must have had effects in both areas.

Fig:3.3.11.

3.4. CASE STUDY TECHNOLOGY:

VEGETATIVE COOLING

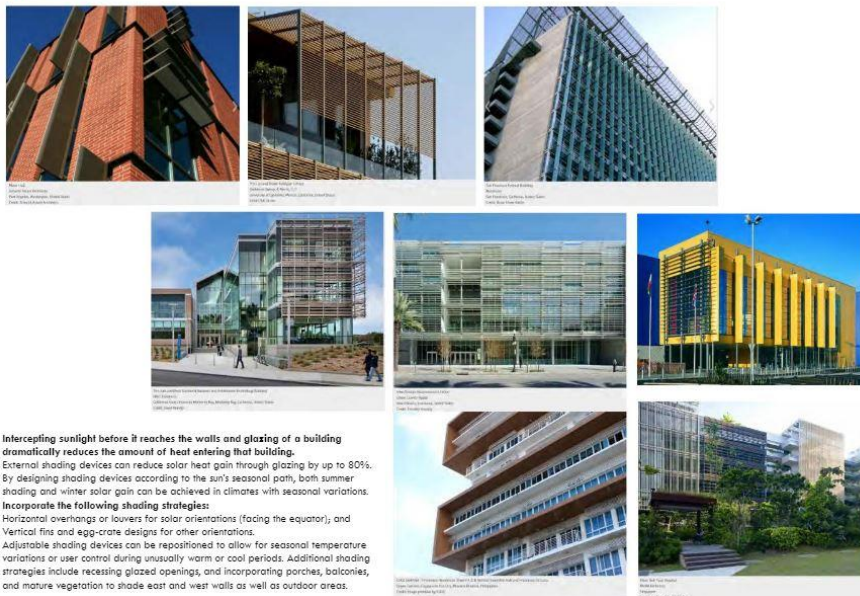


Trees and vegetation shade buildings and surfaces, while water evaporating through their leaves lowers nearby air temperatures. Shaded walls and surfaces may be 11–25°C (20–45°F) cooler than unshaded surfaces. Temperatures under a canopy of shade trees may be reduced 1–5°C (2–9°F) compared to open terrain, and 11–17°C (20–30°F) compared to parking lots.

Locate:
Trees on the east, west, southeast, and southwest sides of a building (east, west, northeast, and northwest in southern latitudes).
Ground cover and shrubs around buildings to lower air temperatures and reduce reflected sunlight.
Trees in courtyards, parking areas, and adjacent to walkways.
Vegetated pergolas and trellises with a high canopy provide shade and allow in beneficial winds. In climates with cold winters, locate trees away from the wall facing the equator a minimum distance of twice the height of trees.

Fig:3.4.1.

SHADING DEVICES



Intercepting sunlight before it reaches the walls and glazing of a building dramatically reduces the amount of heat entering that building. External shading devices can reduce solar heat gain through glazing by up to 80%. By designing shading devices according to the sun's seasonal path, both summer shading and winter solar gain can be achieved in climates with seasonal variations.

Incorporate the following shading strategies:
Horizontal overhangs or louvers for solar orientations (facing the equator); and
Vertical fins and egg-crate designs for other orientations.
Adjustable shading devices can be repositioned to allow for seasonal temperature variations or user control during unusually warm or cool periods. Additional shading strategies include recessing glazed openings, and incorporating porches, balconies, and mature vegetation to shade east and west walls as well as outdoor areas.

Fig:3.4.2.

Vegetative cooling:

Vegetation in buildings and trees can reduce air temperature 1-5degC compare to open terrain, Locating on East, West, Southeast and Southwest sides of the

Form for Cooling:

Form should elongate along East-West direction. Building form should flow with natural site energy by minimizing solar heat gain and allowing natural air to cool indoor spaces.

Shading devices:

Interpreting Sunlight before it reaches the walls and glazing of building can reduces the amount of heat entering the

Night vent cooling:

The more surface area of mass in the space, the more stable the indoor temperature. Use cross or Stack ventilation to cool mass at night.

FORM FOR COOLING



A building elongated in the east-west direction exposes the shorter east and west sides to maximum solar heat gain and high afternoon temperatures during warm months.

Design a building to take advantage of natural site energy flows by minimizing solar heat gain and allowing naturally occurring air currents to cool indoor spaces.

Shape a building so that it:

- *Is elongated in the east-west direction; and
- *Has a narrow floor plate for incorporating cross or stack ventilation.

Shade east and west walls and all glazed openings during the summer – all year in hot climates – and make the roof a light color.

In hot-humid climates, create forms that shed water and shade both exterior walls and outdoor living spaces. In hot-dry climates, admit cooler outdoor air through shaded outdoor living areas or courtyards.

Fig:3.4.3.

NIGHT VENT COOLING



Thermal mass (e.g., concrete, masonry, adobe, etc.) located in a space and cooled at night, absorbs heat and provides cool indoor surfaces and temperatures the following day.

In dry climates with a diurnal temperature difference of 11°C (20°F) or more, and where summer nighttime temperatures fall at least 5.5°C (11°F) below the desired indoor daytime temperature, use cool night air to flush heat from a space and cool interior thermal mass. A space will then remain cool during the daytime without the use of off-site energy sources.

Incorporate thermal mass in the walls, floor and/or ceiling:

*A minimum of 10.2 cm (4 inches) in thickness, with

*An exposed surface area of 1 to 3 times the floor area.

The more surface area of mass in a space, the more stable the indoor temperature. Use cross or stack ventilation to cool the mass at night.



EAST-WEST SECTION

High thermal mass to absorb & release heat
Nighttime cooling by flushing thermal mass
Cooling by night

Fin-3.4.4



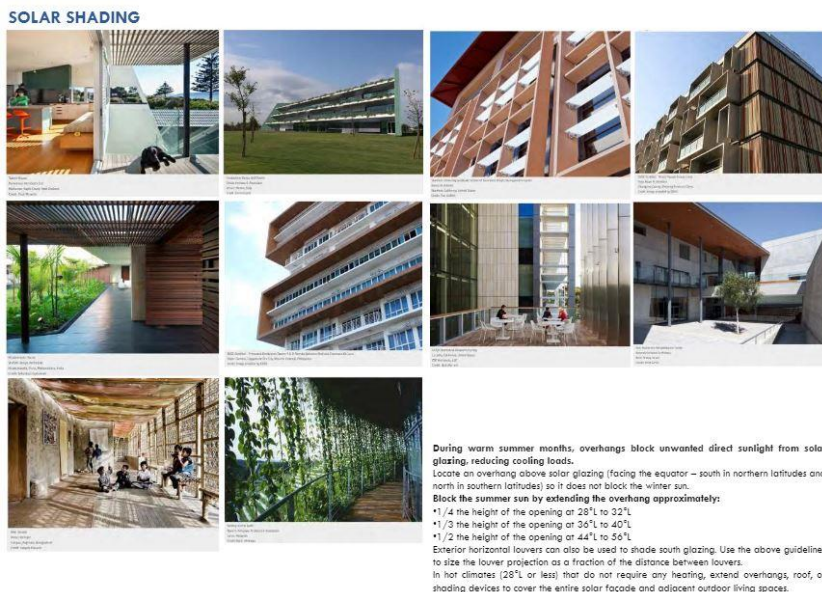
Cool Roof:

Cool roofs have the surface that reflect sunlight and emit or discharge heat efficiently, The two Surface properties than determine roof temperature are solar reflectance and thermal emittance

Fig:3.4.5.

Cross Ventilation:

Building can be cooled or ventilated by taking advantage of site natural wind currents,
 Locate inlet openings perpendicular to wind direction and provide outlet openings opposite to inlet openings with size larger than inlet openings.



Solar shading:

Locate the overhang above solar glazing hence it does not affect winter sun. In hot climate that do not require heating, Extend overhangs, roof or shading device to cover the entire solar façade

Earth Sheltering:

In addition to protecting a Building from the elements earth sheltering can preserve natural habitat and also maintain temperature below earth level.

Fig:3.4.6.

3.5. Hygroskin and Hygroscope: Biomimetic meteorosensitive pavilions.



Hygroscopicity refers to an object's ability to absorb moisture from its environment when dry and shed moisture to its environment when wet.

Fig:3.5.1.



Fig:3.5.2.

Utilizing the intrinsic physical characteristics of wood and its one-directional nature the project creates a hygroscopic mechanism that requires no energy or metabolic process to run, as it is entirely animated by the naturally changing climate. responding to humidity, paper thin triangular wooden flaps absorb air moisture and expand.



Fig:3.5.3.

Benefits of a living structure that responds directly to changes in the environment due to its mechanical properties that require no energy whatsoever.

3.6. SDU- Kolding University of Southern Denmark:

Henning Larsen quite literally changed the façade system of modern architectural buildings; he created a climate responsive façade for the university which clearly displays the ever so constantly changing life inside the university on the exterior. A composition of triangular shape with a hint of colour on the white textured surface adds to the aesthetic.



Fig:3.6.1.



Fig:3.6.2.

The 1600 triangular motifs are not only beautiful but also regulate and control the climate in the building with the help of sensors; these sensors monitor heat and light levels around the building, allowing the facade panels to shift from open to half-open to fully open. Even when fully closed, a controlled amount of natural light is able to shine through a custom pattern of round holes, some of which are linked to create amoeba-like openings.

3.7. Abu Dhabi Investment Council New Headquarters – Al Bahr Tower

The design concept for AHR's innovative design is derived from an formed by Islamic principles of design, that has been supplemented by the application of a dynamic translucent 'Mashrabiya' which opens and closes in response to the

movement of the sun, increasing the heat insulation by 50%. This façade and building is an amalgamation of traditional and modern techniques.



Fig:3.7.1.

The quilted cube

The quilted cube is a mixed use building constructed in Barcelona. This building has two layers to its façade that in□ate or de□ate according to the sunlight. The south façade has 104 cushions and an ETFE membrane. This membrane is connected to each cushion which allows only desired amount of sunlight to enter.



Fig:3.7.2.

3.8. ITRI- Taiwan



Fig:3.8.1.

The industrial technology research institute in Taiwan by Noiz architects has designed the exterior wall as free flowing and light design solution to create a soft veil like curtain as the façade of the building, it consists of 4000 fins which are offset from curtain walls, creating the double-skin building envelope. The doubleskin composition allows to hide maintenance space in between, while providing flexibility for future addition of pipes and ducts without affecting the landmark appearance of the building.

3.9. UNStudio's future-friendly office

The facade is girded by a series of fins that reduce the heat lost to high winds in winter, and help shade the interior in summer. Natural daylight and ventilation, adjustable at each workspace, also helps reduce energy use and provide comfort inside.



Fig:3.9.1.

3.10. SITE JUSTIFICATION AND ANALYSIS

SITE: CHENNAI WHY?

Green building or an eco-friendly building uses less water, optimises natural resources, saves energy, provides healthier space and generates less waste when compared with the conventional buildings.

IGBC - 1745 buildings spread over 1.21 billion.

Chennai can boast of 42 green buildings of the 212 structures in India and all the 42 are certified as eco-friendly by the IGBC



Fig:3.10.1.

Currently Chennai houses many smart city projects in an around the city its high time People, Students, Architects and Engineers getting knowledge and research about sustainable in that way helps and contributes much to environment much more in near future.



Fig:3.10.2.



Fig:3.10.3.

Egatoor Chennai is in OMR road, the site is located in between road and Buckingham canal. There is illegal dumping of waste on the site and also on the banks of this ecologically sensitive waterbody. The centre also helps in creating a waste generation into biogas also helps prevent waterbody converting to cooum.

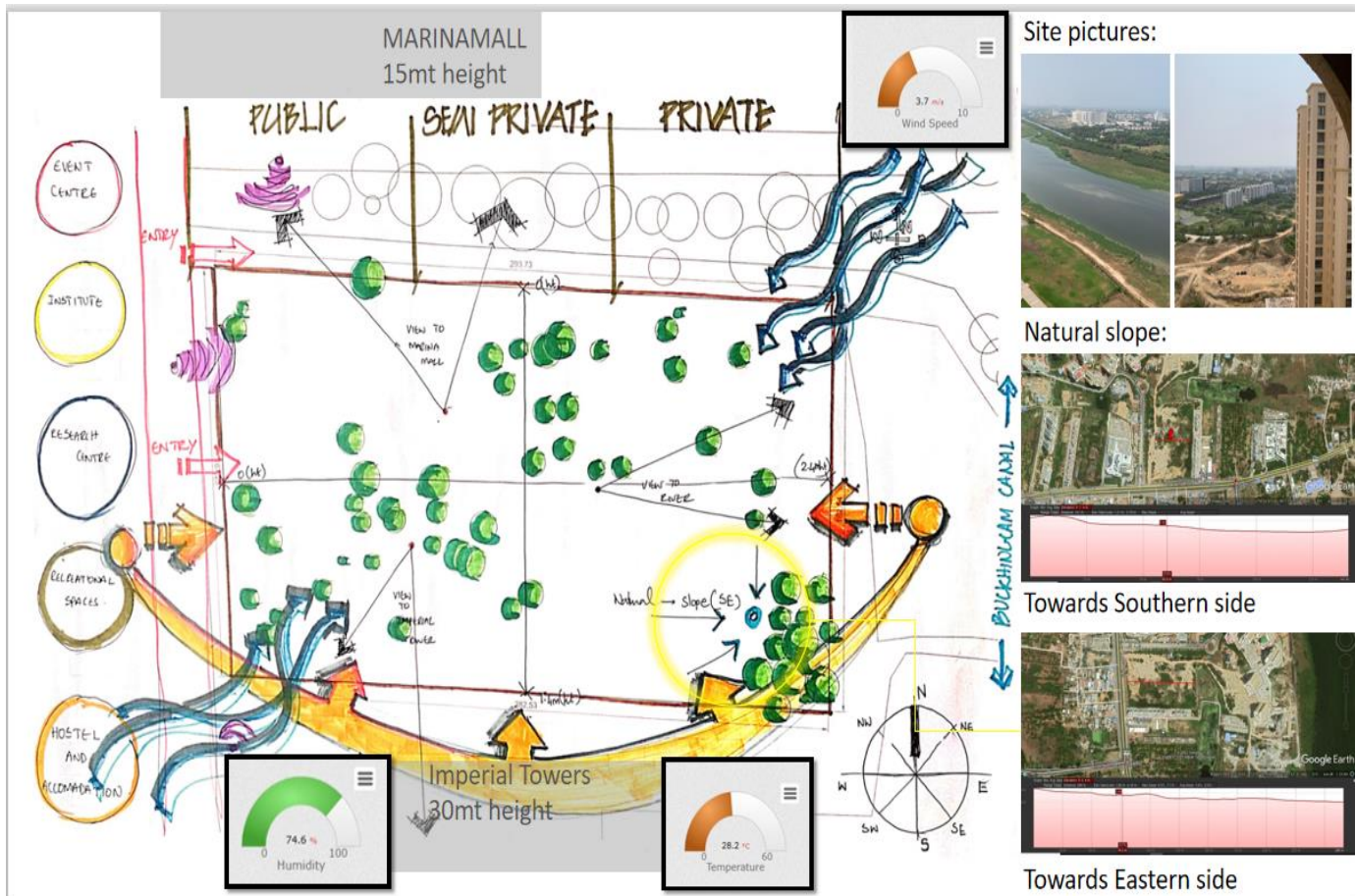
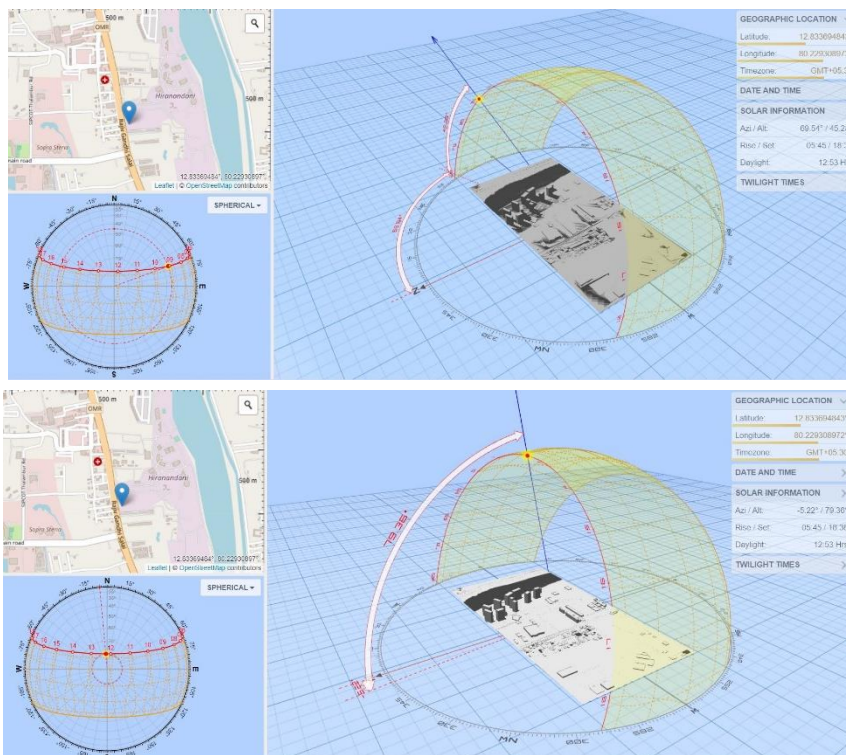
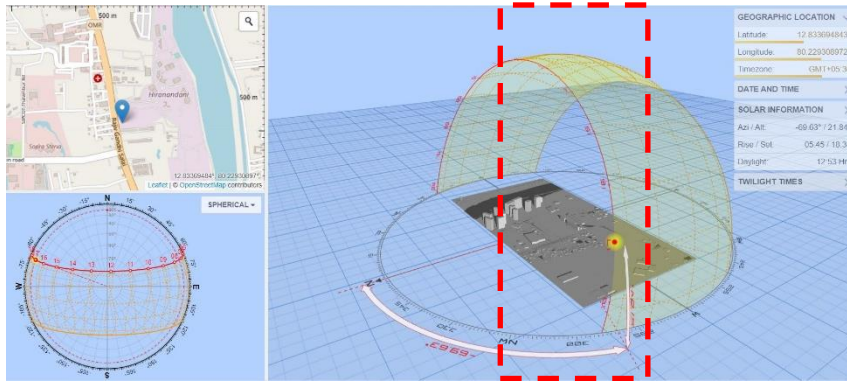


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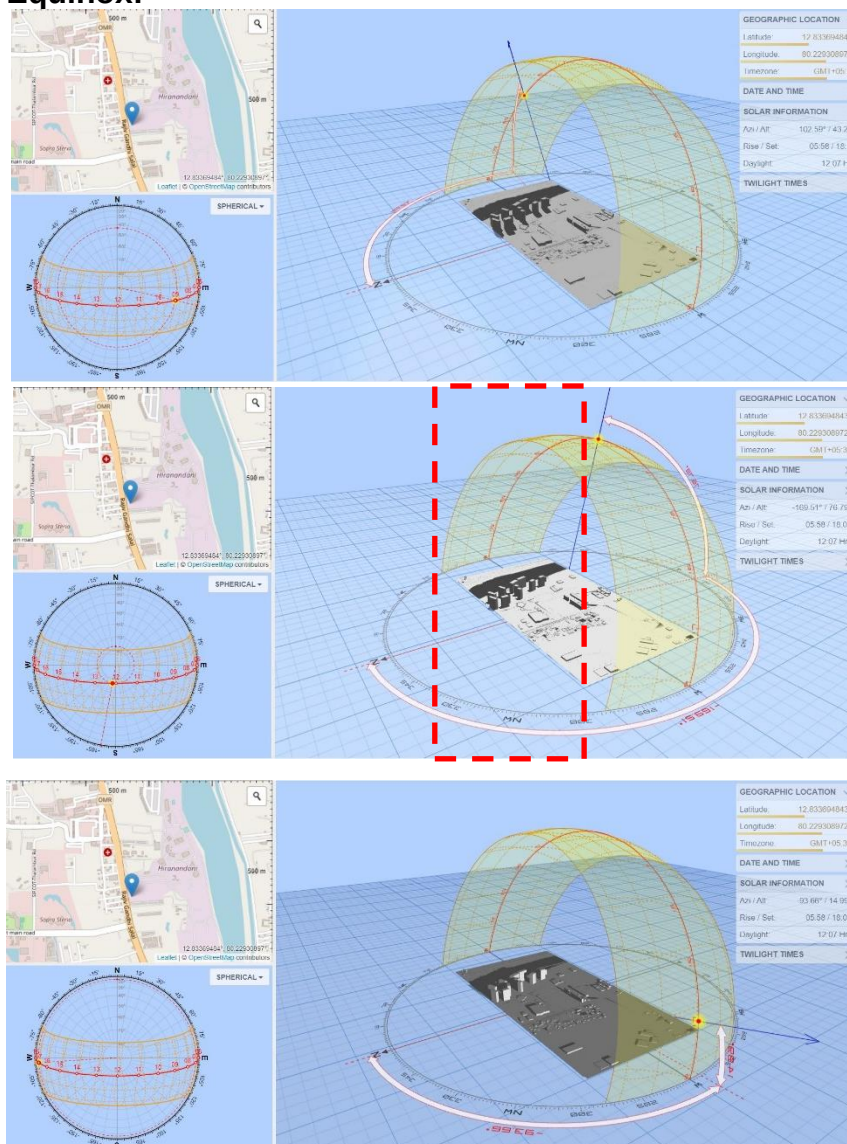
Summer solstice:





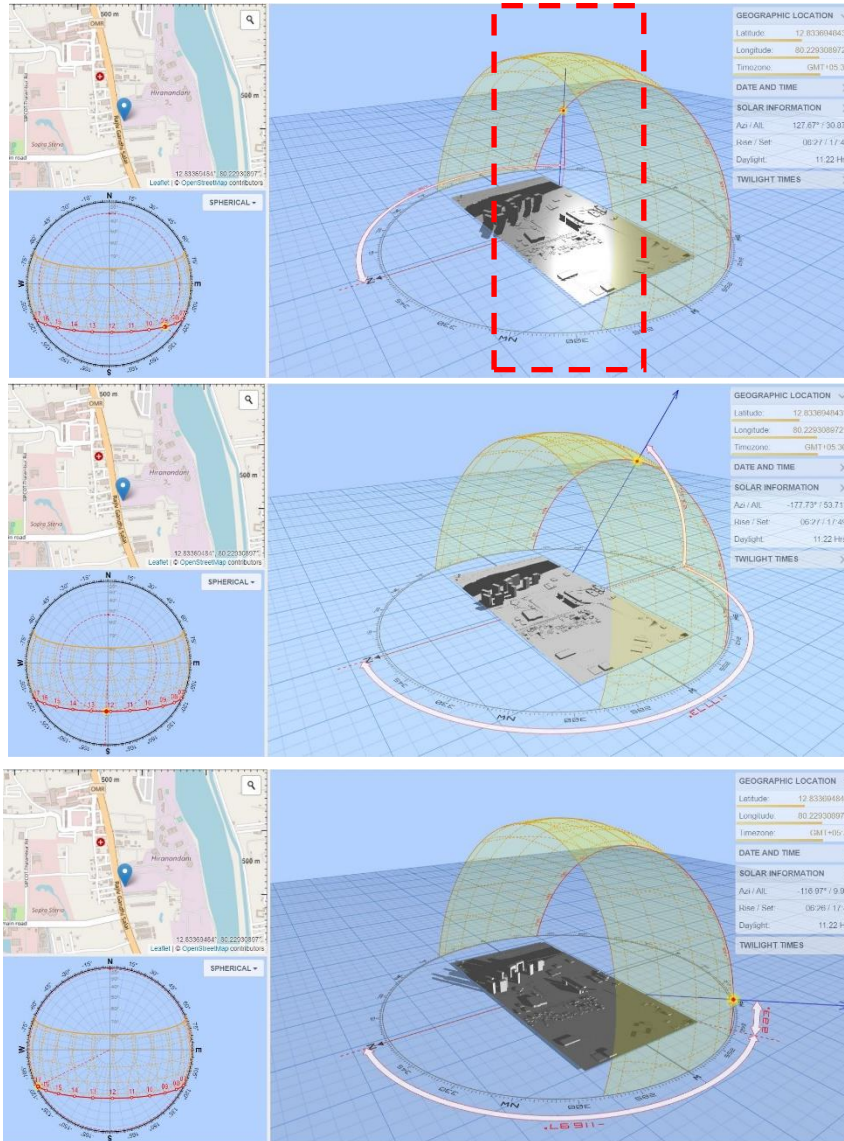
Radiation is high during peak hours on western side, Thus facade treatment on the western side reduce impact.

Equinox:



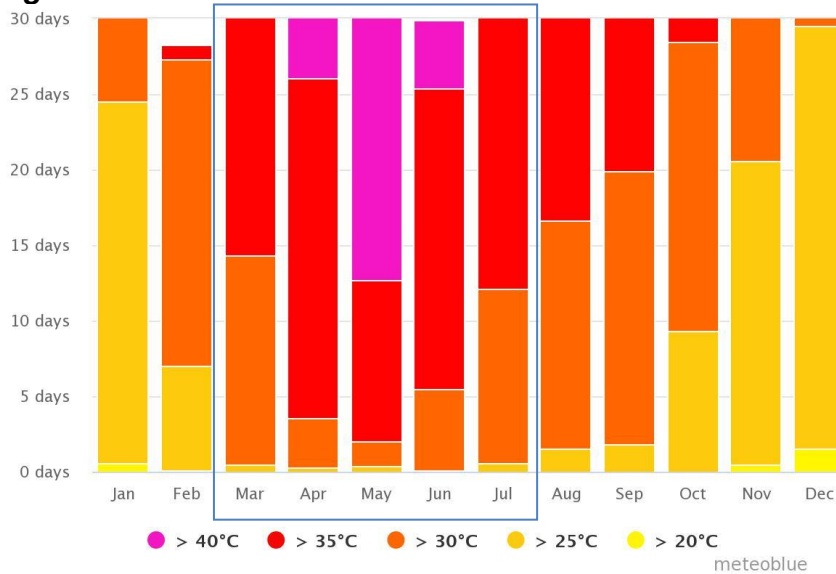
Since the adjacent buildings are not closer to the site, hence there is no mutual shading from adjacent buildings.

Winter solstice:



Since there is no mutual shading hence building can use more solar during winter times which maintains temperature.

Fig:3.10.7.



The maximum temperature diagram for Chennai displays how many days per month reach certain temperatures.

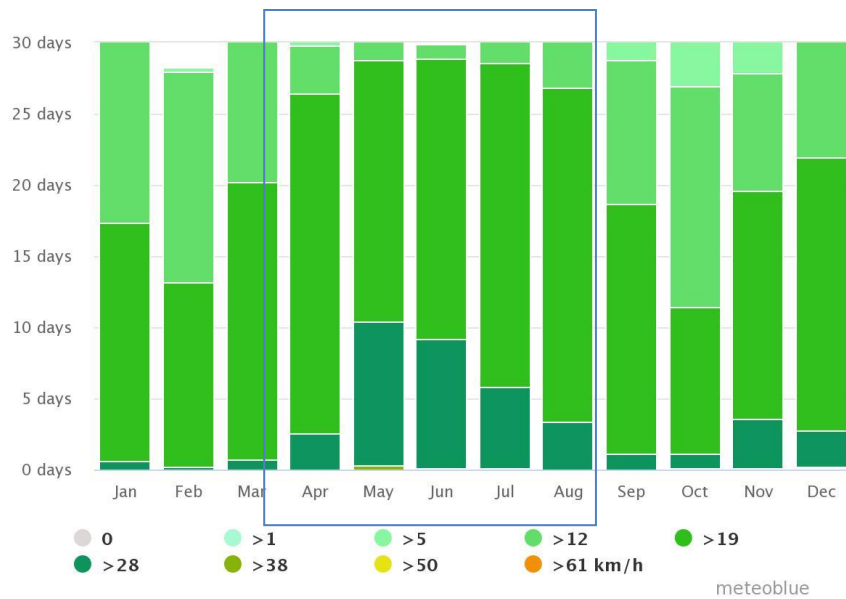


Fig:3.10.8.

Max temperature experienced is during march – July.
 Sunny days is marked during march – may.
 Max wind Flow is experienced during April- Aug.

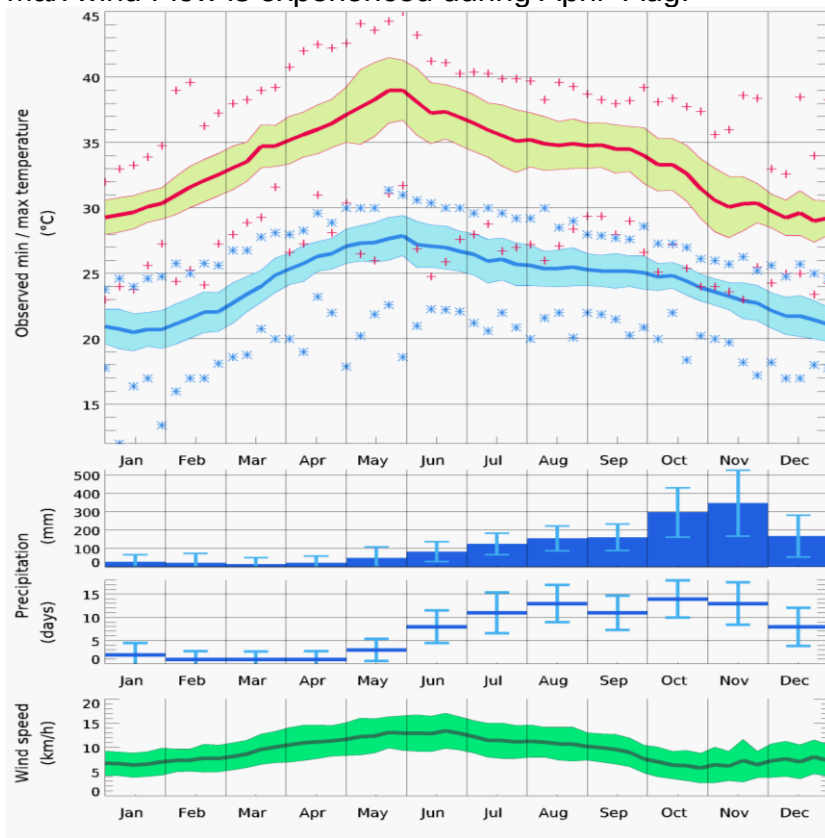


Fig:3.10.9.

