

ECO TOWER

A Thesis

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

by

AMRITHAA K R (40890002)



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

SATHYABAMA

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

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY 2022



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DEPARTMENT OF ARCHITECTURE

BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **AMRITHAA K R (40890002)** who carried out the Thesis entitled “**ECO-TOWER**” under our supervision from January 2022 to May 2022.

Internal guide

(Ar. CATHERINE
SELVARAJ)

Internal Panel Member

(Ar. SHEETAL
AMRAOTKAR)

External guide

(Ar.KRITHIKHA
MUTHUKRISHNAN)

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

Submitted for Viva voce Examination held on 6th MAY 2022

Internal Examiner

External Examiner



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DECLARATION

I **AMRITHAA K R** hereby declare that the Thesis Report entitled “**ECO-TOWER**” is done by me under the guidance of **Ar. Sheetal Amraotkar** (Internal) and **Ar.KRITHIKHA MUTHUKRISHNAN** (External) at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Master of Architecture degree in Sustainable Architecture

DATE:

PLACE:

A handwritten signature in blue ink, appearing to read 'K.R. Amritha', with a stylized flourish extending to the right.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

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

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ABSTRACT

The Tower, as a building typology, is inherently unsustainable. This has been observed at multiple grounds including economic, social and environmental. Towers are big consumers of energy and they limit people's access to natural light, views and ventilation. Skyscrapers, are often poorly insulated and consume large amount of energy in order to artificially light, heat and cool the buildings, results in generating excessive greenhouse emission.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The Tower, as a building typology, is inherently unsustainable. This has been observed at multiple grounds including economic, social and environmental. Towers are big consumers of energy and they limit people's access to natural light, views and ventilation.

Skyscrapers, are often poorly insulated and consume large amount of energy in order to artificially light, heat and cool the buildings, results in generating excessive greenhouse emission.

1.2 AIM

To design a eco tower to achieve environmental, social and economic sustainability in vellore.

1.3 RESEARCH QUESTIONS

How to design a environmental friendly building (eco-tower) with energy production, waste management and adaptive facades.

How to identify the new methods to enhance the ecological vertical living.

How to design a space which bring closer to nature and harmony.

How to develop the source of energy required to make the tower self sufficient in energy consumption.

1.4 OBJECTIVE

To design a environmental friendly building (eco-tower), energy production, waste management, adaptive facades.

To identify the new methods to enhance the ecological vertical living

To design a space which bring closer to nature and harmony

To develop the source of energy required to make the tower self sufficient in energy consumption.

1.5 NEED OF STUDY

Energy has become the vital force fueling the life on earth and also plays a significant role in the economic development of any country. Energy is required in every aspect of life, from making various equipment and products to charging our phones. Energy systems in India have evolved over the past six decades along with India's economic development, and the aspiration of 1.2 billion people. Ever increasing urban populations and the improved quality of life in cities have resulted in greater demand for energy. This situation has posed tremendous pressure on India's limited energy resources and has necessitated optimum use of its resources.

1.6 SCOPE AND LIMITATION OF THE STUDY

The main scope of the project to design a eco friendly building and limitation is the building only deals with the warm and humid climate and design according to the IGBC rating.

1.7 METHODOLOGY

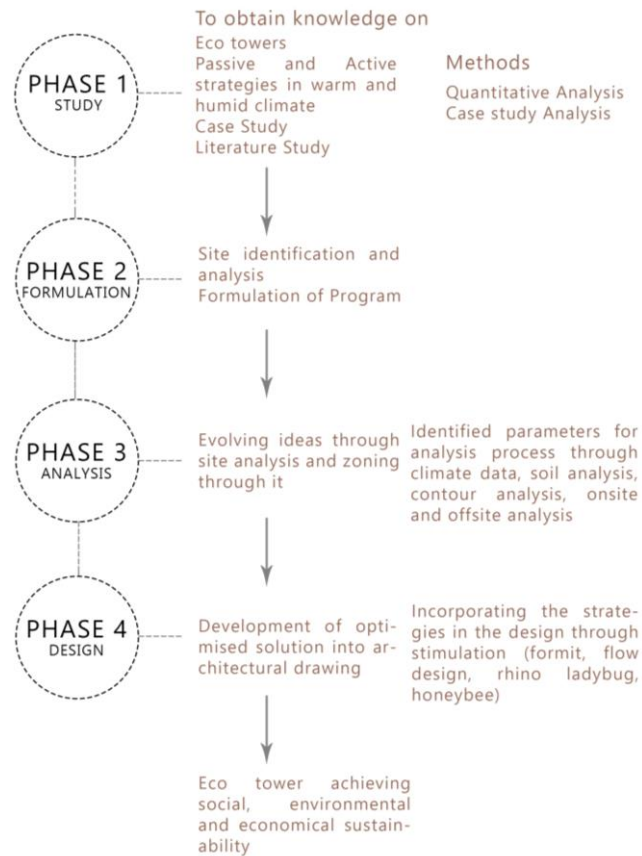


Figure 1: METHODOLOGY

CHAPTER 2 ECO TOWER

2.1 ECO TOWER

ECO?...

Eco Architecture seeks to minimize the negative environmental impacts of structures through improved efficiency and the use of sustainable construction materials. Beautiful buildings that work with the environment are the heart and soul of eco architecture.

TOWER?...

Tower is a tall structure, taller than it is wide, often by a significant margin.

ECO TOWER?...

Eco-Towers focuses on providing environmentally-friendly tall buildings by employing a wide-variety of innovative methods, creative designs, and green technologies.

ENERGY EFFICIENCY IN HIGH-RISE OFFICE BUILDING

Energy systems in India have evolved over the past six decades along with India’s economic development, and the aspiration of 1.2 billion people. Ever increasing urban populations and the improved quality of life in cities have resulted in greater demand for energy.

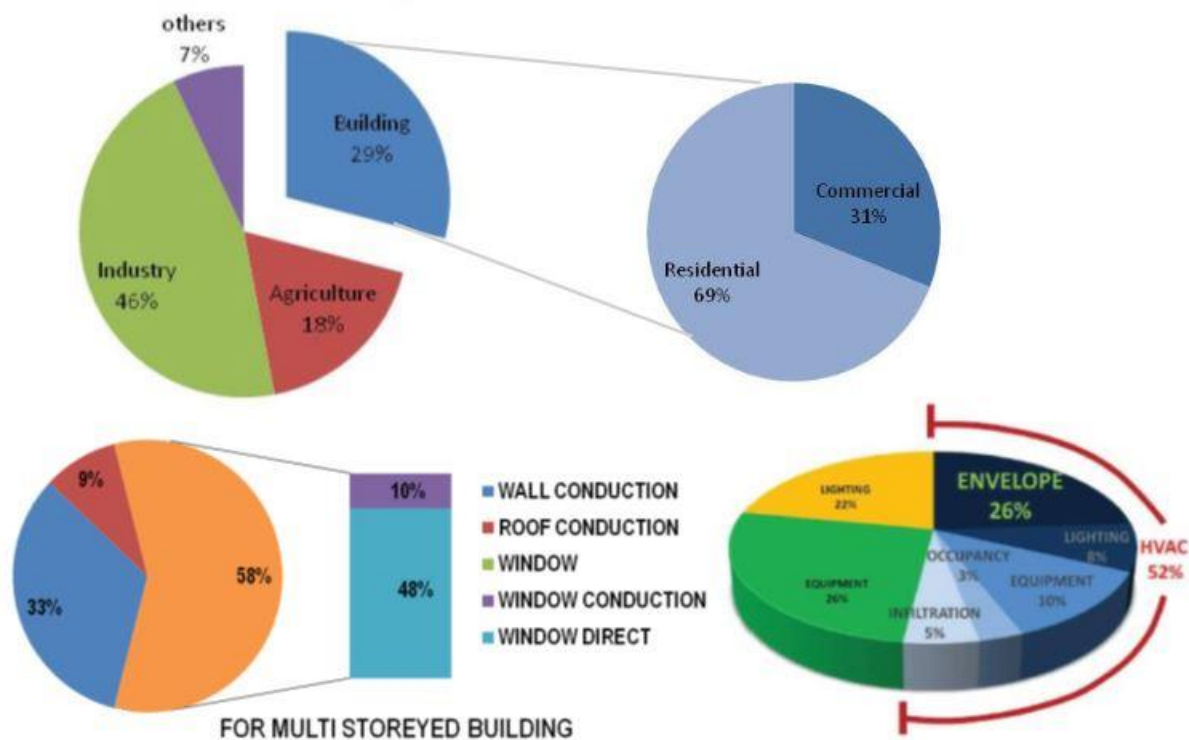


Figure 2: ENERGY CONSUMPTION IN HIGH RISE BUILDING

CHAPTER 3 LITERATURE STUDY

RESEARCH PAPER	AIM	METHODOLOGY	INFERENCE
Energy Efficiency Design Strategies in Office Buildings: A Literature Review Erebor E. M. , Ibem E. O. , Ezema I. C. and Sholanke A. B(Erebor, 2021, March)	Identifying and categorizing the existing energy efficiency design strategies used in office buildings	Formulation of research questions, Evaluation of literatures, summarizing and Interpretation of findings	Design strategies at the pre-construction stage, design strategies at the construction stage and design strategies at the post-construction stage.

RESEARCH PAPER	AIM	METHODOLOGY	INFERENCE
Adaptive building envelopes of multistory buildings as an example of high performance building skins Hadeer Samir Mohamed Shahin (Shahin)	The design of three strategies used in constructing adaptive building envelopes of multistory buildings, integrating improved energy performance and architectural innovation	Analyze existing examples and ideas of adaptive envelopes, gaining an overall understanding of the concept of three adaptive building envelopes, knowledge of the materials commonly used and how they perform and energy saving	The adaptive building facade responds intellectually and accurately to the fluctuating climatic conditions and indoor conditions requirements, where it will utilize the existing natural energies to light, heat and ventilate

RESEARCH PAPER	AIM	METHODOLOGY	INFERENCE
Examining the Role of Building Envelope for Energy Efficiency in Office Buildings in India Farheen Bano, Mohammad Arif Kamal (Bano, 2016)	Reducing energy efficiency by building envelope	Energy consumption in commercial sector, energy consumption in means of all building components	Different components of building envelope have different energy saving potential incorporating all the parameters the energy saving potential ranges would be as high as ranging from 17 to 42%.

RESEARCH PAPER	AIM	METHODOLOGY	INFERENCE
Energy-efficient tall buildings design strategies: A holistic Approach Hazem Elotefy, Khaled S.S. Abdelmagida, Ezzat Morghanya, Tarek M.F. Ahmed (Elotefy, 2015)	Integrated approach to achieve energy efficiency in tall buildings	Compared several case studies on tall buildings and found buildings in implementing energy efficiency strategies yet there is a great potential in achieving higher energy efficiency in tall buildings through an integrated approach	Energy efficiency through Building shape, form and geometry (various types and experimental model) Different type of tall buildings and the relationship between building height, shape and reduce in energy consumption.

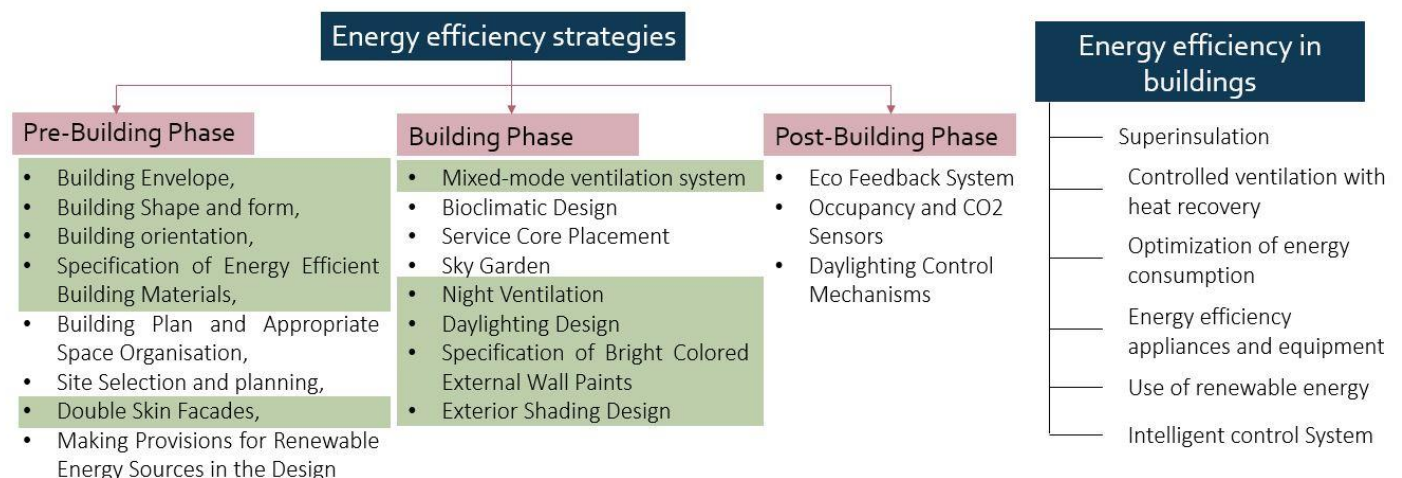


Figure 3: ENERGY EFFICIENT STRATEGIES
(Erebor, 2021, March)

The Barcelona Media-ICT building, Barcelona



Figure 4: BARCELONA MEDIA-ICT BUILDING

Smart materials, ETFE material, 20% less in energy consumption, this decreases the solar factor (SF) by four times, from 0.45, as accepted by the Building Code, to 0.10.

Al Bahar Towers by Aedas, Abu Dhabi, UAE



Figure 5: AL BAHAR TOWERS BY AEDAS

Responsive facade system, decrease solar gain by more than 50 % and decreases the usage of air conditioning, permit the usage of natural type of tinted glass, which permits more sunlight to enter the building and decreases the need for artificial lighting.

Terrence Donnelly Centre for Cellular and Biomolecular Research.



