IMPACT SCHOOL ARCHITECTURE

People's Education Trust (R), Mandya
P.E.S. COLLEGE OF ENGINEERING
"Professionally Excellent Socially Committed Engineers"

Solar Decathlon India

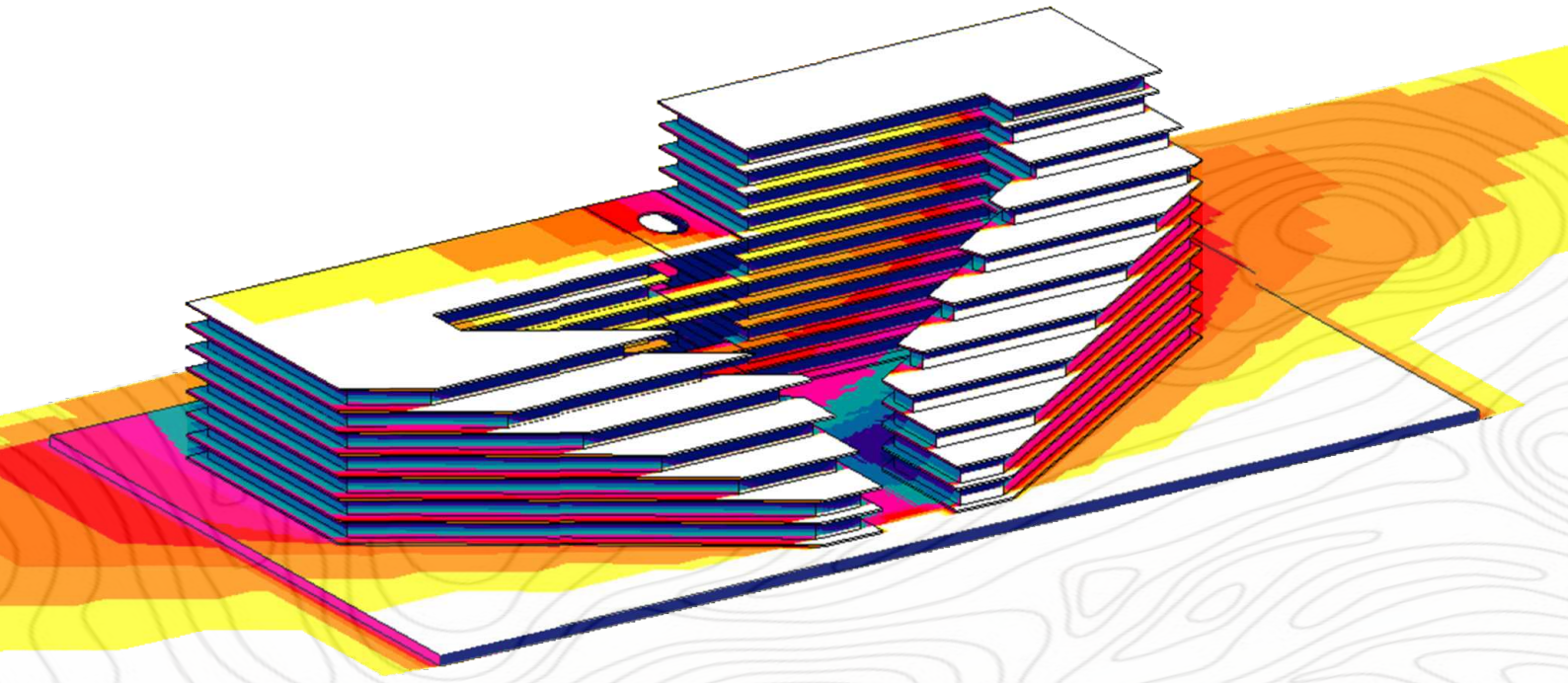
FINAL DESIGN REPORT

Infosys®

OFFICE BUILDING

APRIL 2023

TEAM POIESIS



SOLAR DECATHLON 2022-23

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G.Summary of Embodied Carbon calculation