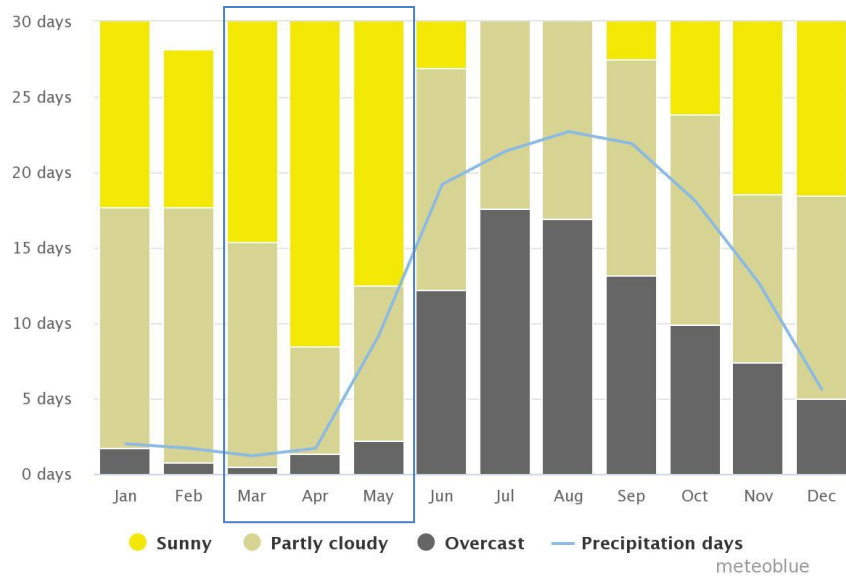


Fig:3.10.10.

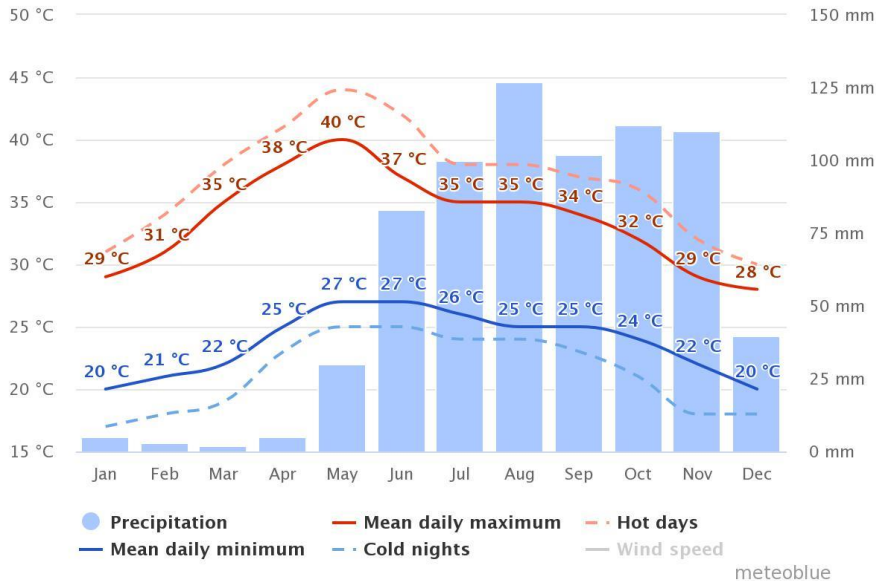


Fig:3.10.11.

ENVIMET ANALYSIS:

SITE : Egattur Chennai Tamilnadu

The following data is annual meteorological data for Chennai.

Meteorological Data Summary

Parameter	Min	Max	Avg
Wind Speed m/s	N/A	10.5	3.7
Temperature °C	19	36.7	28.2
Dew Point °C	14.8	27.5	23.1
Humidity %	41.7	96.9	74.6
Pressure hPa	996.2	1016.7	1006.5

Fig:3.10.15.

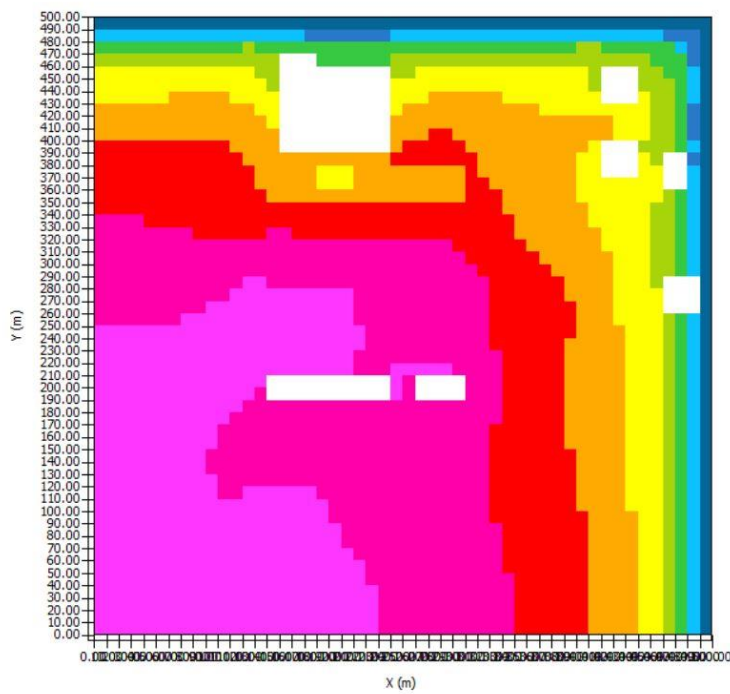
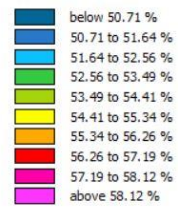


Figure 1: rakesh site
16.00.01 23.06.2018

x/y Cut at k=0 (z=1,0000 m)

Relative Humidity



Min: 49.78 %
Max: 59.04 %

Fig:3.10.16

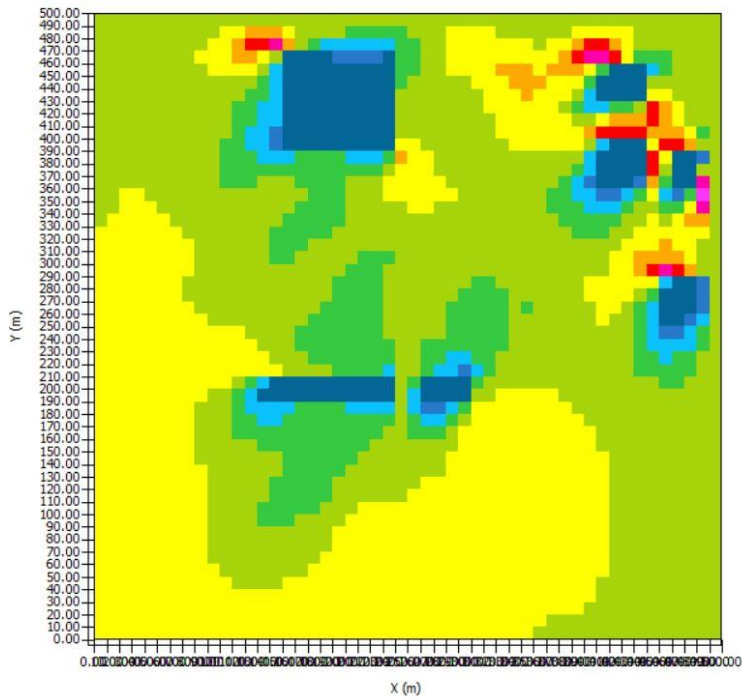


Fig:3.10.17

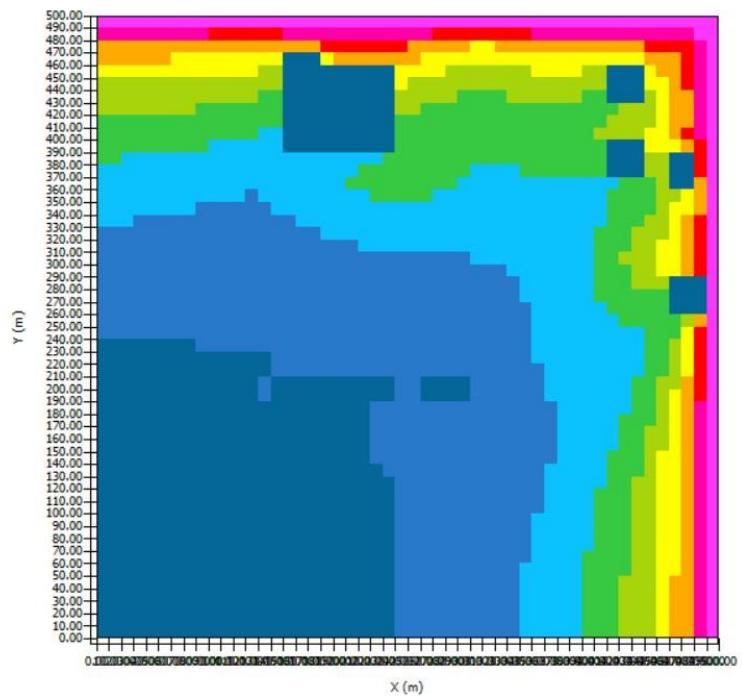


Fig:3.10.18

Figure 1: rakesh site
16.00.01 23.06.2018
x/y Cut at k=0 (z=1.0000 m)

Wind Speed

below 0.72 m/s
0.72 to 1.28 m/s
1.28 to 1.85 m/s
1.85 to 2.41 m/s
2.41 to 2.97 m/s
2.97 to 3.54 m/s
3.54 to 4.10 m/s
4.10 to 4.66 m/s
4.66 to 5.22 m/s
above 5.22 m/s

Min: 0.16 m/s
Max: 5.79 m/s

Figure 1: rakesh site
16.00.01 23.06.2018
x/y Cut at k=0 (z=1.0000 m)

Potential Air Temperature

below 31.27 °C
31.27 to 31.75 °C
31.75 to 32.23 °C
32.23 to 32.71 °C
32.71 to 33.18 °C
33.18 to 33.66 °C
33.66 to 34.14 °C
34.14 to 34.62 °C
34.62 to 35.10 °C
above 35.10 °C

Min: 30.79 °C
Max: 35.57 °C



WIND SPEED:

The windspeed in the site is around
2.41 to 2.97m/s

Hence planning in such a way the building uses maximum amount of natural wind current in site.

Which reduce usage of artificial cooling devices.

AIR TEMPERATURE:

Since humidity is high hence comparatively temperature is low, proper plants and vegetation helps prevent site for overheating in summer and also openings with manual or sensory openings can be used In both winter and summer for comfort.

3.11. AREA REQUIREMENTS :

From Pre thesis :

SITE

LIMITS TO GROWTH.

There is certain place where
Project should take place those are
satisfied.

DESIGN SHOULD INCLUDE URBAN AGRICULTURE.

Since site area is 9.5 acres there is
scope for urban agriculture.

HABITAT EXCHANGE.

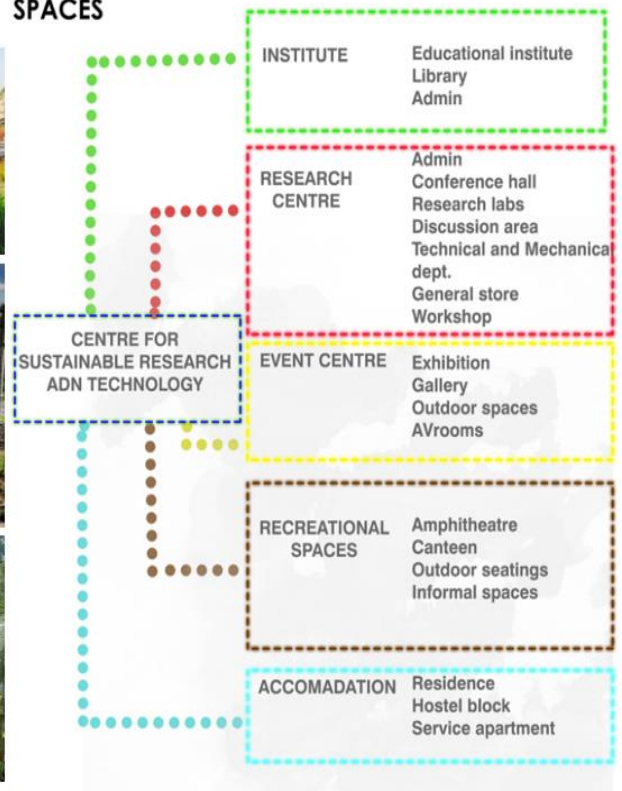
The site surrounded by farmlands
before since there is more of
infrastructure development there
is less green space for habitat
exchange hence the urban
agriculture helps around farm
animals and maintain habitat
exchange.

HUMAN POWERED LIVING.

Designing in such a way reduce
carbon emitting vehicles entering
the place



SPACES



AREA REQUIREMENTS AND STATEMENT:

Tab.3.11.1. Area requirements

Number of students 300	Number of faculty 25	Number of persons in RI 75		
Area Distribution	SPACES	UNITS	AREA IN SQM	TOTAL
INSTITUTE				
	ADMIN AND CONTROL			
	FOYER	1	50	50
	LOBBY	1	30	30
	OFFICE	3	75	225
	GENERAL SPACES	2	50	100
				405
	EDUCATIONAL INSTITUTE			
	COMMON HALL	4	150	
	DESIGN STUDIO			600
	INFORMAL SITTINGS AND DISCUSSION	3	50	
	LABS	4	90	360
	ENERGY AND ATMOSPHERE			
	WATER EFFICIENCY			
	MATERIAL AND RESOURCE			
	ENVIRONMENTAL CONCERN			
				1110
	LIBRARY AND RESOURCE CENTER			
	LIBRARY	2	150	300
	RESOURCE CENTER FORMAL/INFORMAL	2	75	150
	DISCUSSION ZONE AND LOBBY	2	50	100
	STORAGE	2	10	20
				570

HOSTEL AND ACCOMMOOATION				
	MESS AND CANTEEN			
	STAFF DINING ROOM	1	75	75
	STUDENT DINING ROOM	1	300	300
	WASH AREA	1	20	20
	KITCHEN	1	20	20
	SERVING STATION	1	15	15
	COLLECTION AREA	2	10	20
				450

RESEARCH CENTER				
	ADMIN	1	250	250
	WORK SHOP	3	100	300
	OFFICES	5	50	250
	CONFERENCE, HALLS AND AUDITORIUM	3	450	1350
	RESEARCH LABS	5	150	750
	COMMON/PRIVATE DISCUSSION AREA	3	50	150
	TECHNICAL AND MECHANICAL DEPT.	2	100	200
	TRADING CENTRE + STORAGE	1	1500	1500
				4750
EVENT CENTER				
	EXHIBITION CENTER	3	300	900
	GALLERY	2	200	400
	OUTDOOR OPEN SPACES	2		
	AV ROOMS	3	75	225
				1525
RECREATIONAL SPACES				
	SPORTS GROUND AND FITNESS CENTRE	1	1500	1500
	AMPHITHEATRE	1		
	LAWN	1		
	INFORMAL SPACES	5	75	375
				1875
TOTAL AREA				10685
CIRCULATON + SERVICES		1	35%	3739.8
				14425

3.11 Case study -Kinetic Technology.

Hygroskin and Hygroscope: Biomimetic meteorosensitive pavilions.

Hygroscopicity refers to an objects ability to absorb moisture from its environment when dry and shed moisture to its environment when wet



Figure 3.11.1

Utilizing the intrinsic physical characteristics of **wood** and its **one-directional nature** the project creates a hygroscopic mechanism that requires no energy or metabolic process to run, as it is entirely animated by the naturally changing climate. responding to humidity, paper thin triangular wooden flaps absorb air moisture and expand.

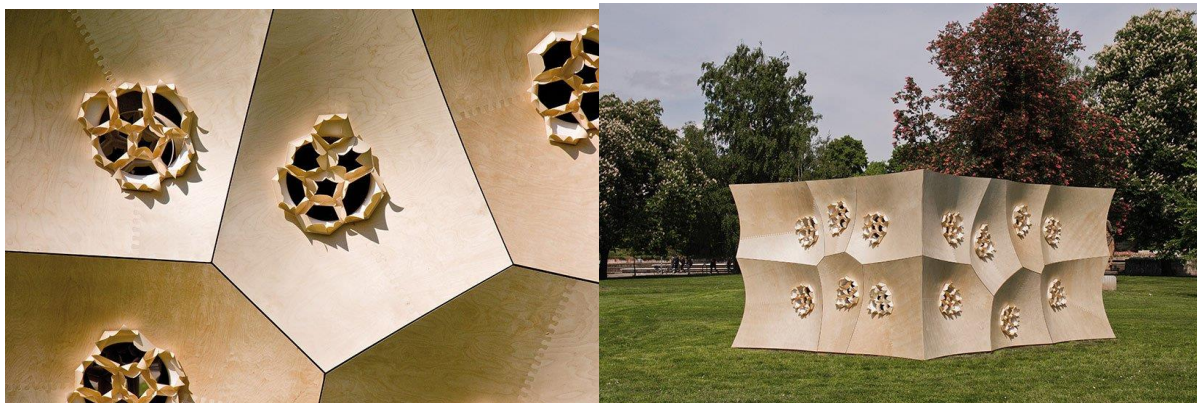


Figure 3.11.2

Benefits of a living structure that responds directly to changes in the environment due to its mechanical properties that require **no energy** whatsoever.

3.11.1 SDU- Kolding University of Southern Denmark:

Henning Larsen quite literally changed the façade system of modern architectural buildings; he created a climate responsive façade for the university which clearly displays the ever so constantly changing life inside the university on the exterior.

A composition of triangular shape with a hint of colour on the white textured surface adds to the aesthetic.



Figure 3.11.1.1

The 1600 triangular motifs are not only beautiful but

also regulate and control the climate in the building with the help of sensors;

these sensors monitor heat and light levels around the building, allowing the facade panels to shift from open to half-open to fully open. Even when fully closed, a controlled amount of natural light is able to shine through a custom

pattern of round holes, some of which are linked to create amoeba-like openings.



Figure 3.1 1.1.2

3.11.2 Abu Dhabi Investment Council New

Headquarters – Al Bahr Tower

The design concept for AHR's innovative design is derived from an formed by Islamic principles of design, that has been supplemented by the application of a dynamic translucent 'Mashrabiya' which opens and closes in response to the

movement of the sun, increasing the heat insulation by 50%. This façade and building is an amalgamation of traditional and modern techniques.



Figure 3.11.2.1

3.11.3 The quilted cube

The quilted cube is a mixed use building constructed in Barcelona.

This building has two layers to its façade that inflate or deflate according to the sunlight.

The south façade has 104 cushions and an ETFE membrane. This membrane is connected to each cushion which allows only desired amount of sunlight to enter.



Figure 3.11.3

3.11.4 ITRI- Taiwan

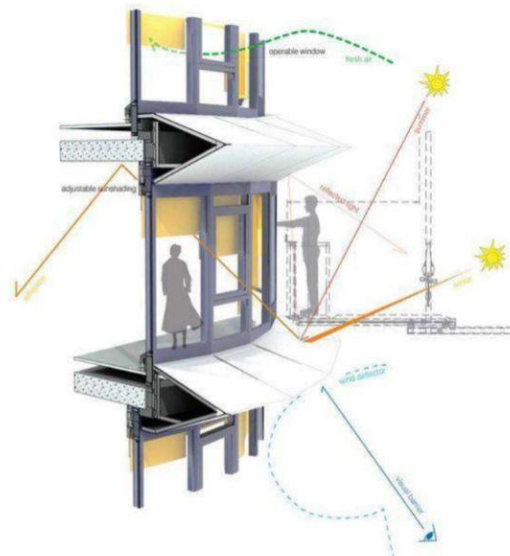
The industrial technology research institute in Taiwan by Noiz architects has designed the exterior wall as free flowing and light design solution to create a soft veil like curtain as the façade of the building, it consists of 4000 fins which are offset from curtain walls, creating the double-skin building envelope. The double skin composition allows to hide maintenance space in between, while providing flexibility for future addition of pipes and ducts without affecting the landmark appearance of the building.



Figure 3.11.4

3.11.5 UNStudio's future-friendly office

The facade is girded by a series of fins that reduce the heat lost to high winds in winter, and help shade the interior in summer. Natural daylight and ventilation, adjustable at each workspace, also helps reduce energy use and provide comfort inside.



UNStudio the 92 metre-tall building has a facade covered in horizontal fins to provide shade and reduce the need for artificial cooling.



Figure 3.11.5

3.12 SITE -Justification and Analysis

SITE:

CHENNAI

WHY?

Green building or an eco-friendly building uses less water, optimises natural resources, saves energy, provides healthier space and generates less waste when compared with the conventional buildings.

IGBC - 1745 buildings spread over 1.21 billion.

Chennai can boast of 42 green buildings of the 212 structures in India and all the 42 are certified as eco-friendly by the IGBC.

Currently Chennai houses many smart city projects in an around the city its high time People, Students, Architects and Engineers getting knowledge and research about sustainable in that way helps and contributes much to environment much more in near future.

SMART CITY PLAN:



Figure 3.12.1

CURRENT

CONDITION:



When Express visited these areas, the waterbody was found devoid of any considerable aquatic life. The colour of the water near the landfills was black with leachate oozing out into the backwaters. There was a stormwater drain coming from underneath a nearby township, flushing sewage into the waterbody.

Source: The Indian Express

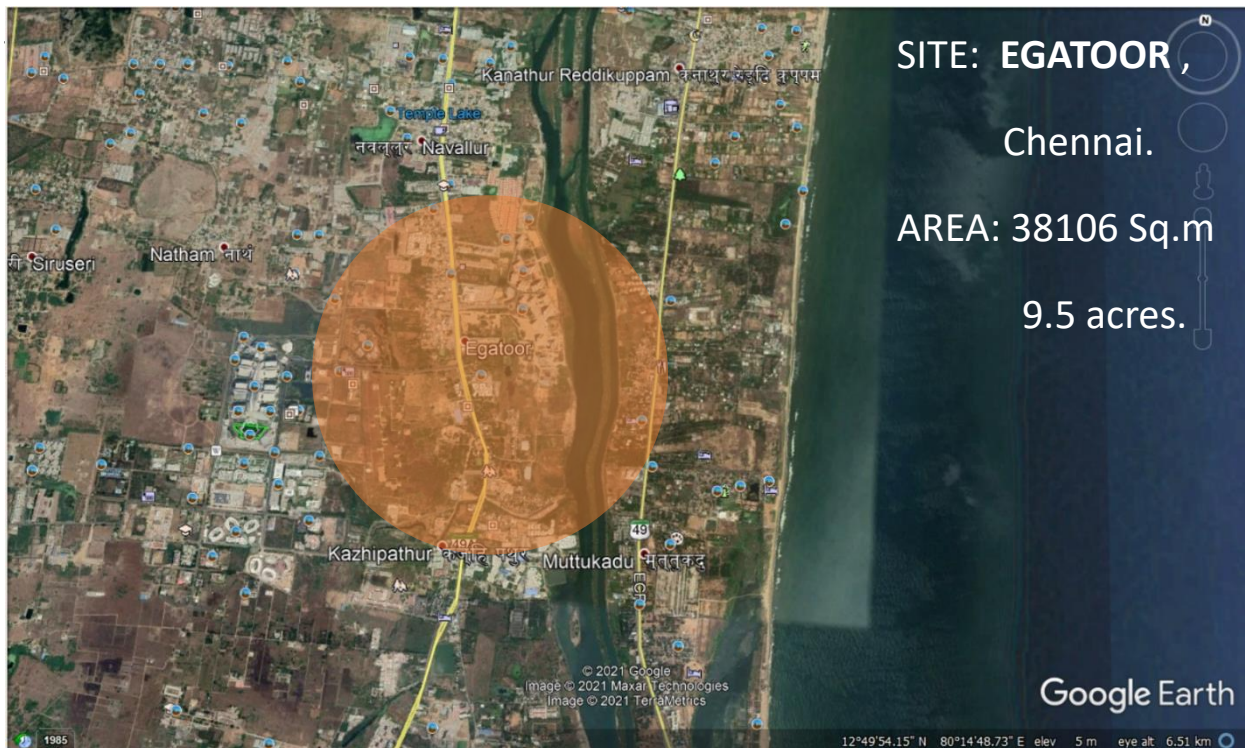


Figure 3.12.2



Figure 3.12.3

Egatoor Chennai is in OMR road, the site is located in between road and Buckingham canal. There is illegal dumping of waste on the site and also on the banks of this ecologically sensitive waterbody. The centre also helps in creating a waste generation into biogas also helps prevent waterbody converting to cooum.

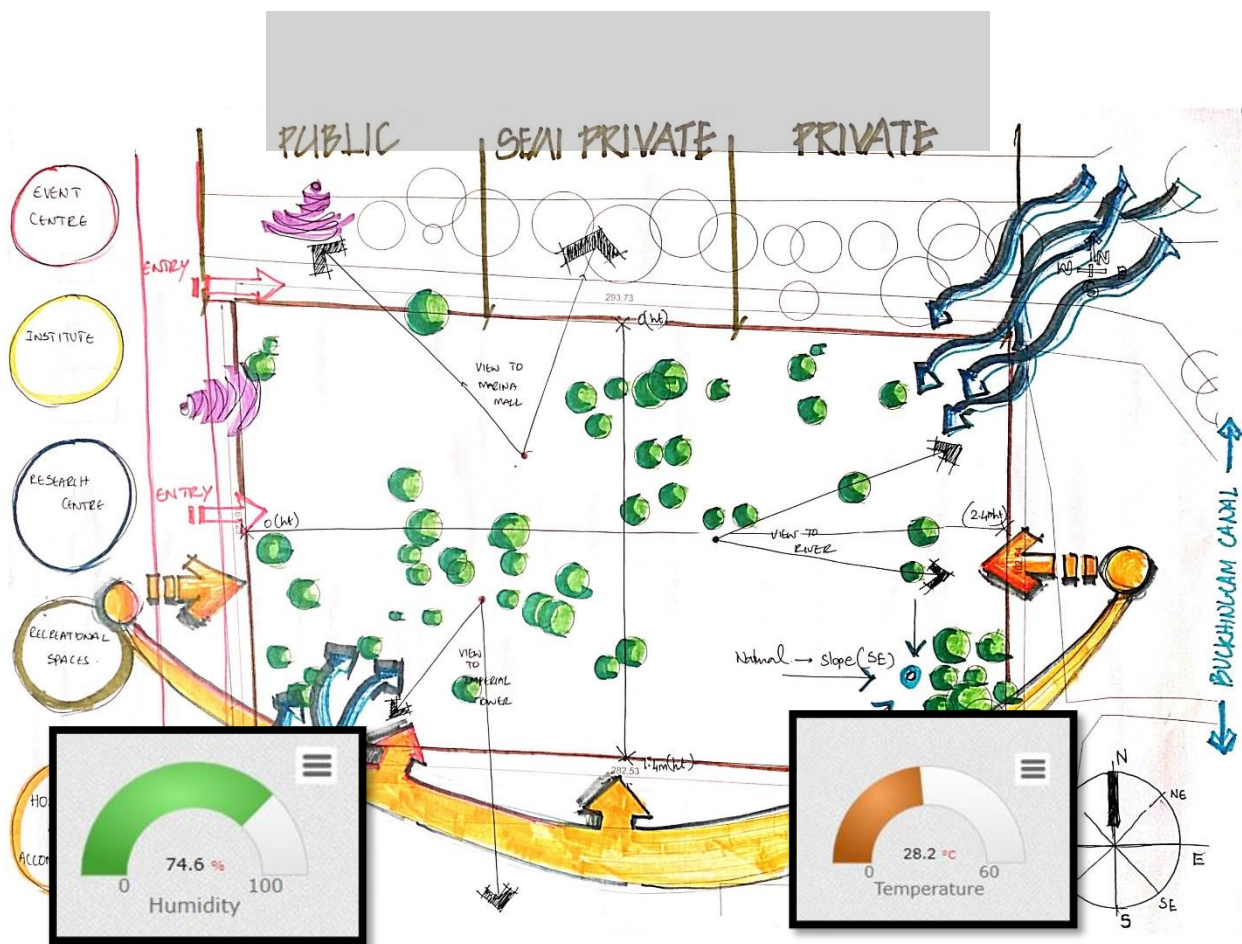


Figure 3.12.4

Figure 3.12.5 Site



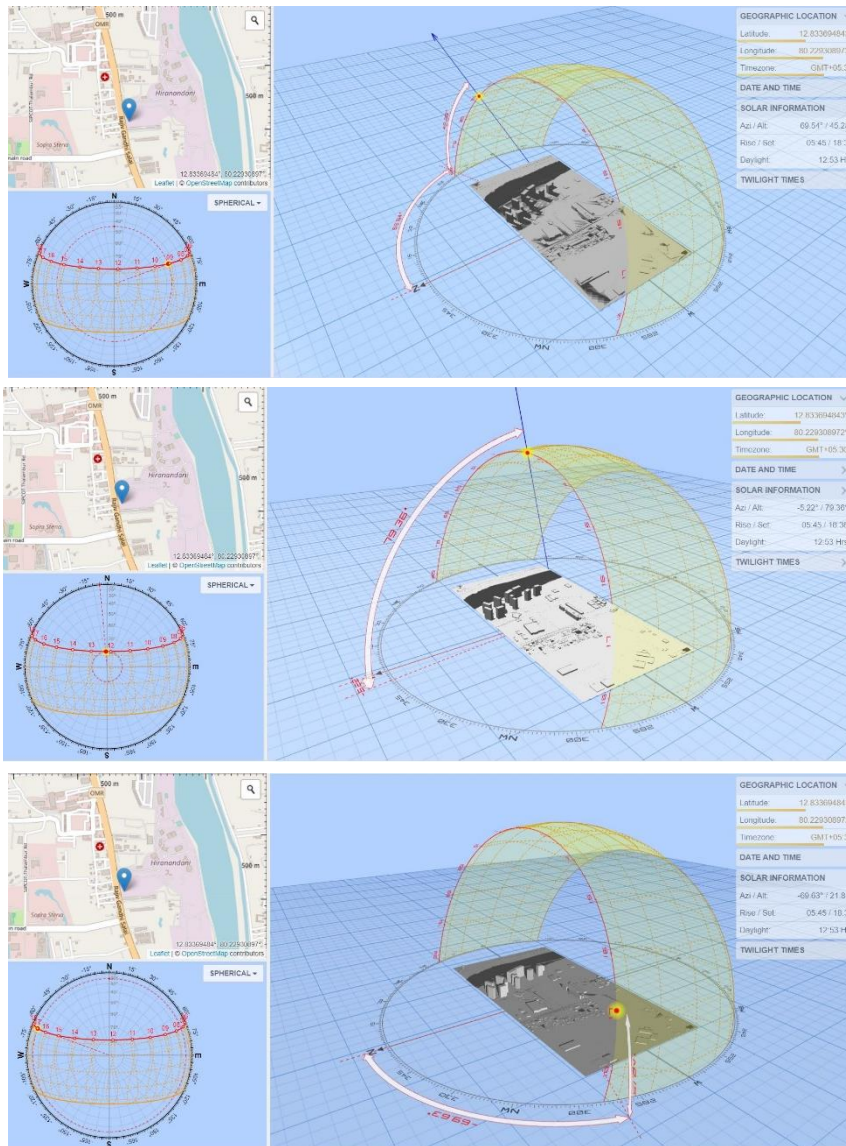
Figure 3.12.6



Figure 3.12.6 Towards Southern side

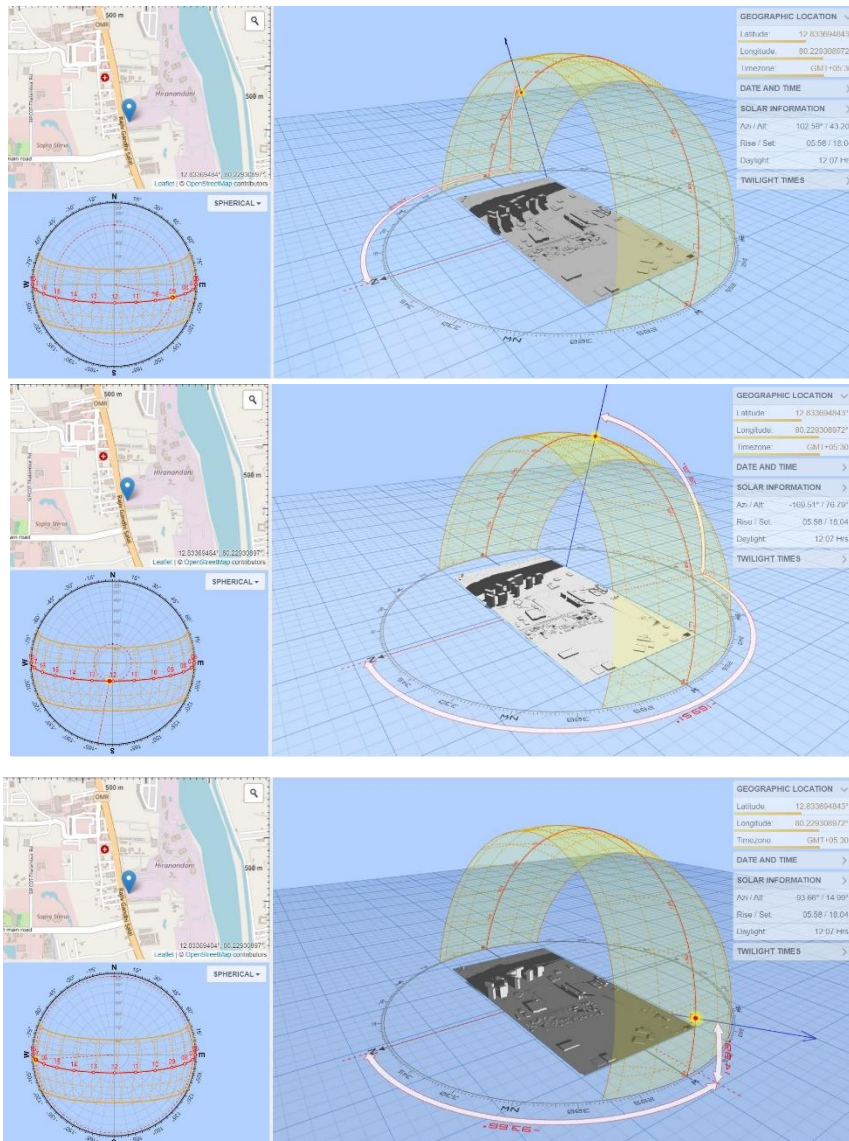


Figure 3.12.7 Summer solstice:



