

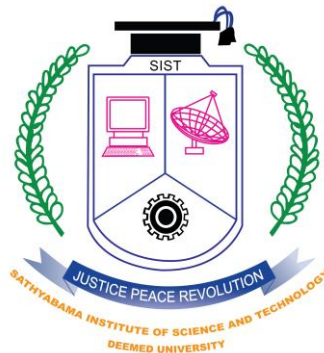
'THE IMPACT OF SHADING DEVICE ON ENERGY CONSUMPTION BY REDESIGNING AN OFFICE BUILDING

A Thesis

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

By

MANJULA S (39890011)



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

SATHYABAMA

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

Accredited with Grade "A" by NAAC

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MAY 2021



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DEPARTMENT OF ARCHITECTURE

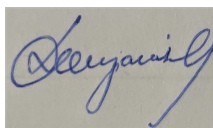
BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **MANJULA S(39890011)** who carried out the Thesis entitled "**THE IMPACT OF SHADING DEVICE ON ENERGY CONSUMPTION BY REDESIGNING AN OFFICE BUILDING**" under our supervision from January 2021 to May 2021.

Internal guide
(Ar. EBIN)


Internal Panel Member
(Ar. SHEETAL AMRAOTKAR)

External guide
(Ar. GANESH)



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Dean, School of Building and Environment
Department of Architecture

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

MANJULA S hereby declare that the Thesis Report entitled “**THE IMPACT OF SHADING DEVICE ON ENERGY CONSUMPTION BY REDEIGNING A OFFICE BUILDING**” done by me under the guidance of **Ar. EBIN** (Internal) and **Ar. GANESH, 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

ACKNOWLEDGEMENT

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

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

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

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

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

With the on going trend, Every buildings came up with **large windows glazing and inappropriate shading device**. But they have **failed** to cope up with the external conditions which lead to **ingress of solar heat**, causing **discomfort** it to the occupant. Commercial Building space accounts for **33%** of the total built space and increasing at a rate of **8-10%** annually. The average annual electricity consumption for space conditioning and lighting in **India** is around **80 KWh/m²** and **160 KWh/m²**.

1.2 AIM

1.3 The study is aimed at analyzing the energy performance of an existing office building and redesigning it to maximize energy saving through optimized shading device

1.4 OBJECTIVE

- 2 The main objective is to determine the optimum external shading device to reduce energy consumption
- 3 And to compare the effectiveness of the shading device and its thermal performance of a building

3.1 LIMITATIONS FOR THE STUDY

- 4 Understanding the different aspect of designing office building with respect to the site
- 5 Redesigning a existing office building into a less energy consumption building by integrating passive strategies and various shading device and renewable energy system
- 6 STANDARDS Office building codes and norms from-NBC AND ECBC guidelines

6.1 RESEARCH QUESTIONS

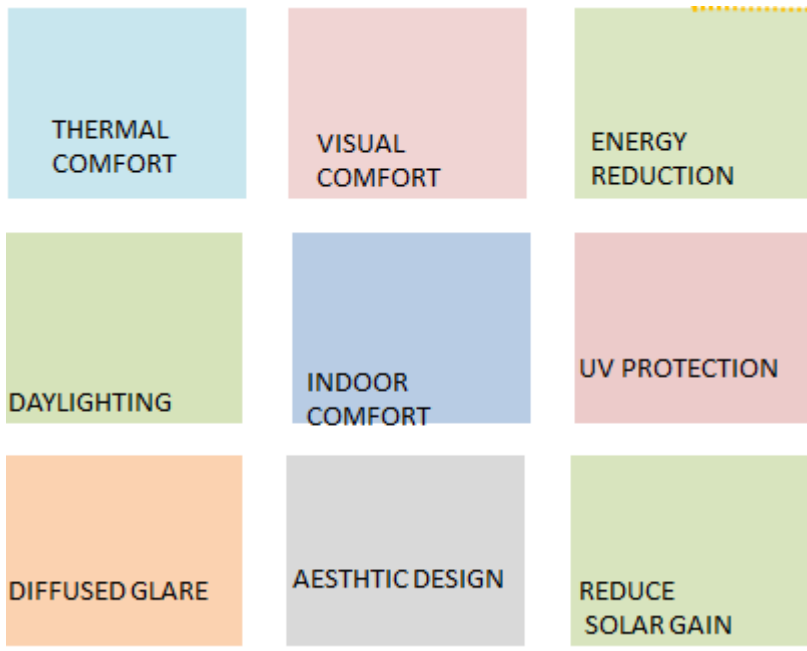
1. HOW SHAING DEVICE AFFECTS THE ENERGY
2. HOW GLAZING AFFECTS ON ENERGY CONSUMPTION

7 LITERATURE REVIEW

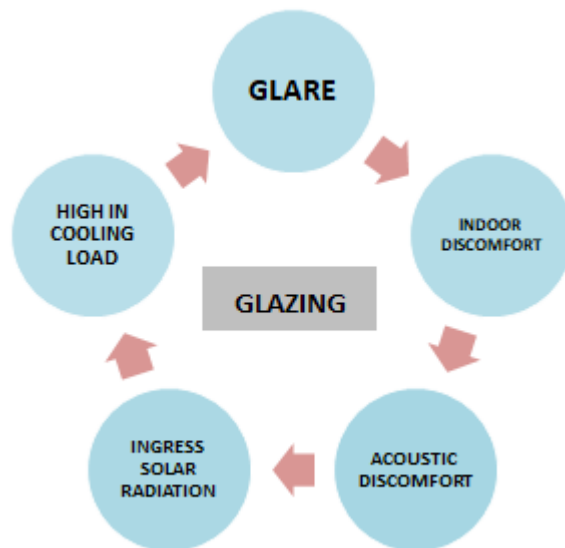
2.1 The study aims to critically analyze the various shading devices and their associated parameters

THE ROLE OF SHADING DEVICE

EFFICIENCY OF SHADING DEVICE



2.2 THE PROBLEM OF HIGHLY GLAZED BUILDING

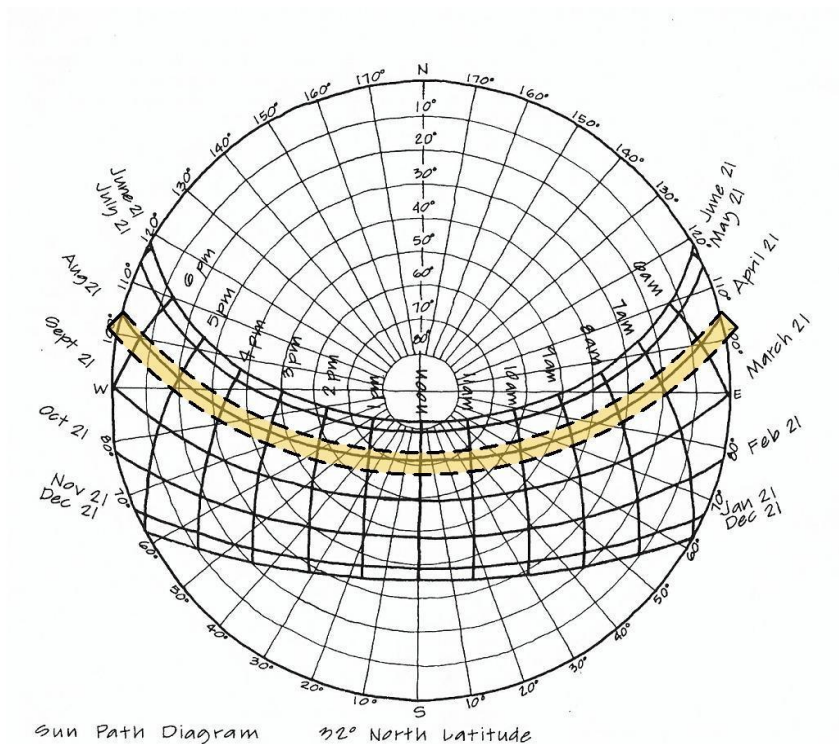


2.3

Solar Study

Solar paths differ seasonally: in winter, the sun rises from the east and sets on the west, while in summer the sun rises from the north-east and

sets on the north-west. In the Northern Hemisphere, the sun's movement is described by solstices and equinoxes. Solstices are the period of a year when the sun reaches either its highest or lowest point in the sky at noon. June 21 and December 22 are the two different solstices that respectively mark the highest and lowest point for the sun in the northern hemisphere; these days are also called summer solstice and winter solstice respectively.



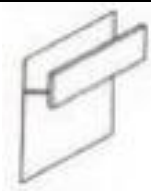
Shading Devices Shading devices have been prominent elements in architecture. Historically, porticos, colonnades, and overhangs have been used in different shapes and sizes as shading elements in buildings during different eras of architecture. Frank Lloyd Wright used shading strategies in the form of overhangs to shade, create thermal comfort and make an “aesthetic statement” (Lechner, 2014). Le Corbusier’s architecture highlighted the use of the “brise-soleil”, which means “sun breaker”, as a fixed structural sunshade.

Shading devices Buildings around the world require a large amount of energy for cooling, heating and lighting. Lighting in office buildings alone accounts for around 20–40% of total energy used in the buildings

Fixed Shading Devices Fixed shading devices can be horizontal, vertical, or a combination of both, commonly called an “egg crate.” Horizontal shading devices are effective on the equatorial facing façades when the sun altitude is high and are suitable for the summer months. Vertical shading devices are preferred in the east and the west directions where the solar altitude is low and the entire window faces the sun.

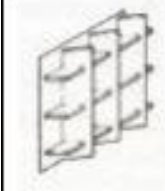
External shading devices decrease solar heat gain by as much as 80% (Handbook, 2009). A very deep horizontal overhang tends to trap hot air and can also be loaded with snow, while overhangs with smaller horizontal louvers in the horizontal plane can solve those problems. Vertical fins are recommended on the polar side in very hot places because the sun rises on the north-east and sets on the north west in the northern hemisphere during the summer months. Yet vertical fins, vertical slanted fins, and egg-carets are problematic because they obstruct view although eggcrate can be successful in hotter climates because they require less depth, and the higher global illuminance of lower latitudes can still admit adequate light through an eggcrate. The positioning and inclination of shading can be determined by accounting for the angle of solar 21 incidence on the window during winter, window height and length, and height above the window

Shading types	Description	Recommended Direction	Pros and Cons
	Overhang horizontal panel	South, east, west	Traps hot air, Can be loaded by snow and wind

	Overhand horizontal louvers in horizontal plane	South, east, west	Free air movement, snow or wind load is small,
	Overhang horizontal louvers in vertical plane	South, east, west	Reduces length of overhang, View restricted and available in miniature louvers
	Overhang Vertical Panel	South, east, west	Free air movement, No snow load, View restricted

EXTERNAL DEVICE

	Vertical fins	East, west, north R	restricted view; for north facades in hot climates only
	Vertical fin slanted	East, west	Slant toward north, restricts view significantly

	Eggcrate	East, west	For very hot climates, view restricted and traps hot air
	Eggcrate with slanted fins	East, west Slant towards north.	View restricted, traps hot air and also for very hot climate.

LITERATURE REVIEW

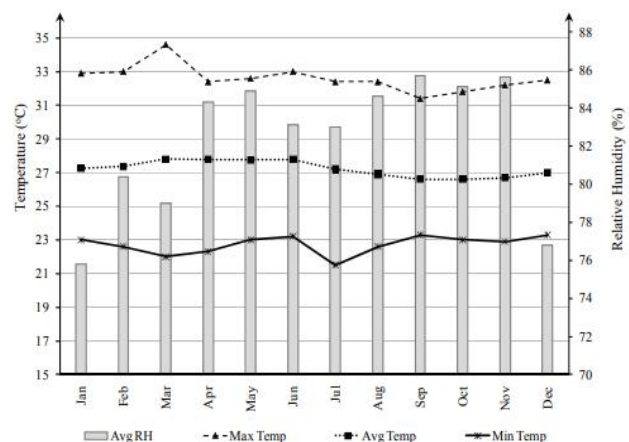
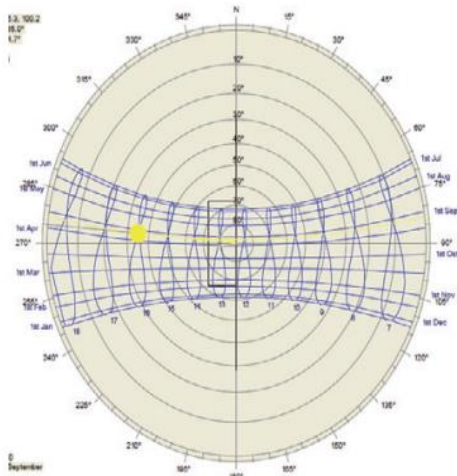
The potential of shading devices for temperature reduction in high-rise residential buildings in the tropics.

- **INTRODUCTION**
- The present study focuses on the **effect of shading devices** on the indoor temperature of high-rise residential buildings in the **hot–humid climate of Malaysia..**
- Malaysia has a diurnal temperature range at a minimum of **23–27 oC** and a maximum of **30–34 oC**
- **SIMULATION**
- A computerized simulation tool (**IES**) is used

METHODOLOGY

To calibrate the building simulation, IES simulation results were compared with fieldwork data. The methodology was pursued in **three phases**.

- The **first phase** was the **data collection from the field**.
 - The **second phase** was the verification and validation process, which included a **model of the external shading device** similar to the real one used in a residential unit.
 - The results of the field measurement were then compared with those of the simulations.
 - The last stage involved simulating the five proposed models **with different types of shading device**.
- **RESULTS AND DISCUSSION**
- The simulation output was compared with the fieldwork results for the indoor/outdoor temperature pattern for two consecutive days in the selected room (R1) **under ventilated and unventilated conditions**



3. CASE STUDIES:

CASE STUDY: ARCOT PLAZA- CHENNAI

THE DESIGN:

The idea was to maximize the visibility of the building and tap the potential in terms of footfall as the site is located between the existing railway station and an upcoming Metro Station. The ground plane was designed as a public zone. The front edge of the site was designed as a Public Plaza extending the side-walk into the site with the building having an inviting double-height atrium for the Retail branch. The Office floors have a separate entrance lobby at the rear with a Vehicular drop-off. The top floor was designed as a premium office with a large terrace garden which cuts the heat load of the offices.

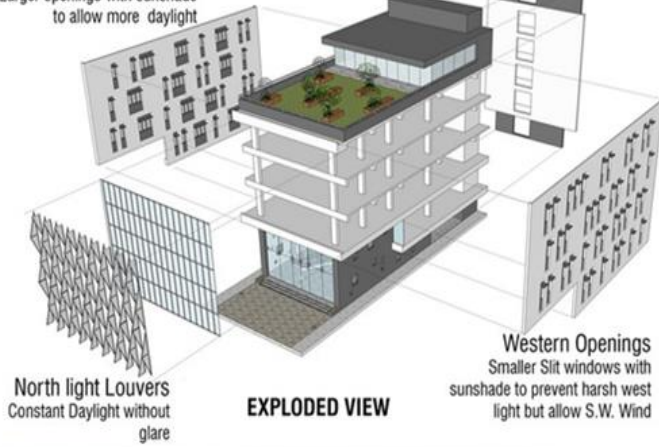
ARCOT PLAZA

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SUSTAINABILITY

Eastern Openings
Larger openings with sunshade
to allow more daylight

Southern Openings
Minimal openings on the
south to minimise building's
heat gain



North light Louvers
Constant Daylight without
glare

EXPLODED VIEW

Western Openings
Smaller Slit windows with
sunshade to prevent harsh west
light but allow S.W. Wind



WESTERN FACADE : Slit windows at random patterns protect the Inside from the harsh-sun.



EASTERN FACADE : Larger windows on the East in designed pattern.

SUSTAINABILITY : The Form of the Building was a direct response to the Climate. The Northern side faces the Street. Care was taken to protect the glass frontage of the building with appropriate and innovative shading-devices thereby providing effective day-lighting and reducing the solar heat-gain on the building. The Retail Facade is protected by the Office Floors Cantilevering from above. The Western and Eastern Side have been designed with appropriate openings to facilitate Cross-ventilation inside.



An ICON through Fenestration Design.



DESIGN : SLIT-WINDOWS:Effective Solution for West.

SUSTAINABILITY: The Form of the Building was a direct response to the Climate. The Northern side faces the Street. Care was taken to protect the glass frontage of the building with appropriate and innovative shading-devices there-by providing effective day-lighting and reducing the solar heat-gain on the building. The Retail Facade is protected by the Office Floors Cantilevering from above. The Western and Eastern Side have been designed with appropriate openings to facilitate Cross-ventilation inside

ARCOT PLAZA



DAY-LIGHTING: The Northern Louvers create Glare-free Natural Light.