H.Building operation narratives

I.Key parameters to messures performance of building

RESPONSE FOR COMMENT

Section	Reviewer's Comment	Our Response
Reviewer 1		
Energy Performance	The EPI is well achieved, below the targeted EPI. There are few discrepancies in the EPI for equipment calculation, Please recheck the calculations	It as been rechecked.
Embodied Carbon	Although the specification of material for roof, wall, window is provided. The section of embodied carbon detailing the carbon content comparing the base case and proposed case is not mentioned.	It is mentioned in pg no. 32
Engineering and Operations	In addition to the civil details and construction drawings of the building, the positioning and sizing of the RWH plant, SWM plants and such other provisions needs to be specified.	It is mentioned in pg no. 31 & details are in appendix pg no. 78
Affordability	Your construction cost mentioned is 57600 rs/ sq.m which seems to be extremely high, kindly reconsider the construction budget	It is rechecked & mentioned in pg no. 38
Innovation	For the parametric façade, make sure you provide the details for the energy consumption and feasibility.	It is mentioned in pg no. 36
Health and wellbeing	The strategies with regards to design, i.e the landscaped buffers and letting in natural light is mentioned. You may elaborate more related to fresh air, sections describing airflow networks, comfort hours achieved.	It is updated in the pg no. 33
Reviewer 2		
Energy Performance	The calculation and understanding is well mentioned - 80% reduction due to efficient fixtures seems unrealistic , you may justify it	-
Water Performance	Rwh and waste water not taken into account in a detai	It is mentioned in pg no. 31 & details are in appendix pg no. 78
Embodied Carbon	Not attempted in a detailed way.	It is mentioned in pg no. 32
Health and wellbeing	Inbuilt efforts for health and wellbeing	It is updated in the pg no. 33

EXECUTIVE SUMMARY

"Sustainable development is the pathway to the future we want for all. It offers a framework to generate economic growth, achieve social justice, exercise environmental stewardship and strengthen governance." ~ Ban-ki-Moon

With the construction sector experiencing a resurgence in growth, the building sector contributes to 23% of air pollution, 50% of the climatic change, 40% of drinking water pollution, and 50% of landfill wastes, and 40% of worldwide energy usage, with estimations that by 2030 emissions from commercial buildings will grow by 1.8%, according to research by the U.S Green Building Council (USGBC).
We, Team Poiesis, as part of Solar Decathlon India, have taken this opportunity to propose the design of a net-zero energy building for Infosys Hyderabad.

It is a G+11,G+8 storey office buildings with a built-up area of 94,763 sqm. We have tried to design a net-zero energy building that will prove to be both cost, as well as energy efficient, while simultaneously providing maximum thermal comfort to its users through natural lighting and ventilation, with reduced usage of HVAC systems. We have been able to achieve an EPI of 58.67014552, by working on various aspects of design, after a thorough study of climate, energy, building principles, and performance of pre design analyses. We have achieved our net-zero target through Solar PV generation of 5559759kWh.

Our design is also water-efficient, with reduction of up to 80% of fresh water demand through rainwater harvesting and water recycling methods.

Overall heat gain of the building has been reduced through design features like parametric facade, projections and buffer zones with green pockets that help in reducing direct sunlight and glare inside the building. The green pockets also act as interactive spaces that help in increasing overall productivity of its users.

Through this design, we have tried to reduce the negative impact of the building on the environment, as well as make it affordable, with a reduction in cost of construction by up to 10%.