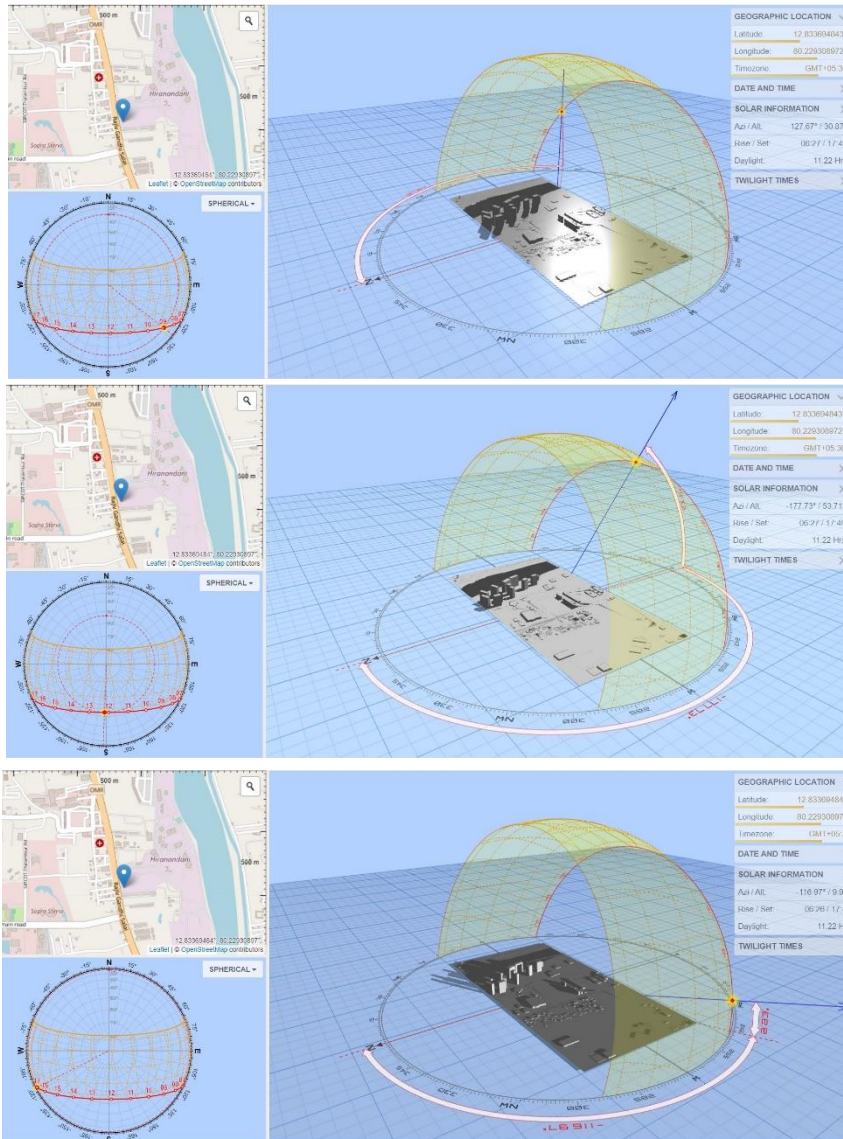
Radiation is high during peak hours on western side, Thus facade treatment on the western side reduce impact.

Figure 3.12.7 Equinox:

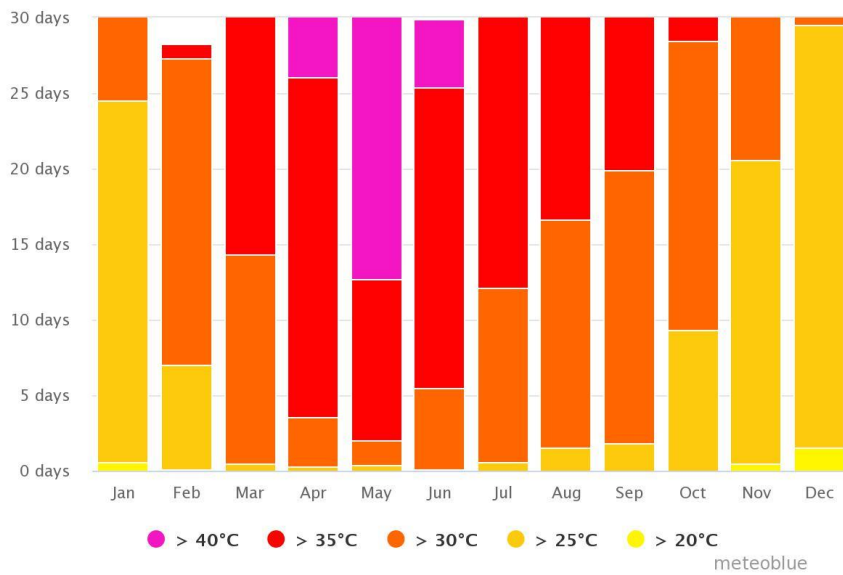


Since the adjacent buildings are not closer to the site, hence there is no mutual shading from adjacent buildings.

Figure 3.12.9 Winter solstice:



Since there is no mutual shading hence building can use more solar during winter times which maintains temperature.



3.12.10 The maximum temperature diagram for Egattur, Chennai displays how many days per month reach certain temperatures.

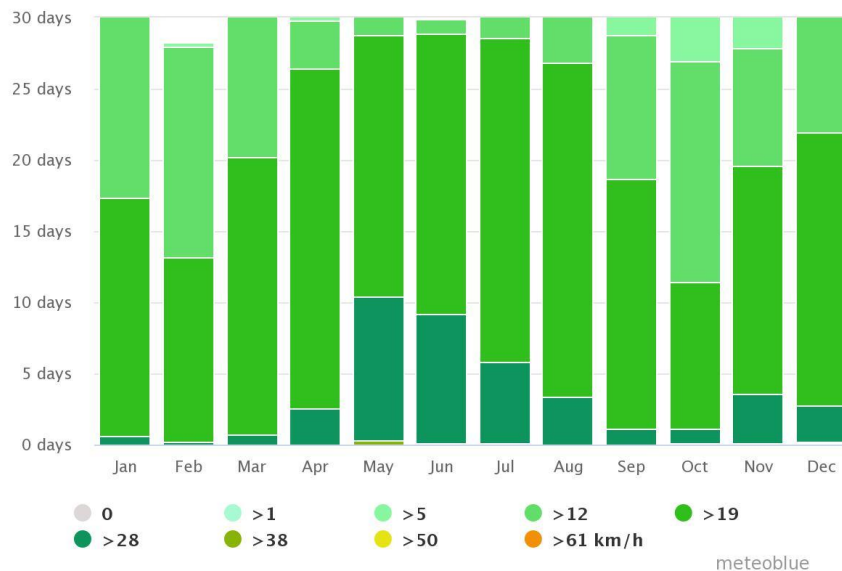


Figure 3.12.11 The diagram for Egattur, Chennai shows the days per month, during which the wind reaches a certain speed.

Max temperature experienced is during march – July.

Sunny days is marked during march – may.

Max wind Flow is experienced during April- Aug.

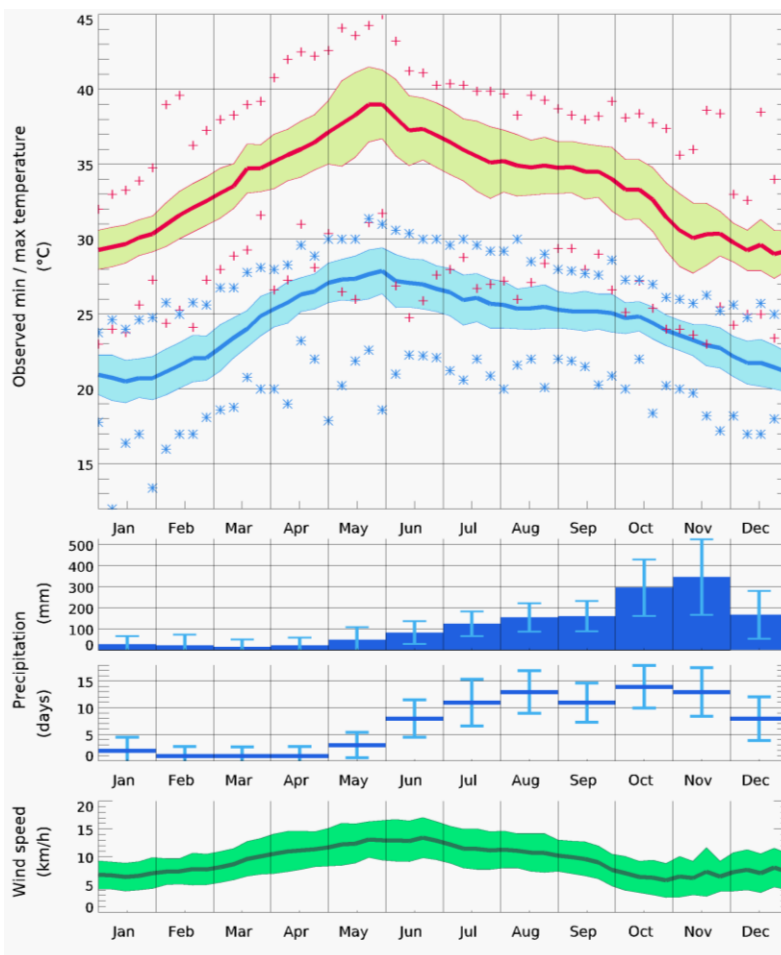


Figure 3.12.12

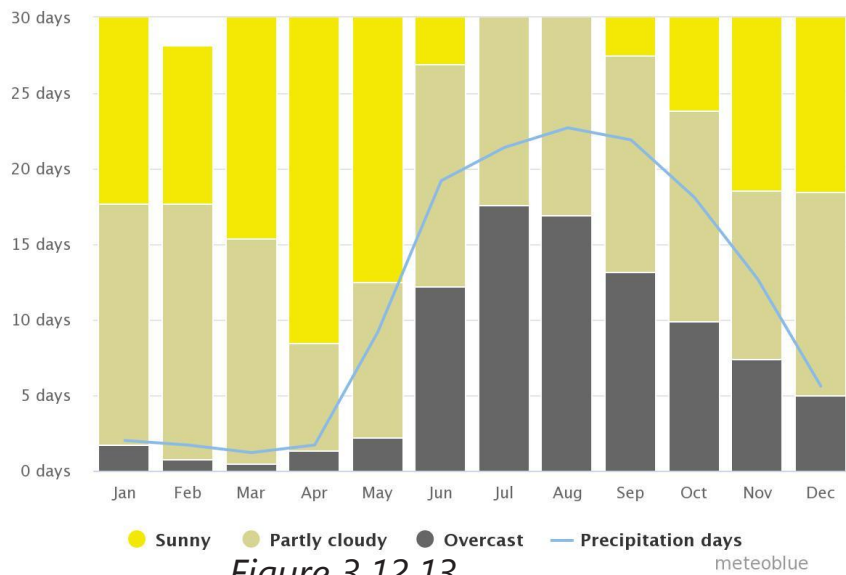
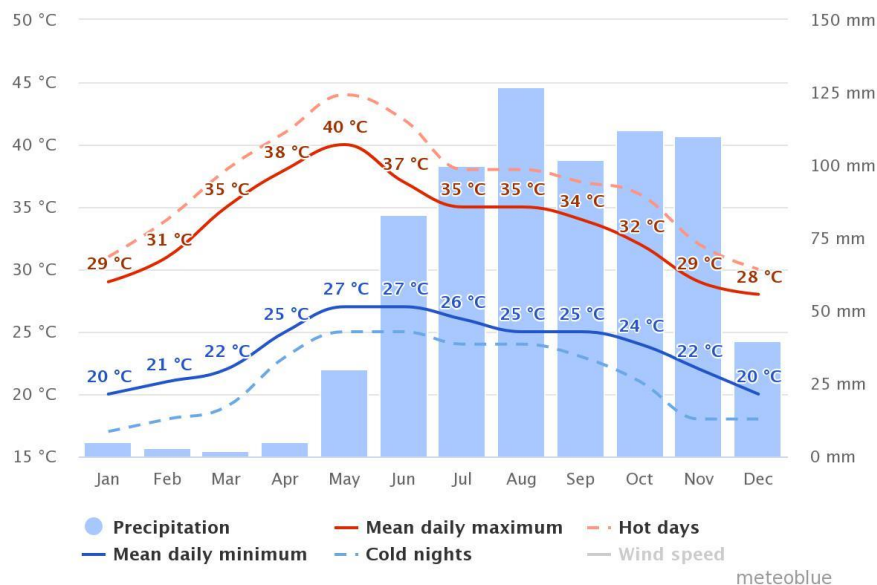


Figure 3.12.13

The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

Figure 3.12.14



3.13 ENVIMET ANALYSIS:

SITE : Egattur Chennai

Tamilnadu

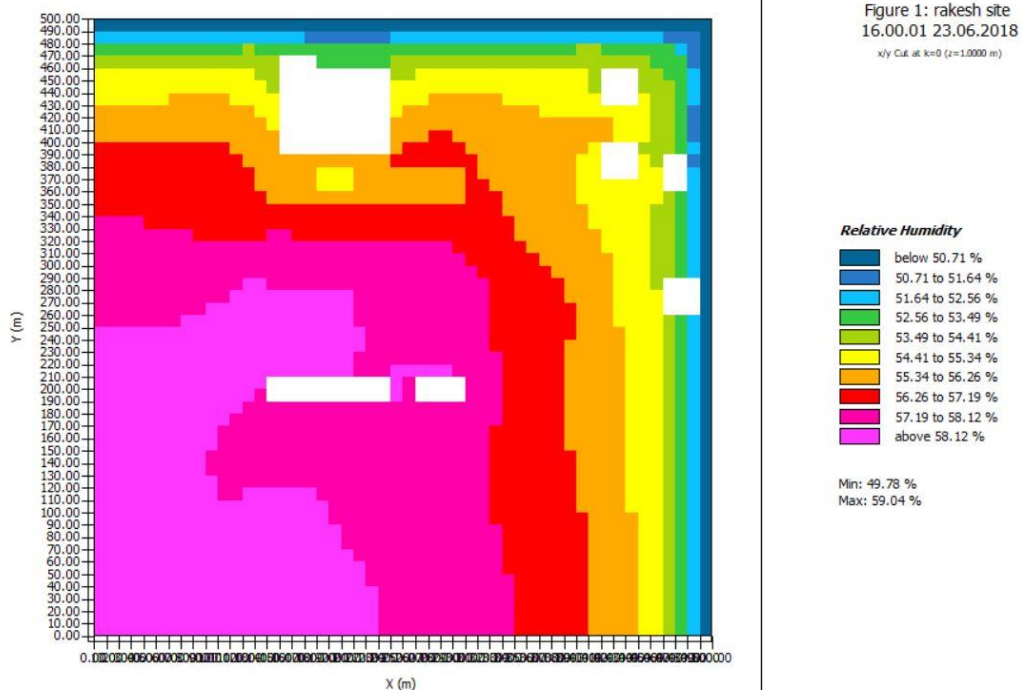
The following data is annual meteorological data for Chennai.

RELATIVE HUMIDITY:

The site experience maximum amount of relative humidity hence usage of wind flow and proper vegetation and also building should shaded by external shading devices and proper spacious planning to increase wind flow and reduce humidity .

Meteorological Data Summary			
Parameter	Min	Max	Avg
Wind Speed m/s	N/A	10.5	3.7
Temperature °C	19	36.7	28.2
Dew Point °C	14.8	27.5	23.1
Humidity %	41.7	96.9	74.6
Pressure hPa	996.2	1016.7	1006.5

Figure 3.13.1



WIND SPEED:

The windspeed in the site is around

2.41 to 2.97m/s

Hence planning in such a way the building uses maximum amount of natural wind current in site.

Which reduce usage of artificial cooling devices.

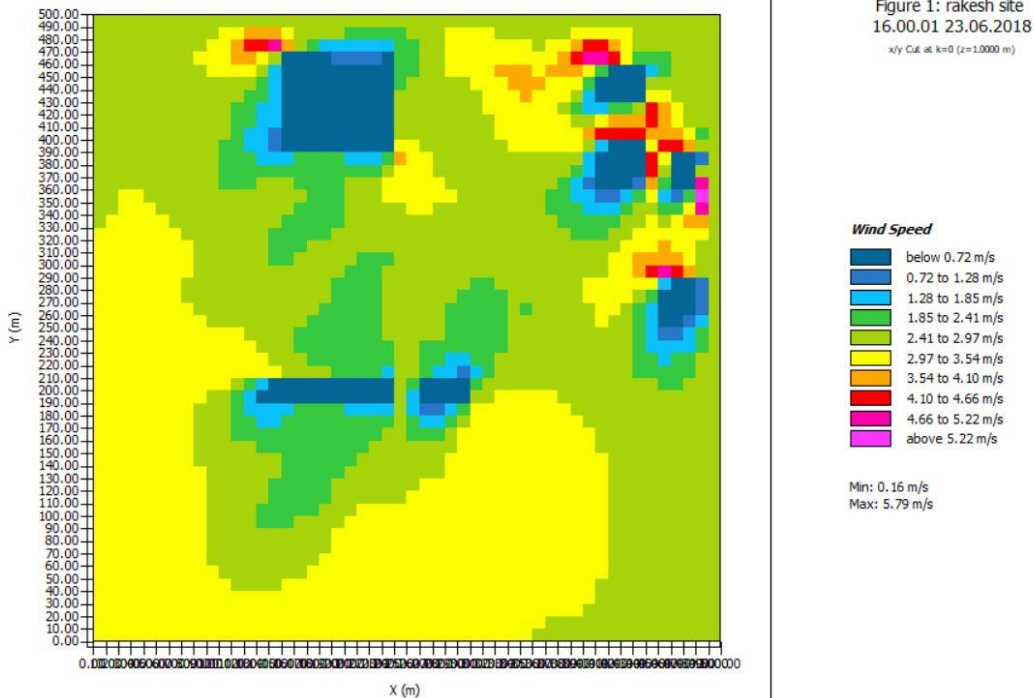


Figure 3.13.3

AIR TEMPERATURE:

Since humidity is high hence comparatively temperature is low, proper plants and vegetation helps prevent site for overheating in summer and also openings with manual or sensory openings can be used In both winter and summer for comfort.

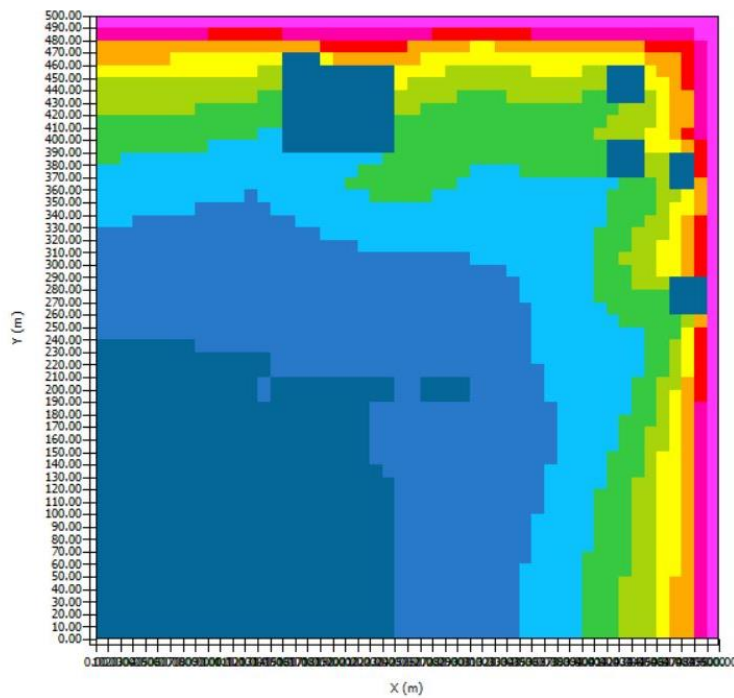


Figure 1: rakesh site
16.00.01 23.06.2018
x/y Cut at k=0 (z=1.0000 m)

Potential Air Temperature

- below 31.27 °C
- 31.27 to 31.75 °C
- 31.75 to 32.23 °C
- 32.23 to 32.71 °C
- 32.71 to 33.18 °C
- 33.18 to 33.66 °C
- 33.66 to 34.14 °C
- 34.14 to 34.62 °C
- 34.62 to 35.10 °C
- above 35.10 °C

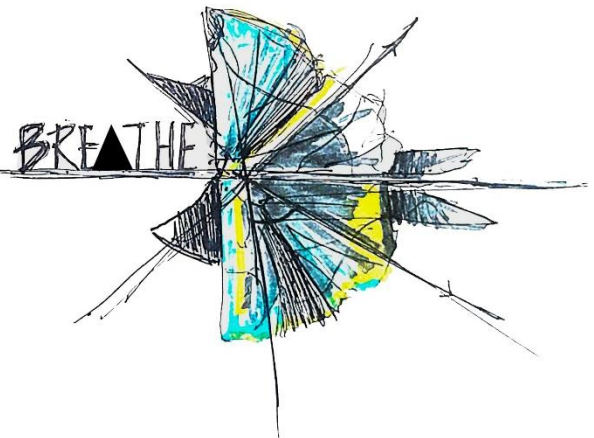
Min: 30.79 °C
Max: 35.57 °C

Figure 3.13.4

4. DESIGN

4 .1 CONCEPT

CENTRE FOR SUSTAINABLE RESEARCH AND TECHNOLOGY.



CONCEPT:

A small change caused can create a major impact in universe

In Sustainability:

One small change in building's Site, Material, Energy can create major change in both the Buildings and surroundings.

In Typology:

Since it's a research centre the change cause by research in sustainability can create a major impact in future generation.

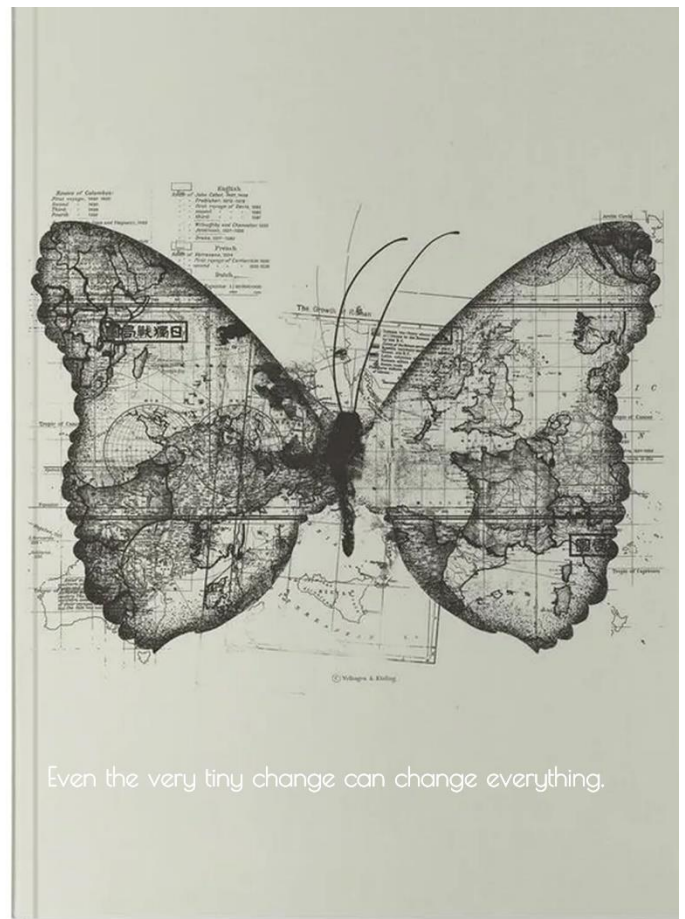


Figure 4.1.1

BUTTERFLY

EFFECT.

Nature is driven by butterfly effect a small seed can create a tree same way a small minerals creating rock and then creating mountains river flow everything in and around us.

How this can implement in architecture and sustainability.

MICHALANGELO PAINTING :

Michalangelo created a master piece called creation of adam in the painting decoding researcher said that the artist created god in his own brain so he painted the god like human brain.

Thus michalangelo said everything can be created in our one's own brain and nowhere else.

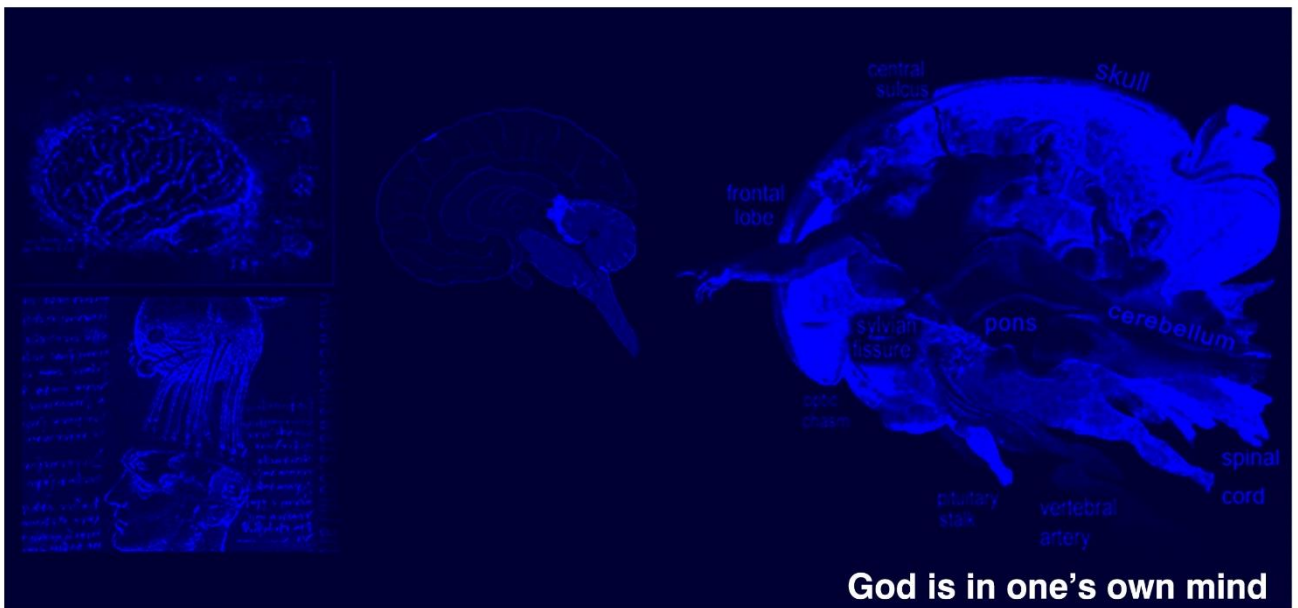
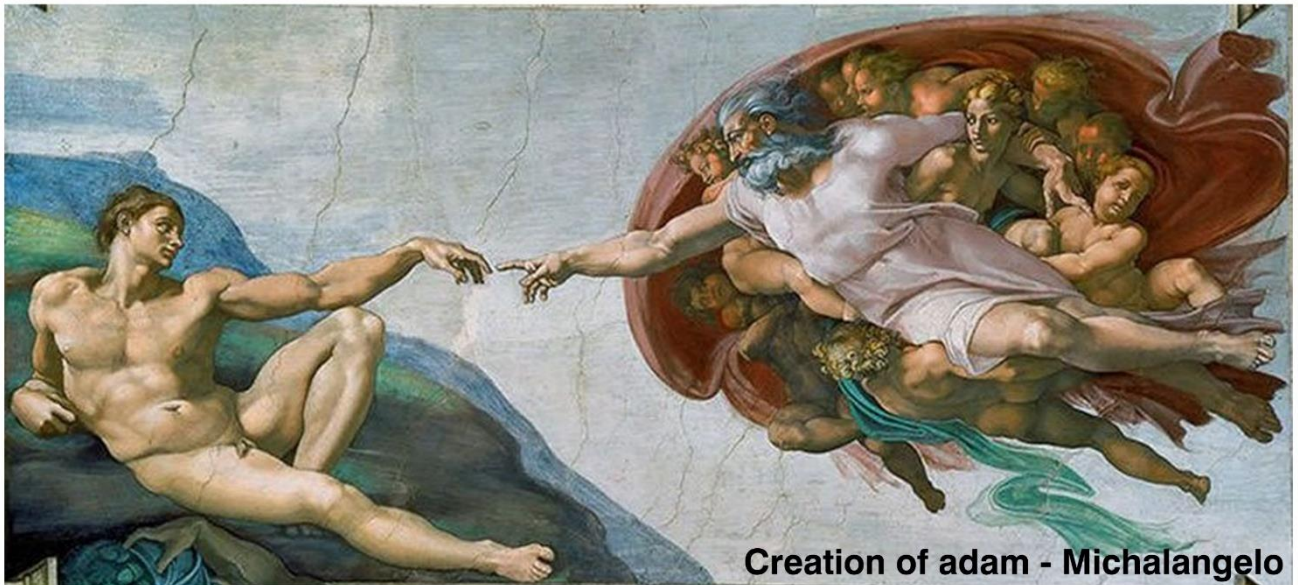
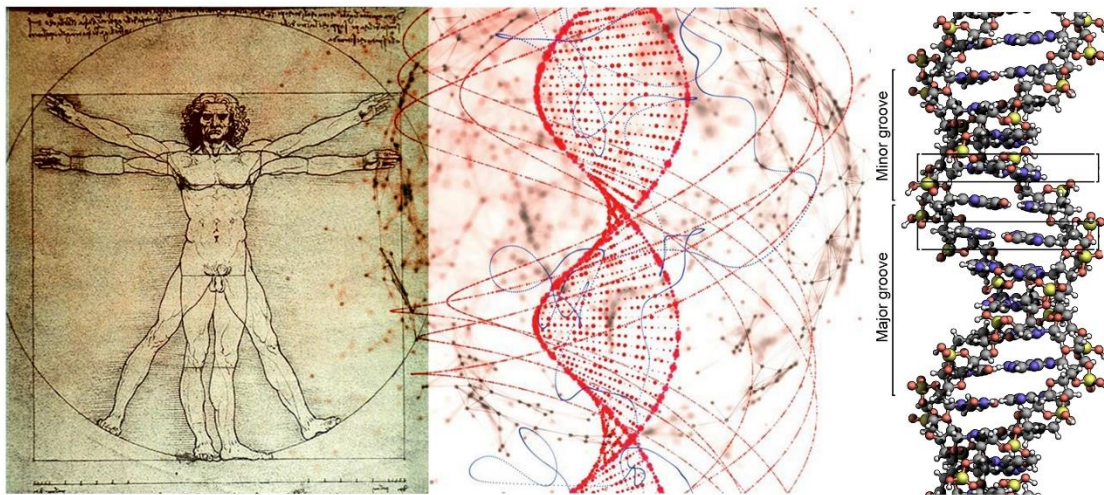


Figure 4.1.2

BUTTERFLY

EFFECT IN HUMAN.

