

RESEARCH AND ENTREPRENEURSHIP CENTER

A Thesis

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

By

INDRAVARMAN A (39890008)



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

SATHYABAMA

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

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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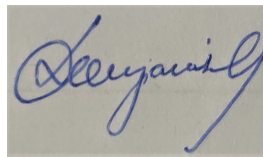
BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **INDRAVARMAN A (39890008)** who carried out the Thesis entitled "**RESEARCH AND ENTREPRENEURSHIP CENTER**" under our supervision from January 2021 to May 2021.

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DECLARATION

I **INDRAVARMAN A** hereby declare that the Thesis Report entitled “**RESEARCH AND ENTREPRENEURSHIP CENTER**” done by me under the guidance of **Ar. DEEPALAKSHMI** (Internal) and **Ar. BALAMURUGAN RAJKUMAR, Principal Architect -Proton Ateliers** (External) at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Master of Architecture degree in Sustainable Architecture.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

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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.

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I would like to express my sincere and deep sense of gratitude to my Project Guide **Ar. Deepalakshmi** 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

Old buildings are the main features from which one can easily identify neighborhoods their distinct character and at the same time also connects to the past. Sometimes buildings start their original purpose for which it was built. This results in the implementation of adaptive reuse of in order to make the existing building and surroundings active once again. When the original use of a building or complex changes or is no longer required, architects have the opportunity to bring or propose change the primary function of the structure, while keeping some of the existing architectural details and zoning that make the building unique. The conservation and sustainable development in the urban area provide economic, social, and environmental benefits to a community and its stake holders. The conservation of the built structures is not only a contributor towards the economic and environmental composition of a community, but also to the social and cultural identity, which helps to create dynamic places, and defines the 'spirit, character and sense of a place.

1.2 AIM

The aim is to provide systematic approach in revitalizing the unused construction site avoid the site from being abandoned. The main aim is to make the unused building to usable more functioning space in a sustainable approach.

1.3 OBJECTIVE

To study the practice of the adaptive reuse and identify the approach to the buildings.

To study about the factors that need to be understood, documented and focuses on the existing plan and condition of the buildings.

To analyze about the existing building and to evaluating with the suitable function to the building in a sustainable manner. .

To provide the ways of much-needed approach in the adaptive reuse and making them the function in the contemporary times.

1.4 LIMITATIONS FOR THE STUDY

The structural constraints involved in the approach of design. To make fit the new use into existing buildings were challenging.

Requires expensive mitigation process due to the environmental contaminants.

Case study and measurements area limited through literature reviews. Hence data from existing papers are taken into the study.

1.5 RESEARCH QUESTIONS

1. What are the challenges, opportunities and role of adaptive reuse?

2. How can it revitalize the building from the abandonment in a sustainable manner?
3. What function can be adopted in the building?

2 LITERATURE REVIEW

2.1 WHAT IS ADAPTIVE REUSE?

Adaptive reuse is the process of taking an old building or site, and reusing it for a purpose other than it was designed. Typically, it is closely related to historic preservation or conservation around cities with rich history. Adaptive reuse of buildings can be an attractive alternative to new construction in terms of sustainability. It has prevented thousands of buildings demolition and has allowed them to become critical components of urban regeneration.

2.2 CO – WORKING SPACE:

They look like an office without the rigidity of one. Co-working offers social opportunities, networking prospects, and general human interaction in place of the isolation of working strictly from home.

Co-working takes the most important and expensive business cost—the workplace—and turns it into a service. The space-as-a-service model unburdens balance sheets and creates workforce flexibility.

Benefits of co-working space:

- Co-working benefits both companies and employees. For companies, it's all about cost savings. On the employee side, it's about having the freedom to work in a way that's best for every individual. As the demise of the traditional workplace creates more remote workers, benefits will increase:
- Allows employees to work remotely in a professional setting
- May prove more cost-effective for businesses, opposed to a larger lease
- Improves networking opportunities for mobile workers.
- Diverse space types, from individual workstations to group spaces.



RESEARCH PARKS:

Research and development parks are helps to develop the innovation, commercialization and economic development through collaborations between industry and universities. Research parks are provides a bridge where industries carry out their research in a collaborative environment.

Benefits of Research and development parks:

Creating a collaborative environment between industry and academic through joint research projects and consulting assignments.

Developing a self-sustaining and technologically fertile environment. Encouraging and enabling R&D activities that are aligned to potential need of the industry.

Enabling development of high quality personal and motivating professional growth for researchers in the companies through part time.

2.3 WHY ENTREPRENEURSHIP CENTRE?

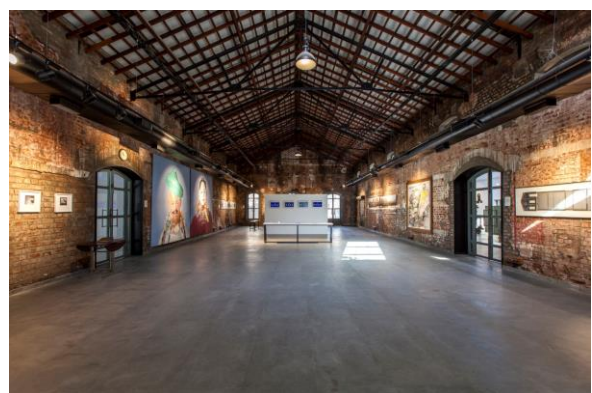
The site located in the special economic zone and the surroundings are with numerous IT park and the engineering colleges. This centre will act as the bridge with students and the experts. This research lab will promote the students to come up with their new ideas and this will helps to communicate the students with the workers and the entrepreneurs.

The main aim of this centre is to encourage multi-disciplinary collaborations and to provide a common platform to a diverse range of individuals and companies to come together to share resources and knowledge. These informal spaces helps in networking and resolving problems in a collective manner. They provide a space to work with the interaction with the other people.

3. CASE STUDIES:

3.1 ALEMBIC INDUSTRIAL HERITAGE AND REDEVELOPMENT AT VADODARA

Alembic industries is a 92 acres of industrial campus in the heart of the Vadodara established in 1907 and growing ever since. The scope of products manufactures over these years range from year glassware to tinctures, spirits, dry ice, ethyl chloride, carbon dioxide etc. the client urged for a new masterplan for the entire campus to convert it into a corporate hub inclusive of a few buildings, manufacturing units, retail units and recreational facilities.



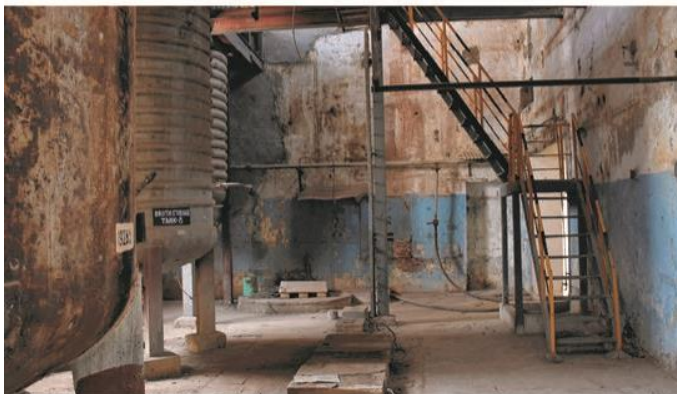
PLAN:



SECTION:



BEFORE RENOVATION:



APPROACH:

Architectural purpose was to approach this is a sculpture is to maintain the true spirit of the building in terms of materials and the physical quality of the space. The only new architectural elements are new partition walls in between studio spaces.

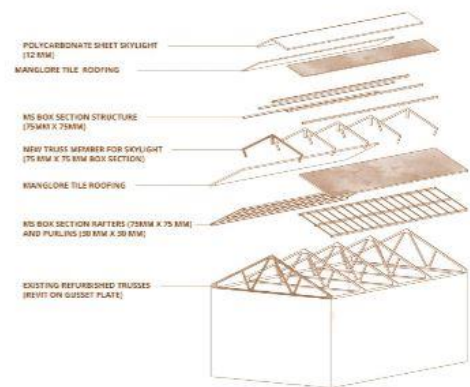
The existing building is characterized by arches, which have been blocked. We are opening up as many arches considering the structure of it.

DESIGN APPROACH:

- Major architectural element is the design of the roof.
- The trusses are riveted as opposed to being welded. The detail of the riveted trusses, is riveting.
- Many of the trusses are in great condition. Only a handful of the trusses will require strengthening.

MATERIALS USED:

- The existing exterior roof material is of Mangalore tiles.
- These terracotta tiles are battered and will have to be removed.
- New Mangalore tiles will be installed with added insulation above the top-chord of the truss.
- We are very keen to leave the purlins and rafters exposed to express the quality of the structure.
- The material majorly used was the masonry with lime plaster and for pitched roof they used steel truss and the Mangalore tile.



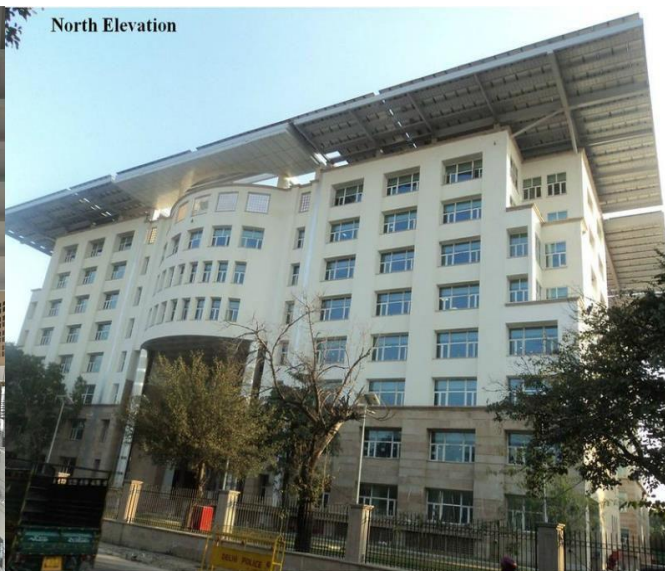
Inference:

Since the building was too old and they want to refurbish the building. They used the questionnaire survey method to reduce the cost efficiency and they categorize the renovation as per mentioned in the literature review.

3.2 INDIRA PARIYA BHAWAN

This is a project of ministry of environment and forests for construction of new office building at New Delhi. The basic design concept of the project is to make the net zero energy green building. The plot is easily approachable from aurobindo Marg and Lodi road.

- PLOT AREA:9565sq m
- Maximum ground coverage:30%
- F.A.R: 200
- Height:35m
- Built-up area : 3,1400 m²
- (18726 m² – superstructure & 12675 m²- Basement)
- Year of completion : 2013
- The site is surrounded on east by NDMC housing15M. Row, on west by 12m row and on north Lodi colony and 12m.



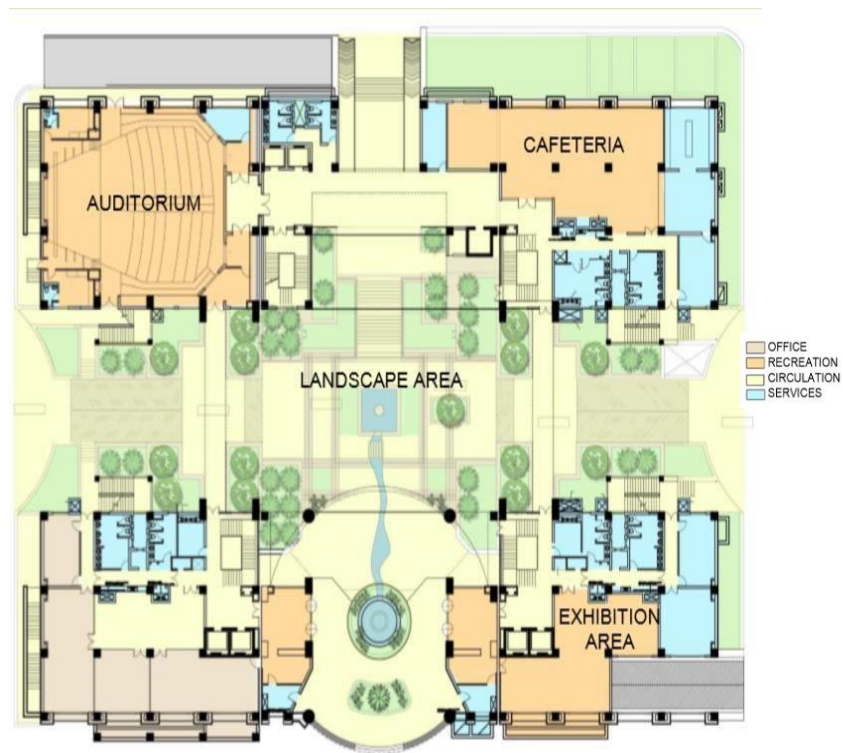
ACHIEVEMENT:

- 40% savings in energy
- Zero electricity billing
- 55% saving in water
- Zero net discharge
- Largest roof top solar power in many multistoried buildings.(930KWP)
- First in government sector targeted for both ratings of green building (5 star griha LEED India platinum)

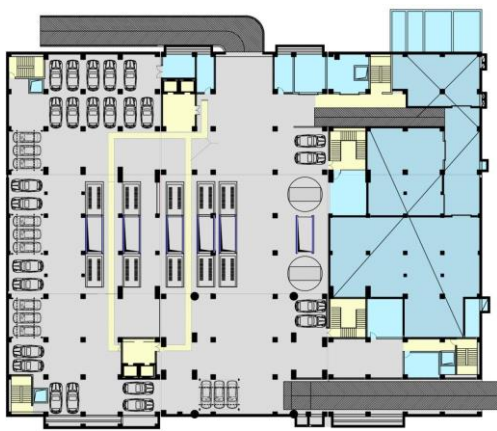


- Wider Front Setback (22m) to protect front tree line.
- Preserve the integrity of the green street.
- Preservation of the local ecology, Tree Cutting approvals for 46, but only 19 cut 11 Trees Transplanted.

Excavated Soil reutilized at other construction sites and the Zoo. The IPB office building for the ministry of environment and forests has been planned in 2 parallel blocks facing the north south direction, with a large linear open court in the center. The Building blocks create a porous block form to optimize air movement throughout the site and the N- S orientation allows for optimum solar access and shading. More than 50% area outside the building is soft with plantation and grassing. Circulation roads and pathways soft with grass paver blocks to enable ground water recharge.



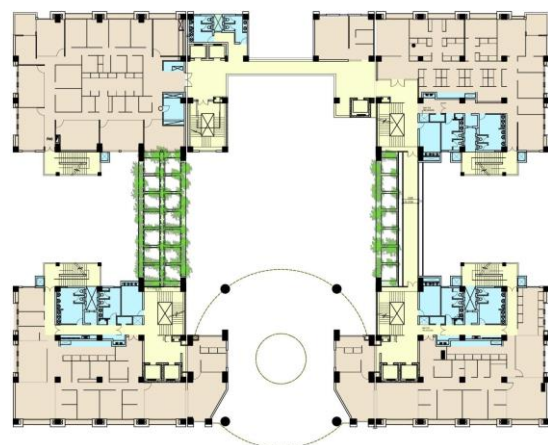
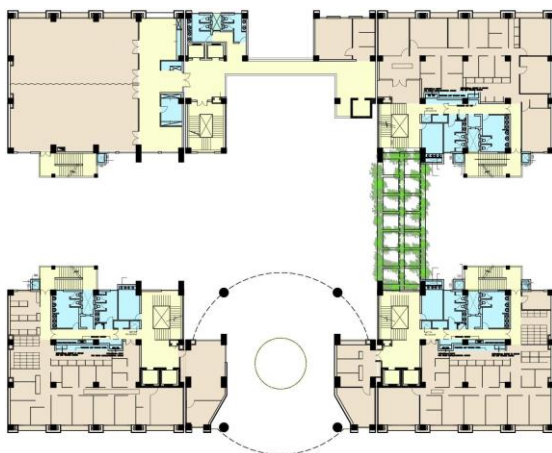
Site plan

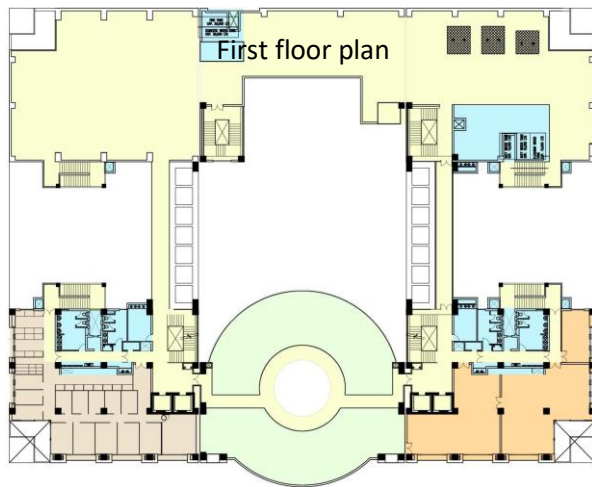


Parking Plan

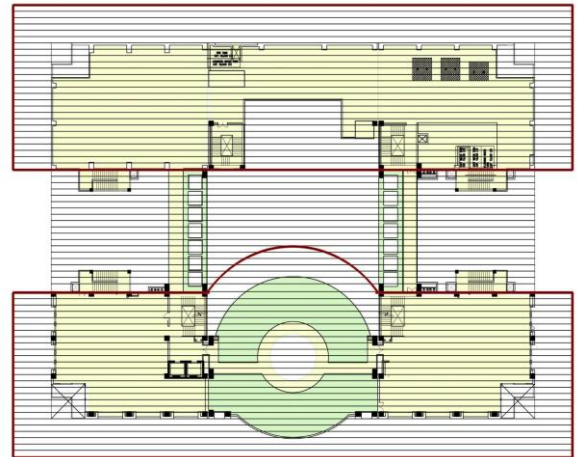


Parking Plan



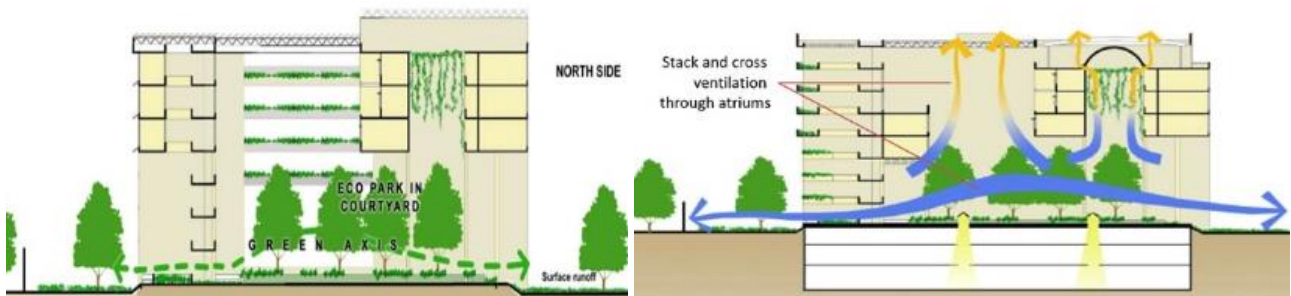


Open terrace garden

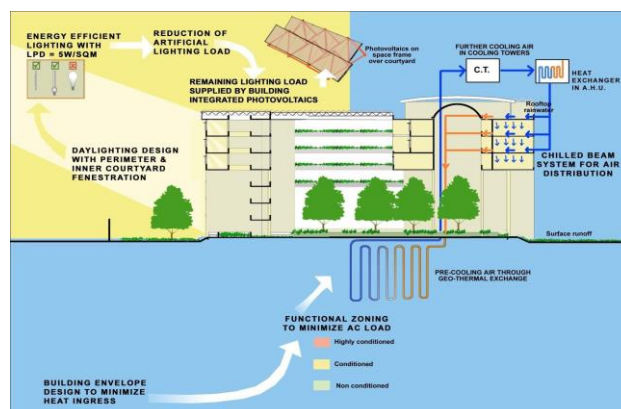


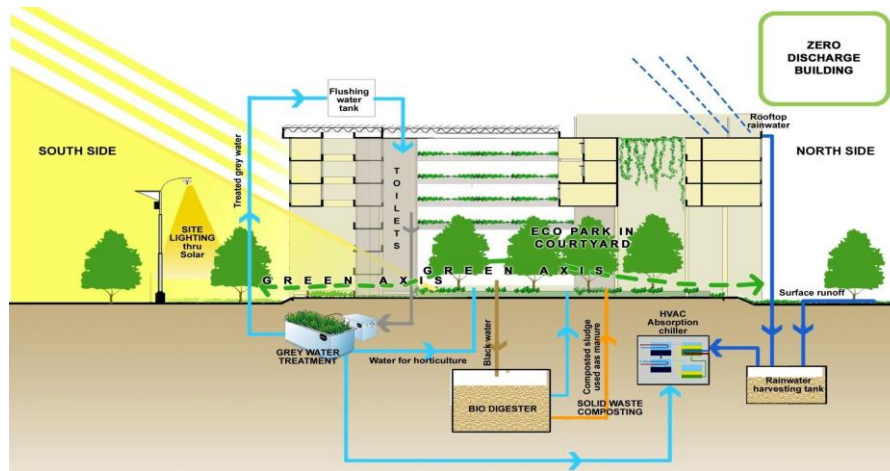
Solar panel plan

Zero tolerance to surface parking to reduce heat island First Basement Parking with Automated parking below. Helps reduce volume of parking / excavation / embodied energy of structure. Automated Parking with 19sqm/car instead of 35sqm/car in manual parking Keeping Service Areas, Staircases on low light areas. Efficient Usage of the perimeter to maximize sunlit areas and views for the users. Provision of Solar Photovoltaics for Net Zero requirement also Shades the Roof.



Maximum Ground Coverage Used (30%) to keep building height comparable to the surroundings. Respecting the Eco-logic of the site. Building Punctures & jalis to Aid Cross Ventilation and maximizing non-conditioned spaces like lobbies, passages, service areas Photovoltaics stepping towards the south side creating a strong agenda for the future for urban buildings on limited site areas. Effective ventilation by orientating the building E-W and by optimum integration with nature by separating out different blocks with connecting corridors and a huge courtyard.