1.0. TEAM INTRODUCTION

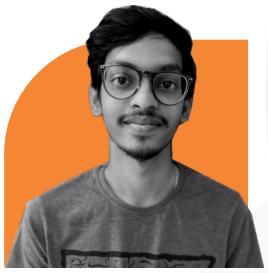
1.1. Team Name - POIESIS

1.2. Institution(s) names

- IMPACT SCHOOL OF ARCHITECTURE, Bangalore-Lead Institute
- PES College of Engineering, Mandya

1.3. Division - Office Building

1.4. Team members - Team "Poiesis" comprises 7 members out of which 6 are from the Impact School of Architecture, Bengaluru. 1 civil engineer from PES College of Engineering, Mandya.



PIYUSH
B.Arch(Team Lead, Designer & Affordability)

PRAJWAL C P
B.Arch(Energy & Water performance)

SOHAN PREETHU D R
B.Arch(Designer Health & wellbeing)

JNANESH PREETHAN
B.Arch(Innovation & Visual Designer)

RAKSHITH PATEL N K
B.Arch(Energy & Market Potentional)

CHIRAG
B.Arch (Resilience & Communication)

VINAY KUMAR B
civil(Engineering operations)

1.5. Approach

An office building for the global IT firm INFOSYS is being designed by our team. Designing a net-zero building is our aim. To better understand the site, its location, and its condition, we first conducted a site study. Then, we went through the specified requirements provided by our project partner. Finally, we conducted case studies and examined the techniques that were implemented to obtain the outcome. We should make the structure energy efficient to do this. use appropriate passive and active design techniques in this situation. To do this, we first began to comprehend and get familiar with the 11 categories provided by the SDI. We next attempted to include them into the design techniques. In order to review the project brief and requirements and develop a plan to address this and produce good results, we are holding group meetings and meetings with academic advisers.

1.6. Background of Lead Institution

Established in 2013, IMPACT School of Architecture (ISA) is a private self-financing college which is located in Bengaluru, Karnataka. It is affiliated with Visvesvaraya Technological University, Belgaum, and approved by the Council of Architecture (COA), New Delhi. This institute is a part of the IMPACT Group of Institutions.

P. E. S. college of engineering, mandya was started in the year 1962 by people's education society, Mandya under the leadership of late sri k. v. shankara gowda.the college is permanently affiliated to visvesvaraya technological university (vtu), belagavi, and has obtained autonomous status in the year 2008-09 by the ugc. it is recognized by all india council for technical education (aicte), new delhi and accredited by national board of accreditation (nba). the college is functioning under the grant-in-aid code, government of karnataka and also beneficiary of teqip grants.

1.7. Faculty Lead and Faculty Advisors-

Faculty Advisors-
Srishti Srivastava: Professor, design chair
Srishti Srivastava is an architect with an experience of 18 years, she also is an environment & energy consultant, working with interdisciplinary area of digital architecture & regional planning using computational concepts and data modelling.

Faculty Advisors
Shree Lalitha: Associate Professor
Shree Lalitha has done her bachelor's from Sathyabama University, Chennai and masters in the field of General architecture from Anna University. She has a flair for sustainable architecture Vernacular architecture & Indigenous knowledge in architecture and planning.

Visiting faculty
Jagadish R. Bhaktha is an architect with 18 years of experience in multiple disciplines with in the field of architecture including planning and execution of residential building and simultaneously practicing interior designing for various commercial, construction documentation and residential projects.