The DNA consists of many small molecules and structures thus those small structures combine to create our human body thus, The small change in DNA like structure can create a massive change in whole human body.



Butterfly effect in one's own body

Figure 4.1.3

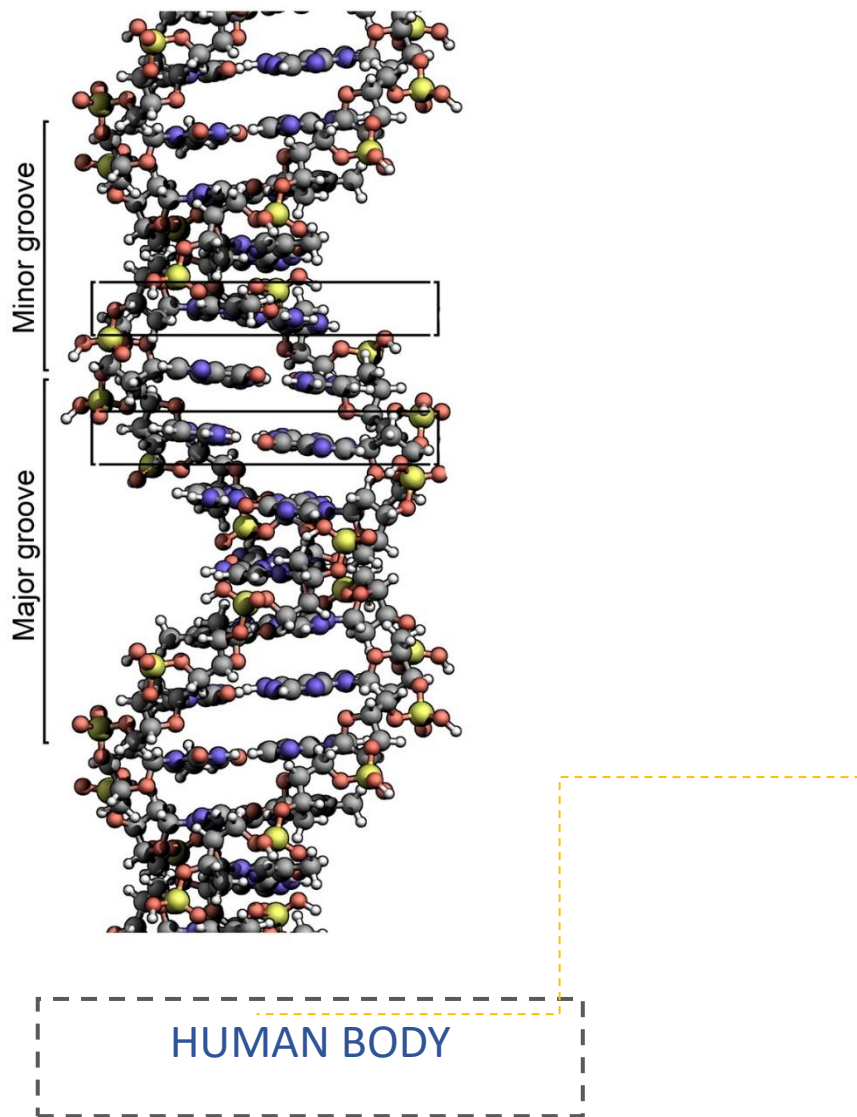


Figure 4.1.4]



BUTTERFLY EFFECT

Figure .4.1.5



SITE

WATER

ENERGY

COMFORT

MATERIALS

SUSTAINABILITY

ANALYZING DNA STRUCTURE:

By analysing DNA structures and decoding it. The Triangular Structure is the one multiplied to form whole DNA Structure, This Triangular form can be incorporated in the design thus form a Building with triangulation form.

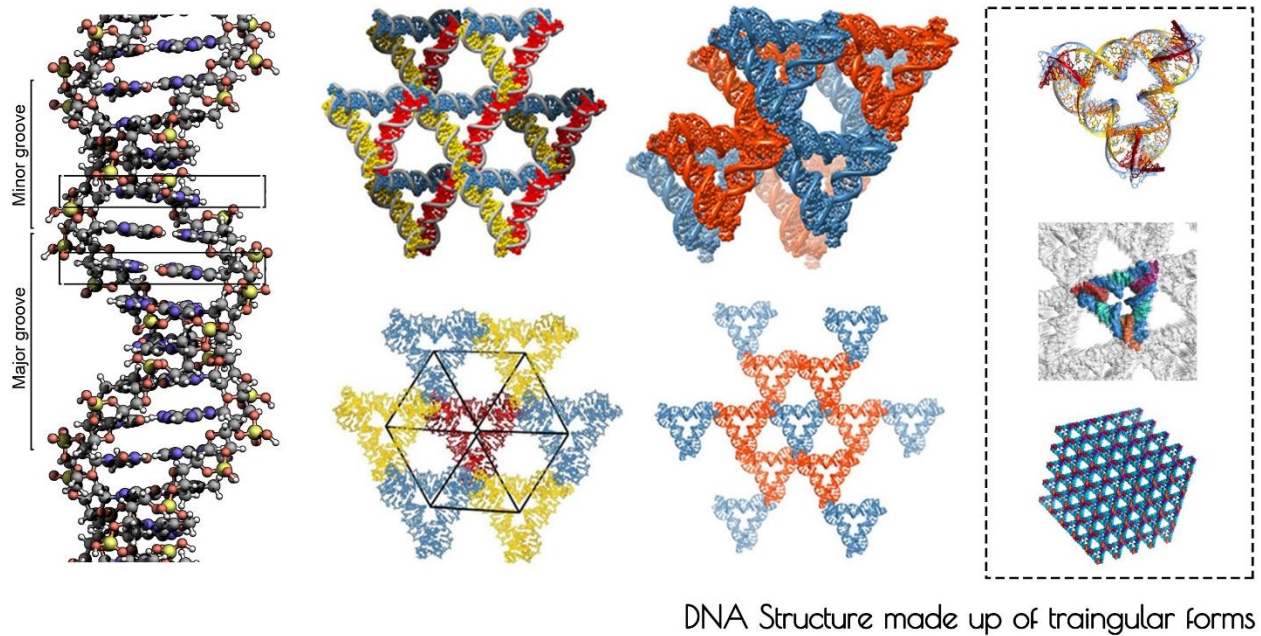


Figure 4.1.6

4.2 BUBBLE DIAGRAM

Conceptual bubble diagram shows how the spaces arranged according to proximity of people usage and site orientation.

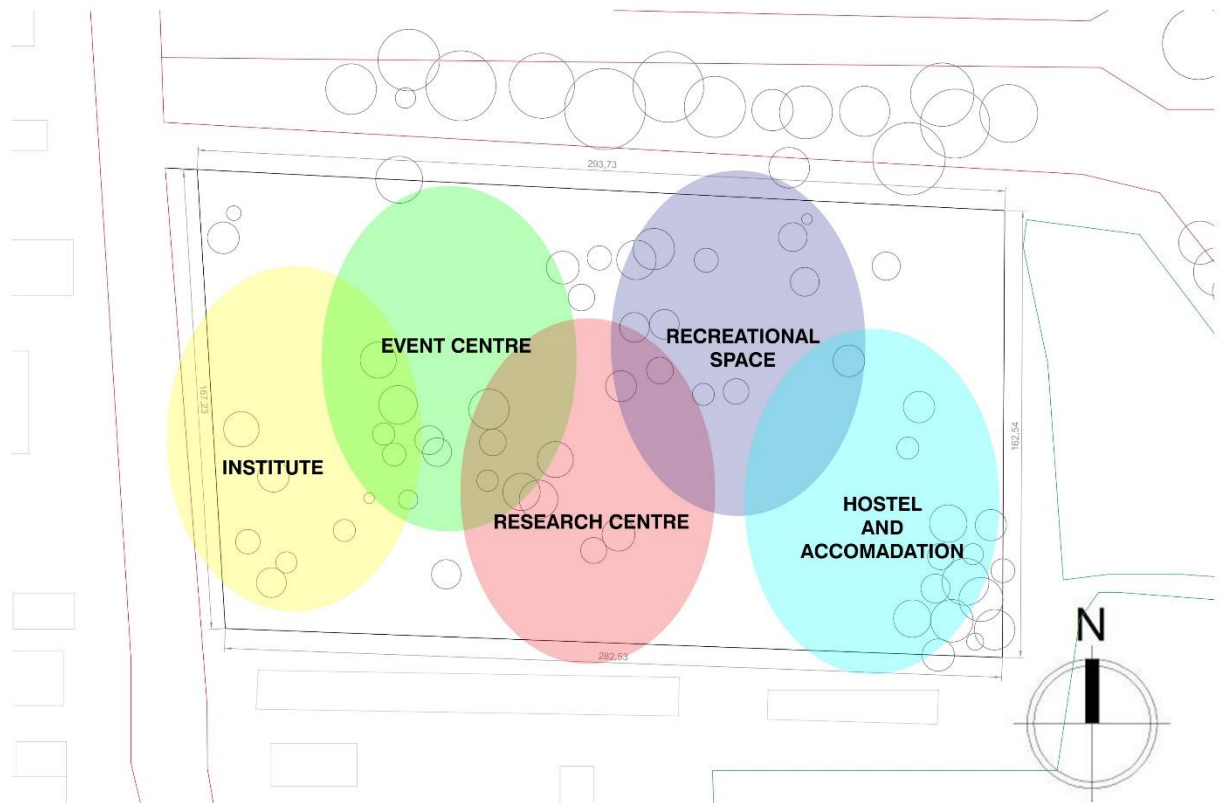


Figure 4.2.1

CONCEPT INCORPORATION

Incorporating triangle like structure into spaces in the site and zoning according to it.

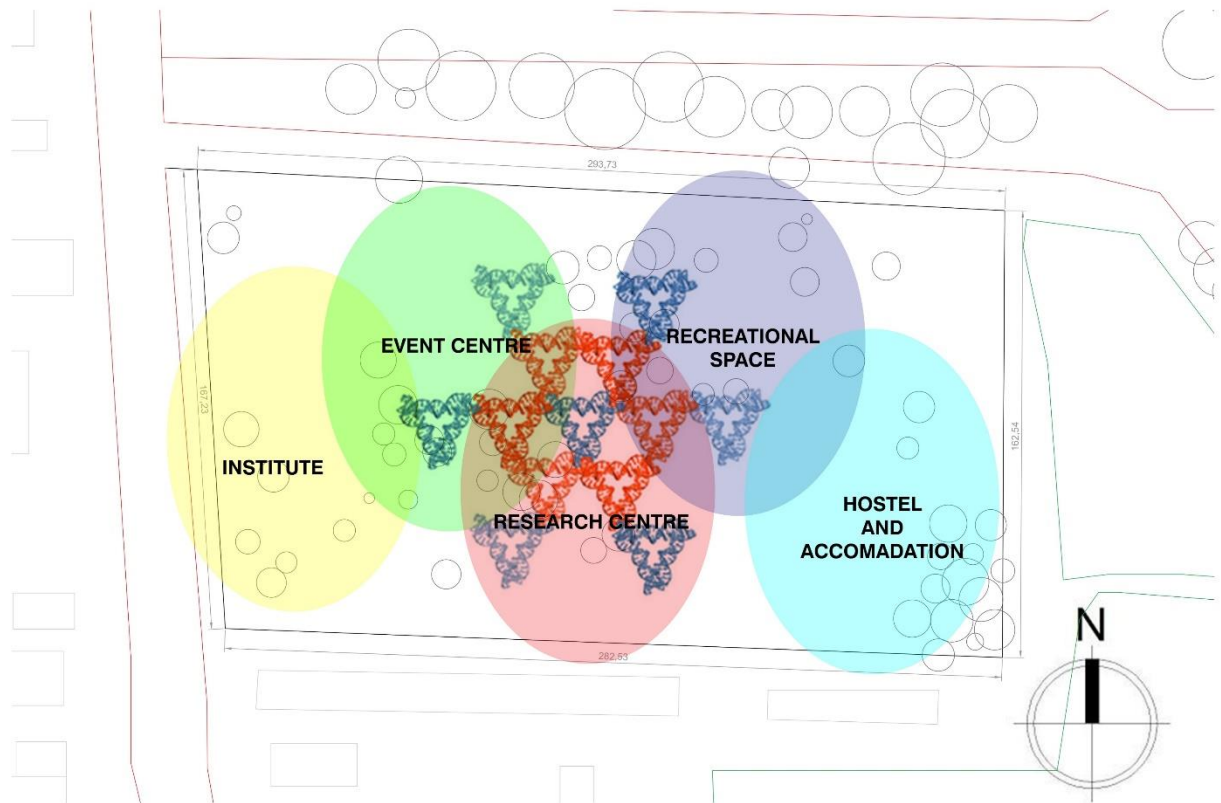


Figure 4.2.2

Overlaying triangle on one another creates a shape where joints act as spaces and perpendicular lines acts as circulation for students and peoples

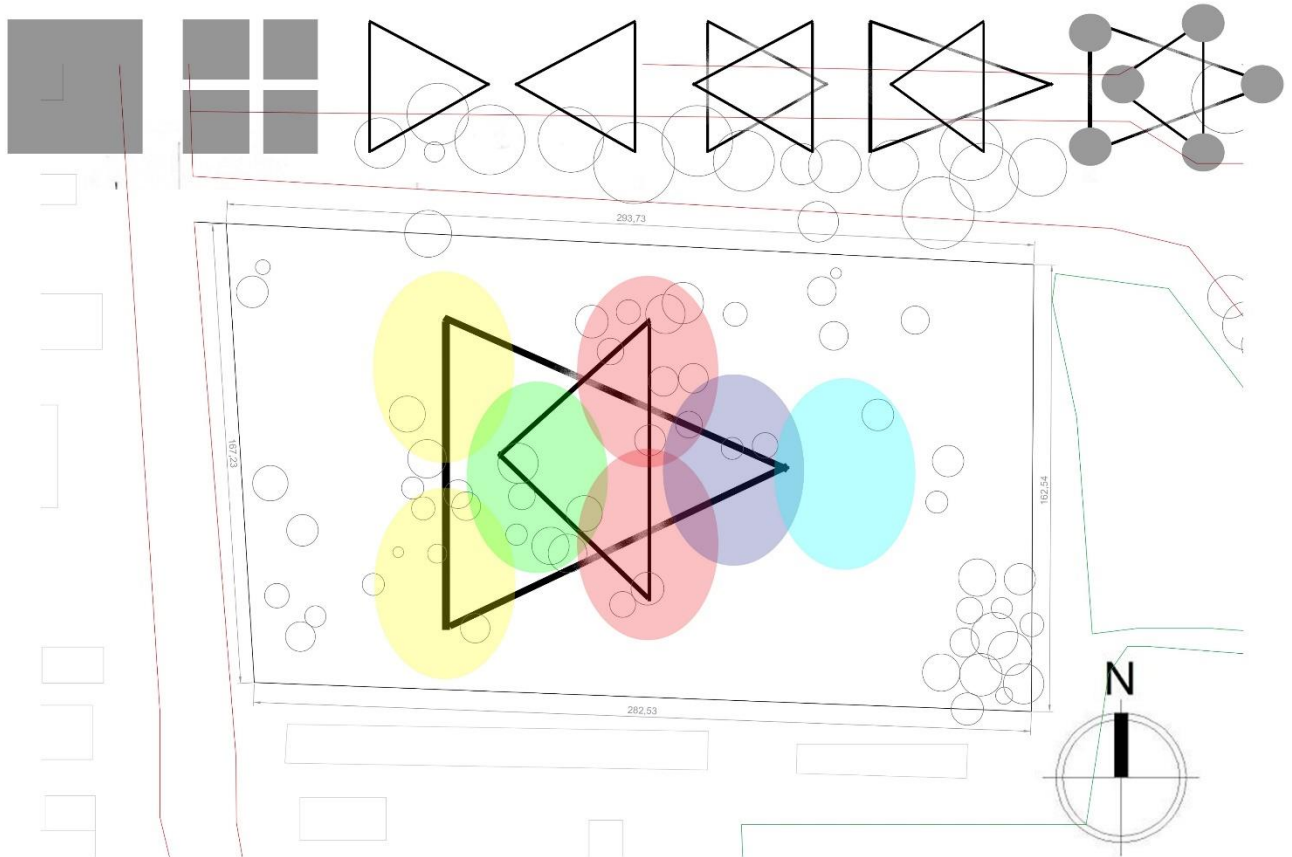


Figure 4.2.3

4.3 FORM EVOLUTION

ZONING EVOLUTION:

- 1.This zoning is done according to public/ semi public/ private zones of spaces by accessibility of people to site.
- 2.Conceptual zoning done for how intervention of triangles create spaces with angles and how it can be altered for further site zoning.
- 3.Radial planning goes well in Research centre/Institutions also it goes with conceptual zoning for the site.
4. Blocks placed radially from centre event space and also spatially well arranged in order to create more wind flow into site thus reduce humidity in site and helps main comfortable temperature among users and site.

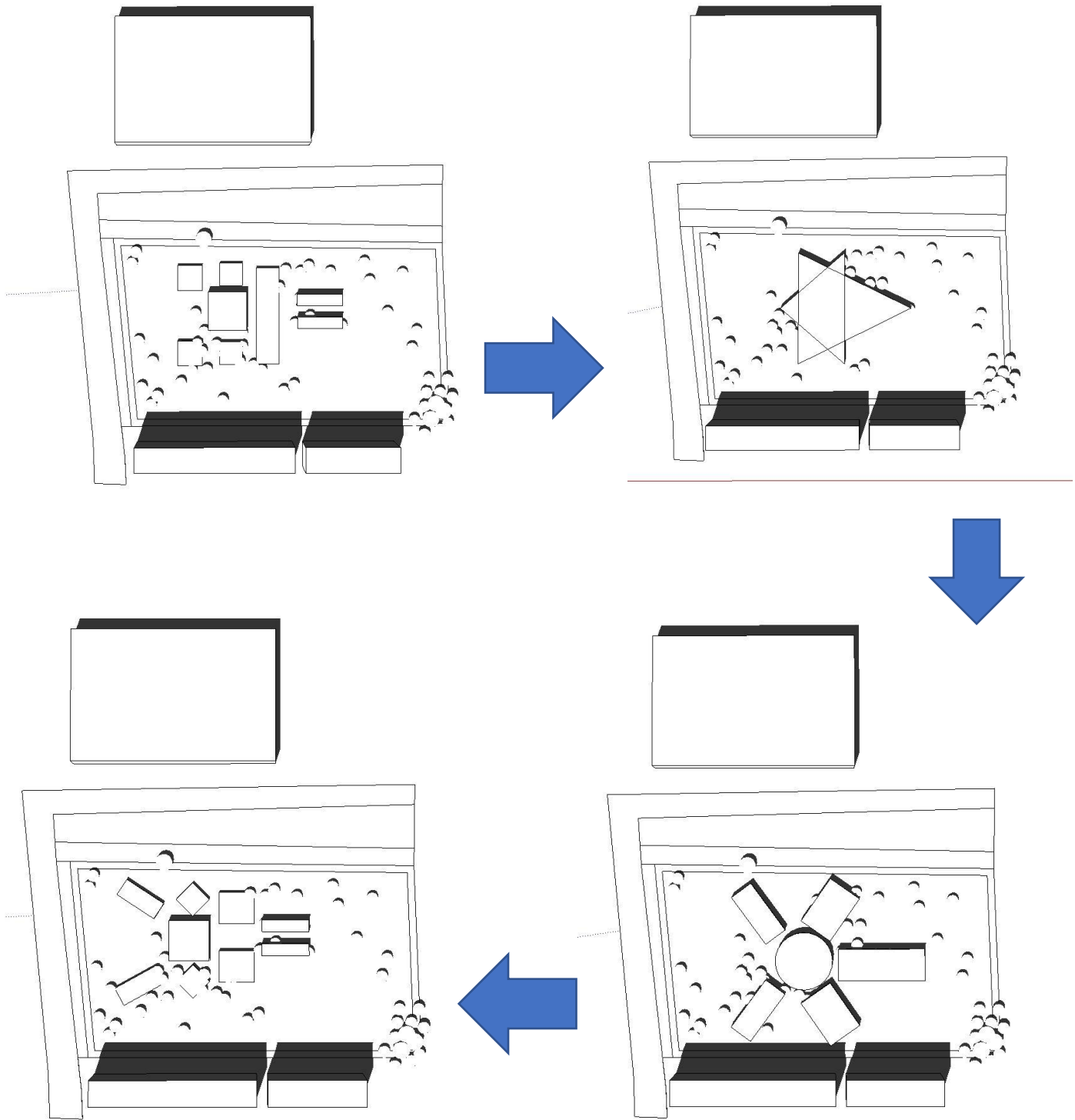


Figure 4.3.1

ZONING ITERATION 1

The zoning shows the spaces orients in 45deg to site and also helps in direct wind flow to site, but due to closely placement of blocks reduce wind circulation inside the site and within buildings.

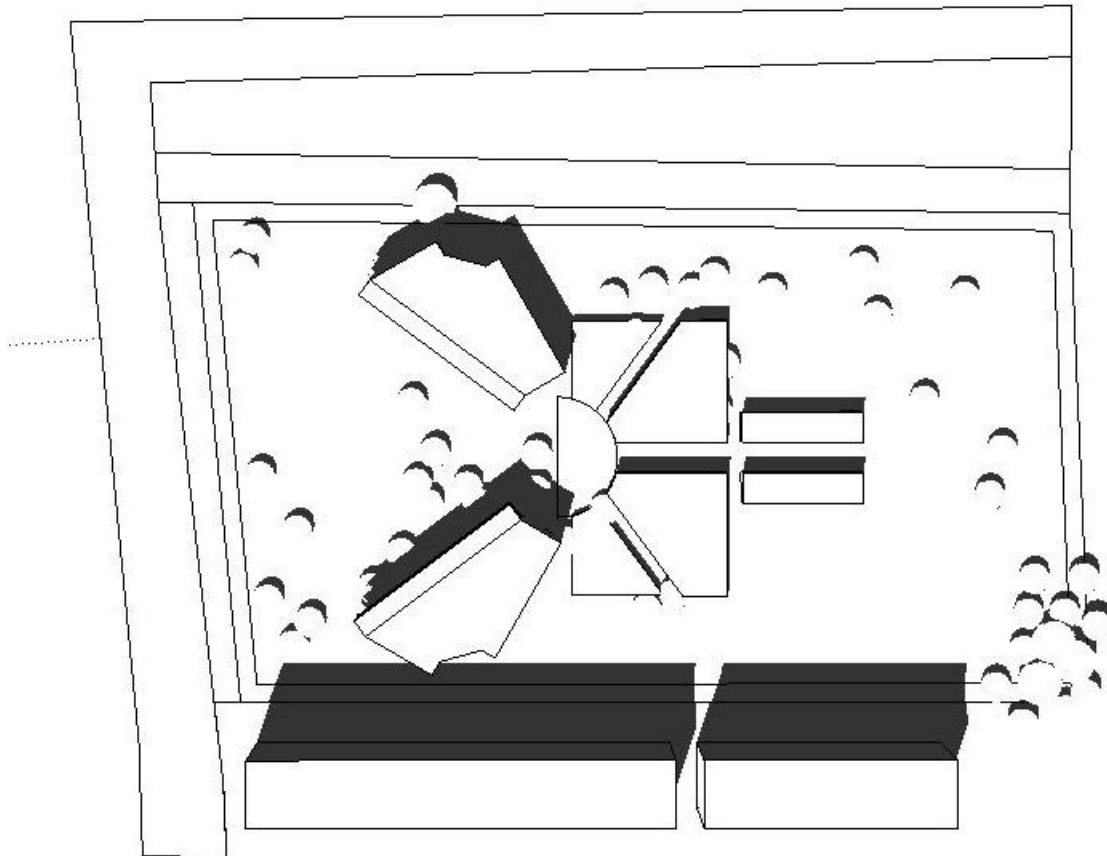


Figure 4.3.2

FORMIT ANALYSIS:

The images shows that the sun radiation is high in roof due to larger roof area (1657 btu) hence mutual shading by zoning can help reduce solar heat gain by buildings roof area.

And western side is more exposed to sun hence façade treatment should be monitored in order to maintain comfort temperature inside the building.

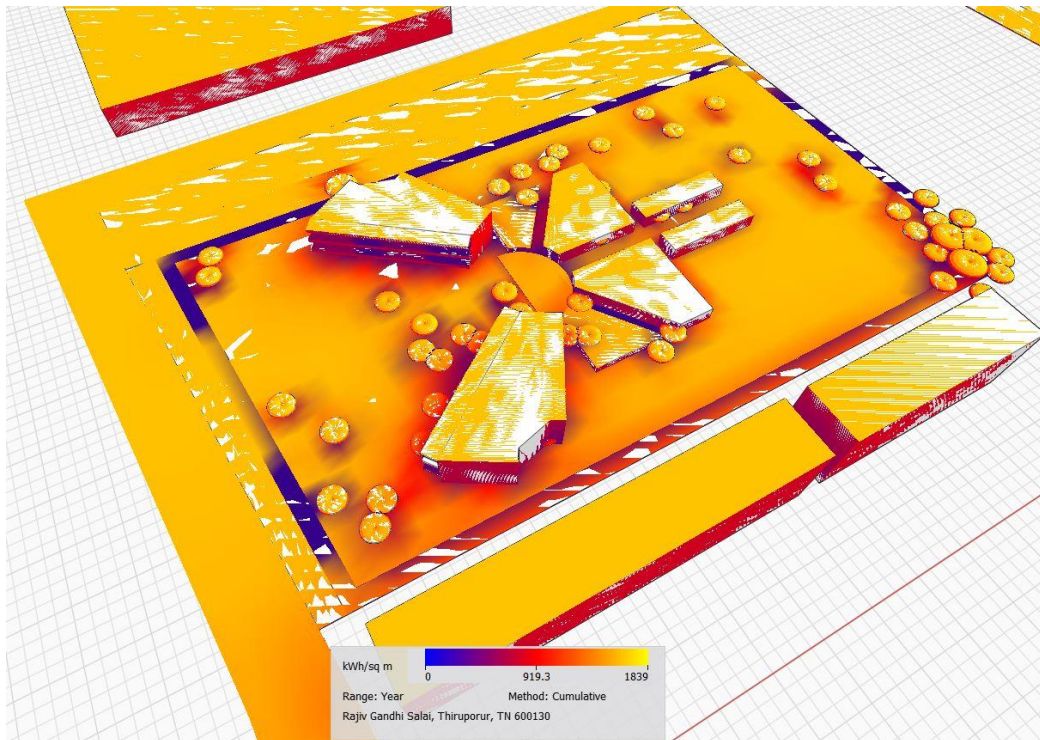


Figure 4.3.3

ZONING ITERATION 2

The zoning shows the space is arranged slightly away from centre space to create wind flow inside the building. The wall area is more exposed to sun on eastern and western side

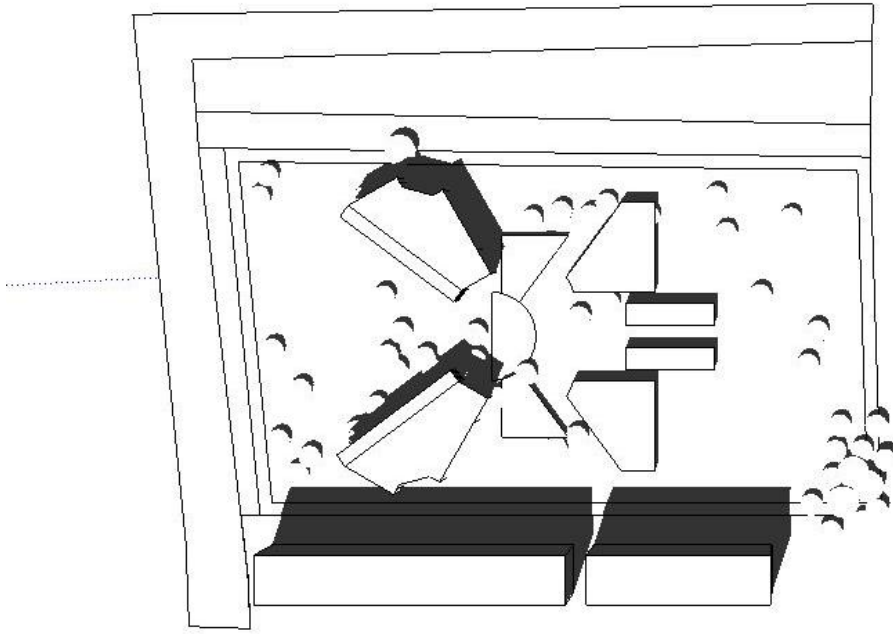


Figure 4.3.4

FORMIT ANALYSIS:

The images shows that the sun radiation is high in roof due to larger roof area (1657 btu) hence mutual shading by zoning can help reduce solar heat gain by buildings roof area.