Reduce landscape water requirement:

- Drip irrigation
- Use of native species of shrubs and trees having low water demand in landscaping.
- Low lawn area so as to reduce water demand.
- Reuse of treated water for irrigation

Reduce water use in the building:

- Low discharge fixtures
- Dual Flushing cistern
- Waste water treatment
- Reuse of treated water for irrigation and cooling towers for HVAC
- Rain water harvesting
- Efficient water use during construction-Use of curing compound.

SYSTEM

- Variable chilled water pumping system through VFD.VFD on cooling.
- Fans and AHU.
- Pre cooling of fresh air from toilet exhaust air through sensible & latent heat energy recovery wheel.
- Entire hot water generation through solar panels.
- Maximum daylighting.
- Regenerative lift.
- Use of LUX level sensor to optimize operation of artificial lighting.
- Solar powered external lighting.

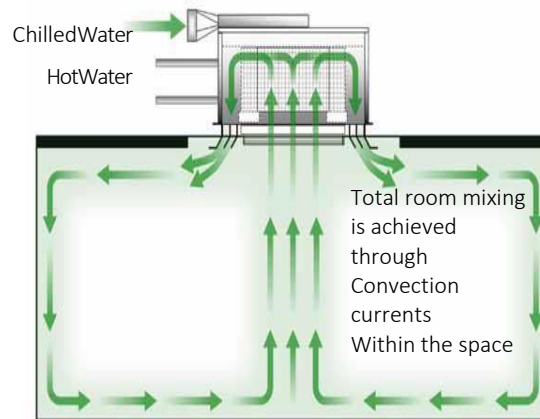
Optimize energy performance of building within specified comfort limits-

Reducing energy consumption (compared to GRIHA benchmarks) while maintaining occupant comfort:

For achieving visual comfort:

Direct line of sight to the outdoor environment to vision glazing for building occupants for more than 90% of the occupied spaces.

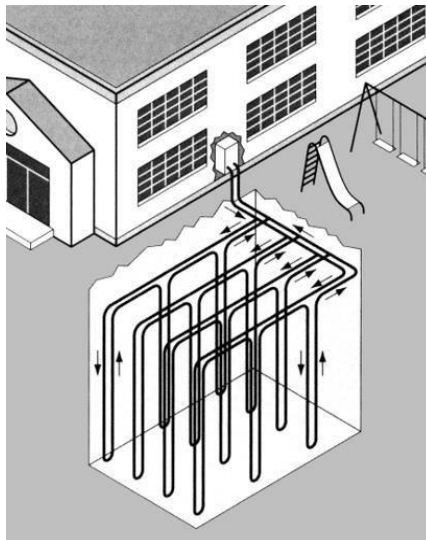
Avoiding Deep floor plates to create maximum day lighted spaces. Landscaping planned with native species and water body features in central court and all around the building.



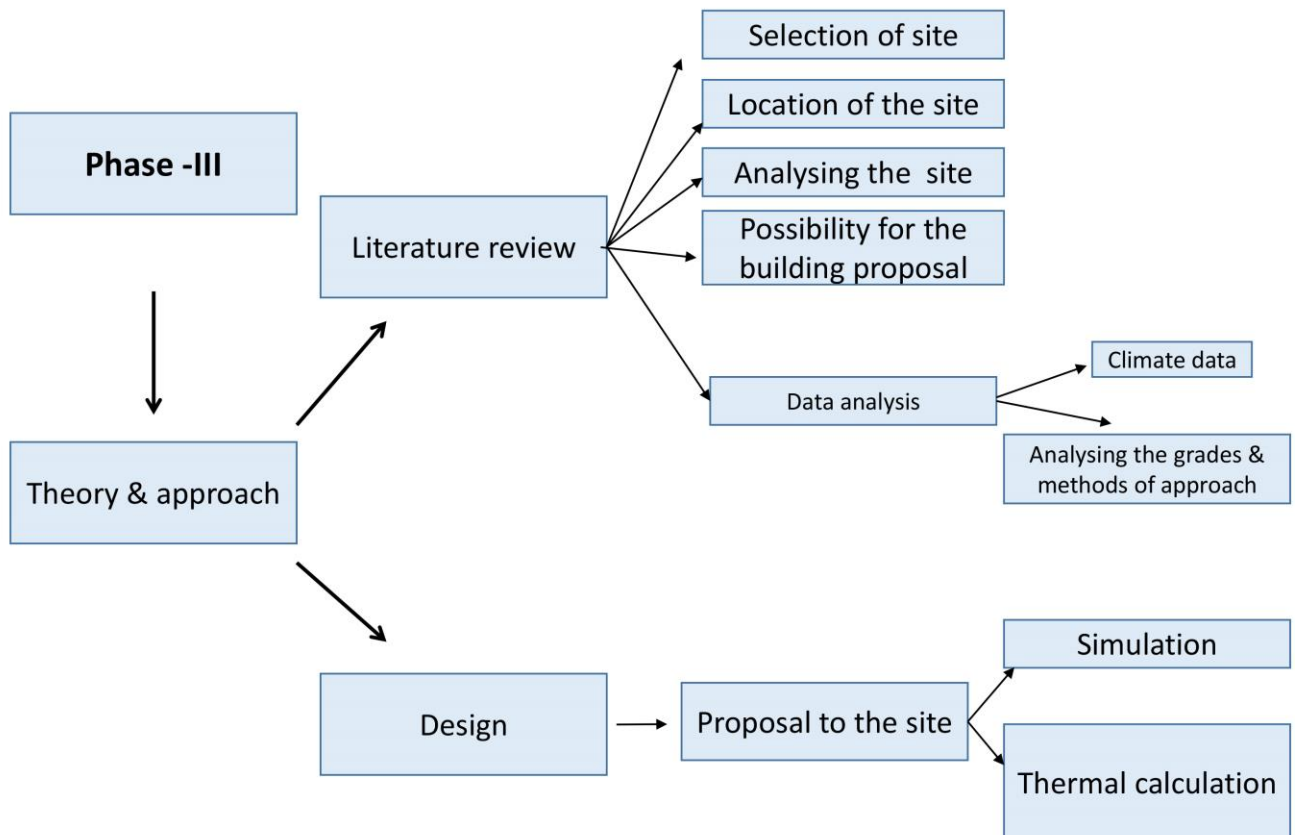
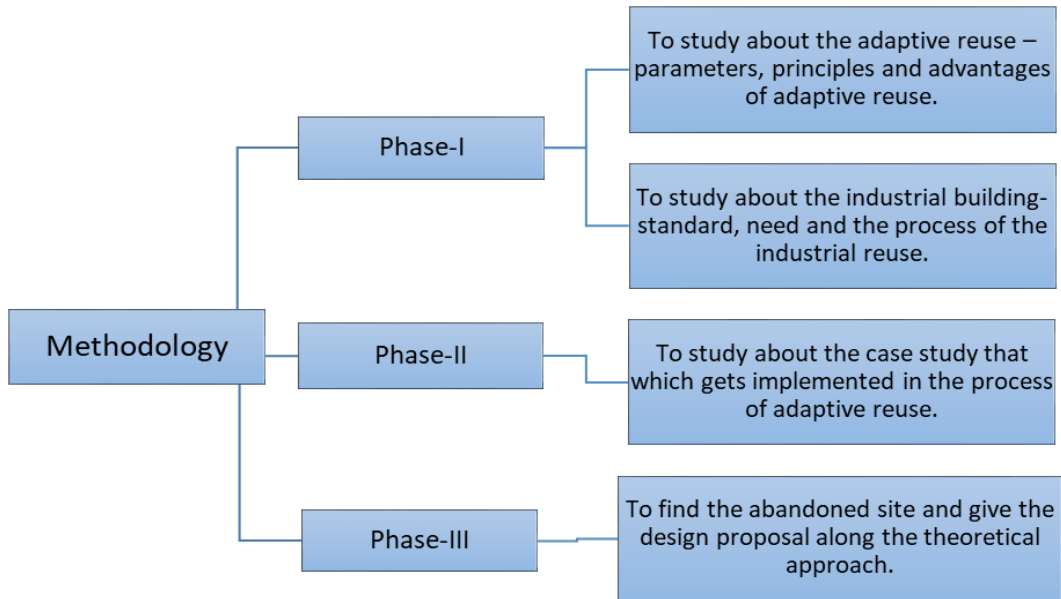
GEOTHERMAL HEAT EXCHANGE

There are 180 vertical bores at the Depth of 80 meter all along the Building Premises. Minimum 3 meter distance is maintained between any two bores. Each bore is lowered with HDPE pipe U-loop (32mm outer Dia.) and grouted with Bentonite Slurry. Each U-Loop is connected to MS Header Pipe (100mm Dia.) Which finally joins the Condenser Water Line in Plant Room. Condenser hot water is sent at 100°F (37.8° C) & back at 90° F (32.2° C).

- Rejection capacity, so all together 160 TR of Heat rejection is obtained without using a cooling tower. Enormous water saving since no makeup water is required.
- Make up water pumping & treatment cost get eliminated.
- Saves cooling tower fan energy.



4.0 METHODOLOGY:

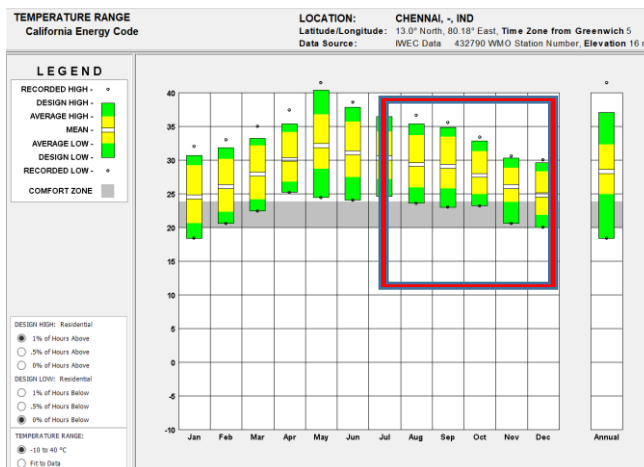


5 CLIMATE ANALYSIS

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.

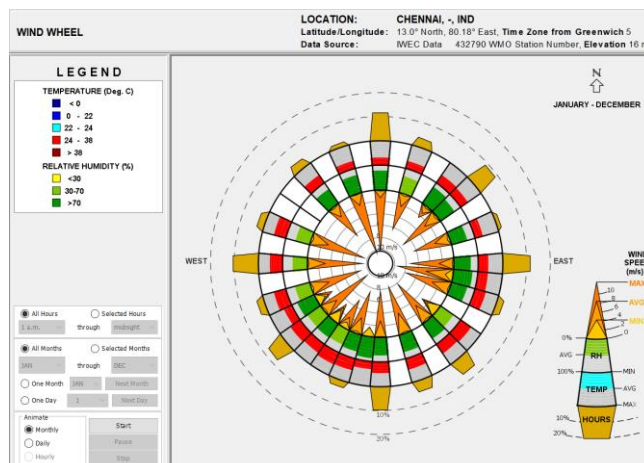
Temperature range:

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.



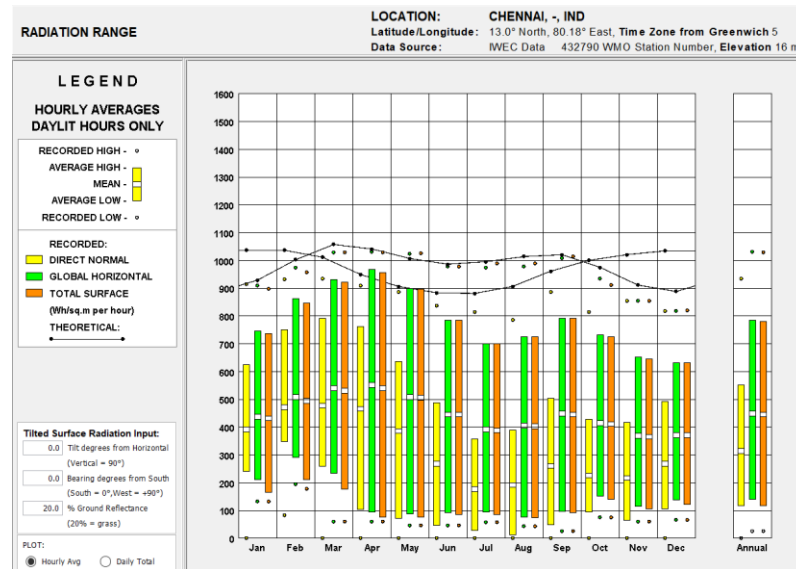
Wind wheel:

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:

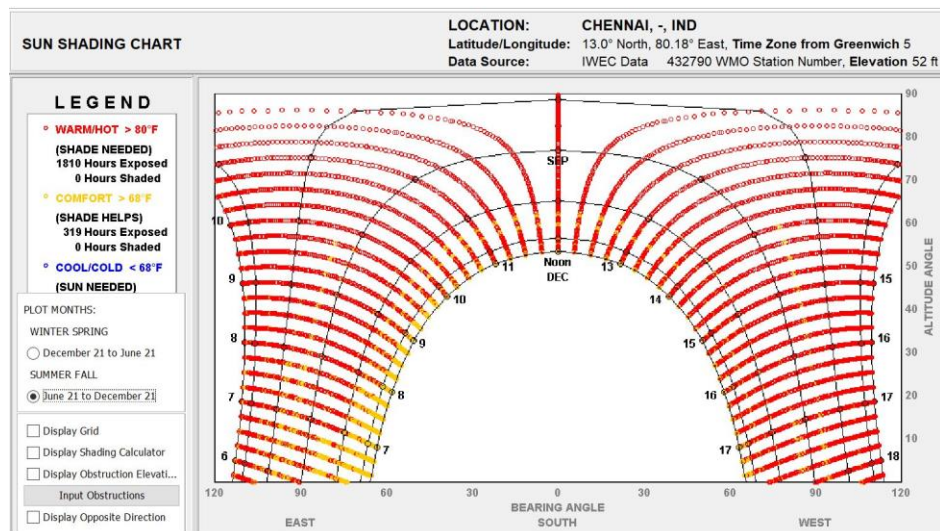
The radiation range of Chennai recorded as high in the months of March and recorded low in the month of October. The Radiation chart explains about the level of radiation recorded in the region throughout a year. A theoretical radiation range is fixed to compare the measured level of radiation with the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



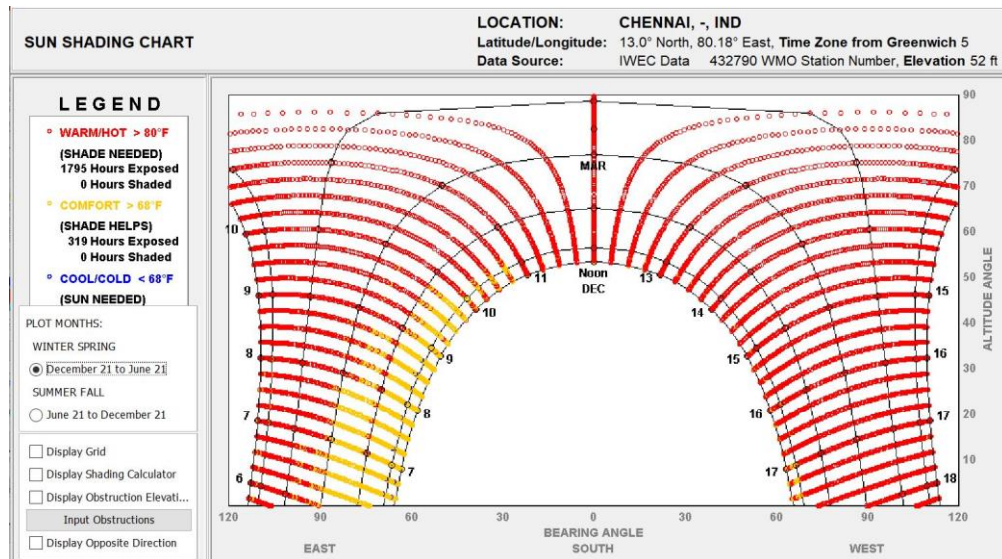
SUNSHADING CHART:

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.

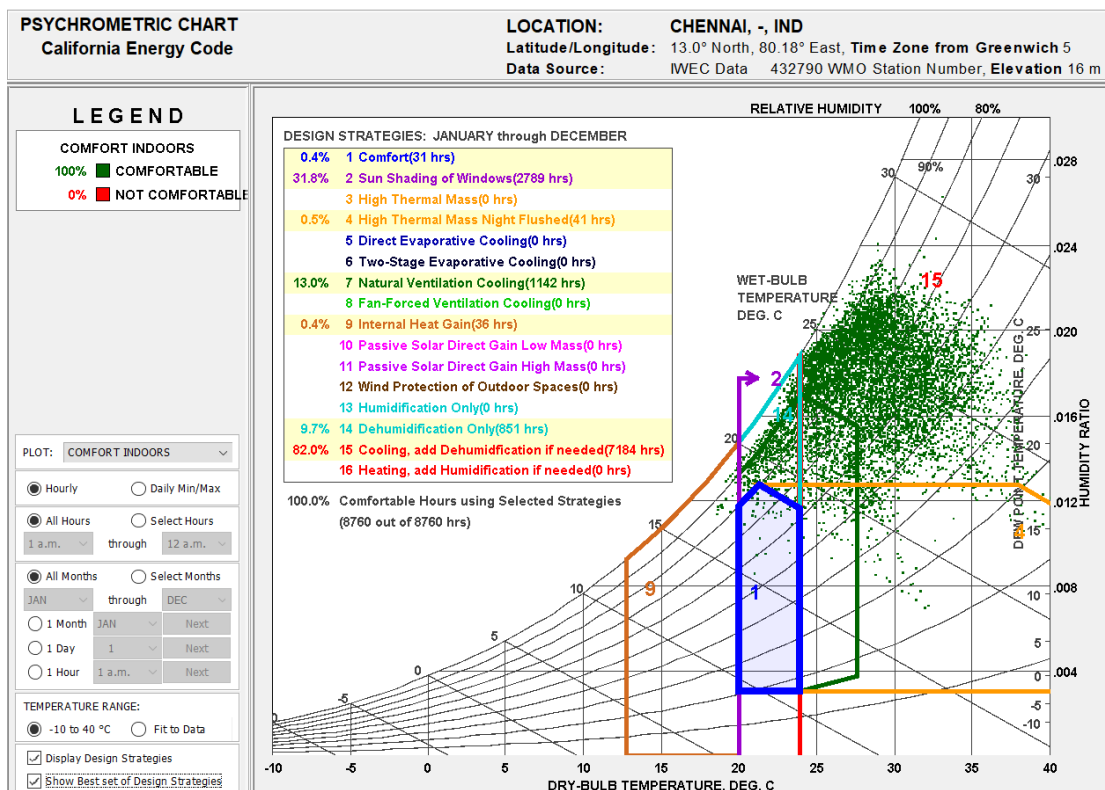


DECEMBER TO JUNE:



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:



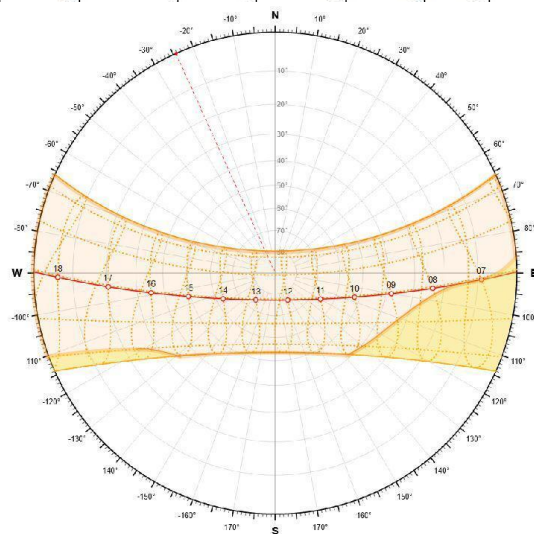
From the psychrometric chart it's clearly stated that 100% of comfort is achieved by using

Passive and active techniques.

MAHONEY TABLE:

Air Temperature														
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	high	AMT
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	28.5
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	17
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:



Some of IT companies in surroundings:

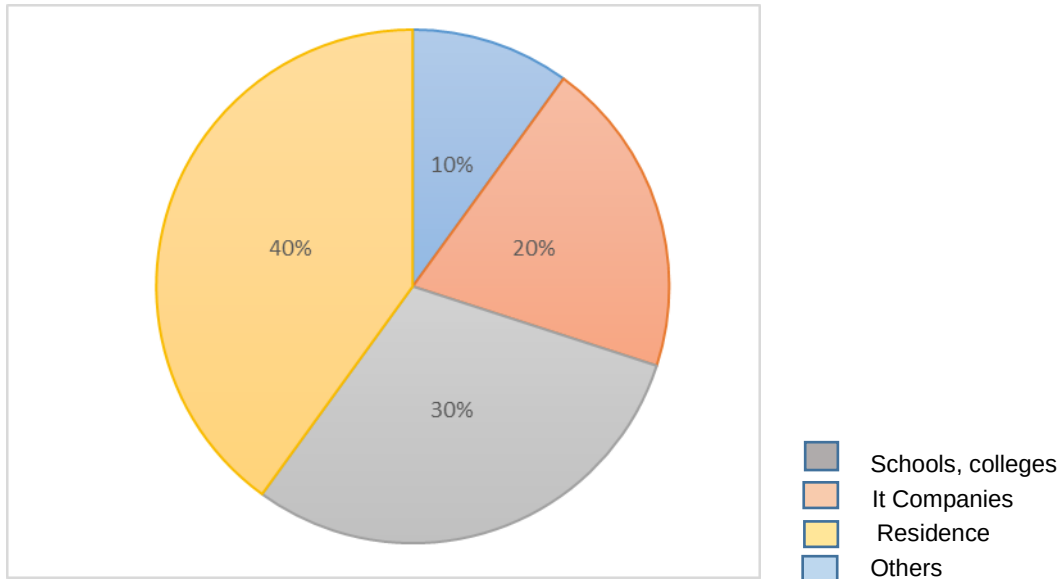
- Tcs;
- Cognizant;
- Capgemini
- Hcl
- Global software solution
- Hexaware technologies
- Aspire systems



List of colleges in surroundings:

- TJ college of engineering;
- KCG college of engineering
- Agni college of engineering;
- Sathyabama university
- St. joseph college of engineering
- Mohammed sathak college of engineering
- Hindustan university
- Jeppiar college of engineering
- SRR college of engineering





6.2 SITE DETAILS:

The site area is located in the sipcot it park. The land use of the site is special economic zone. The total site area is 20,000 sq.m. The building has 2500 sq.m in the site area. Total build-up area of the site is 12500 sq.m. The site constructed in the year 2005. Due to personal issues they made the building abandoned.