Figure 6: TERRENCE DONNELLY CENTRE AND BIOMOLECULAR RESEARCH

Intelligent building skin, double façade permit Natural ventilation throughout the 13 floors, enhancing air circulation, cooling and natural ventilation, Louvers placed at the facade control the penetration of sunlight' (Shahin)

- Most of the commercial buildings have energy performance index (EPI) of 200 to 400 kWh/ sq m/ year to be converted to 100 to 150 kWh/ sq m/ year
- 40-50% reduction in energy efficiency
- HVAC accounts for the highest energy consumption in the Commercial buildings.
- The building envelope parameters orientation, shape, walls, fenestrations, shading device and roof, the HVAC load can be reduced in commercial buildings. (Bano, 2016)

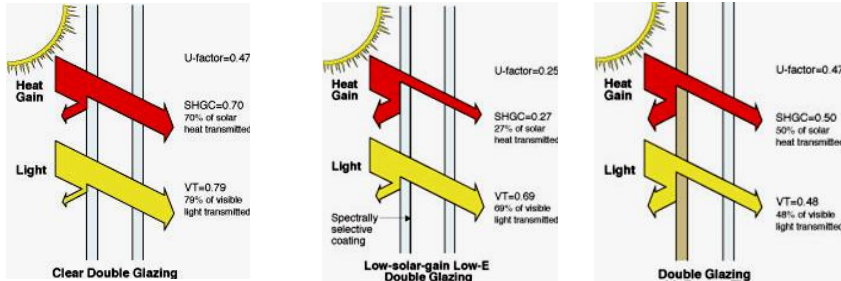
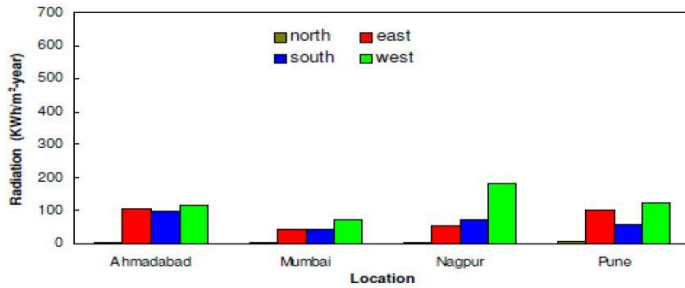


Figure 7: GLAZING PROPERTIES



(c) Window shaded by 0.6 m chajja and full fins (1.2m x 1.2 m)

Building component	Ahmadabad (223.037MWh)		Mumbai (201.892 MWh)		Nagpur (198.756 MWh)		Pune (137.764 MWh)	
	Cooling Load (MWh)	Percentage of Annual Cooling Load	Cooling Load (MWh)	Percentage of Annual Cooling Load	Cooling Load (MWh)	Percentage of Annual Cooling Load	Cooling Load (MWh)	Percentage of Annual Cooling Load
Walls	81.141	36.4	66.532	33	71.151	35.8	36.487	26.5
Roof	18.996	8.5	15.148	7.5	17.845	9	12.288	8.9
Ground	4.957	2.2	4.557	2.3	3.000	1.5	0.129	0.1
Window (Conduction+ Direct Solar)	117.941 (28.563+ 89.378)	52.9 (12.8+ 40.1)	115.654 (17.405+ 98.249)	57.3 (8.6+ 48.7)	106.761 (19.608+ 87.153)	53.7 (9.9+ 43.8)	89.119 (6.180+ 82.939)	64.7 (4.5+ 60.2)

Table 1: THE HEAT GAIN THROUGH VARIOUS BUILDING ELEMENTS ON THE COOLING LOAD

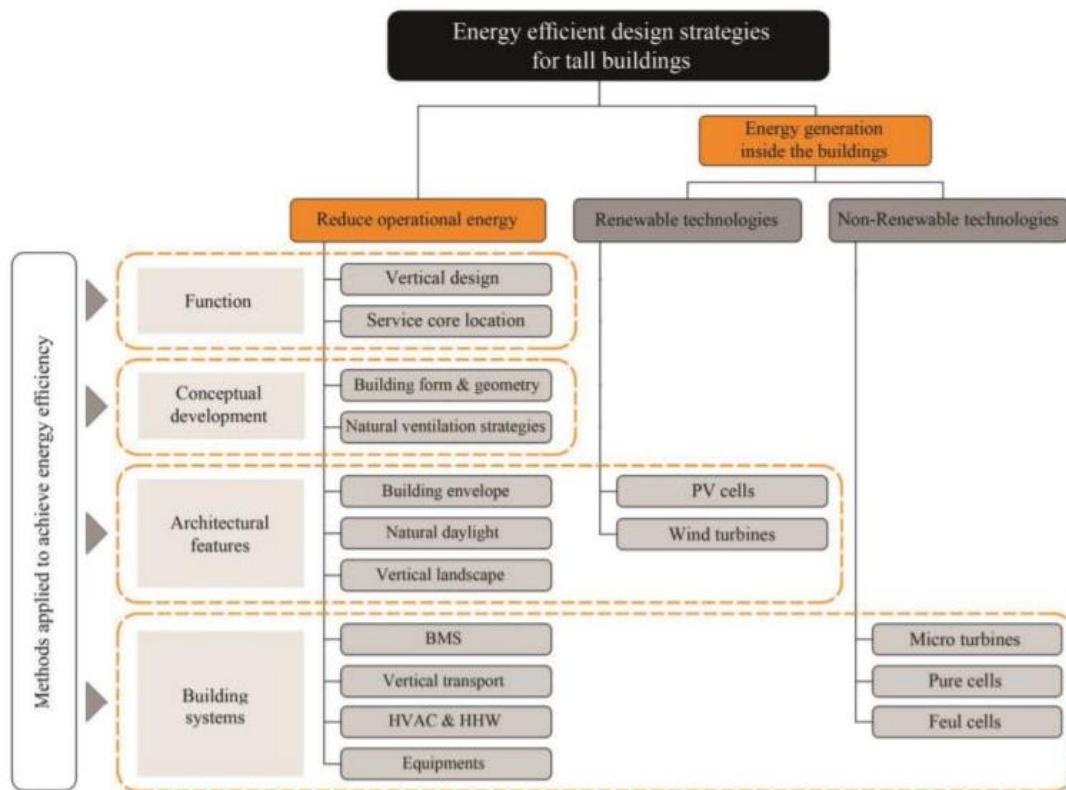
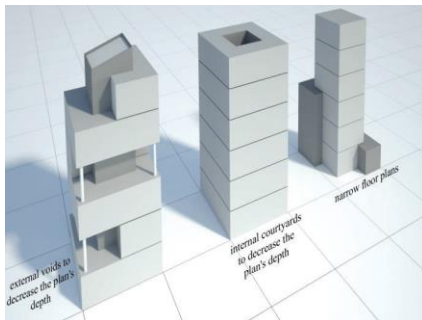
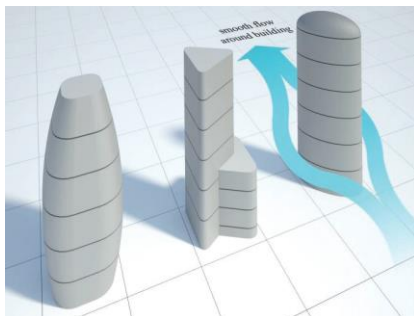


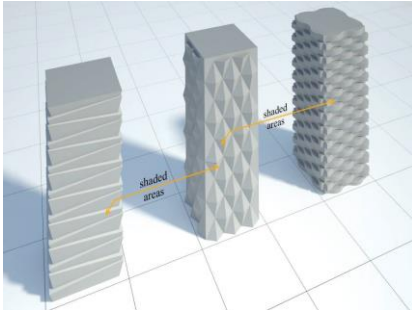
Figure 8: ENERGY EFFICIENT DESIGN STRATEGIES



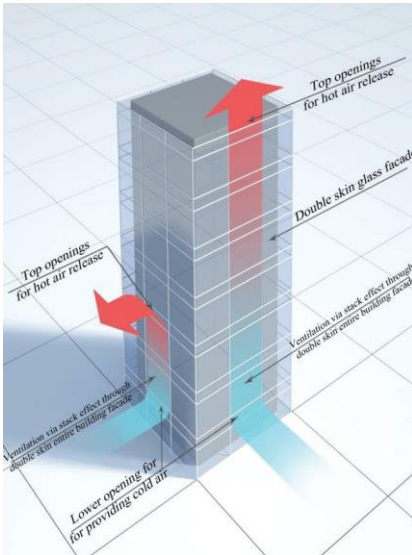
Increase the external surface area to volume ratio



Aerodynamic shapes for tall buildings



Contrast in facades surface pattern



Natural ventilation via central courtyard and external openings

(Elotefy, 2015)

Figure 9: DESIGN ENVELOPE

CHAPTER 3 CASE STUDY

4.1 SIGNATURE TOWER - SPRIAL EDGE

Location: Manesar, Haryana, India
 No. of stories: 20 stories + Roof garden
 Site Area: 4765 Sq.m
 Building Type: Commercial + Office
 Architect: Ken Yeang



Figure 10: SIGNATURE TOWER – SPIRAL EDGE

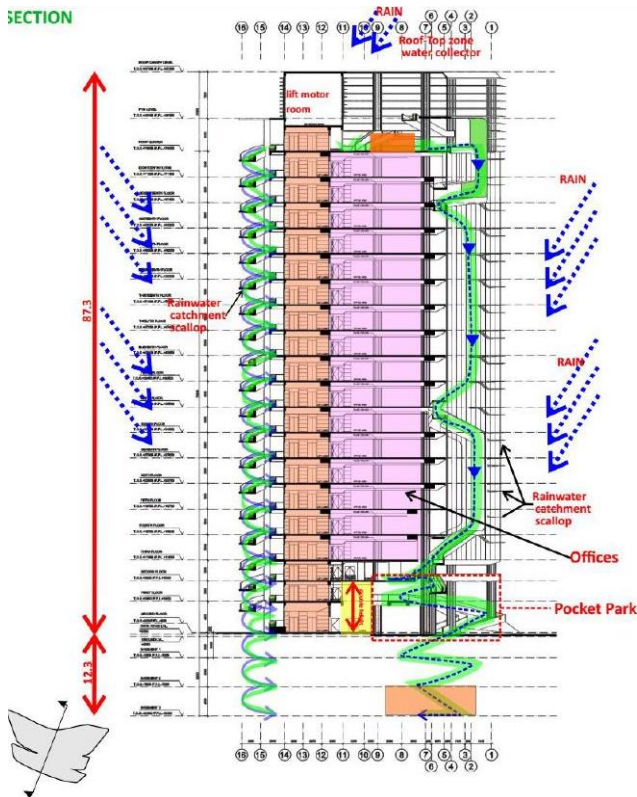
Climate: Warm and humid Climate

Temperature: 35 - 23°C

Humidity: 90 – 70%

Wind direction: north and south

SECTION



ENERGY EFFICIENT TECHNOLOGIES

- Energy conservation measures include high albedo paint, over-deck roof insulation, high performance glazing, efficient lighting design, air economisers, variable air volume systems, efficient water cooled centrifugal chiller and cooling tower fans with variable speed.

- Provision for generation of electricity through renewable energy sources to meet partial requirements of the building in future.

INFERENCE

Office space are placed in the north to avoid solar radiation

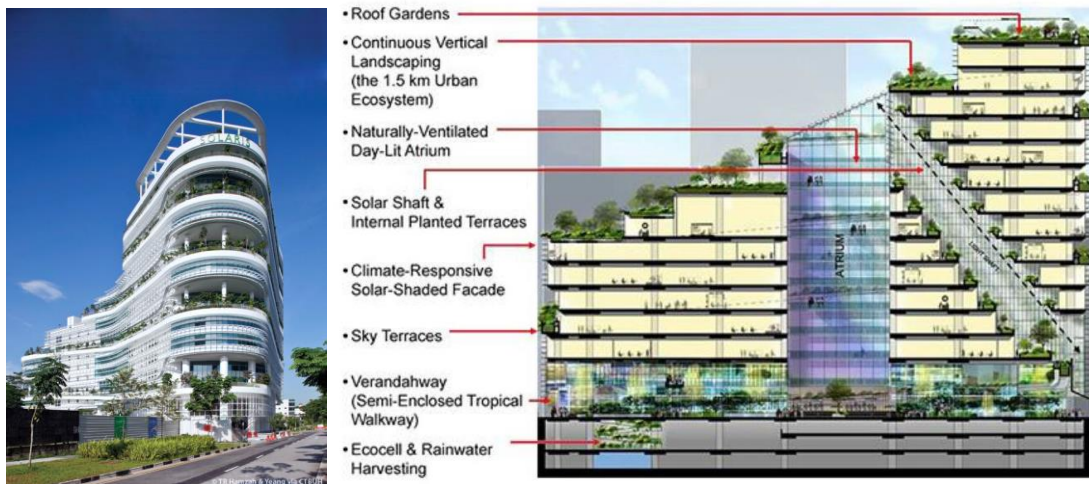
South facade – continuous ramp facade with plantation acts to avoid radiation in living space and also for rainwater catchment.

East and west facade has two louvers and north has one to obtain maximum daylight for office space.

This strategies are most suitable for warm and humid climate to avoid solar radiation leads to energy efficient design.

4.2 SOLARIS, SINGAPORE

Military base site, which meant that most of the original ecological system had been destroyed. The architect's response was to conserve site and cause the least ecological damage, helping to improve the site's biodiversity simply through the positioning of the building. (Nyawara, n.d.)



Corner sky Terraces



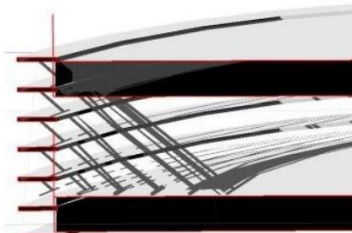
Eco-cell (from the continuous ramp) to the basement for rainwater harvesting, which is 5 days of recycling water between rains.



Atrium view



Eco Cell



Climate Responsive Facade



solar shaft

(Nyawara, n.d.)

Figure 11: DESIGN STRATEGIES

INFERENCE

Two blocks separated with central atrium, with louvers in the roof (sensors open and close) to let out the hot air.

Louvers in different levels to reduce glare in hot climates

Continuous perimeter landscape ramp in the exterior facade from basement to rooftop with plantation creates microclimate to the building.

Rain water harvesting

4.2 TERI, BANGALORE

Location: Bangalore, India

No. of stories: 3 stories

Site Area: 2600 Sq.m

Building Type: Office

Architect: Sanjay Mohe



Figure 12: TERI, BANGALORE

Climate: Moderate
 Temperature: 34°C(max) – 10°C(min)
 Humidity: 70 – 30%
 Wind direction: West and East

- TERI Bangalore is south India's first energy efficient and environmentally sustainable campus.
- Sun, Air, Earth, Water and sky (interplay of natural elements) to meet requirements of thermal, visual and aural comfort.

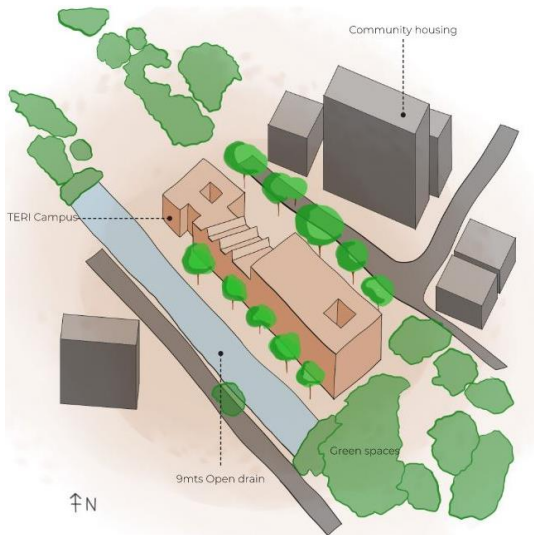


Figure 13: CONCEPTUAL PLAN

ARCHITECTURAL DESIGN

- The building opens to the north to take maximum advantage of glare-free light.
- Adequate natural lighting and ventilation is provided through an optimised combination of solar passive design, energy-efficient equipment, renewable sources of energy and materials with low embodied energy. (Kumar, January 2014)

