Institute of Architecture and
Planning,Technology .
Nirma University.

SOLEIL
ALT+E

Competition Division:
Office Building.

Final Design Report - April 2021

Solar™ Decathlon India

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Executive Summary

Team Soleil Alt+E from Nirma University, Ahmedabad focuses on creating a net zero building in a campus that is surrounded by such similar large scale premises by providing efficient solutions specifically catering to the hot and dry climate prevailing in Ahmedabad. As a 15 membered multi-disciplinary team, we bring forward "The Edge", an energy efficient office building,

GIFT City has been conceptualized to be designed above or at par with globally benchmarked International Financial Centres and is envisaged to become a hub for Financial Services, IT/ ITES and other services. Our office building, "The Edge", is designed in a way that fits into the GIFT city in all aspects ranging from technological aspects to futuristic developments.
With a very particular orientation of the site, our primary concept was to control the heat gains and harsh light from the south facade and to optimize daylight. We tried to bring out a form that maximizes daylight usage and achieves thermal comfort by efficient cooling technology of Radiant Cooling and Mix mode ventilation by carrying out different simulations and analysis.

Being in a specific climate, we have used solar energy for the production of renewable energy and our design would be able to produce about 1100 kWh per year.
We have tried to look into not only the energy reduction, but also ways in which we can use local materials and labour to construct the structure. We've also used precast members of Ferro cement shell for slabs trying to make this structure affordable and make the construction quicker and reduce the usage of cement.
Looking at the details and going to the organisational level, we have tried to consider organizing the equipment together in a room which reduces the overall cooling load of the space.
While staying at par with other technologies, we also reduced the water consumption to about 40% by using water efficient fixtures and reusing grey water.

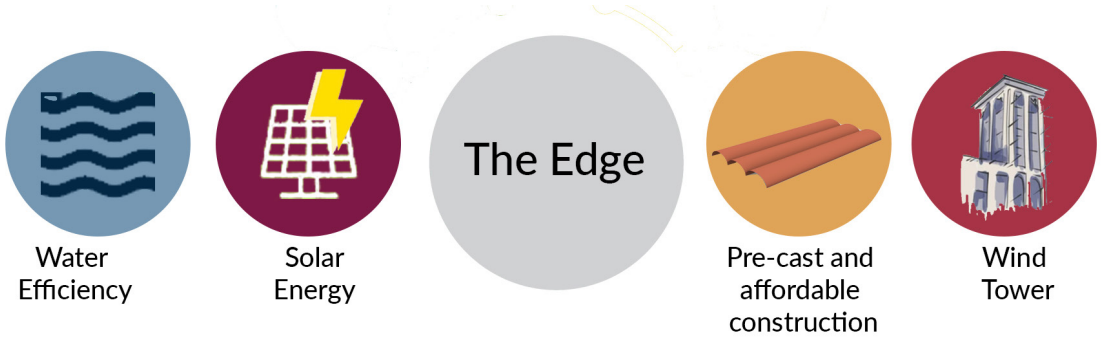


Fig 1: Executive Summary Key Points

Institution Profile

Nirma University
Nirma University, Ahmedabad is a research oriented, student centric, multidisciplinary academic institution, which includes wide realm of Institutes like Architecture and Planning, Technology, Management, Law, Science, Commerce, Pharmacy and Department of Design.
The program of Institute of architecture and planning, technology closely connects with the creative realm of imagination and empirical execution of the same. The Institutes's pedagogy focuses on understanding of scenarios, development of perception, interaction with the real world and learning by doing.

Faculty Lead:
Name: Prof. Jaydeep Bhagat

Designation: Professor & Academic Co-ordinator at Institute of Architecture and Planning, Nirma University
Bio: Academician, Architect and Urban Designer with an overall experience of 25 years in teaching and design of institutions, individual residences and urban design.

Industry Partner

Industry Partner:
Fibre tech Composite is a leading manufacturer of FRP Water pipes. These pipes are highly durable compared to other alternatives. These pipes have low carbon footprint compared to other metal pipes. Most importantly FRP water pipes do not rust and are resistant to corrosive chemicals. FRP is also an Environmentally responsible material choice recognized by LEED this is because it maximizes energy performance.

Company's name– Spanco Semiconductors
Owner - Bharat Soni
'Spanco semiconductors' was establish in 1995 and has successfully provided lighting solutions all over India, with their innovative technical team and advanced machineries. They manufacture environment friendly and quality products at low cost.
The proficiency of the company in lighting industry extends into commercial lighting, industrial lighting, architectural lighting solutions and manufacture solar panels and lights. They design, develop and produce high quality, robust and reliable engineered products which suit to a wide range of applications.

Team Profile

Team Name- Soleil Alt+E

Team Approach- Our team comprises of 15 members from Architecture and Engineering. Having 15 distinct opinions towards a similar concern, offers vision from various bearings. Our aim is to disperse the work depending on the abilities. Regular meetings shall provide us a platform to share our views and help us keep a check on the work progress which shall broaden our vision. We plan to have design charades, discussions, and debates, to exchange our ideas to bring out more creative solutions. Frequent discussions with facul
ty advisors for regular checks in progress and to provide practical insights for the project shall be conducted.

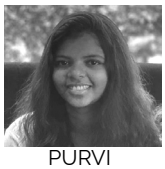
Team Members	Qualification	Roles
Nikee Shah	Architecture	Team Leader
Nimesh Bansal	Architecture	Energy Performance Analysis
Nil Donga	Architecture	Architectural Design
Rutu Kevadiya	Architecture	Water Performance Analysis
Purvi Dabhi	Architecture	Comfort and Environmental Quality
Aesha Acharya	Architecture	Architectural Design
Ojas Kothari	Architecture	Resilience
Mansi Chapla	Architecture	Innovation
Shanay Patel	Architecture	Energy Performance Analysis
Prachi Kalathiya	Architecture	Comfort and Enviornmental Quality
Prachi Pokar	Architecture	Resilience
Aryan Prajapati	Architecture	Financial and Market Analysis
Pururava Kalavadia	Architecture	Financial and Market Analysis
Khushboo Palkhiwala	Architecture	Presentation and Drawings
Apurva Ganatra	Civil Engineering	Engineering Design and Operation


NIKEE


NIMESH


NIL


RUTU


PURVI


AESHA


OJAS


MANSI


SHANAY


PRACHI


PRACHI


ARYAN


KHUSHBOO


PURURAVA


APURVA

Project Introduction

Project Name- The Edge
Project Partner- GIFT City
A green field smart city and a global financial hub, GIFT city, is focused on setting up International Financial Services Centres. It is an integrated development on 996 acres of land with 62mn sq.Ft. Of built up area which includes Office spaces, Residential Apartments, Institutions, Utilities and various Recreational Facilities, which makes this City a truly "Walk to Work" City. GIFT City consist of conducive Multi-Service SEZ (Special Economic Zone) and an exclusive Domestic Area. It is changing the economic face of Gujarat and would keep India on the global map as a centre of excellence in the financial and IT Services domain.

GUJARAT INTERNATIONAL FINANCE TEC-CITY

Project Brief-

"The EDGE" – an office building is one of the proposals in GIFT city, Gandhinagar Gujarat which is going to be built, owned and operated by the same. The site where the project is located is one of the futuristic sites of Gujarat regarding the development in economy, infrastructure, and other aspects. Site abuts a four lane National Highway (NH8) which connects Ahmedabad and Gandhinagar on its eastern side and the Sabarmati River demarcates the western boundary. The project site is located near the World Trade Centre which is one of the major commercial projects in GIFT City.
Coordinates: 23°09'54.48" N 72°41'17.62"E
Site Area: 1300 sq. m
The site is located in the hot and dry climate. It is a project that they have planned to build after a couple of years. The temperature here averages 27.2 °C and annual rainfall is 746 mm.

Fig 2: Site Context


Fig 3: Site Photographs

Basic Area Distribution:

- Site Area: 1300sq.m
- No. of floors: 7
- Floor Plate: 470 sq m. (leaving margins)
- Total Built Up Area: 470 * 7 = 3290 sq.m
- Softscape Area: 200 sq.m
- Hardscape Area: 556 sq. m
- Parking: 760 sq.m

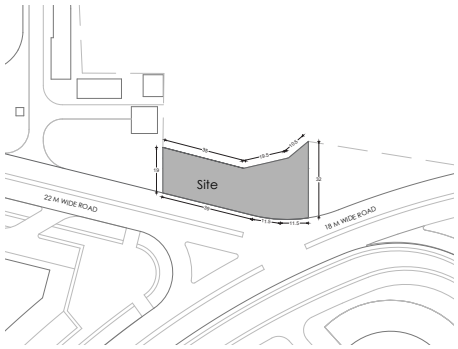


Fig 4: Site Plan

Context and Market Analysis

Being in GIFT City which is a hub for big and small-scale corporate banking services, all kinds of IT Services because of the growing infrastructure. The location of the city between two megacities with facilities like water, electricity, transport, and district cooling plant and many more makes it an opportunity for growth of offices with easier employment opportunities and good living conditions.

Our project is a small-scale IT Service and has occupants from around 225-250 and the hour of operations are around 7-8 hours a day for 25-27 days a month.

Performance Specifications

Performance Specifications		
Envelope (U-Value)		
External Wall	350 mm thick exposed cavity wall	R-0.4
Roof	500 mm depth pecast panel with china mosaic	R-4.54
Window	Double glazed unit with Aluminium frame	R-2
Column	350*500 R.C.C. M-20 grade	R-4.54
Staircase	3 mm thick L section staircase	R-0.83
Windows SHGC	Low SHGC because of hot and dry climate	0.3
Windows VLT	Shading devices are used hence low VLT	33%
HVAC System		
Type	Ductless system giving us high capacity	VRF
Cooling Source	Electric Mode	Electric
Cooling Capacity	capacity in Tr	9.75
Cooling Capacity	capacity in KW	175
Cooling COP	capacity in KW	16.5
ISSER	one time investment with quick returns	4.2
Star Rating		4
Internal Loads		
LPD	Interior Average Lighting Power Density	4.8 W/m2
EPD	Average Equipment Power Density	3.58 W/m2
Lighting & Appliances	one time investment with quick returns	5 star rating
Renewable Energy		
Type	Solar Panels on roof of building and parking	-
Size and power	2m*1m PV panels each	2.25 Kwh
Average Production	196 panels with each capacity of 5.6 Kw/day	1100 Kw/day
Surplus	Average Consumption is 800 Kw/day	300 Kw/day
Water System		
Type	Rootzone system	-
Waste water recycling	Average treated grey water per day	4563 LPD
Consumption	Average Consumption	8167 LPD

Table1: Performance Specifications

Design Goals and Stratergies

Energy Performance and Engineering Design

•Using solar panels on the roof helps to generate maximum energy from the site which helps in gaining maximum sun radiation.(830 kWh/m2).

•In order to tackle the heat generated from appliances we have separate designated spaces, provided with maximum ventilation. The wind speed at the site is low, we intend to achieve ventilation through the combined outcome of the wind tower and stack effect.

Water Performance

• Water performance can be increased by installation of water efficient fixtures which will reduce consumption.

• Grey water generated shall be treated and reused for landscaping and flushing.

• Roofs can be modulated to transfer the rainwater towards the storage trenches

Resilience

• Gandhinagar is a city which has comparatively less vulnerable factors and three most likely hazards that can occur on the site which are seismic activity, floods and heat waves.

• Our aim is to esign a structure which withstands the seismic loads and by carrying out simulations.

We incorporated UPS whenever there is a supply outage, this system can supply electricity for atleast 3 hours.

Affordability, Scalability and Market Potential

• Use of traditional materials and precast members would reduce the cost

• Opportunities to generate revenue by renting out certain office spaces like auditoriums and common cafes that are not used on a daily basis.

Comfort and Environment

• Our main aim is to provide a comfortable working environment by providing maximum daylight, and thus reducing the equipment load by 50%.

• Rightsizing will reduce the HVAC load significantly. We aim to reduce HVAC Loads to about 60-65%.

Architectural Design

• We aim for the office building to go beyond the conventional norms and have spaces which encourage creativity and provide a healthy working environment with various gathering spaces

• Organisation of spaces in respect to natural elements like solar radiation, daylight, ventilation would help to reduce the heat gains and discomfort from the surrounding spaces.

•Adding a vertical garden on the south facade helps reduce thermal load and gives .an aesthetic effect.

Documentation of Design Process

As a team of 15, we carried out various online design discussions about our project. Starting with the preliminary design analysis, we divided various categories among us. After receiving comments from the 2nd deliverable, we started working on the different specializations and came together to meet and discuss the progress on each.