This arrangement cause more of radiation on site which affects building and users.

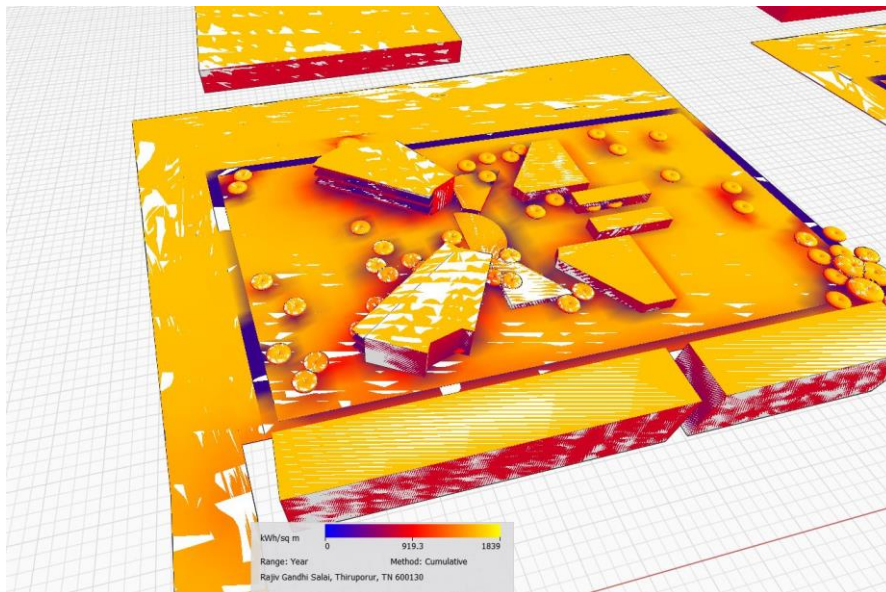


Figure 4.3.5

ZONING ITERATION 3

The zoning shows the space is arranged slightly away from centre space to create wind flow inside the building. The wall area is more exposed to sun on eastern and western side.

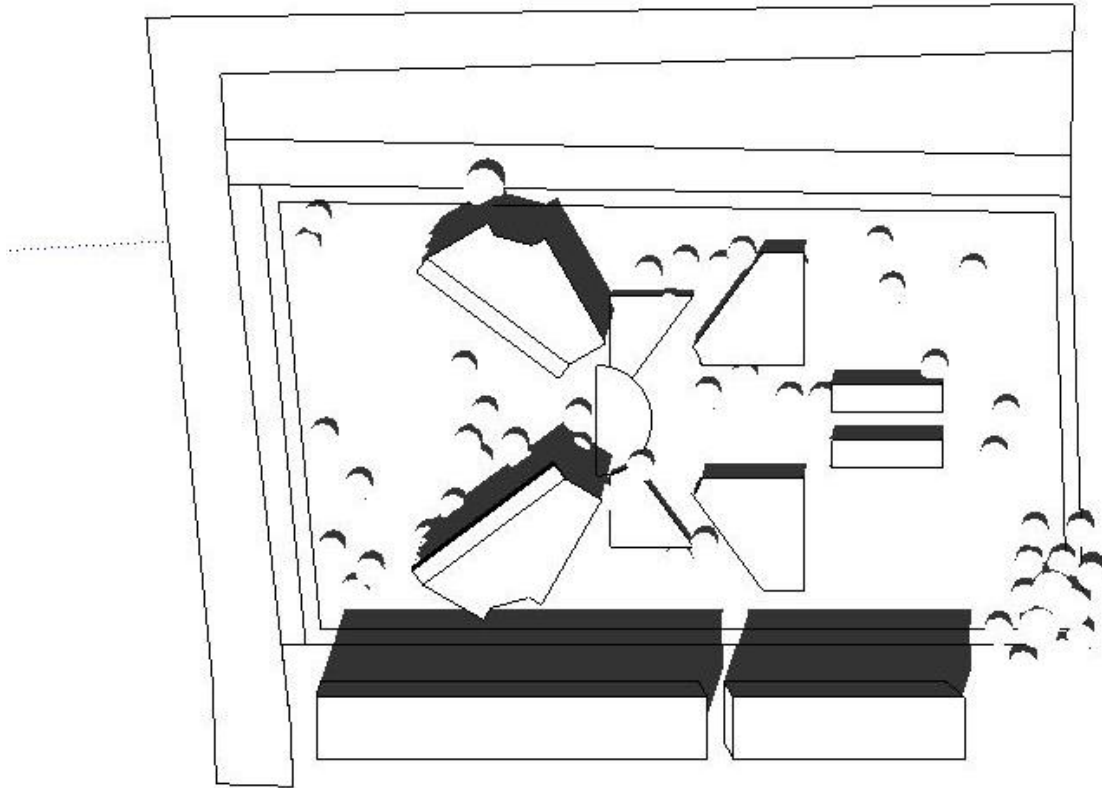


Figure 4.3.6

FORMIT ANALYSIS:

The analysis shows that walls experience less amount of heat(919.3btu) due to orientation of blocks placed in such a way it reduces more of heat gain from sides.

But the roof experience more of heat during peak hours thus proper insulation or planning strategies can be designed.

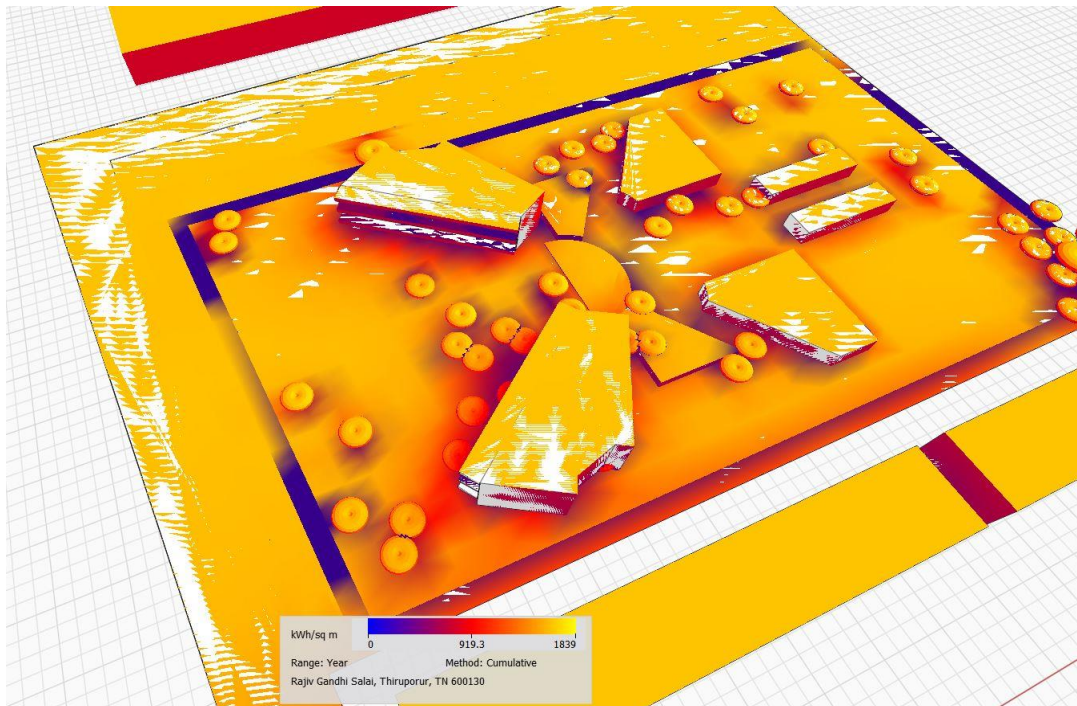


Figure 4.3.7

ZONING ITERATION 4

The zoning shows the space is interlocked with one another reduces surface area exposed to sun and also helps in distribution of wind among the block.

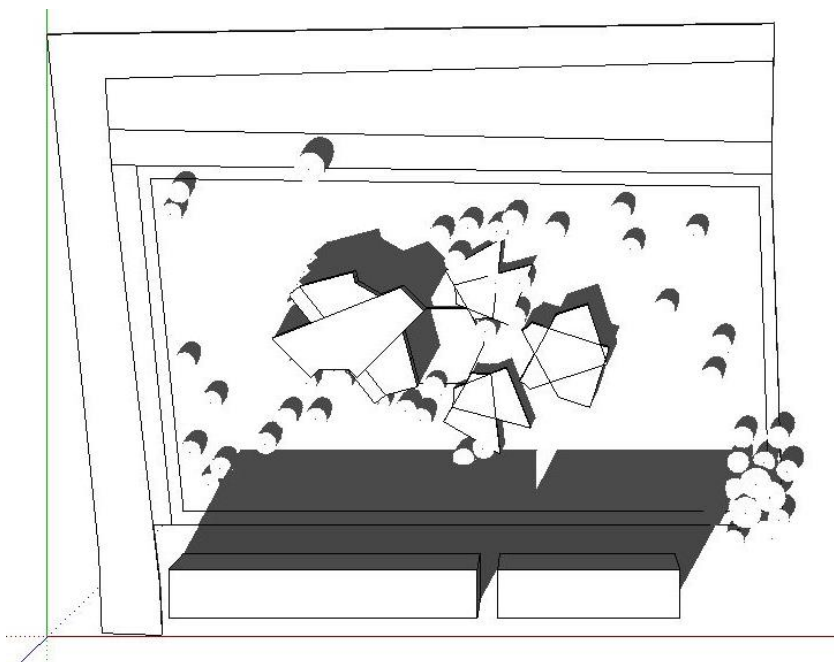


Figure 4.3.8

FORMIT ANALYSIS:

The analysis shows that walls experience less amount of heat(764.3btu) due to orientation of blocks placed in such a way it reduces more of heat gain from southern and western sun.

Surface area exposed to sun is less compare to other iterations but the impact is same compare to other iterations.

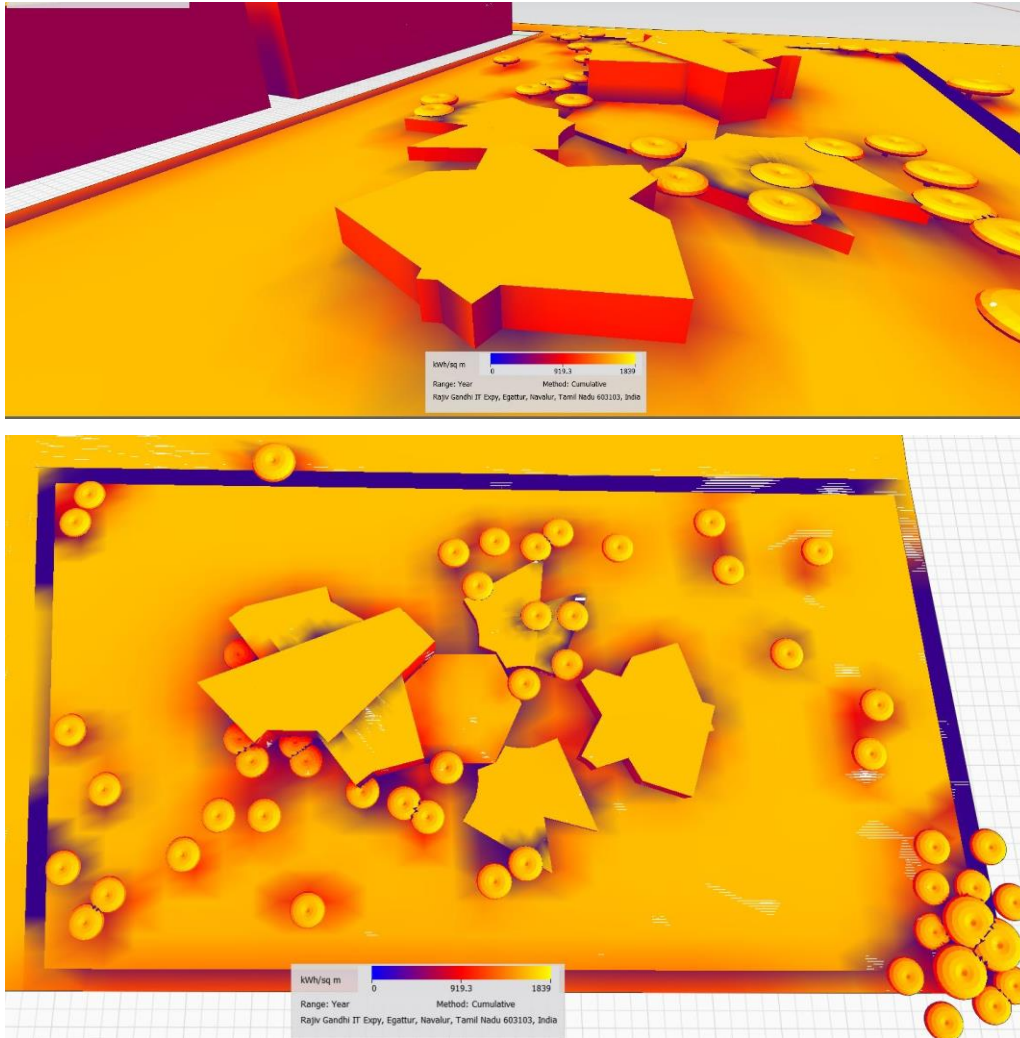


Figure 4.3.9

ZONING ITERATION 5

The zoning shows the space is overlapped with one another increase mutual shading thus helps in reduction of surface area exposed to sun and also helps in distribution of wind among the blocks.

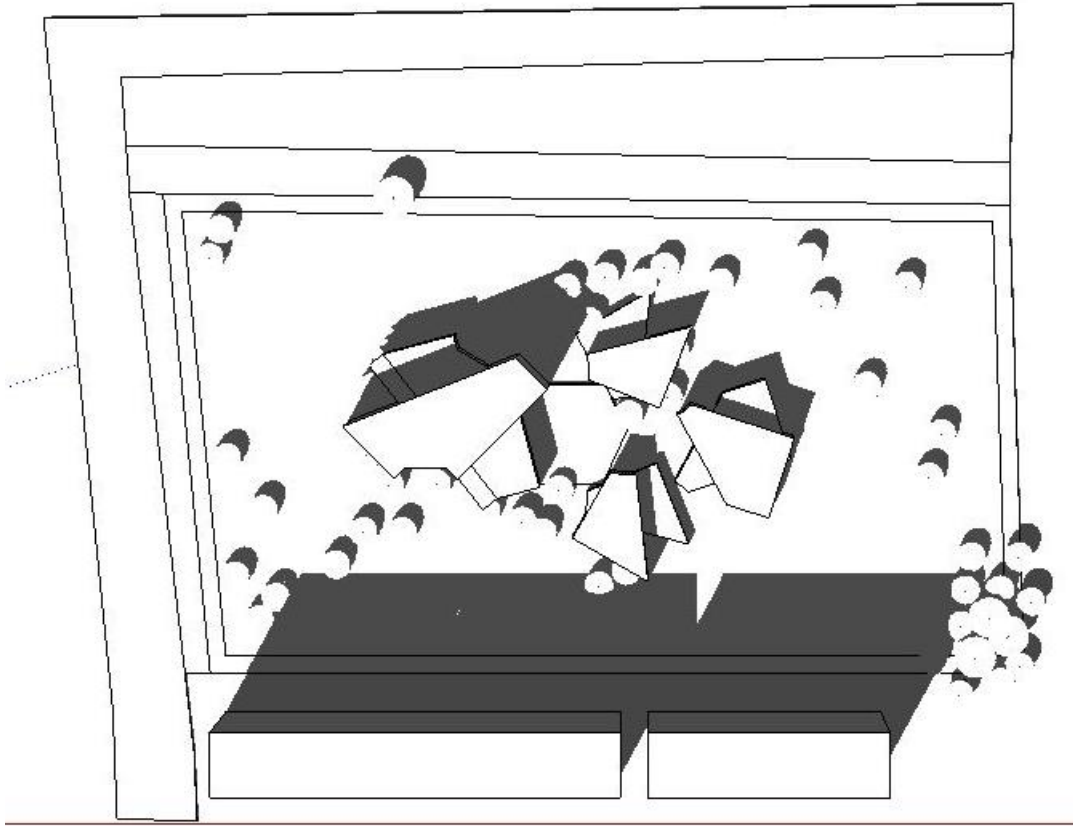


Figure 4.3.10

FORMIT ANALYSIS:

The analysis shows that walls experience less amount of heat(567.7btu) due to orientation of blocks placed in such a way it helps in attaining mutual shading thus reduces more of heat gain from southern and western sun. Venturi effect is used to distribute wind among buildings and site helps maintain humidity level inside the building

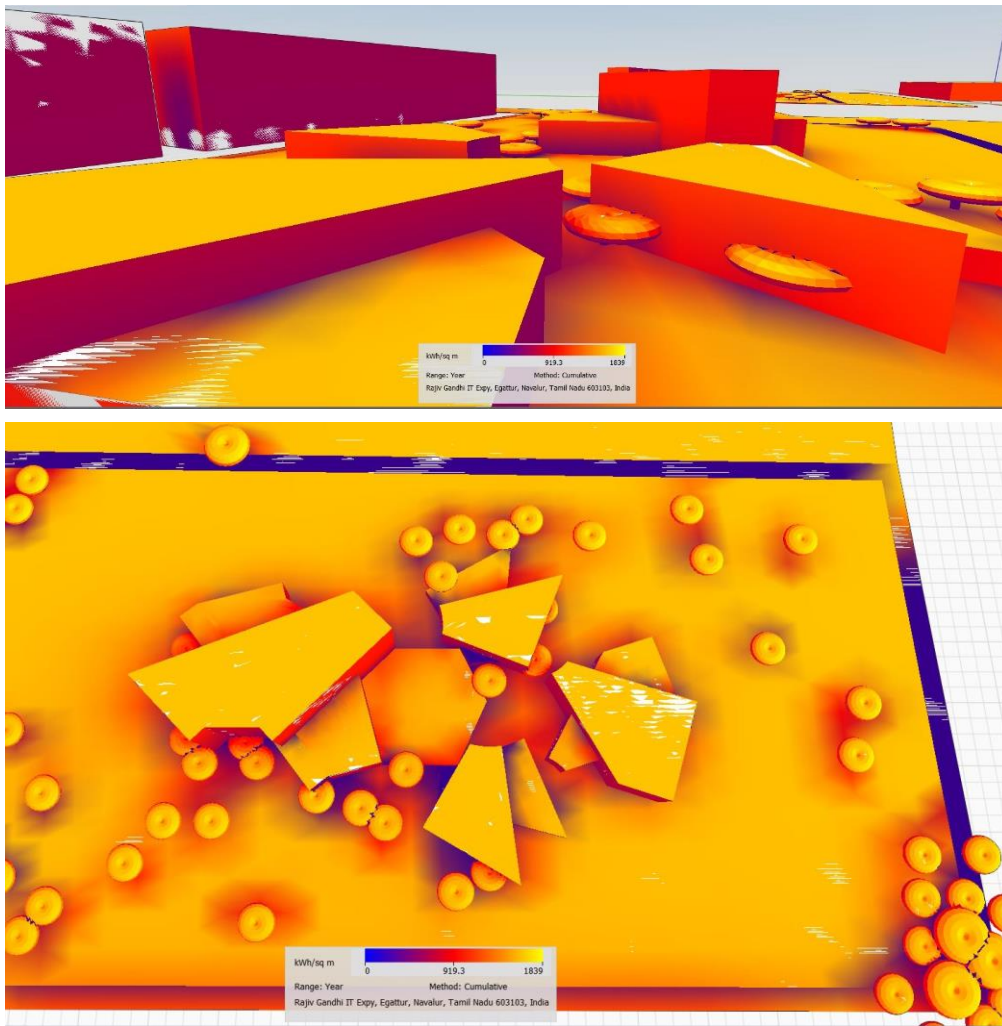


Figure 4.3.11

Conceptual Zoning.

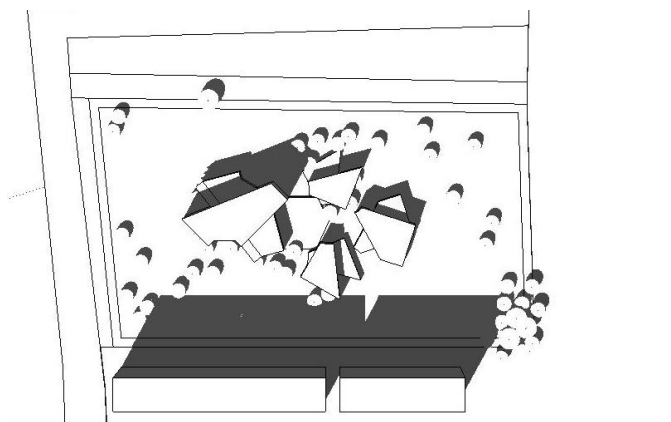


Figure.4.3.12

Conceptual Section.

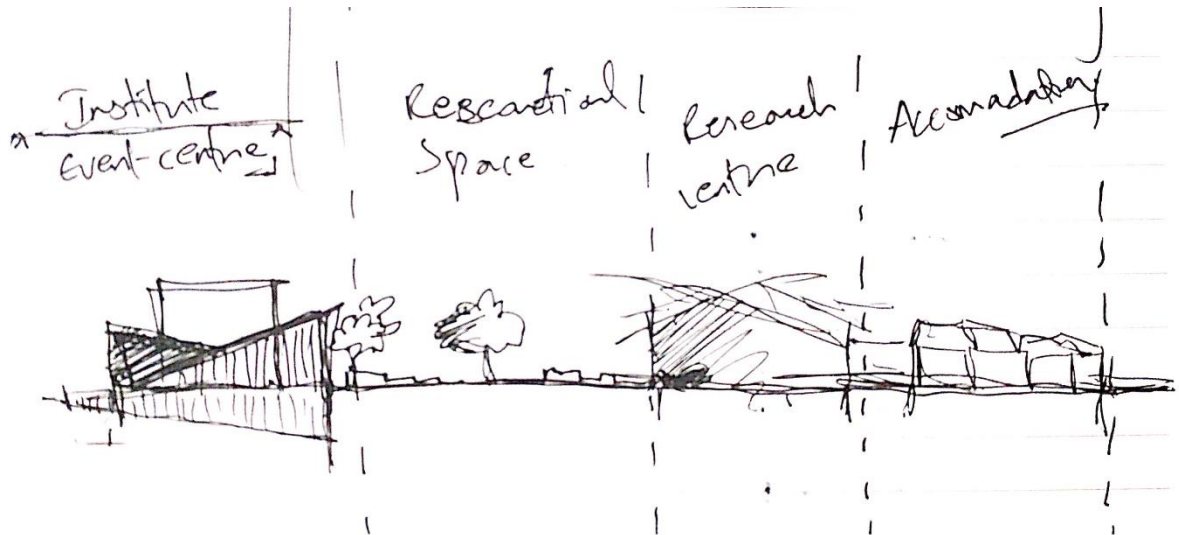


Figure 4.3.13

Equinox.

Openings on the windward side reduce humidity.

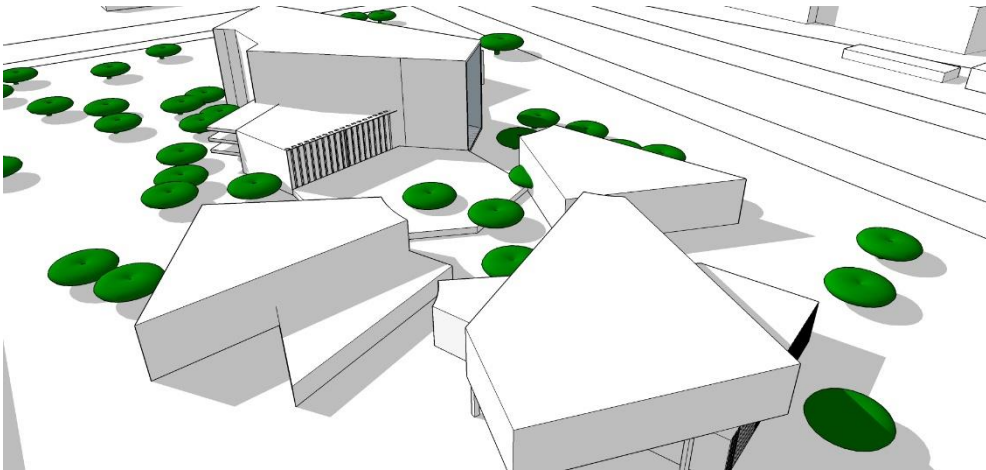


Figure 4.3.14

Summer solstice.

Mutual shading on the buildings reduce over heating.

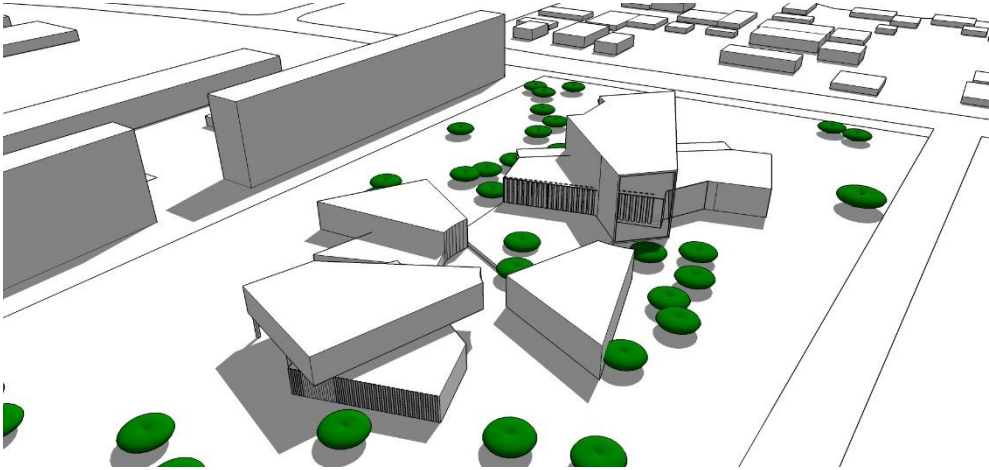


Figure 4.3.15

Winter solstice.

Manual openings and louvers on the SW side helps maintain temperature

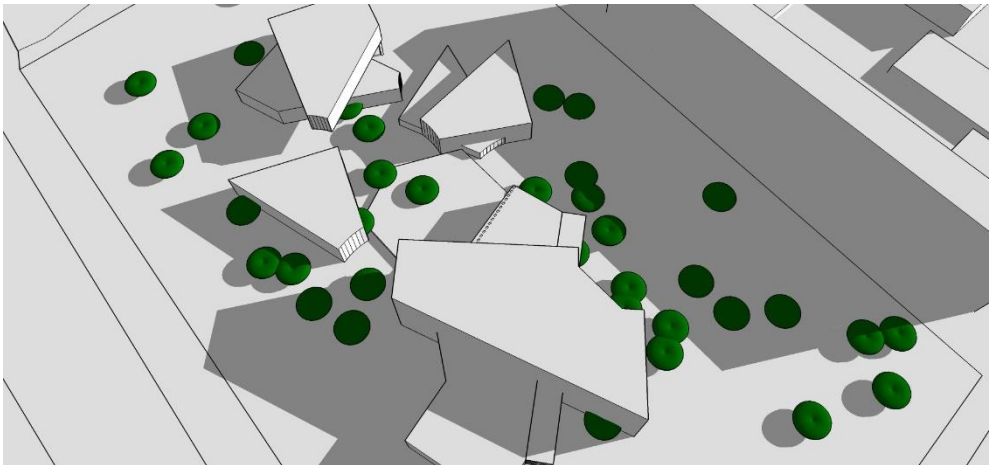


Figure 4.3.16

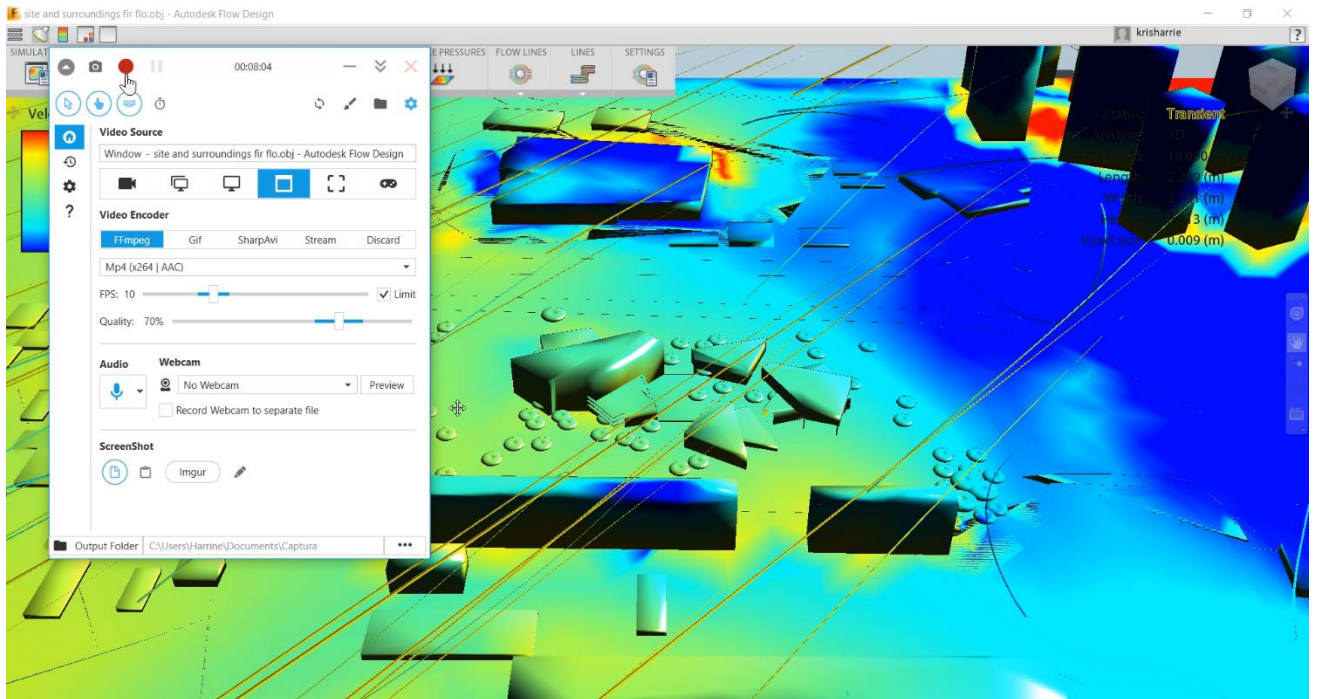
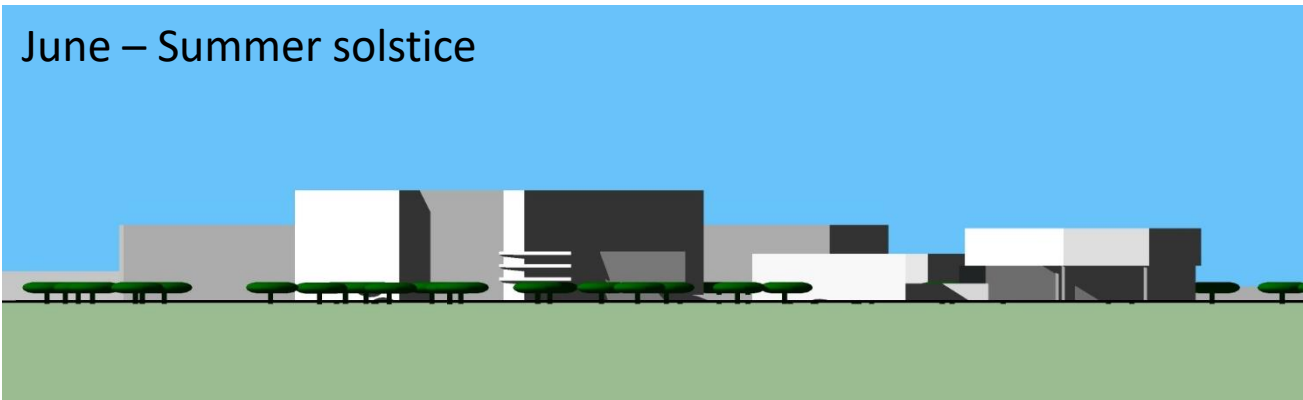
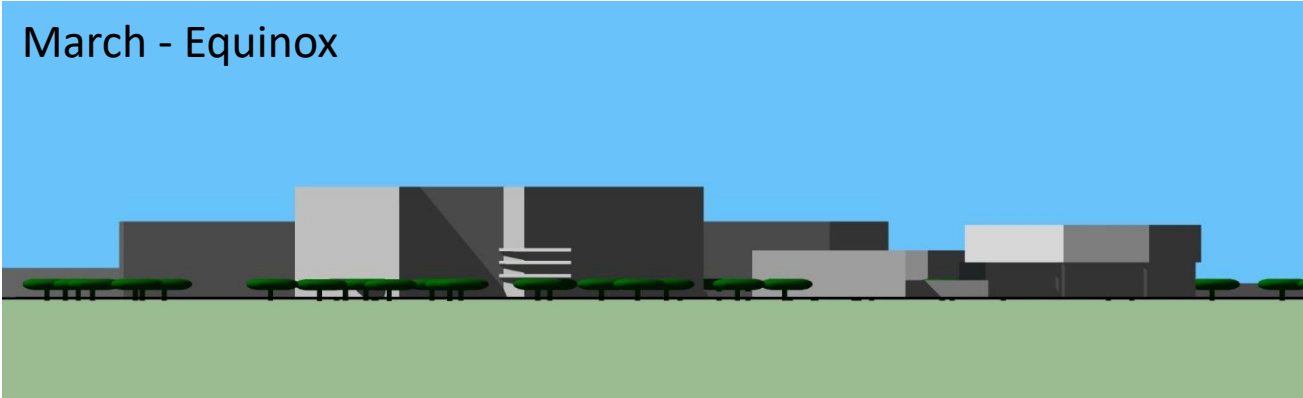
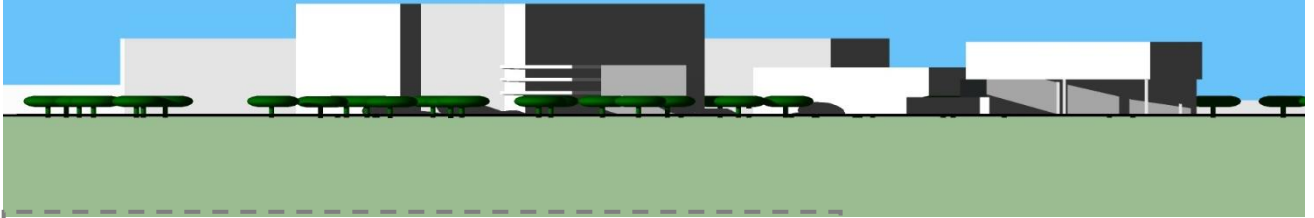