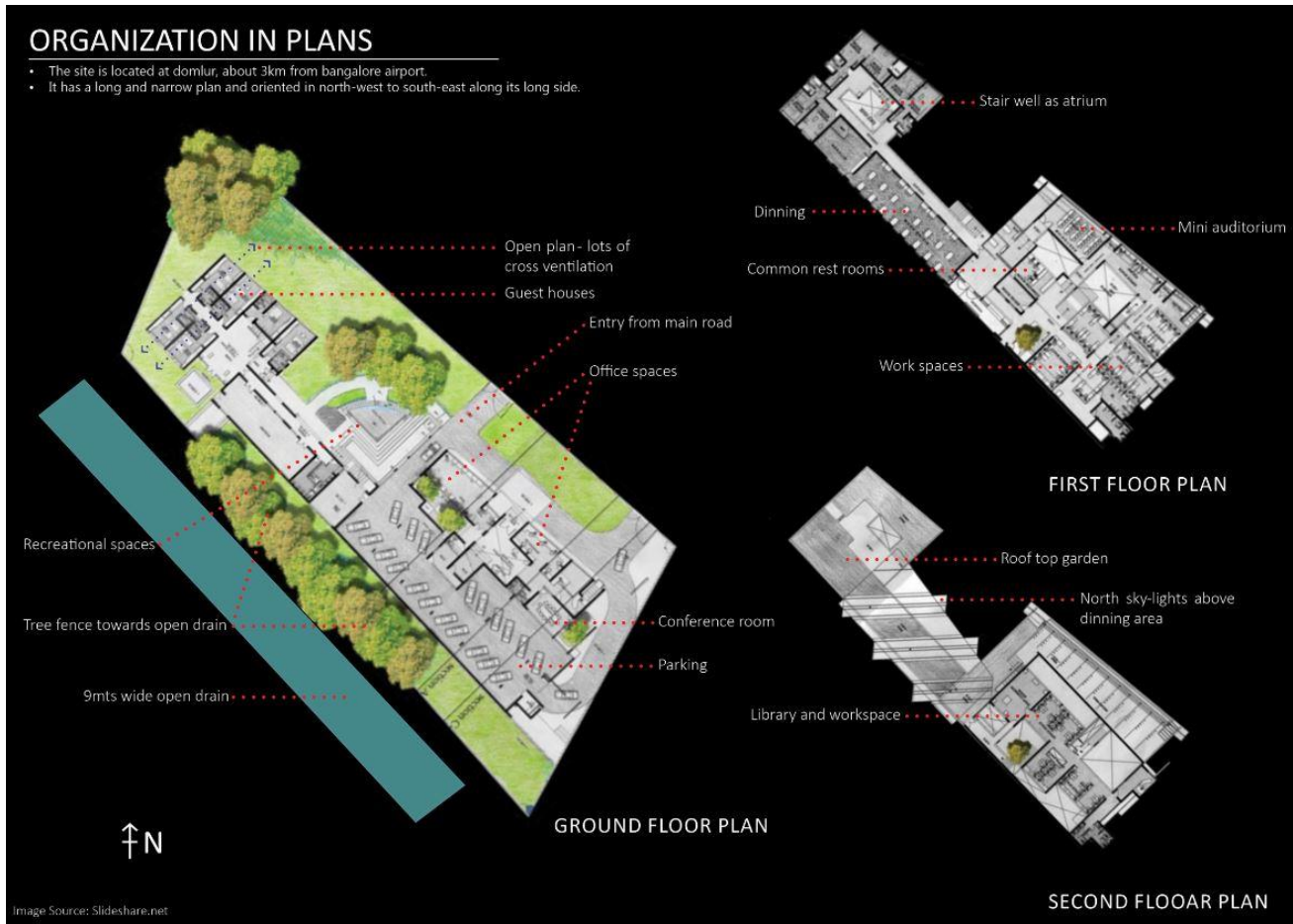


Figure 14: FLOOR PLAN

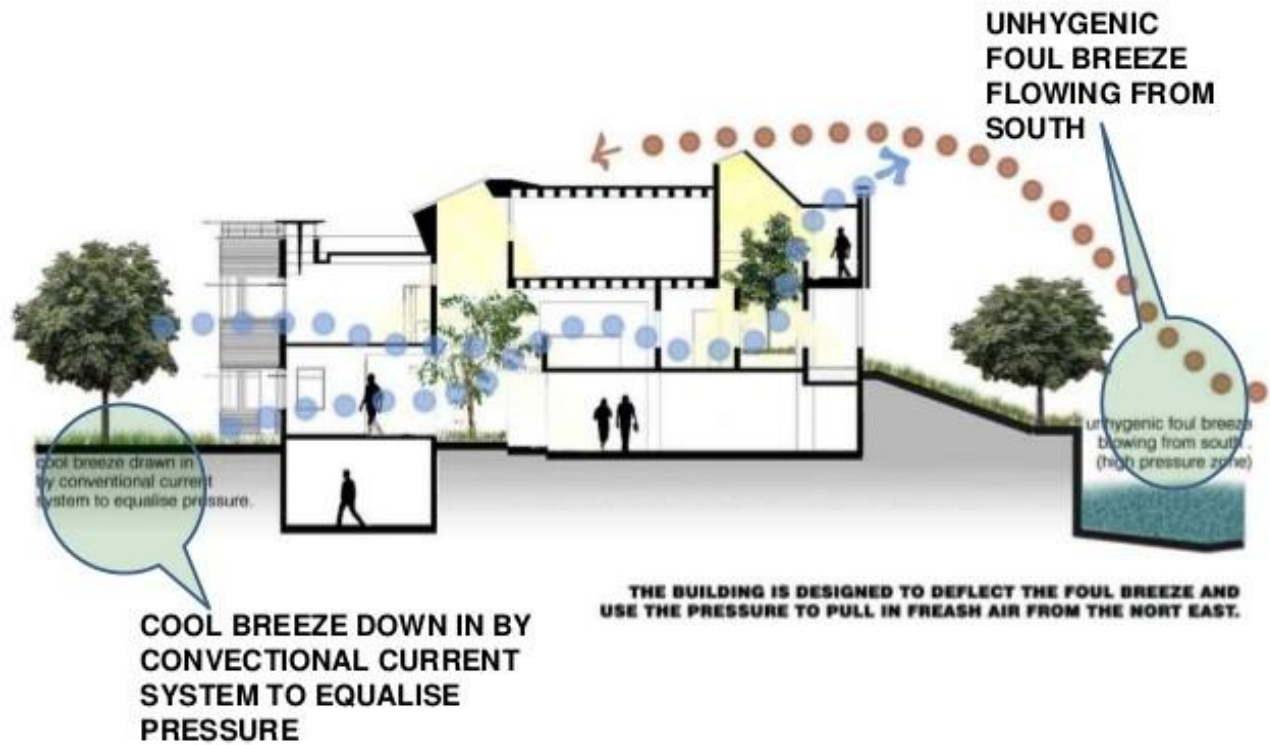
PASSIVE DESIGN - ENVELOPE



- The building has been designed with landscaped courts at various levels.
- These courts help to enliven the working environment as well as enhance the micro climate within the structure.

- Reduces the heat exchanges and heat flow between the structure and outside environment. (Kumar, January 2014)

Figure 15: WIND AND VENTILATION



ARCHITECTURAL DESIGN

Openings have been designed such that the requirement of artificial lighting is minimum throughout the day when building is used maximum usage. (Kumar, January 2014)

DAYLIGHT ANALYSIS



Figure 16: ATRIUM DAYLIGHT

INFERENCE

- Daylighting(atrium) and ventilation is used in a optimized way by even blocking southwest walls.
- Earth berm structure to maintain the temperature as temperature underground is low.
- Different levels in building used to stop the heat transfer

4.3 SINO-ITALIAN ECOLOGY AND ENERGY EFFICIENT BUILDING

Location: Beijing, China

No. of stories: 10 stories

Site Area: 20000 Sq.m

Building Type: Office and Educational

Architect: Mario Cucinella Architects



Climate: Composite

Temperature: 32°C(max) – -3.7°C(min)

Humidity: 67 – 34%

Wind direction: Northwest

Figure 17: SINO-ITALIAN ECOLOGY AND ENERGY EFFICIENT BUILDING

The Sino-Italian center of education, training and research for the protection of environment and energy conservation.

- The building is U shaped in plan around a central courtyard to obtain maximum daylight from south.
- It is closed and well insulated on the northern side that faces the cold winter winds.
- Offices and laboratories on the upper floors have terraced gardens shaded by photovoltaic panels that produce energy for the building. (Butera, 2008)



Figure 18: NORTH AND SOUTH FACADE

North façade, main entrance – completely opaque and is highly insulated to protect the building from cold winter winds.

Southern facades – double skin louvers

East and west façade- double skin with inside and outside light shelves and interior blinds (Butera, 2008)

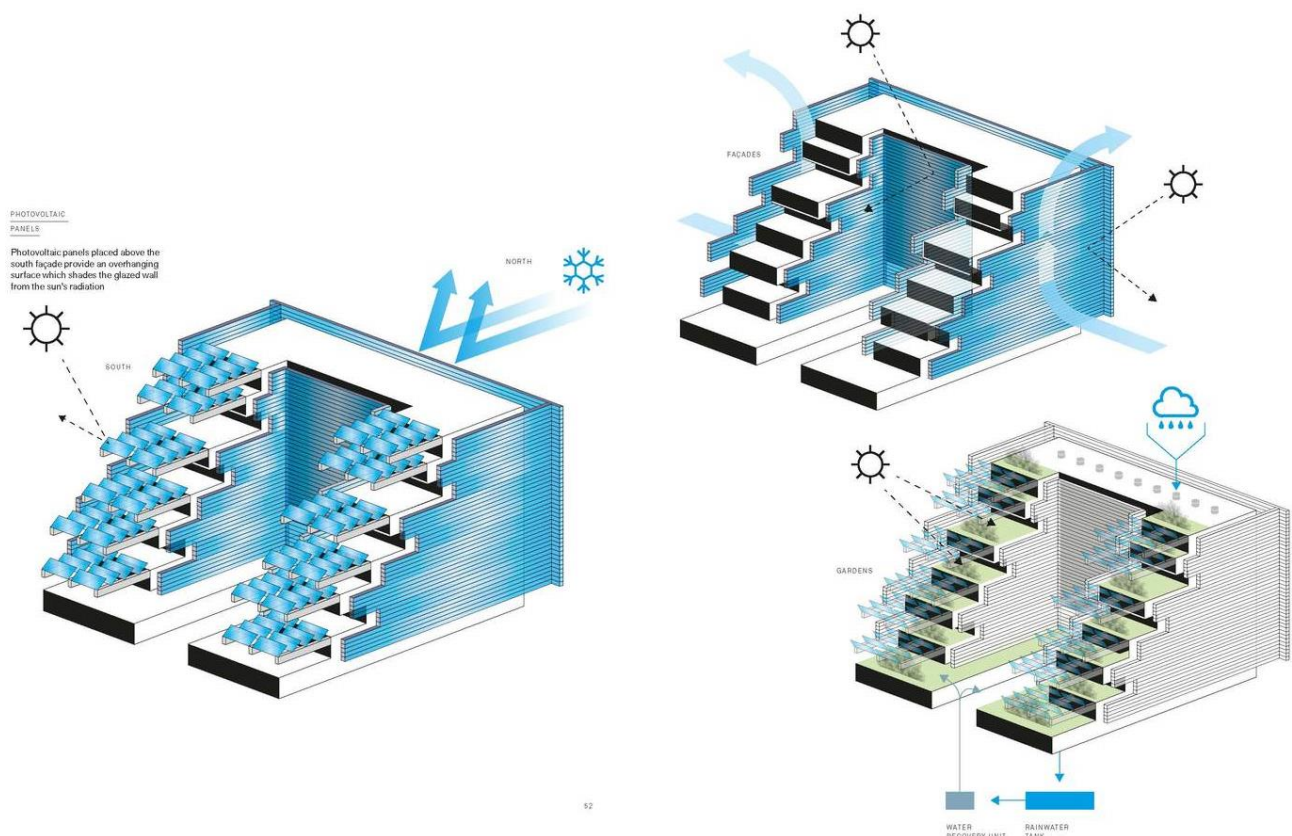


Figure 19: CONCEPTUAL MASSING

Energetic performance:
HVAC consumption (Heating,
Ventilation and Air Conditioning)



TOTAL CONSUMPTION:
24 CO₂ / M²

Heating performance



Cooling performance

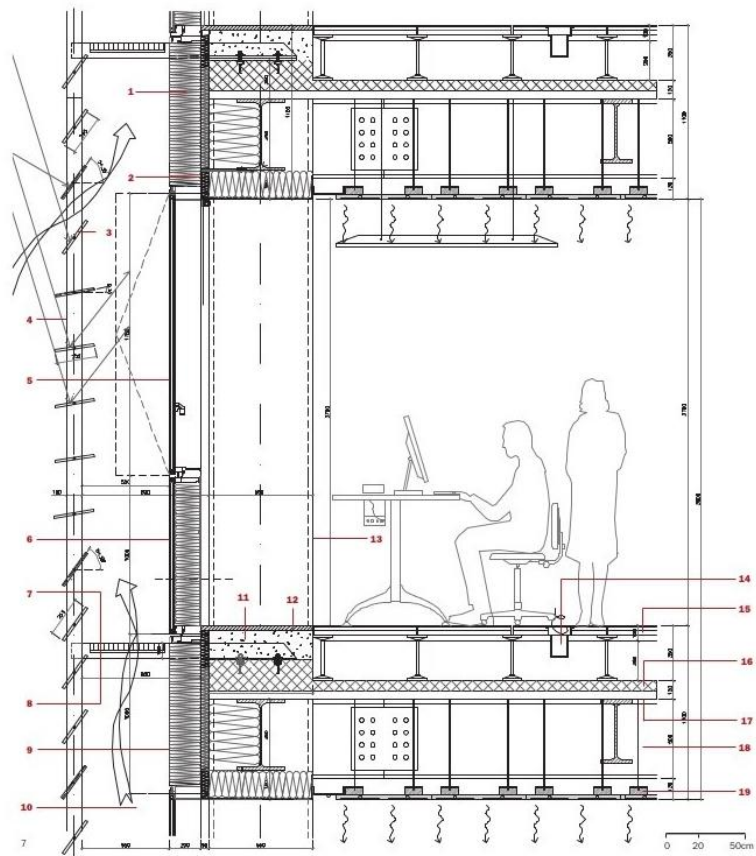
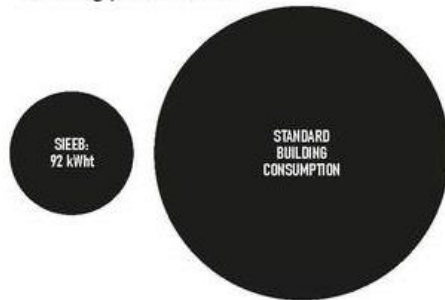


Figure 20:ENERGY PERFORMANCE AND DOUBLE SKIN
INFERENCE

- Double skin - east & west (avoid solar radiation)
- louver skin in south to avoid radiation in summer and solar gain in winter
- Balconies in south makes it self-shading and solar panels are provided.
- U shaped plan to obtain maximum amount of daylighting.

4.4 CYBERTECTURE EGG

Location: Mumbai, India

Built Area: 33000 Sq.m

Building Type: office

Architect: James law

Climate Type: Warm and humid



Figure 21: CYBERTECTURE EGG

This Cyberecture Egg is covered by an intelligent system of an elliptical egg-shaped frame, integrated with glass panels. (Mathur, n.d.)

1. Orientation of the building
2. Sky Gardens
3. PV Solar Panel Farms
4. Smart Glass Façade
5. Water Recycling System
6. Groundwater Cooling
7. Intelligent Building Management System

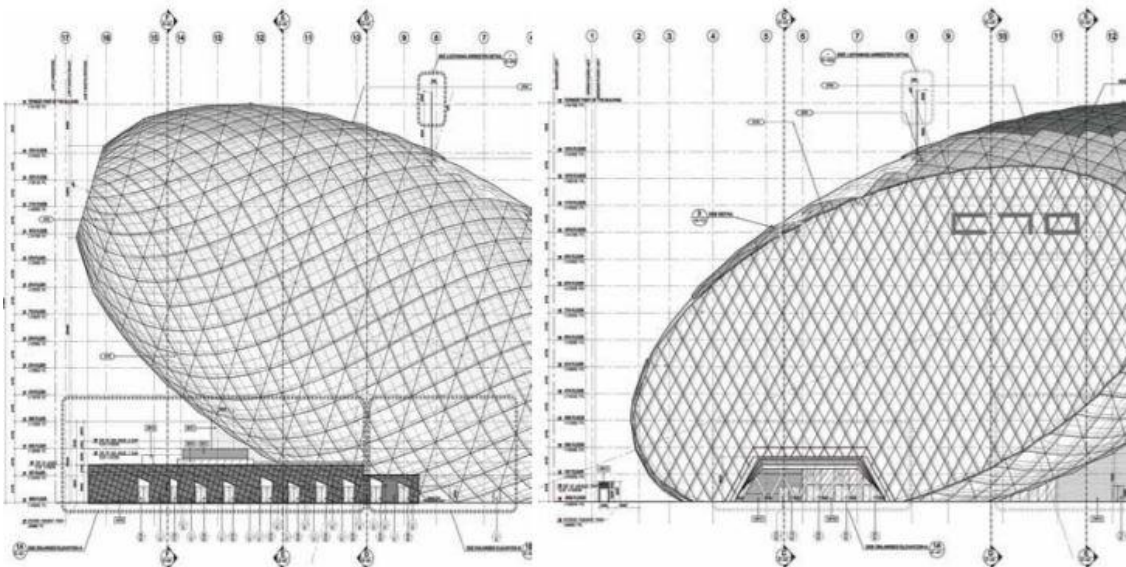
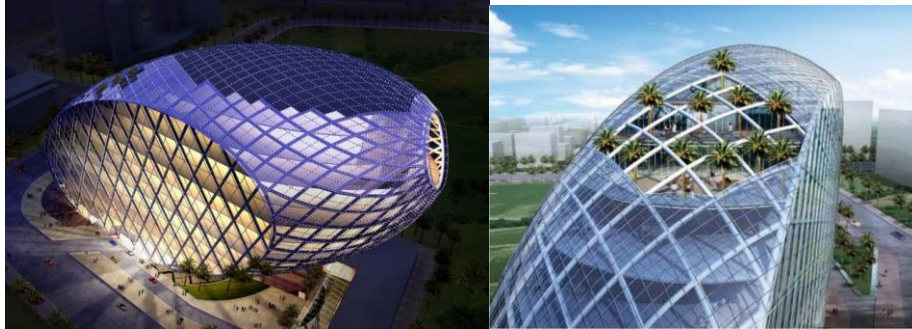


Figure 22: NORTH AND SOUTH FACADE

The building will use wind turbines and solar photovoltaic panels to generate onsite electricity. Making it a high-performance net-zero energy building, the structure reuses greywater for landscaping, BIM to minimize energy use, sensors for performance control, and many more features that spell towards a sustainable existence.