We then started working with the comments that we received in the pre-design simulations, and to improve them, we initially worked on the envelope of the space with shading devices and made decisions about the material which ultimately led us to deciding on the form, organisation, and distribution of spaces in the built form.

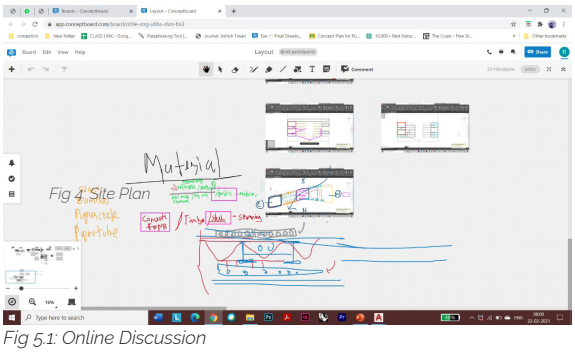


Fig 5.1: Online Discussion

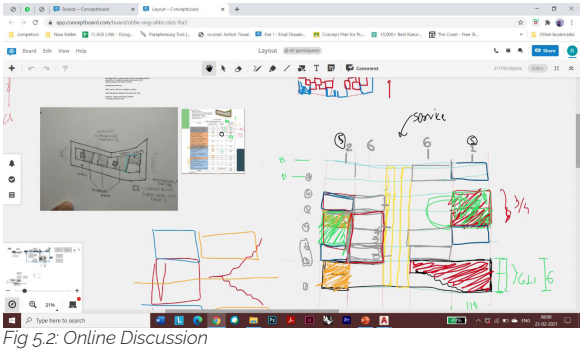


Fig 5.2: Online Discussion

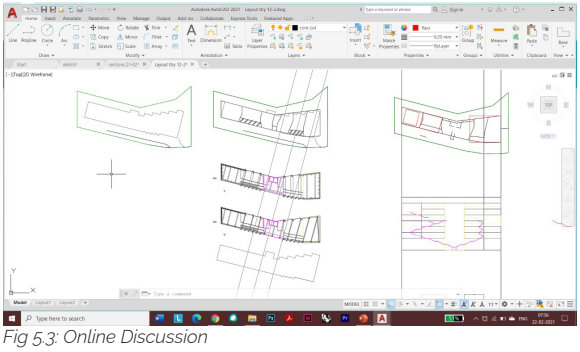


Fig 5.3: Online Discussion

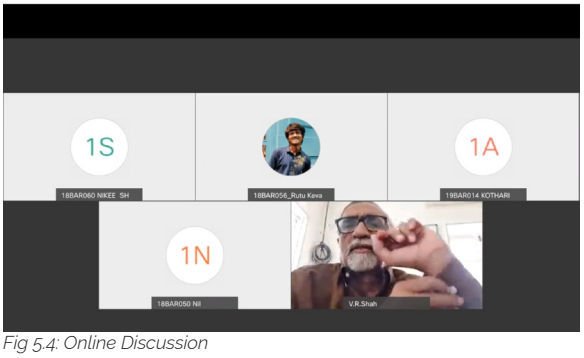


Fig 5.4: Online Discussion

Similarly, we carried out discussions when we faced challenges and discussed them with various faculties during the process about the materials, construction system, structure and got various inputs from them and discussed with the industry partner as well.
Working on their inputs and integrating the previous remarks from the team and faculties, Soleil Alt + E, reaches the level so forth presented.

Similarly, we carried out discussion and facing challenges and discussing with various faculties during the process about the materials, construction system, structure and got various inputs and discussing with the industry partner. Working on the points they provided and ascertaining the previous remarks from the team and faculties, Soleil Alt + E, reaches the level so forth presented.

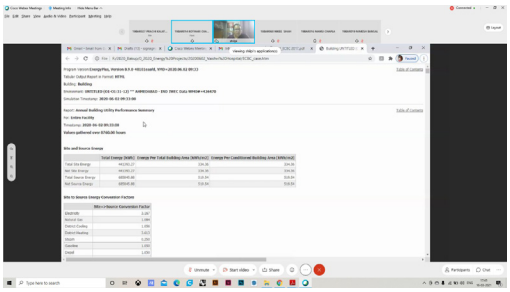


Fig 5.5: Online Discussion with Prof. Shipli Saboo

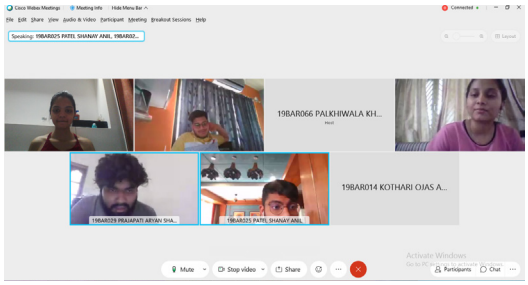


Fig 5.6: Online Internal Discussions

With the comments received from the Deliverable 3, we have tried to incorporate the changes and improvements in the design. We have also focused more on the technical aspects and tried to work them out and document them with more clarity.

The water calculations done initially were corrected and more strategies were incorporated in order to use the existing water more efficiently. We have provided a slope on site for more surface run-off to collect more rainwater for reuse and there is a grey water system in place which makes sure that there is no wastage of water. Detailed calculations were done in order to justify the water usages and the entire cycle.

Since the initial innovation pitch was detailed, we have managed to work it out and place separate rooms for the CPUs in the building with appropriate calculations in order to reduce the heat gain and maintain thermal comfort.

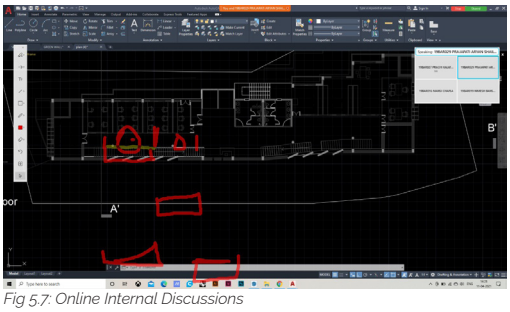


Fig 5.7: Online Internal Discussions

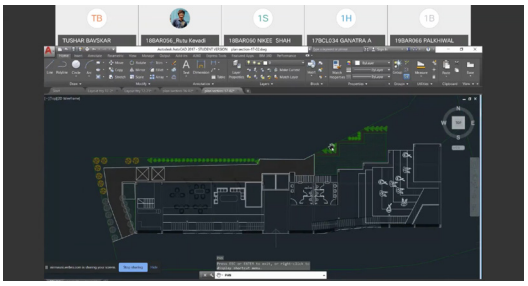


Fig 5.8: Online Internal Discussions

We were having issues with having just one wind tower in the building as it wasn't sufficient to provide the ventilation that we were aiming for. In order to tackle this problem, we looked at the minimum requirements for natural ventilation in buildings and added another wind tower which enhances the existing ventilation. The fins on the southern facade also support this ventilation system and make it more efficient. This addition has made 6 ACH ventilation possible in the building and ensured the air flow or distribution across the floors.

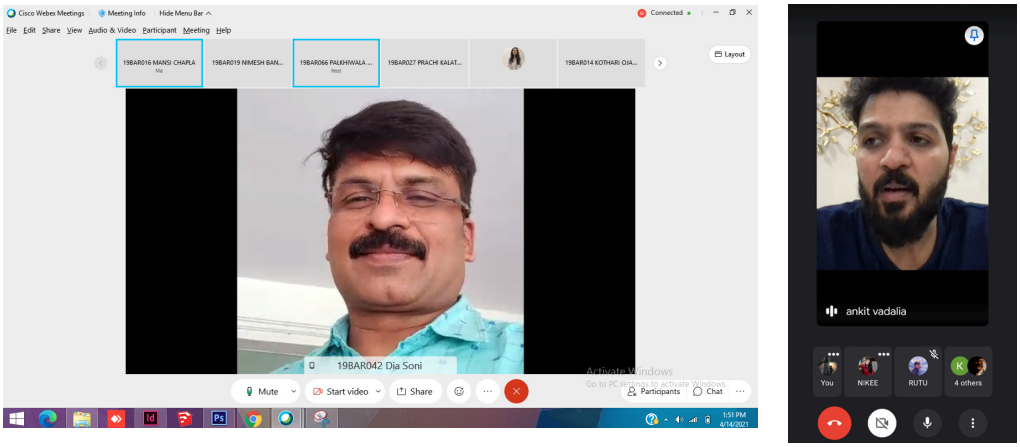


Fig 5.9: Industry Partner Meetings

We had multiple discussions with our Industry Partner regarding the efficiency of solar panels. Initially we had installed the solar panels on the southern facade but they proved to be inefficient cost-wise. With further studies and calculations, we came to a consensus to add the solar panels on the roof of the building and the parking shade. Despite the change in the amount of extra energy (the energy left after calculating the consumption for each day) generated, this decision to change the placement of the panels was taken as it was more cost-effective, and also easing the installation difficulties. We also had discussions regarding the pipes and efficient installation systems and the best suitable type.

Architecturally, we have made sure to place the services appropriately and more or less towards the center. They are all overlapping which makes the resolution of plumbing very easy. The drawings were also improved in their legibility and presentation.

Energy Performance

Climate Analysis: -

Gandhinagar has a tropical wet and dry climate with three prominent seasons: summer, monsoon and winter. Besides monsoon the climate is generally dry and hot. Gandhinagar has high temperature range throughout the year which exceeds the comfort range and has average rainfall around 746 mm, which is relatively low. The wind rose diagram for Gandhinagar shows how many hours per year the wind blows in the illustrated direction . This indicates that the wind direction flows from North to South west, the south west wind is far more effective because of the speed.

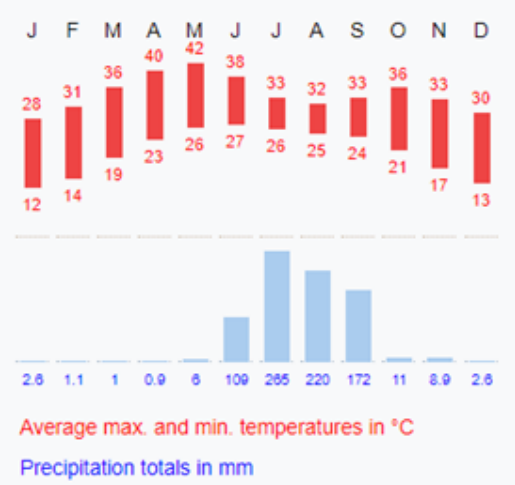


Fig 6.1: Average Temperature

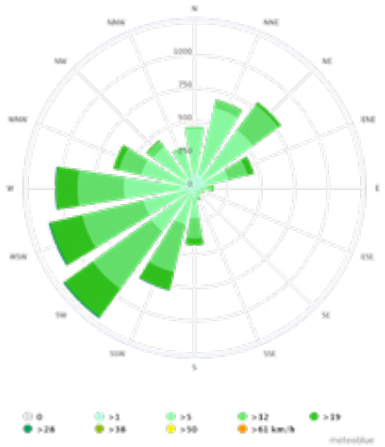


Fig 6.2: Wind Diagram

Site Analysis - Solar Shadow Analysis

Through the solar shadow analysis we figured out a range of shadows formed by the existing buildings and we observed that our site has no shadows during summer season. During winters it is shaded for few hours a day. Therefore, the use of solar PV panels could be done to a full extent without having any intermediate shading of buildings. The building has to be independent of the pre-existing structures in the context while designing the envelope.

Fig7.1: Shading on site at June 21st

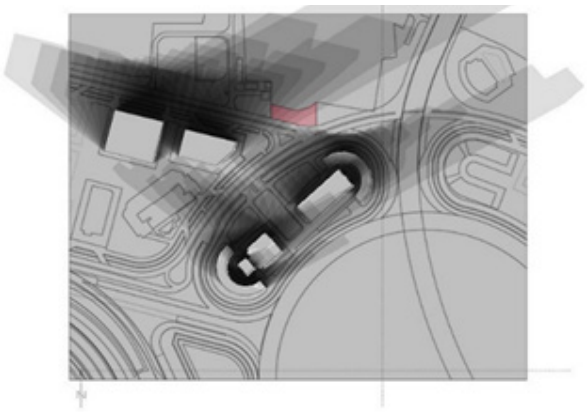


Fig7.2: Shading on site at December 21st

Energy Performance

Sun Hour Analysis

The average range of sun hours for the existing building was studied with the sun hour analysis. According to our EUI simulations we analysed the final result for the sunlight analysis. Through which we observed that our site has ample amount of sunlight. During the summer months the fins help us shade the southern facade while the north receives diffused light. Which helps in maintaining thermal comfort without the need of mechanical cooling. During winter, north is shaded and south receives sunlight creating desirable temperatures. Vertical Garden on the southern facade also reduces the direct sunlight and also maintains the thermal comfort in the surroundings.