6.3 SITE ACCESS

- The site is connected to SH49A old mahabhalipuram road.
- The site is oriented towards east. It has 15m road on east.
- The site can be accessed by bus through the sipcot bus stop.



SITE CONDITIONS:

- Climate: warm & humid
- Slope: Gradual towards the west side of the building.
- Soil type: **Alluvial and hard rock**
- Seismic zone III
- Relative humidity :70%
- The predominant wind direction is south east to North West.

- Annual rainfall: 1348 mm in sipcot,siruseri, heavy rainfall during November – December

SITE PROXIMITY:

- NEAREST AIRPORT
- Chennai international airport 20km
- NEAREST RAILWAY
- TAMBARAM railway station 16.5km
- ANNAI hospital -3.4km
- NEAREST BUS STAND
- Satyabhama university bus stop 200m

SITE DRAINAGE SYSTEM:

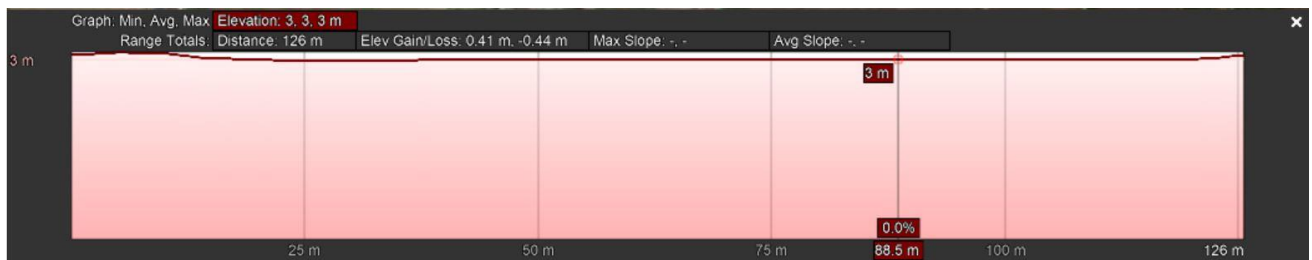


The drainage system is get connected to the central drainage system which is placed under the pavement area and then it gets connected to the underground.

SITE SECTION:



SECTION- AA'



SECTION- BB'

The site contour is almost flat, gradually it has the slope. In longitudinal section, the site gets slopes downward of 1 metre and it again gets raises and gets down of 1 metre towards east. In the latitudinal section, it has the slope on the south of side of the site, which has the slope of 1 metre.

FLOOD PRONE DETAILS:

The Tamil Nadu government has classified 306 areas in Chennai as flood-prone areas, of which 37 are considered as very highly vulnerable. The mapping of vulnerable areas was done by the Tamil Nadu State Disaster Management Authority (TNSDMA) after the December 2015 Chennai floods. the water level was more than five feet due to heavy rains, it was classified as very high vulnerable areas while those having two to three feet water level were considered highly vulnerable. The areas with water level of two to three feet were considered medium vulnerable and those below two feet were considered as low vulnerable.

BUILDING ANALYSIS:



- This plan of the building is oriented towards east to west. The longer axis of the building has located in the north – south direction.
- The plan has the large triple height entry plaza, near entry plaza the service area is located.
- In the corner of the building the restroom and store room is located.
- The glass façade is worked on the west and the north direction of the building.
- The major construction material is concrete and the glass façade. The structure of the building was in good condition.

S.W.O.T. ANALYSIS:

Strength:

The site is located in the special economic zone of the city. The Development of the site will be good in the future utilization. The feasibility of building was good.

Weakness:

The building is not that much old structure, so it doesn't carry a big history. So the building has the less heritage value.

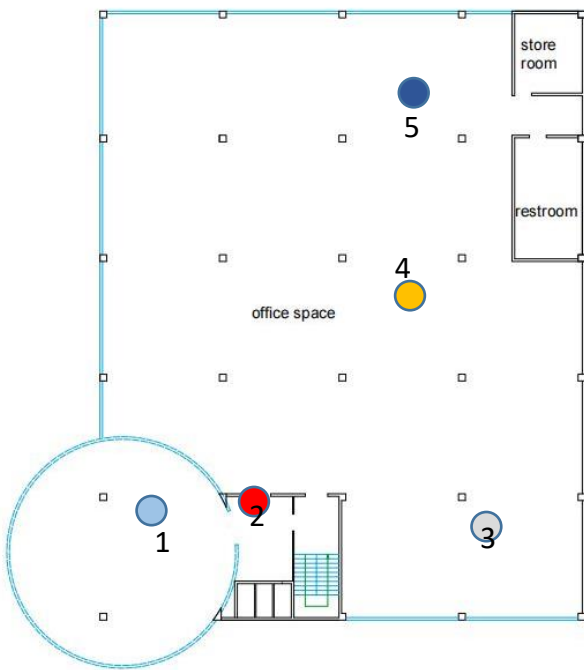
Opportunities:

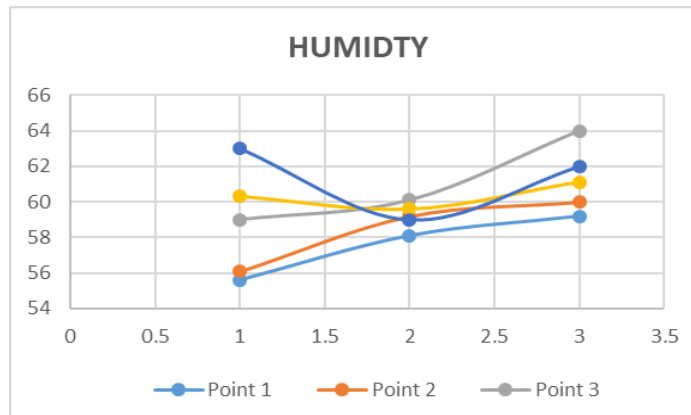
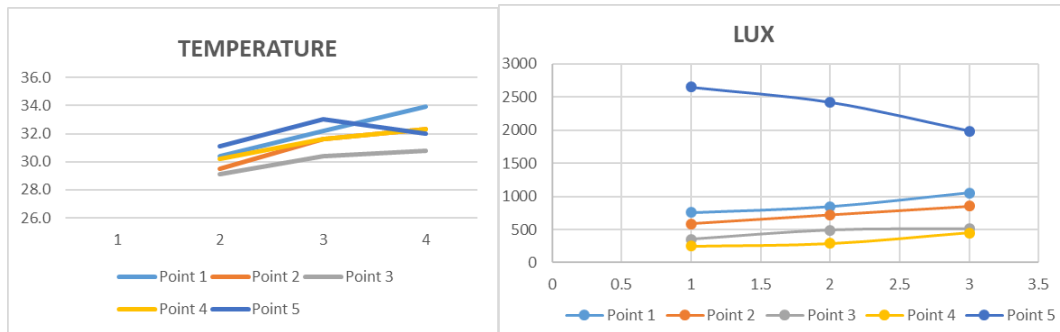
The development of the site will enhances and also improve the sustainable approaches to the surroundings.

Threat:

Since site is abandoned for more than 15 years, mitigation process will take a huge process.

The readings have been taken from the building. The temperature and humidity of the building was quite high because the building doesn't under use and the lux was very low because the maximum portion of the building was covered with glass façade and the interior of the building is incomplete.





7. AREA REQUIREMENT:

RESEARCH PARK	NO.OF PERSONS	TOTAL UNITS	CARPET AREA	TOTAL AREA
LARGE LABS	80	3	800	2400
MEDIUM LABS	60	2	500	1000
PRIVATE LABS	30	30	15	450
COMMON RESTROOMS				540
SEMI PUBLIC ZONE				
LECTURE HALLS	75	1	210	210
LECTURE HALLS	50	2	140	280
AUDITORIUM	300	1	650	650
AUDITORIUM	150	1	350	350
VIP LOUNGE	5	1	50	50
MULTIPURPOSE HALL	100	1	180	180
SEMINAR ROOM	30	1	100	100
PRIVATE DISCUSSION ROOM	10	3	50	150
EXHIBITION HALL	200	1	660	660
FOOD COURT	300	1	1000	1000
FOOD COURT	200	1	800	800

CO-WORKING SPACE				
OPEN STUDIOS	150	3	1000	3000
SHARED MODULE	100	3	1000	3000
PRIVATE MODULE	50	50	20	1000
SOFTWARE LABS		2	100	200
TESTING LABS		2	200	400
LIBRARY	50	1	400	400
DEMO ROOM	5	2	75	150
STORE & UTILITY		2	100	200
WORKSHOPS				
MECHANICAL WORKSHOP	40	1	300	300
ELECTRICAL WORKSHOP	40	1	300	300
CIVIL WORKSHOP	40	1	300	300
FABRIC WORKSHOP	40	1	300	300
ADMIN				
OFFICE	4	4	25	100
MANAGER'S CABIN	1	1	20	40
STORE AND UTILITY ROOM	5	2	20	40
MAINTENANCE ROOM		1	30	50
FOOD COURT				300
SHOPS				100
TOTAL				19000
adding 30% of circulation and service area				5700
TOTAL				24700

Total built-up area of existing building – 12500 sq.ft

Floor area excluding foyer, service core- 1700 sq.ft

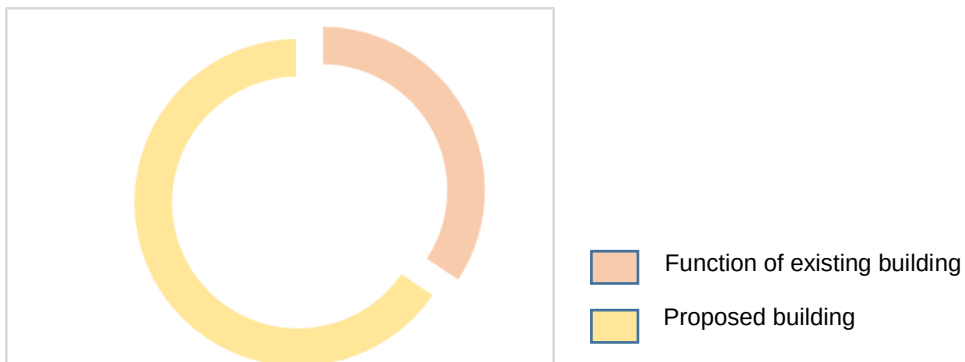
Total floor area- 8500 sq.ft

Total site area - 17850sq.ft

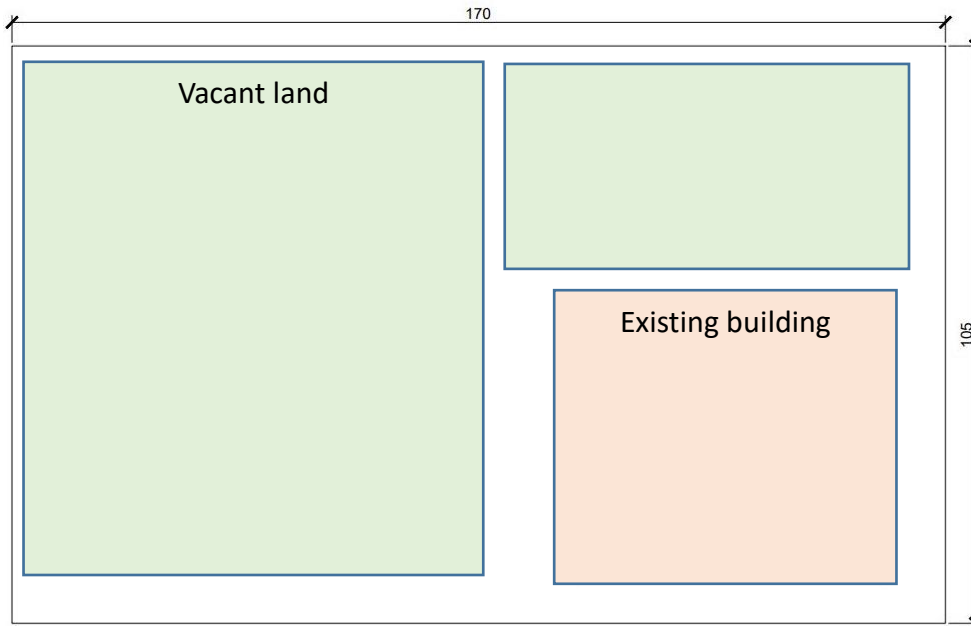
Proposed site area – 13500 sq.ft

Total proposed built-up area – 24700sq.ft

New proposed built-up area – 16500 sq.ft



SITE ZONING:

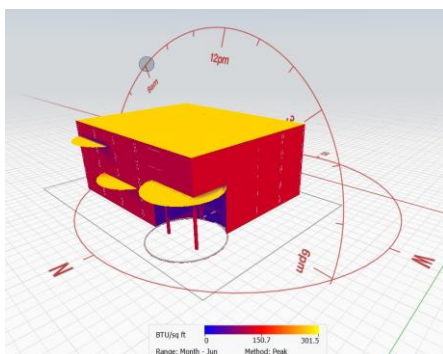


TABLE

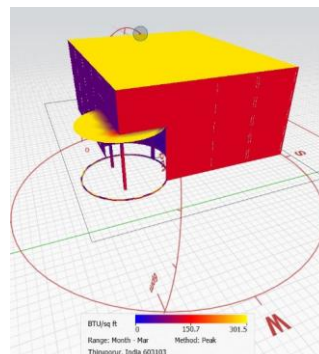
Sl. No	Description	All Areas		
A.	Minimum Road width	12m.	15m.	18m.
B.	Normally Permissible FSI	2.0	2.5	3.25
C.	Maximum Coverage	50%		
D.	Minimum set back all around	Height of the building above ground level	Minimum required setback space from the property boundary	
		Upto 30m.	7m.	
		Above 30m.	For 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.	

8. ITERATIONS: SIMULATION ANALYSIS EXISTING BLOCK

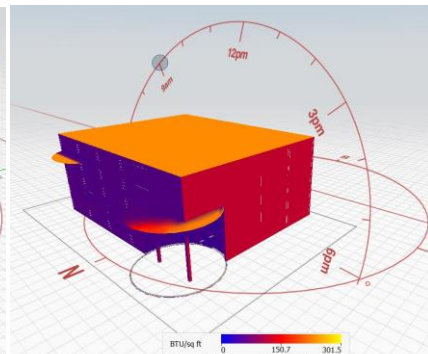
FORMIT:



SUMMER SOLLSTICE



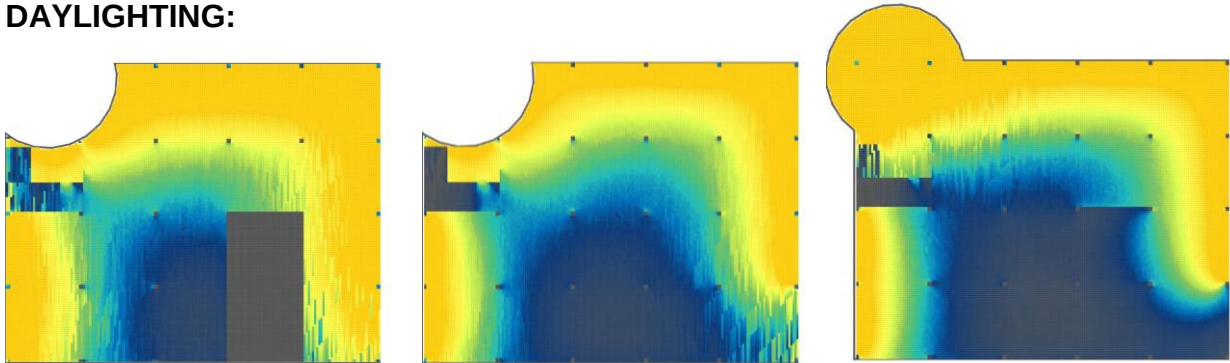
EQUINOX



WINTER SOLLSTICE

In formit, the sun's radiation is high in the summer solstice and even equinox experience high heat radiation in the south while comparing to the north. In winter solstice the building experiences less heat.

DAYLIGHTING:

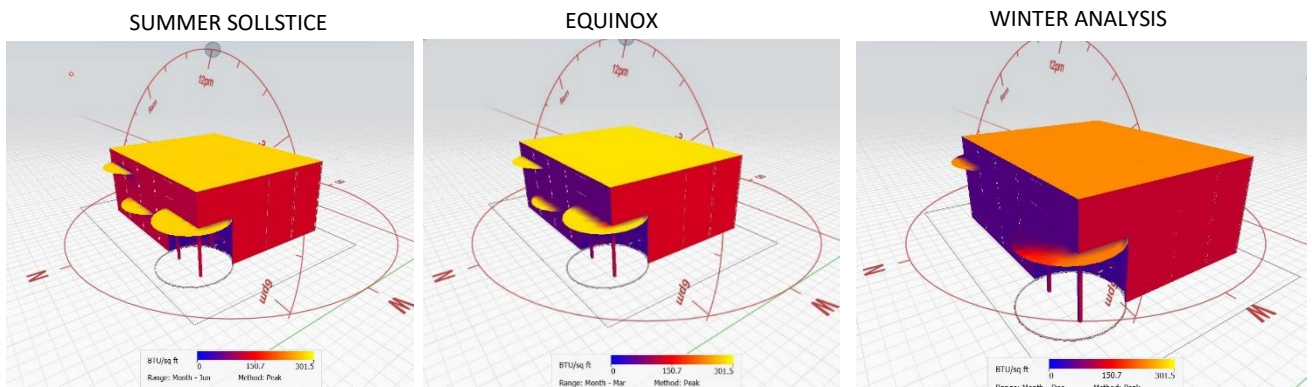


In daylight analysis, the building experiences very poor amount of daylight inside the building. The total building experiences the maximum of 29.3% of natural light and average of about 5.90%.

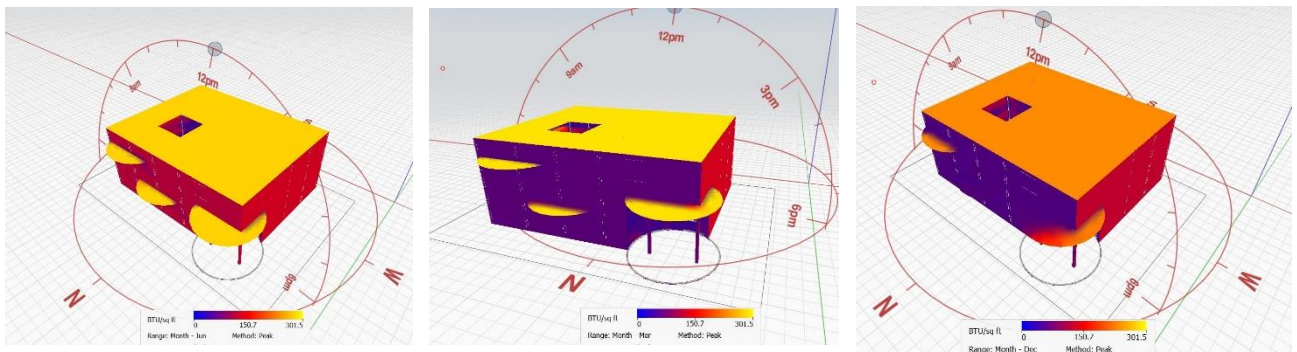
ITERATIONS:

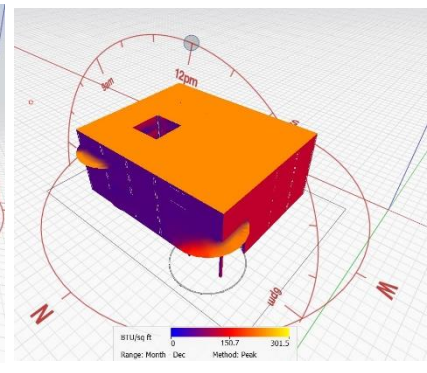
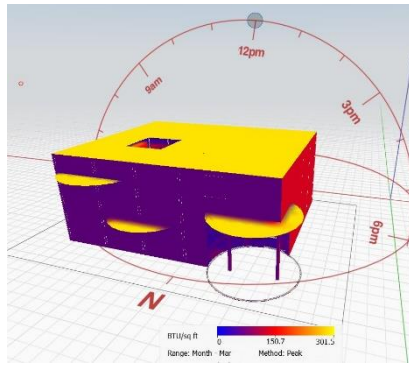
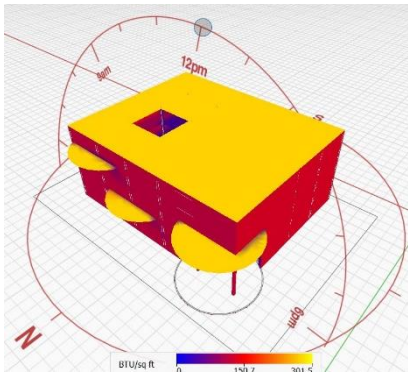
FORMIT ANALYSIS

OPTION-1



OPTION-2



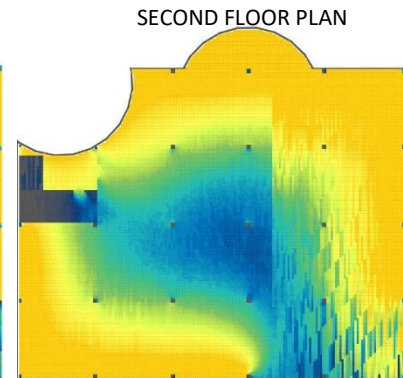
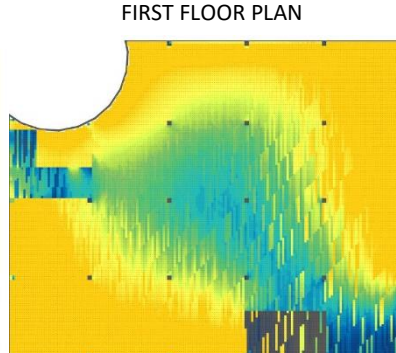
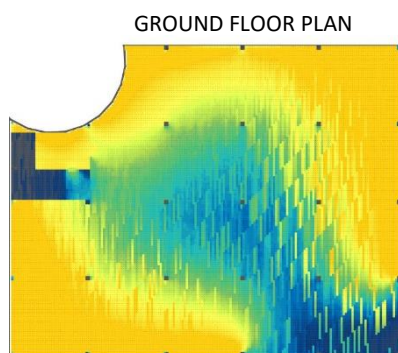


OPTION-3

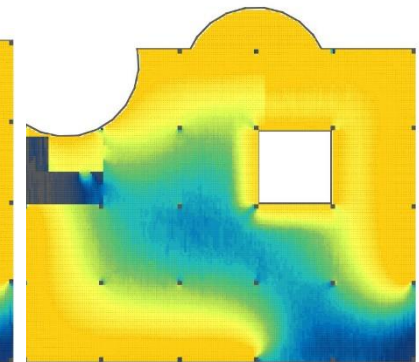
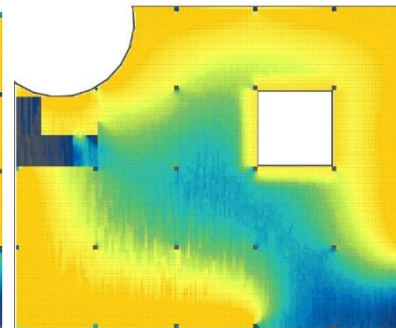
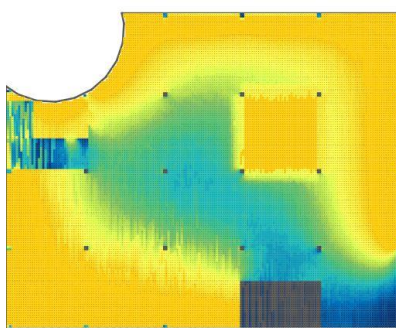
In formit, the sun's radiation is high in the summer solstice and even equinox experience high heat radiation in the south while comparing to the north. In winter solstice the building experiences less heat.