The concept was inspired by considering the world as an ecosystem allowing life to evolve.

Diagrid exoskeleton - 15% reduction construction materials (Mathur, n.d.) (growth', AUGUST 14, 2021)



	Solaris	TERI	Cybertecture Egg	Sino-Italian ecological and energy efficient building	Spiral Edge – Signature Tower
Location	Singapore	Bangalore	Mumbai	Beijing	Manesar
Year	2008	1990	2010	2006	
Image					
Climate	Warm and humid	Moderate	Warm and humid	Composite	Composite
Temperature	35 -23°C	34 – 15°C	41 – 20°C	32.2 - -3.7°C	41°C – 7°C
Humidity	90 – 70%	70 – 30%	96 – 30%	67 – 34%	74 – 43%

Plan			-		
Building Orientation	✓	✓	✓	✓	✓
	NE-SW	NE - SW	N – S	N - S	E - W
Building shape and form	✓	✓	✓	✓	✓
Building plan and space organisation	✓	✓	✓	✓	✓
Double skin	-	✓	-	✓	-
		south			
Renewable energy	✓	✓	✓	✓	✓
Mixed mode ventilation system	✓	✓	-	✓	✓
Night ventilation	✓	✓	-	✓	-
Bio climatic design	✓	✓	✓	✓	✓
Specification of Bright coloured	✓	✓	✓	✓	✓

External Wall paints					
External shading device	Plants, Louvers	-	-	Double skin, louvers	Louvers, plants
Features	Exterior continuous Ramp, louvers, atrium, green roof,	Double skin, materials, renewable energy, atrium, earth berm, different levels of building to stop heat transfer	Oval shape exterior, wind turbines, solar panels	Orientation, reduction in CO2 emission, double skin	Ramp in south facade, louvers, sky gardens, green roof

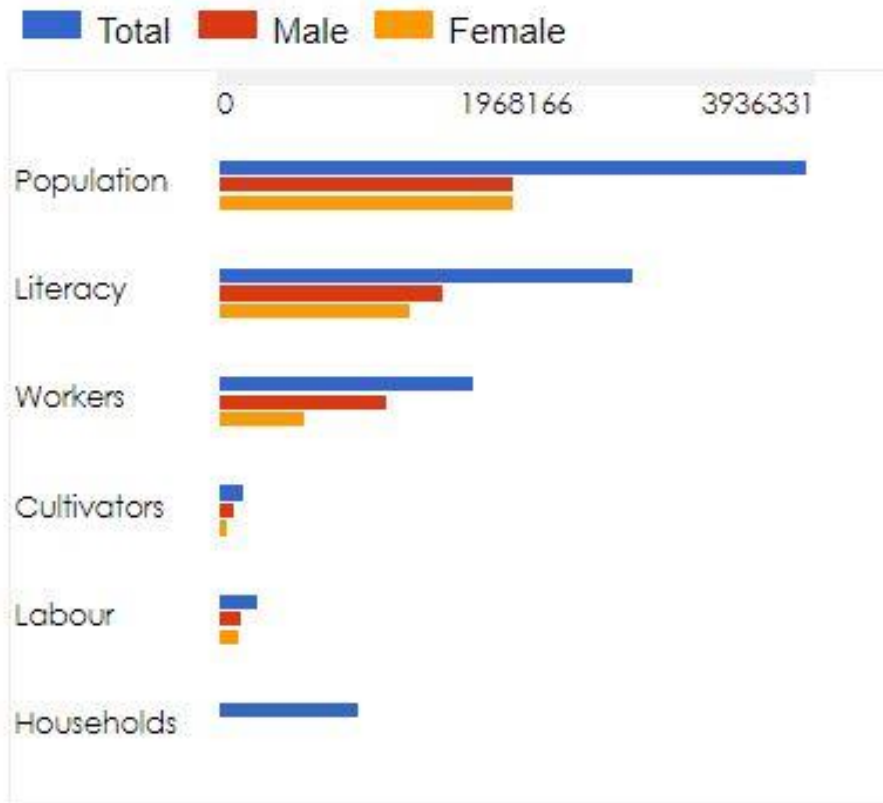
Table 2: INFERENCE OF CASE STUDY

CHAPTER 5

SITE SELECTION AND JUSTIFICATION

5.1 POPULATION CENSUS

Population 41 LAKHS



(vellore population, 2021)

Figure 23: POPULATION CENSUS

No. of engineering colleges 20

Students outcomes per year 4000

5.2 PROPOSAL

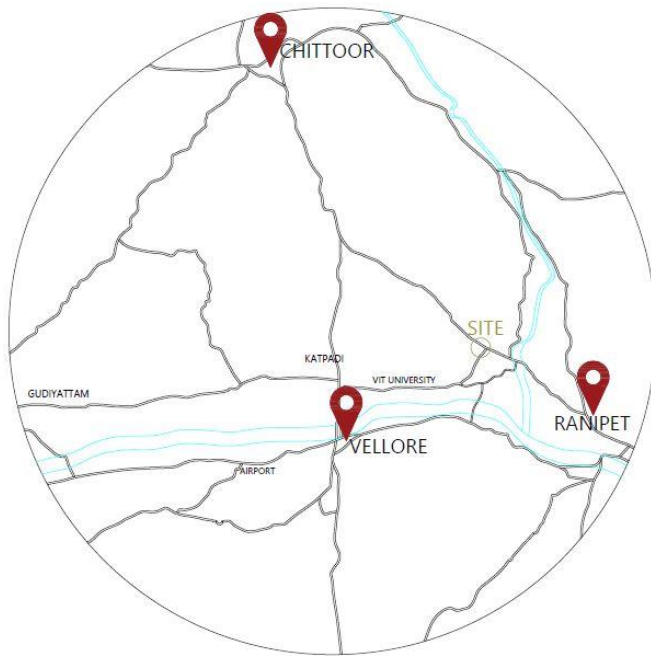
Location: Vellore, Tamil Nadu

Latitude: 12.91N

Longitude: 79.13E

Altitude: 216M

Climate: Warm and Humid



Site is located in kugaiyanallore, Vellore in NH40 connecting Chittoor and Ranipet.

Site – Vellore Bus Stand ----- 19KM

Site – Vellore Airport ----- 26KM

Site – Katpadi Railway station ----- 17KM

Site – Ranipettai Bus Stand ----- 14KM

Site – Chittoor Bus Stand ----- 35KM

Population: 41.6 Lakhs

No. of colleges: 20

Students outcome per year: 4000

Vellore Tidel Park proposed in TN Budget 2021

August 13, 2021 Mani Bharathi

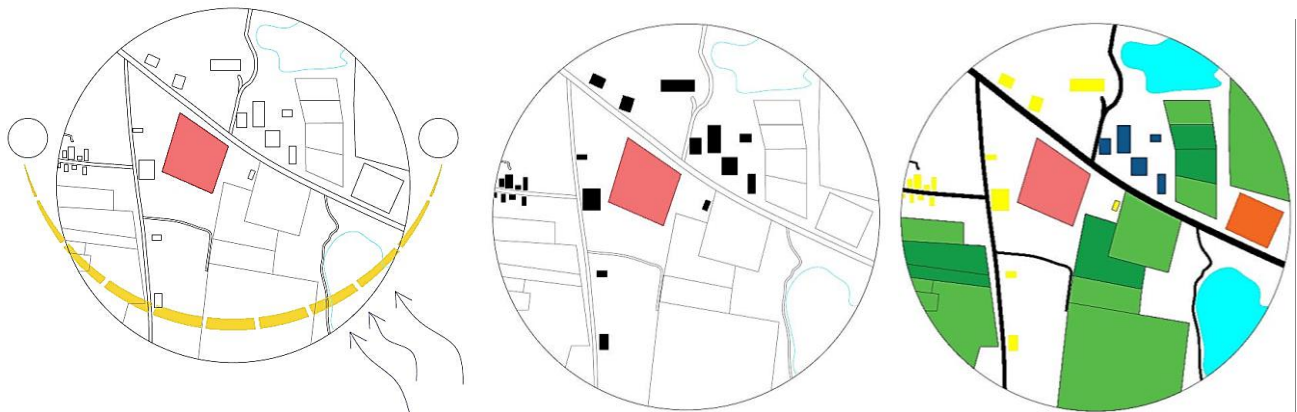


Vellore Tidel Park:

Vellore Tidel Park has been proposed in the TN Budget 2021 by the TN Govt. Earlier this year Govt had plans of introducing small IT hubs all over Tamil Nadu to increase youth employment.

Finance Minister of Tamil Nadu, Pazhanivel Thiagarajan has proposed today in the TN Assembly during the TN Budget 2021 where a Tidel Park will be established at Vellore. Apart from Vellore, Villupuram, Tiruppur and Tuticorin would also be receiving Tidel Parks.

SITE ANALYSIS





5.3 SWOT ANALYSIS

S

Site is well shaped, electricity and communication.

Site is located in outskirts of city reduces traffic. Connects many other cities

Good view access in Site.

W

Located in outskirts of city, traveling distance is high

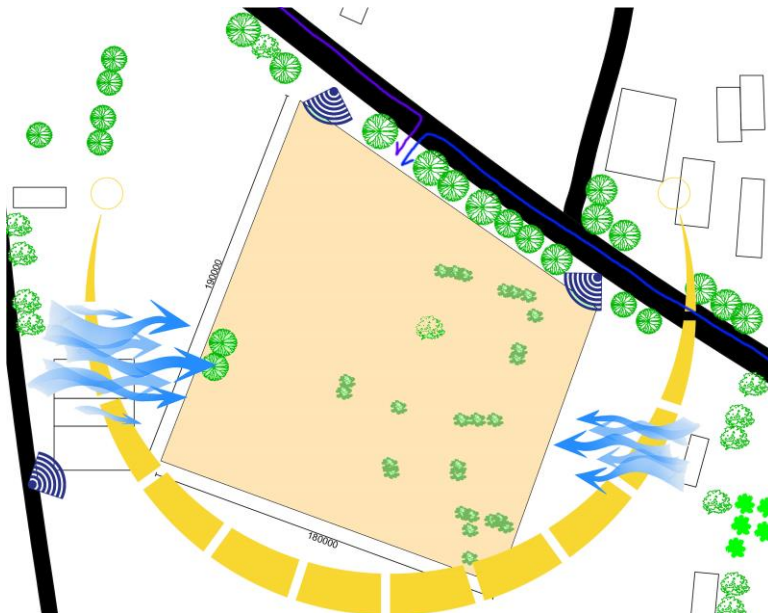
O

Creates employment, reduces migration

Connects many other cities.