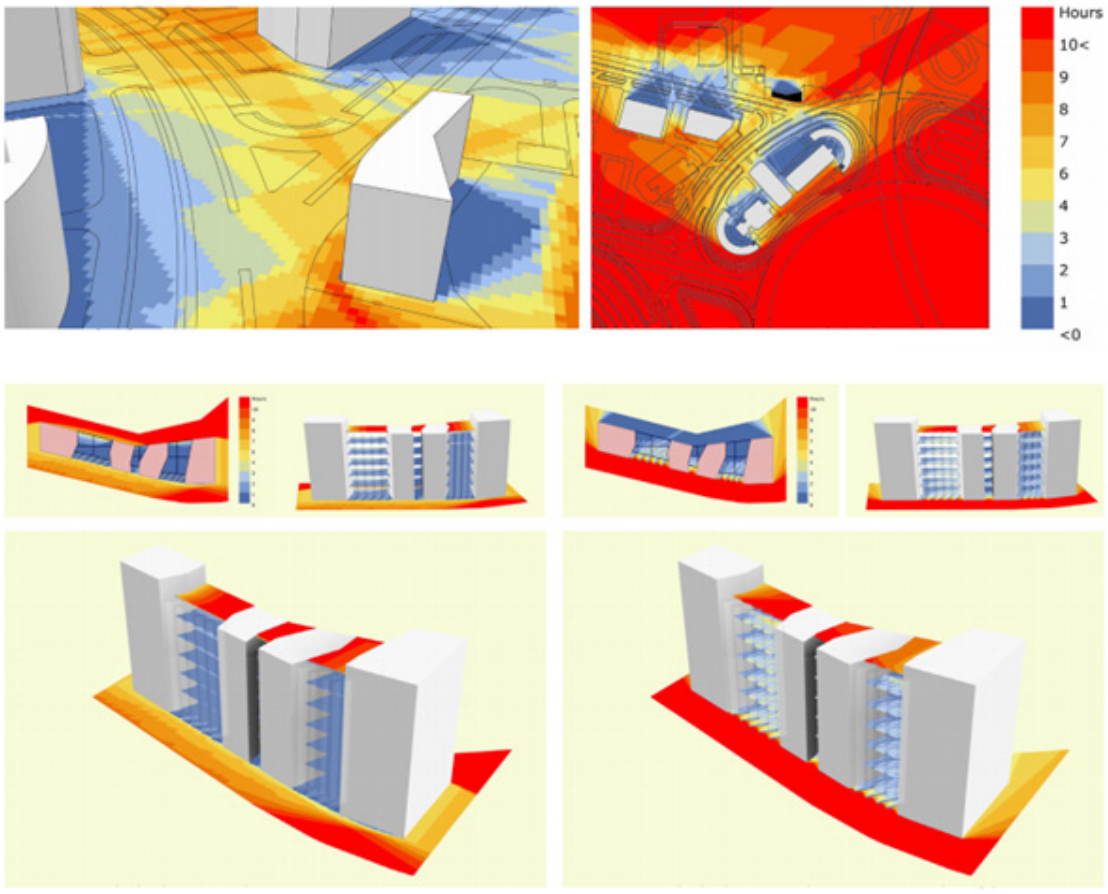


Fig8: Sun Hour Analysis

Energy Performance

Building Envelope- Materials

After the initial design discussions, we were working on the materials for the built envelope. We were focussed on using the local and precast materials while keeping in mind the affordability, market potential and architectural aspects.

For the roof and flooring, we selected precast ferrocement shells which reduce the weight as well as amount of cement used in order to lower the weight and carbon footprint. It significantly makes the construction easier and faster.

The U-value of the ferrocement shell in the floor with an insulation strip between two shells is 0.22 compared to a concrete block having U-value 5.85.

For walls we had the option to make it load bearing using bricks along with cavities or to use an RCC Frame structure with a brick cavity wall as an infill. Again, looking at affordability, quicker construction and structural integrity, we moved forward with the idea of a frame structure.

Then, we carried out simulations to check for the appropriate envelope configuration in the Design Builder for different configurations of brick walls, concrete blocks and glass.

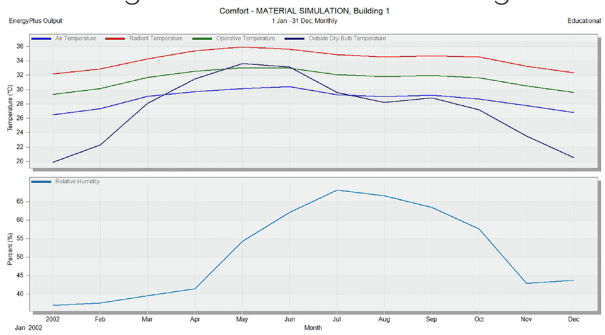


Fig.9.1: 300mm thick brick wall & zero glazing

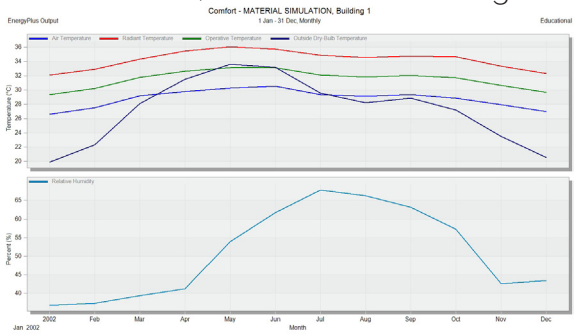


Fig.9.2 : 200m thick brick wall (u value - 2) with insulation & single glazing

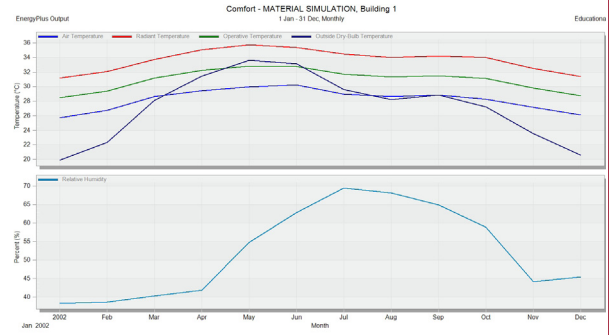


Fig9.3 : 300mm thick AAC wall (U-value = 5.52) & single glazing

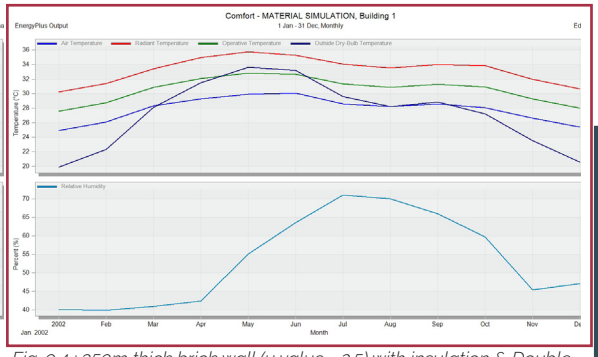


Fig. 9.4 : 350m thick brick wall (u value - 2.5) with insulation & Double glazing

The best result run was the 4th one and we have selected the same for the building envelope configuration. Walls- Brick cavity wall 350mm(u-2.5) thick with double glazed glass (u value - 0.5) Roof- Ferrocement shell (whose heat further will be reduced because of highly reflective china mosaic roof finish) (u value - 0.22). Windows- double glazed window with aluminium frame.

WWR- 0.16 (N- 0.27, E- 0.135, W- 0.29)

After all these considerations, we are also proposing to have solar panels on the roof and on the south facade which will further reduce the heat gain by cutting off direct sun radiation.

Energy Performance
Intermediate Stage Analysis

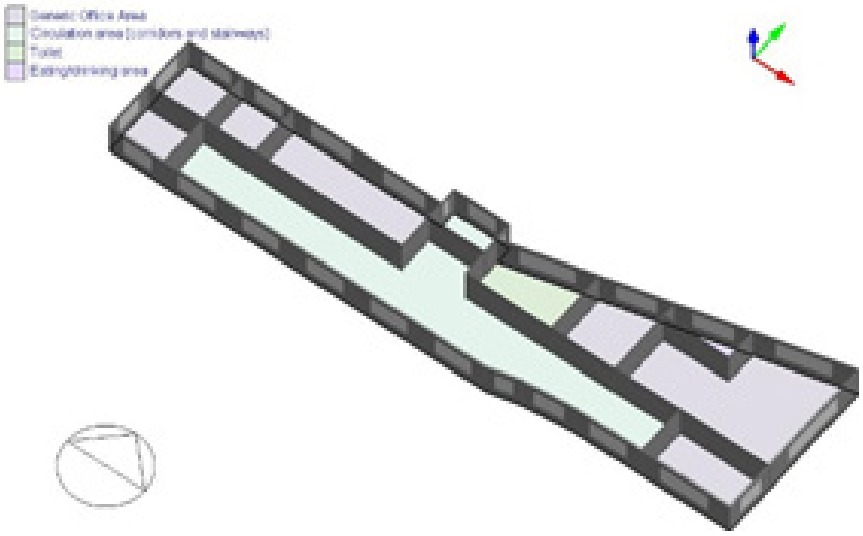


Fig 10.1 : (Base Case According to ECBC Guideline)

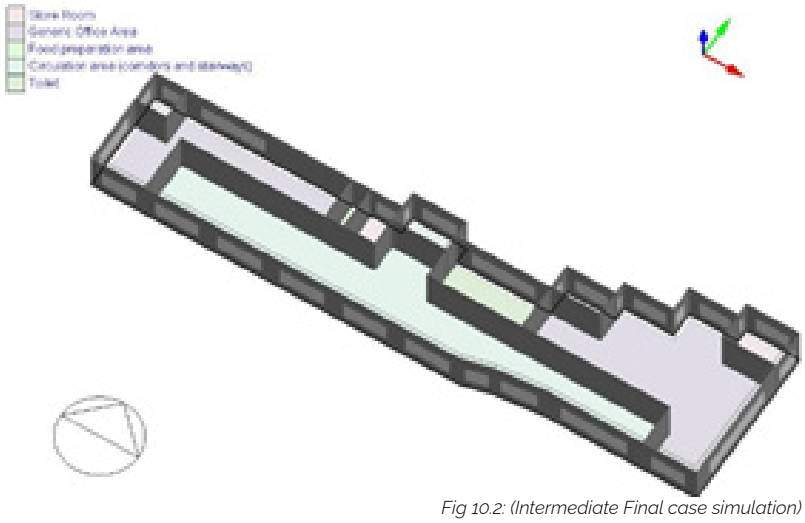


Fig 10.2: (Intermediate Final case simulation)

	Base Case	Evaluated Case
Roof Assembly (U- Value) (W/m2.K)	0.12	0.33
External Wall (U-Value) (W/m2.K)	0.25	0.63
Vertical Fenestrations (W/m2.K)	1.2	3
WWR (%)	40%	20%