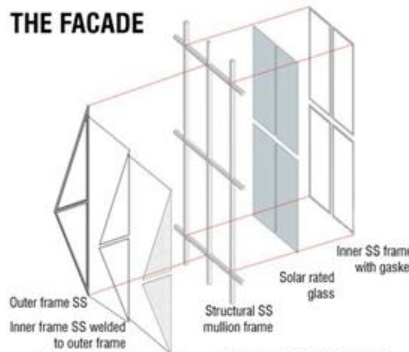


INTERIOR VIEW - WORKSTATIONS: Natural Day-Lighting in the Office



INTERIOR VIEW - CONFERENCE: A comfortable internal environment

THE FACADE



FACADE DETAILS: Exploded View of Detailed Design.

INNOVATIVE DAY-LIGHTING FACADE : The Northern Facade of the Building for the Office Floors was designed to give glare-free day-lighting for the work spaces. The triangulated translucent poly-carbonate fins placed at carefully determined patterns cuts the direct sun-light. In Chennai during summer the setting sun moves Northward. During such months the Fins provide diffused light. During other times they cut the glare from the bright sky. It also offers an interesting view to the street from the Office spaces breaking the monotony of the Spaces. Also the glass used is solar rated glass to cut heat-gain. The exploded diagram explains the facade construction system.



EXTERNAL VIEW : Views through Facade

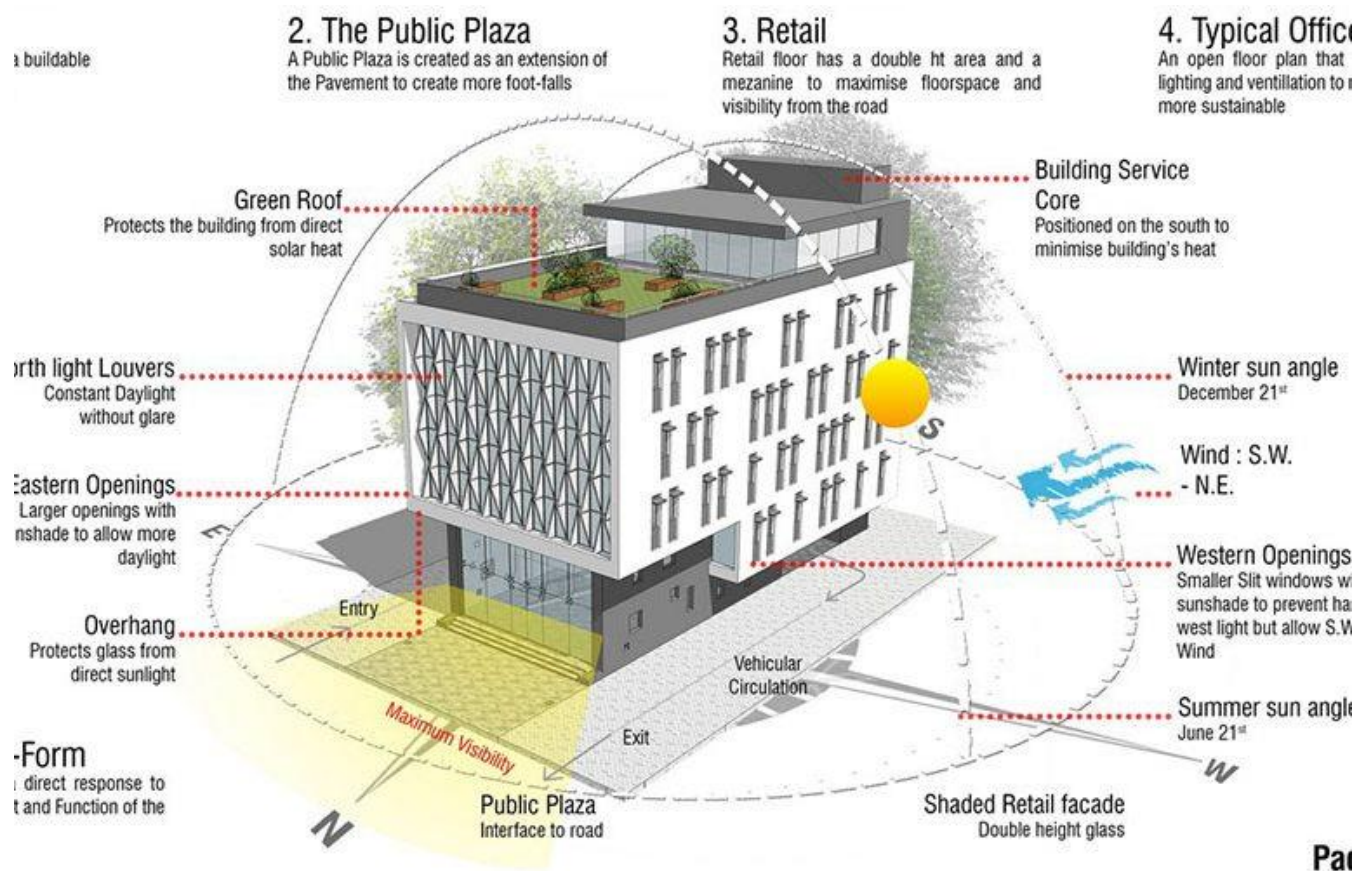


BUILDING ARTICULATION : S-West Facade



INNOVATIVE FACADE: Translucent shading devices designed to filter the Sun-light.

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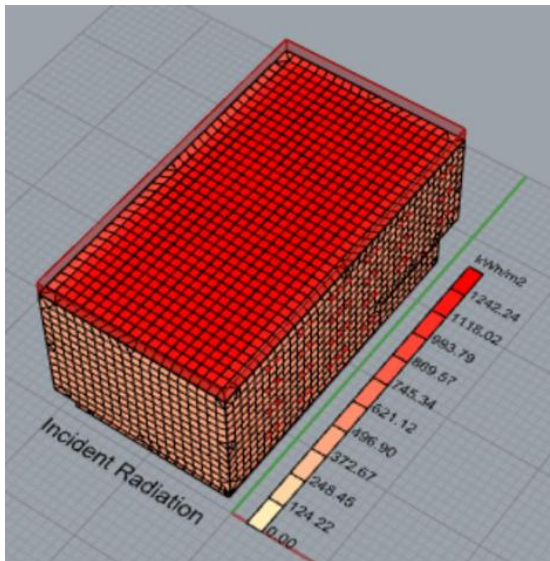


THE SUCCESS: The building has an iconic presence on the street and due to the sensitive design fetched higher RENT per SQ FT. Also the building consumes 15% less energy due to the climate-sensitive design features

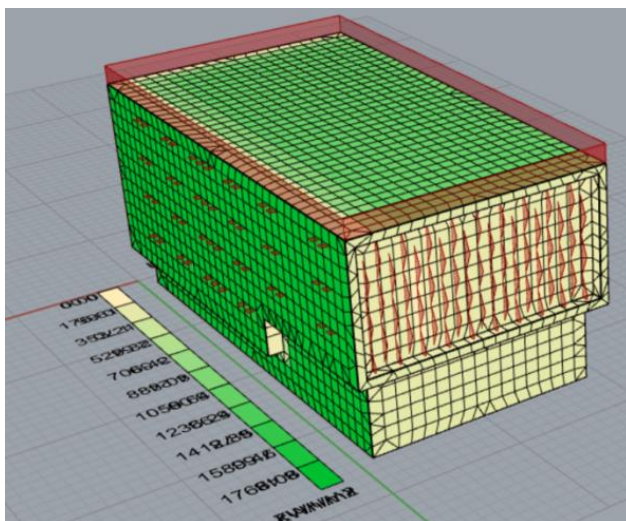
- RADIATION ANALYSIS

- HARMFUL RADIATION

	{0;0;0}
0	1.5549e+6



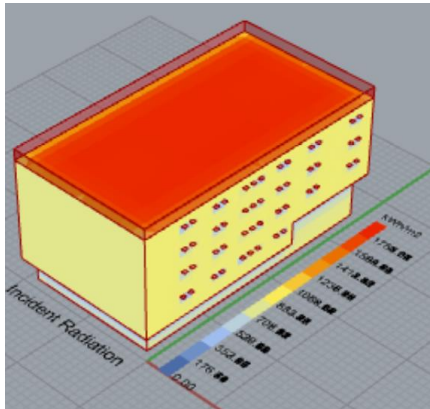
USEFUL RADIATION



THIS IS THE RESULT OF HARMFUL AND USEFUL RADIATION OF THE BUILDING WHICH HELPS TO IDENTIFY THE AREA WHICH IS EXPOSED TO DIRECT SUN AND THE OTHERS CAN BE CONVERTED INTO ENERGY

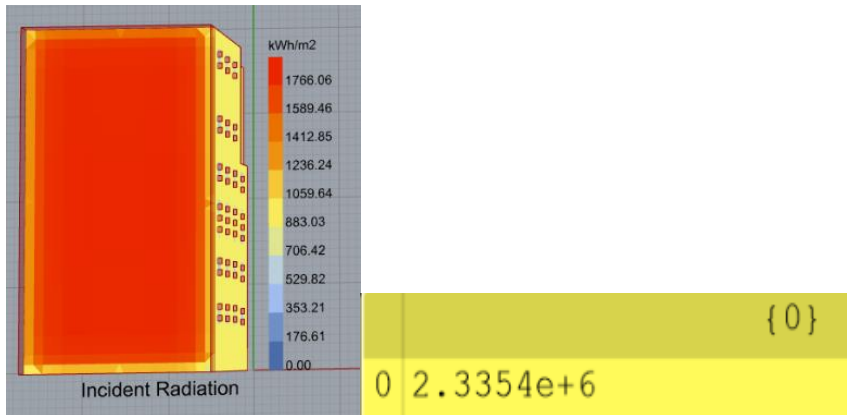
	{0;0;0}
0	10426.965573

BEST ORIENTATION ACCORDING TO SOLAR RADIATION

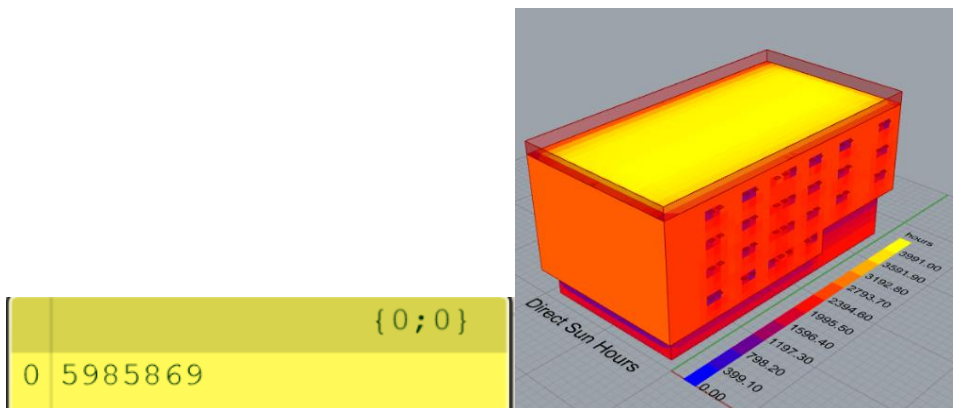


(0;0)		(0;0)	
0	2.2524e+6	0	90
1	2.2568e+6	1	270
2	2.2592e+6	2	100
3	2.2609e+6	3	80
4	2.2638e+6	4	280
5	2.2647e+6	5	110
6	2.2651e+6	6	260
7	2.2688e+6	7	120
8	2.27e+6	8	70
9	2.2707e+6	9	290
10	2.2738e+6	10	250
11	2.2758e+6	11	300
12	2.2786e+6	12	60
13	2.2813e+6	13	240
14	2.2892e+6	14	130
15	2.2972e+6	15	310
16	2.3014e+6	16	50
17	2.3024e+6	17	230
18	2.3036e+6	18	140
19	2.3082e+6	19	150
20	2.3118e+6	20	320
21	2.3166e+6	21	220
22	2.317e+6	22	40
23	2.3172e+6	23	330
24	2.3191e+6	24	210
25	2.3217e+6	25	30
26	2.3236e+6	26	160
27	2.329e+6	27	180
28	2.3305e+6	28	170
29	2.3328e+6	29	340
30	2.3329e+6	30	200
31	2.3354e+6	31	0
32	2.3362e+6	32	190
33	2.3373e+6	33	20
34	2.3388e+6	34	350
35	2.3414e+6	35	10

RADIATION VALUE



TOTAL DIRECT SUN HOURS



IMAC VALUE

THE RESULT OF SOLAR RADIATION ANALYSIS ARE SIMULATED FROM GRASSHOPPER

28.36	21.44
28.69	21.44
29.13	22.21
29.69	22.77
30.31	23.39
30.53	23.61
30	23.08
29.75	22.83
29.66	22.74
29.41	22.49
29.01	22.09
28.63	21.71
29.4308	22.4833

SUMMARY AND CONCLUSIONS

In this study, the design and effects of an effective external shading device for an office building were examined. The reduction in cooling loads due to the blockage of solar radiation was also evaluated. For the design of the external shading device, the authors first calculated the average monthly temperature for the region where a target building was located. The period when the temperature exceeds 20°C was denoted as the overheated period, and the building was configured to be shaded during this period. A shading device was designed to differ depending on the direction of the target building, and its effects were evaluated by dividing them into the overshadowing percentage and the effect of the solar radiation blockage due to the shading device.

4.

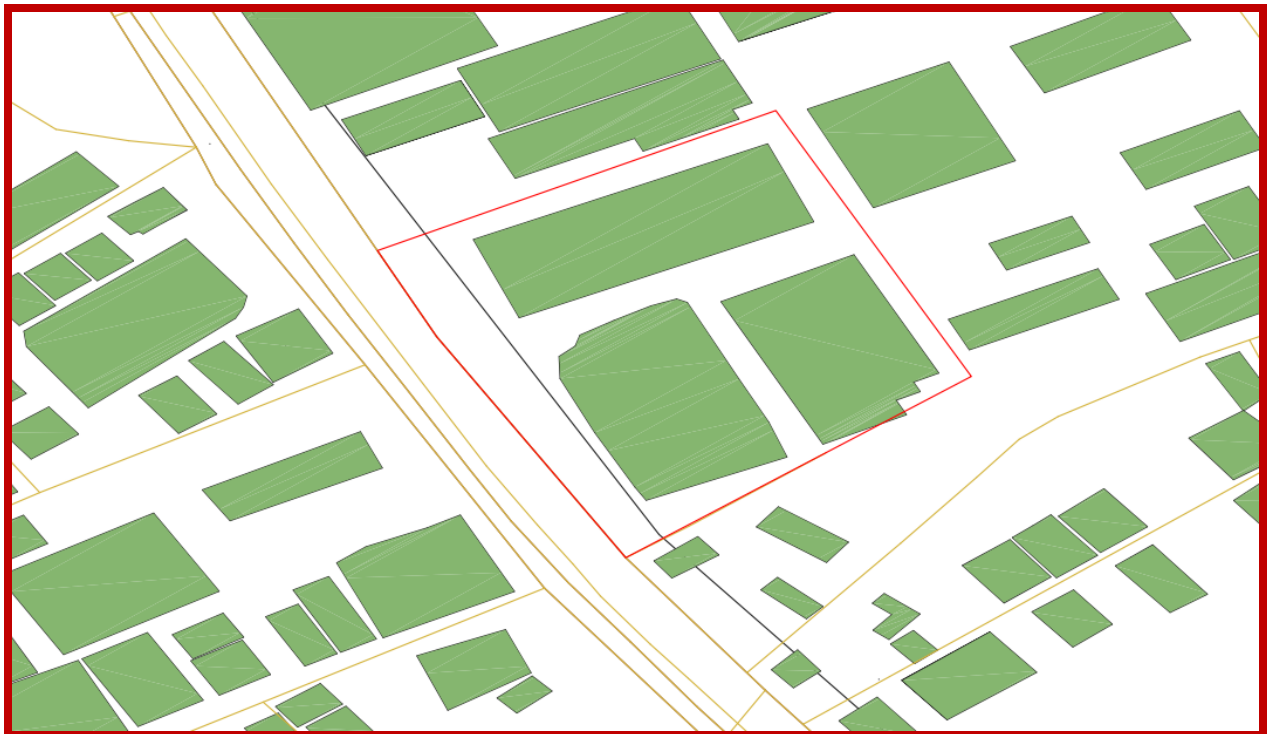
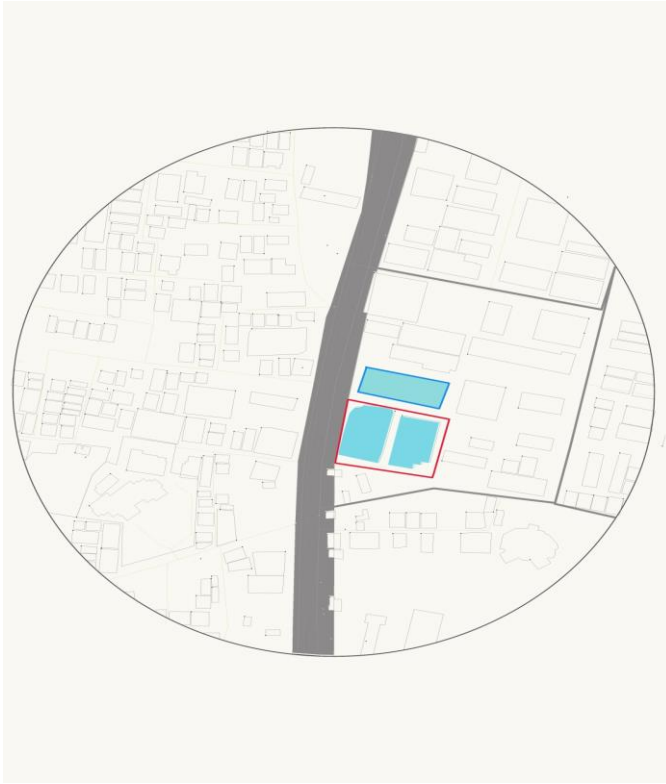
CASE STUDY 2

RAMANIYAMS LORD BUILDING

LOCATION: EKKATUTHANGAL
ARCHITECT: RAMANIYAM
AREA: 1.3 ACRES

THE SITE IS LOCATED ON THE MAIN ROAD OF EKKATUTHANGAL AND THE BUILDING BLOCK IS DIVIDED INTO 2 BLOCKS WITH A RAMP AND THE BLOCK IS 6 AND 8 FLOORS RESPECTIVELY

1. THE BUILDING IS A WEST FACING PLOT.
2. THE MAIN ROAD IS 80FT ROAD,
AND THE METRO STATION IS WITHIN 4KM
3. WEST-ENTRY
4. EAST-VACANT LAND ON EAST SIDE ,THEREFORE INCREASE IN SOLAR GAIN
5. WEST-RESIDENTIAL ZONES WITH LOW RISE
6. NORTH-ANOTHER BLOCK OF LORD'S BUILDING OF 8 STORIES



SITE JUSTIFICATION

THE BUILDING IS MAINLY TARGETED FOR ITS HIGHLY GLAZED STRUCTURE WHICH IS PROPOSED TO REDESIGNED TO ACHIEVE ENERGY EFFICIENT OFFICE BUILDING AND THE SITE IS LIMITED WITH 2 BLOCKS



THE BUILDING IS LOCATED ON MAIN ROAD OF THE EKKATUTHANGAL.THE BUILDING IS DIVIDED INTO 2 BLOCKS.