DAYLIGHTING:

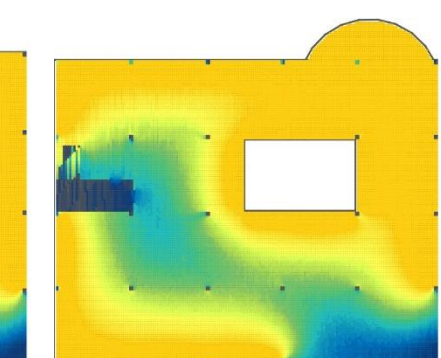
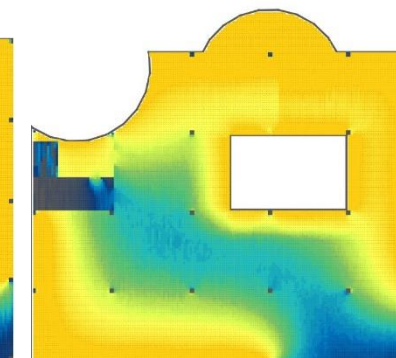
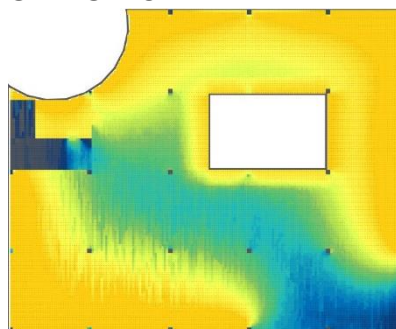
OPTION – 1



OPTION – 2



OPTION-3

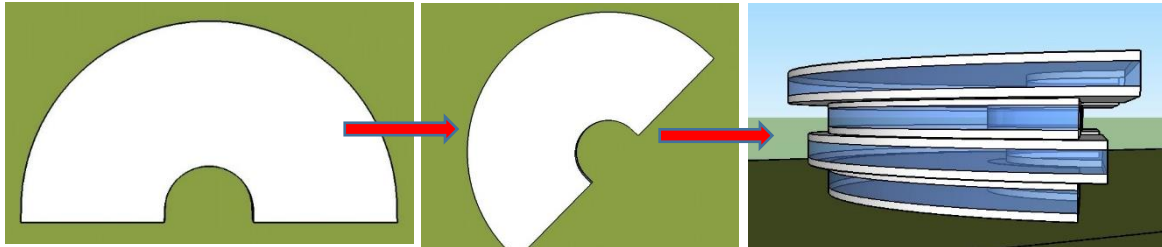


In iteration 1, the total building experiences the maximum of 40.3% of natural light and average of about 7.90%. In iteration 2 total building experiences the maximum of 33.3% of natural light and average of about 8.50%. In iteration 3 the total building experiences the maximum of 55.3% of natural light and average of about 10.55%.

8.1 PROPOSED BUILDING:

ITERATION 1:

FORM EVOLUTION



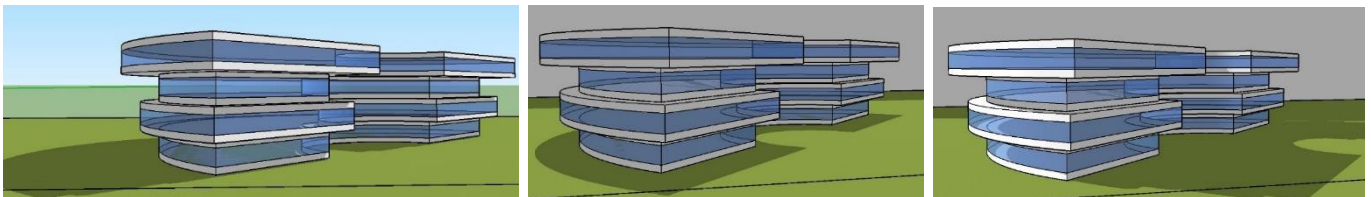
Form 1: The circular form will not receive the direct radiation, it easily gets scatters due to the form, so it is placed on the south direction.

Form 2: The form is tilted 30 degrees towards south east, since the major wind flow, and to reduce the longer axis radiation.

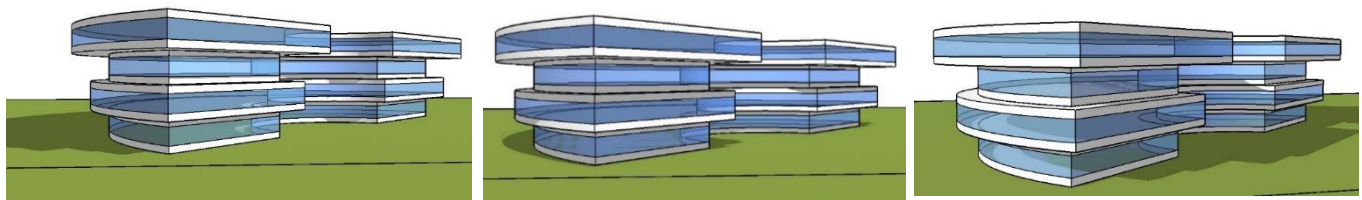
Form 3: The section is planned to the building, it should become the self-shading devices over the buildings, so the projections will help to reduce the sun's radiation to the below floors.

Shadow analysis

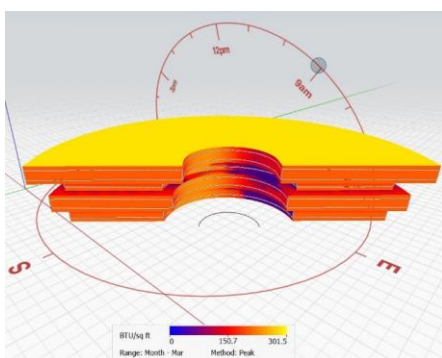
SUMMER SOLSTICE



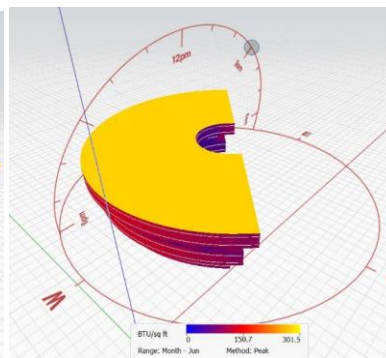
WINTER SOLSTICE



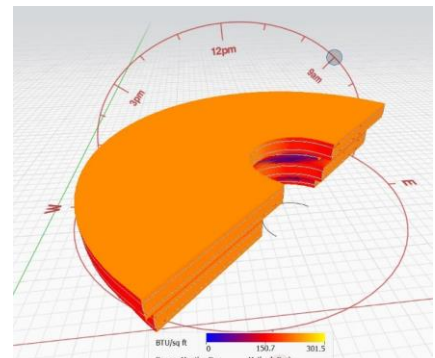
FORMIT:



SUMMER SOLLSTICE



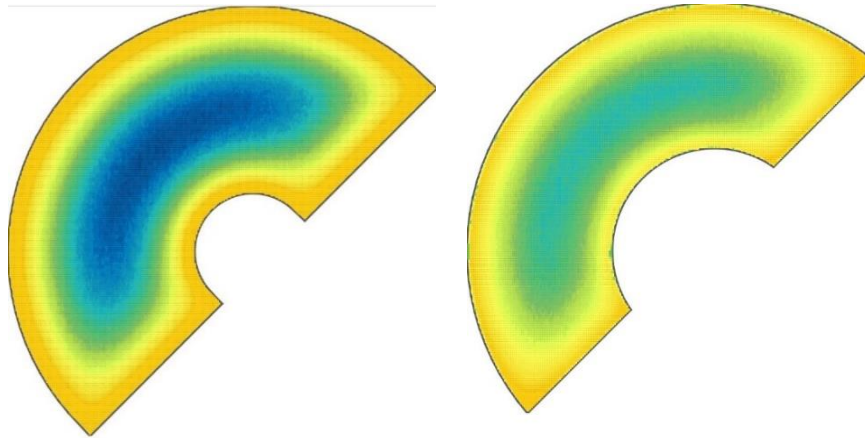
EQUINOX



WINTER ANALYSIS

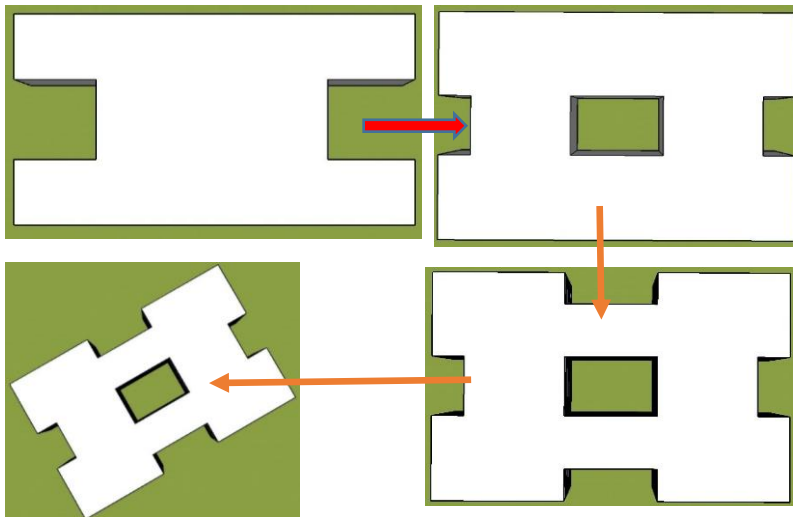
The formit, the sun's radiation was less, since the projection of the building, even though the south west direction experiences the less heat while comparing to the direct heat from the south direction.

DAYLIGHTING:



It experiences the maximum of 28.5% of daylight and the average of 7% of daylight.

OPTION-2



Form 1: Building is placed along the longer axis north – south.

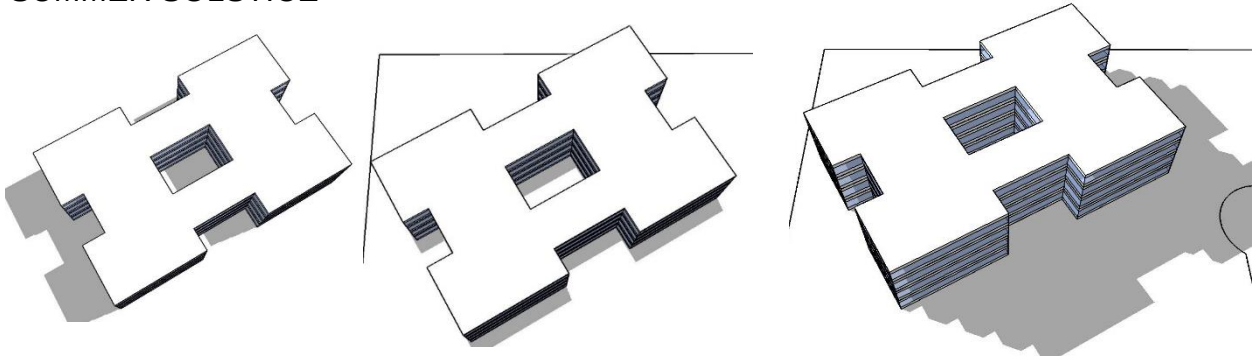
Form 2: The central courtyard is opened out at the centre of the building for the daylight and the use of stack effect.

Form 3: The north and south axis is little tilted at 15 degree for the larger opening for the entry and exit to the building.

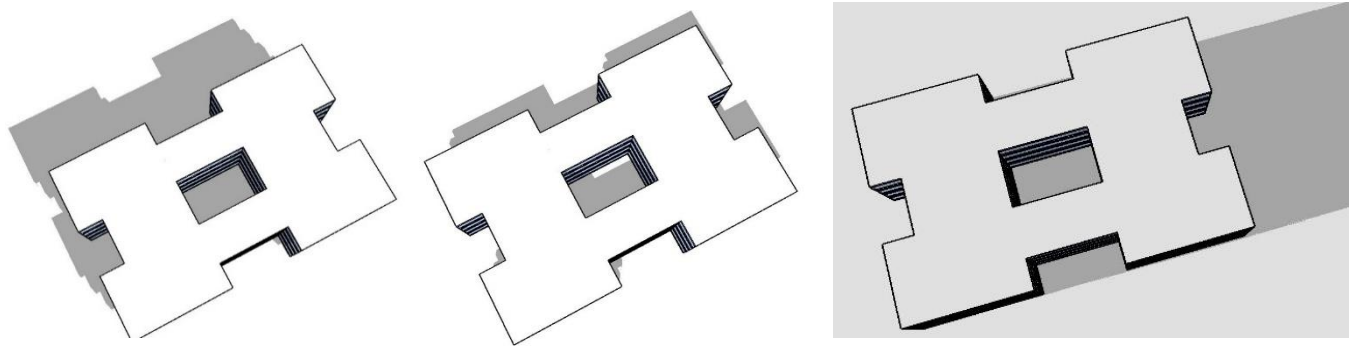
Form 4: The south axis is little projected to cut down the direct axis of the sunlight.

SHADOW ANALYSIS:

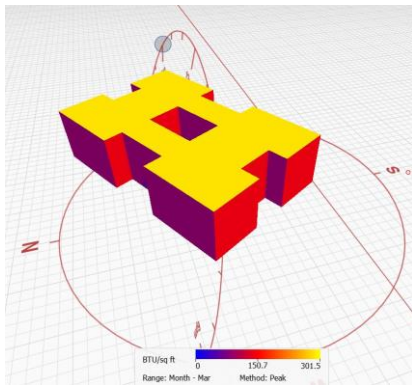
SUMMER SOLSTICE



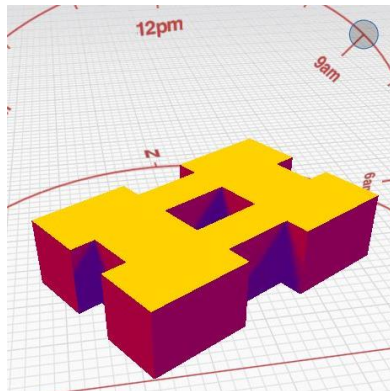
WINTER SOLSTICE



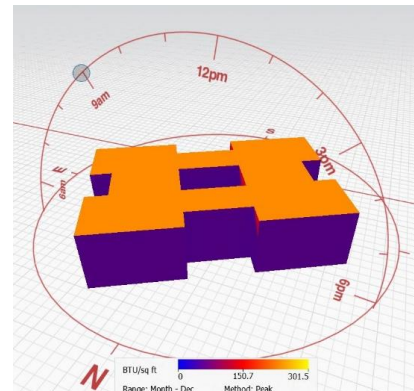
FORMIT:



SUMMER SOLSTICE



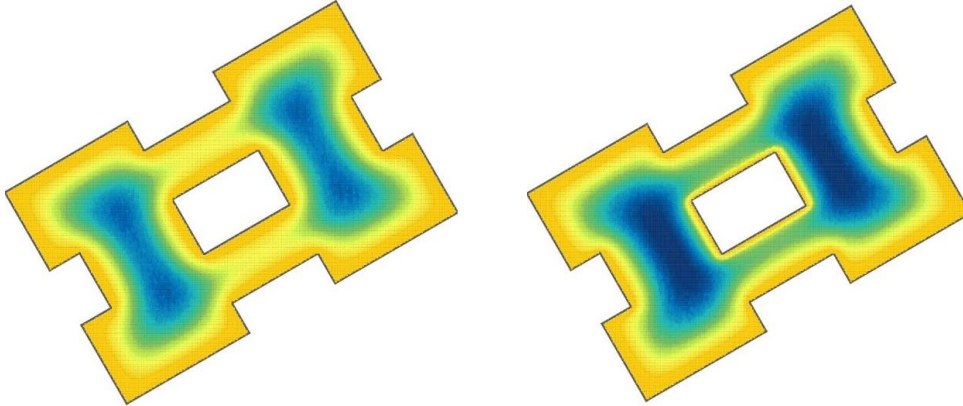
EQUINOX



WINTER ANALYSIS

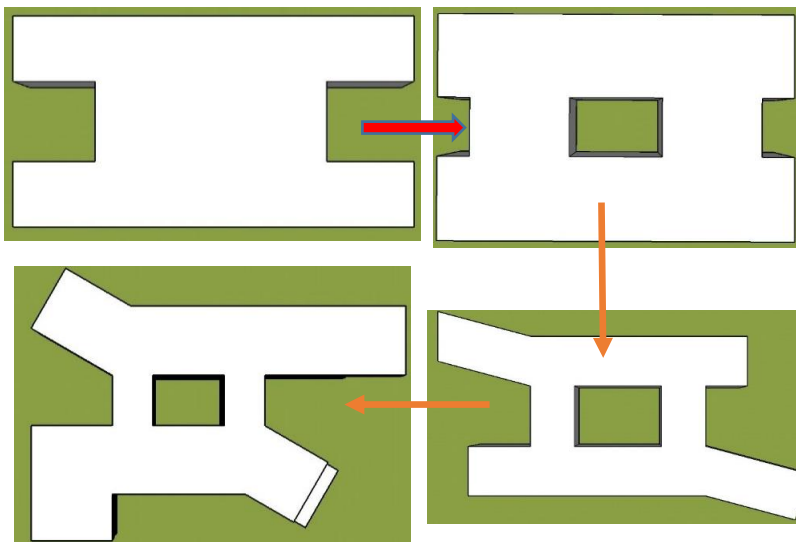
In formit, the sun's radiation of the building was high, while comparing to the other forms, there is no projection on wall, which the radiation directly affect the building. The cut in the longer axis will act as a buffer space to the heat radiation gets enter into the building.

DAYLIGHTING:



The building experiences about 38% of the maximum daylight and the average of 9.50% of the daylight.

OPTION-3:



Form 1: Building is placed along the longer axis north – south.

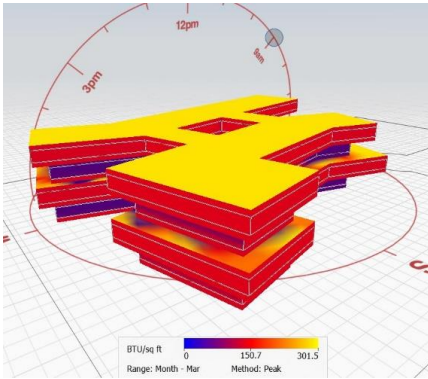
Form 2: The central courtyard is opened out at the centre of the building for the daylight and the use of stack effect.

Form 3: The north and south axis is little tilted at 15 degree for the larger opening for the entry and exit to the building.

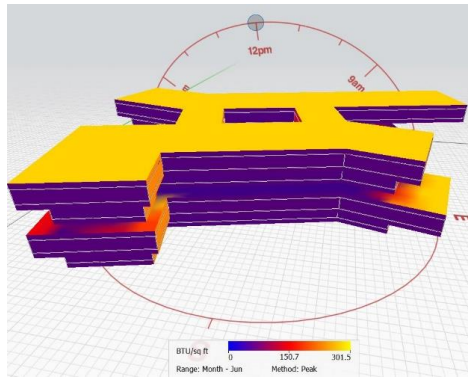
Form 4: The south axis is little projected to cut down the direct axis of the sunlight.

FORMIT:

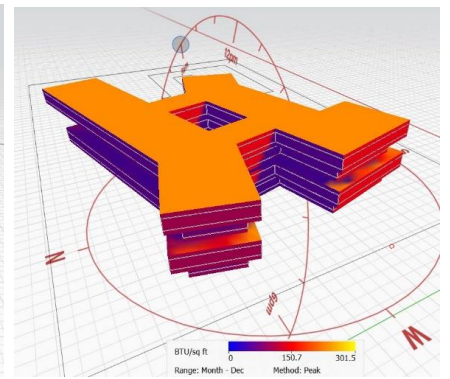
In formit, the sun's radiation of the building was less while comparing to the other forms, the projection over the each floor will reduce the heat that enters into the below floors of the building.