Table2: Energy simulation specifications

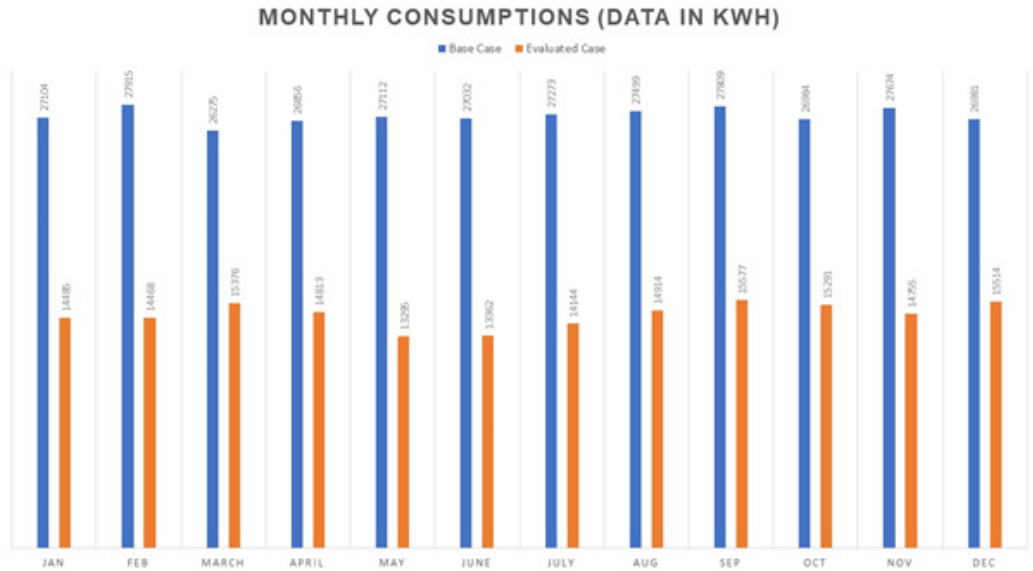


Fig. 10.3: Monthly Energy Consumptions

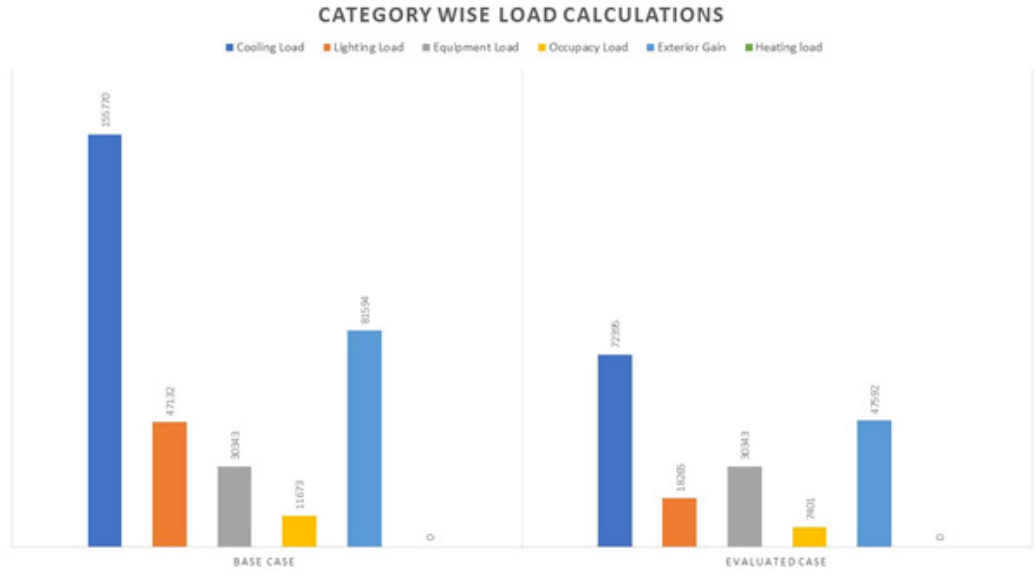


Fig. 10.4 : Category Wise Calculations

We perfomed the intermediate analysis between the base case and the intermediate case. Where the perimeters for simulation of base case were take from ECBC guidelines whereas, our design simulation perimeters were taken with evolution of our design from each stage.
Through this simulation we noticed that epi of base case would be around 97, wheareas through design decisions we reduced it to 53 and it was further reduced by incorporating passive design techniques.

Energy Performance

Renewable Energy Production Potential - Solar Energy :-

Renewable Energy Production Potential - Solar Energy
The site has immense potential for Solar Energy production because of its hot and dry climate with 830 KWh/m2 solar radiation received on site.
Target : To produce 1110 KWh of solar energy.
Strategies : We have used Solar PV panels on the roof and in the southern periphery of the site.
The panel's configuration and mechanical data is taken from the adani solar group brochure.
There are two types of solar panels available in India, such as:

Criteria	Mono Crystalline panels	Poly Crystalline panels
Efficiency	High efficiency 17-20%	Less efficiency 13-16 %
Design & Looks	Made of single silicon cells – all cells are black in colour	Made of multiple silicon cells – looks blueish in colour
Space	Occupies less rooftop space	Takes more space
Performance	Performs better even in low light	Low efficiency in cloudy weather.
Price	Expensive	Relatively low price

Table3.1: Types of Solar Panels

Material- anodized aluminium frame with twin wall profile.
The panels we used are Mono Crystalline Solar Panels.
The basic information of solar panels is as shown in the given tables.

Base Case

Total renewable energy

Areas where panels are used	Number of panels used	Power	Dimensions of one panel (m2)	Efficiency	Weight
Facade	0				
Roof	190	2.25Kwh	1.950*0.975 M2	0.175	22 Kgs
Parking	40	2.25Kwh	1.950*0.975 M2	0.175	22 kgs

By parking	40*5.6 = 224 Kwh/day
By roof	190*5.6= Kwh/day

Table3.2: Total renewable energy consumed in base case

Total production per day by the all panels= 1400 Kwh/day
•According to standard ECBC code for small office total energy consumption for adults is in range of 3-6 Kwh/day.
• From our calculations the consumption per day for our office is 4.5 Kwh/day.

Number of people per day	Total production by our building	Total consumption required
200-250	1260Kwh/day	1125Kwh/day

Table3.3: Total renewable energy consumed in a day

•Surplus 163Kwh is generated a day.

Final Case

Areas where panels are used	Angle of inclination	Radiation received (Kwh/m2)	Production per panel
Parking	23 degrees	1600 Kwh/m2	1600*0.175*2=5.6 Kwh/day
Roof	23 degrees	1600 Kwh/m2	1600*0.175*2=5.6Kwh/day

By parking	56*5.6 = 316 Kwh/day
By roof	140*5.6= 784Kwh/day

Table3.4: Total renewable energy consumed in final case

Total production per day by the all panels= 1100Kwh/day
•According to our analysis we found that by the use of passive cooling techniques, shading devices and other different measures,per person 3.2Kwh/day energy is required.
•Hence total consumption is 3.2*250= 800Kwh/day

Number of people per day	Total production by our building	Total consumption required
200-250	1100Kwh/day	800Kwh/day

Table3.5: Total renewable energy consumed in a day

•Surplus 300Kwh is generated in a day.

Fig: 11.1: Solar Panel on car sheds at an inclination of 23 degrees

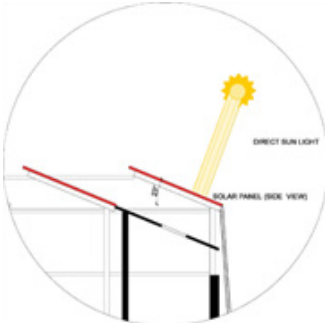


Fig 11.2: Solar Panel on roof at an inclination of 23 degrees.

Energy Performance

Natural Ventilation

We have extreme low wind speeds of only about 7km/hr with the most prominent wind from south west. Due to its speed we have kept the south facade solid in order to reduce the heat gain significantly. We have used wind towers in combination with stack effect to enhance the natural ventilation inside the building.

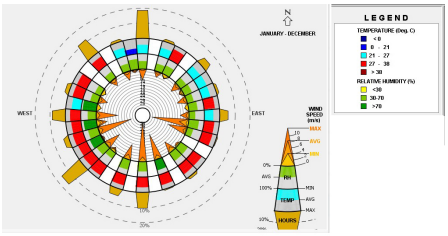


Fig. 12.1: Windrose Diagram

The process carried out would bring in the cold air from the wind tower, using it with mist to cool down the hot air from the outside. This is done by using evaporative cooling and with the front buffer circulation zone in the stack effect which is facing south so it would be efficient for the buffer circulation zone for the stack effect.

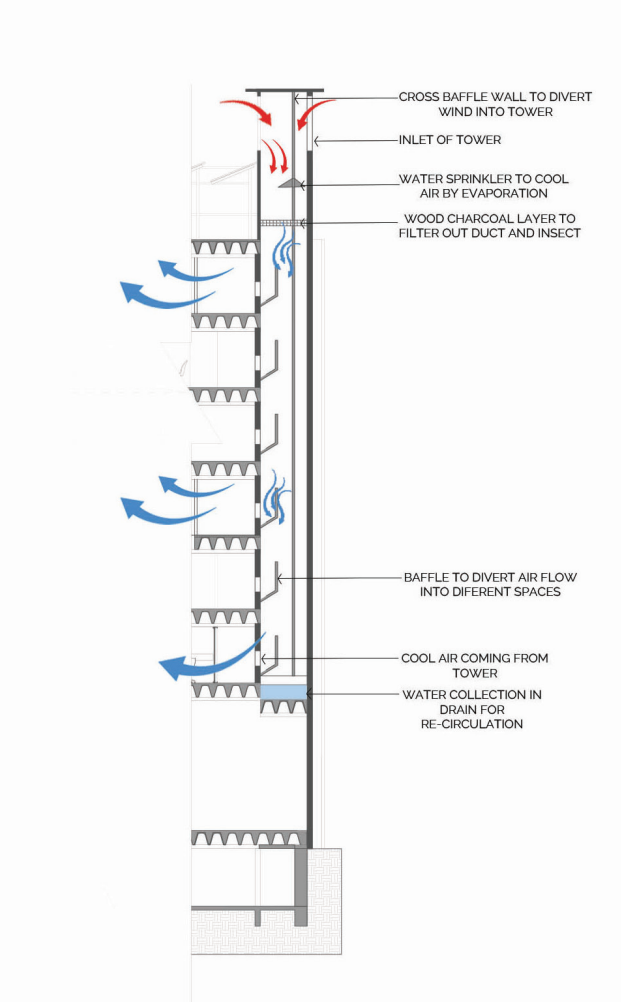


Fig. 12.2: Schematic Wind tower cross section

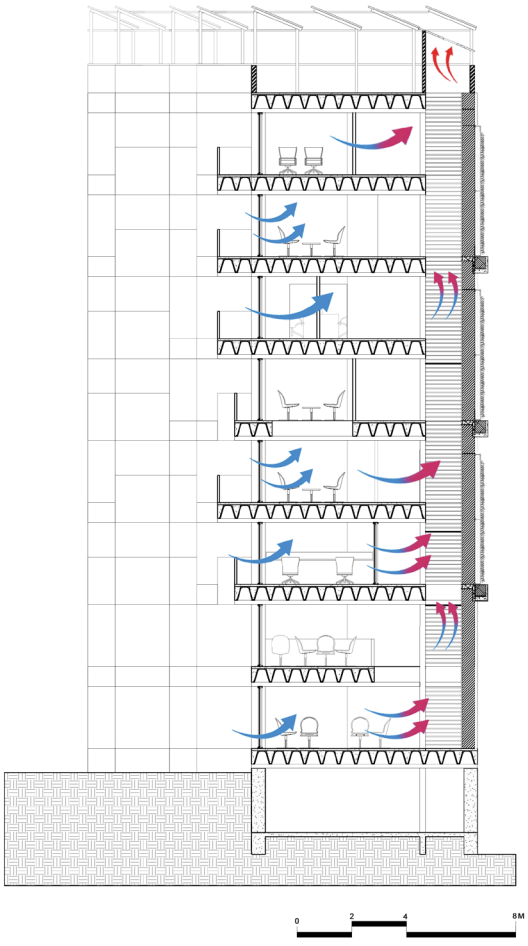


Fig.12.3: Schematic Stack tower cross section

Comfort and Environmental Quality

Natural and Passive Ventilation

We have incorporated two wind towers in the building which will help in better ventilation. These wind towers help in circulating the cool air in the whole building, which has been shown in the figure below.

Fig.13.1 : Wind Tower Plan Layout

Natural Ventilation Analysis

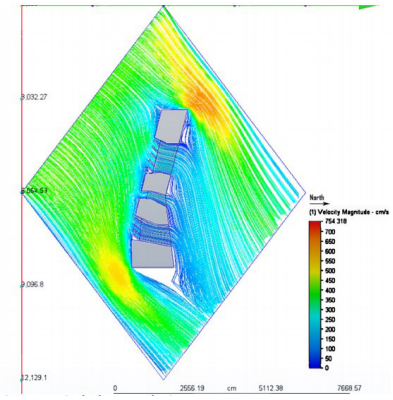


Fig.13.2: Ventilation flow with fins

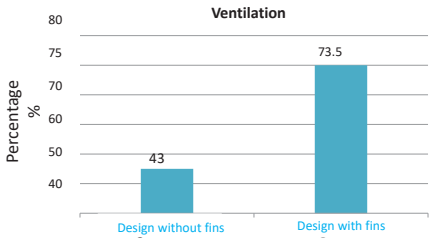


Fig. 13.3 Results of ventilation with fins and without fins

To treat the south facade we added fins which help us to get more ventilation in the building. The angle of fins have been placed in such a way that the wind flow is directed towards the building, shown in the figure above.
After the analysis of natural ventilation we found out that on adding the fins to the facade the ventilation was increased by 30% as shown in bar graph above.

Comfort and Environmental Quality

Daylighting

Being in an office building which operates in daytime the appropriate decision is to use the day light thus reduce the use of artificial light significantly. We have derived various strategies to use the maximum potential of daylight while avoiding direct solar heat gain.