BLOCK 1- AREA OF ONE FLOOR 17000 SQFT

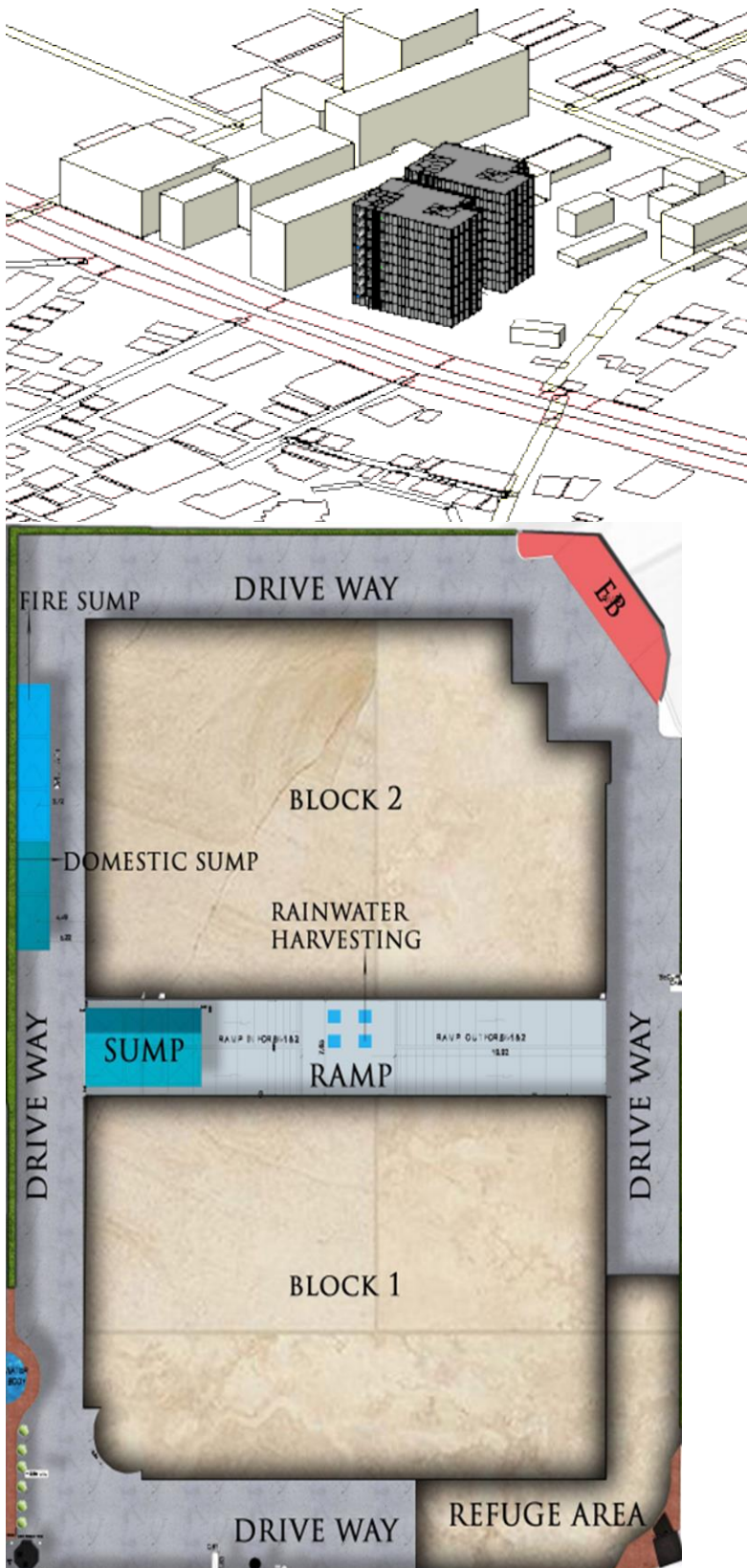
TOTAL AREA-9476.11 SQM

OCCUPANTS-1053

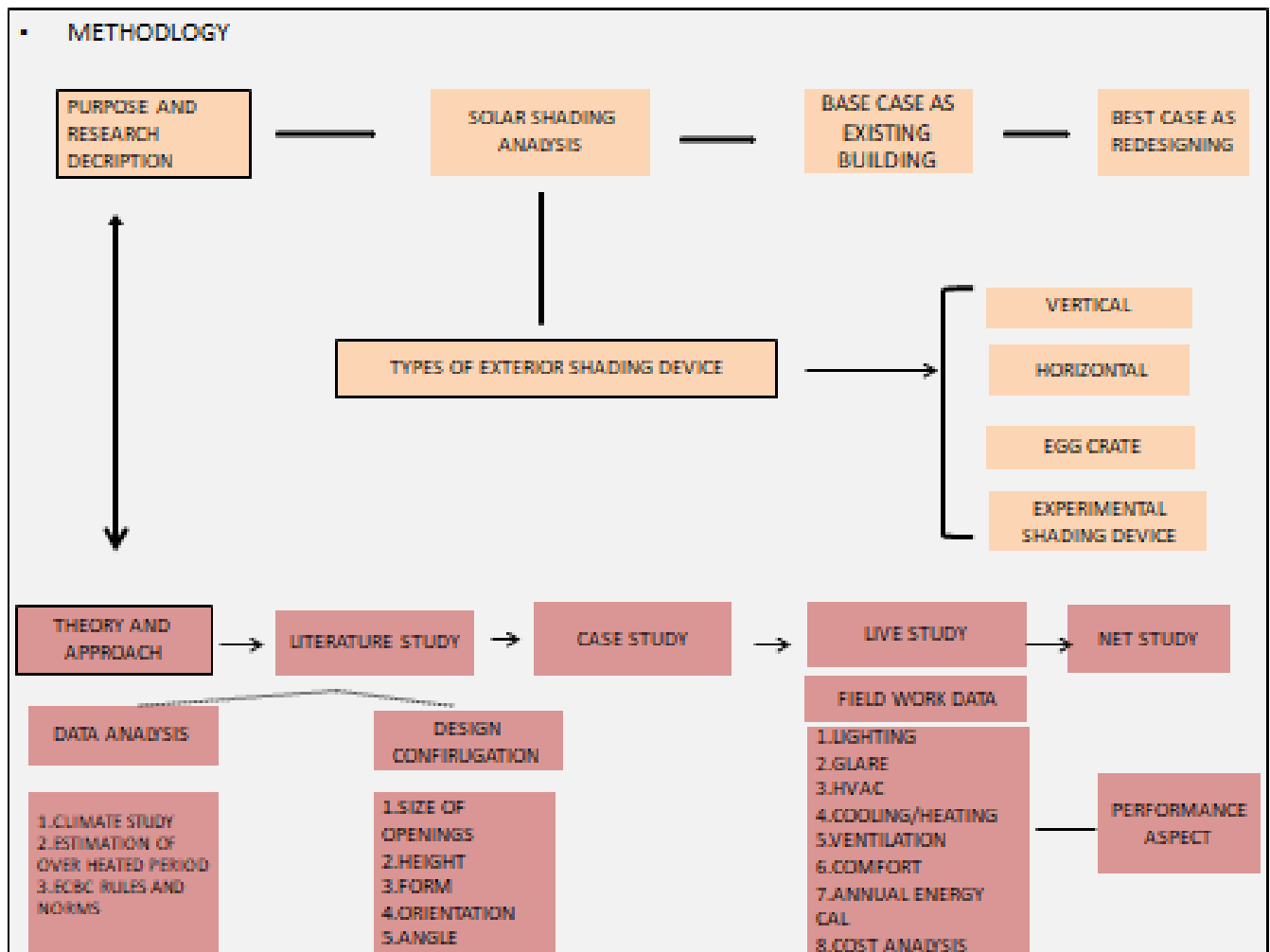
BLOCK 2-TOTAL AREA 7896.SQM

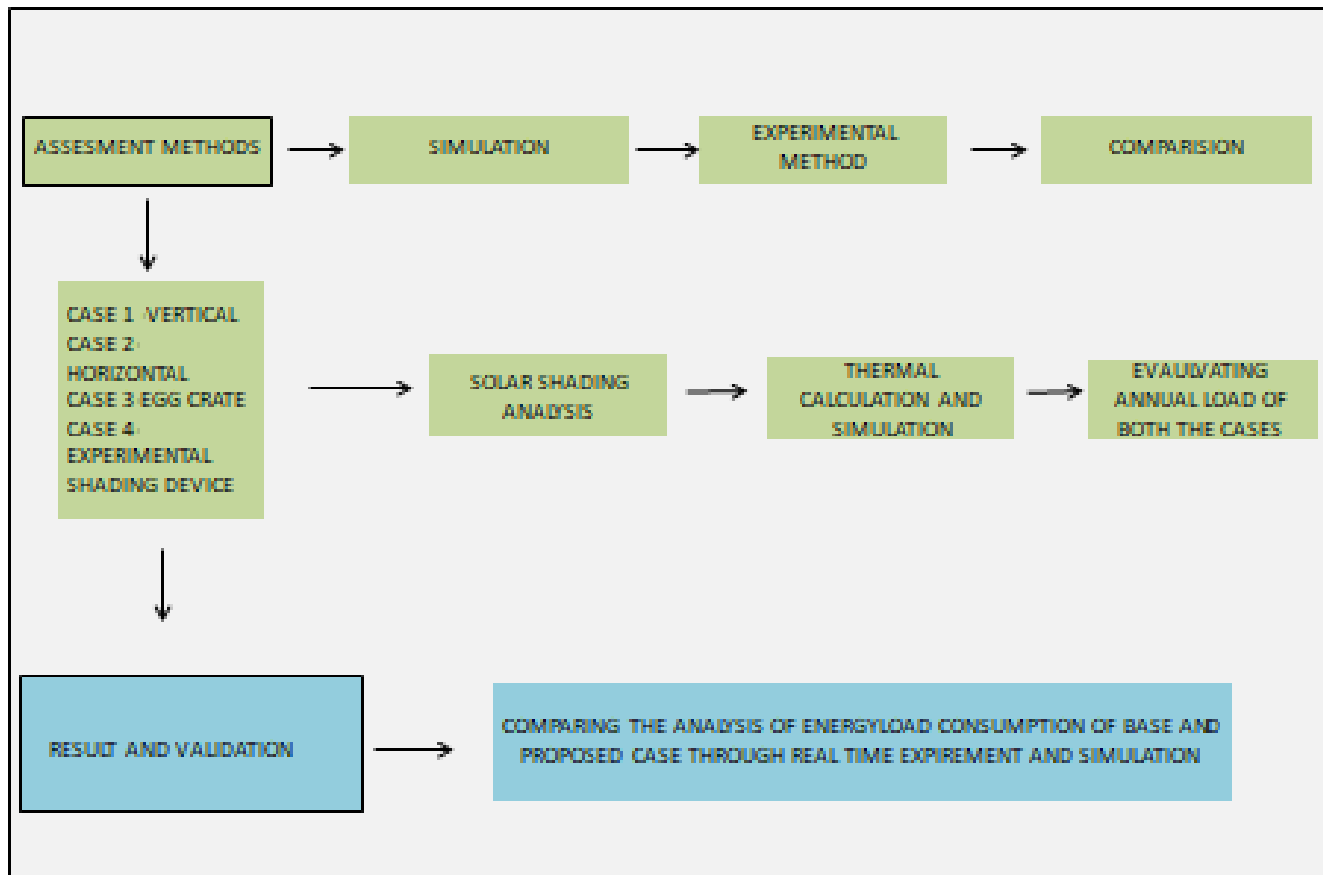
TOTAL NUMBER OF OCCUPANT-877

BLOCK	TOTAL AREA
1	1,02,000sq.ft
2	1,19,000sq.ft
BLOCK 1	BLOCK 2
1 BASEMENT	1 BASEMENT
STILT + 6	STILT + 5



4.0 METHODOLOGY:





5 CLIMATE ANALYSIS

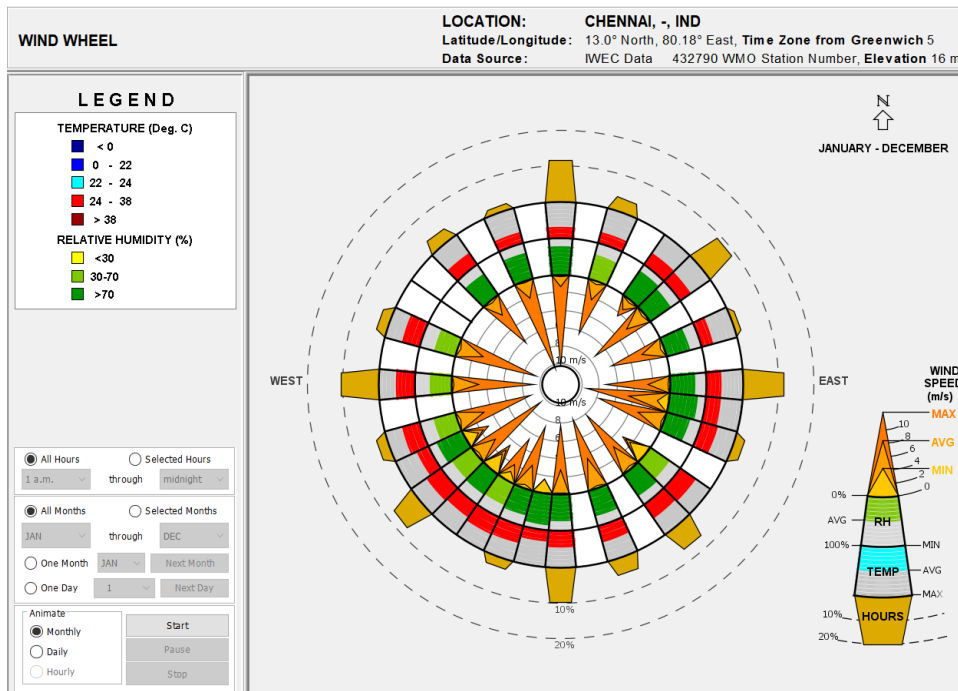
Chennai experiences warm and dry humid climate due to the coastal area. It does not experiences extreme variation in seasonal temperature. This can increase discomfort considerably. Comfort band for Chennai- 20 deg.celcius to 24 deg.celcius.

Temperature range:

In summer it experiences 30-35 deg.celcius during daytime and in night 25-30 deg.celcius in winter 25-30 deg.celcius during day and 20-25 deg.celcius at night. The maximum temperature recorded is mostly around the month of MARCH, APRIL, MAY, JUNE being the recorded maximum of the year. As we look at the relation between the comfort bands the recorded temperature seems to be pretty higher than the comfort level. So a lot of design considerations has to be given to the control of daylighting in the building.