DESIGN PROCESS DOCUMENTATION

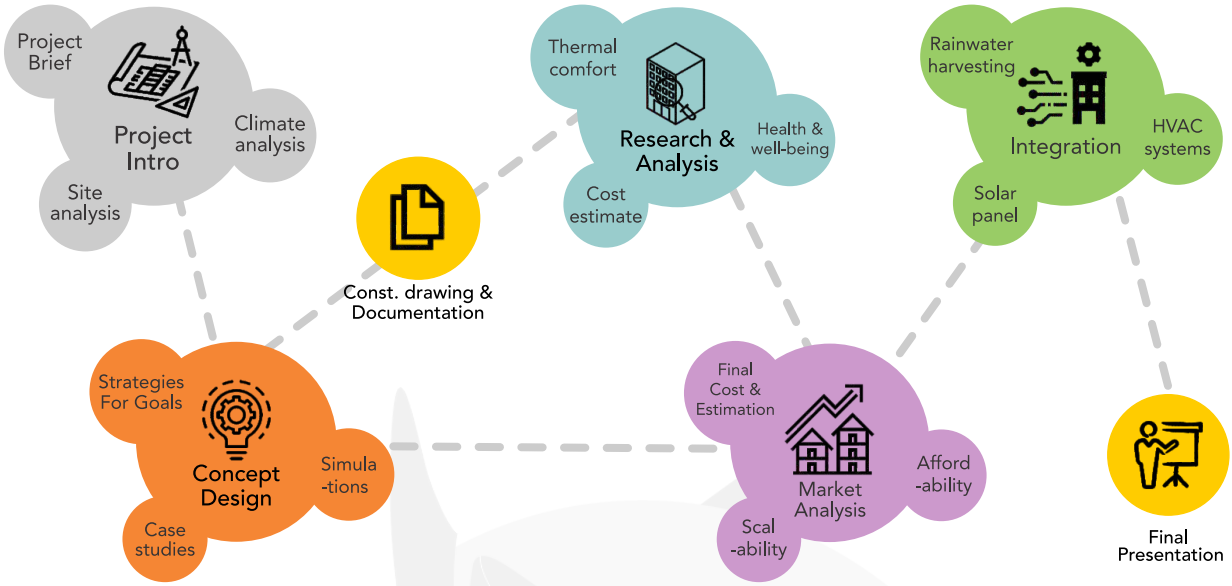
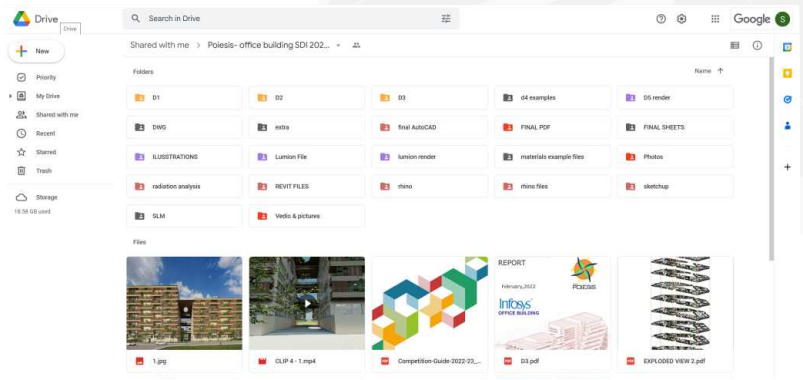


Fig 1 : Design Documentation

TOOLS USED

Fig 2 : Tools Used

WORK INTEGRATION



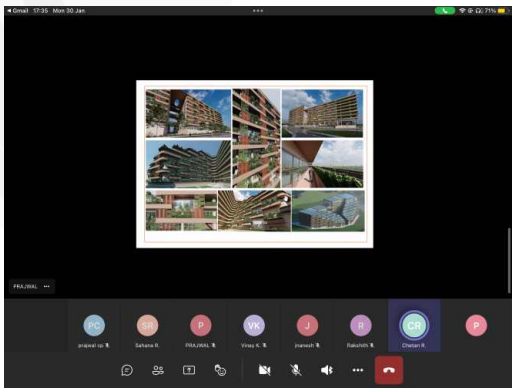


Fig 3 : Discussion Platform

PROJECT BACKGROUND

2.1. Project Name - Infosys Hyderabad office

2.2. Project Partner - Infosys Limited

Infosys Limited is an NYSE-listed global consulting and IT services company in India, with more than 335k employees that provide global leadership in digital services, business consulting, and outsourcing services. Established in 1981, by seven engineers in Pune, Maharashtra, India. It has nine development centers in India and over 50 offices worldwide. In their journey of 39 years, they have catalyzed some of the major changes which led to India's emergence as the global destination for software services talent. Infosys pioneered the Global Delivery Model and became the first IT Company from India to be listed on NASDAQ. Their employee stock options program created some of India's first salaried millionaires.