Figure 4.3.16



December – Winter solstice



SECTIONS:

Conceptual Section from South side of the site showing how the mutual shading helps cut off direct radiation from sun during peak hours

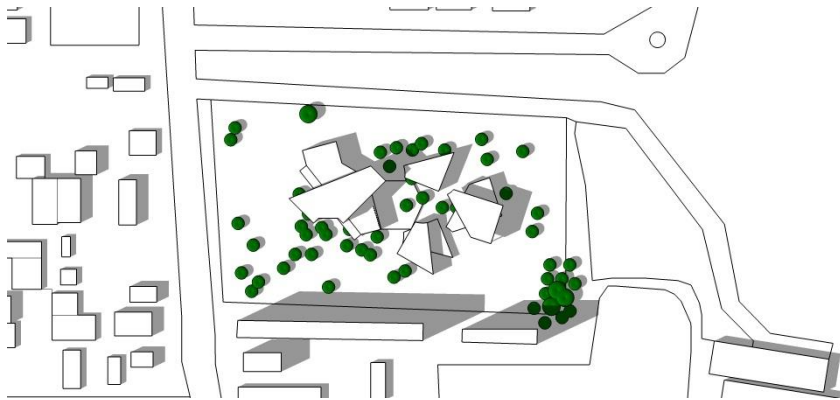


Figure 4.3.17

SPACES

Creating a wind tunnelling effect on the windward side thus reduce humidity inside the building and site.

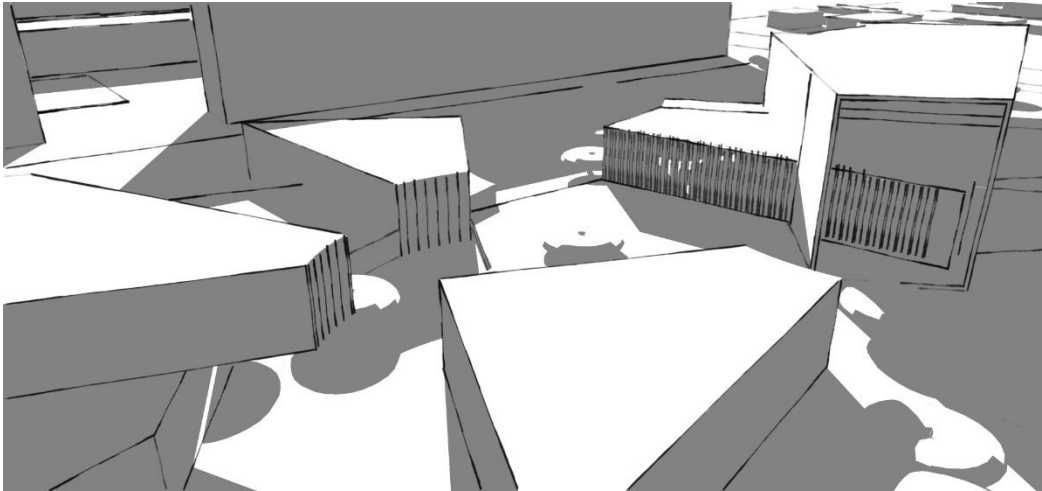


Figure 4.3.18

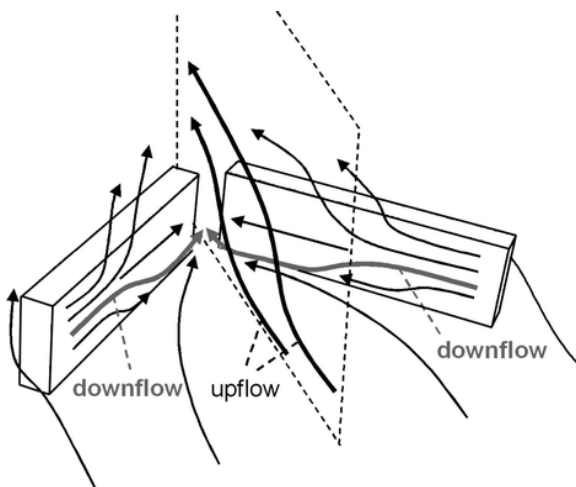


Figure 4.3.19

VENTURI EFFECT:

The **Venturi-effect** refers to the increase in fluid speed due to a decrease of the flow section in confined flows. The reason is the wind-blocking **effect**, which causes a large part of the oncoming wind to flow over and around the **buildings**, rather than being forced through the passage.

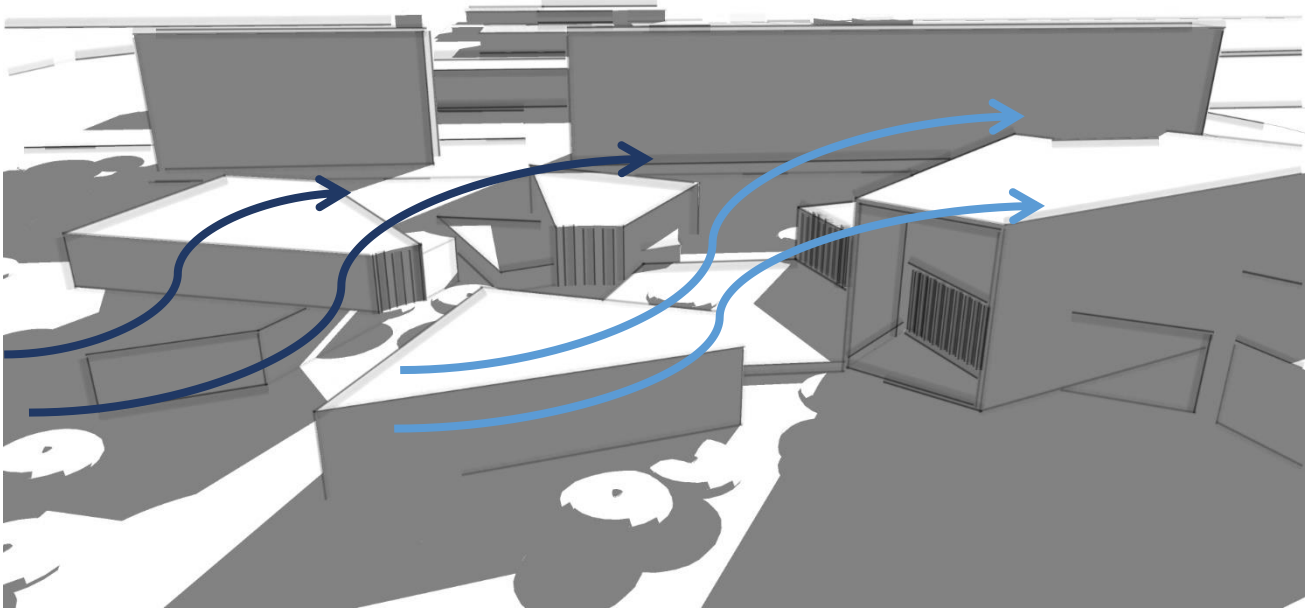
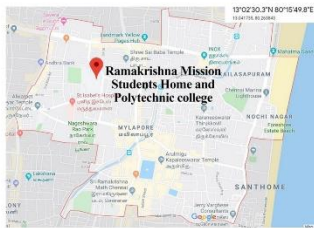


Figure 4.3.20

4.4.CASE STUDY IN WARM AND HUMID CLIMATE

CASE STUDY: Polytechnic college Institute Building.

Climate: Warm and Humid



LOCATION:

66, PS Sivasamy Salai, Kattukoil Garden, Mylapore, Chennai, Tamilnadu - 600004.

The site is located in the prime location in the City. It holds one of the Green campus in the concrete jungle around the site.

The Site encompasses a vast residential zone allowing the city population to access education at the doorstep.

The site is a clustered campus planned in a chronological sequence concurring the requirement and the development the mission underwent. The historical building which housed the high school is located close to the entrance whereas the newly constructed polytechnic block is located besides the school block.

CAMPUS DETAILS:

The site has a large play ground in front of the polytechnic building, there is vegetation surrounding the playground.

The playground is also faced by an old polytechnic building which still function stably.

The site's entrance has a road junction which increases the traffic noise and pollution to the site.

But with the presence of dense vegetation which are mostly native species helps in controlling the noise and pollution from the vehicular traffic.



2003 - Site with the old Students' Home



2010 - Site with Polytechnic building

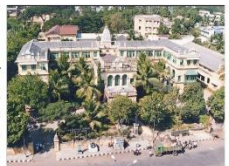


2012 - Site with the dense vegetation

The site is densely vegetated and the development happened with incorporating vegetation into the development.

The vegetation reduced during the natural disaster, but most of the trees were not affected since they are all native natured vegetation

The site has solar panels installed in the roof top and the power is given to the grid and received back.

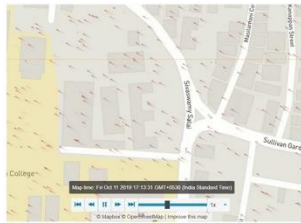


2016 - Site with Solar panels

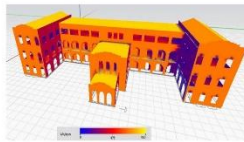


2019 - Site with the Skill Development Center

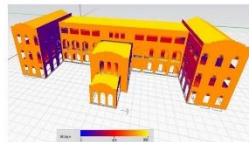
WIND ANALYSIS



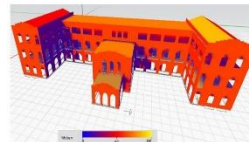
SOLAR RADIATION ANALYSIS OF SCHOOL BUILDING



June 21

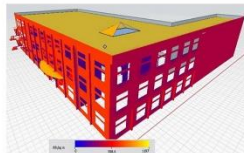


September 21

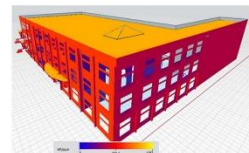


December 21

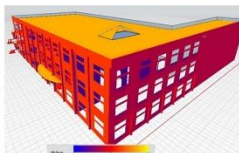
POLYTECHNIC BUILDING



June 21

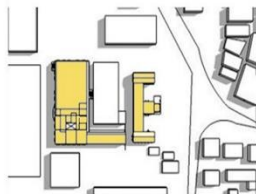


September 21



December 21

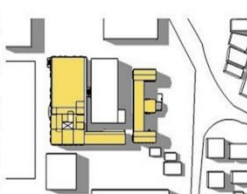
SHADOW ANALYSIS



June 21 - 9:00 am



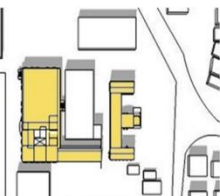
June 21 - 12:00 noon



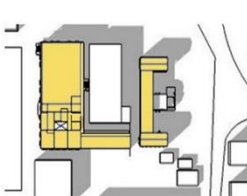
June 21 - 3:00 pm



December 22 - 9:00 am



December 22 - 12:00 noon



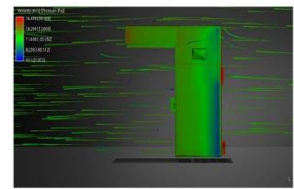
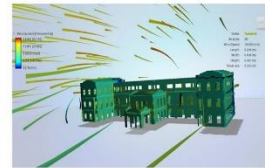
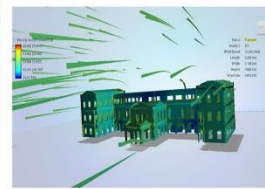
December 22 - 3:00 pm

The shadows are analyzed through software simulation and pictures taken at site to understand the self shading between the building blocks.

The results found to be successful in achieving self shading of the building blocks during the extreme conditions of the day and helps in maintaining the outdoor thermal comfort.

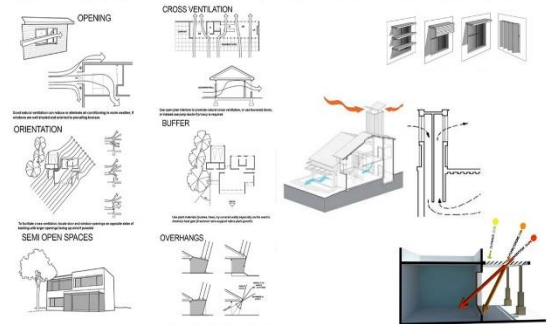
The site has various outdoor activities happening during the evening and the thermal comfort in outdoor is achieved through self shading and native vegetation available at the site.

WIND FLOW ANALYSIS



The predominant wind direction for Chennai is mostly Westerly in a year. The same is observed in Simulation of Wind flow movement. During the study the wind flow was observed westerly on September 10, 2019 and North easterly when the NE monsoon started in the month of October, 2019

PASSIVE DESIGN STRATEGIES FOR CHENNAI - WARM AND HUMID CLIMATE

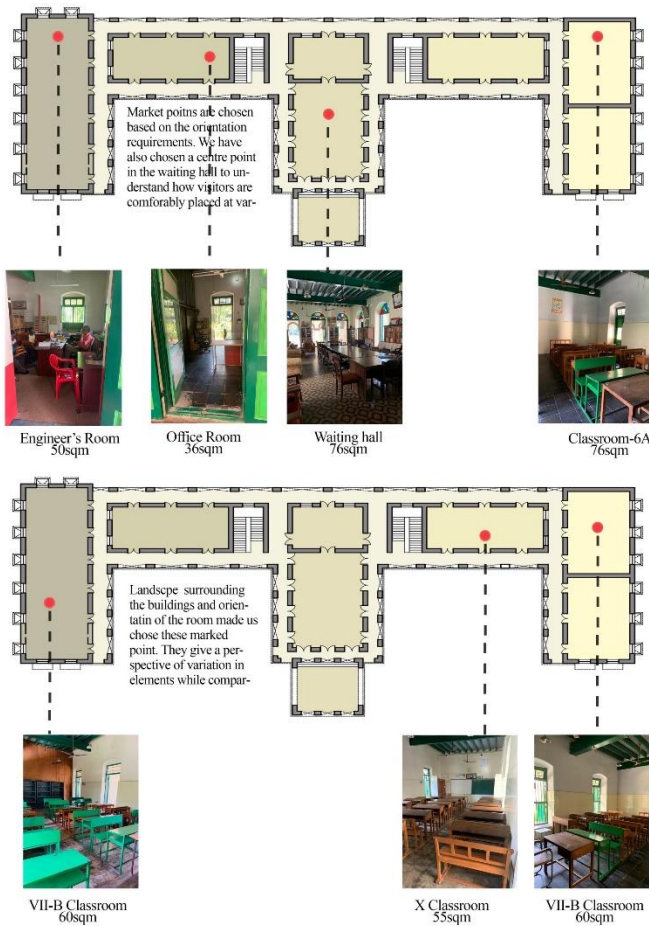


INFERENCE

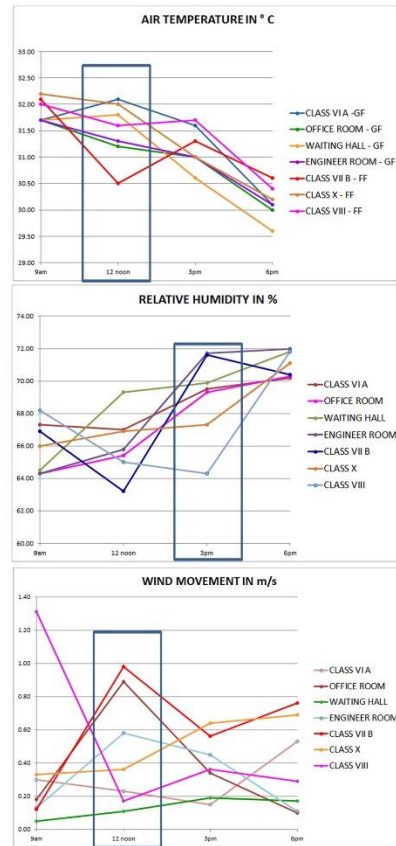
The Mutual shading helps in reducing heat gain on the surface in the building blocks.

Since the typology of building is institution hence outdoor activities are more on the site hence the building shape and height achieve thermal comfort in outdoor through self shading and native vegetation in the site.

READINGS FROM CASESTUDY:



INFERNECE FROM GRAPH READINGS



It was observed that the air temperature in the southern half of the building gets reduced by noon as shown in the graph. The wind movement was from S-N which influenced the air temperature at 12 noon.

Since the wind movement was from N to S at 3 P.M, it was observed that the RH for northern half of the building was reduced during this time.

Outdoor Max. temperature was 37°C and Max indoor temperature was observed to be 32°C and the difference in temperature was 5°C.

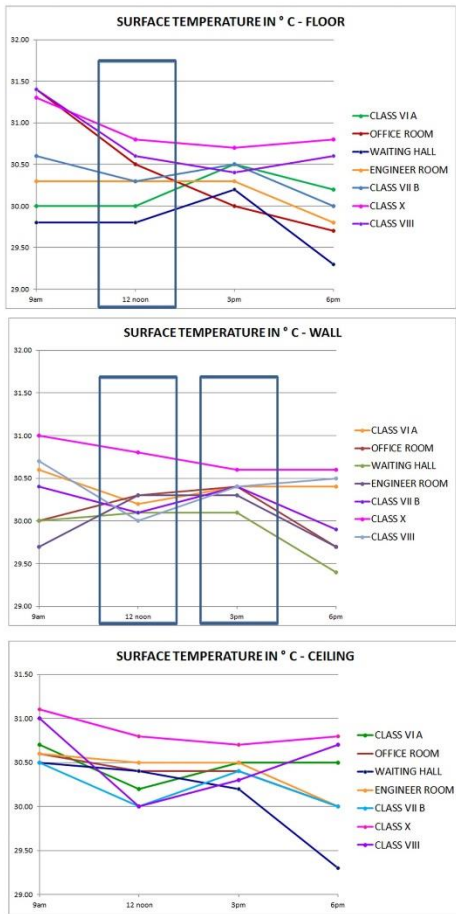
Max. outdoor Rh @ 6 P.M for the day was 74%, the observed max. indoor RH was 72% and the difference was 2%.

The above changes are due to various parameters such as : cross ventilation, orientation of the building in favor of wind movement, native plants and trees present at site.

The wind movement was from S-N which influenced the air temperature at 12 noon. The classroom VII b is located in the south western side which should have had a relatively high air temperature in the noon, rather it was recorded a drastic reduction in the atmospheric air temp ,this was due to the increased air movement in the southern side of the building at noon.

The recorded high atmospheric temp was scene in classroom VI A Which coherent to the fact that the air movement was very less throughout the day. The gradual reduction also comprehends to the trend in increase in the air movement

SURFACE TEMPERATURE:



The FLOOR -There is a sudden change in temperature between 12 noon and 3P.M is due to floor to floor heat transfer, where as there is a gradual difference in temperature due to wall to floor heat transfer.

WALL – Change in temperature at 12 noon is due to the exposure of the southern wall to direct sun. Gradual decrease in temperature is observed in spaces with sharing walls and not exposed to direct sun. As we can see a peak temperature reading in classroom X due to its orientation towards direct sunlight in the morning and evening .

CEILING – There is a change in surface temperature is due to the madras terrace roofing technique. The ceiling surface temperature in the waiting hall reduces very drastically since it does'nt receive any amount of direct sun light.

MATERIAL ANALYSIS:

MATERIAL WITH CONSTRUCTION TECHNIQUE	SKETCHES / IMAGES	INFERENCE
Brick wall - with lime mortar and lime plaster on both the sides		The masonry walls of the old school building was made out of 45cm thick brick wall with lime plaster. This type of construction was predominantly used in older building constructions which would provide cooling effects inside the building Clay brick wall with lime mortar and lime plaster - 1.36 W/m²K
Stone		The entrance of the old school building was made out of stone arches symbolising a strong exterior which was common in public buildings during the period. Since the stone arches are heavy the heat transmittance of the materials is relatively less and doesn't impact the thermal comfort Stone Arch - 1.60W/m²
C u d d a p a h Stone flooring		Cuddappah stone flooring is used majorly in the building to have a maintenance free floor due to its usage and the nature of the stone to be cool and have less heat gain, in the corridors the stone is combed along red oxide flooring to give aesthetics for the passage.
Handmade Tiles		The flooring in the guest waiting room is treated with aesthetically designed handmade tiles which gives a good impression for the visitors due to its receptive presence in the entrance. The heat gain capacity of hand made tiles are very less comparing to other flooring materials used.
Carpet flooring		The flooring in the Engineer's office room is fully carpeted which reduces the flooring's heatgain. It also enhances the office's aesthetic quality. U value - 0.81W/m² Source: https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781119174851.app1
Red oxide flooring		The red oxide flooring in the corridor is combined along with the cuddappah stone to give an aesthetic feel to the external space.

MATERIAL WITH CONSTRUCTION TECHNIQUE	SKETCHES / IMAGES	INFERENCE
Cement		Flooring of the class room in first floor is cement flooring. The heat gain is more compared to other flooring materials
Mangalore tiles		The sunshades of the old block is ornamented in wooden design to give articulation for the façade. This increases the richness of the building and also avoids the penetration of direct sunlight.
Teak wood		Doors, windows, Corridor railing and staircase railing of the old school building, since all the vernacular buildings are mostly made of teak windows and doors. This has comparatively moderate u value. Solid core teak wood of thickness 1.75" - 0.46 W/m ² K
Marble		The flooring in the prayer hall is laid with marble which symbolizes the sophistication provided to the divine space. This also makes the heat gain coefficient more. Hence it is provided with a nave around. U value - 9.43 W/m²
Madras Terrace roof		Madras terrace roofing system is a technique used to reduce the heat gain on roofs in the tropics. This has multiple layers of roof and helps in cooling of the interior spaces through less heat gain U value for Madras Terrace roof – 1.59 W/m²K

ROLE OF BUILDING MATERIALS IN THERMAL COMFORT

The school building was constructed a century back and the materials used with the construction techniques plays a vital role in maintaining the thermal comfort of the indoors.

The colonial style of Architecture with vernacular construction techniques such as

MADRAS TERRACE ROOFING

STONE ARCHES

BRICK WALLS OF 45CM THICK WITH LIME PLASTER

USING LOCALLY AVAILABLE AND NATURAL MATERIALS

are the success of maintaining thermal comfort for the users.

The embodied energy is less for the natural materials used for construction. The building is climate responsive and native vegetation surrounding the building blocks helps to modify the micro climate.

The U value of the materials such as madras terrace roofing, brick wall of 45cm thick and thick stone arches helps in less transmittance of heat to the indoors. The time lag for these materials are more and hence the heat transmittance is less & slower.

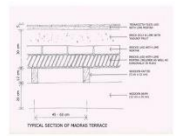
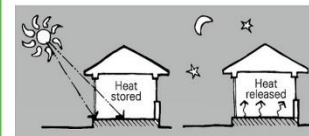
The polytechnic college building has conventional construction materials and techniques such as

BRICK MASONRY - 230 MM THICK

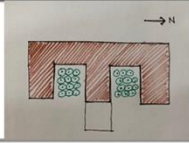
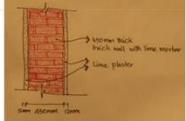
RCC ROOF SLABS, SUNSHADES AND PROJECTIONS

The above said materials are conventional and creates impact in maintaining the thermal comfort as well as the more embodied energy harming the environment.

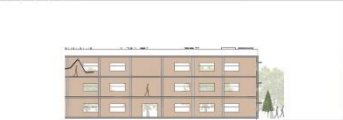
The U value of these materials are high compared to the vernacular materials. Hence transmits radiation faster and retains the thermal mass for longer period resulting in increase in the latent heat of a material.



INFERENCE FROM CASE STUDY

PASSIVE DESIGN STRATEGY	INSTITUTIONAL	DESCRIPTION	INFERENCE
BUILDING FORM		As a passive design strategy, the built form shall be in U or E shape, so that it helps in the trapping of wind within the flanges and also helps in self shading	The E shaped building helps in maintaining the comfort level through self shading and courtyards present in between the flanges of the E shape.
BUILDING ORIENTATION		The building is oriented facing east and the shorter axis facing N-S	The building faces the East and the shorter side gets exposed to South, which helps in cutting the radiation into the building
COURTYARD		The building has external courtyards with thick shrubs and flowering plants	The Courtyard helps in respiration of the building. The courtyards enhances wind flow into the building
BUILDING HEIGHT		The old school building has a ceiling height of 4.2m at all levels.	The ceiling height helps in taking the hot air out through the ventilation provided above the windows and doors.
ENVELOPE - WALL		Old building used vernacular construction technique that is brick wall with lime mortar and lime plaster.	Difference in U value conveys that the vernacular construction techniques helps in reduction of radiation.
ENVELOPE - FLOOR		Old building has mostly natural building materials for the floors.	Materials like cuddappah stone, red oxide, hand made tiles helps in maintaining the indoor temperature.
ENVELOPE - ROOF		Madras terrace roof is used which is the vernacular construction technique	Madras terrace roof have been provided everywhere, which also is less in U value and helps in keeping the thermal comfort in control.

INFERENCE FROM CASE STUDY

CROSS VENTILATION		The openings are placed diagonally to achieve cross ventilation in maximum of the spaces.	All the rooms in the old building is achieved in cross ventilation which helps in reducing the RH and increase in indoor air movement.
WINDOWS AND DOORS		The window and door openings have ventilator on top. This can be seen in all the openings.	An opening above windows and doors helps in taking the hot air out from the indoors.
SHADING DEVICE		The shading devices provided are of vernacular style and the corridor can be seen as buffer space / shade in the critical directions - S, W & E	Importance is given for the shading device in all the openings which helps in resisting heat and rain.
VEGETATION		Vegetation plays a vital role in warm and humid climate to maintain the indoor thermal comfort and the native species are seen at the maximum	The native species such as Hibiscus, arali, manoranjitham, parijatham are seen in and around the buildings which helps as a microclimate modifier
COLOUR & TEXTURE		The colour code used in the school building portrays the colonial style prevailed during 1900's	The colour code is aesthetically appealing and the light colours used does not absorb heat.
COURTYARD		The Courtyard in the building is internal and has polycarbonate roofing at the second floor with wind turbines for ventilation	The courtyard helps in bringing day light to the indoor. But the roofing material used for the OTS absorbs more heat.
BUILDING HEIGHT		The new polytechnic building has a ceiling height of 4.2m at ground floor, 3.5m respectively at first and second floors.	The ceiling height at ground floor helps in taking the hot air out through the ventilation provided above the windows.

4.5. ITERATION

SITE DETAILS:

Location: Egattur , Tamilnadu.

Temperature: Max: 37 degC
Min: 28 degC

Humidity: 76%

Wind Direction: NE and SW

Access:

Rajiv gandhi salai OMR road

Surroundings:

Marina Mall - 15mts height

Imperial Towers - 30mts height

Site Condition:

Landfill from nearby apartments.

Exploiting nearby River by dumping of waste and sewage.