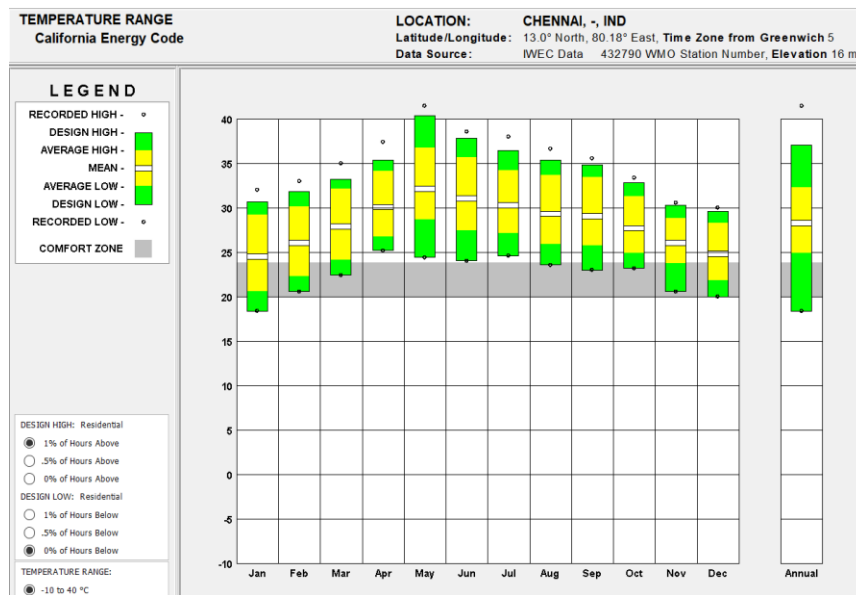
Wind wheel:

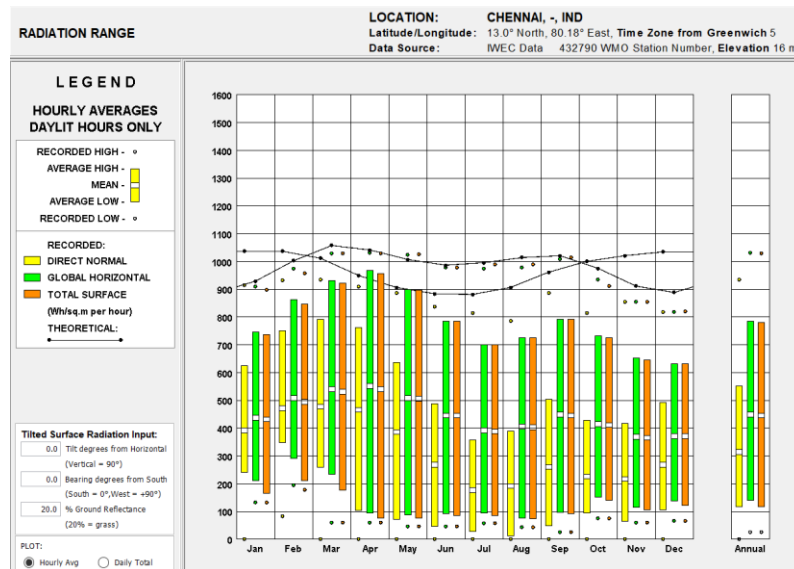
The wind wheel explains the direction and the intensity of the wind approach in the region. The wind pattern is predominantly from the south east to North West direction and the temperature of the wind is also cooler compared to the south eastern wind which is high in temperature.



Radiation range:

The radiation range of Chennai recorded as high in the months of March and recorded low in the month of October. The Radiation chart explains about the level of radiation recorded in the region throughout a year. A theoretical radiation range is fixed to compare the measured level of radiation with the actual found out level of radiation. Since the radiation level is moderate paved surfaces should be considerably used.

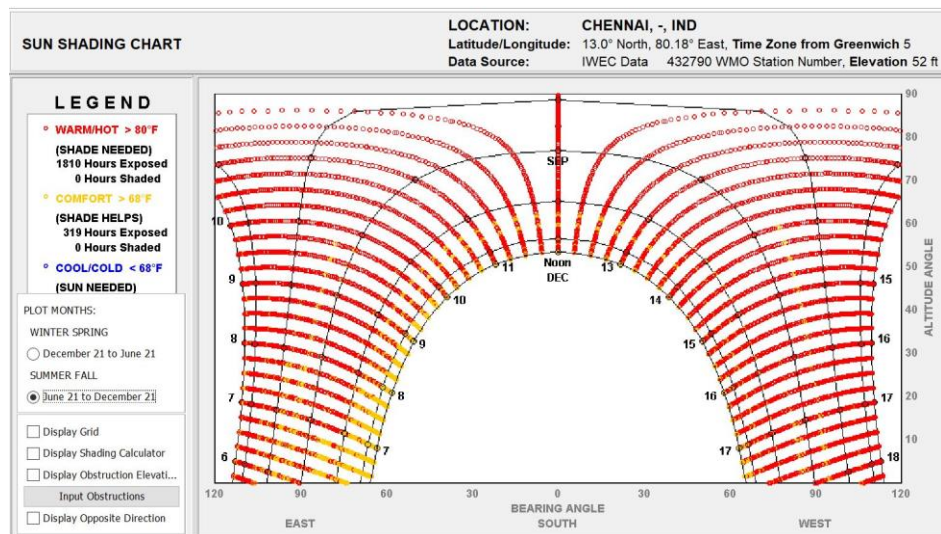




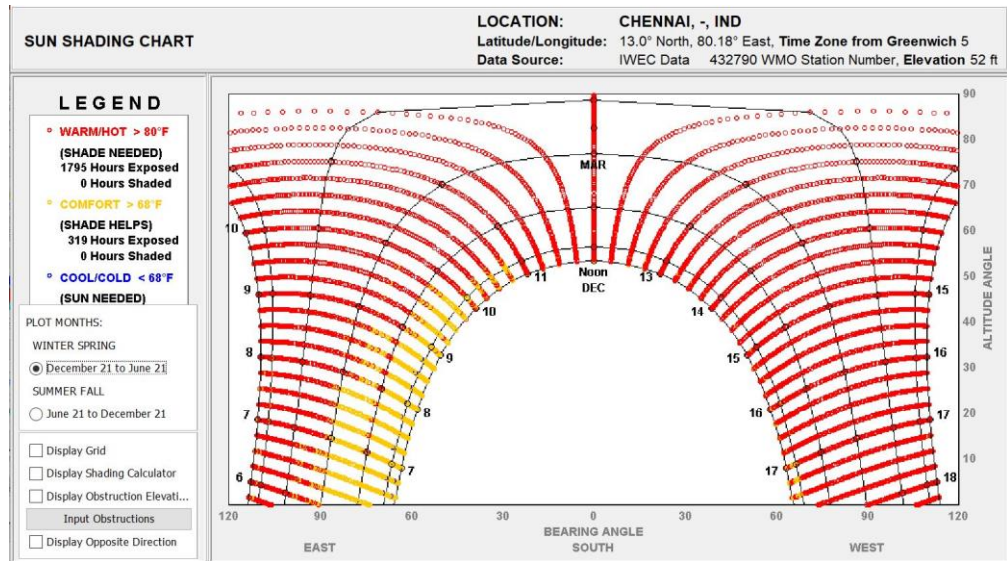
SUNSHADING CHART:

JUNE TO DECEMBER:

The sun shading chart explains about the bearing angle of the sun from east to west through south and the amount of sun exposure a building receives in that angle. The shading region and the hours of exposure it receives from the sun's radiation. This differs from summer fall and the winter spring.

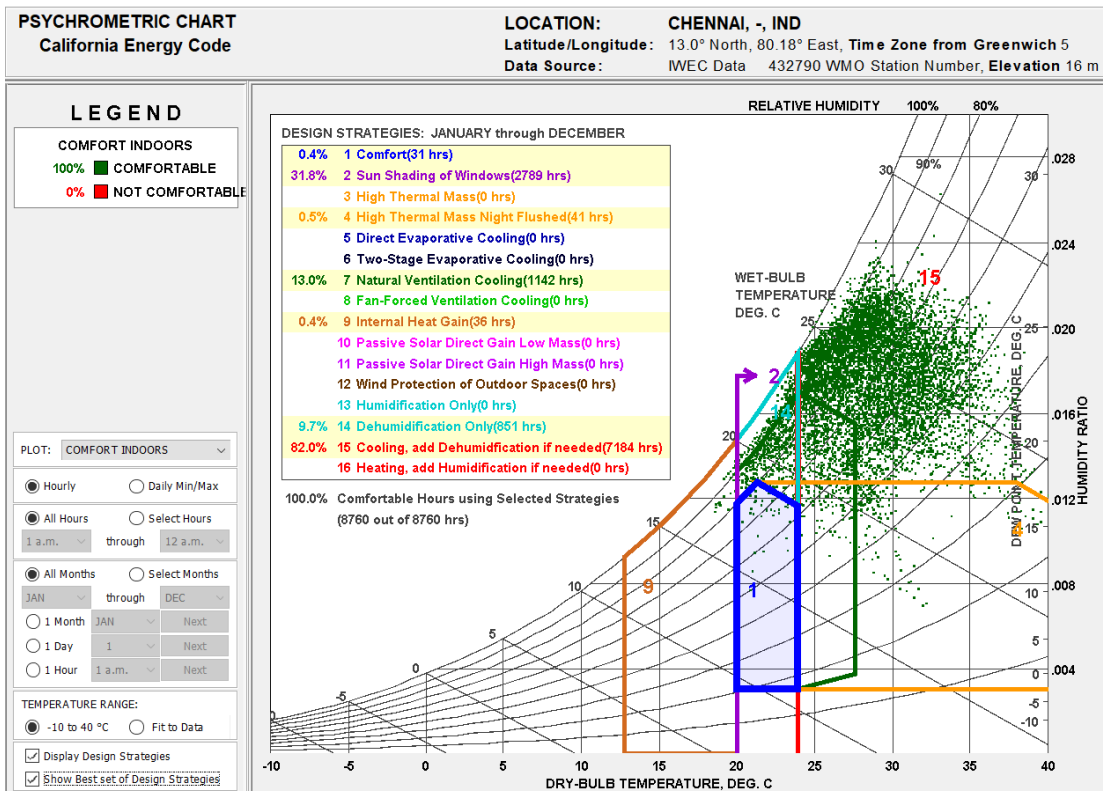


DECEMBER TO JUNE:



It's almost same in the winter spring and the comfort level is increased bit compared to the summer fall in the month from Dec –March by day time and in the month of oct-dec. hence shading and cooling is required.

PSYCHROMETRIC CHART:

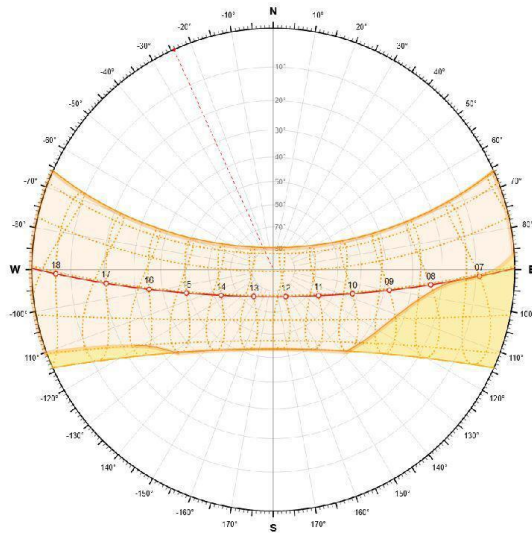


From the psychrometric chart it's clearly stated that 100% of comfort is achieved by using Passive and active techniques.

MAHONEY TABLE:

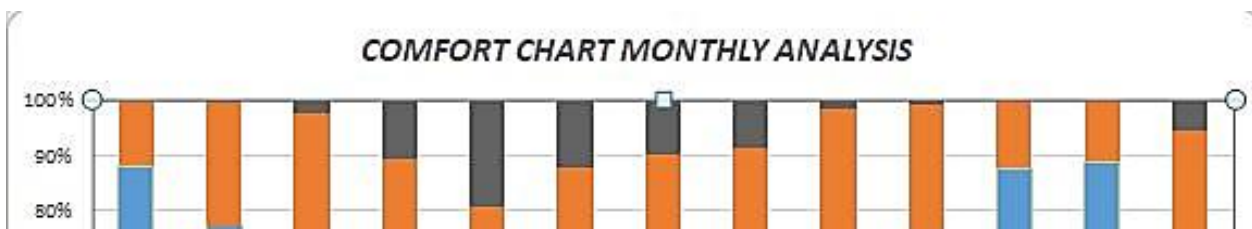
Air Temperature													
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	high
Air temperature Month	31	32.6	34.5	35.3	39.1	38.3	36.2	35.2	36.2	33.6	30.6	29.5	37
monthly mean min.	16.9	18.9	22.3	23.9	24.9	24.4	24	23.4	24.3	23.2	21.8	19.7	20
Monthly mean range	14.1	11	12.2	12	14.2	13	12.2	14	11.9	15	8.8	16	low
													AMR

RELATIVE HUMIDITY %												
	jan	feb	march	april	may	june	july	aug	sept	oct	nov	dec
Monthly mean max. a.r	72	68	72	64	59	57	68	66	67	76	81	72
monthly mean min. p.m	58	53	66	61	55	52	60	56	59	70	72	63
Average Relative Humi	65	60.5	69	62.5	57	54.5	64	61	63	73	76.5	67.5
Humidity group	4	3	4	4	3	3	3	4	4	4	4	4



INFERENCE:

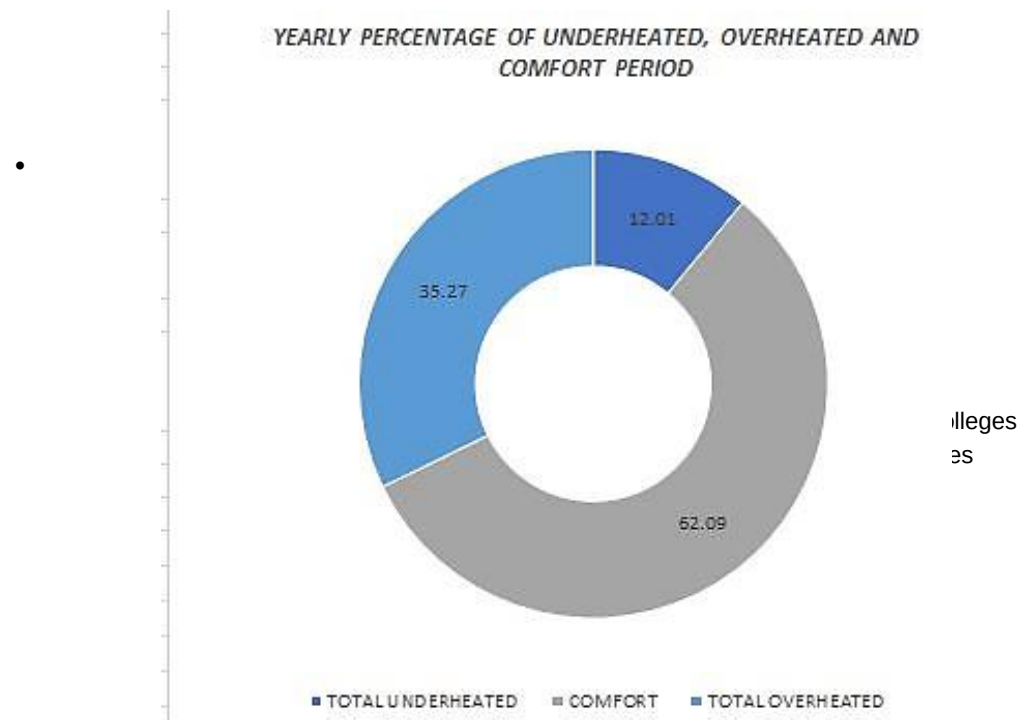
In this Mahoney table, the air temperature and relative humidity has noted for each month with monthly mean maximum and minimum. The sun path explains about the comfort band of the location. The inference of the chart depicts the comfort hour of the days from 7 to 8:30 a.m. and evening time. Rest of the hours makes feel to discomfort.