2.4. Brief description of the Project

Location: Survey No. 41 (Pt),50 (pt), Pocharam Village, Singapore Township PO, Ghatkesar Mandal, Malkajgiri, Hyderabad, 500088
Coordinates - 17°26'30.6"N 78°37'34.0"E.
Stage of the project: Design Stage
Estimated total built-up area: 91,000 sq.m
Site area: 65 Acres approx.
Climate zone: hot and dry climate
Purpose: IT office OR Build-own-operate
Profile of occupants: 10,500 ODC**(Offshore Development Center)** Capacity Hours of operation: 8 hours

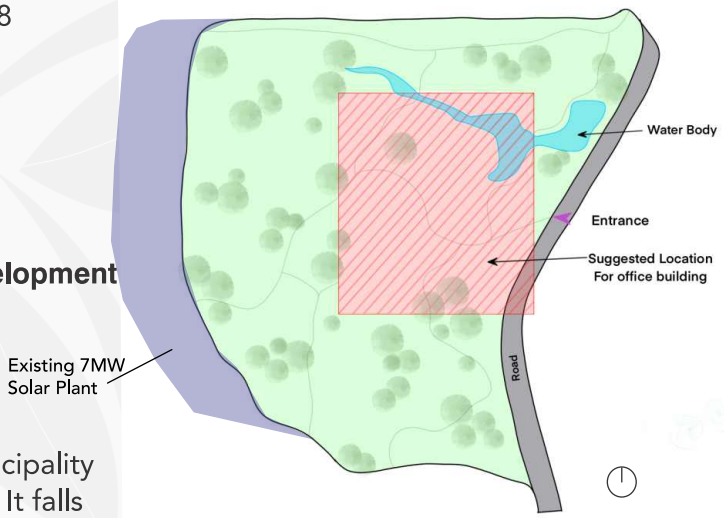


Fig4:Site context

2.4.1Site context

Narapally is a village under Pocharam Municipality in Medchal-Malkajgiri District in Telangana, India. It falls under Ghatkesar mandala. Narapally is an upcoming residential and commercial suburban area due to its close proximity to Singapore Township and Raheja Mindspace. It is on theNational Highway 163. It is located 67 KM to the East of District headquarters in Hyderabad. 4 KM from Ghatkesar.

- **Proposed site area is 65 acres out of which 6.3 acres of area allocated for phase 2 marked in red in fig.4 this area has been considered for area and FAR calculations**
- No height limitation
- Buildings will be located where your current footprint is shown, however, we are given the freedom to modify the shape and size of the footprint.
- we will be ignoring the existing Solar Power plant which generates **7MW** on the west side of the site, such that they will not use the renewable energy generated from this plant to show net zero performance for the building.

2.5. estimated built-up area

Permissible area	Area as per the site
Site area	65 acres (2,63,045.7s Sq.m)
F.A.R - 2	5,26,091.4 Sq.m
Ground cover – 25%	65,761.42 Sq.m

Table 1: Permissible FAR and ground coverage.

2.6. Target Energy Performance Index (EPI)

- EPI < **65**
- LPD: **0.5** W/Sqft
- HVAC: **750 Sqft/TR**
- EPD: **3.5 W/Sqft**

Facade & Daylight:

Total Facade solar loads in the building at peak design conditions for the location cannot exceed 0.65 W/sqft

Spatial daylight autonomy 100/100% (sDA100/100%) of at least 85% of the regularly occupied area is achieved.

Annual sunlight exposure 1000,250 (ASE 1000,250) of no more than 10% of the regularly occupied area is achieved (Use the regularly occupied floor area that is daylight per the sDA100/100% simulations).