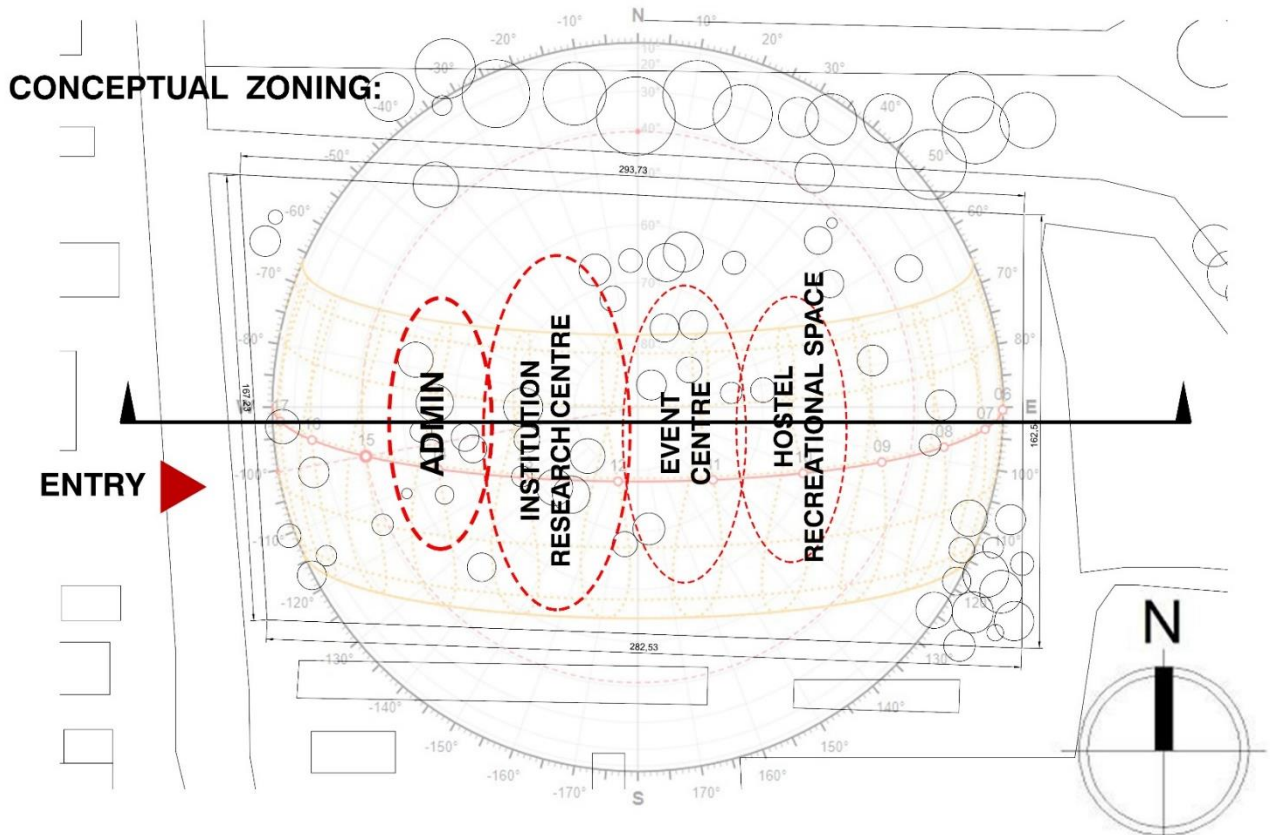


Fig. 4.5.1. Conceptual Zoning

CONCEPTUAL SECTION:

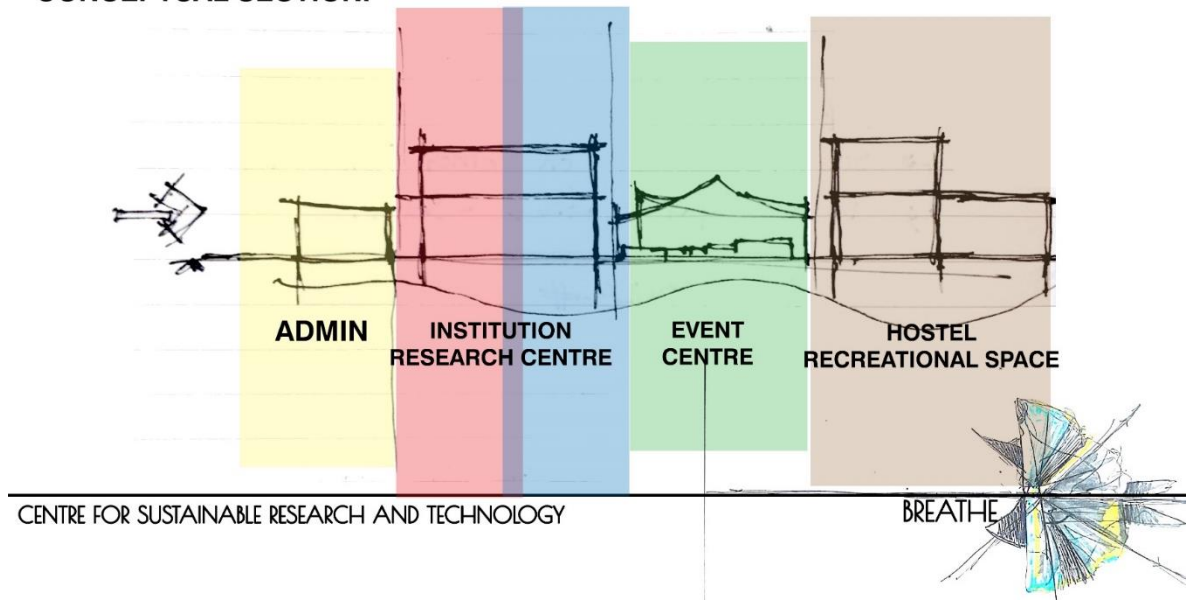
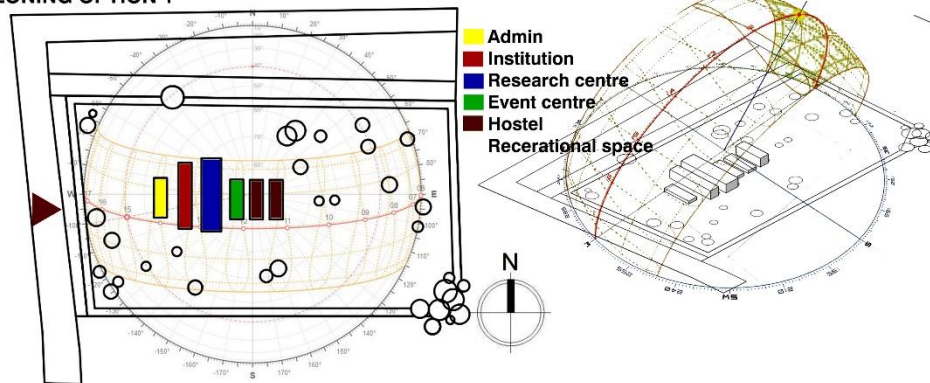


Fig. 4.5.2. Conceptual Section

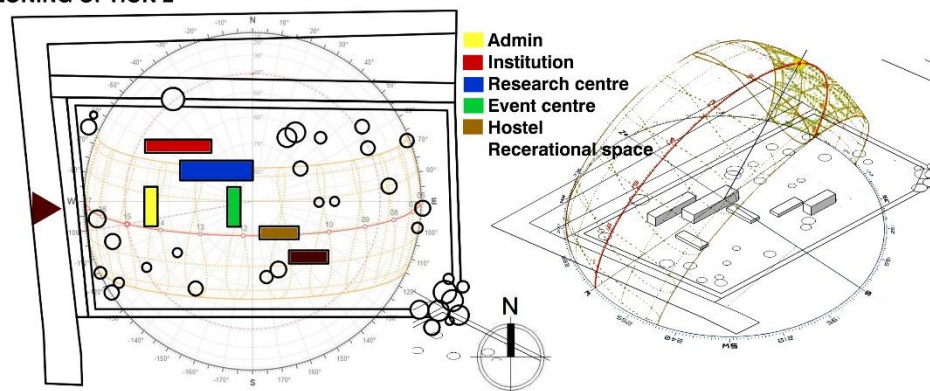
ZONING OPTION 1



Inference:

Considering the blocks as single block hence its in EW orientation, But considering it has Individual blocks it has tend to experience more heat on sides.

ZONING OPTION 2

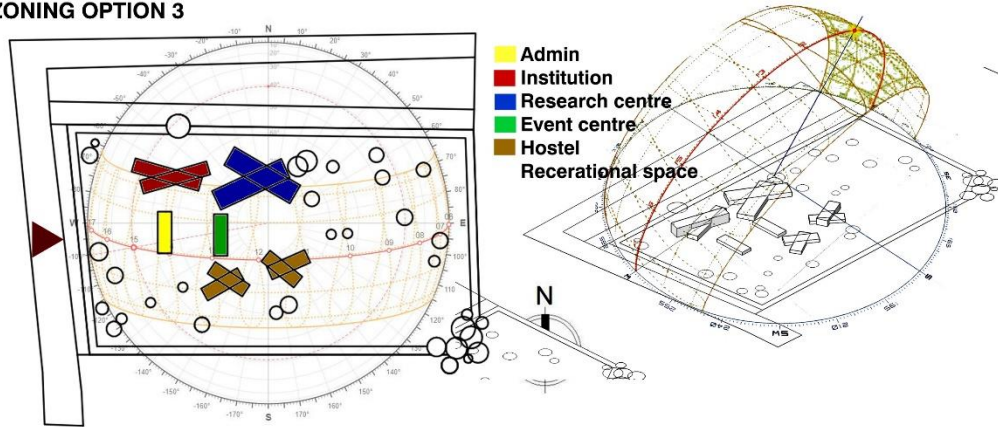


Inference:

The blocks are oriented according to sun direction and radiation which helps in reduction in the radiation on the sides of the block but the radiation on the roof is high which increase temperature inside the block.

Fig. 4.5.3. Zoning option 1

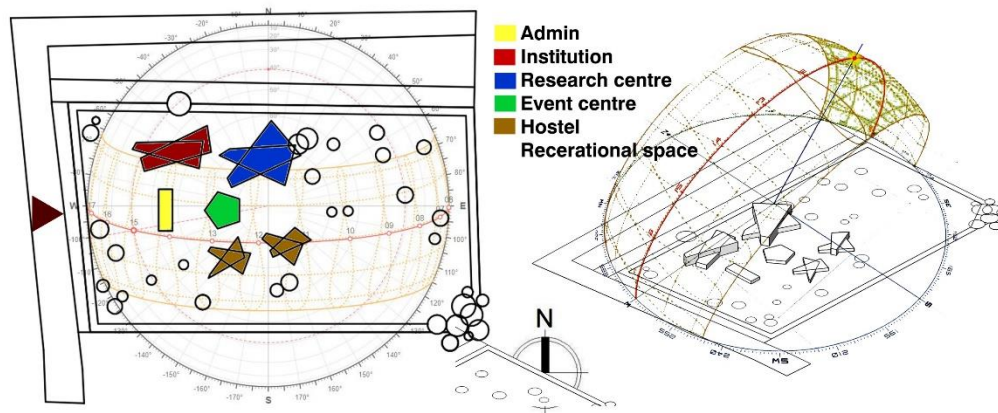
ZONING OPTION 3



Inference:

The block placed on one another helps in mutual shading thus reduce surface area exposed to sun and also oriented to reduce direct exposure to western side thus reduce radiation on the walls.

ZONING OPTION 4



Inference:

The block placed on one another helps in mutual shading thus reduce surface area exposed to sun and shape of the block helps in reduction of solar gain on the walls and also helps in wind movement inside the site due to large area on the windward side.

Fig. 4.5.4. Zoning option 3 & 4

ZONING	ISOMETRIC VIEW	ANALYSIS	INFERENCE
			WALL 1860 sq.m - 651 kWh/sq.m ROOF 4325 sq.m - 1301 kWh/sq.m This zoning is based on basic people usage and proximity to spaces. The roof area and wall area exposed to solar radiation is maximum in this iteration and thus create discomfort inside the block.
			WALL 930 sq.m - 651 kWh/sq.m ROOF 4325 sq.m - 1301 kWh/sq.m Change in Orientation helps reduce into half the size which exposed to solar radiation, The roof exposed to solar radiation experience 1301 kWh/sq.m per year.
			WALL 510 sq.m - 651 kWh/sq.m ROOF 2504 sq.m - 1301 kWh/sq.m The orientation helps in reducing wall area exposed to sun, But to reduce roof area the floor plates placed one on another to reduce solar radiation on roof. The roof area is reduced to half of the area compare to the previous options
			WALL 438.5 sq.m - 651 kWh/sq.m ROOF 2741 sq.m - 1301 kWh/sq.m This floor plates is placed on one another thus reducing heat gain on the roof and also The Shape of floor plates is changed as passive strategies for further iterations to reduce radiation on sides and roof and also to create wind flow inside the block.

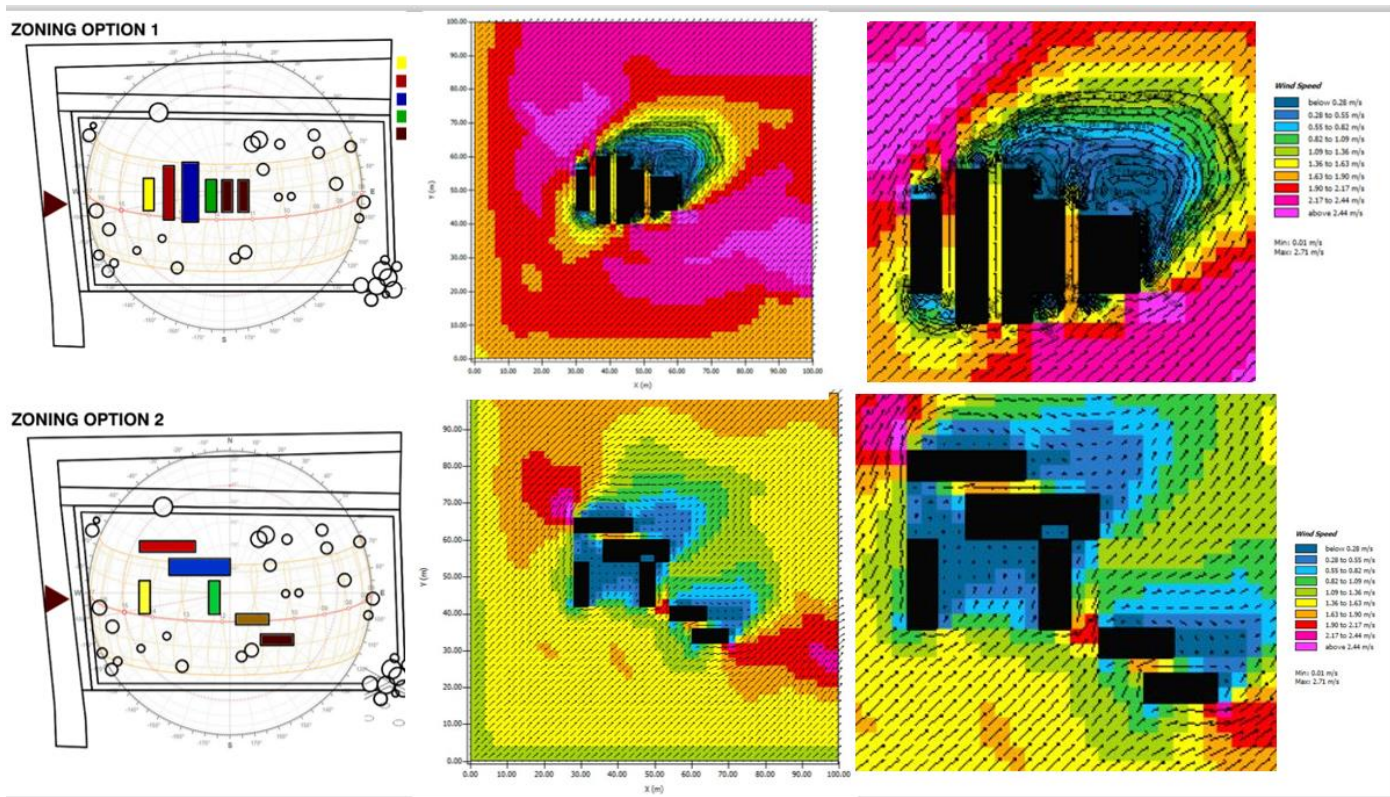


Fig. 4.5.5. Zoning option 1 and 2

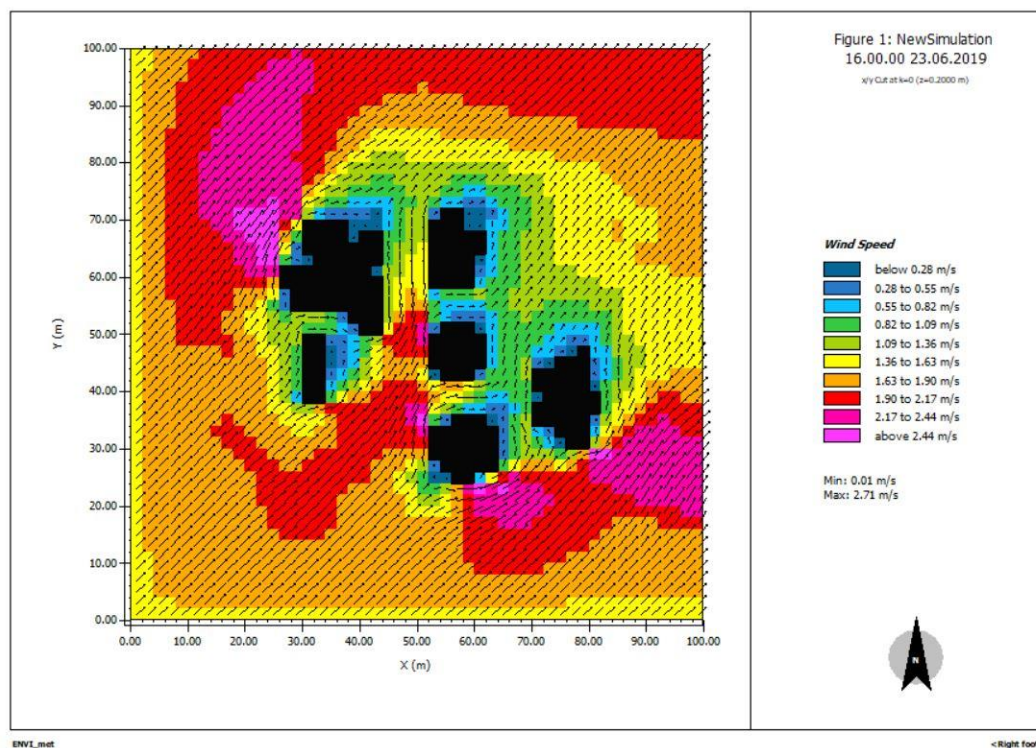


Fig. 4.5.6.

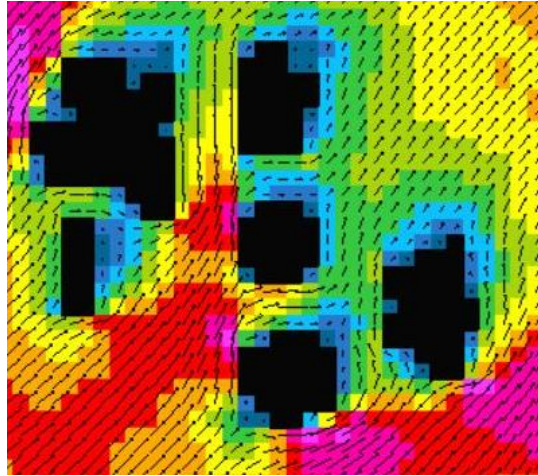
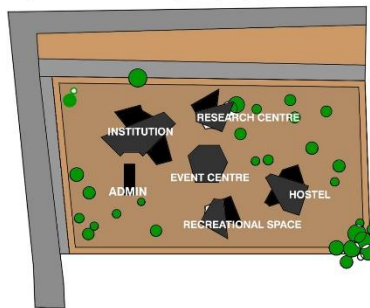


Fig. 4.5.7.

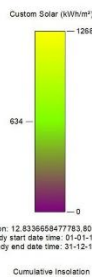
FORM ITERATION 8- SOLAR RADIATION:



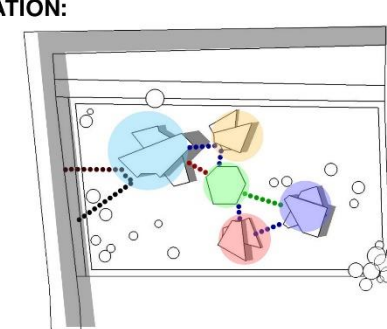
REVIT - SOLAR ANALYSIS

The scale show yearly cumulative analysis of how much radiation the structure experience.

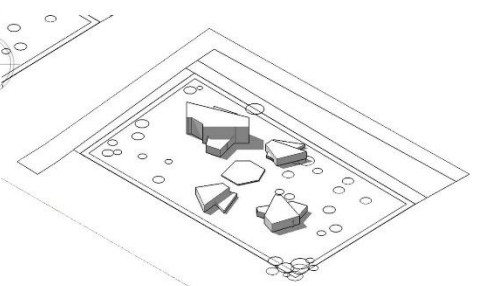
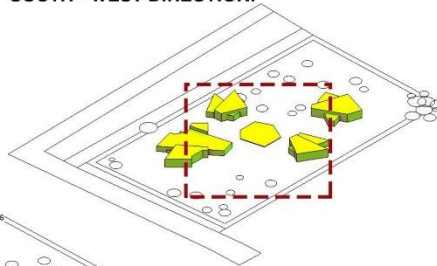
ROOF 1268 kwh/sq.m
WALL 487 kwh/sq.m



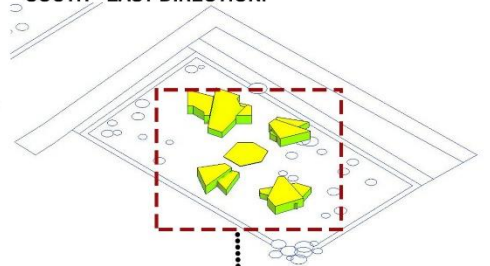
Project location: 12.8336688477783, 80.2303771972656
Sun study start date time: 01-01-19 07:00:00
Sun study end date time: 31-12-19 16:00:00



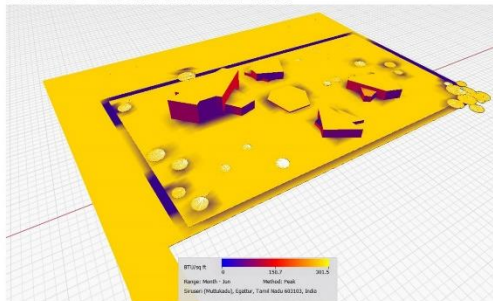
SOUTH - WEST DIRECTION.



SOUTH - EAST DIRECTION.



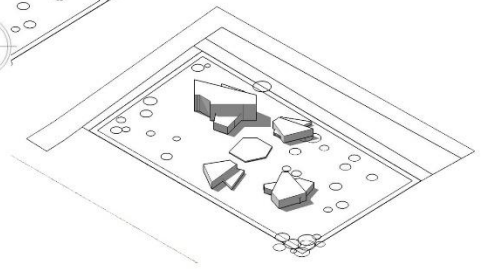
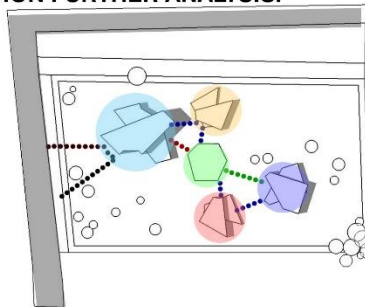
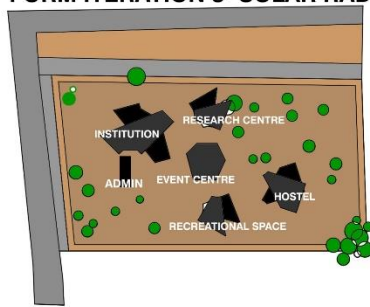
FORMIT - RADIATION ANALYSIS



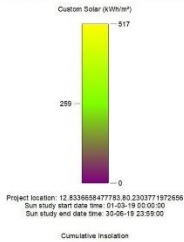
Formit analysis shows 3985.9 Sq.m of area expose to direct solar radiation which experience maximum of **0.95 kwh/sq.m on less amount of roof** and **0.11kwh/sq.m on walls** during june.

The blocks are placed on one another to reduce solar heat gain through roofs and walls, The blocks placed apart from each other to create wind flow between blocks to reduce humidity in atmosphere.

FORM ITERATION 8- SOLAR RADIATION FURTHER ANALYSIS.



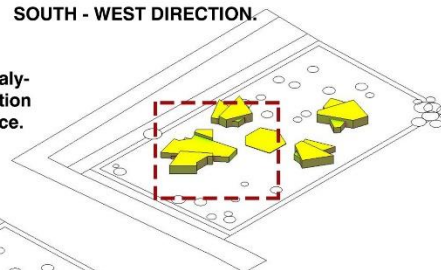
REVIT - SOLAR ANALYSIS (Peak months)



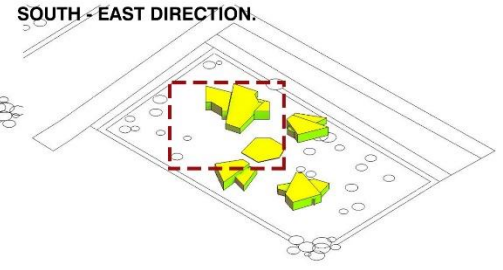
The scale show peak months cumulative analysis of how much radiation the structure experience.

ROOF 517 kwh/sq.m
 WALL
 SE 259 kwh/sq.m
 SW 197 kwh/sq.m

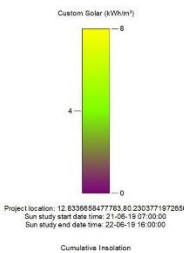
SOUTH - WEST DIRECTION.



SOUTH - EAST DIRECTION.



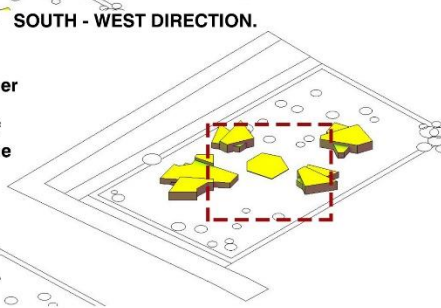
REVIT - SOLAR ANALYSIS (Summer solistice)



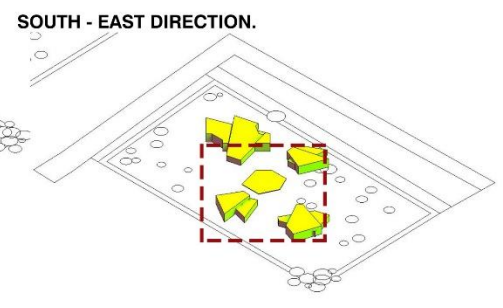
The scale show summer solistice(per day) cumulative analysis of how much radiation the structure experience.

ROOF 8 kwh/sq.m
 WALL
 SE 4 kwh/sq.m
 SW 2 kwh/sq.m

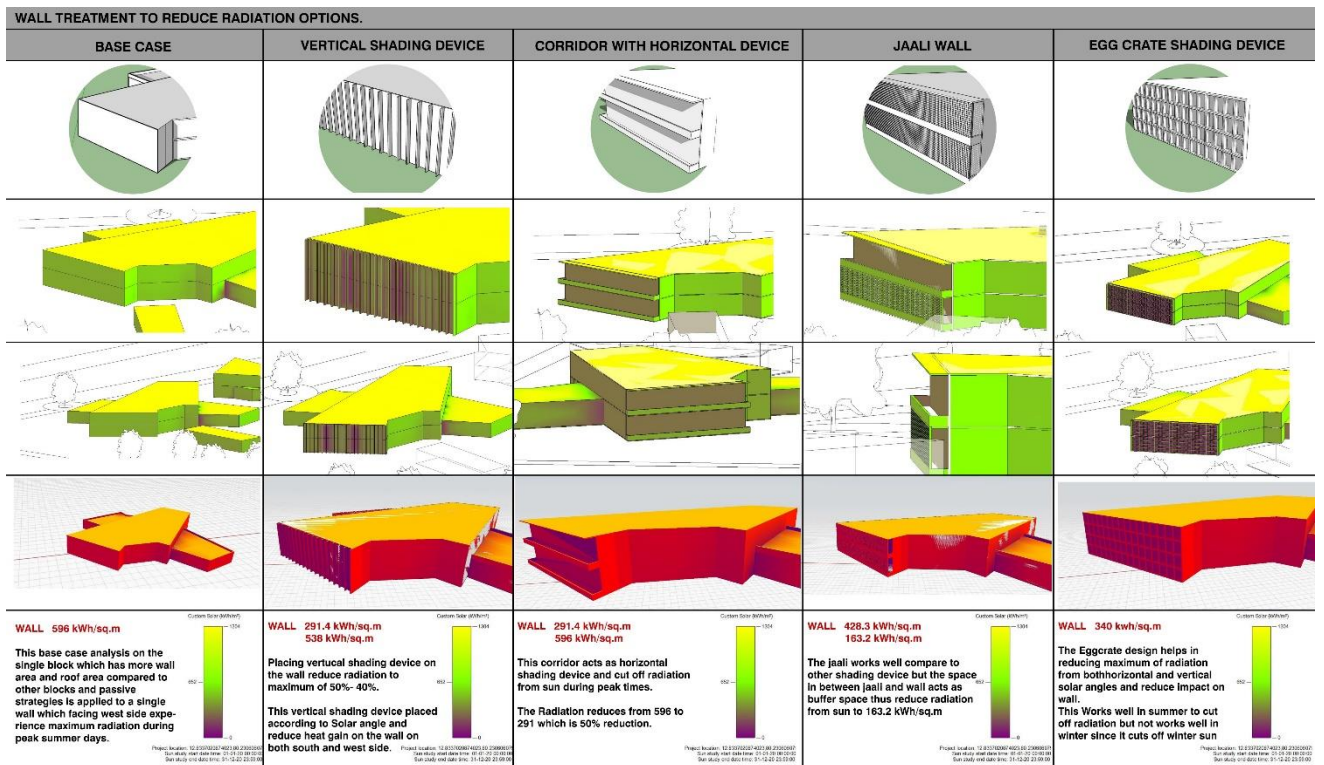
SOUTH - WEST DIRECTION.



SOUTH - EAST DIRECTION.



Tab.4.5.1.



4.6. SITE PLAN



To make a building perform as an ecosystem meeting the following primary needs by LBC and UNDP in 2015.



- SITE
- WATER
- ENERGY
- COMFORT
- MATERIALS

Fig.4.6.1.

This are the primary needs for the building to perform as ecosystem.

This followed by Govardhan Eco village in india and many other countries around the world.

Tab.4.6.1.

TO ACHIEVE SITE :
LIMITS TO GROWTH: Project may only be designed or built on certain sites and not on the list discussed above.
URBAN AGRICULTURE: The project must integrate opportunities for agriculture appropriate to its scale and density using the Floor Area Ratio.
HABITAT EXCHANGE: For each hectare of development, an equal amount of land away from the project site must be set aside for habitat exchange.
HUMAN POWERED LIVING: Project should encourage human transport more than co2 emitting vehicular transport.

4.6.2.SITE:

LIMITS TO GROWTH:

Project is build on Landfill site where apartments from near locality dump waste into site and river (Buckingham canal) nearby.

Source: Indian express.

This site is located in developed locality surrounded by brownfields and wetlands.