SUMMER ANALYSIS

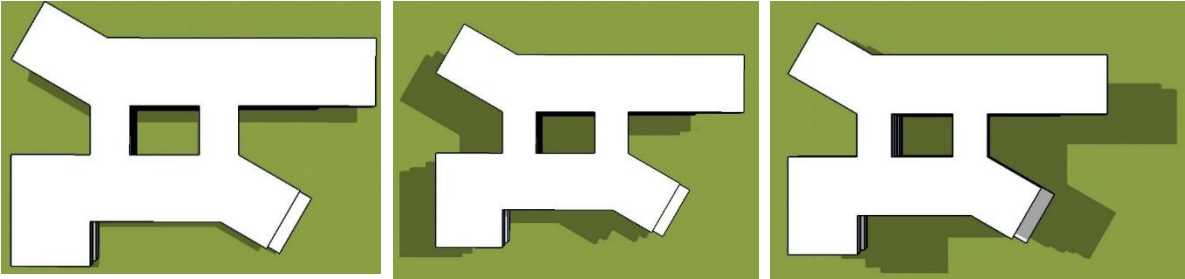


EQUINOX

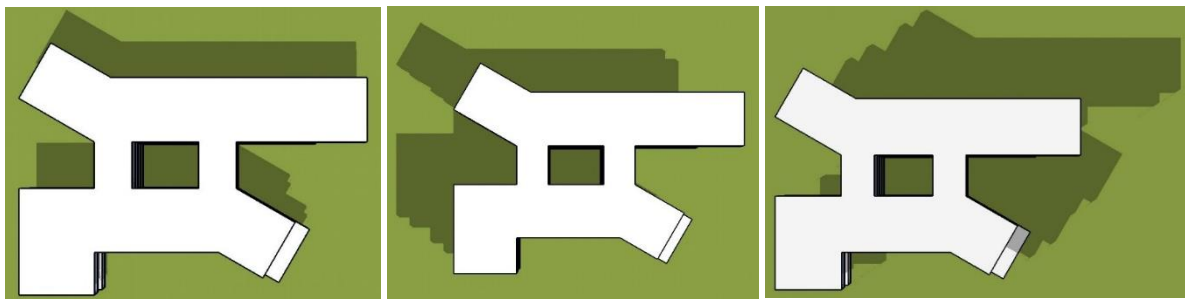


WINTER ANALYSIS

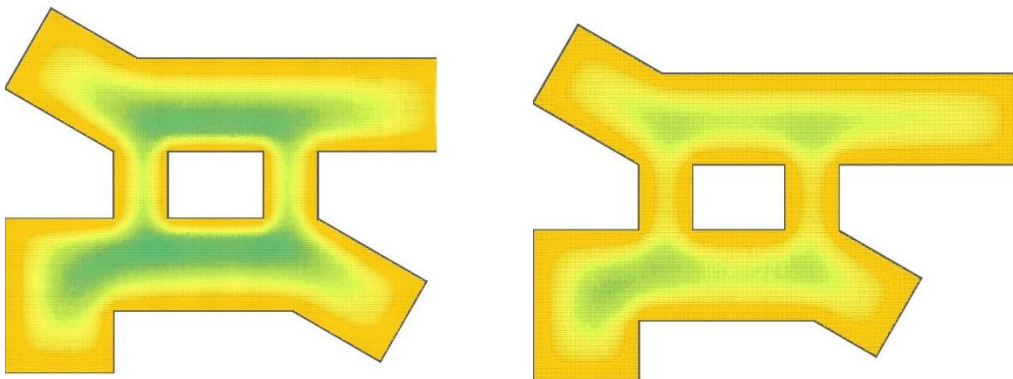
SUMMER SOLSTICE



WINTER SOLSTICE

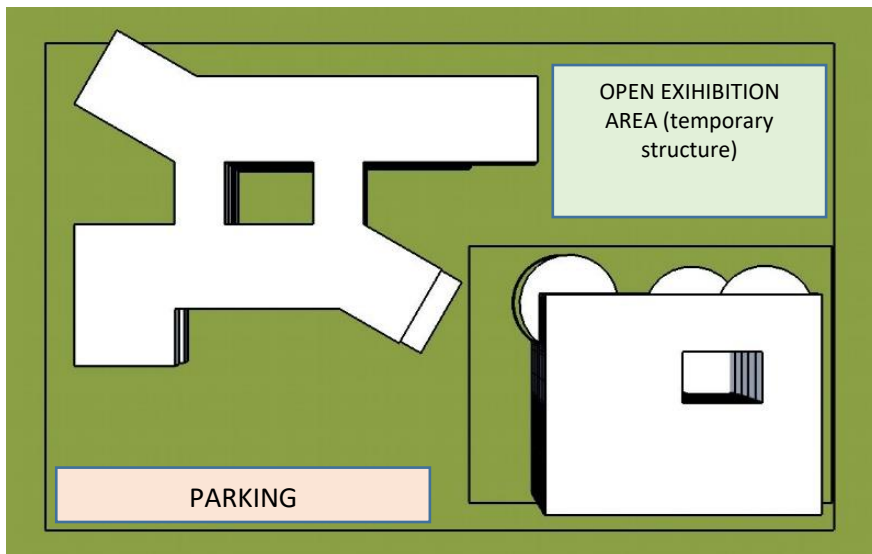


DAYLIGHTING:

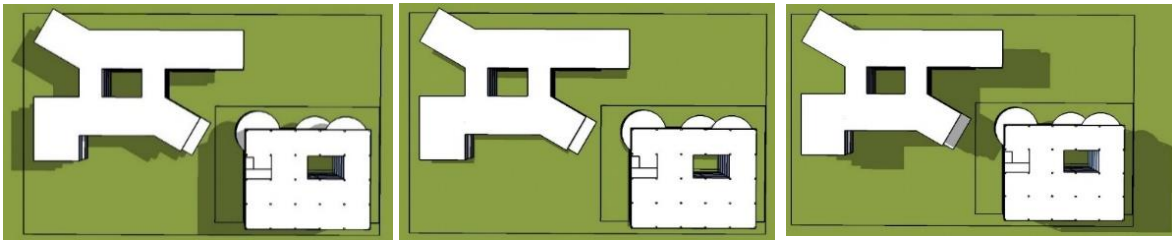


In this form the building is in well-lit in condition, the building experiences about 55% of the maximum daylight and the average of 11.88% of the daylight

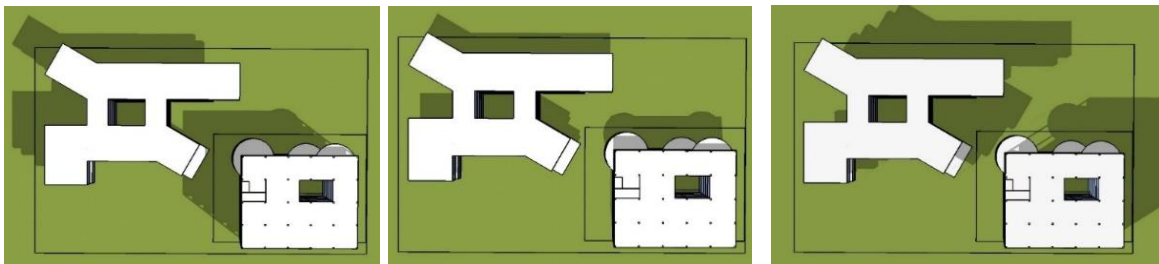
8.2 SITE ZONING: OPTION-1



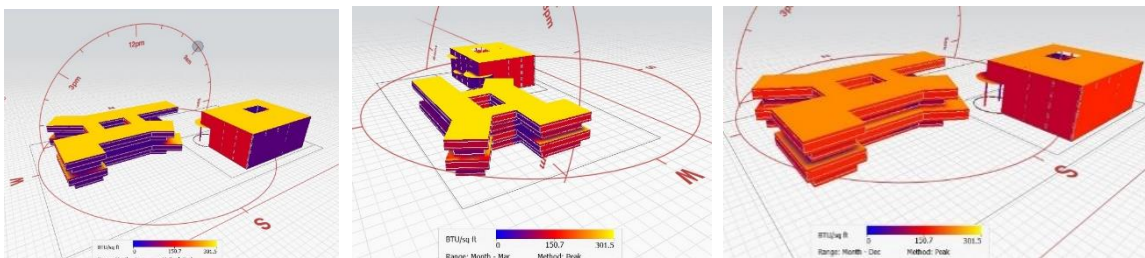
Shadow analysis:
Summer solstice



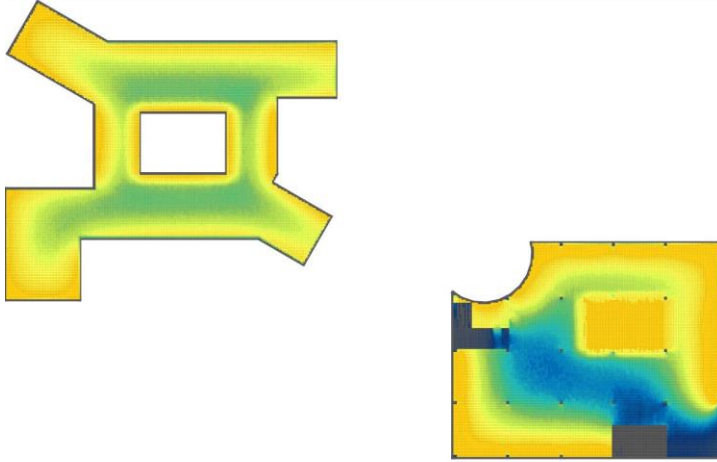
Winter solstice



FORMIT:

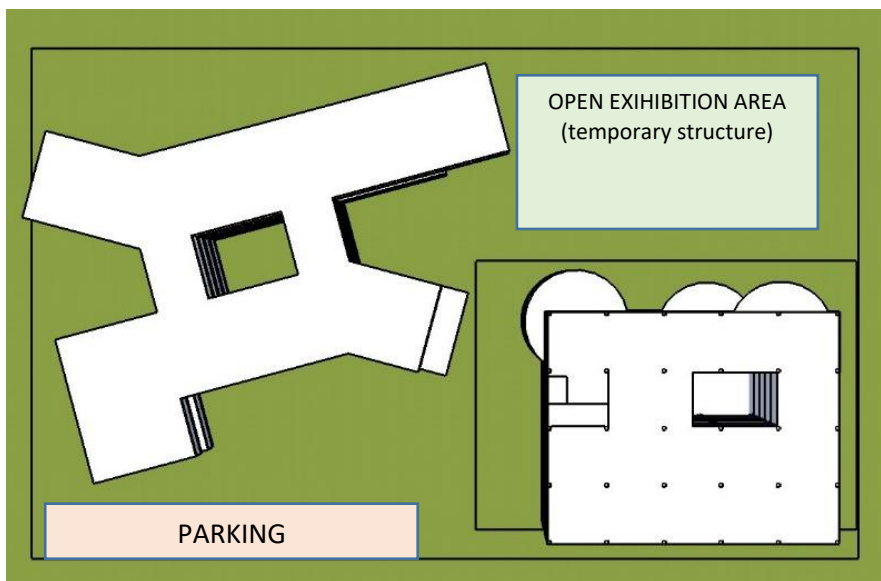


DAYLIGHTING:



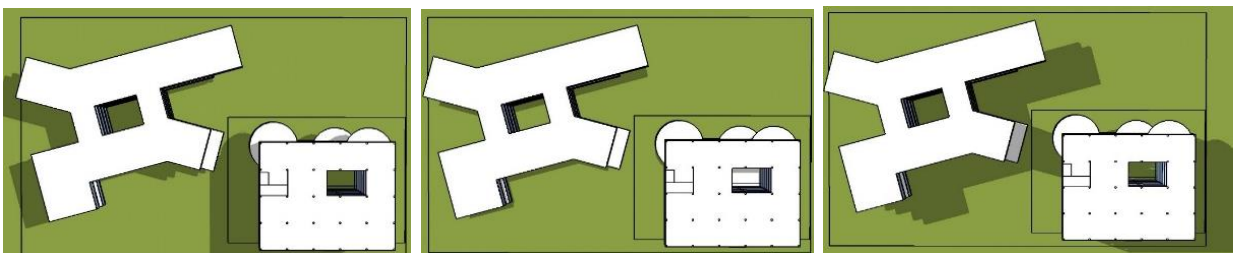
In this zoning iteration 1, shows the proposed building which is placed in the North West side of the site. The south west has the parking and the roads that connects the blocks and surround with the water body, since the major wind flow is from south east to North West. The air will reduce the heat radiation in the building.

OPTION-2:

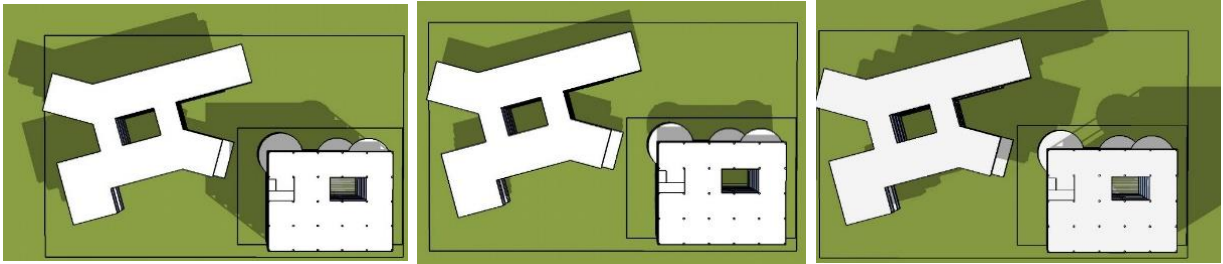


SHADOW ANALYSIS:

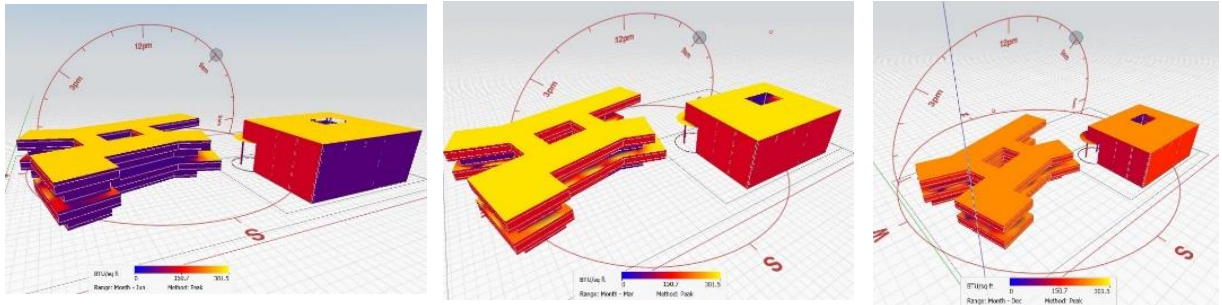
Summer solstice



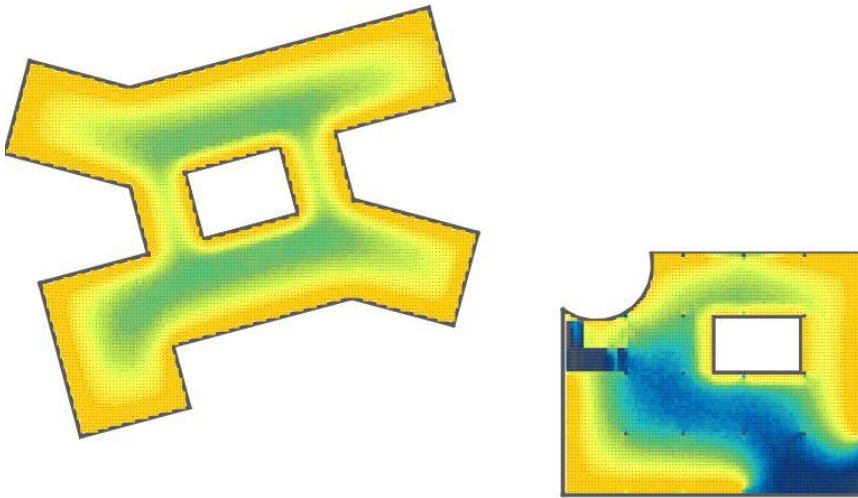
Winter solstice



FORMIT:

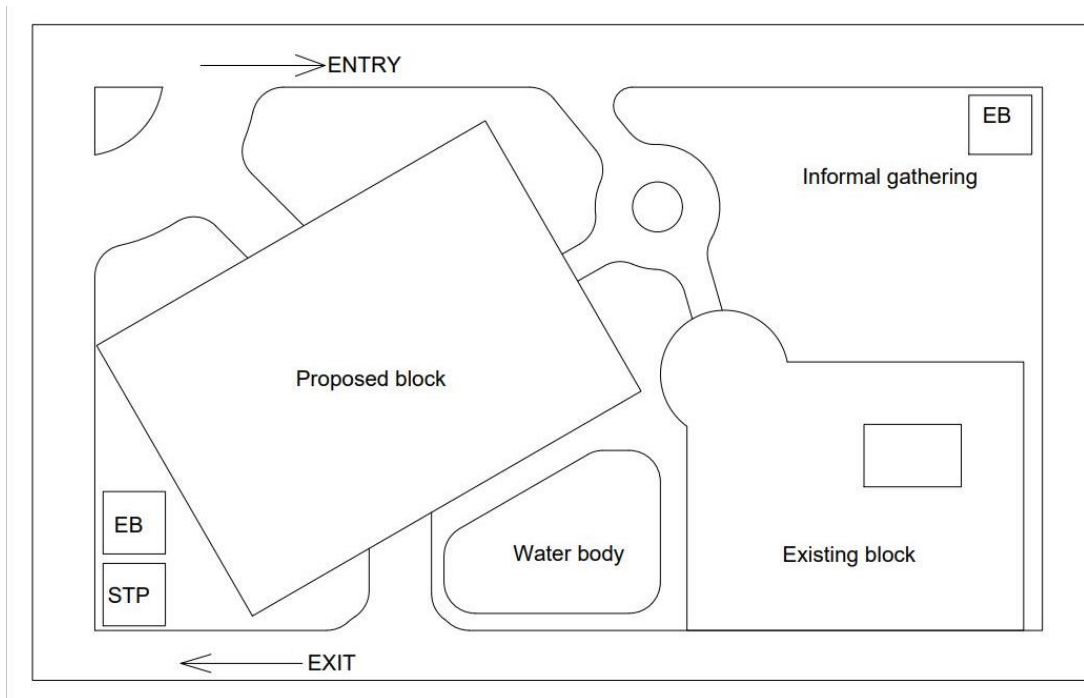


DAYLIGHTING:



In this zoning iteration 2, shows the proposed building which is placed in the North West side of the site. The roads that connects the blocks and surround with the water body, since the major wind flow is from south east to North West. The air will reduce the heat radiation in the building. The proposed block is tilted 15 degree towards north, since the longer axis also doesn't experience the heat.

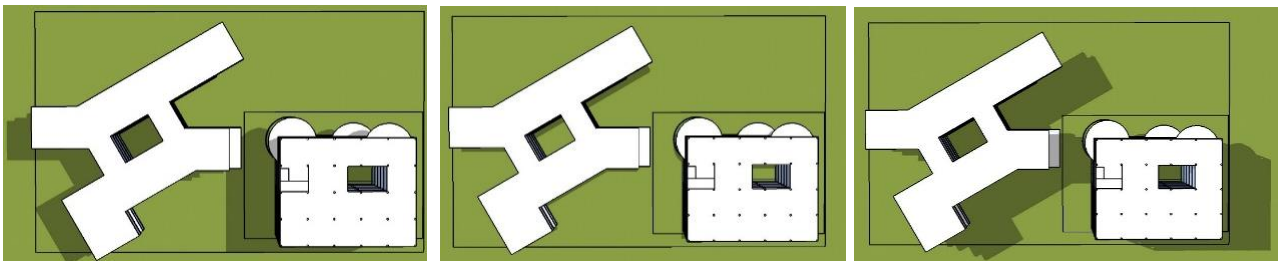
OPTION-3:



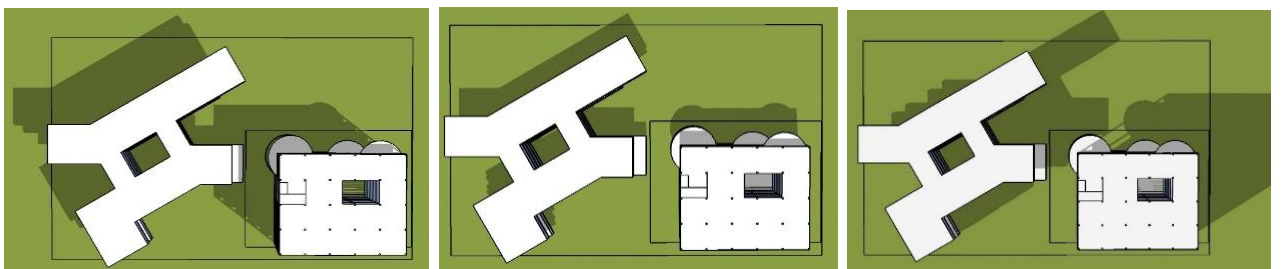
In this zoning iteration 3, shows the proposed building which is placed in the center of the site. The proposed block has tilted 30 degree towards north, since the building has direct wind flow. The west has the parking and the south east space has the water body, since the major wind flow is from south east to North West. The air will reduce the heat radiation in the building.