No direct solar radiation on any workstation.

2.7 Socio-Eco Background

Economy of secunderabad is mainly dependent on the various small and large scale industries that have found base in this city and also many information technology companies that have generated jobs for the youth.

2.8 Target Population

The office designed for Infosys is specially designed for the employees who are majorly residing in urban areas with future planning for future development. Major mode of transport of the employees is by two or four wheeler local rickshaw and bus shuttle services

The population profile shows that total population of the study area villages is 5,84,167. The villages falling in this Study area are Rampalle, Annojiguda, Narepalle, Godamkunta, Boduppal, Ghatkesar, Uppal, Keesara etc. Uppal has the highest population (3,84,835) and Thimmaiguda has the lowest population (398). The total population density of the study area is about 1861 persons/sq. km.

	Total (0- 10km)
Household	139765
Population	584167
Male Population	299023
Female Population	285144
Household Size	3 - 4
Sex ration	954
Source:- Census 2011	

Fig 5: Demography

2.9. Estimated construction budget (INR/m2)

25,296INR/sqm. (refer appendix)

2.10. Special requirements of Project Partner & our achivement

LEED V 4.1

WELL Standard

NET ZERO Energy & Water

ECBC+ above

Radiant Cool Building

No direct solar radiation on any workstation.

Sewage To Be treated 100% At the Site with Zero Discharge.

3.0. Findings from Pre-Design Analysis

3.1. Climate analysis

The climate of Hyderabad is tropical, with a rainy season from June to October, due to the monsoon, and a dry season from November to May .The city is located in south-central India, at **17** degrees north latitude and **550**M (1,800 feet) above sea level. Due to the distance from the sea, the rains are not abundant, moreover, the dry season is long, so the landscape is semi-arid. Before the monsoon the temperature rises, and in April and May, on the hottest days, it can reach **45 °C** (113 °F). On the other hand, owing to the altitude, nights can be cool from November to March.

	Temperature	Humidity	Wind	Rainfall
Range	16- 38 °C	24- 63.8%	2.5 - 4.5 m/s	2.5- 156mm
Avg	32°C	45.00%	3.5 m/s	79 mm
Max	40°C (MAY)	69% (AUG)	5.8 m/s (JUL)	156mm (AUG)

Table 2: climate report

- **16%** of operational hours are spent in a comfortable zone, **50%** of operational hours require natural wentilation aided by mechanical ventilation while **34%** of the time, it will require artificial air conditioning to keep employees comfortable.