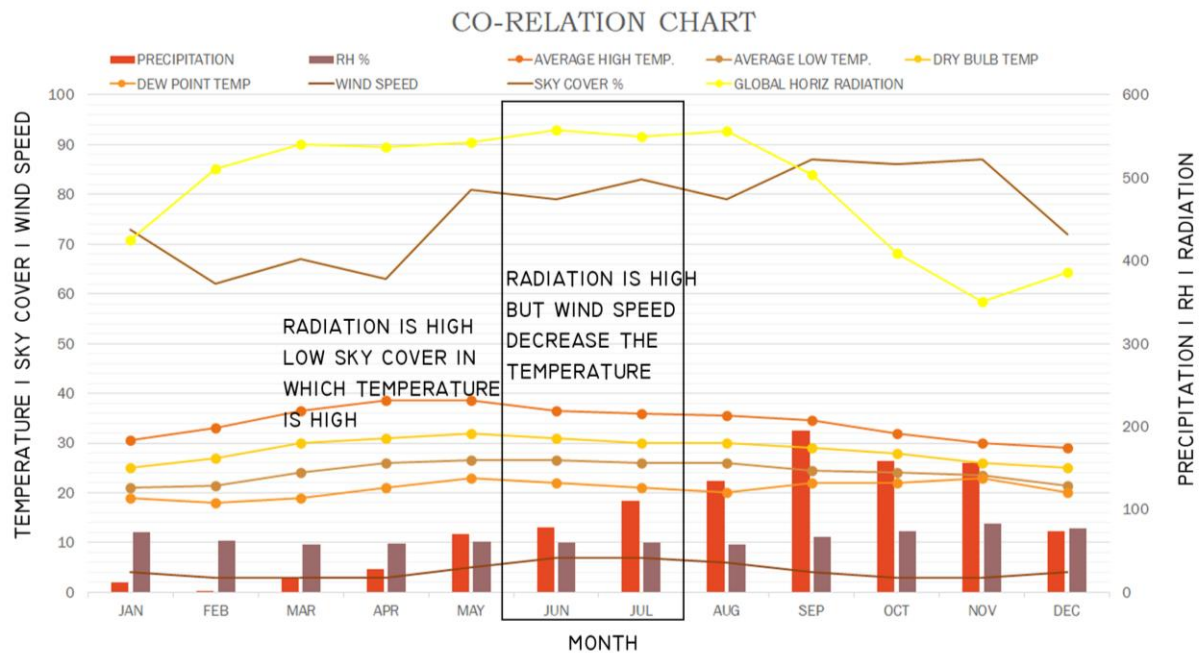
T

Can deplete the Farm Land when increase in price of real estate



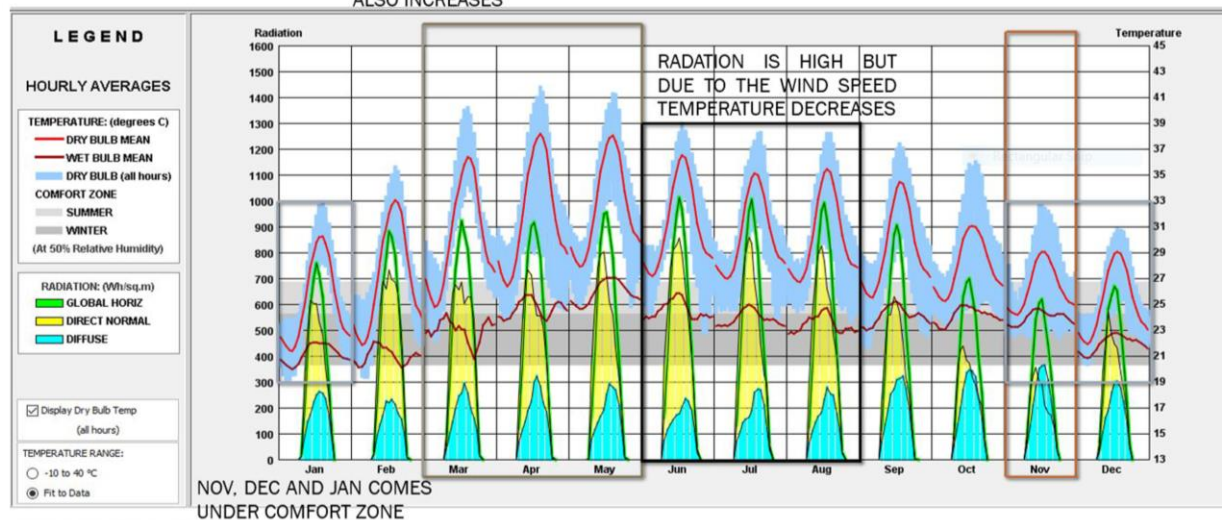


CLIMATE ANALYSIS

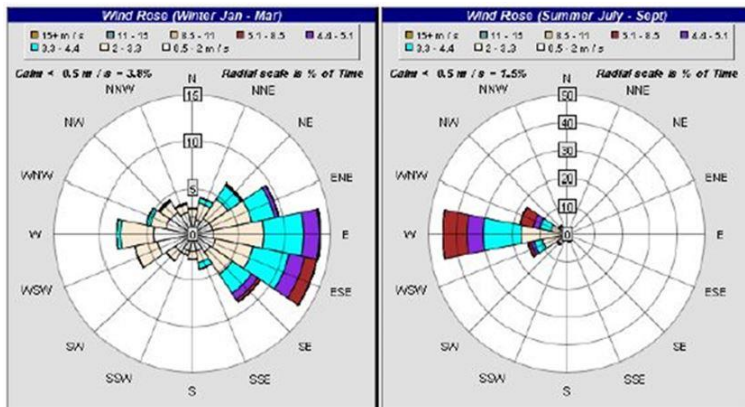
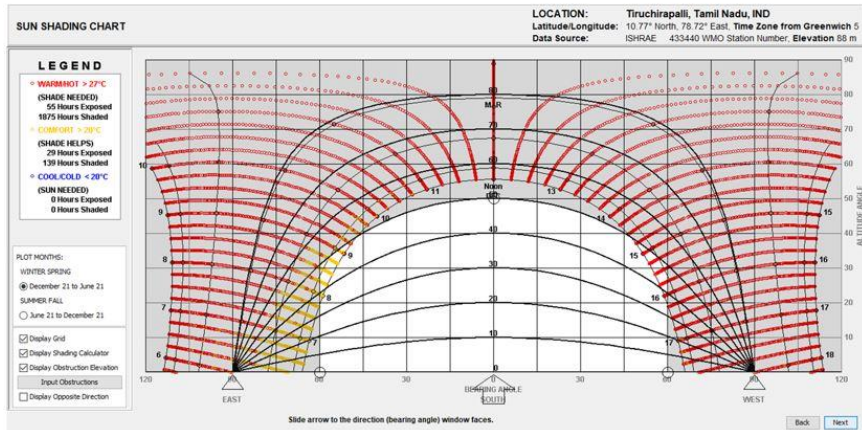
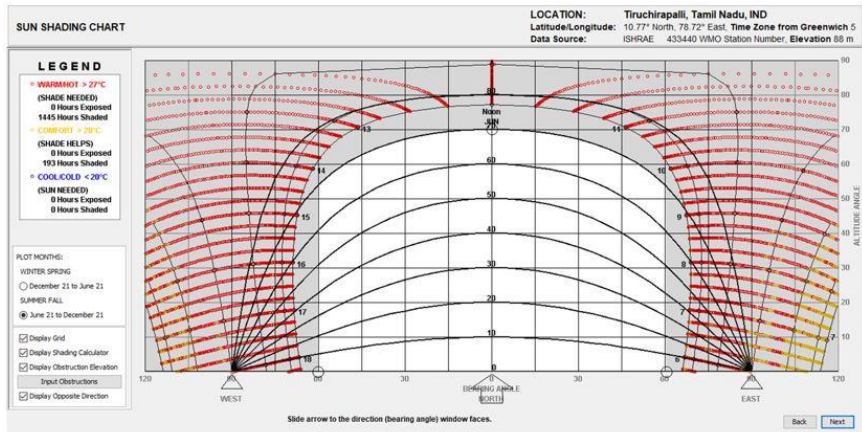


LOW SKY COVER INCREASES RADIATION IN WHICH, DRY AND WET BULB TEMPERATURE ALSO INCREASES

HIGH SKY COVER DECREASES RADIATION IN WHICH, TEMPERATURE ALSO DECREASES



COMFORT BAND: 20.5 - 27 °C



6. STANDARDS

S.no.	Description	All Areas	
A.	Min. Road Width	18m	
B.	Maximum FSI	3.25	
C.	Minimum Coverage	50%	
D.	Minimum setback all around	Height of the building above ground level	Minimum Required setback space from the property boundary
		Upto 30m	7m
		Above 30m	For every increase in height of 6m or part thereof above 30m minimum extent of setback space to be left additionally shall be one meter subject to the maximum setback of 20m.
E.	Spacing between blocks in case of more than one block of high rise building	Height of the building above ground level	Minimum required spacing between blocks
		Upto 30m	7m
		Above 30m	For increase in height of 6m. Or part thereof above 30m. Space to be left additionally shall be one meter subject to maximum setback of 20m.

Light Levels in Office building

General lighting only	Average level (lux)	At work station
Corridors, toilets, ancillary rooms	30	-
stairs	60	-
archives	120	250
Clerical work, post room, kitchen	250	500
Technical, drawing	600	1000
Laboratory		4000

Typical ventilation requirements

Fresh air m ³ /h/person	To VDI requirements	To ASHRAE guideline
10	Non-smoking; heating air when < 0C outside	Office space
10-27 20-30 26-34	Non-smoking	
30-40 34-51 51-68	smoking	Smoking exec. office

Minimum areas per person in Offices - 9.3 m² (excluding stairs and lavatories)

Sanitary appliances for any group of staff

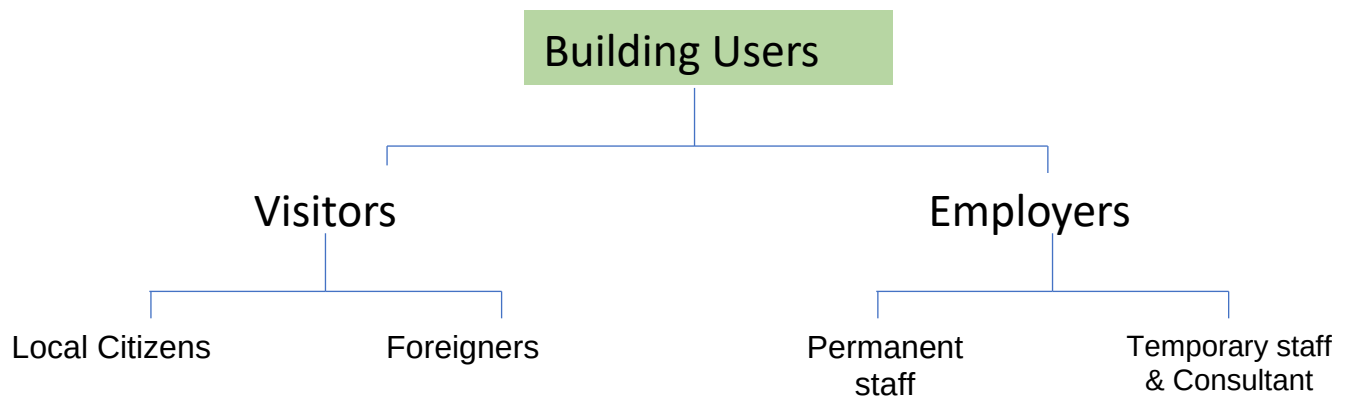
Number of persons at work	Number of WCs	Number of washing stations
1 to 5	1	1
6 to 25	2	2
26 to 50	3	3
51 to 75	4	4
76 to 100	5	5
Above 100	One additional WC and washing station for every unit or fraction of a unit of 25 persons	

Number of men at work	Number of WCs	Number of urinals
1 to 15	1	1
16 to 30	2	1
31 to 45	2	2
46 to 60	3	2
61 to 75	3	3
76 to 90	4	3
91 to 100	4	4
Above 100	One additional WC for every unit or fraction of a unit 50 men provided at least an equal number of additional urinals are provided	

If public also use staff toilets, add 1 to each number of conveniences above

Table 9-8 Maximum Allowed EPI Ratios for Buildings in Warm and Humid Climate

Building Type	Warm and Humid		
	ECBC	ECBC+	SuperECBC
Office (24Hours)	1	0.88	0.76

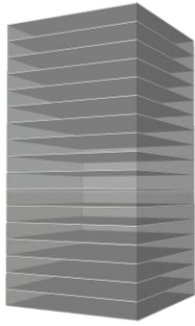


7. AREA STATEMENT

OFFICE BUILDING				
WORK STATION		SQ.M / PERSON	PERSON	AREA
	OFFICE EMPLOYEE	4.5	900	4050
	SECRETARY	6.7	20	134
	DEPARTMENTAL MANAGER	9.3	50	465
	DIRECTOR	13.4	5	67
	ASSISTANT VICE PRESIDENT	18.5	2	37
	VICE PRESIDENT	28	2	56
	ARCHIVE			450
TOILET				750
SERVICE AREA	STAIRCASE, LIFT	60		60
CONFERENCE ROOM		20	8	160
RESIDENCE				
	SERVICE APPARTMENT	10	45	450
	GUEST ROOM	10	100	1000

COMMERCIAL SPACE				
	SHOPS	5	30	150
	RESTAURANT	2	50	100
	LIBRARY	1	200	200
	FOOD COURT	1	200	200
	TOILET			
PARKING				
	CAR PARKING	220		4500
	TWO WHEELER	500		1600
	auditorium	2.3	300	690
	exhibition space			500
TOTAL				14429
CORRIDOR	30%			4328.7
	Total			19947.7

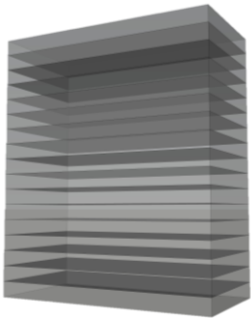
8. BUILDING FORM ANALYSIS



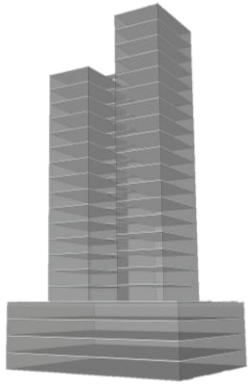
397.25kWh/sq.m Square



344.12 kWh/sq.m Circle



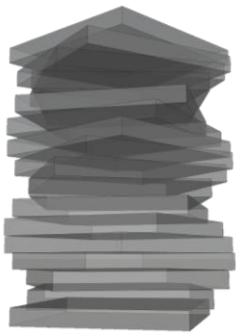
390.60 kWh/sq.m Rectangle



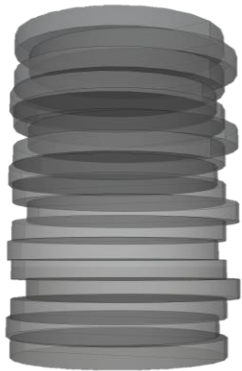
382.79 kWh/sq.m Two Tower



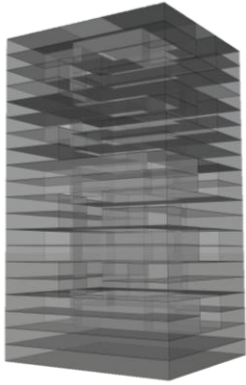
380.20 kWh/sq.m Triangle



390.30 kWh/sq.m Square Tilted



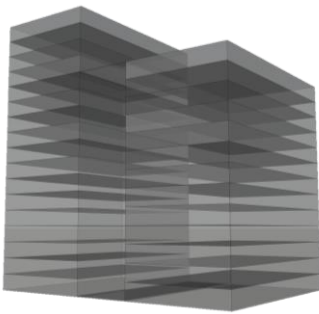
370.50 kWh/sq.m Circle projected



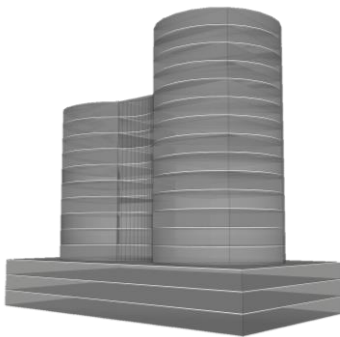
378.35 kWh/sq.m Square with atrium



395.55 kWh/sq.m Triangle with atrium

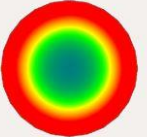
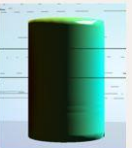
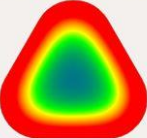
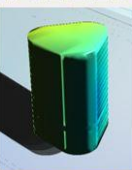
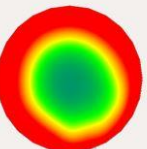
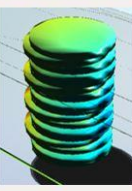
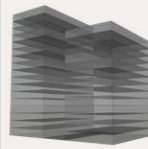
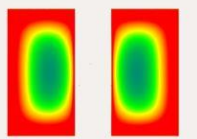
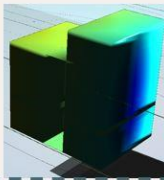
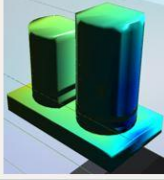


375.79 kWh/sq.m Two Tower



370.60 kWh/sq.m

8.1 INFERENCE

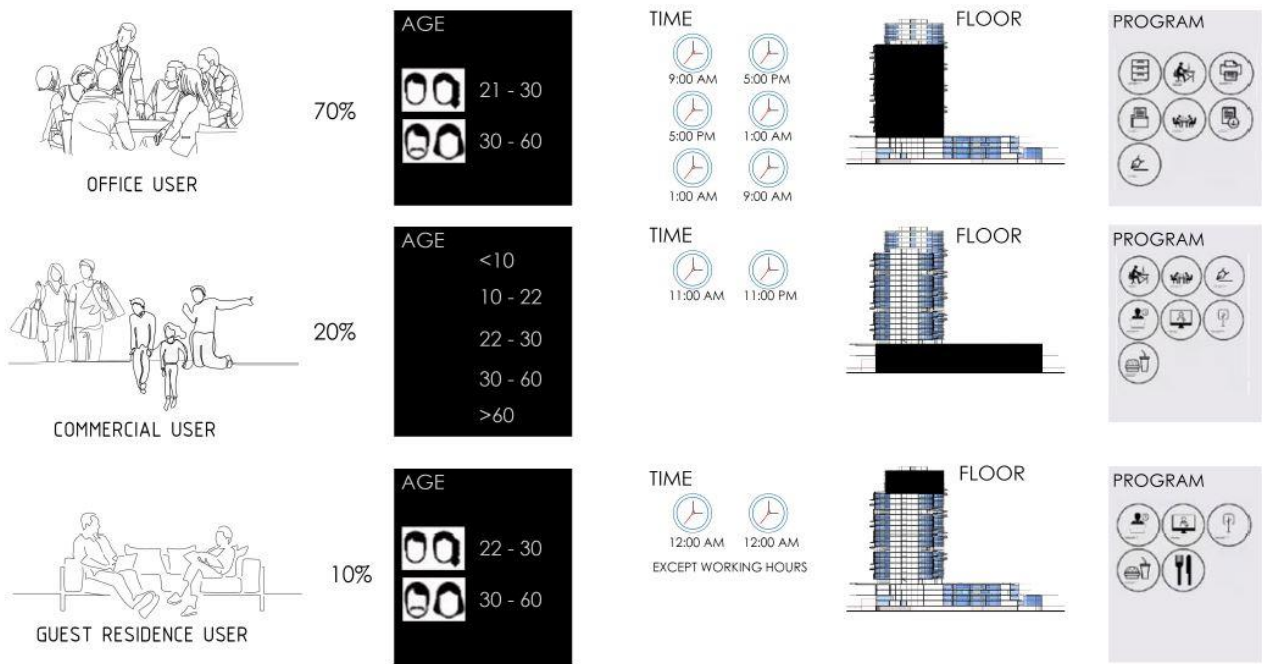
ALTERNATION	SOLAR RADIATION (WH/SQ.M)	DAYLIGHT ANALYSIS LUX	ENERGY PER TOTAL BUILDING AREA [kWh/sq.m]	WIND FLOW VELOCITY (M/S)	INFERENCE
	East - 1021 West - 550 North - 393 South - 615		344.12		Lack of lighting in the centre core. Solar radiation is comparatively Low. Wind flow is obtained in all sides, which reduces the temperature in building envelope.
	East - 938 West - 553 North - 446 South - 700		380.20		Lack of lighting in the centre core. Solar radiation is comparatively Low. Wind flow is not obtained in very less spaces, which reduces the temperature in building envelope.
	East - 976 West - 435 North - 380 South - 500		370.50		Lack of lighting in the centre core. Solar radiation is comparatively Low. Wind flow is not obtained in all sides, which reduces the temperature in building envelope.
	East - 1131 West - 565 North - 426 South - 700		375.79		Lack of lighting in the centre core. Solar radiation is comparatively Low. Wind flow is not obtained in all sides, most of spaces don't have ventilation.
	East - 1122 West - 575 North - 410 South - 664		370.60		Lighting is obtained in the centre core. Solar radiation is comparatively Low. Wind flow is not obtained in all sides.