Shadow analysis:

Summer solstice

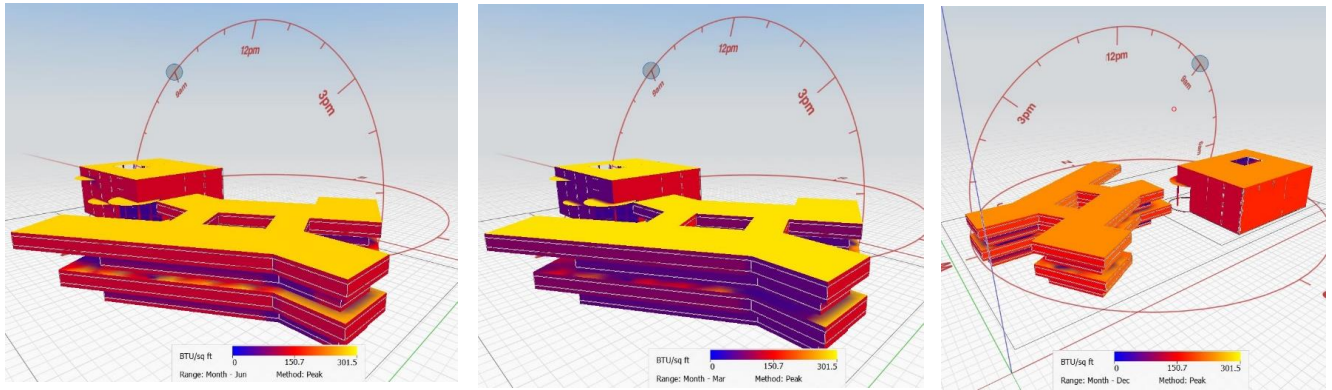


Winter solstice

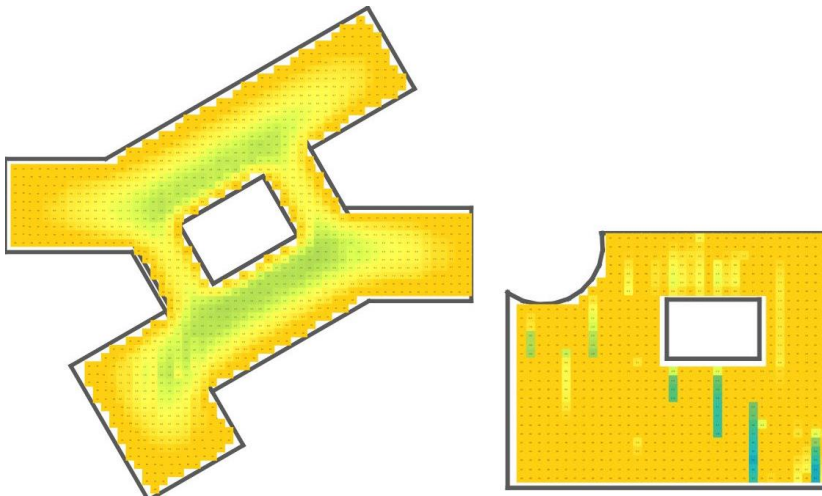


FORMIT:

In formit, the blocks of the building affect the neighboring blocks, but not as a major impact to the building. The wall of the proposed building doesn't experience the major radiation while comparing to the other iteration.



DAYLIGHTING:

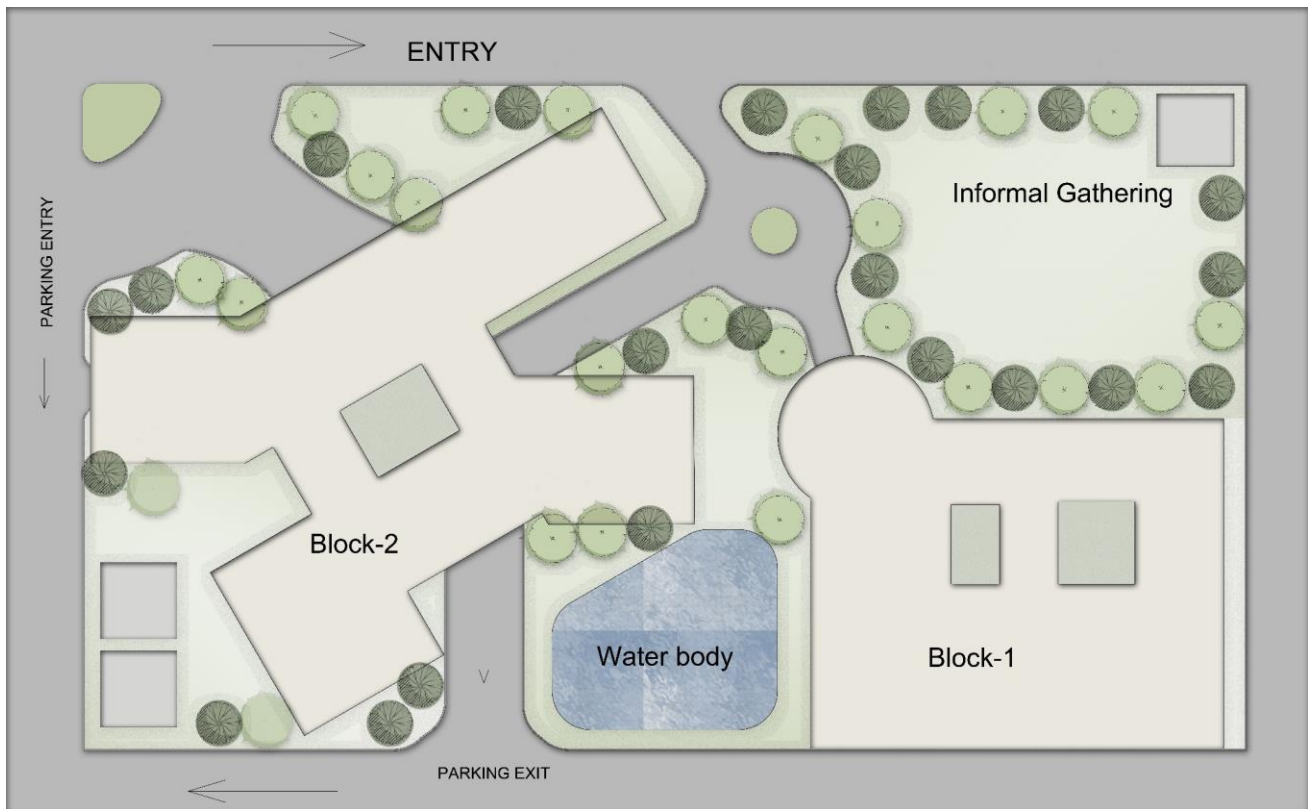


In daylight analysis, the experiences the same amount of lit in the building, there is no change or it doesn't affect or respond the neighboring blocks.

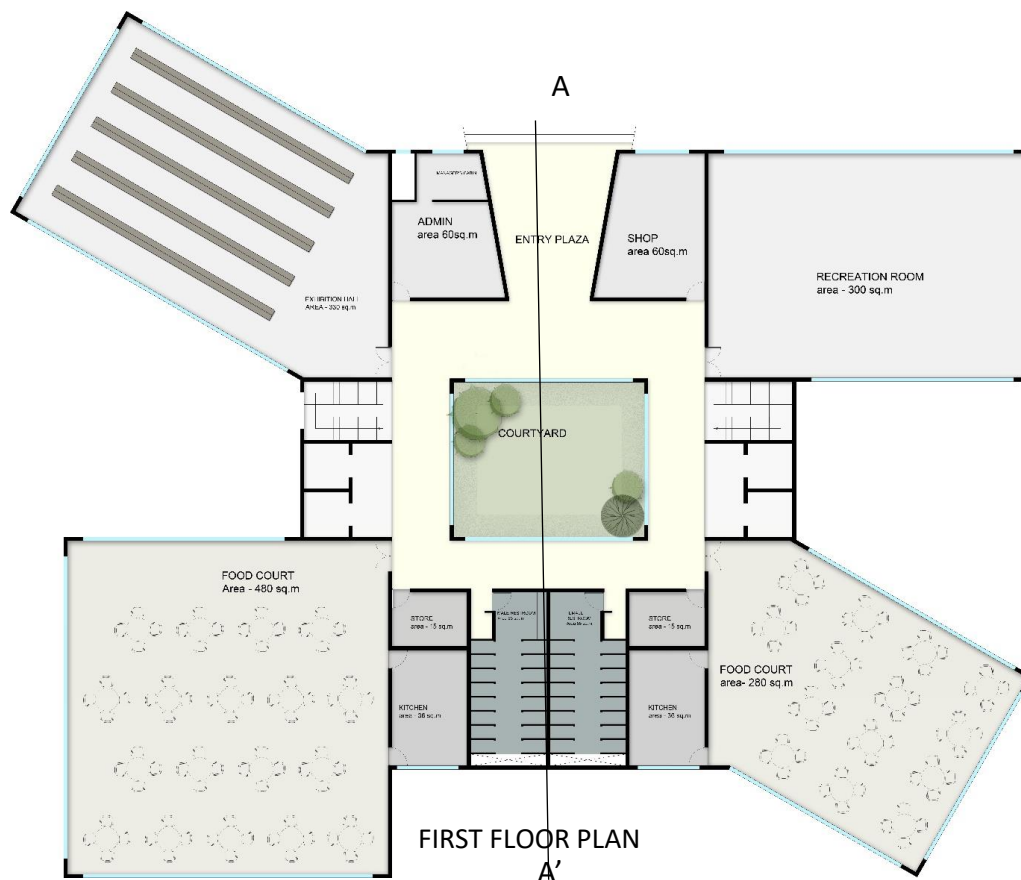
INFERENCE:

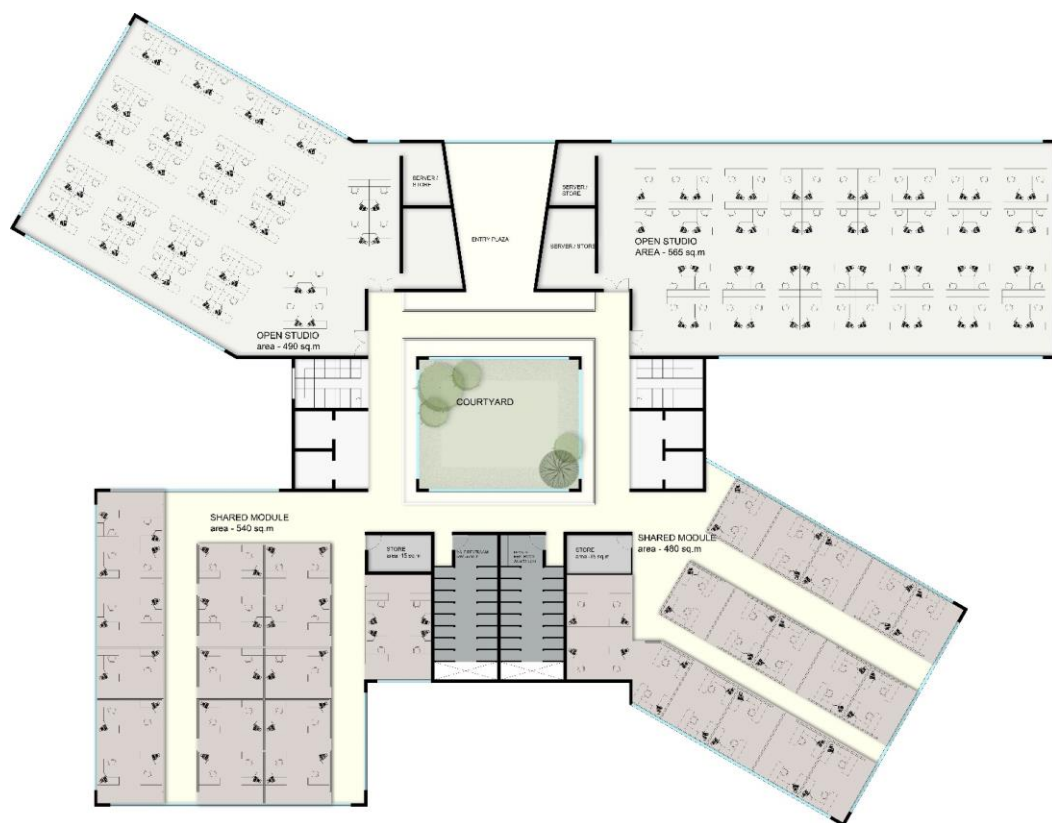
As from the above iterations in the form, angle and site zoning iterations, option 3 function better while comparing to all the other options. So the site zoning option 3 is considered as the final form which satisfies more while comparing to other options.

9. PROPOSED SITE PLAN:



9.1 PROPOSED BLOCK PLAN:







FOURTH FLOOR PLAN



FIFTH FLOOR PLAN

9.2 RETROFITTED PLAN:



GROUND FLOOR PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN



THIRD FLOOR PLAN

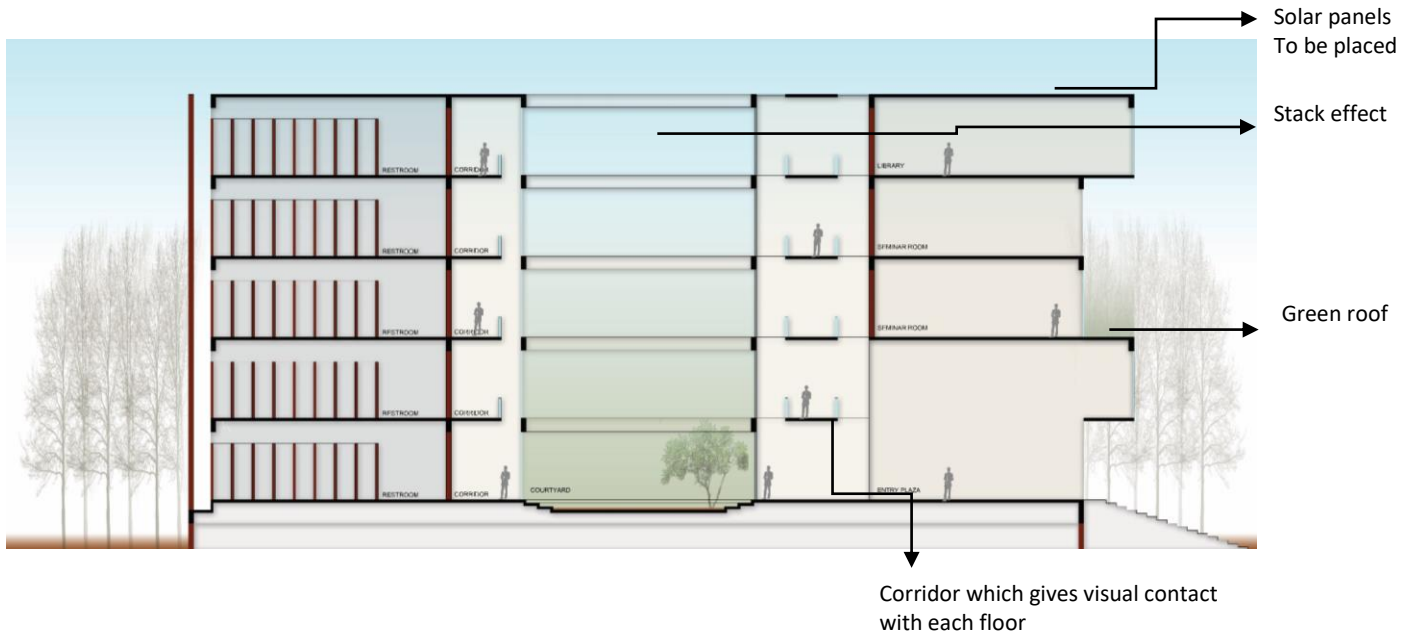


FOURTH FLOOR PLAN



RETROFITTED BLOCK- SECTION:

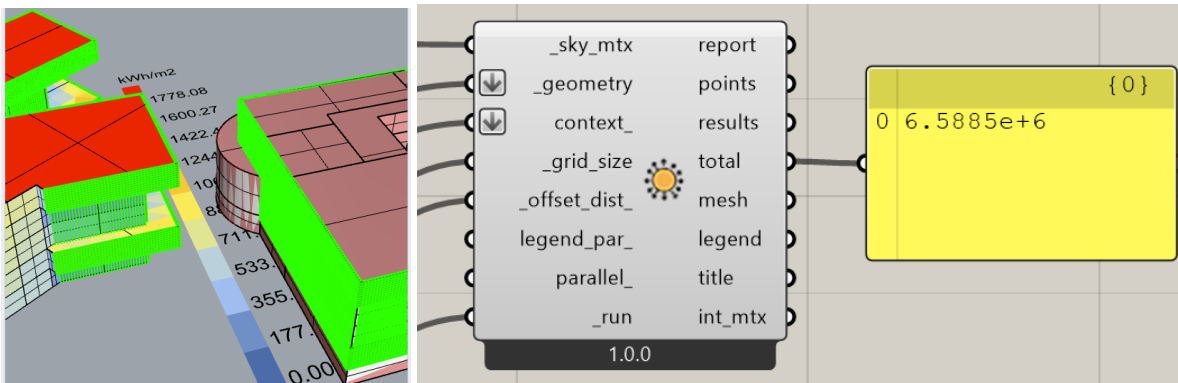
PROPOSED BLOCK- SECTION:



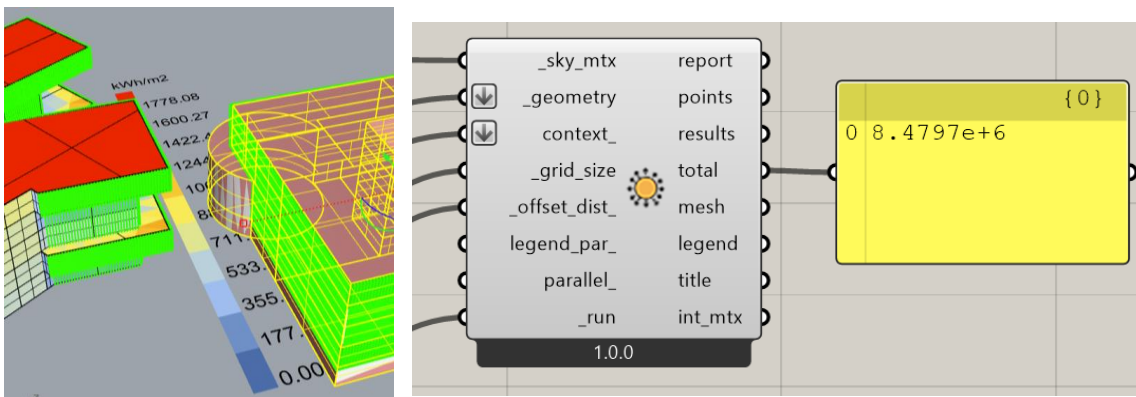
10 SIMULATION ANALYSIS:

10.1 RADIATION ANALYSIS

PROPOSED BLOCK WITH SHADE

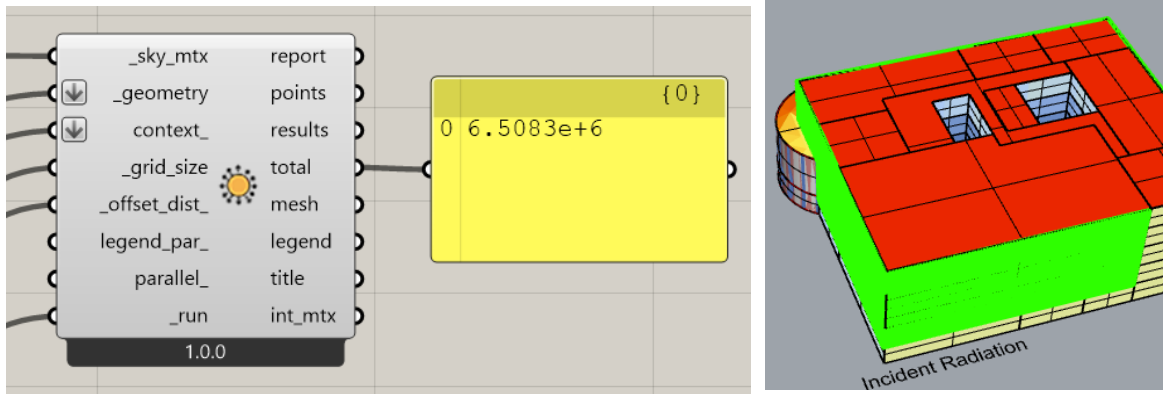


PROPOSED BLOCK WITHOUT SHADE

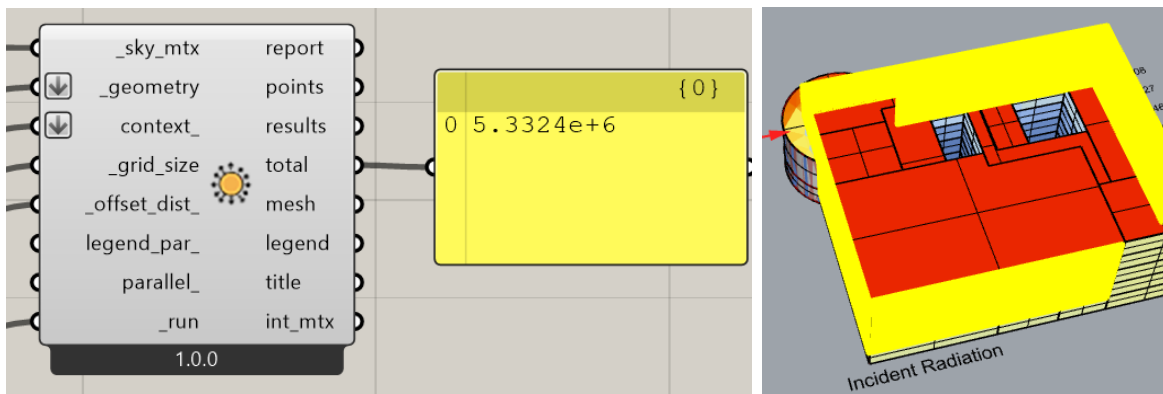


In the proposed block, the sun's radiation is analyzed. The radiation which exposed in the building experiences lesser radiation while comparing with the building without shade. The proposed case experience less amount of radiation while comparing to the base case.