3.1.2 Psychrometric Chart :

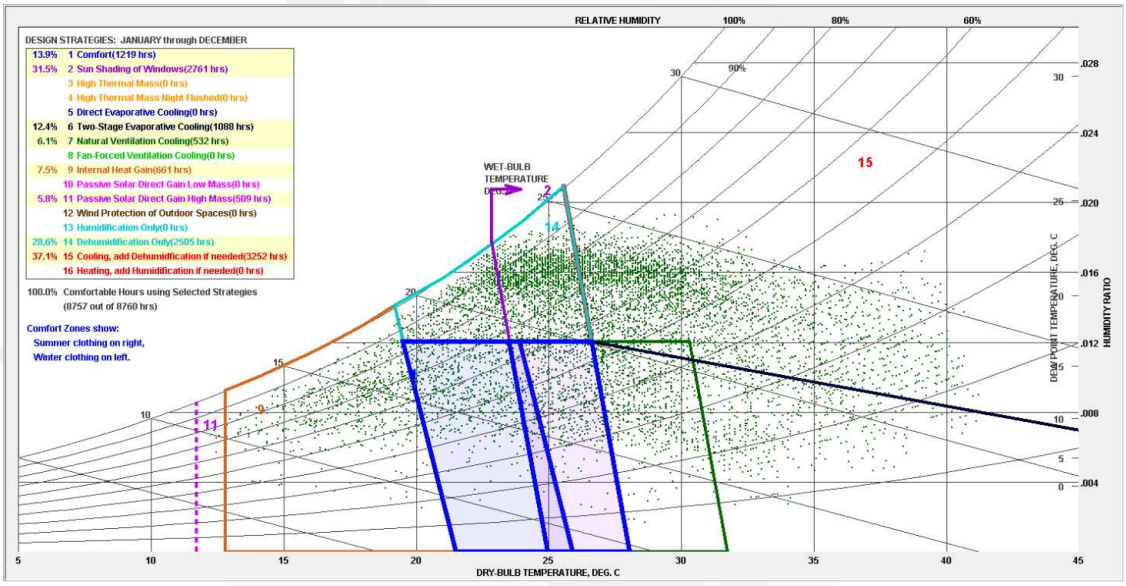


Fig 6: Psychrometric Chart

To better comprehend the comfort range during different seasons, a psychometric chart was created. During the winter, the comfort range is **22-26°C**, while in the summer, the comfort range is **24-28°C**.

An Climate consultant tool has been used to breakdown the % of comfortable hours, which helped to analyse the number of hours required for cooling.

DESIGN STATERGIES : Horizontal balcony projections are used as passive design & dynamic facde for active shading devices

3.1.3 Comfort Zones As Per ASHRAE 55 Standards :

Further breakdown of Comfort zone using CARBSE tool

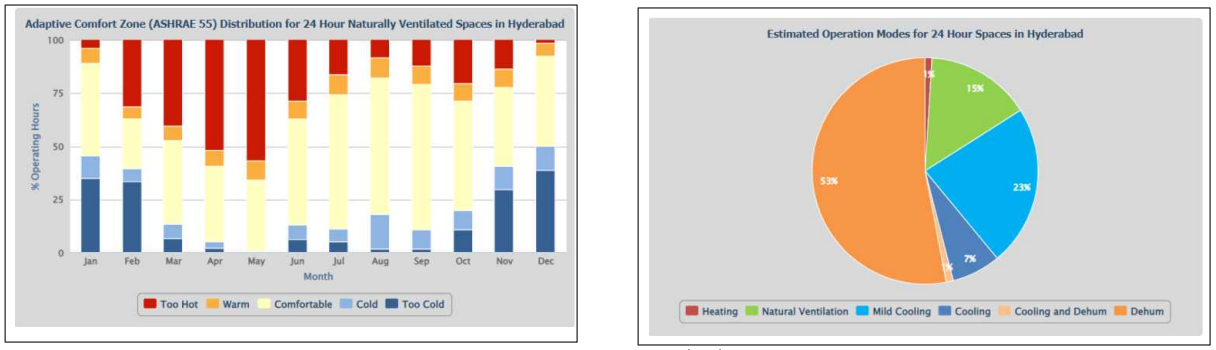


Fig 7: ASHRAE Standards

AREA STATEMENT

Distribution	Area
Ground coverage	11387 sq/m
Hardscape areas	6200 sq/m
Softscape areas	4500 sq/m

Table 3: Area summary

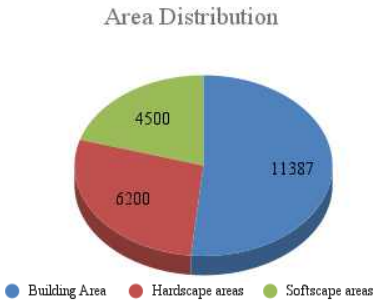


Fig 8: Area Distribution

DRISTIBUTION	Distribution format building 1 (43,308 sqm)				Distribution format building 2 (51,455 sqm)			
	No. of ODC	NO.OF PEOPLE	AREAS PER ODC	TOTAL AREA	No. of ODC	NO.OF PEOPLE	AREAS PER ODC	TOTAL AREA
25-50 seat ODC	20	1000	260sqm	5200	36	1800	260sqm	9360
50–100seatODC	10	1000	612sqm	6120	29	2900	612sqm	17748
150- 200seat ODC	9	1800	930sqm	8370	10	2000	930sqm	9300
Total Nos of seats		3800	**Total Area**	19,700		6700	**Total Area**	36408