- All the working spaces are placed towards the edge of the north facade taking in maximum daylight.
- Fins helps to avoid solar radiation while letting in light at the same time.
- Using fenestration on the western and eastern facade along with shading devices for maximizing daylight daylight.
- Use of Lime plaster as the internal finish does not absorb the sunlight while having reflectance of about 0.70-0.80

We have carried out simulations in Design Builder for the daylighting effect in the indoor spaces for a typical floor of working space where the most amount of daylight is required. The results of the simulation are as shown below:

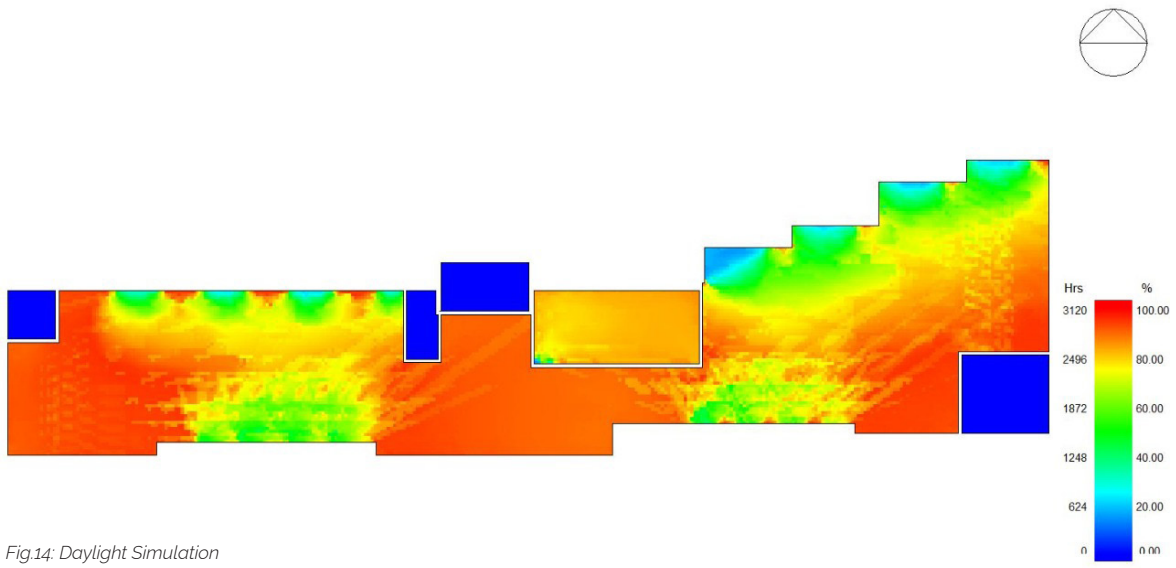


Fig.14: Daylight Simulation

This shows that we are able to take a large amount of light into the built form and we are able to work using natural day light for a major part of the day thus reducing equipment loads.

Comfort and Environmental Quality

Artificial lighting

Lighting is an important criteria that has to be considered while designing a zero-energy office building as it can contribute to reduction of energy consumption if designed properly. The main approach is to use lighting with maximum luminous efficiency (lm/W) and provide optimum lux levels for each space for a well-lit home. Performance-The design goal is to reduce lighting energy requirements. The lighting design requirement for each space was obtained from IES (Illuminating engineering society). The number of lights in each space was calculated as given below in the table

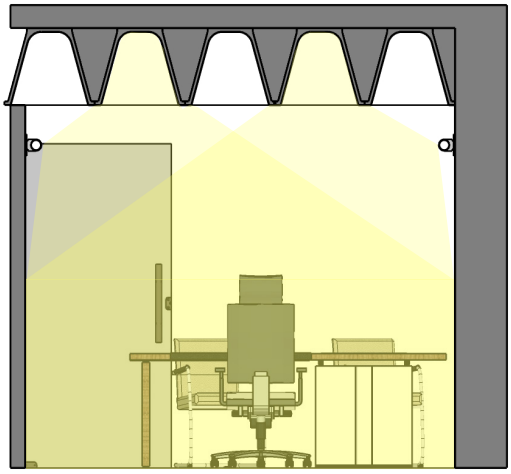


Fig.15.1: Lux Light in Section

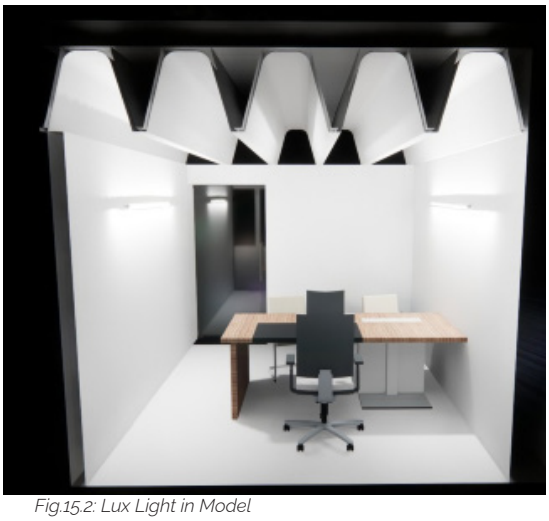


Fig.15.2: Lux Light in Model

office floor

Space Function	Type of Lighting	IES Standard(footcandle)	LUX Level (foot candle)	LUX Level (Lumens/m2)
Conference Room	24-Watt LED warm white light	15-60	55	592
Toilets	7 - Watt T- bulb LED	2.5-10	15	161
Corridors	24-Watt LED warm white light	2.5-10	10	108
Cabins	24-Watt LED warm white light	30-50	44	474
working space type 1	24-Watt LED warm white light	30-50	32	344
working space type 2	24-Watt LED warm white light	30-50	44	474
working space type 3	24-Watt LED warm white light	30-50	41	441
working space type 4	24-Watt LED warm white light	30-50	39	420
CPU room	24-Watt LED warm white light	30-50	41	441
Janitor room	7 - Watt T- bulb LED	2.5-10	18	194
green room	24-Watt LED warm white light	30-50	50	538
café	48 - Watt concealed LED panel	5 -20.	15	161
kitchen	24-Watt LED warm white light	30-50	40	431
gathering space	48 - Watt concealed LED panel	5-20.	27	291

Table4: Lux Calculations

Comfort and Environmental Quality

HVAC

Through research it was analysed that operating the building in mixed mode can prove to be an essential strategy, which is driven by both reduction in cooling loads and improving natural ventilation.
With this we developed two design options that minimize exposed surfaces and increase cross ventilation. These designs were compared with each other, while keeping all other building materials and specifications same.
Detailed hourly schedules of occupancy, lighting, equipment, natural ventilation and HVAC were defined based upon results from several studies and surveys mentioned in the report.
The data of base case vs the right sizing calculation per floor was calculated for better understanding.

	BASE CASE	EFFICIENT CASE
Ground Floor	8.96 TR	5.32 TR
First Floor	17.48TR	9.75TR
Second floor	14.46TR	7.82TR
Third Floor	15,58 TR	8.04 TR
Fourth Floor	8.95TR	5.06 TR
Fifth Floor	14.62 TR	8.16TR
Sixth Floor	16.60 TR	8.96TR
TOTAL	96.65 TR	53.11 TR

Table5: Base Case and the Efficient Case in HVAC

While shifting from base case to Efficient case we rectified and used the value of building materials and changed their U values to understand the effeect of building materials on cooling loads.

The cooling load for the building was calculated using dependable factors from ISHRAE handbook. The peak loads were calculated using outdoor design conditions for Ahmedabad. The result for peak cooling load out of whole building 9.75TR (Tonnes of Refrigeration). The above image shows the distribution of VRF system along all the floors. A distribution system using REFNET joints was used, and the diagram demonstrates pipe sizing, along with refrigerant line for gas and liquid. For catering to a load of 117.018 kBTU/hr, a Variable Refrigerant Volume system of 72kBtu/hr – 240KBtu/hr is installed with an individual indoor-unit capacity of 1.36 Btu/hr.

Comfort and Environmental Quality

Comfort Hour analysis with HVAC system

The National Building Code of India also states that in hot and humid places, wind speeds are desirable for achieving thermal comfort conditions at different temperatures and relative humidities.The Operational schedule for HVAC was made by superimposing the IMAC comfort band with additional humidity thresholds, to survey the data of 20 Chennai households, and comfort conditions obtained through NBC guidelines. 69% annual hours are comfortable by using Natural Ventilation assisted with a ceiling fan – the design goal of reaching comfort for about 70% annual hours was thus achieved. There is a need for meeting the remaining 31% hours with active cooling and a centralized VRF system.

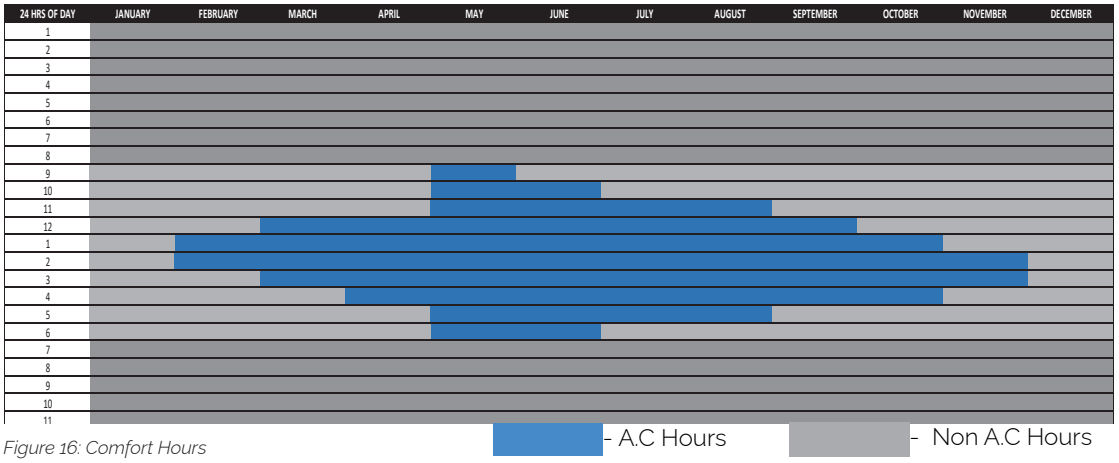


Figure 16: Comfort Hours

Affordability

The office is designed as an IT service building and owned, built and operated by the project partner itself. Compared to other projects in the premises, it is a small building and currently they are on the stage of planning such a project and thus much information about the finances is not available, but the project as committed by the project partner would be self-financed.

Adding to the financial value, we have tried to come up with several strategies for the control and optimisation of construction cost like the usage pre-fabrication which helps in quality control as well as the fast construction. One of the ideas behind using brick walls was that it is a local material and affordable labour is easily available.

Standardization of fenestration materials for construction and sizes. Usage of plain lime plaster as interior finish in order to avoid paints.

To contribute to the revenue generated by the building, our team focused on allotting certain spaces for public usage, For example, the design includes an auditorium and a cafe on the ground floor for people to easily access it.

Cafes can be rented out to different food franchises and auditoriums of 80 capacity can be rented out for additional revenue.