1 OPTION

3 OPTION

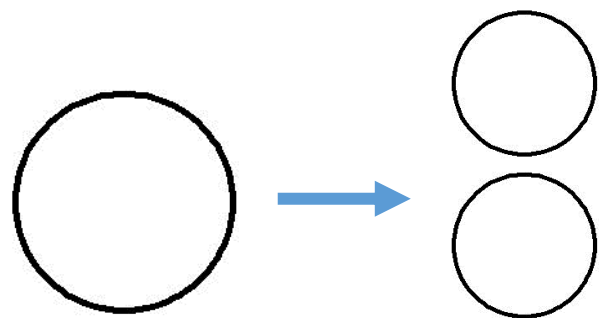
2 OPTION

USER ANALYSIS

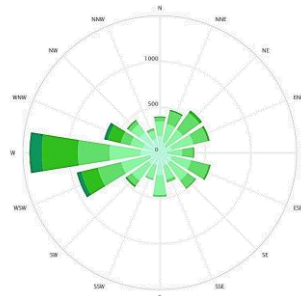
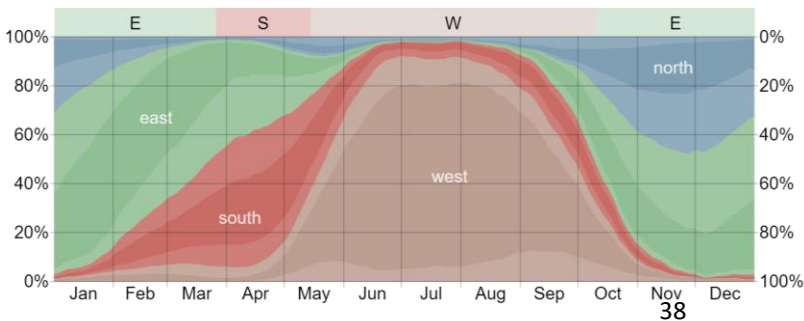


9. CONCEPT – DESIGN EVOLUTION

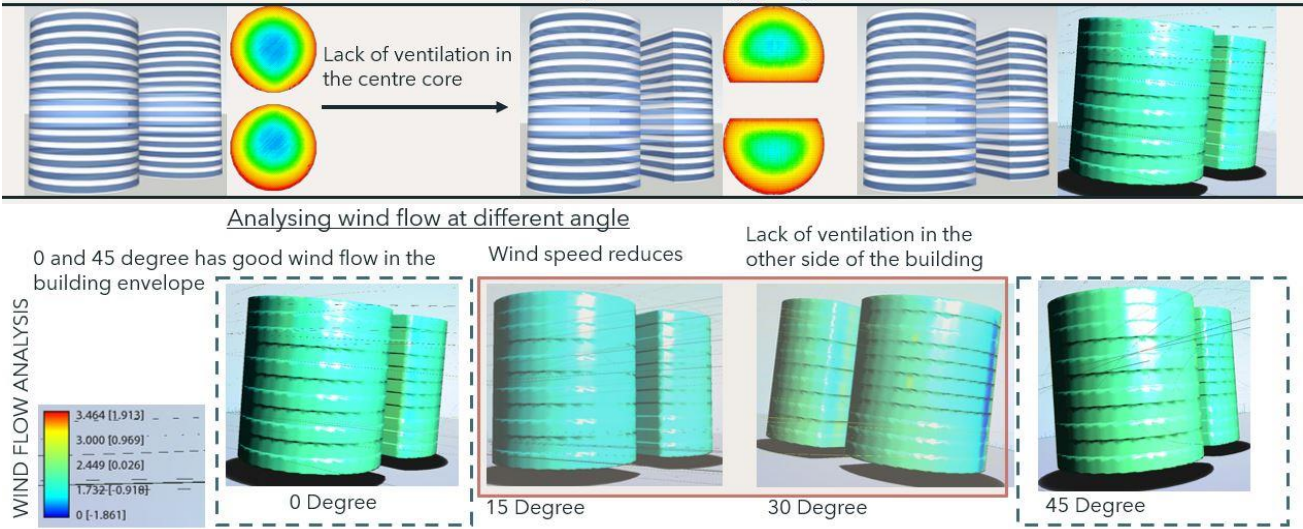
9.1 OFFICE



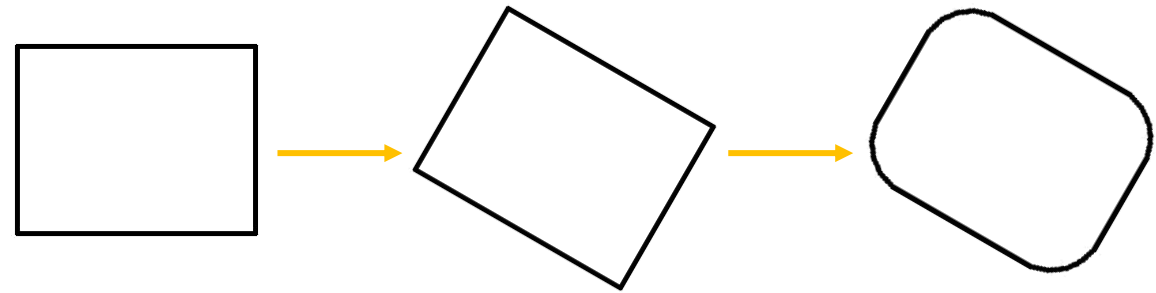
Lack of ventilation in the centre core,
To increase daylight into the building

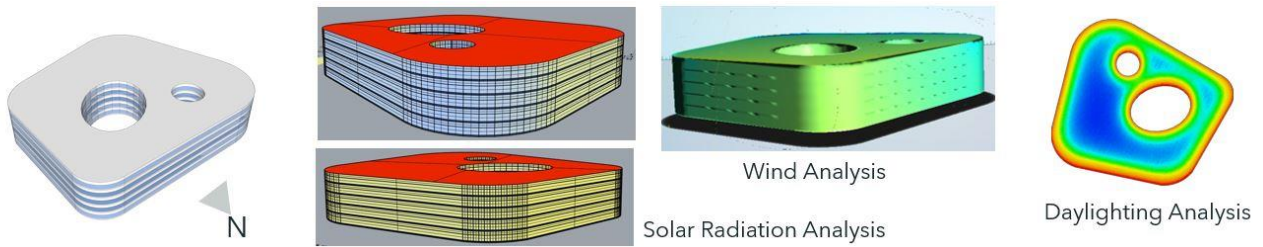
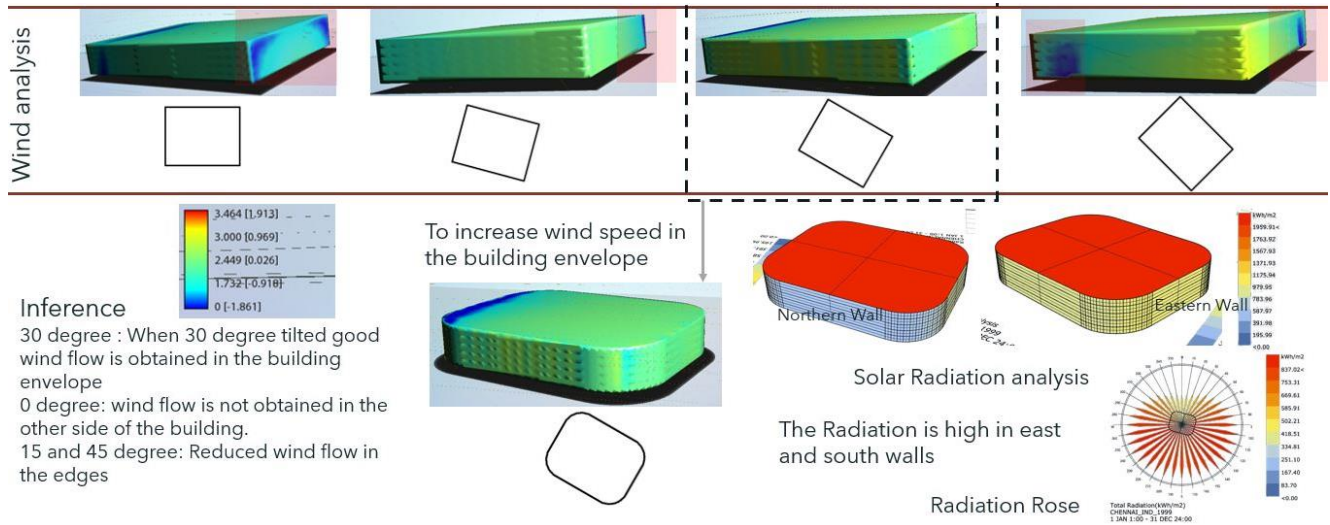