RETROFITTED BLOCK WITH SHADE



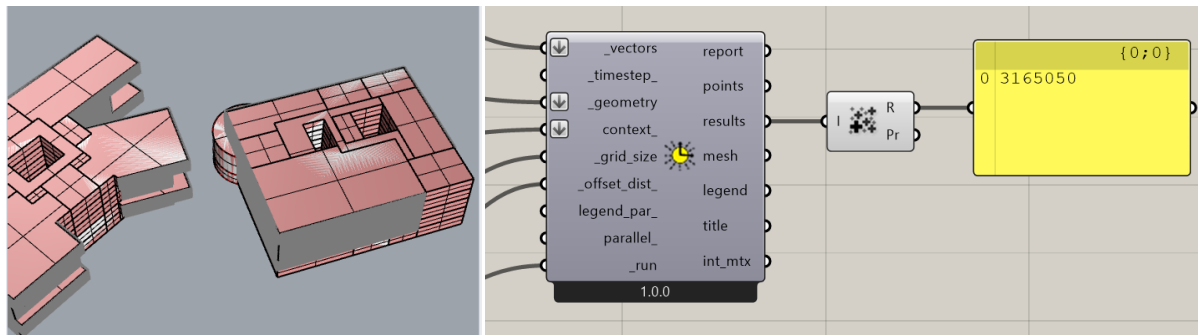
RETROFITTED BLOCK WITHOUT SHADE



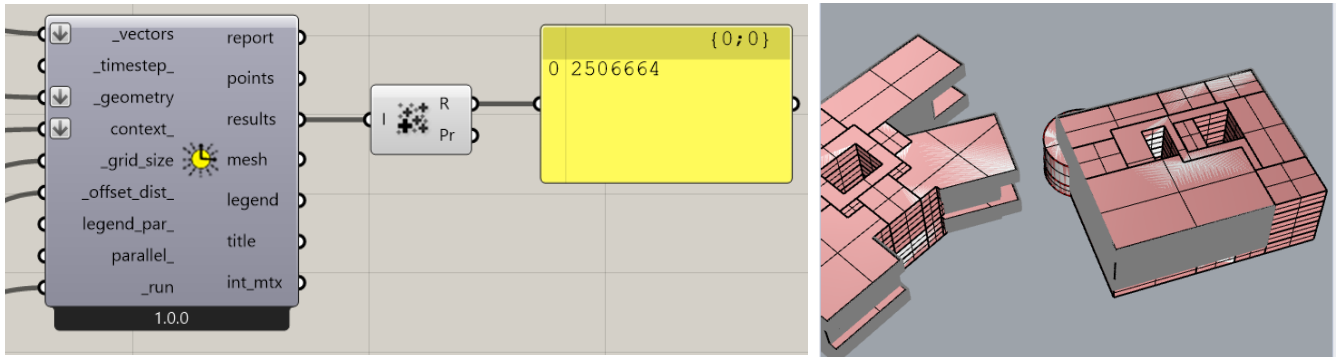
In the existing block, the sun's radiation is analyzed. The radiation which exposed in the building experiences lesser radiation while comparing with the building without shade. The proposed case experience less amount of radiation while comparing to the base case.

10.2 SUNHOUR ANALYSIS:

PROPOSED BLOCK WITHOUT SHADE:

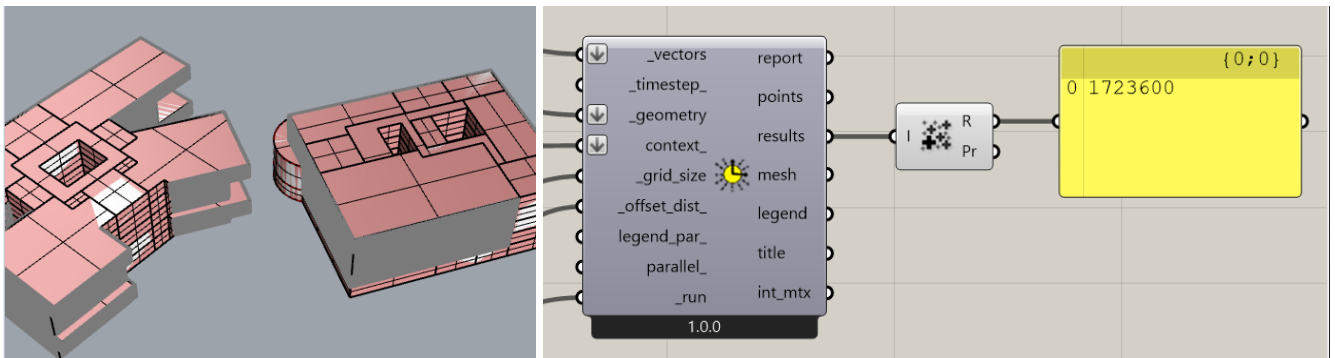


PROPOSED BLOCK WITHOUT SHADE:

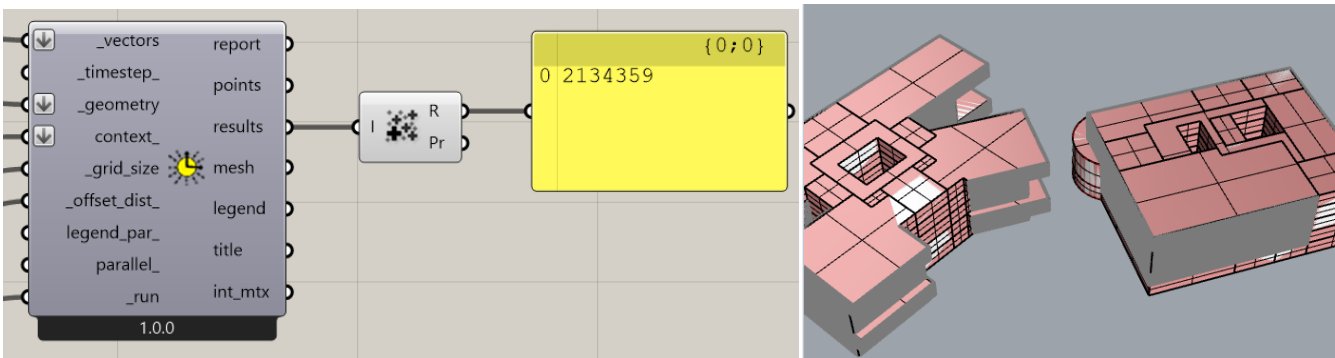


In the proposed block, the sun's hour radiation is analyzed. The radiation which exposed in the building experiences lesser radiation while comparing with the building without shade. The proposed case experience less amount of radiation while comparing to the base case. This leads to less amount of energy load is used in the building.

RETROFITTED BLOCK WITH SHADE:

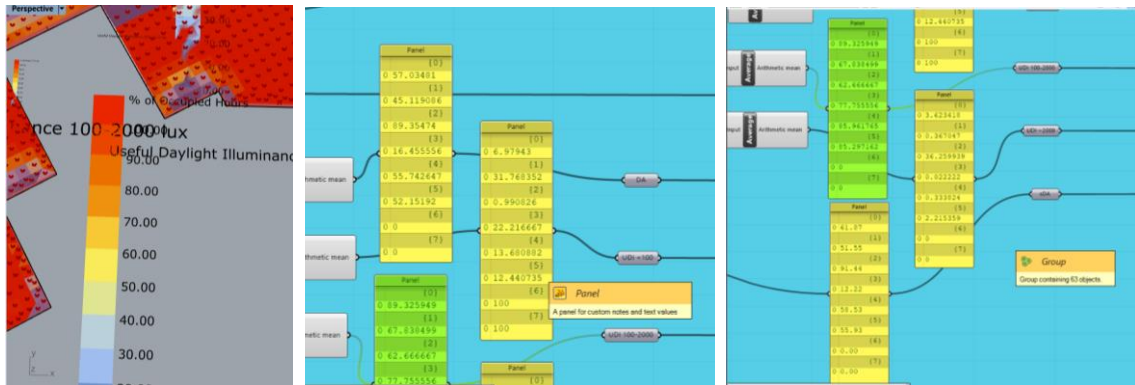


RETROFITTED BLOCK WITHOUT SHADE:



In the retrofitted block, the sun's hour radiation is analyzed. The radiation which exposed in the building experiences lesser radiation while comparing with the building without shade. The proposed case experience less amount of radiation while comparing to the base case. This leads to less amount of energy load is used in the building.

PROPOSED BLOCK



In the proposed block, the daylight radiation is analyzed. The daylight is calculated along with the daylight analysis, useful daylight illuminance less than the lux value of 100 to 2000. The proposed case experience a large amount of building experiences daylighting, than the usage of artificial light.

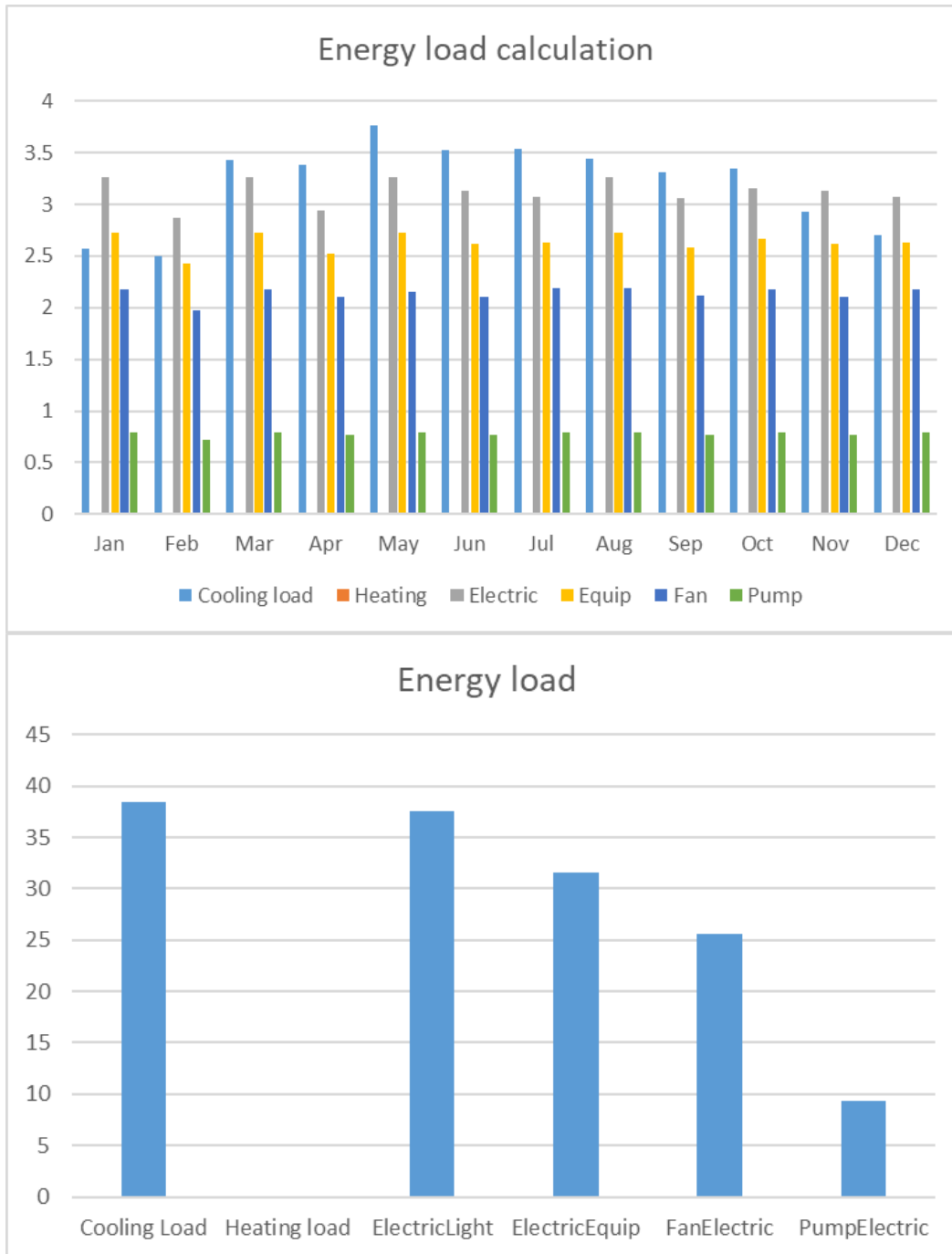
RETROFITTED BLOCK:



In the proposed block, the daylight radiation is analyzed. The daylight is calculated along with the daylight analysis, useful daylight illuminance less than the lux value of 100 to 2000 The proposed case experience a large amount of building experiences daylighting, than the usage of artificial light.

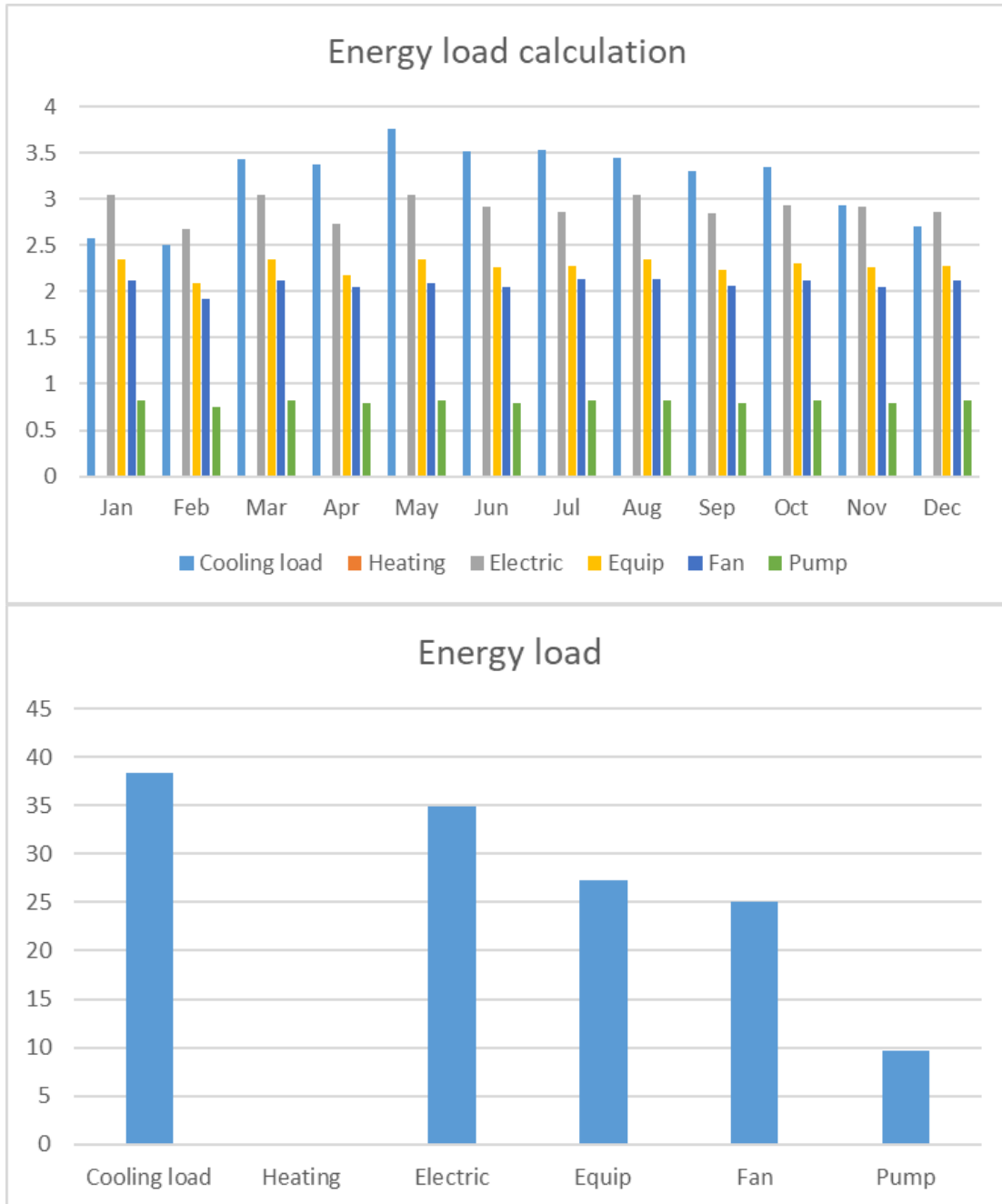
10.4 ENERGY CALCULATION:

BASE CASE:



The energy load is calculated for the building. The total load calculated for a year **142.545** Kwh/m². In the second chart explains about the energy calculated in each month.

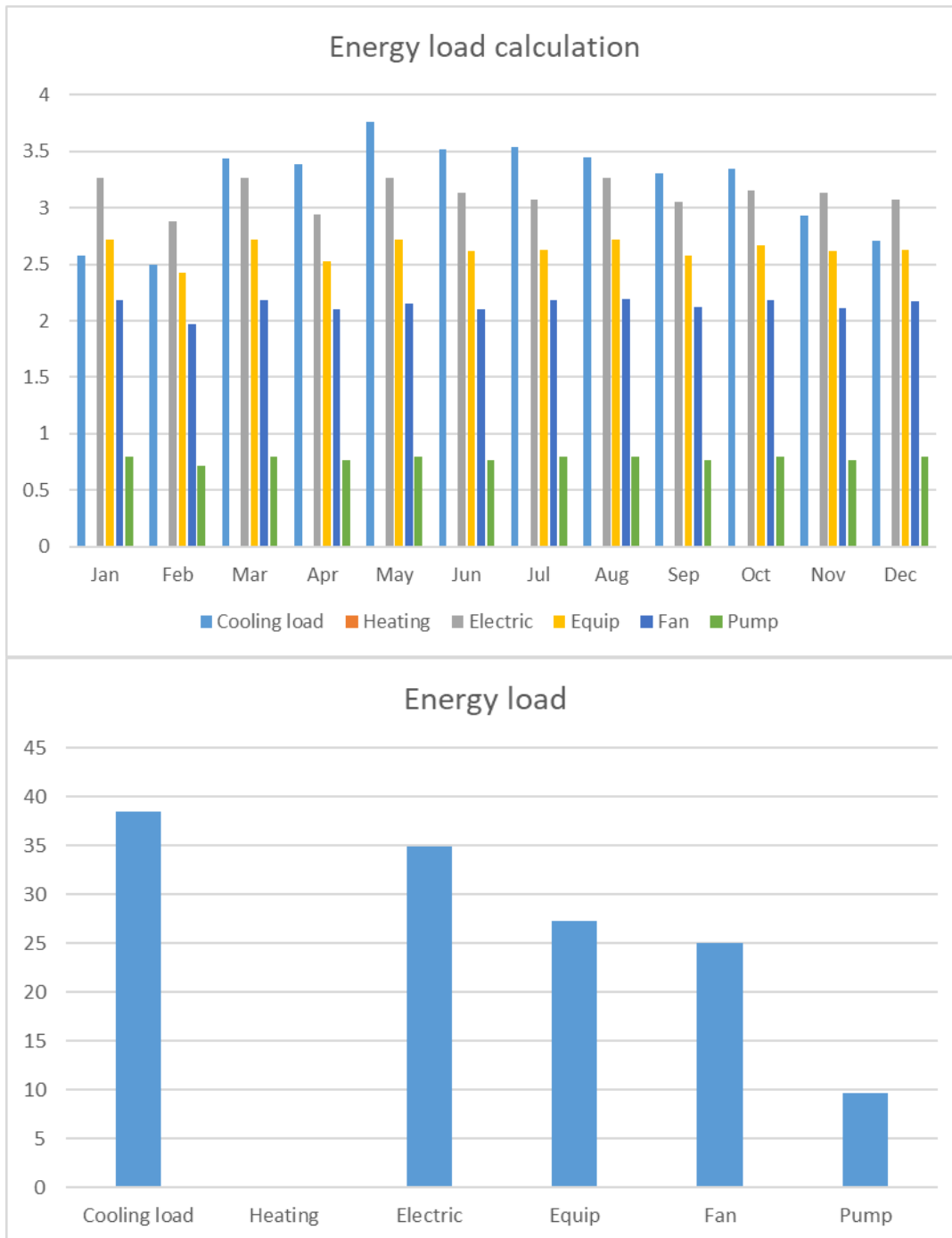
PROPOSED CASE:



The energy load is calculated for the building. The total load calculated for a year **135.3968** Kwh/m2. In the second chart explains about the energy calculated in each month.

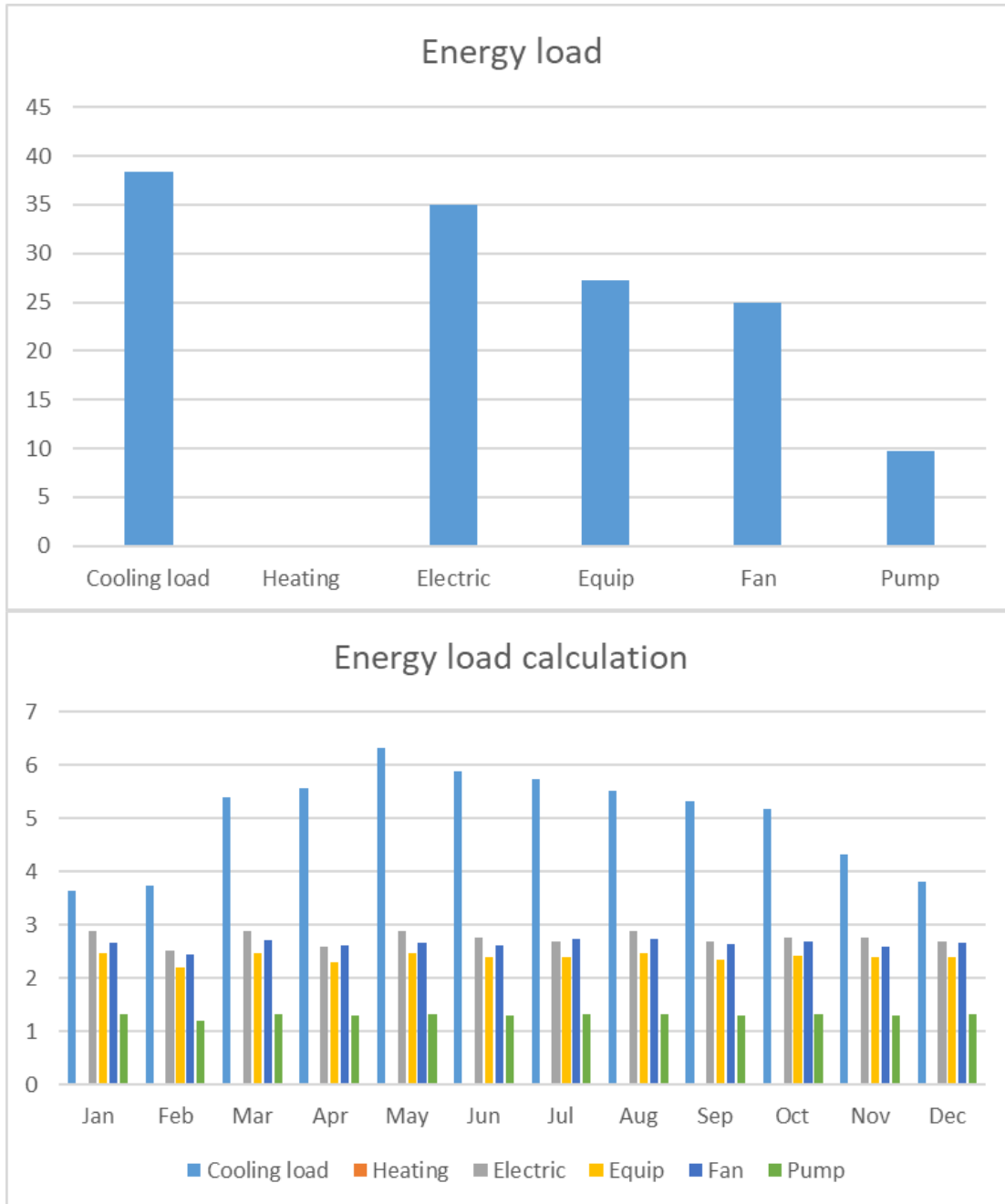
PROPOSED BLOCK:

BASE CASE:



The energy load is calculated for the building. The total load calculated for a year **185.9763** Kwh/m². In the second chart explains about the energy calculated in each month.