Water Performance

Water Cycle

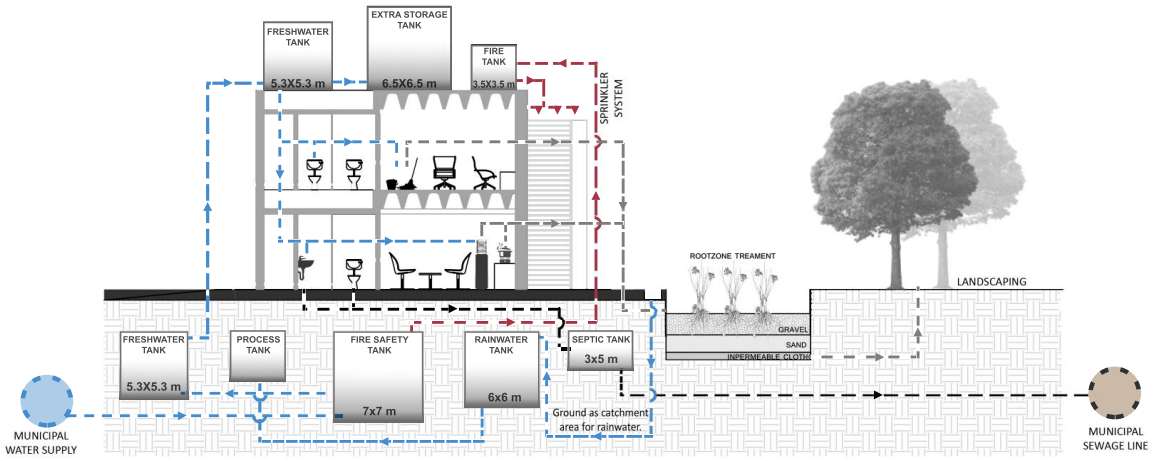


Fig. 17: Water Cycle

- **Sources:**
- The main source of water for the site is through the Narmada main canal (through the Water Treatment Plant laid by the Gift City)
- The water from fresh water tanks (underground tanks) goes up to the fresh water tanks (overhead tanks) via pump.
- The fresh water tank supplies water to drinking, cooking, flushing, cleaning, storage tanks and fire safety tanks.
- **Wastewater Treatment (root zoning):**
- The grey water is re-used for irrigation purpose and landscaping.
- **Grey water generation:**
- The generated grey water is used for irrigation purpose and grey water is used for flushing.
- The waste water generated from RO is treated as grey water.
- **Water Consumption:**
- An average office water requirement for each individual is 45 litre per day according to NBC, which after using efficient water fixtures we have reduced it to 32 litres per day.
- For irrigation we have considered consumption to be 1l/sq.m having approximately 200 sqm area.
- For cooling requirements, we have 5.5 l/tr with peak requirement of 27.15 tr
- **Fire safety tanks:**
- The water from the safety tank goes to the fire safety tank via pump onto the roof.
- In case of fire the fire safety tank water is used in the corridor.
- The water in fire safety tanks can also be used for storage in case of emergency
- **Septic water tank:**
- The black water from flushing and wash basin is collected in septic tanks which follows the municipal sewage line.

FUNCTION	LOCATION	CAPACITY(IN L)	VOLUME(IN M^3)	DEPTH(IN M)	AREA (IN M^2)	LENGTH(IN M)	BREADTH(IN M)
FRESH WATER SUPPLY	UGT	28125	28.125	2	14.0625	2.5	5.5
FRESH WATER SUPPLY	OHT	28125	28.125	2	14.0625	4	3.5
SEPTIC TANK	UGT	30000	30	2	15	5	3
RAIN WATER TANK	UGT	72621	72.621	2	36.3105	6	6
EXTRA STORAGE TANK	OHT	78750	78.75	2	39.375	11.5	3.5
FIRE SAFETY	UGT	100000	100	2	50	7	7
FIRE SAFETY	OHT	20000	20	2	10	3.5	3.5

Table 6.1: Dimension and Capacity of Water Tank

Rainwater harvesting surfaces	Area m^2	Runoff coeffecient	Effective catchment area m^2
Roof Surfaces	544	0.85	462.4
Hardscape areas	648	0.70	453.6
Softscape areas	135	0.30	40.5
Other			0
Total Effective catchment area			**956.5**

Table 6.2: Effective catchment area

Vertical Garden

Green walls not only provide an amazing aesthetic but also are of low maintance then potted plants. These vertical gardens on our south facade help us protect our building from the harsh sunlight and thus reducing the overal thermal temperature of the building. These gardens are irrigated by drip irrigation method which helps in saving a lot of water. In summers, they use a process known as evapotranspiration, which helps in cooling air around it.

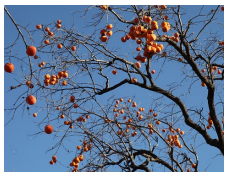
- **Rainwater Harvesting**
- 803.4 mm per annum rainwater is harvested from the open to sky area on ground and stored in the rainwater tank, by providing a gradual slope towards the tank.
- The main aim is to increase the surface run-off to collect water at the catchment area by using hardscapes all around and areas of some soft scapes (more trees than turf, to reduce evaporative losses).
- Rainwater is collected by ground as catchment area by introducing ducts which are connected to the rain water harvesting tank. Further the water goes to process tanks for filtration and then is collected to the fresh water tank (UGT).

Months	Rainfall (mm)	Effective rain (mm)	Harvested rainwater (L)
July	287	282	269733
August	191	186	177909
September	168	163	155910
October	14	9	8609
November	5	0	0
December	2	0	0
January	1	0	0
February	0	0	0
March	2	0	0
April	1	0	0
May	3	0	0
June	72	67	64086
Total Rainwater harvested			**676246**

Table 6.3: Rainwater harvested

Landscape

Native plant species like: Sweet Orange, Mosambi, Cochlospermum religiosum. Buttercup Tree, Yellow Silk Cotton Tree, Golden Silk Cotton Tree, Cocosnucifera. Nariyal, Coconut. And some plant species like: Ziziphus Jujuba, Indian Jujube, Indian Plum, Bor, etc. which require less water are used to achieve resilience to reduce heat waves and cyclones. They all are deciduous trees which would shade and reduce the direct heat in summers and shed leaves during winter to allow light and heat to come in. Also, these have an average height of 8 meters which clears the eye level.



Scientific Name	Common Name	Habitat	Height	Flowering Season	Uses
Ziziphus jujuba	Common Jujube	Decidious	5-12m	September to November	Edible and used as a medicinal plant
Dovyalis caffra	Kei Apple	Sub-Tropical	3-8m	November to December	Edible, improves nutrition, boosts food security
Cochlospermum religiosum	Yellow Silk Cotton Tree	Decidious	7.5m	February-April	Used to achieve enlightment in ancient times
Ficus carica	Yes	Common fig	Upto 10m	March-May	Edible
Diospyros kaki	Japanese persimmon	Decidious	0	May-June	Edible

Table 7: Some native trees which can be grown on site

Plant species like Bubbler system is used for irrigation via the treated water from root zoning treatment.

Resilience

Analysing the vulnerability Maps of India regarding various hazards we have found the seismic activity, floods, cyclone, and heat wave as potential hazards of the site located in Gandhinagar.

Resilience to cyclone and heat waves

- Dense and tall trees, shaded roof areas, elevated plinth and all the natural slopes of site run towards the softscape part of site and then outside the building such type of solutions have been provided for cyclone, heat wave and other resilience hazards. Ferro cement is constructed in parts as it contributes for negligible dead weight, and at the same time it is crack resistant, water proof,strong and fire resistant.

Structural Integrity for sesmic activities

After deciding the materials, we further checked for the resilience of structure according to the given load patterns on Etabs Version 18 for the analysis on structural integrity.
We have the material simulation for RCC Frame structure with Brick cavity wall. and ferrocement shell flooring with roofing material.

Name	Is Auto Load	Type	Self Weight Multiplier	Auto Load
LLRF	Yes	Other	0	
Dead	No	Dead	1	
EQ	No	Sesimic	0	ISI 1893 2002
EQ(1/2)	Yes	Sesimic	0	
EQ(2/2)	Yes	Sesimic	0	
Live	No	Live	0	
Wind	No	Wind	0	Indian IS875:1987
Wind(1/2)	Yes	Wind	0	
Wind (2/2)	Yes	Wind	0	

Table 8 : Wind Load Patterns

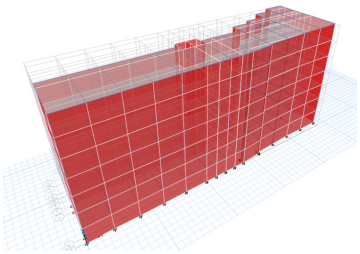


Fig 18.1: 3D model for Resilince Simulation

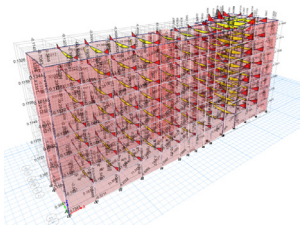


Fig 18.2: Bending moment diagram

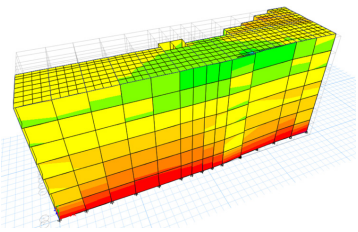


Fig. 18.3: Shear force Diagram

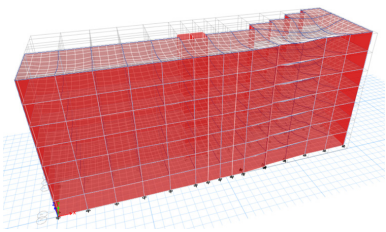


Fig 18.4: Deformations

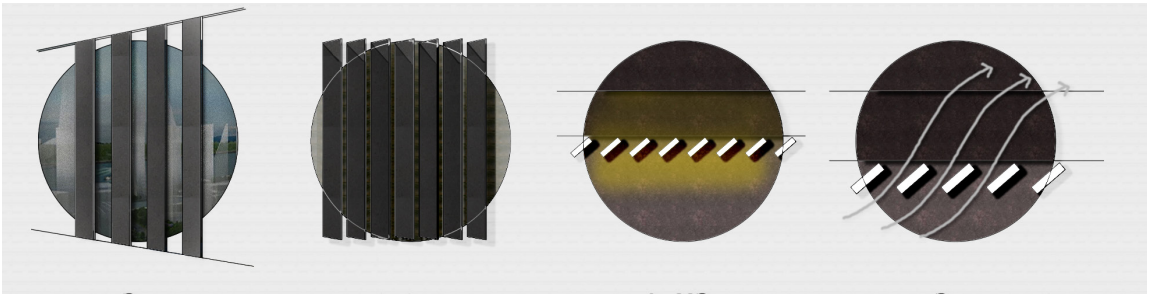
From the results we got that all the elements are checked for structural analysis.

Resilience

Passive performance of the building

Most of the activities inside the building are towards the south facade and hence shading devices can be the best way to provide visual and thermal comfort.

Fins on the south facade have been provided for cross ventilation, to draw light while limiting the heat radiation and to create buffer spaces.



View Shading Buffer Cross-ventillation

Wind towers also called wind catchers are installed in the builduings which serves for natural ventillation in spaces.
The main function of windtowers is to catch the cool breeze prevailing above ground and to pass it to the interiors and to let the hot air rise up and move out.

Recovery Plan for Supply Outage

Incorporating UPS in CPU rooms when there is a supply outage. This 9000 KVA UPS can give supply outage for 3 hours.

Fig19.1: Elite II RT 10K-SS(EXT) by PoweHub

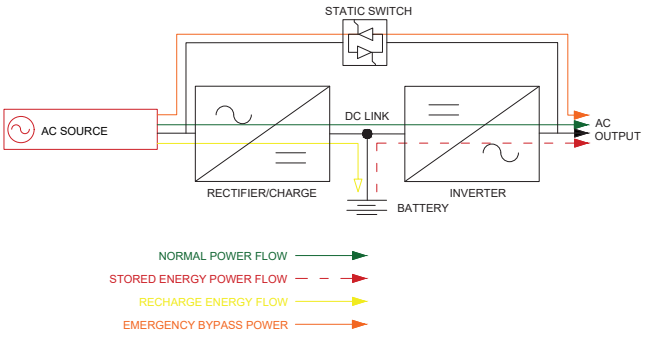


Fig19.2: Single line drawing of the UPS

SPACE	EQUIPMENT	WATT	NO,	TOTAL WATT	TOTAL VA	SUB TOTAL VA
CONFERENCE ROOM	LED LIGHTS	24	5	120	133.3	
	FAN	24	1	24	26.7	
	PROJECTOR	700	1	700	777.7	
				844	937.7	937.7
WORK SPACE 1	FAN	24	4	96	106.6	
	LED LIGHTS	24	7	168	186.6	
	PC	40	19	760	844.4	
	TELEPHONE	8	19	152	168.8	
				1176	1306	1306
CORRIDORS AND TOILET	TOILET LIGHTS	7	6	42	46.6	
	LED LIGHTS	24	6	144	160	
				186	206	206
CABINS	LED LIGHTS	24	4	96	106.6	
	FAN	24	2	48	53.3	
	PC	40	2	80	88.8	
				224	248.7	248.7
CPU ROOM	CPU	85	40	3400	3777.7	
	CPU	85	40	3400	3777.7	
	LED LIGHTS	24	2	48	53.3	
				6848	7608	7608
WORK SPACE 2,3 AND 4	FAN	24	4	96	106.6	
	LED LIGHTS	24	10	240	266.6	
	PC	40	12	480	533.3	
	TELEPHONE	8	12	96	106.6	
				912	1013	1013

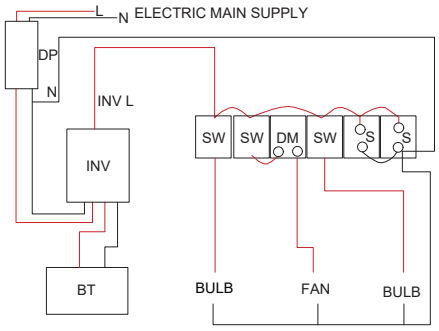
Table 9 : Size of the UPS

TOTAL VA PER FLOOR	11319.2 VA
FUTURE EXPANSION(X1.2)	13583.28 VA
NO OF CPU ROOMS	4
SO TOTAL B/W 2 FLOORS	27166.56 VA
POWER STORED BY SINGLE UPS	9000 VA
NO OF UPS REQUIRE B/W 2 FLOOR	3

Table 10 : UPS Power details

UPS CONFIGURATION:	VALUES
MODEL	ELITE II RT 10K-SS(EXT)
RATING(VA/W)	10000/9000
DIMENSIONS(W*D*H)(IN MM)	443*580*3U(UPS)
	443*720*3U(BATTERY CABINET)
WEIGHT(KG)	25(UPS)
	75(BATTERY)

Table 10.1 : UPS Details



DP=DOUBLE POLE CIRCUIT BREAKER
BT=BATTERY
INV=INVERTER/UPS
N=NEUTRAL
L=PHASE
INV L= PHASE WIRE FROM INVERTER/UPS

SW=SWITCH
S=SOCKET
DM=DIMMER SWITCH
RED COLOR=FOR LINE OR PHASE/BATTERY + TERMINAL
BLACK COLOR=FOR NEUTRAL WIRE - TERMINAL

Fig19.3: Single line drawing of the UPS

Innovation

The success in incorporating innovations and creative approaches that enhance the performance is what a building depicts.
The main problem in office building is the heat generated by the appliances and surrounding humans which makes the atmosphere uncomfortable. Majority of the heat generated is done by the Processing units.