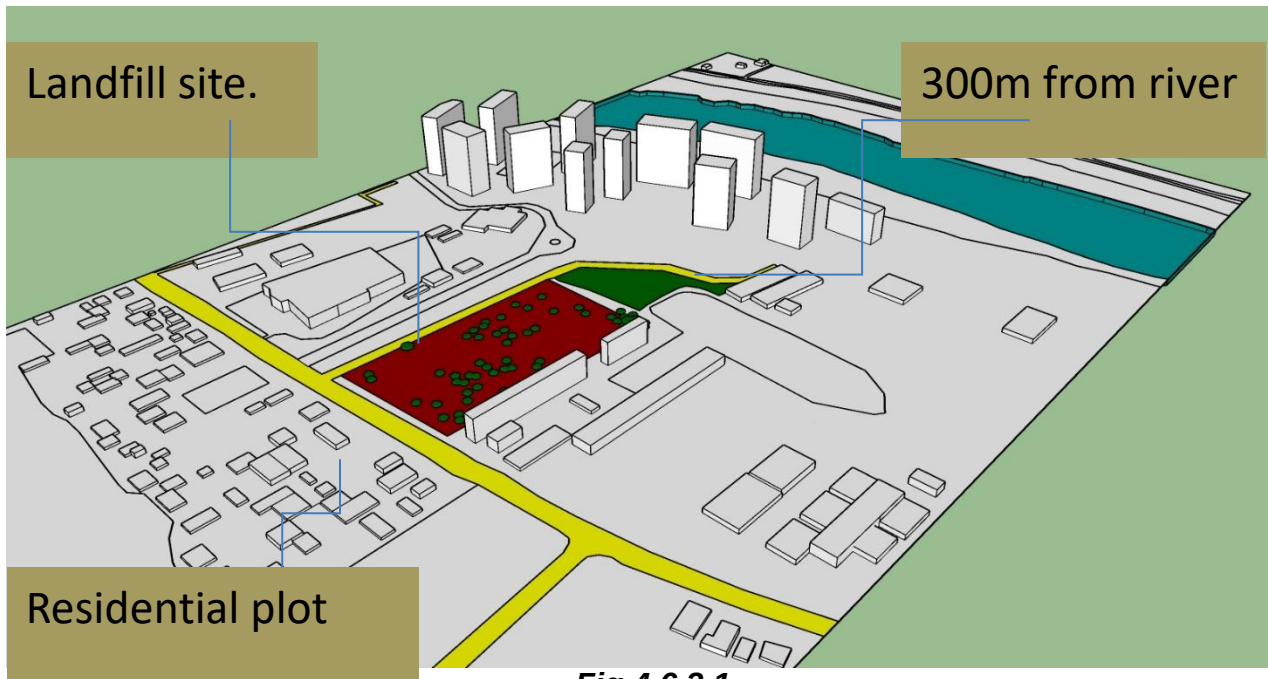


Fig.4.6.2.1.

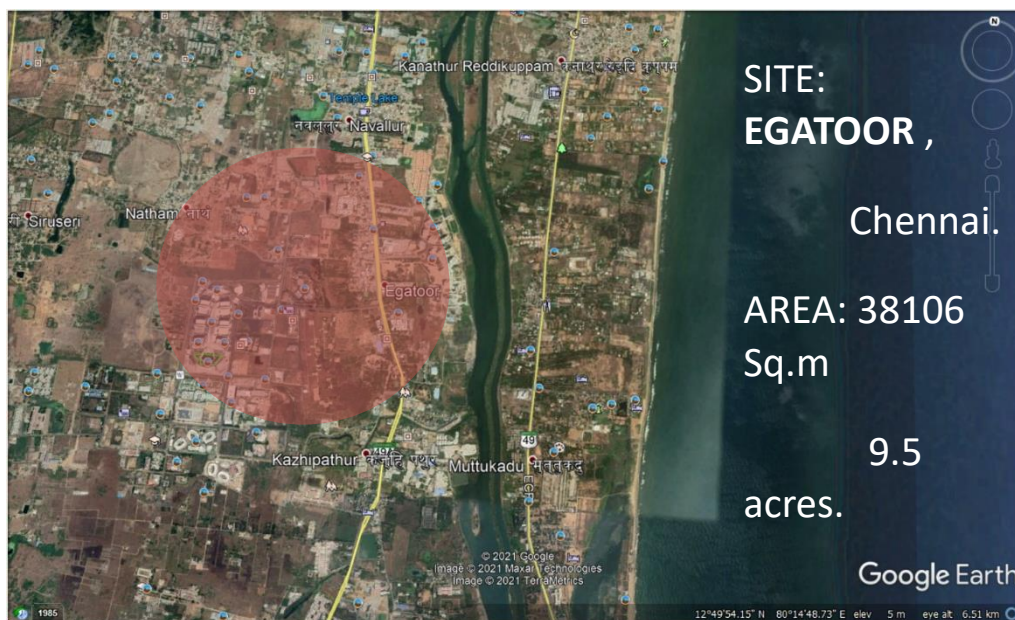


Fig.4.6.2.2.



Fig.4.6.2.3.

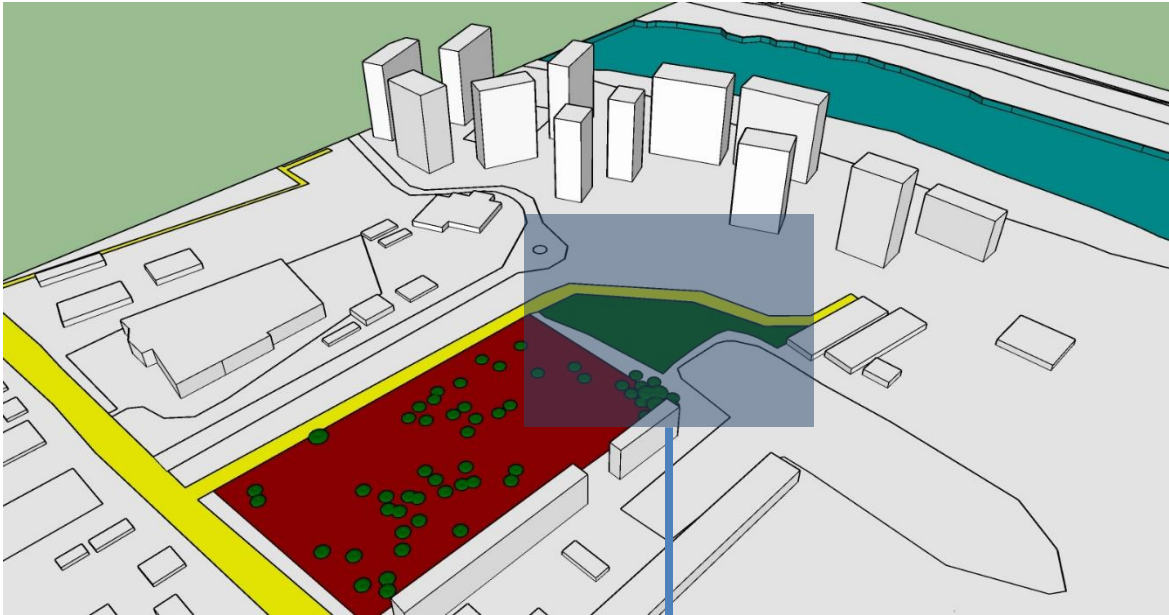
- Natural flow towards eastern side where river is located
- Rainwater is used for onsite landscape and its maintenance.

URBAN AGRICULTURE:

- According to FAR ratio the Minimum of 5% area should be allocated for urban agriculture in the site.
- Hence the space for urban agriculture is allocated according to natural slope in the site in order to maximise the use of storm water run off and rainwater



Fig.4.6.2.4.



HABITAT EXCHANGE:

The site is located in OMR where farm animals like cow is maximum in number and those cause many traffic and congestion in roads and site,

Thus creating a space for Habitat exchange can create a place for animals as well as helps people to understand importance of ecosystem and other living organisms

HUMAN POWERED LIVING:

- Project should encourage human transport more than co2 emitting vehicular transport

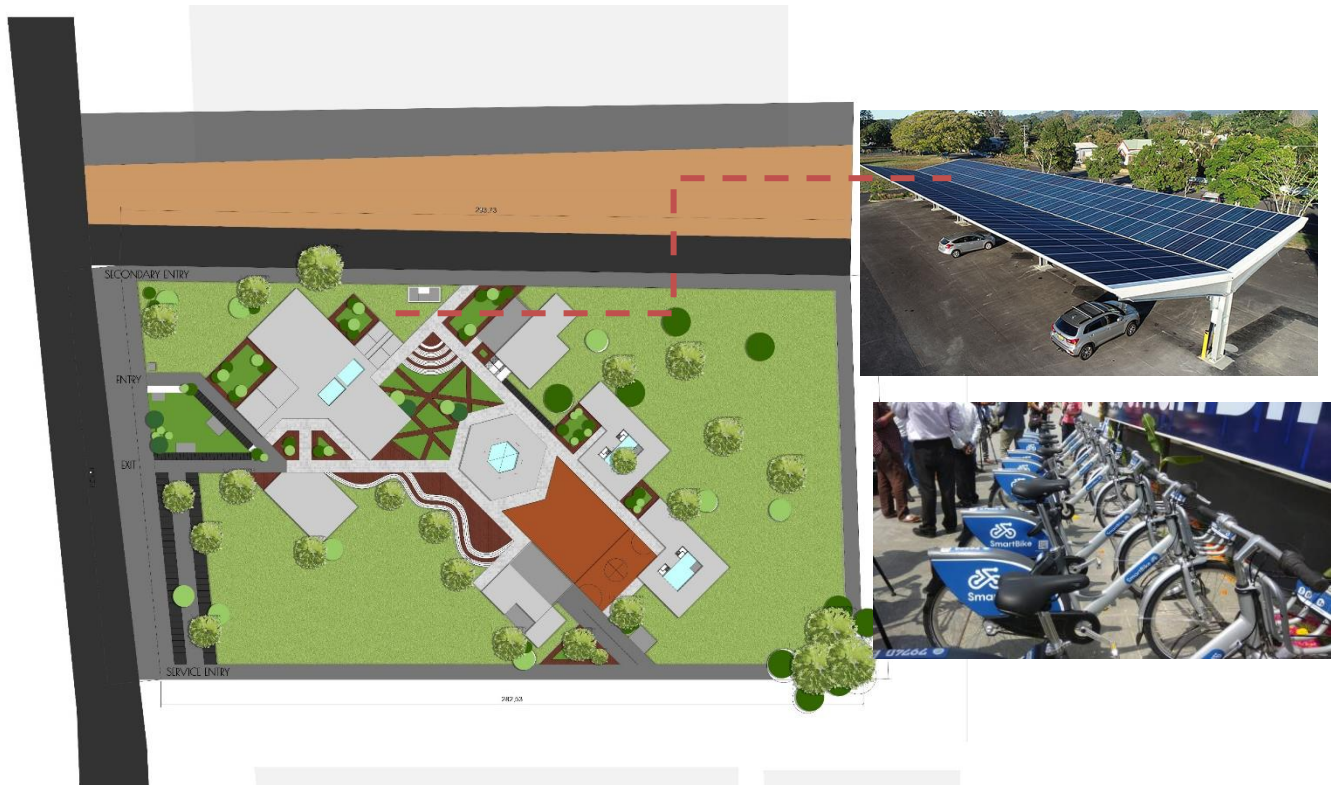


Fig.4.6.2.5.

- Solar panel is placed on top of shading device thus increase in solar energy which helps to charge battery bikes and smart bikes which reduces CO2 emitting vehicle in the site.
- To Increase human powered living in the site , restricting CO2 emitting vehicle inside the site by providing parking adjacent to entry and providing smart electric bikes which powered by solar is placed in site entrance and also power source and hub is placed in site.
- Pavement is maintained well to increase human circulation inside the site.

Tab.4.6.2.2.

TO ACHIEVE WATER:

NET POSITIVE WATER:

One hundred percent of the project's water needs must be supplied by captured precipitation or other natural closed-loop water systems, and/or by recycling used project water, and must be purified as needed without the use of chemicals.

RAIN WATER HARVESTING:

Rain water should be collected and stored for future use depends on the annual rainfall of the place.

GREY WATER TREATMENT:

Reusing grey water from toilet and flushing by filtering and using it for irrigation and other landscape purposes.

STORM WATER RUNOFF TREATMENT:

Water stored from pavements treated and used for other purposes in building and this surface runoff helps increasing water table for the site.

WATER:

NET POSITIVE WATER:

- Project's water need is supplied by captured precipitation and recycled projects water for landscape in site.
- RAIN WATER HARVESTING | GREY WATER TREATMENT | STORM WATER RUNOFF

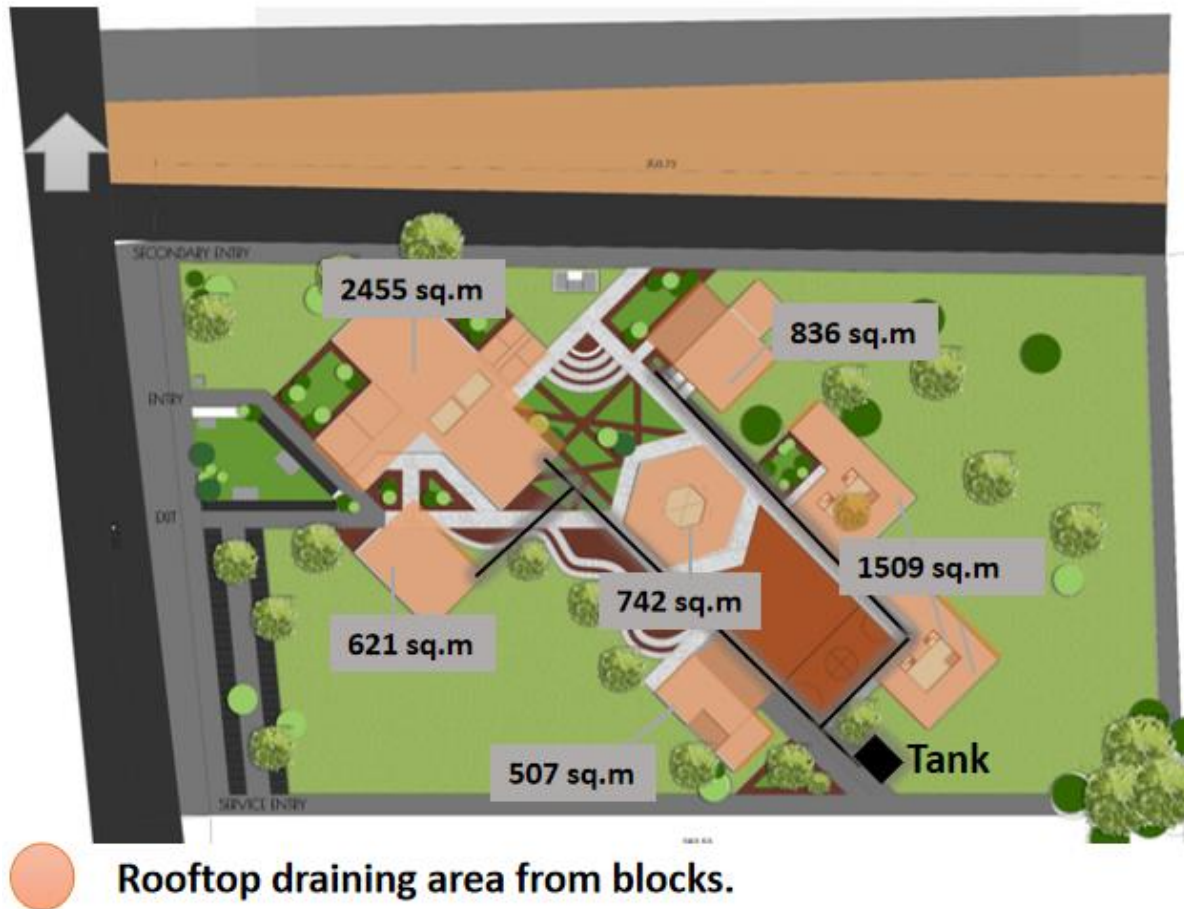


Fig.4.6.2.6.

ROOF TOP DRAINING AREA CALCULATION

Rain water harvesting from roof = Area of roof x coefficient x annual rainfall (in mm)

Area of the Total roof = 6670.2 sqm

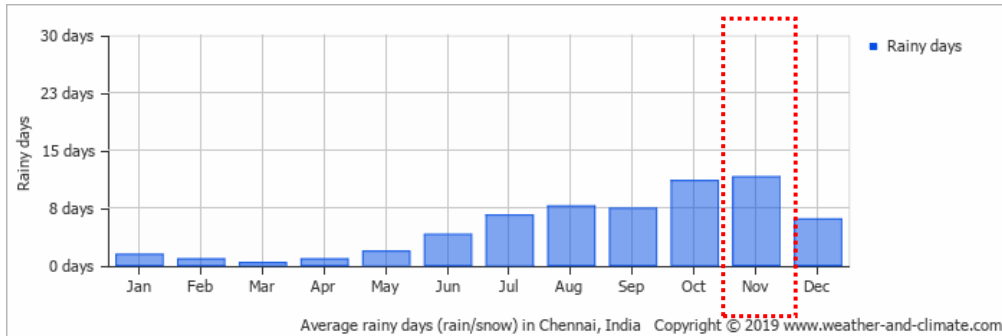
Coefficient of runoff = 0.9

Annual Rainfall of Chennai = 1382 mm

Rain water harvesting from roof = 8,29,63,947.6 litres annually.

For the month of November (highest rainfall 399mm)

= 23,95,268.82 litres



Type of surface or land use	Runoff coefficient C
Forest	0.1 - 0.3
Turf or meadow	0.1 - 0.4
Cultivated field	0.2 - 0.4
Bare earth	0.2 - 0.9
Pavement, concrete or asphalt	0.8 - 0.9
Flat residential, about 30% impervious	0.4
Flat residential, about 60% impervious	0.55
Sloping residential, about 50% impervious	0.65
Sloping, built-up, about 70% impervious	0.8
Flat commercial, about 90% impervious	0.8

Types of surface and land use shows how much water is harvested from building and roof.

STORM WATER RUN OFF AREA CALCULATION

Storm water runoff from pavements = Area of pavements x coefficient x annual rainfall (in mm)

Area of the pavements = 2020 sqm

Coefficient of runoff = 0.9

Annual Rainfall of Chennai = 1382 mm

Storm water run off from pavements= 25,12,476 litres annually.

For the month of November (highest rainfall 399mm) = 7,25,382 litres.



Fig.4.6.2.7.

POROUS & PERMEABLE PAVING MATERIAL

Fig.4.6.2.8.

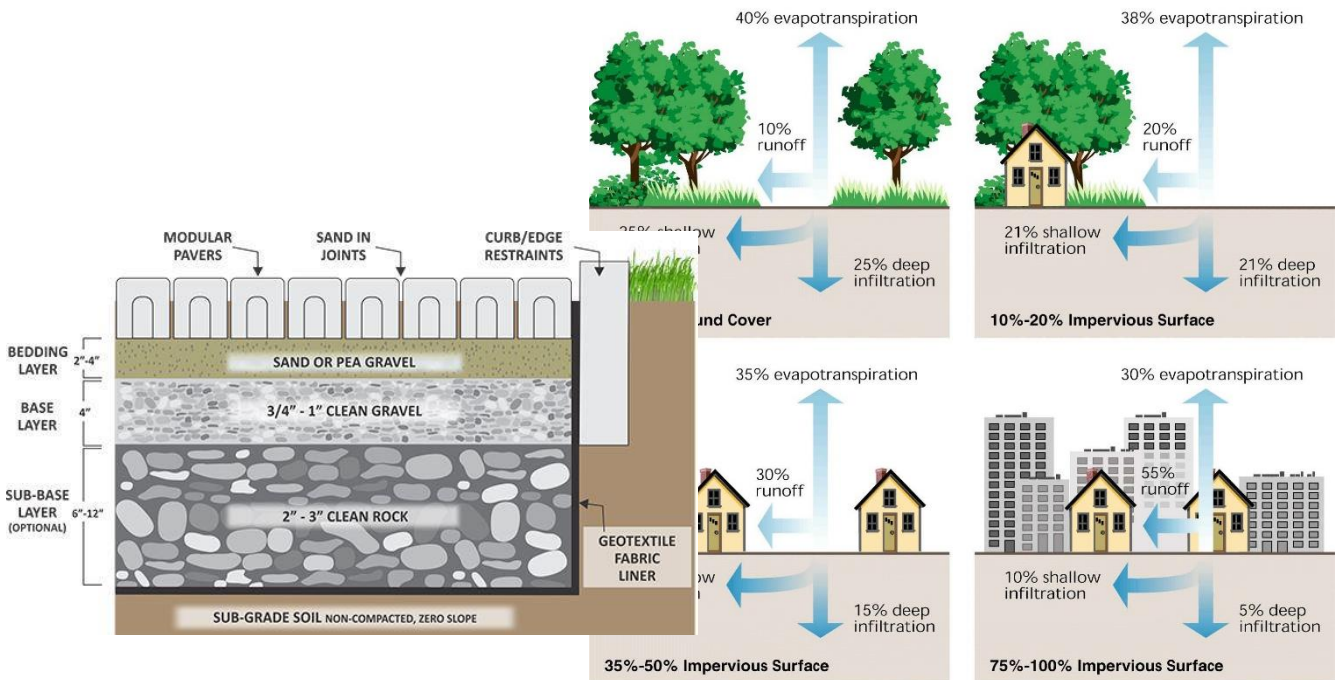


Fig.4.6.2.9

- REQUIRED TANK CAPACITY
- For the month of September(highest rainfall 399 mm)
- Total collected litres from roof top = 23,95,268 litres
- Total collected litres from pavements = 7,25,382 litres
- Total collected water = 31,20,650 litres
- TANK CAPACITY -13mx13mx10m = 1690cum x 1000litres= **16,90,000 litres**

Two tanks need to be provided.

GREY WATER CALCULATION.

- WC = 1.28 gallons per flush
- Wash basin = 2 gallon/min for 20sec = 0.67 gallons
- Urinals =1 gallons per flush
- kitchen sink = 2.2 gallons per minute
- Shower = 14.5 gallons



Fig.4.6.2.10.

Tab.4.6.3.

SPACES	WC	WASH BASIN	URINALS	SHOWER	TOTAL WATER/ USAGE
ADMIN	8	4	2		14.92
INSTITUTE	16	8	2		27.84
HOSTEL 1	10	4	4	10	164.48
HOSTEL 2	10	8	-	10	163.16
MESS	4	8			10.48
KITCHEN SINK			2		4.4
TOTAL WATER CONSUMPTION 385.28 gallons (1458.44 litres)					

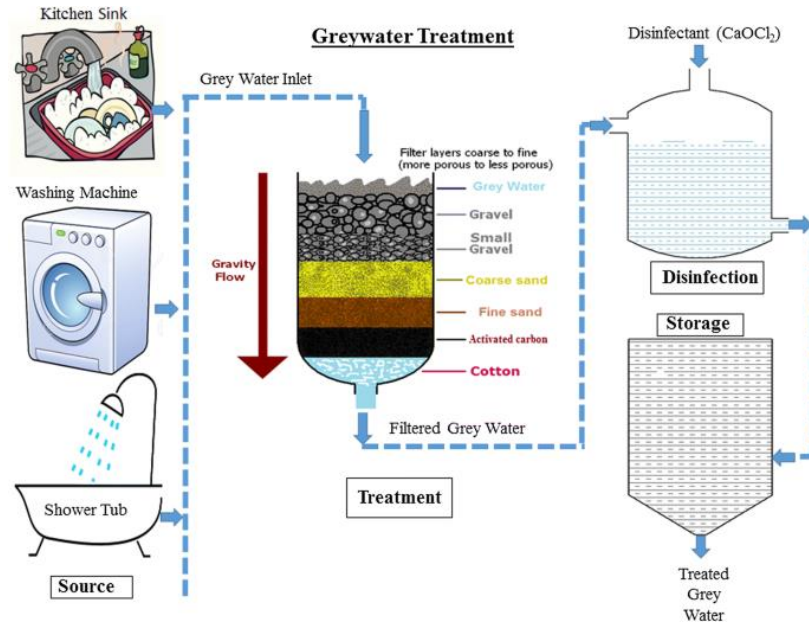


Fig.4.6.2.11.

- AMOUNT OF GREY WATER RECYCLED 323.84 gallons
- (1225.8 litres)
- Assuming 150 persons/day.
- •48,576 gallons of grey water/day.
- •Providing the specific filtration process in order to reuse water.

WATER CONCLUSION:

AMOUNT OF WATER USED PER DAY:

1458.44 Litres x 150 peoples – 2,18,766 litres used per day.

AMOUNT OF GREY WATER RECYCLED PER DAY:

1,83,880 litres of greywater / day

AMOUNT OF RAINWATER HARVESTED IN PEAK MONTH:

31,20,650 litres i.e - 1,04,021 litres per day

Thus the amount of water used is 2,18,766 litres which is restored by both grey water treatment and rain water harvesting which is around 2,87,901 litres in peak months where this rain water is stored and used during summer months.

Tab.4.6.4.

Types of surfaces	Materials	Characteristics
Paved surfaces		
Flat roofs	Concrete, cement sheets, china chips, bricks with cement lining	Safe and clean catchments are least prone to contaminants. They also yield maximum run-off available for harvesting
Sloping roofs	GI (galvanised iron) sheets, Mangalore tiles, slate, fibre sheets	As above
Treated roof surfaces	Thatched roofs covered with polythene sheets	Improves water collection
Driveways, courtyards, pavements, internal roads	Cement, concrete, tiles	Collects good quantity of rainwater of reasonable quality, depending on maintenance of the site
Highways, roads, parking lots	Asphalt, concrete, bricks, stones	Can be used after installing oil and grease traps and other filtration devices
Unpaved surfaces		
Lawns, parks, gardens from large open spaces	Soil, grass or vegetation	Substantial amounts of water can be recovered
Playgrounds, courtyards	Hard, packed soil	Water collection efficiency will be more than on vegetation covered surfaces
Source: Centre for Science and Environment (CSE), New Delhi		

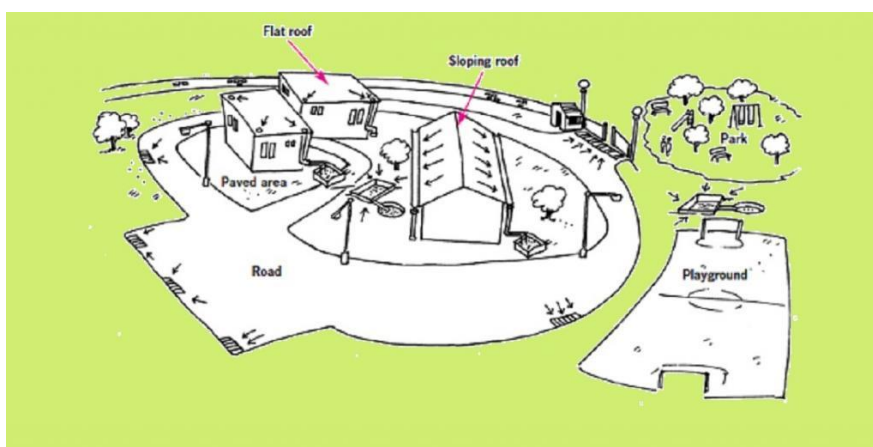


Fig.4.6.2.12.

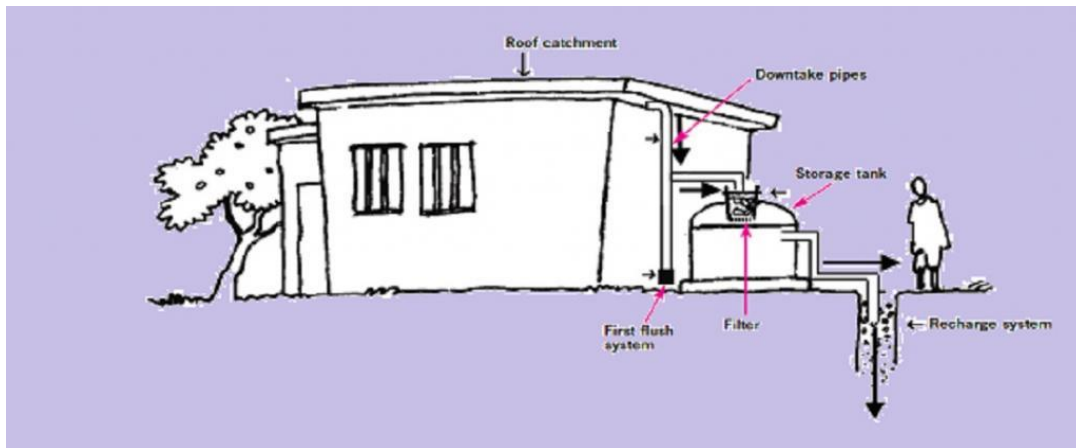


Fig.4.6.2.13.

Tab.4.6.5.

TO ACHIEVE ENERGY:

NET POSITIVE ENERGY.

One hundred percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion.

100% RENEWABLE ENERGY.

SOLAR ENERGY:

The building should use all of its electricity from renewable resource like solar energy by calculating solar panel output capacity as discussed earlier.

- Solar panels can be fitted onto buildings or within fields. They turn sunlight into electricity. New technology is making solar panels able to generate electricity on cloudy days, which would be good for many countries.



Fig.4.6.2.14.

Tab.4.6.6.

BLOCKS	ROOF AREA	NO. OF PANELS	ENERGY
ADMIN BLOCK	621	320	1,60,000 wh/day
INSTITUTE	1235	639	3,19,500 wh/day
RESEARCH	597	309	1,54,500 wh/day
HOSTEL (X2)	1508	781	3,90,500 wh/day
RECREATIONAL	511	264	1,32,000 wh/day

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	
Total roof area	3799.2 sq.m	
NO. of solar panels to be installed - Roof area / Area of single solar panel	1987.10	1987 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	993500	Wh/day

BIO GAS ENERGY :

Biogas typically refers to a gas produced by the breakdown of organic matter in the absence of oxygen. It is a renewable energy source, like solar and wind energy. Furthermore, biogas can be produced from regionally available raw materials and recycled waste and is environmentally friendly and CO₂ neutral.



Bio gas plant located in site.

Fig.4.6.2.15.



Fig.4.6.2.16.

- Modular system that could be installed or uninstalled and
- transferred easily everywhere and anywhere

1000kg waste / day - 180 cubic metre

methane gas and 600kW electricity / day

Tab.4.6.7.

Types of energy	Biogas with generator	Solar energy with batteries
Source	Needs 1000kg/day organic feedstock and operator	Needs 150 kWp panel capacity with 4-5h max sun shine plus additional light
Efficiency	600kW and 182m ³ Methane Gas per day	4hours sunshine (150kWp x 4) = 600kW per day
Operational cost	Need diesel to run the generator (1 litres diesel = RM4)	No need
Battery backup	Battery backup for 6 hour only	Battery backup for 2 days (for raining and cloudy day)
Production	Gas and electricity	Electricity

Tab.4.6.8.

Weeks	Amount of feedstock (kg)	Amount of methane gas production (m ³)
1	200	35.48
2	200	37.23
3	200	39.20
4	400	70.76
5	400	78.40
6	500	98.00
7	600	117.60
8	700	137.20
9	800	156.80
10	900	176.40
11	1000	196.00
12	1000	196.00