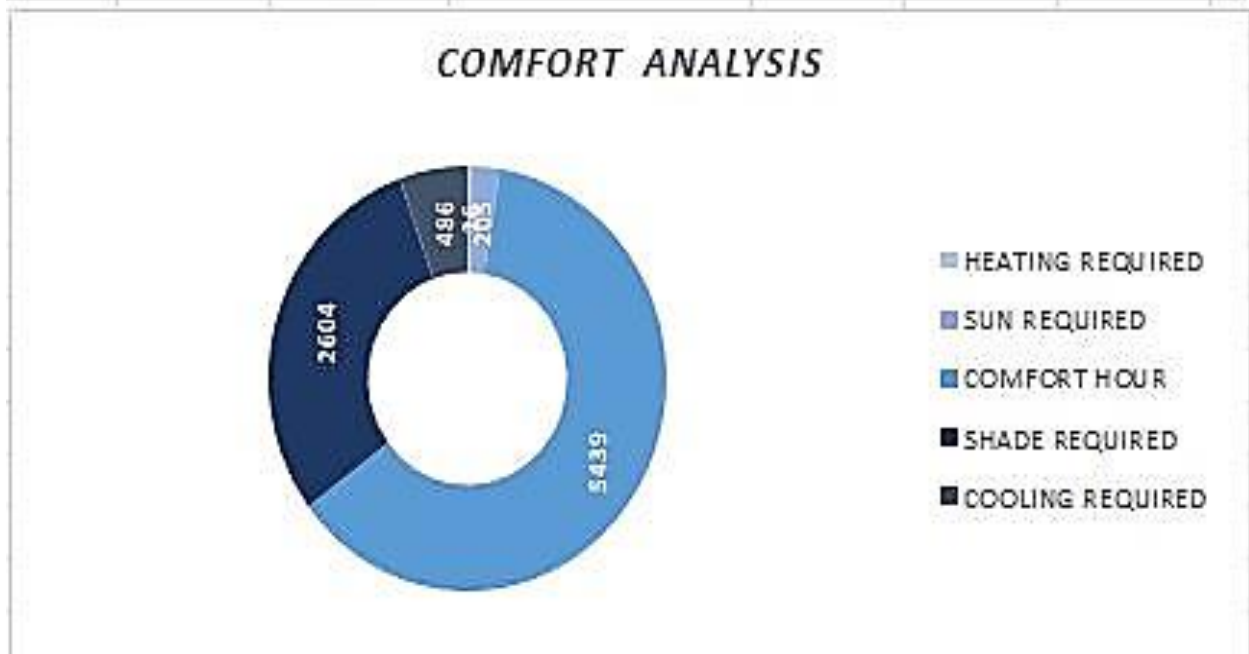
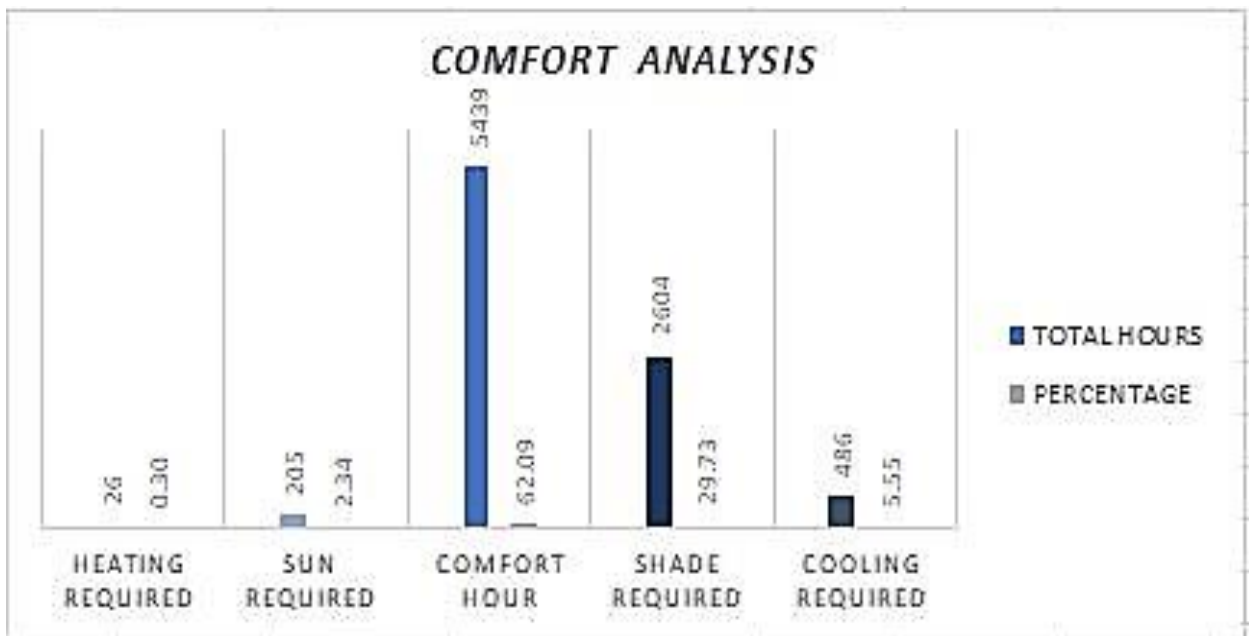


6.SITE

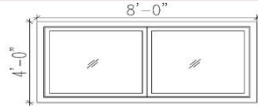
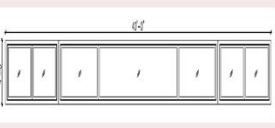
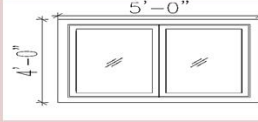


6.1 SITE PROXIMITY:





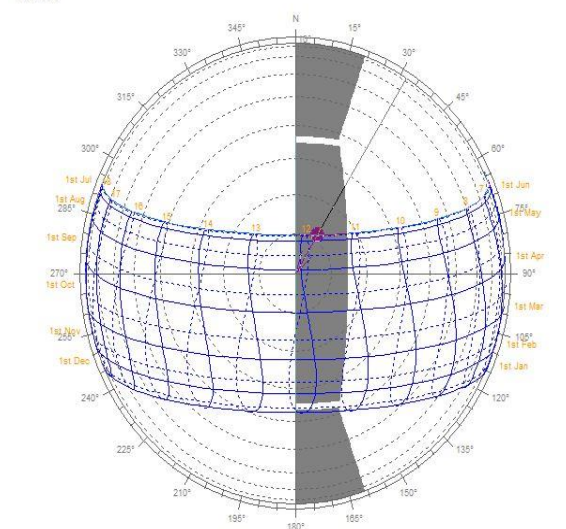
BUILDING ENVELOPE

WINDOW ORIENTATION	ON SITE	SIZE AND DIMENSIONS	GLAZING TYPE AND PROPERTIES
WINDOW 1 ORIENTED ON EAST			6 mm single glazing WITH FROST GLASS SHEET. $U = 5.7 \text{ W/m.K}$
WINDOW 2 ORIENTED ON NORTH			OPERABLE DOUBLE GLAZED WINDOW OF 12MM WITH COOLING SHEET. $U = 6 \text{ W/m.k}$
WINDOW 3 ORIENTED ON SOUTH			Fixed double glazed with single opening with frost sheet $u=6\text{w/m.k}$
FULLY GLAZED ON WEST ORIENTATION			Fixed double glazed for noise pollution

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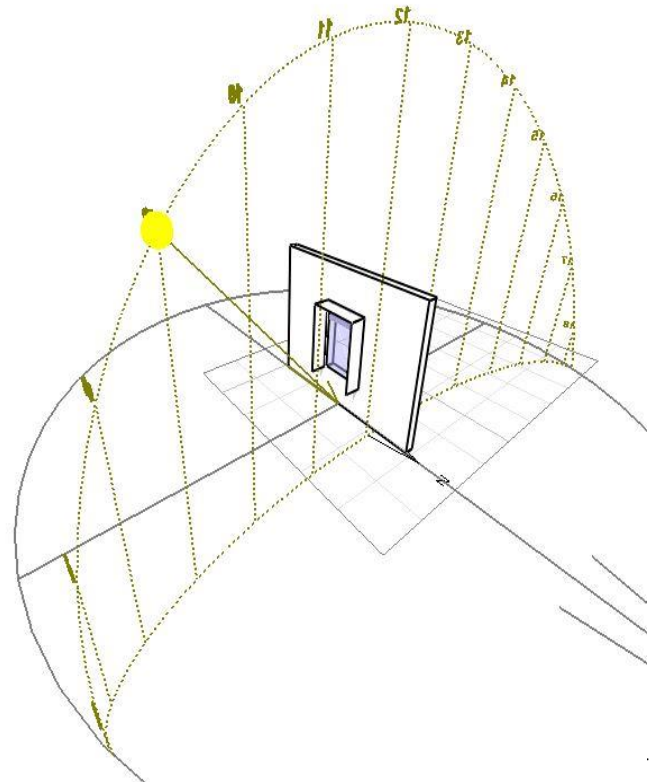
Spherical Projection

Location: 13.8°, 80.3°
Sun Position: 31.9°, 78.6°
HSA: -58.1°
VSA: 83.9°



Time: 11:45
Date: 25th Jun (176)
Percentage Shading: 100%

BRE VSC: 10.8%
Overcast Sky: 14.3%
Uniform Sky: 17.0%



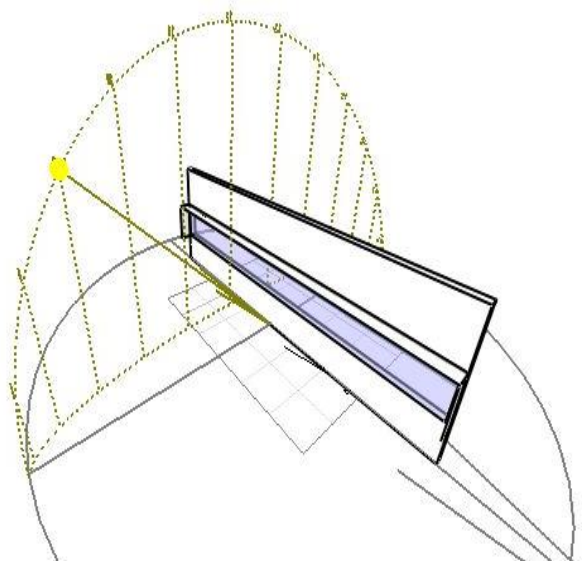
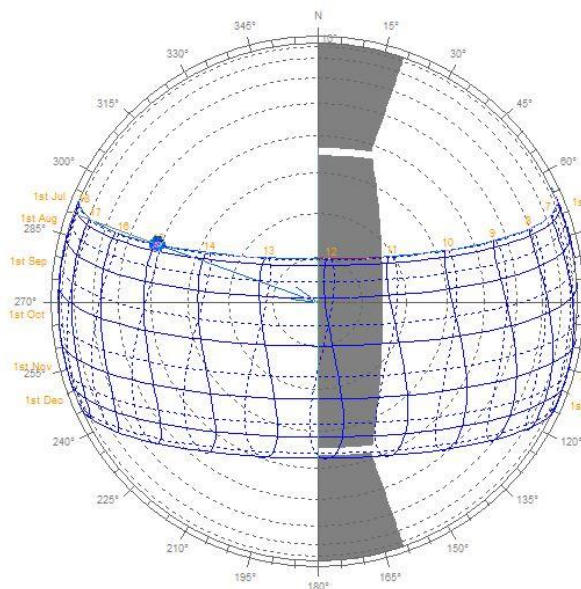
Effective Shading Coefficients

Latitude: 13.8°
 Longitude: 80.3°
 Timezone: 82.5° [+5.5hrs]
 Orientation: 90.0°

Month	Avg.SC	Max.SC	Min.SC
January	45.8%	100.0%	10.0%
February	39.1%	100.0%	0.0%
March	35.7%	100.0%	0.0%
April	35.5%	100.0%	0.0%
May	37.7%	100.0%	0.0%
June	37.2%	100.0%	0.0%
July	35.2%	100.0%	0.0%
August	35.0%	100.0%	0.0%
September	39.1%	100.0%	0.0%
October	40.3%	100.0%	0.0%
November	45.3%	100.0%	10.0%
December	51.0%	100.0%	10.0%
Winter	45.3%	100.0%	6.7%
Summer	36.7%	100.0%	0.0%
Annual	39.7%	100.0%	2.5%

Spherical Projection

Location: 13.8°, 80.3°
 Sun Position: -70.1°, 49.0°
 HSA: -160.1°
 VSA: 129.3°

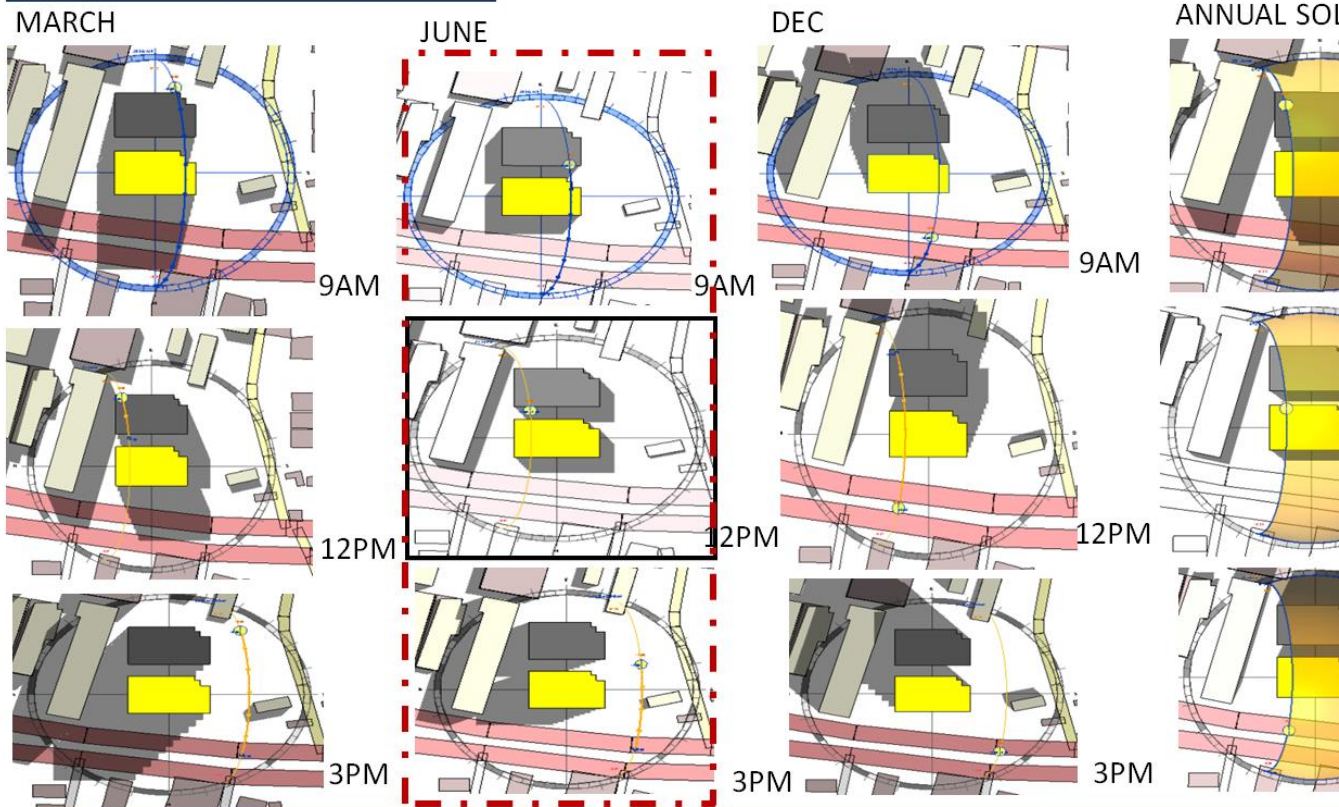


Time: 15:00
 Date: 26th Jun (177)
 Dotted lines: July-December.