- To solve the problem our team tried the new innovative idea by giving a separate designated spaces or room for the C.P.U.
- These spaces can be cooled separately and ventilated either naturally or mechanically without the infiltration of the surrounding air and keeping these masses inside a solid thermal build space would reduce the heat gain.
- This solution would be replicated and multiplied to various scales making it a general soltuion which can be applied to office building and also instituional building which have high equipment loads.

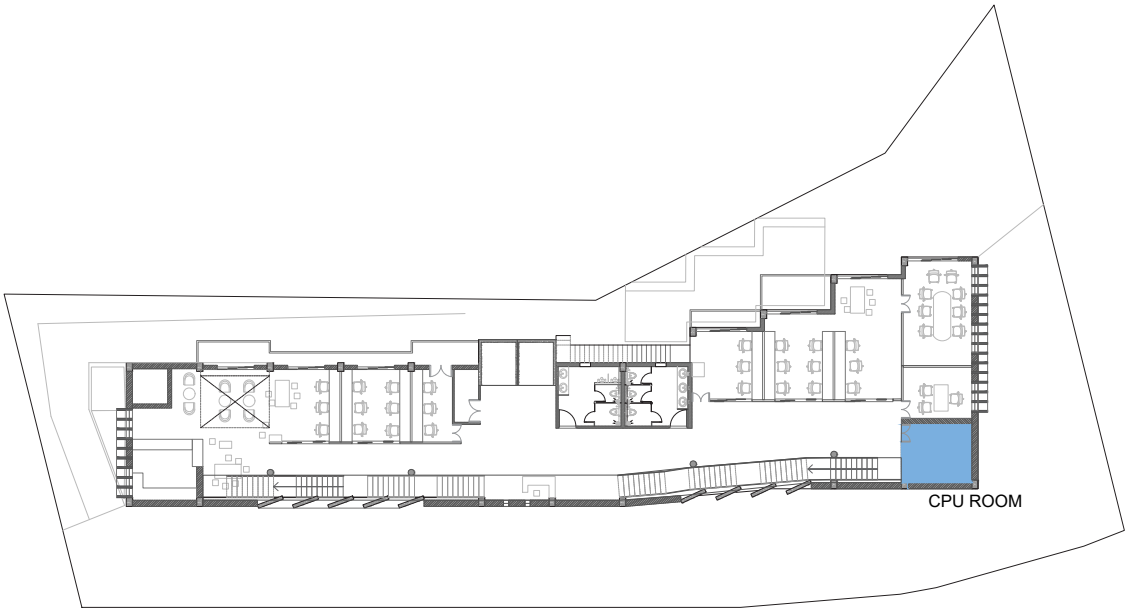


Fig 20: Key Plan indication CPU Room

There are 3 CPU rooms in the building. Of which the total number of CPUs on each floor are 40.
The total number of CPUs in the building are 160.

HEAT GENERATED BY A SINGLE CPU (PER HOUR).	2577	BTU	0.77	KWH
HEAT GENERATED BY A SINGLE CPU (PER DAY)	20616	BTU	6.18	KWH
HEAT GENERATED IN AN HOUR PER FLOOR.	103080	BTU	30.92	KWH
HEAT GENERATED IN A DAY PER FLOOR.	824640	BTU	247.39	KWH
TOTAL HEAT GENERATED IN AN HOUR.	412320	BTU	123.70	KWH
TOTAL HEAT GENERATED IN A DAY.	3298560	BTU	989.57	KWH

Table 11.1 : Heat generated by the CPU

PER HOUR						
	MIN	MAX		MIN	MAX	
ENERGY REQUIRED TO COOL A SINGLE UNIT	2600	4100	BTU	7.8	12.3	KWH
FOR 40 PCS	104000	164000	BTU	312	492	KWH
TOTAL ENERGY	416000	656000	BTU	1248	1968	KWH
PER DAY						
	MIN	MAX		MIN	MAX	
ENERGY REQUIRED TO COOL A SINGLE UNIT	20800	32800	BTU	62.4	98.4	KWH
FOR 40 PCS	832000	1312000	BTU	2496	3936	KWH
TOTAL ENERGY	3328000	5248000	BTU	9984	15744	KWH

Table 11.2 : Energy requirement

- According to our calculations upto 15744 KWH energy is reduced in the cooling load.

We have designated 4 spaces on different floors each of 4x3.5meter each for all the CPU to be gathered and then only desktops are present in the office spaces.

Scalablity and Market Potential

Context Analysis:

Socio-Economic Analysis: As it is was mentioned earlier that GIFT City is a financial hub and a financial Central Business District (CBD) between Ahmedabad and Gandhinagar. It is a greenfield development and an urban complex between these two cities.

1) Land Area - 3.58 sq km 2) Construction Scale – 8.5 mn sq m
3) Greenbelt – 1183 ksq m 4) Height - 410m

The project aims to produce a mixed-use district of residential, commercial, and open space facilities that optimise land and real estate values.

And looking into present scenario, the upcoming projects in the GIFT City are SBI, LIC, Savvy Pragya, World Trade Center , etc.

- Water and Sewage: Water Sources to the site are Narmada Main canal, Reuse of Wastewater and Rainwater Harvesting .
- District Cooling System: Provide energy efficient district cooling system to occupants of city which ensures chilled water distribution.

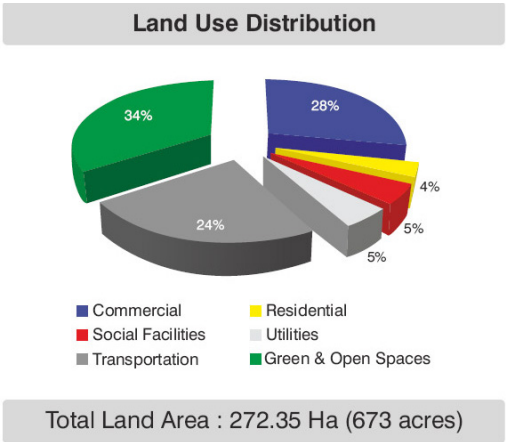


Fig 21.1: Land use distribution

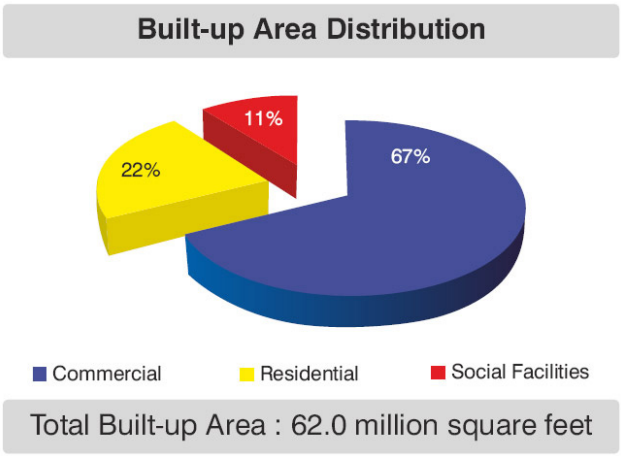


Fig 21.2: Built-up Area distribution

- Solid Waste Management: Automated Waste Collection System through chute system.
- Utility Tunnel: It has two sections Wet and Dry. All the water related utilities are placed in wet section. Dry section is placed at top and is physically separated.

- Transport: Externally - connected to Major cities i.e. Ahmedabad and Gandhinagar (8km) with BRTS Network and Metro Plan and Internally- there are 4 metro station, multi-level underground parking limiting the vehicular roads.

Many trees were cut down while clearing which also created an impact to the ecosystem and biodiversity of the area and nearby wildlife and Indodra Nature Park. Being in hot and dry climate they are planning to have blue and green landscape but near the building site there is no prominent landscape to shade.

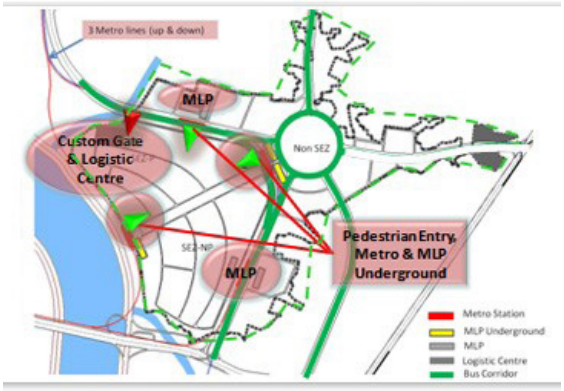


Fig 21.3: Road Indications

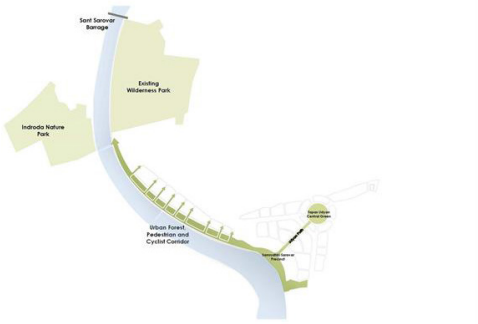


Fig 21.4: Context

TARGET MARKET

Being in SEZ zone of GIFT city we can have a target market which is very closely related to the kind of business and financial services targeted by GIFT and looking at the scale of our building we have established our target business of having small scale corporate banking services and all other kinds of IT Services, etc.

MARKET POTENTIAL

The project sits on a very stratergic site, well connected to all the infrastructure and a part of very futuristic development which allows for further growth developement.

As we aim to provide a healthy environment for the occupants and being a net-zero energy and water building, they have additional benefit of efficient working and low cost maintenece of the building.

Scalablity and Market Potential

Construction Technique

The pre-fabricated and pre-cast elements were emphasised in the construction technique used.

We have proposed precast ferrocement shell which is made of uniform distribution of reinforcement by the use of chicken wire mesh and welded mesh encapsulated in rich cement mortar, Thereby achieving significant reduction in both steel reinforcement and dead weight of roof, this composition provides a more uniform distribution of strength as compared to RCC.