PROPOSED CASE:



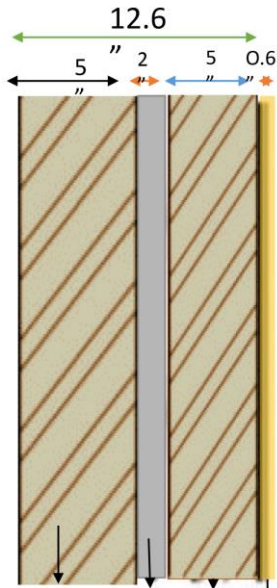
The energy load is calculated for the building. The total load calculated for a year **169.8862** Kwh/m². In the second chart explains about the energy calculated in each month.

11. MATERIAL ANALYSIS:

WALL ASSEMBLY

R VALUE FOR WALL ASSEMBLY:	
MATERIAL	R VALUE (M2.K/W)
127 MM BRICK	1.22
127 MM BRICK	1.22
12 MM PLASTER	0.02
50MM AIR CAVITY	0.14

EMBODIED ENERGY(EE) TABLE:	
MATERIAL	EE (MJ/M2)
127 MM BRICK	350
127 MM BRICK	350
12 MM PLASTER	30



Sum of all the energy required to produce = $350 + 350 + 30$
 = 730 mj/m²

Total r.value = sum of component R-values.
 = 2.6 m².k/w

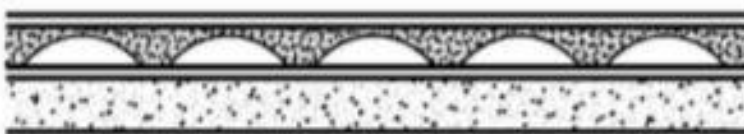
Ecbc recommended r.value for wall assembly:
 = 2.27 m²k.w

OVERVIEW OF MASONRIES ENVIRONMENTAL IMPACT

As stated local material, **brick wall** has lower embodied carbon emission when compare with other available building materials.

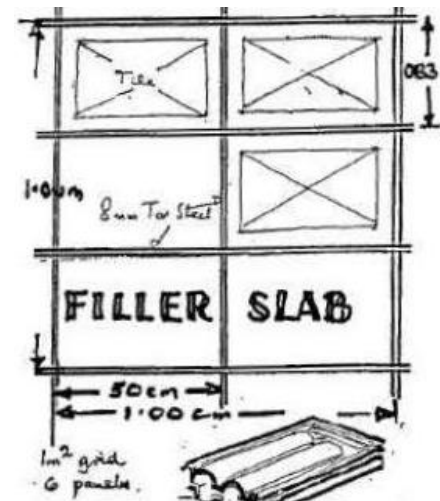
R value: 1.42m².k/w
 K value: 1.83 w/mk

ROOF ASSEMBLY:



R VALUE FOR WALL ASSEMBLY:	
MATERIAL	R VALUE (M2.K/W)
127 MM BRICK	1.22
127 MM BRICK	1.22
12 MM PLASTER	0.02
50MM AIR CAVITY	0.14

EMBODIED ENERGY(EE) TABLE:	
MATERIAL	EE (MJ/M2)
20MM MORTAR FINISH	36.40
75MM SMB FILLER	590
100MM RCC SLAB	506.44



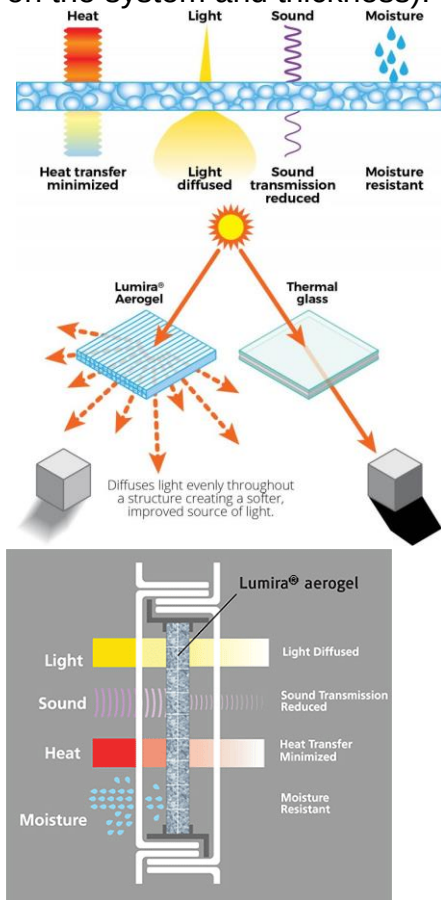
**RCC SLAB + 75MM FILLER MATERIAL
 + 20MM CEMENT MORTAR FINISH**

Total embodied energy: 1132.84 mj/m²

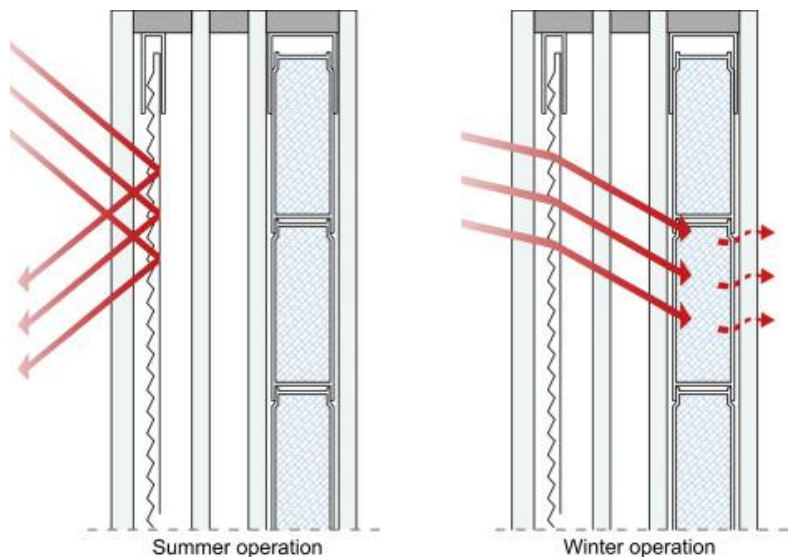
Ecbc recommended r.value: (3.8 m².k/w)

AEROGEL CURTAIN WALL

Lumira aerogel, a translucent product made from a dry silica particulate, is a high performance insulating gel used to insulate a polycarbonate. When added, lumira increases thermal ratings and light transmission while reducing glare, sound transmission, and the thermal transfer of heat and cold. Lumira aerogel is characterized by an excellent light transmission of up to 90% at 1 cm of thickness. High light transmission-75% per cm low thermal conductivity- R value of 8/inch (U- value can go as low as 0.28 W/m²k depending on the system and thickness).



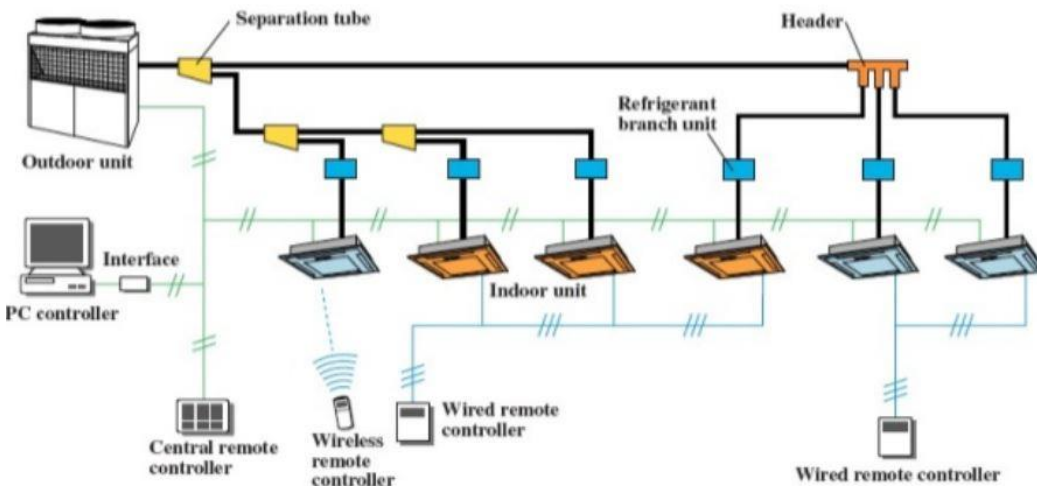
AEROGEL CURTAIN WALL	
R VALUE (M2.K/W)	2.94
U VALUE (M2.K/W)	0.34
SHGC VALUE	0.65
VLT VALUE	72%



HVAC SYSTEM:

VARIABLE REFRIGERANT FLOW

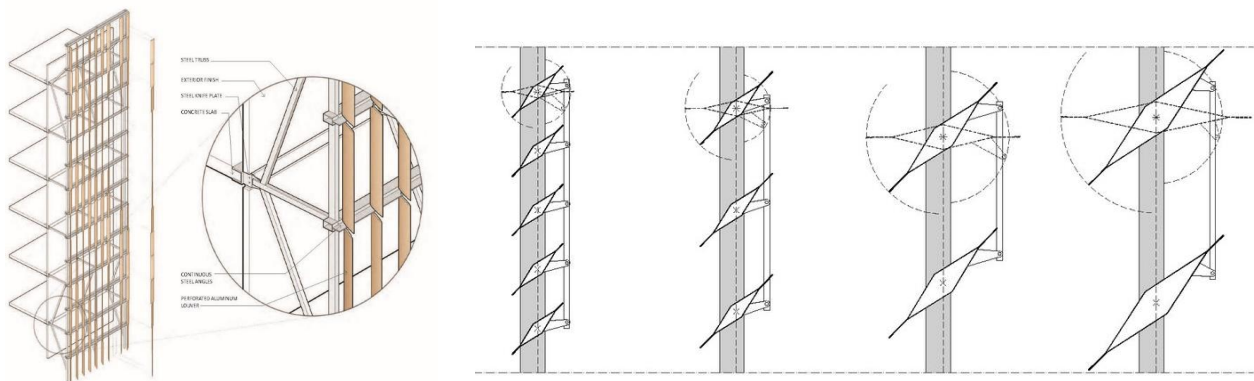
Variable Refrigerant Flow (VRF) or Variable Refrigerant Volume (VRV) air conditioning systems are an extremely energy efficient means of precisely regulating the temperature within commercial buildings. More often than not, the rooms or zones within the building will need to operate at differing temperatures. The cooling and heating requirements of these spaces inevitably change throughout the day, typically as a result of varying occupancy, heat emitting office equipment and lighting, changes in outdoor temperature and notably, the position of the sun. The combined effect of these internal and external influences often means that some areas of the building require cooling, while simultaneously, other areas require heating to maintain a constant and comfortable internal environment.



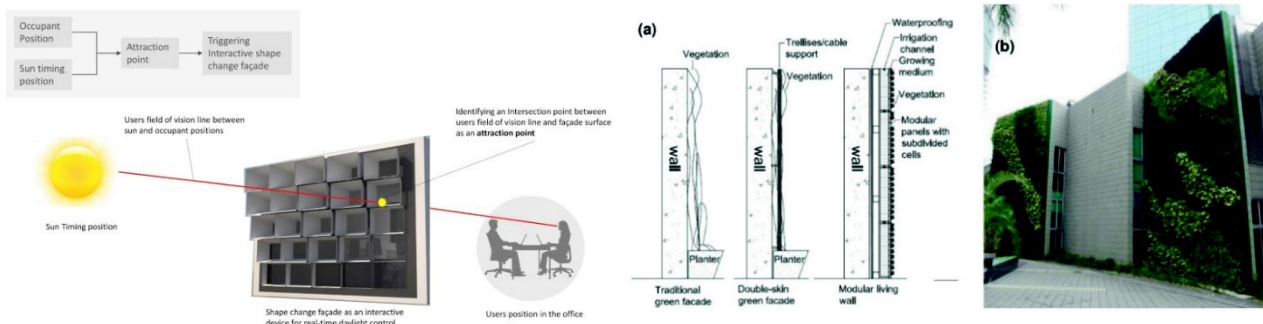
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Vertical louvers:

Automated vertical louvers respond to the sun system. Controllable solar shading systems can better optimize the flow of heat and light energy as compared to fixed solar shading systems with the help of computer software, which controls the louvers to follow the sun path. Since the louvers are designed as such, need for artificial lighting can be potentially reduced with daylight distribution being improved; whilst radiation levels are reduced to a minimum. Automated louvers can eliminate the extreme conditions and remove the delayed reaction of occupants to sky conditions providing a much more robust and balanced daylight levels in the building.



GREEN PERFORATED PANELS:



Perforated panels on a building uses the natural cooling effect of shadow to reduce the temperature and hence the energy bill of air conditioning. By reducing solar radiation, perforated panels reduces total energy costs. Perforated panels plays major role in the daylight control in the interior of the building. Perforated panes can be used to regulate light and ventilation within a space. It can block or limit direct light while still allowing airflow. This can assist in reducing energy consumption.

12. MANUAL CALCULATIONS: DAY LIGHTING –PROPOSED BLOCK

Shading	Latitude	Window Type	VLT < 0.3				VLT ≥ 0.3			
			North	South	East	West	North	South	East	West
No shading or PF < 0.4	≥ 15°N	All window types	2.5	2.0	0.7	0.5	2.8	2.2	1.1	0.7
	< 15°N		2.4	2.0	1.3	0.6	1.7	2.2	1.5	0.8

TABLE 7.1 - Calculation for FIRST FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	52.21M	2.5X3 = 7.5	52.21+2 = 54.21	54.21X7.5 = 406.575 SQ.M
South	2.0	40.55 M	2.5 X 3 = 7.5	40.55 + 2 =42.55	42.55X7.5 = 319.12 SQ.M
East	0.7	23.99 M	2.5 X 3 = 7.5	23.99 +2 = 25.99	25.99 X 7.5 = 194.925 SQ.M
west	0.5	33.94 M	2.5 X 3 = 7.5	33.94 +2 = 35.94	35.94 X 7.5 = 269.55 SQ.M
Term 1 Total					1190.17

TABLE 7.1 - Calculation for SECOND FLOOR, FIFTH FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	97.58 M	2.5X3 = 7.5	97.58+2 = 99.58	99.58 X7.5 = 731.85Q.M
South	2.0	79.27 M	2.5 X 3 = 7.5	79.27 + 2 =81.27	81.27X7.5 = 609.525 SQ.M
East	0.7	31.42 M	2.5 X 3 = 7.5	31.42 +2 = 33.42	33.42 X 7.5 = 250.65 SQ.M
west	0.5	39.11 M	2.5 X 3 = 7.5	39.11 +2 = 41.11	41.11 X 7.5 = 308.325 SQ.M
Term 1 Total					1900.35

TABLE 7.1 - Calculation for THIRD & FOURTH FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	52.21M	2.5X3 = 7.5	52.21+2 = 54.21	54.21X7.5 = 406.575 SQ.M
South	2.0	40.55 M	2.5 X 3 = 7.5	40.55 + 2 =42.55	42.55X7.5 = 319.12 SQ.M
East	0.7	23.99 M	2.5 X 3 = 7.5	23.99 +2 = 25.99	25.99 X 7.5 = 194.925 SQ.M
west	0.5	33.94 M	2.5 X 3 = 7.5	33.94 +2 = 35.94	35.94 X 7.5 = 269.55 SQ.M
Term 1 Total					1190.17

Total light achieved in first, third & fourth floor – 50.5%

Total light achieved in second & fifth floor – 63%

Total day light achieved = (63+ 63+ 50.5+50.5+50.5)/5 - **55.5%**

RETROFITTED BLOCK:

TABLE 7.1 - Calculation for GROUND FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	52.21M	2.5X3 = 7.5	52.21+2 = 54.21	56X7.5 = 420 SQ.M
South	2.0	40.55 M	2.0 X 3 = 6	38.47 + 2 =42.55	40.47X6 = 242.82 SQ.M
East	0.7	23.99 M	0.7 X 3 = 2.1	31.8 +2 = 25.99	33.8X 2.1 = 70.98 SQ.M
west	0.5	33.94 M	0.5 X 3 = 1.5	20.6 +2 = 35.94	22.6 X 1.5 = 33.9 SQ.M
Term 1 Total					766.82

TABLE 7.1 - Calculation for FIRST & SECOND FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	52.21M	2.5X3 = 7.5	52.21+2 = 54.21	56X7.5 = 420 SQ.M
South	2.0	40.55 M	2.0 X 3 = 6	38.47 + 2 =42.55	40.47X6 = 242.82 SQ.M
East	0.7	23.99 M	0.7 X 3 = 2.1	31.8 +2 = 25.99	33.8X 2.1 = 70.98 SQ.M
west	0.5	33.94 M	0.5 X 3 = 1.5	20.6 +2 = 35.94	22.6 X 1.5 = 33.9 SQ.M
Term 1 Total					766.82

TABLE 7.1 - Calculation for THIRD & FOURTH FLOOR					
Orientation	DEF	(Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m ²) Above grade area meeting the UDI requirement for 90% of the time in an year
North	2.5	52.21M	2.5X3 = 7.5	52.21+2 = 54.21	54.21X7.5 = 406.575 SQ.M
South	2.0	40.55 M	2.5 X 3 = 7.5	40.55 + 2 =42.55	42.55X7.5 = 319.12 SQ.M
East	0.7	23.99 M	2.5 X 3 = 7.5	23.99 +2 = 25.99	25.99 X 7.5 = 194.925 SQ.M
west	0.5	33.94 M	2.5 X 3 = 7.5	33.94 +2 = 35.94	35.94 X 7.5 = 269.55 SQ.M
Term 1 Total					1190.17

Total light achieved in ground floor– 45.3%

Total light achieved in first & second floor– 48.4%

Total light achieved in second & fifth floor – 51.6%

Total day light achieved =(45.3+ 48.4+48.4+ 51.6+51.6)/5 – **49.06%**

Thus the value of proposed block satisfies the ECBC+ and the retrofitted block satisfies the ECBC.

RAINWATER HARVESTING:

1. ROOF TOP DRAINING AREA CALCULATION

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

Area of the Total roof =5165 sqm

Coefficient of runoff = 0.9

Annual Rainfall of Chennai = 1382 mm

Rain water harvesting from roof = 64, 24,227 litres annually.

2. STORM WATER RUN OFF AREA CALCULATION

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

Area of the pavements = 6083 sqm

Coefficient of runoff = 0.9

Annual Rainfall of Chennai = 1382 mm

Storm water runoff from pavements= 75, 66,035 litres annually.

3. HARVESTING FROM GARDEN SPACE:

= Area x TAR x Run-off co-efficient

=5674 x 1382 x 0.9

= 70, 57,321 lts.

From pavements & garden areas. The collected water for ground water recharge.

TOTAL = 2, 10, 47,583 lts.

RWH system captures around 20 million liters of rainwater. It reduces the dependences on municipal water supply & ground water extraction.

SOLAR PANEL CALCULATION:

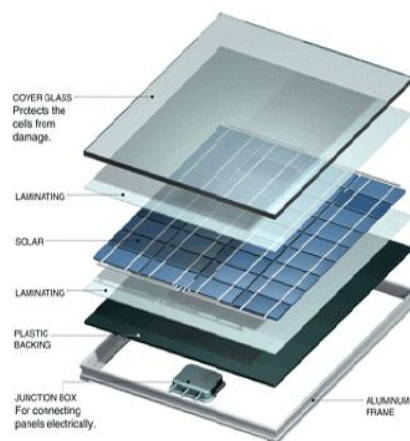
Solar panels can be fitted onto buildings or within fields. They turn sunlight into electricity. New technology is making solar panels able to generate electricity on cloudy days.

BLOCKS	ROOF AREA	NO. OF PANELS
Proposed block	2984	1,499
Existing block	2150	1113

SOLAR PANEL CALCULATIONS		
Dimension of single solar panel (standards for commercial purpose)	77" x 39" - 30030 sq.inch	1.93 sq.m
Electricity produced by a single solar panel	500 Wh/ day	
Total roof area	3799.2 sq.m	
NO. of solar panels to be installed - Roof area / Area of single solar panel	5134	2612
Total generation of electricity in the site through solar panels -Electricity produced by a single solar panel * NO. of solar panels to be installed	2612 x 500 = 13,06,000	

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

Source: Centre for Science and Environment (CSE), New Delhi



VIEWS







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