BRE VSC: 10.8%
 Overcast Sky: 14.3%
 Uniform Sky: 17.0%

<https://www.nap.edu/read/18509/chapter/6#26>
<https://www.aarp.net/what-is-a-research-park>

SHADOW ANALYSIS



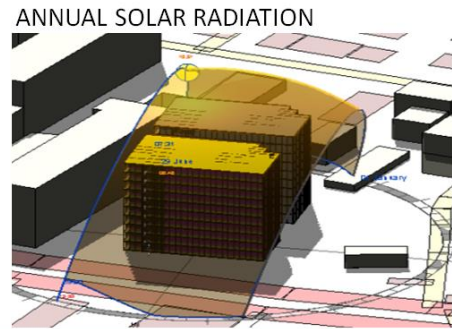
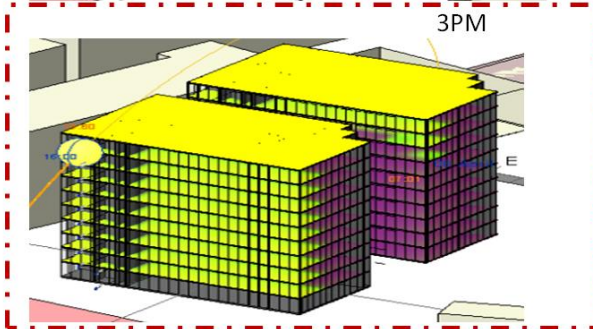
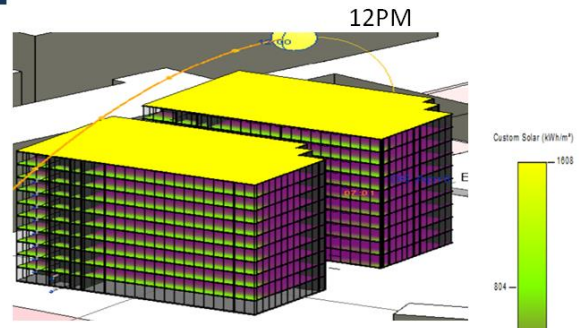
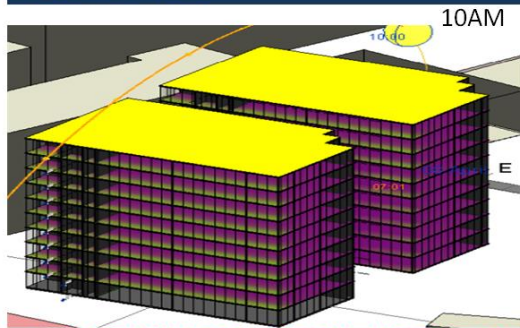
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Effective Shading Coefficients

Latitude: 13.8°
Longitude: 80.3°
Timezone: 82.5° [+5.5hrs]
Orientation: 90.0°

Month	Avg.SC	Max.SC	Min.SC
January	45.8%	100.0%	10.0%
February	39.1%	100.0%	0.0%
March	35.7%	100.0%	0.0%
April	35.5%	100.0%	0.0%
May	37.7%	100.0%	0.0%
June	37.2%	100.0%	0.0%
July	35.2%	100.0%	0.0%
August	35.0%	100.0%	0.0%
September	39.1%	100.0%	0.0%
October	40.3%	100.0%	0.0%
November	45.3%	100.0%	10.0%
December	51.0%	100.0%	10.0%
Winter	45.3%	100.0%	6.7%
Summer	36.7%	100.0%	0.0%
Annual	39.7%	100.0%	2.5%

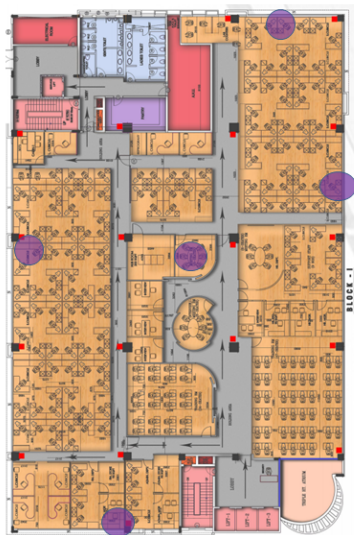
SOLAR RADIATION



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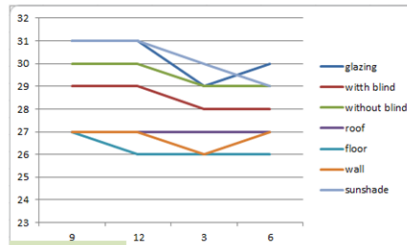
ON SITE READINGS



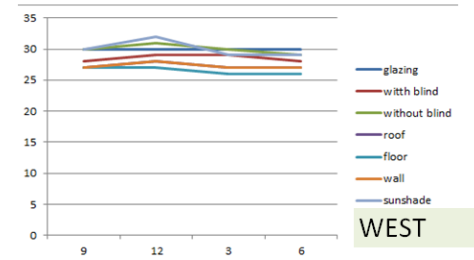
MAXIMUM RH-81.4
MINIMUM RH-17.8

MINIMUM TEMPERATURE-41.4
MAXIMUM TEMPERATURE-25

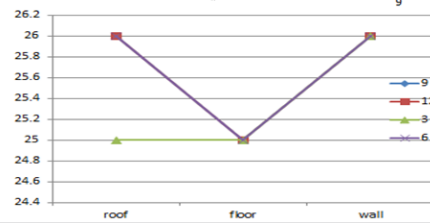
AVERAGE LUX LEVEL WITH BLIND – 510
AVERAGE LUX LEVEL WITHOUT BLIND- 2000



EAST

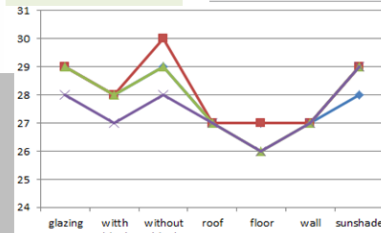


WEST

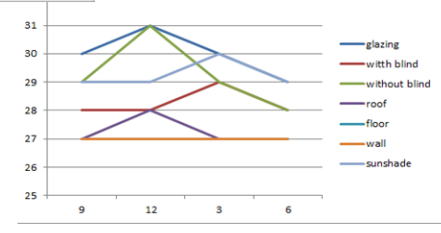


CENTER

north



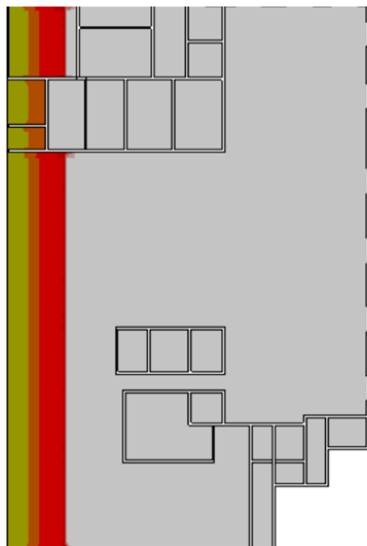
SOUTH



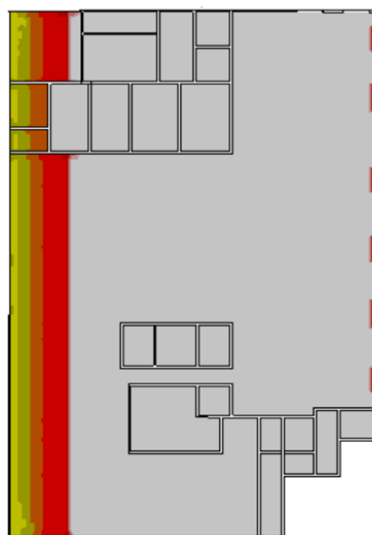
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SOLAR RADIATION EXPOSURE

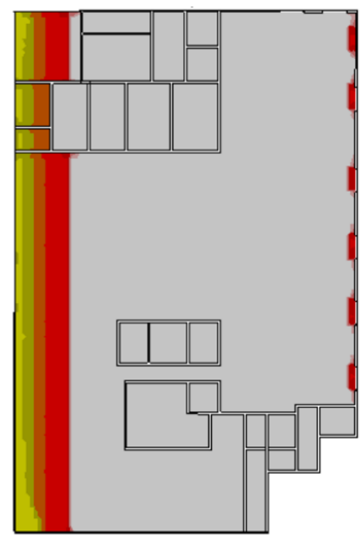
GROUND FLOOR



FOURTH FLOOR



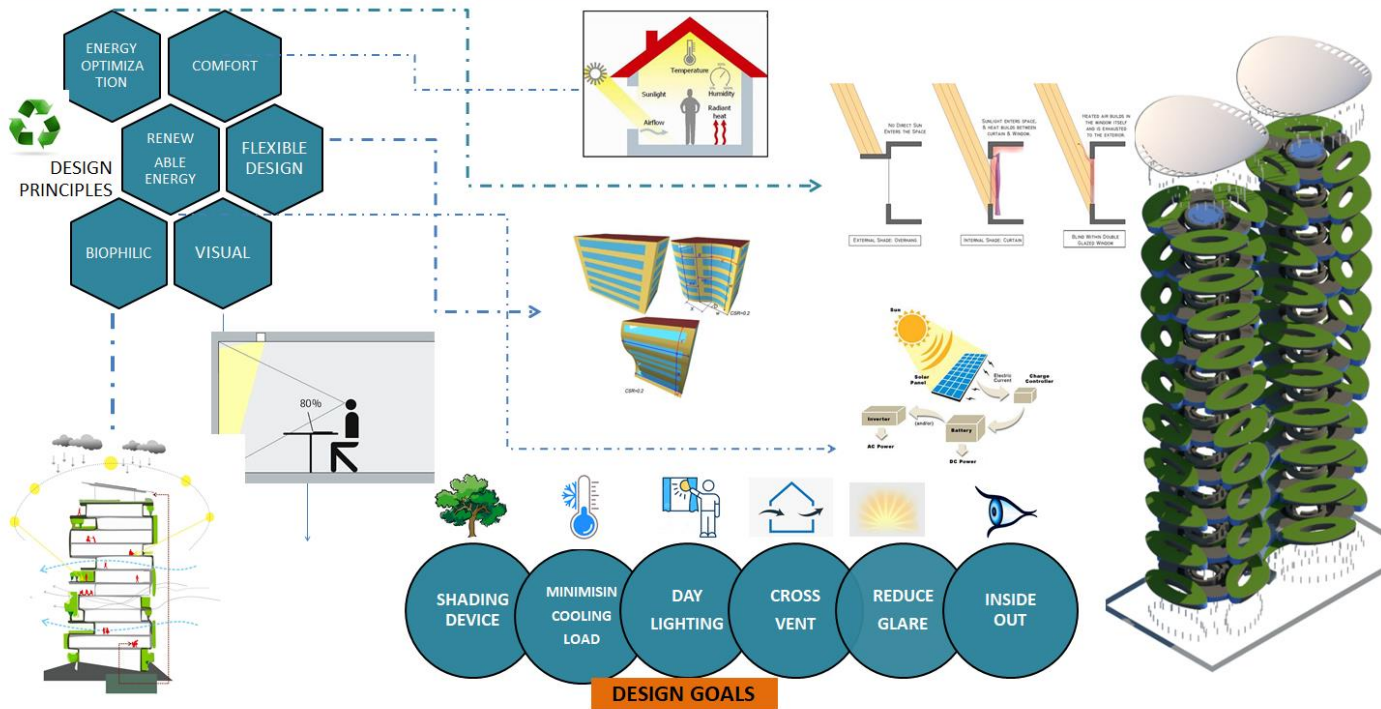
SIXTH FLOOR



In the annual solar exposure the sixth floor receives more solar exposure when compared to ground and 4th floor

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DESIGN CONCEPT CRITERIAS



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SHADING ANALYSIS

west orientation

model	measurements	nos	tilt
Horizontal shade	450mm	3	0
Vertical fin	450mm	2	0
PF=0.3	MF=0.64	Max.shgc of glazing=0.391	Min.vlt of glazing=0.27

The average effective coefficients on summer is 70% is achieved by using eggcrate on western orientation

Effective Shading Coefficients

Latitude: 13.0° Longitude: 80.0° Timezone: 82.5° (+5.5hrs) Orientation: 270.0°			
Month	Avg SC	Max SC	Min SC
January	77.0%	100.0%	42.0%
February	79.8%	100.0%	42.0%
March	77.8%	100.0%	32.0%
April	68.2%	100.0%	4.0%
May	70.4%	100.0%	13.0%
June	65.3%	100.0%	4.0%
July	65.6%	100.0%	4.0%
August	70.3%	100.0%	13.0%
September	74.6%	100.0%	32.0%
October	80.1%	100.0%	42.0%
November	79.8%	100.0%	42.0%
December	80.4%	100.0%	43.0%
Winter	79.3%	100.0%	42.3%
Summer	67.8%	100.0%	7.0%
Annual	74.3%	100.0%	26.1%

south orientation

The average effective coefficients on summer is 100 is achieved by using horizontal fins on southern orientation

model	measurements	nos	tilt
Horizontal shade	300mm	1	0
Vertical fin	300mm	4	0
PF=0.27	MF=0.64	Max.shgc of glazing=0.391	Min.vlt of glazing=0.27

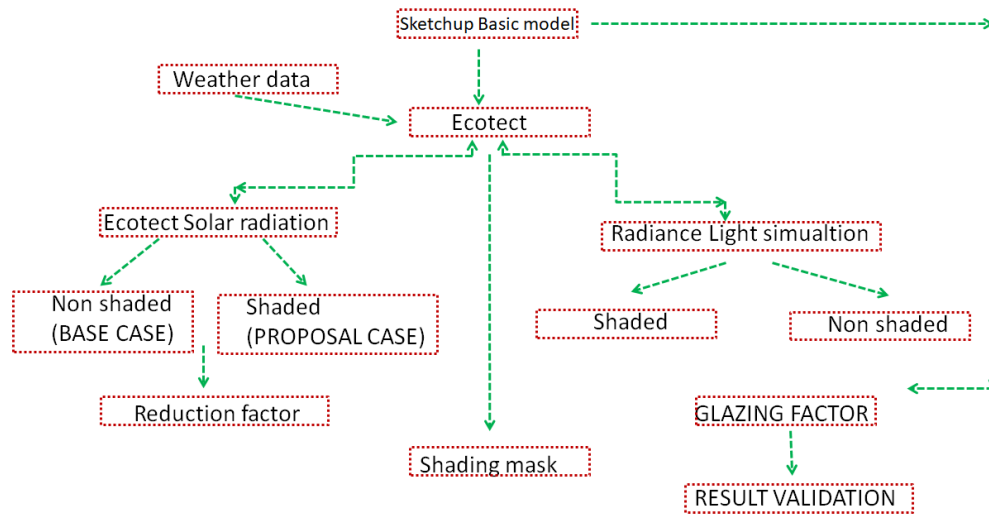
Effective Shading Coefficients

Latitude: 13.0° Longitude: 80.0° Timezone: 82.5° (+5.5hrs) Orientation: 180.0°			
Month	Avg SC	Max SC	Min SC
January	93.0%	100.0%	63.0%
February	100.0%	100.0%	100.0%
March	100.0%	100.0%	100.0%
April	100.0%	100.0%	100.0%
May	100.0%	100.0%	100.0%
June	100.0%	100.0%	100.0%
July	100.0%	100.0%	100.0%
August	100.0%	100.0%	100.0%
September	100.0%	100.0%	100.0%
October	99.9%	100.0%	95.0%
November	91.7%	100.0%	55.0%
December	89.9%	100.0%	40.0%
Winter	94.5%	100.0%	69.7%
Summer	0.0%	0.0%	100.0%
Annual	64.6%	66.7%	88.2%

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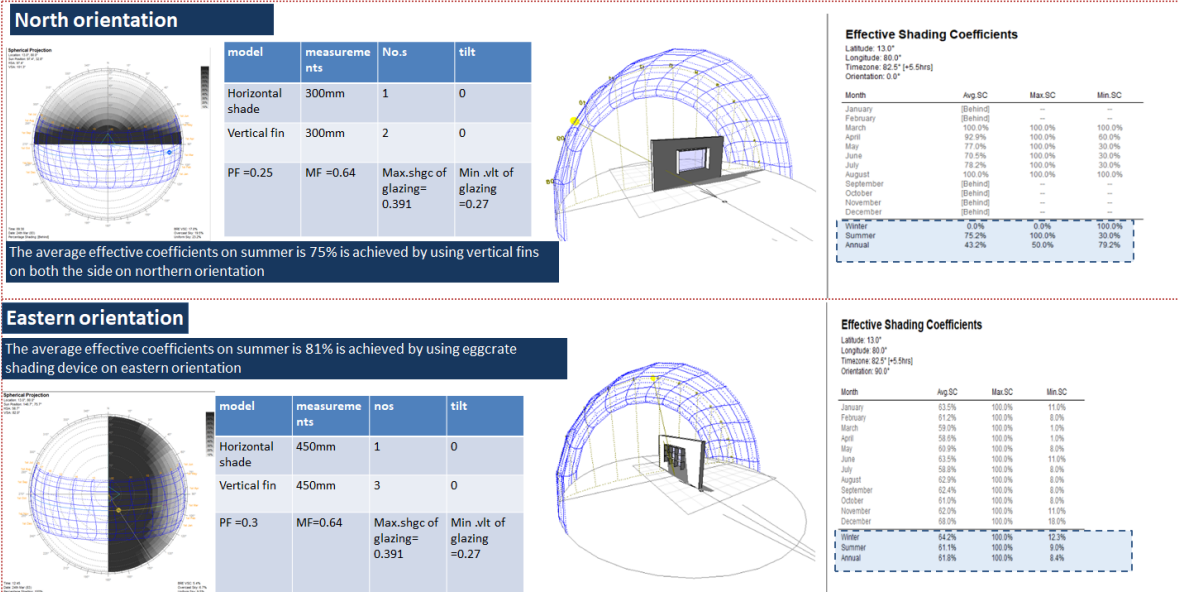
Scheme to determine the defined parameters of shading quality, GLAZING relevance,



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SHADING DEVICE ANALYSIS

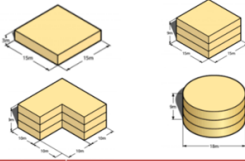


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Why shape affects building's energy efficiency

Heat will gradually make its way to the outside of the building through building's external faces (e.g. walls, roofs, terraces). The larger the area of external faces, the more place heat has to escape to the outside. In principle, to minimise heat transfer through the building's external faces, the building shape should be as compact as possible