Several other advanatges include-

- 60% reduction in dead weight
- Creates employment as the roof components can be locally produced and delivered through micro level enterprise.
- 20% saving in cost is possible because of reduction in steel quantity and elimination of coarse aggregates and shuttering.
- High U-Value

Similarly, the staircase is of a fixed module and is pre-fabricated in advance

Advantages of using Pre-Cast Technology

Fig 22 Factors indicating advantage of Precast

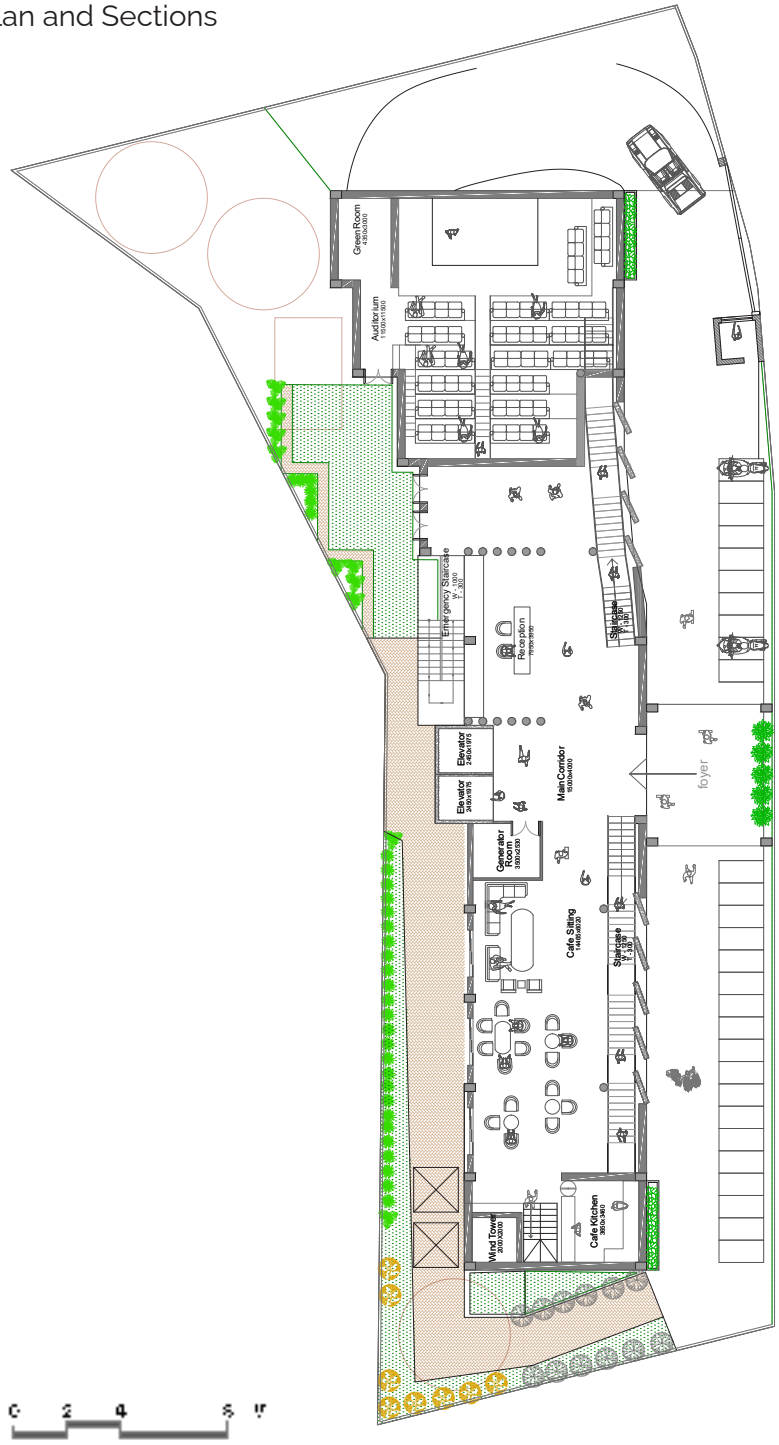
Scalablity and Market Potential

Construction Timeline

Approx. Timeline	W01-W05	W05-W10		W15-W20	W20-W25	W25-W30	W30-W35	W35-W40	W40-W45	W45-W50	W50-W55	W55-W60
Excavation												
Leveling												
Diaphragm/Foundation												
Footing, Steelwork, column & Slab Basement												
Ground Floor Steel Frame work, Column & Slab(Wiring pipe in slab will happen simultaneously)												
FF Steel Frame work, Column & Slab												
2nd Floor Steel work,Column & Slab												
3rd Floor Steel work,Column & Slab												
4th Floor Steel work,Column & Slab												
5th Floor Steel work,Column & Slab												
6th Floor Steel work,Column & Slab												
Break/Setting Time												
Brick wall												
Single plaster												
Plumbing (Drainage, water supply) Electrical Piping ,Window/Door Setting												
Finished Plaster												
Flooring												
Bathroom Fitting & Pantry Fitting												
Furniture,Interior & Door/window placement												
Total												515-520 Days

Table12: Construction Timeline

Architecture
Plan and Sections



Ground Floor Plan

Fig 23.1: Ground Floor Plan

Conceptulisation Of Plan and Sections

Primary requirement of any space is to provide a good environment and liveable space for the occupants no matter what the function is and being in an office building which is the most used space by a person and spends a great deal of the time here. So, to provide spaces which are healthy, open, and have nice environment and surroundings was a must.
The idea for the office building was to move away from the conceptions of boring spaces that most of the office buildings have.

- Auditoriums and Gathering Spaces included with the workspaces.
- Cafes with mezzanine provide informal spaces of discussions
- Spaces on the ground floor attract people from outside into the premises to create opportunities of interaction.
- All the office spaces irrespective of small or big must have equal opportunities for views, daylight and ventilation which ensures to keep healthy environment around.
- Small cozy and comfortable offices
- Opportunities to play with north facade with the balconies and approachable extensions..

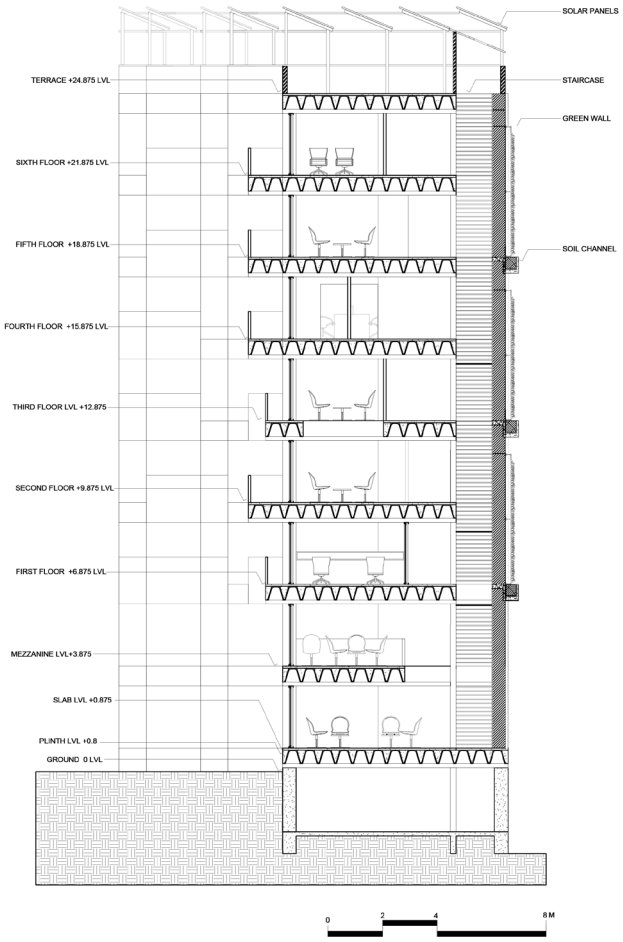


Fig 23.2: Section AA'

Climatic responsive Strategies are.
1. Creating shaded staircase section which also acts a buffer to the working space and reduces the solar gain inside the working spaces.

2. Shading on west and east significantly reduces the solar heat gain.

3. Installed solar panels on the roof vertical garden on the south facade provides shading and insulation to the building envelope.

4. Solar Panels lifted to be able to use the terrace freely.

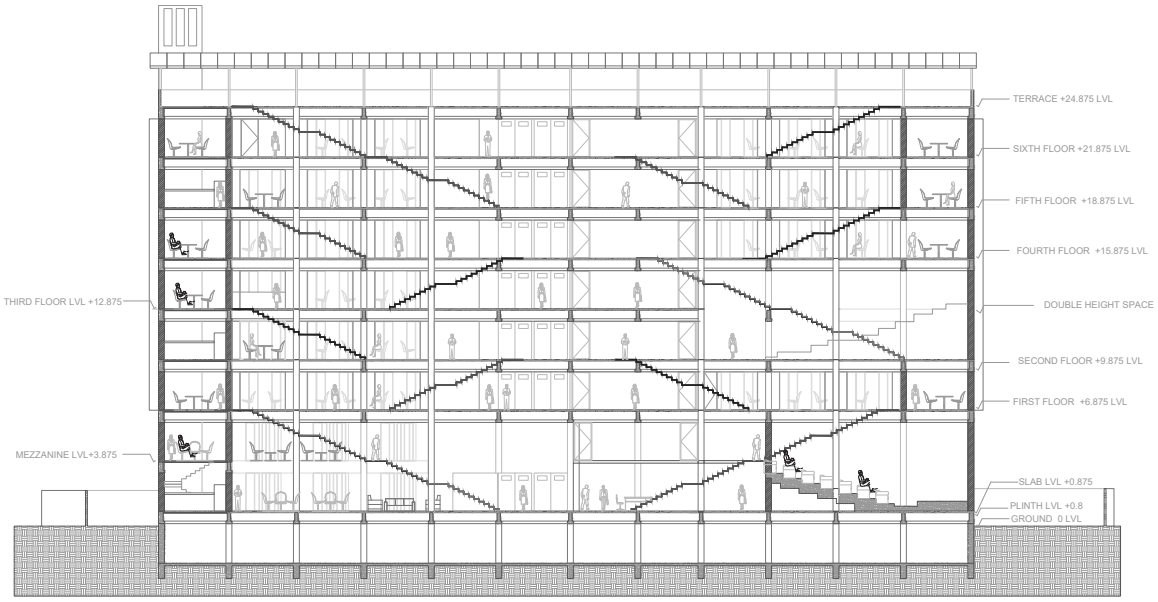


Fig 23.3: Longitudinal Section- SectionBB'

Pitch to the Project Partner

The design is an office building which is meant to go beyond the conventional norms and has spaces that facilitate interaction between the users and make them a part of a larger community.
The design goals align with the competition goals for Architecture, Energy, Engineering, Resilience, Operations, Comfort, Financial Feasibility and Market Potential and the design has managed to find an optimum solution.

The design incorporates multiple passive strategies in order to make it a net-zero energy building. Some of the key features are:

Materials: *The building is made from Ferrocement shells which are cost effective (20% reduction), reduces the dead load by 60%, has a high U-value and is locally available. The brick cavity walls reduce the heat gain inside the building while the RCC framework helps in the structural strength.*

Passive Strategies:

Fins: There are fins inclined at 20 degrees in order to optimize the heat gain and daylight for maintaining the thermal comfort.
Wind Tower: There are two wind towers on the northern vertices of the building combined with stacked effect for better ventilation and wind circulation.

Egg crates: The egg crates have been used on the western and eastern facades in order to filter out harsh daylight due to the extreme temperatures in the context of Gandhinagar. These shading devices help in controlling the heat gain and optimize energy consumption in the building.

Alternating balconies: There are alternating projections of balconies to provide shade to the ones below and to gain maximum light placed on the northern facade.

Vertical gardens: There are vertical gardens on the southern facade to reduce heating and provide insulation to the building. This also reduces the ambient noise acting as a sound barrier to the building. Hence, the environment becomes much quieter, both inside and outside the building making it a suitable workspace.

Maximizing the usage of the northern facade: All the offices or workspaces are situated on the northern side in the building as north light is diffused sunlight and hence does not create sharp shadow which is optimal for workspaces.

Rainwater harvesting: There is a gradual slope on site which is intended for the collection of rainwater for groundwater recharge and longer-term storage.

PV Panels: There are PV panels situated on the roof of the building (140 panels) and the car shed (56 panels) and due to the absence of shading from the surrounding buildings, it's easy and optimum for maximum solar energy generation.

CPU rooms: There are separate rooms provided for the storage of the CPUs so that the heat gain is reduced and the thermal comfort inside the spaces is better.

Internal southern side: The transition spaces like the staircases and corridors are all placed on the southern side of the building acting as a buffer zone which reduces heat gain in the building.

Grey water: There is a grey water system in place in the building which would help in reusing water for toilet flushing or irrigation.

UPS system: There is a Uninterrupted Power Supply (UPS) system in place in the building for emergency purposes.

There are some architectural decisions taken in order to improve the overall experience which have been listed below:

Generation of revenue: The common spaces like the cafe and the amphitheatre on the ground floor are open to the public and can be rented to food franchises and other businesses in order to generate revenue for the company owner.

Recreational spaces: There are recreational spaces on multiple levels in the building to provide a healthier and more interactive environment in the workspace.

Interaction on multiple levels: The informal gathering spaces like the cafes and seating are situated on alternating floors in order to reinforce the concept of a more interactive and lively workspace.

Services: The services in the building, i.e. the wet areas are more or less at the center and are all overlapping which makes it easier for the plumbing.

Fire safety: There are sprinkler systems installed along all the corridors for fire safety in case of a hazard.

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