WIND DIRECTION AND SPEED



9.2 RETAIL

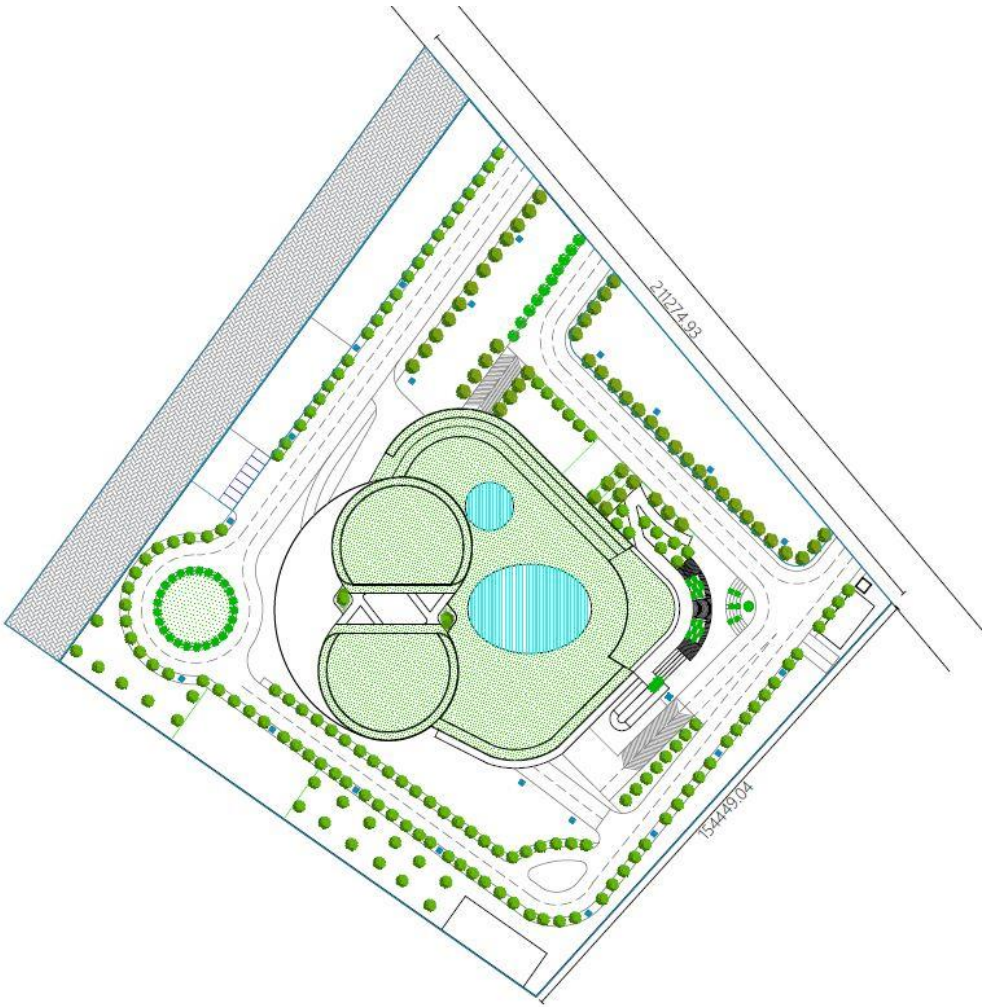




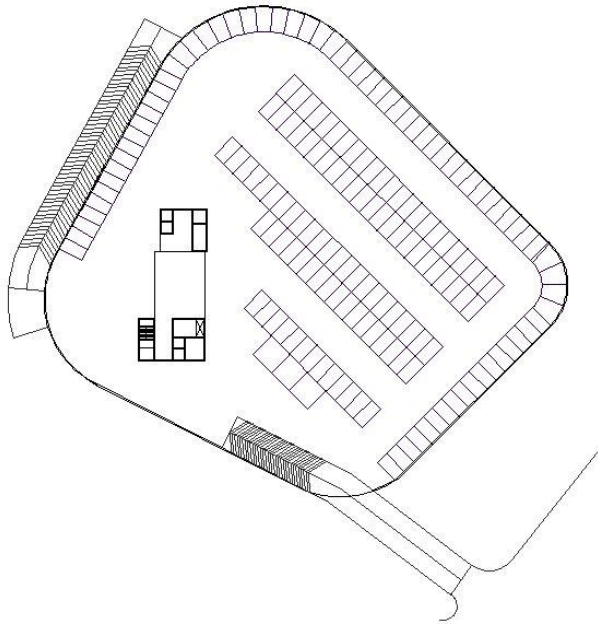
9.3 BUILDING FORM



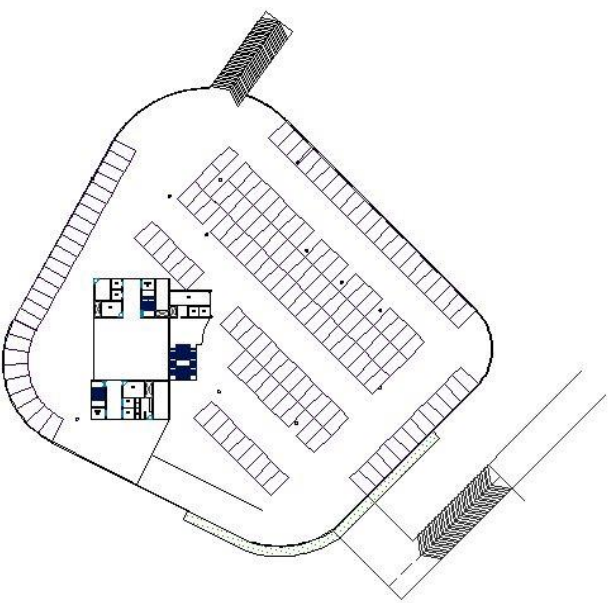
10. DESIGN



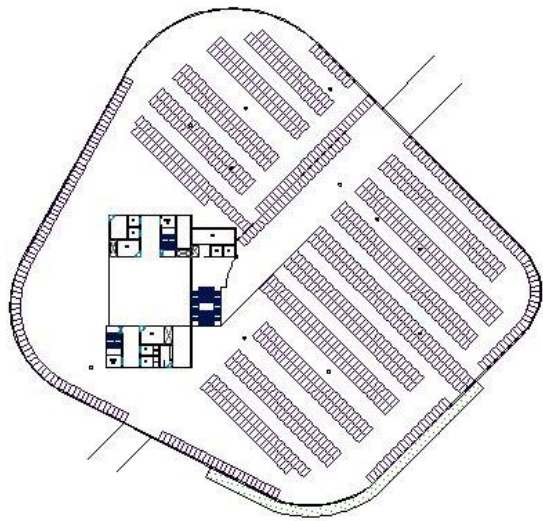
SITE PLAN



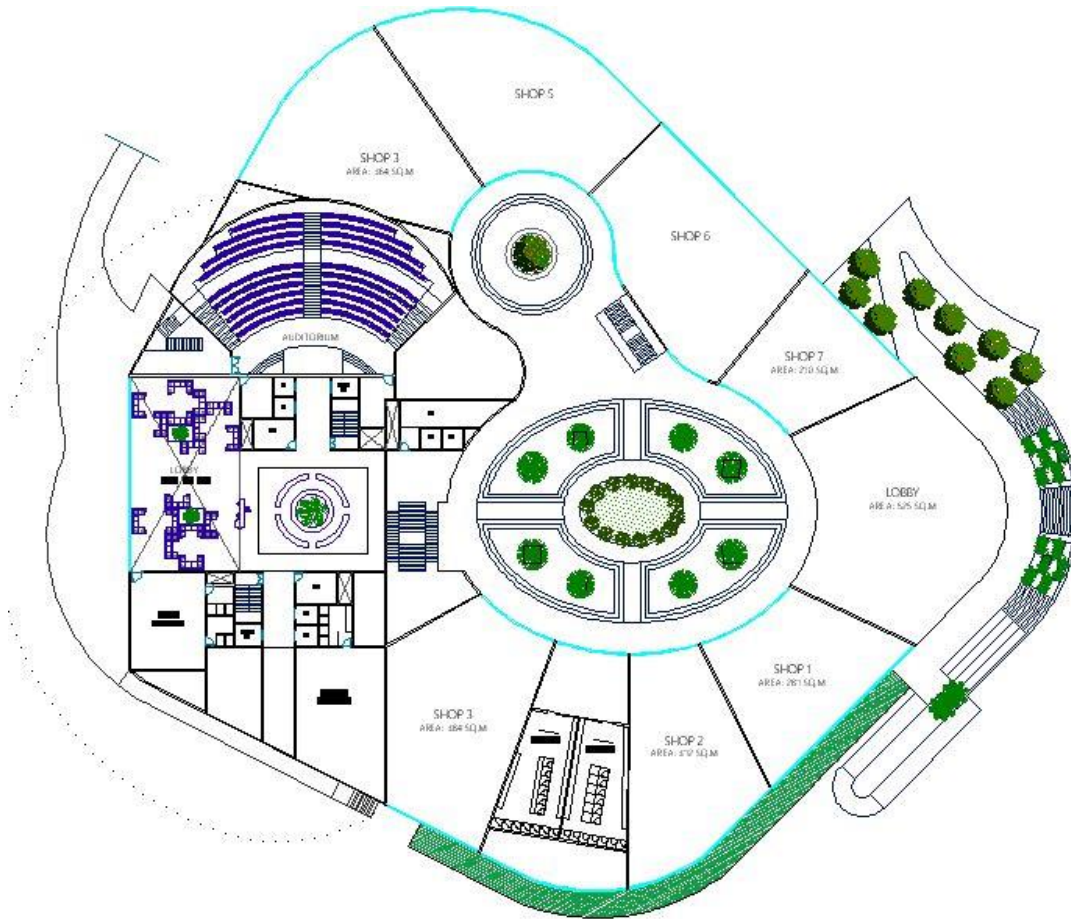
BASEMENT 2



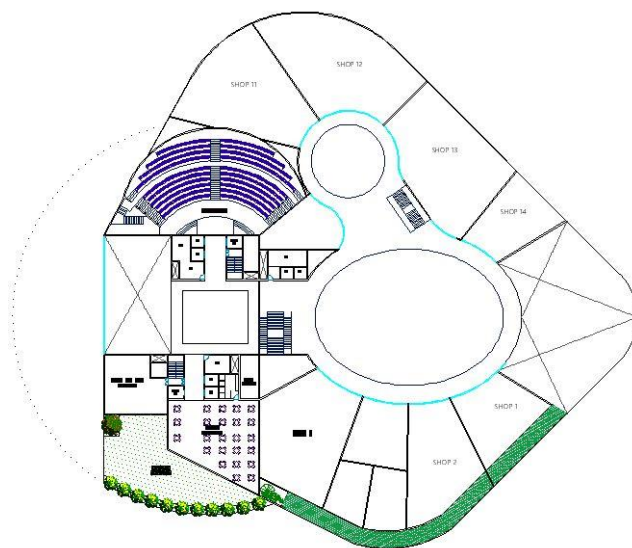
BASEMENT 1



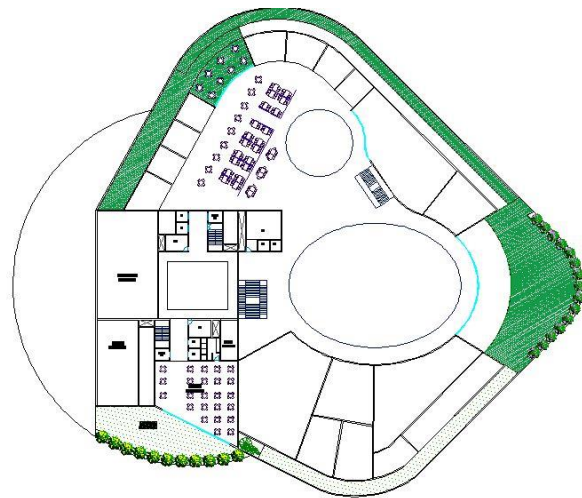
SLIT FLOOR PLAN



FIRST FLOOR PLAN



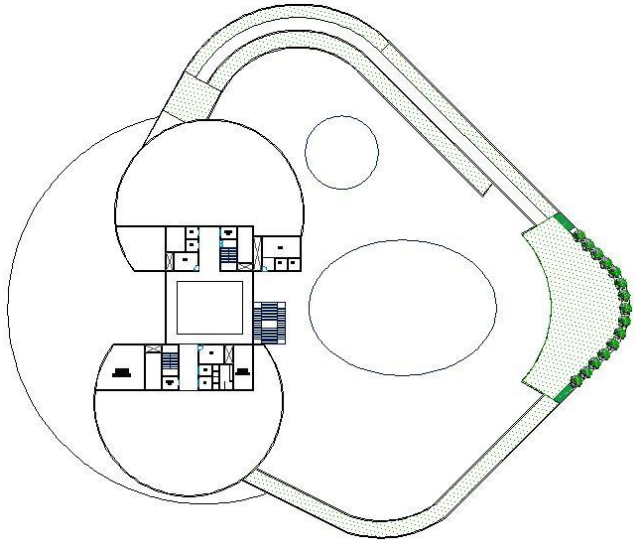
SECOND FLOOR PLAN



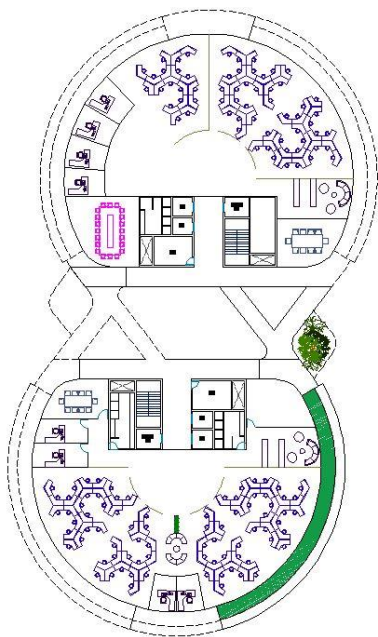
THIRD FLOOR PLAN



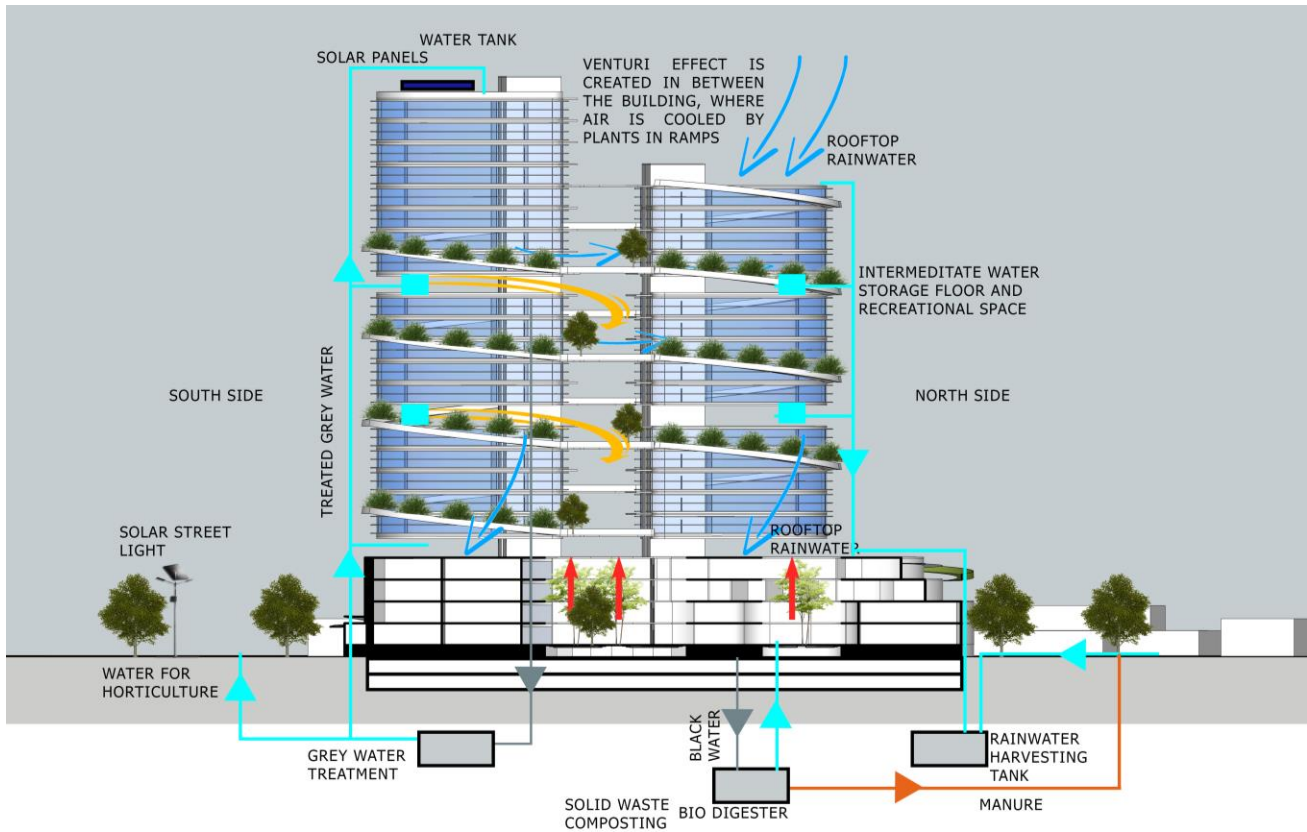
FOURTH FLOOR PLAN



RETAIL ROOF PLAN

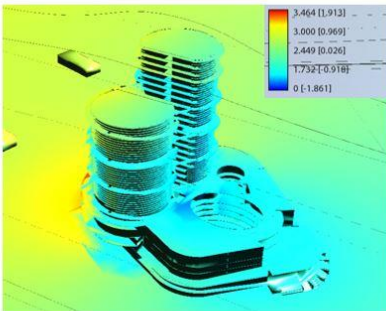


OFFICE TYPICAL FLOOR PLAN



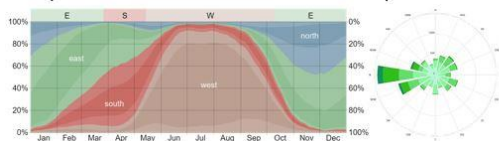
10.2 ANALYSIS

Wind Flow Analysis

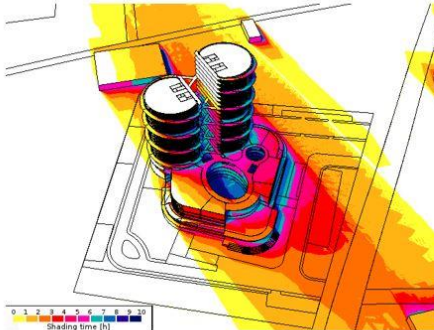


Predominant wind - West direction

Wind Flow (2m/s) is received through of the building as the two tower creates the venturi effect which covers the other part of the building. Atrium in the retail space circulated the air in to the spaces.



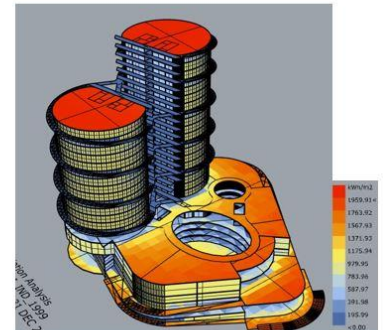
Shadow Analysis



March 21 (10 00am - 6 00pm)

Roof of retail shop is mostly shaded in the evening in the twin towers, which create as the leisure space for people and also reduces the radiation, the space between two blocks also the wind and also allows the lighting to the retail shop.