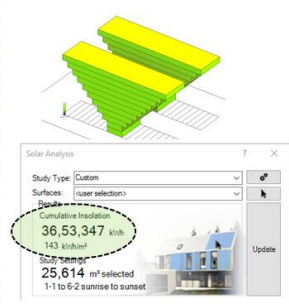
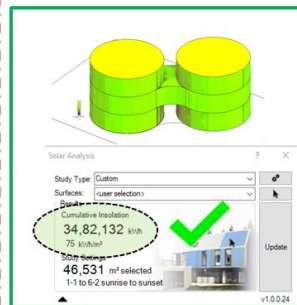
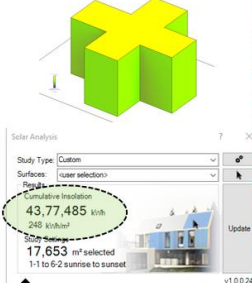
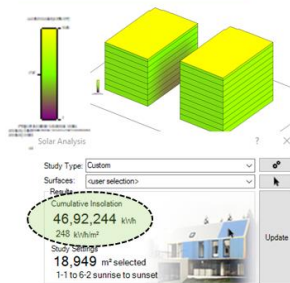
Heat Loss Form Factor (HLFF) is the ratio between the building's envelope area (EA) and its net floor area (NFA). It is calculated as $HLFF = EA / NFA$. HLFF is a number generally between 0.3 and 5, with a lower number indicating a more compact building. A 20-storey skyscraper with $20 \times 20 \text{ m}^2$ floor plan has a HLFF of 0.76. It is calculated as $HLFF = EA / NFA$. Surface to Volume Ratio $HLFF = EA / NFA$

FORM	MODEL	SVR	HLEF	EFFICIENT
		$SVR = EA / V$ $EA = 218116$ $V = 4762720$ SVR=0.04	$HLFF = EA / NFA$ $EA = 218116$ $NFA = 26688$ $HLFF = 0.69$	
		$SVR = EA / V$ $EA = 63968$ $V = 16540$ SVR=0.03	$HLFF = EA / NFA$ $EA = 63968$ $NFA = 88359$ $HLFF = 0.7$	
		$SVR = EA / V$ $EA = 138290$ $V = 35741$ SVR=0.04	$HLFF = EA / NFA$ $EA = 138290$ $NFA = 292437$ $HLFF = 0.05$	
		$SVR = EA / V$ $EA = 124105$ $V = 6162$ SVR=0.03	$HLFF = EA / NFA$ $EA = 124105$ $NFA = 213504$ $HLFF = 0.04$	

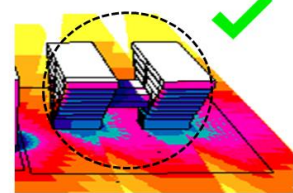
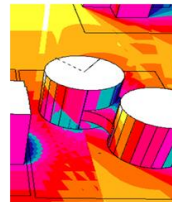
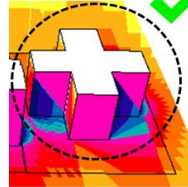
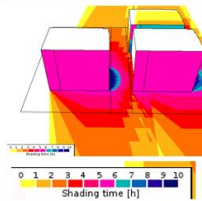
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FORM ITERATION ANALYSIS

SOLAR ANALYSIS

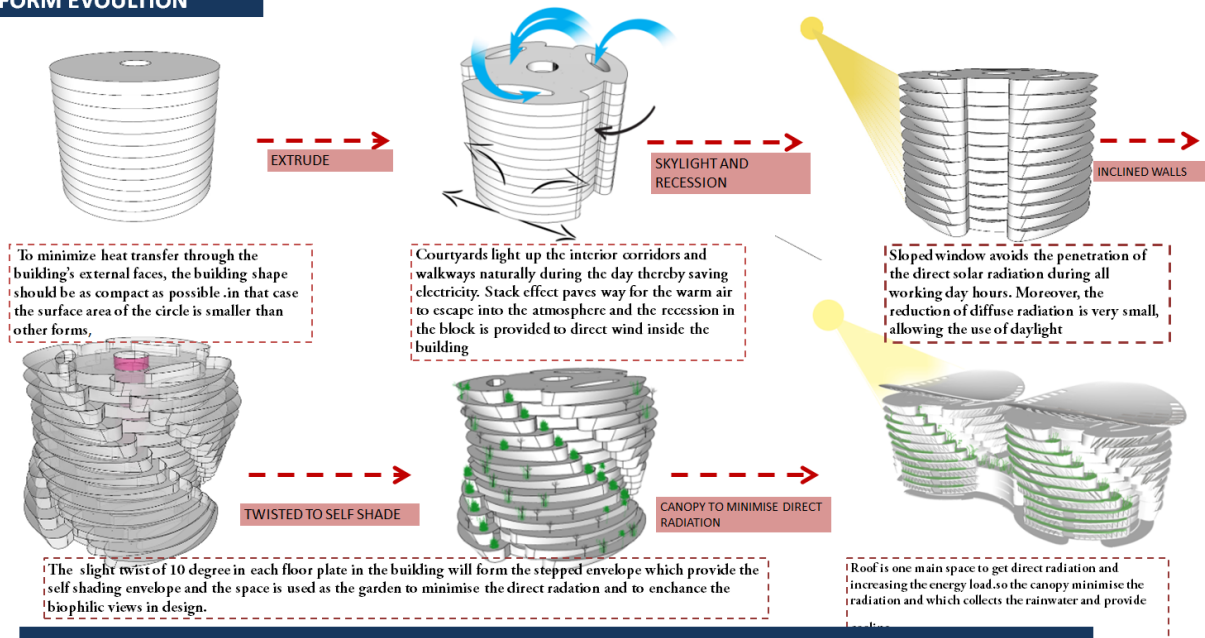


SHADOW ANALYSIS



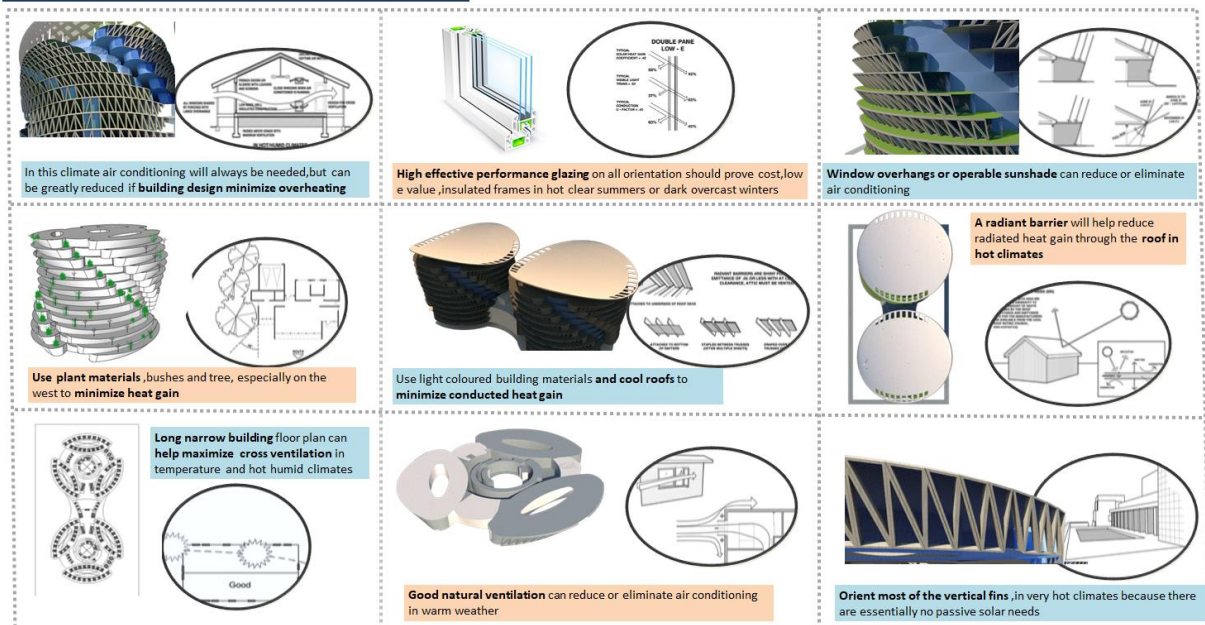
MANJULA.S-39890011 SATHYABAMA UNIVERSITY ARCHITECTURAL THESIS M.ARCH SUSTAINABLE

FORM EVOLUTION



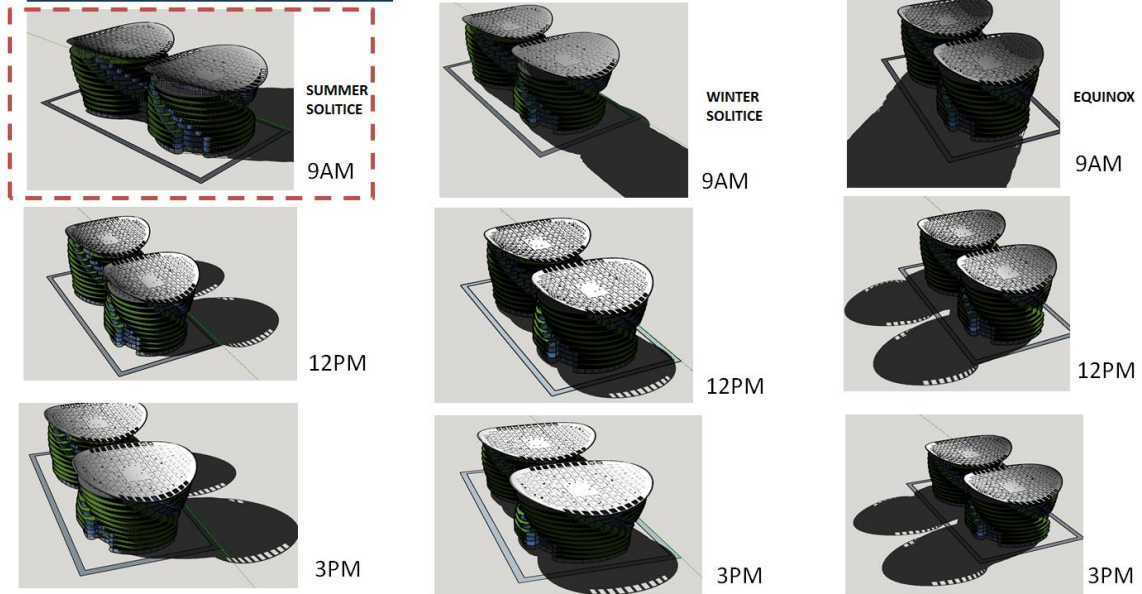
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DESIGN STRATEGIES



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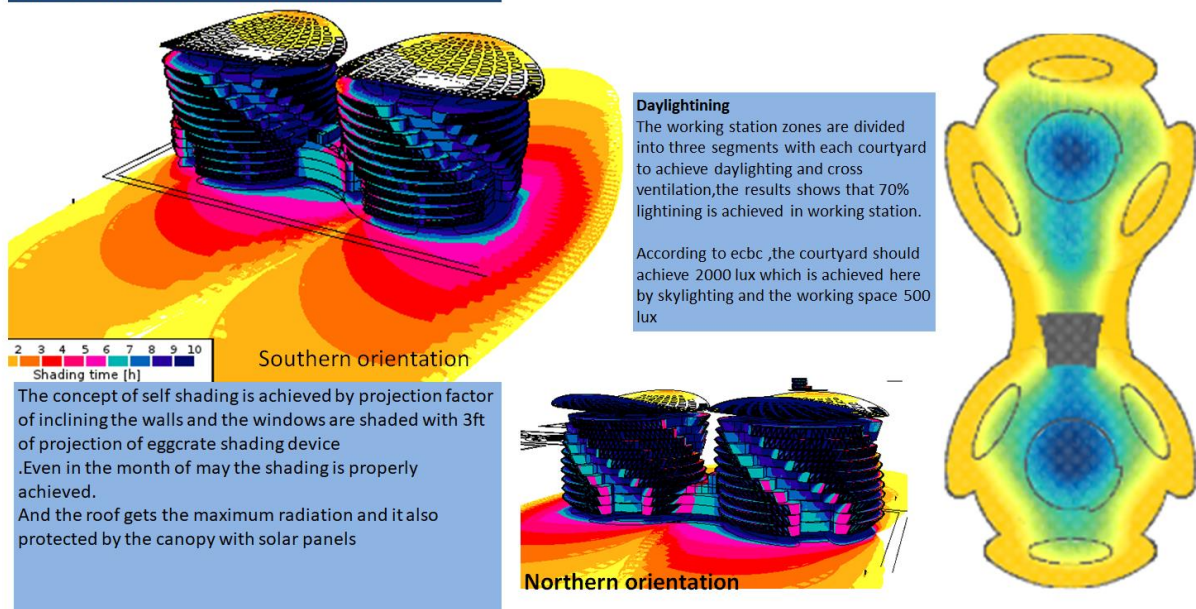
SHADOW ANALYSIS



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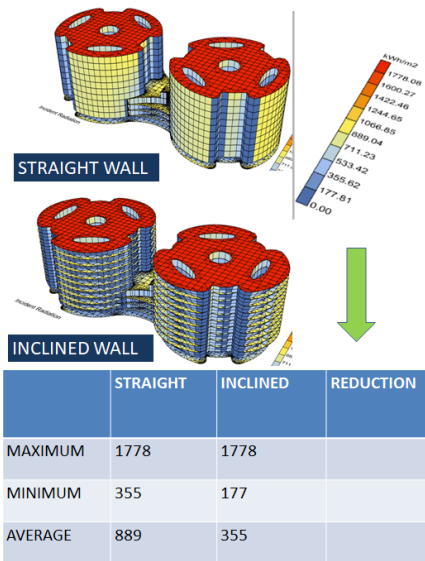
SHADOW ANALYSIS AND DAYLIGHT ANALYSIS



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ITERATION OF SOLAR RADIATION ANALYSIS



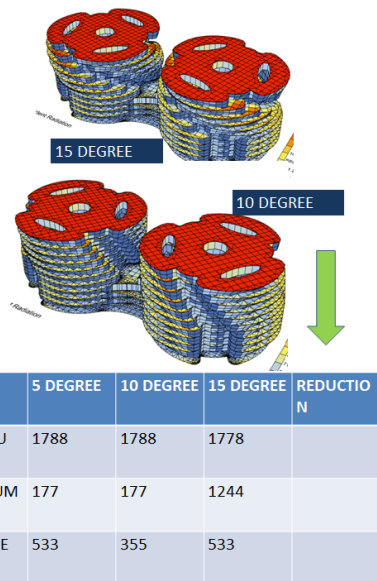
Self shading parameters

On the concept of self shading parameters for building envelope the followings are
 Curvature ,flexible design
 Inclined wall than straight, due to inclined wall the radiation get obstructed and there will be a diffused radiation on the building envelope.

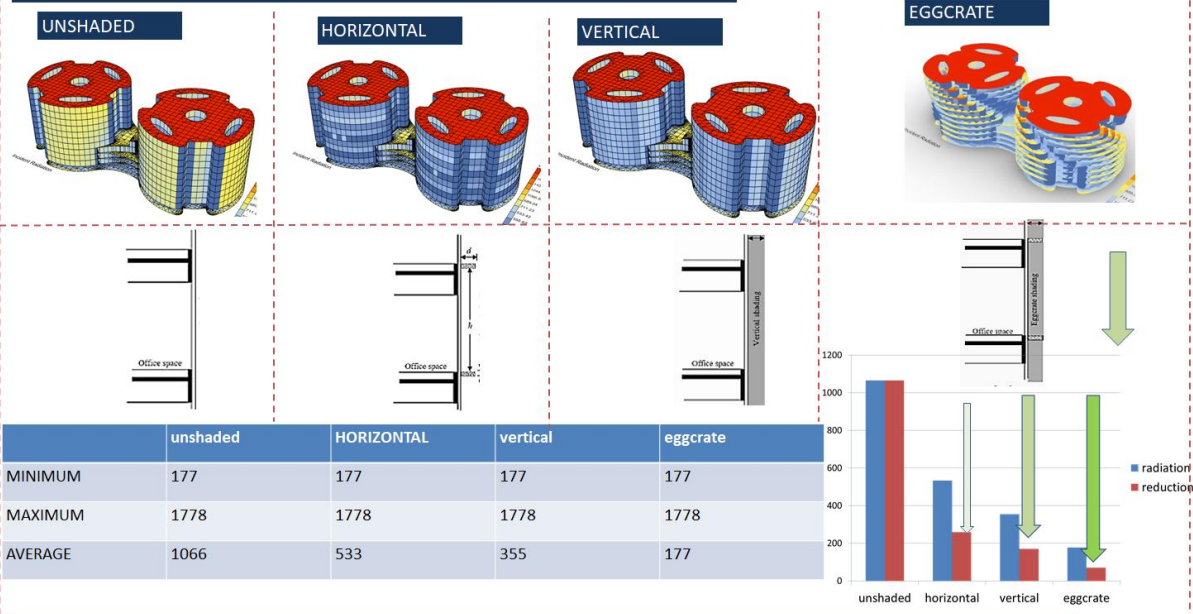
And on the tilting the building get twisted and the projection area will act as the shading device for the below floor plates. on the analysis of both iteration **inclined** and the tower is twisted for **10 degree** to get minimum amount of direct radiation. The results are taken in grasshopper rhinoceros

INFERENCE The reduction factor on solar radiation is seen in by using inclined wall and in twisting the tower of 10 degree