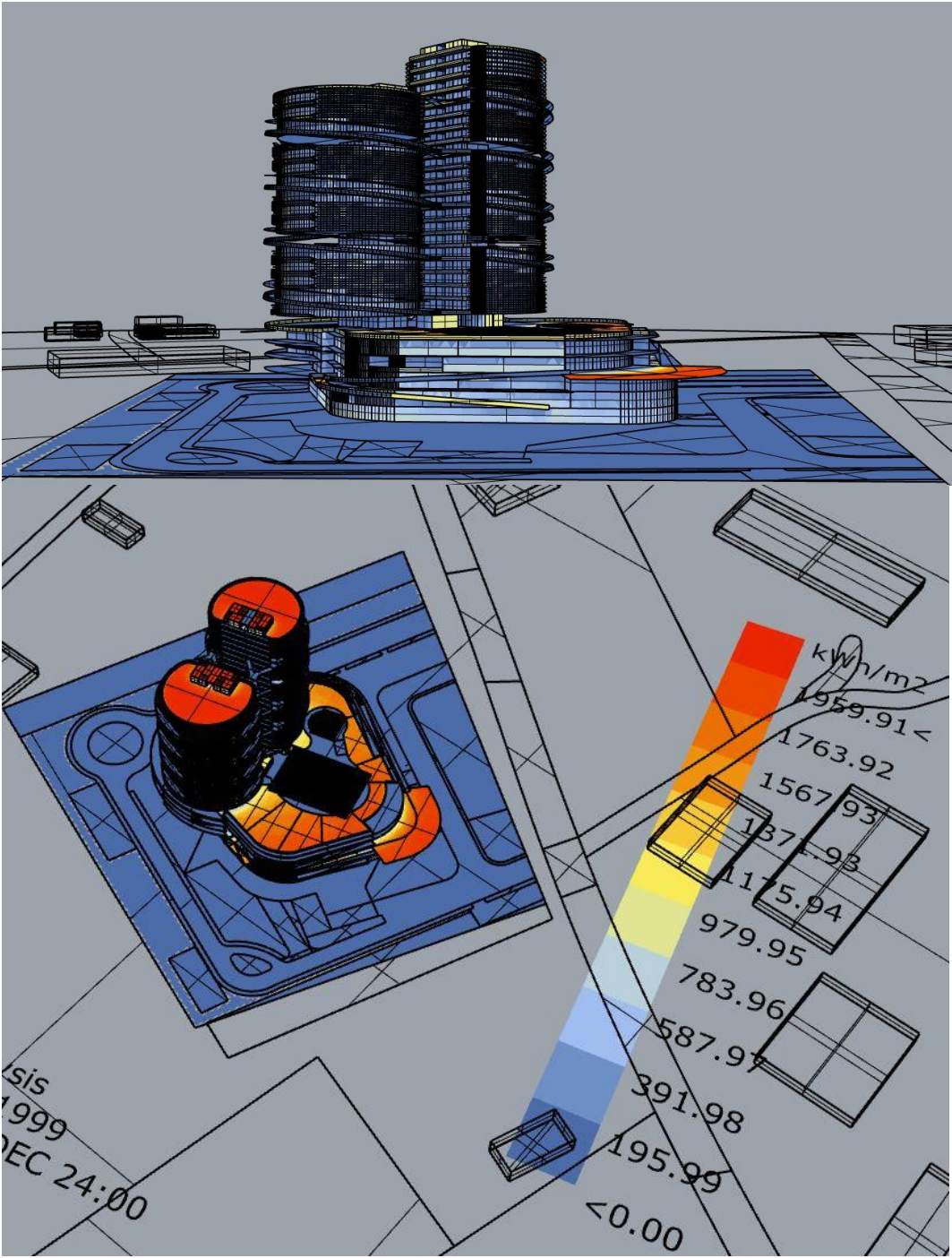
Solar Radiation Analysis



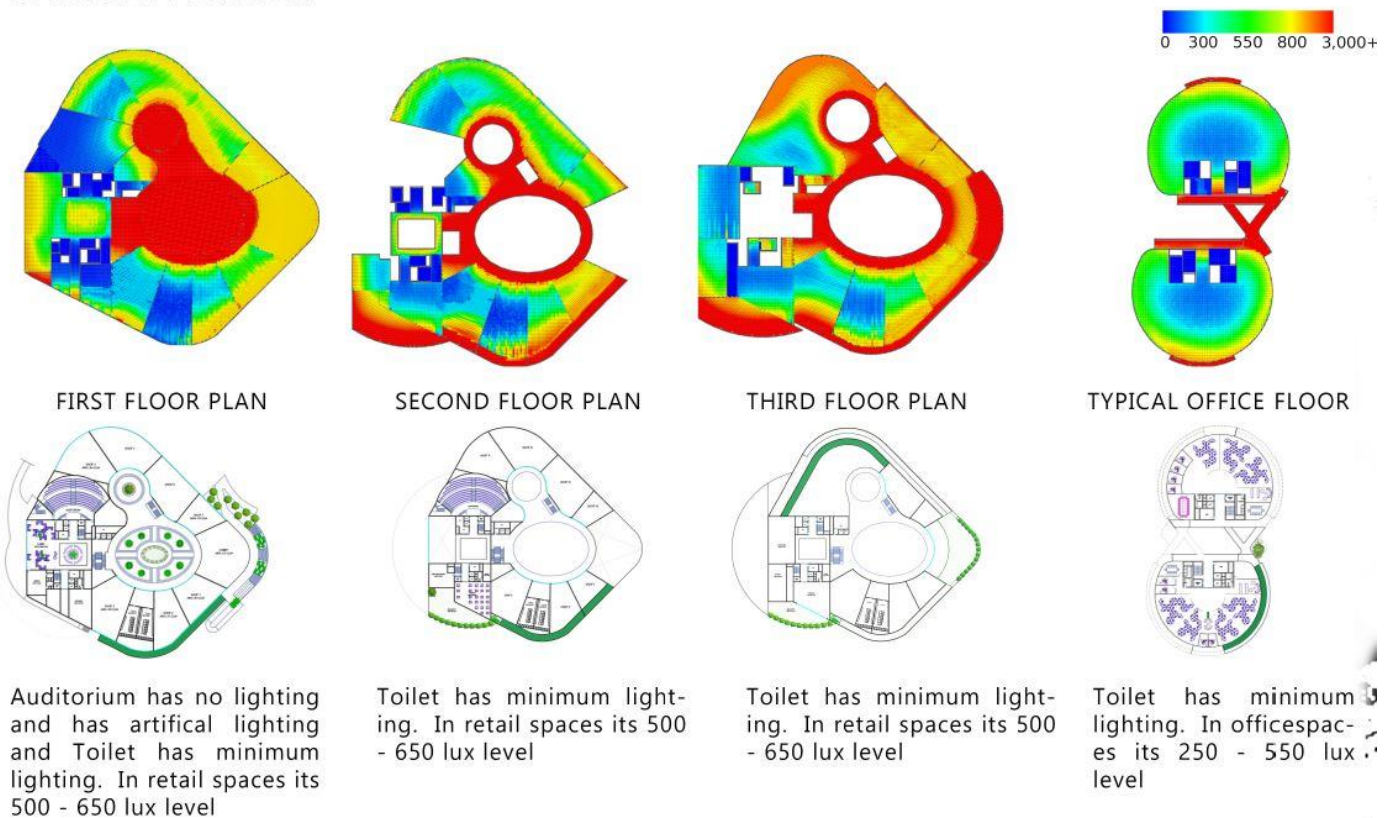
Annual Radiation

Roof receives the high radiation which will be covered with green roof. Office Block Reduces the radiation to the retail shop. But does not stop lighting into the building. Office spaces receives high radiation in east and west side.

SOLAR RADIATION ANALYSIS

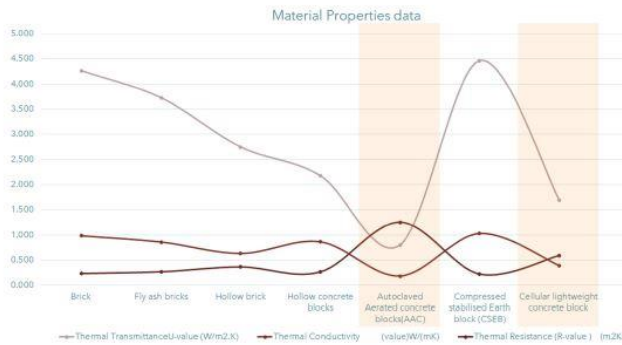


DAYLIGHT ANALYSIS



11.MATERIALS

WALL BRICK, FLY ASH BRICKS, HOLLOW BRICKS, HOLLOW CONCRETE BLOCKS, AAC BLOCKS, CLC BLOCKS



Material	Thickness	Thermal conductivity [W/(m.K)]	Thermal Resistance [W/(m.K)]	Thermal Transmittance U-value [W/m ² .K]	Density (kg/m ³)	Specific heat (kJ/kg.K)
Brick	0.23	0.72	0.639	1.565	1920	0.8
Fly ash bricks	0.23	0.63	0.365	2.739	1600	0.93
Hollow brick	0.23	0.631	0.365	2.743	1520	0.65
Hollow concrete blocks	0.23	0.86	0.267	3.739	930	0.84
Autoclaved Aerated concrete blocks (AAC)	0.23	0.184	1.25	0.8	642	0.79
Compressed stabilised Earth block (CSEB)	0.23	0.84	0.274	3.652	1700	0.94
Cellular lightweight concrete block	0.23	0.39	0.590	1.696	1200	1.13

GLAZING

Double Glazing Units

CLIMAPLUS[®] DOUBLE GLAZING UNITS

Values given according to the standards
*EN 410, *EN 673 and *EN ISO 140-3/717-1

coating	color in reflection	light transmission LT [%]	solar factor g-value ^a	shading coefficient SC	selectivity LT / g	reflection outside LRe [%]	reflection inside LRI [%]	Ug-value [W/m ² .K]	weight [kg/m ²]	assessed sound reduction index R _w ,P [C, C17] [dB]	use as mono glazing (coating on surface #2)	processing possibilities
to be tempered / annealed												
COOL-LITE [®] XTREME 50/22 II with EASYPRO	neutral	47	0.21	0.24	2.24	16	18	1.0	25.0	35(-/-5)		tempering
												lamination tested towards PVG ^b
												bending ^a
												screenprinting & enamelling ^a
												yes

TRIPLE Glazing Units

COOL-LITE [®] STB 136	blue	30	0.24	0.27	1.25	19	19	0.7	35.0	36(-/-5)	yes	temperable	yes	yes
--------------------------------	------	----	------	------	------	----	----	-----	------	----------	-----	------------	-----	-----

ROOF

GREEN ROOF

Autoclaved lightweight concrete (120) – 0.130(W/sqm. K)

Extruded polystyrene(100) – 0.06

Cement Mortar (20) – 0.930

Waterproof material (5.00) – 0.930

U Value – 0.14 W/(sqm.k)

Floor

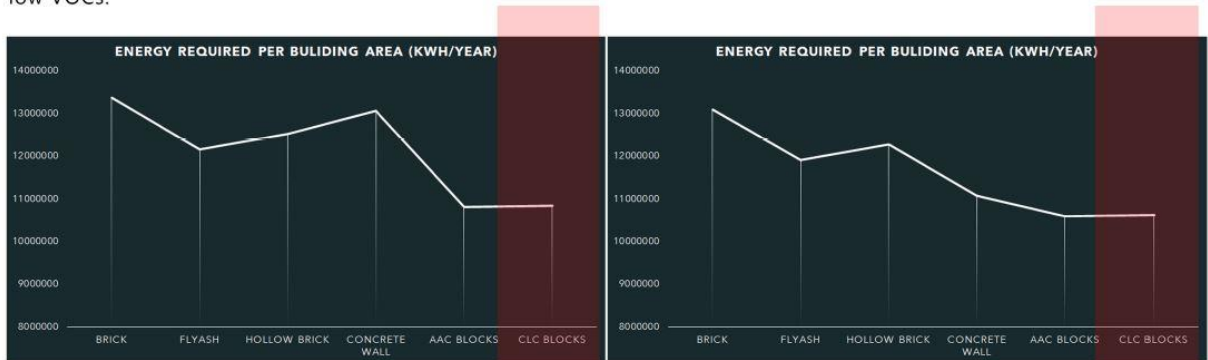
Bio based Tile – Resilient flooring, durability, strength, design versatility, affordability. Its eco-friendly perks include 40% pre-consumer recycled content, a low-carbon footprint and low VOCs.

Road

Recycled plastic road

GRASSHOPPER HONEYBEE
ENERGY REQUIRED [KWH/YEAR]

MATERIAL	DOUBLE GLAZING	TRIPLE GLAZING (E&W)	MEAN WEIGHT
BRICK	1336304.8	1309578.8	6.51
FLYASH	1215437.2	1191128.5	5
HOLLOW BRICK	1251523.2	1226492.8	3.53
CONCRETE WALL	1305650.1	1107953.7	5.47
AAC BLOCKS	1081377.9	1059750.4	2.23
CLC BLOCKS	1083733.5	1062058.9	1.58



VARIOUS TYPES OF WALL WITH DOUBLE GLAZING

VARIOUS TYPES OF WALL WITH DOUBLE GLAZING AND TRIPLE GLAZING IN EAST AND WEST

12. NATIVE PLANTS

INTERIOR PLANTS
(AIR PURIFIER) AND (DEHUMIDIFIER)



Pothos
Epipremnum aureum



Bamboo Palm
Chamaedorea seifrizii



Dragon Tree
Dracaena marginata



Aloe vera
Aloe barbadensis Miller



Peace Lily



Boston Fern

NATIVE PLANTS



Indian gooseberry



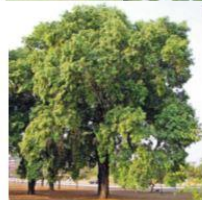
Azadirachta indica, neem tree



Ficus benghalensis, Banyan tree



Ficus carcia (fig)



Syzygium cumini
(Malabar plum, Java plum)



Bougainvillea glabra
(Paper Rose)



Aegle marmelos (Indian bael)



Acanthaceae (Sea holly)

13. WATER CONSERVATION

WATER CONSERVATION

Rainwater Harvesting, Roof & Non-roof

SITE: 35761.79 SQ.M

OSR: 3933.3SQ.M

BUILT-UP AREA: 8147.75SQ.M

SITE - OSR: 31828.49SQ.M

On Ground Vegetation Area: 14230 sq.m

Vegetation on over built structures: 7847 sq.m + 1328 sq.m

Road – 7450 sq.m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	10.5mm	8.4mm	10.4mm	26.4mm	54.2mm	60.0mm	72.8mm	95.7mm	114.6mm	142.6mm	141.4mm	57.2mm

Runoff volume = Surface area x Runoff Coefficient x Rainfall.
Total Runoff Volume = 98600(Road) + 23088(ground vegetation) + 26070(built-up) + 16000(hardscape)=166478 liters

8160 liters from office space (will be stored in intermediate two floors)

60 pits – Each of 2500 litres

WATER REQUIRED

Office– 1700 X 45 = 76500 litres

Retail– 1100 X 5 + 100 X 45 = 10000 litres

Water Required per day= 86500 litres

Enhance efficiency of plumbing fixtures, thereby minimising potable water use.

No Water Tank Toilet



A Waterless Urinal



MONTH	RAINFALL (MM)	RAINFALL PER DAY (12% OF MONTH) LITRES	WATER THROUGH RAINWATER (MONTH)	WATER REQUIRED PER MONTH
JAN	10.5	12485	104,041	2681500
FEB	8.4	10404	86700	2422000
MAR	10.4	12485	104041	2681500
APR	26.4	32962	274683	2595000
MAY	54.2	67673	563941	2681500
JUN	60	74915	624291	2595000
JUL	72.8	90896	757466	2681500
AUG	95.7	119489	995741	2681500
SEP	114.6	143087	1192391	2595000
OCT	142.6	166509	1387575	2681500
NOV	141.4	166478	1387316	2595000
DEC	57.2	71419	595158	2681500

WATER REQUIRED

Water Required per day= 86500 litres

Water Required per day – 86500 litres

Lowest saving month – feb – 83203 litres

Highest saving Month – oct – 41739.5 litres

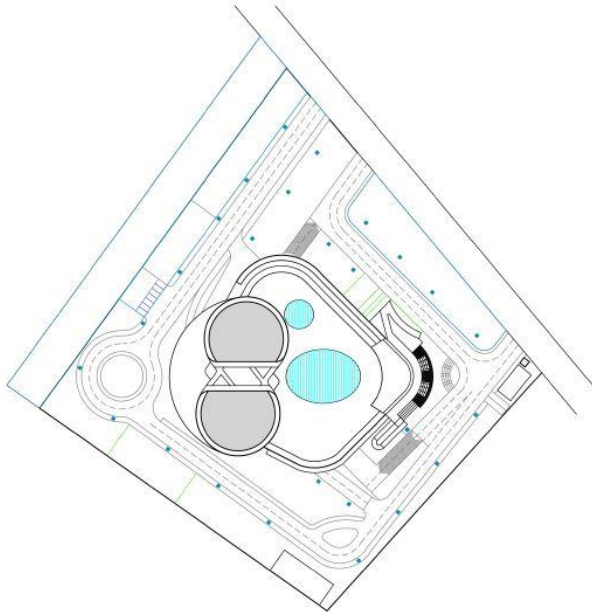


Low Flow Water Efficient Tap water savers

PV PANEL CALCULATON

PV panel Calculation

ENERGY REQUIRED 1062058 KWH/YEAR



35% OF ENERGY IS PRODUCED FROM SOLAR PANELS

5/6/22, 5:32 AM



Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lower performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at <https://sam.nrel.gov>) that allow for more precise and complete modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to the NREL report: The Time Report.

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The energy output range is based on analysis of 30 years of historical weather data, and is intended to provide an indication of the possible interannual variability in generation for a fixed (open rack) PV system at this location.

PVWatts Calculator

RESULTS

366,204 kWh/Year*

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)
January	6.42	36,967
February	6.79	34,350
March	7.07	39,039
April	6.55	34,764
May	5.44	30,664
June	5.11	28,430
July	4.85	28,300
August	4.01	23,260
September	4.92	27,781
October	5.08	29,378
November	4.62	26,479
December	4.53	26,793

Annual 5.45 366,205

Location and Station Identification

Requested Location	vellore
Weather Data Source	Lat, Lng: 12.93, 79.14 1.0 mi
Latitude	12.93° N
Longitude	79.14° E

PV System Specifications

DC System Size	256.2 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Performance Metrics

Capacity Factor	16.3%
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