ITERATION ON TILTING

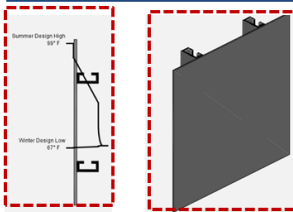


ITERATION ON DIFFERENT TYPES OF SHADING DEVICE ON RADIATION ANALYSIS



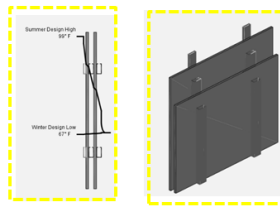
TIME LAG ANALYSIS OF GLAZING

SINGLE GLAZED



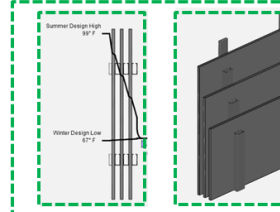
The time lag occurs for every 2 hours in single glazed. The heat loss in peak months receives 18-17 btu/sqft

DOUBLE GLAZED

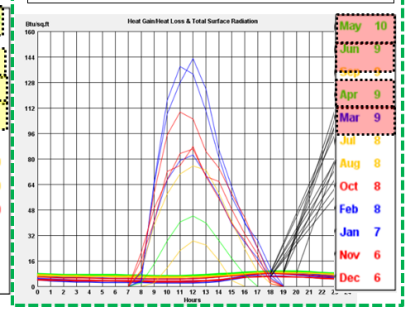
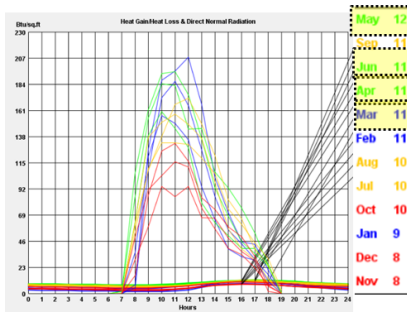
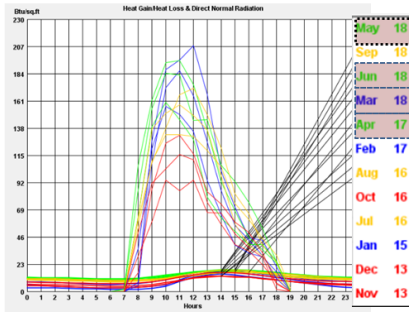


The time lag occurs for every 4 hours in double glazed. The heat loss in peak months receives 12-11 btu/sqft

TRIPLE GLAZED



The time lag occurs for every 6 hours in triple glazed. The heat loss in peak months receives 10-9 btu/sqft



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ENERGY ANALYSIS OF GLAZING

The most commonly glazing material used in openings is glass, although recently polycarbonate sheets are being used for skylights. Before recent innovations in glass, films and coatings, a typical residential window with one or two layers of glazing allowed roughly 75%-85% of the solar energy to enter a building

SELECTION OF GLAZING

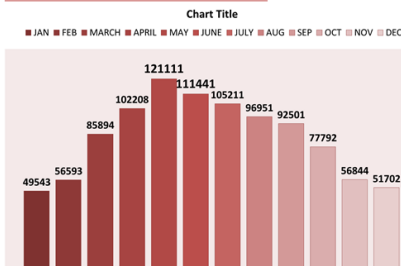
Warm and humid climate:

minimum VLT of glazing = 0.27

Maximum effective s.h.g.c = 0.25

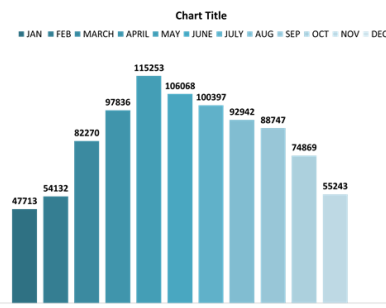
s.h.g.c of glazing-effective s.h.g.c/multiplication factor
glazing with higher u value to minimize conductive heat gain

COOLING LOAD OF SINGLE GLAZING



Single glazing has a
U-value of 5.6
VLT - 72%
SHGC-0.70

COOLING LOAD OF DOUBLE GLAZING



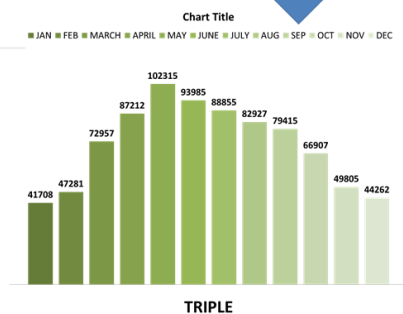
DOUBLE
Double glazing a rating
U value of 2.8
VLT -70%
SHGC-0.39
In the peak months the radiation has been gradually reduced from 121111 kw/hr to 115253 in the month of may
Reduction by 5%

COOLING LOAD OF TRIPLE GLAZING

Triple glazing has been estimated to reduce energy bills by up to 50%.

Triple glazing can offer a
U-value of 0.8
VLT-64%
SHGC -0.27

The radiation is drastically reduced from 121111kw/hr to 102315 in the month of may
Reduction by 5%



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BUILDING MATERIALS AND ROOF

Embodied Energy, Thermal performance, cost and recyclability primary characteristics for material selection.

AAC Block work and RCC framed structure

AAC Block work and steel frame work, and precast

SCIP Structural concrete insulated panel

WALLING MATERIAL OPTION

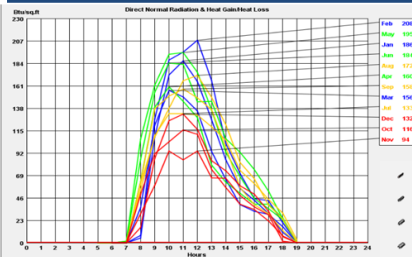
material	Embodied energy	properties	components	details
Cellular light weight concrete block	232mj/m ²	Minimum thickness 0.200m Default thickness 0.200m Maximum thickness 0.400m	Plaster finish Light weight concrete block Plaster finish	Total thickness 222 Total R value 1.3 Total U value 0.769 Decrement factor 0.45 Time lag 8.01
Common brick wall with internal plaster	1616mj/m ²	Minimum thick 0.18m Default thick 0.200m Maximum thick 0.354	Plaster finish Common brick Plaster finish	Total thick 123 Total R value 0.36 Total U value 2.851 Decrement factor 0.81 Time lag 8.19
Autoclaved aerated concrete blocks	341mj/m ²	Minimum thickness 0.124m Default thickness 0.200m Maximum thickness 0.324m	Plaster finish Aircrete (autoclaved aerated concrete blocks) Plaster finish	Total thickness 222.0 Total R value 1.2 Total U value 0.755 Decrement factor 0.41 Time lag 1.49
Compressed stabilized earth blocks	227mj/m ²	Minimum thickness 0.124m Default thickness 0.200m Maximum thickness 0.324m	Plaster finish Ordinary portland cement Stabilized soil blocks Plaster finish	Total thickness 222.0 Total R value 0.4 Total U value 2.40 Decrement factor 0.44 Time lag 6.31

Excellent waterproofing
Efficient use of space
Ultra-violet protection
Fire-resistance
Low-maintenance
Less costly than other systems

Material Name	R Value	Thickness	R Val
Concrete	0.103	152.0	0.103
Air Space (infilling)	0.103	152.0	0.103
Concrete	0.103	152.0	0.103
Air Space (infilling)	0.103	152.0	0.103
Concrete	0.103	152.0	0.103
Air Space (infilling)	0.103	152.0	0.103
Concrete	0.103	152.0	0.103
Air Space (infilling)	0.103	152.0	0.103
Concrete	0.103	152.0	0.103
Air Space (infilling)	0.103	152.0	0.103
Concrete	0.103	152.0	0.103



DIRECT RADIATION OF BUILT OF ROOFING

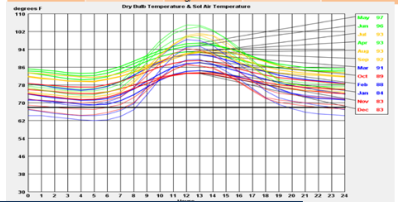


Built-up roofing systems are an evolution of the asphalt roofing method. As compared to other roofing materials (such as metal roofs), BUR roofing membranes are created through a layering process of bitumen and reinforcing fabrics.

The minimum direct radiation of 150btu/sq.ft is achieved in peak months and it lower the radiation the roof is covered by roof garden and its covered by canopy structure to protect the roof from direct radiation

INTERMEDIATE FLOOR OPTION

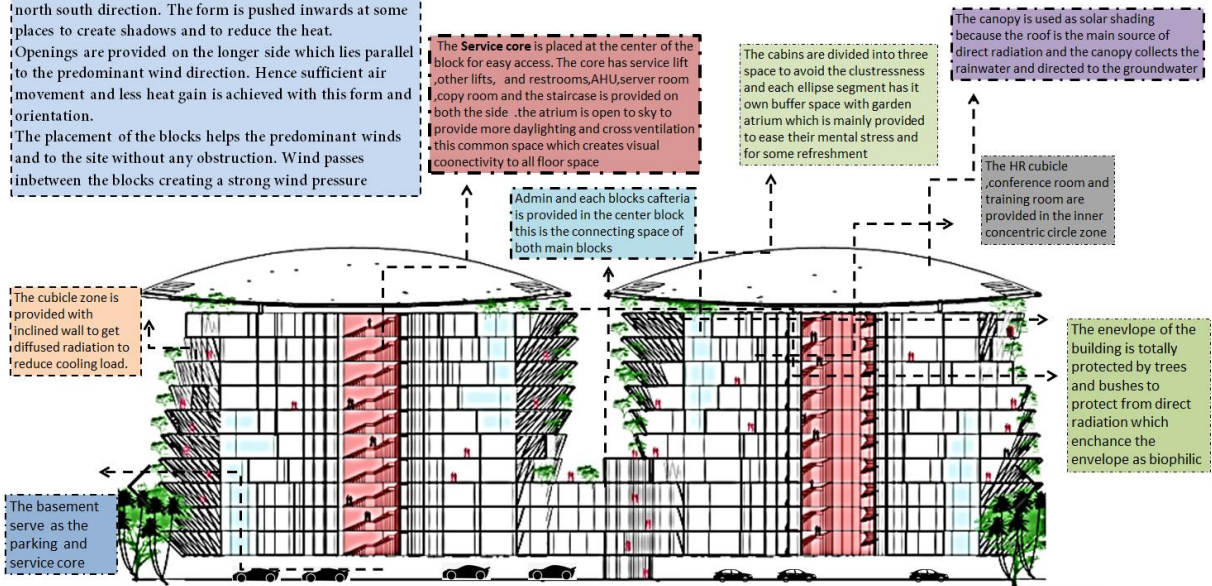
material	Embodied energy	properties	components	detail
Concrete filler slab	471mj/m ²	Minimum thickness 0.100m Default thickness 0.200m Maximum thickness 0.300m default reinforcement 11.0kg/m ²	Concrete Hollow filler blocks Steel reinforcement Plaster finish	
Precast rc planks and joist system	470mj/m ²	Minimum thickness 0.100m Default thickness 0.120m Maximum thickness 0.200m Default reinforcement 11.0kg/m ²	Concrete Precast concrete flooring panels Steel reinforcement for panels and joists Plaster finish	
In-situ trough concrete slab	434mj/m ²	Minimum thickness 0.225m Default thickness 0.300m Maximum thickness 0.500m Default reinforcement 11.5kg/m ²	Concrete steel reinforcement Plaster finish	
In-situ reinforced concrete slab	667mj/m ²	Minimum thickness 0.100m Default thickness 0.200m Maximum thickness 0.250m Default reinforcement 20.0kg/m ²	Concrete Steel reinforcement Plaster finish	



The zoning is done based on the orientation to minimize heat radiation and the circular block with longer axis facing north south direction. The form is pushed inwards at some places to create shadows and to reduce the heat. Openings are provided on the longer side which lies parallel to the predominant wind direction. Hence sufficient air movement and less heat gain is achieved with this form and orientation.

The placement of the blocks helps the predominant winds and to the site without any obstruction. Wind passes inbetween the blocks creating a strong wind pressure

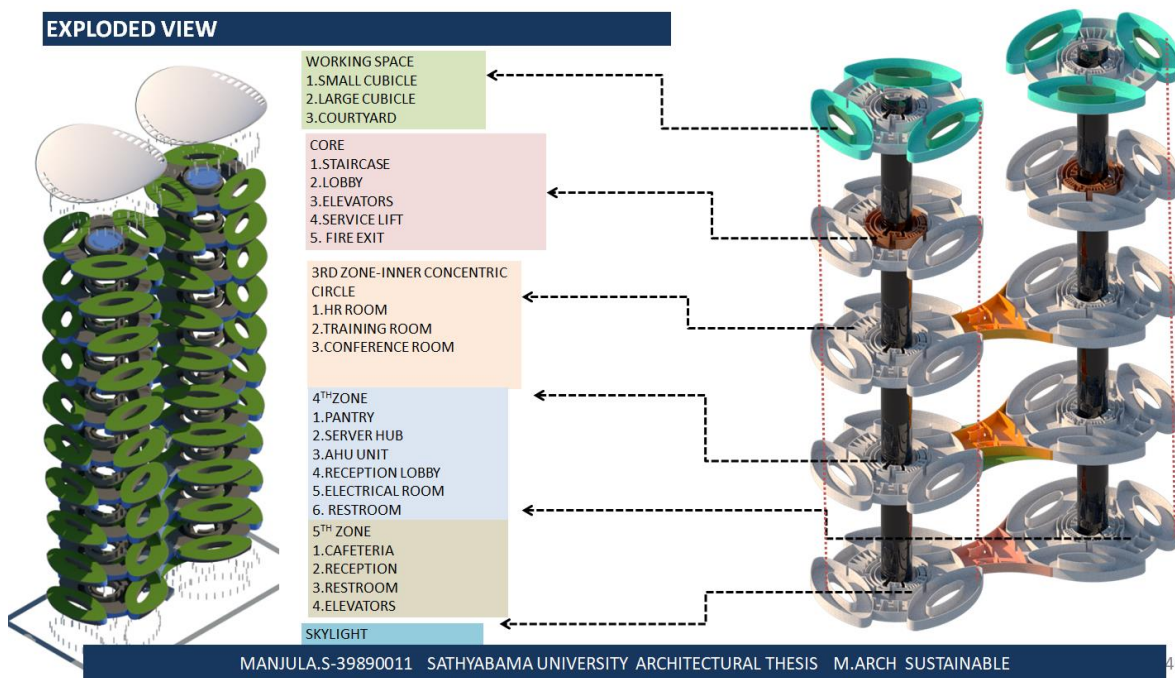
Section



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EXPLODED VIEW



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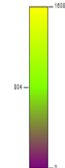
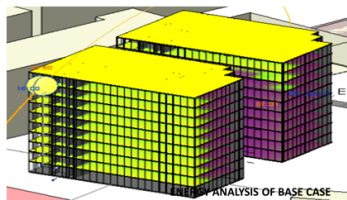


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COMPARATIVE ENERGY ANALYSIS OF BASE CASE AND PROPOSED CASE

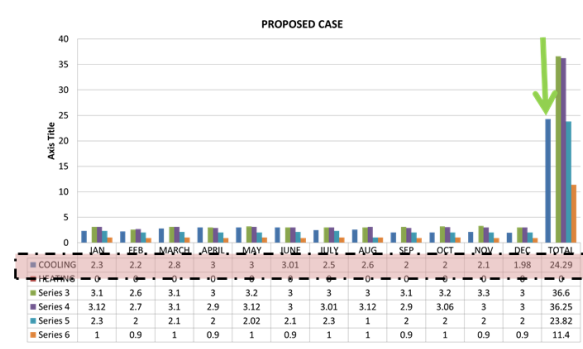
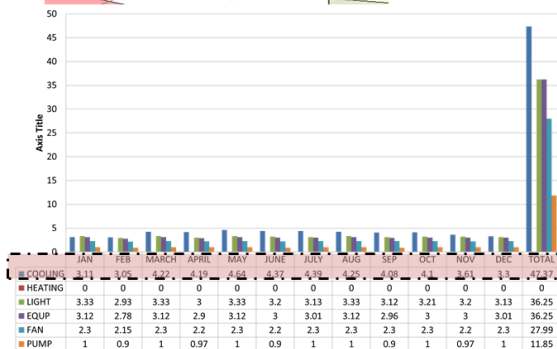
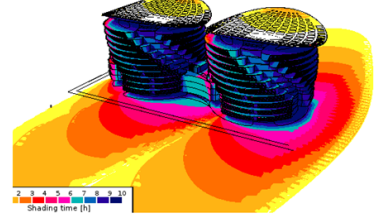
BASE CASE



INFERENCE

COMPARING BOTH THE CASES, WHICH HAS THE SAME OCCUPANCY SCHEDULE, BUT STILL THE ENERGY HAS BEEN REDUCED DUE TO SELF SHADING PARAMETERS USED IN THE DESIGN AND THE USAGE APPROPRIATE GLAZING AND SHADING DEVICE. THE COOLING LOAD IS REDUCED FROM 47.379 KWH/M2-24.49 KWH/M2

PROPOSED CASE



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