Table 4 : Building Areas

SPATIAL ODC DISTRIBUTION							
Description	**50 seater ODC**		**100 seater ODC**		**200 seater ODC**		**HVAC Provision**
	Capacity	Area	Capacity	Area	Capacity	Area	
WORKSTATION							
Linear Workstations	**32**	**210sq/m**	**65**	**470sq/m**	**130**	**765sq/m**	Mixed
Pinwheel Workstations	**7.5**		**15**		**30**		
Focus Work Desks	**5**		**10**		**20**		
High Work Desks	**2**		**3**		**6**		
Reconfigurable Desks	**3**		**5**		**10**		
INTERACTION SPACE							
BM Cabins	**1**	**12sq/m**	**2**	**12sq/m**	**4**	**12sq/m**	Conditioned
10 Pax Meeting Rooms	**-**	**30sq/m**	**1**	**30sq/m**	**1**	**30sq/m**	
4/6 Pax Discussion Rooms	**1**	**25sq/m**	**1**	**25sq/m**	**2**	**25sq/m**	
Collab Area	**4 seats**	**25sq/m**	**4 Seats**	**25sq/m**	**4-5 Seats**	**25sq/m**	
Quiet Rooms	**-**	**12sq/m**	**1**	**12sq/m**	**2**	**12sq/m**	
VC Room	**-**	**30sq/m**	**1**	**30sq/m**	**1**	**30sq/m**	

Table 5 : ODC Areas

Description	Nos (per floor)	HVAC Provision
ODC Work stations	Area varie per floor	Mixed
Waiting & Entrance Lobby	264 sq/m	Mixed
Open Space	307 sq/m	Unconditioned
Cafeteria	250-310sq/m	Mixed
Toilet	105-138sq/m	Unconditioned
Server Room	60 sq/m	Conditioned
B.M.S Room	18 sq/m	Conditioned
Electric Room	110 sq/m	Conditioned
Lift Lobby	118 SQ/M	Conditioned

FOOD COURT	
Kitchen & storage	720 sqm x 4
Storage(dry,wet,cold) veg cooking space. non-veg cooking space, preparation space, cutlery storage, utility storage, service counter, cleaning station, wet area, dry area, staff lobby, changing room, handwash area, rest room.	
Seating Area	2755 sqm x 4

Table 6: Other Areas

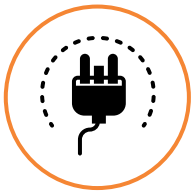
GOALS AND STRATEGIES

Architectural Design

Aim: Create a passive design approach for simulating climate responsiveness that prioritizes thermal comfort.

Strategy: Optimum thermal comfort is achieved through the utilization of a passive design approach, which is supplement -ed by active methods when necessary, resulting in reduced operational costs.

Energy Performance

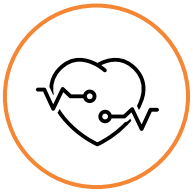


Aim : The objective is to achieve net-zero energy design.
Target: The focus is on achieving maximum energy efficiency of the built environment through the use of an EPI and maintaining the same level of LPD.
EPI < 65 HVAC :750 sqft/TR,
LPD: 0.5 w/sqft, Electrical: 3.5 w/sq
Strategy: An EPI of **58** has been achieved through the implementation of passive design strategies that lead to reduced energy consumption, solar energy generation, and efficient

Water Performance

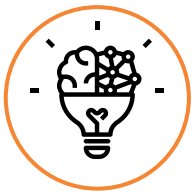
Aim: The goal is to minimize overall water demand using a self sustainable water plant.
Strategy: Employing low flow plumbing fixtures , sprays and drip irrigation systems
-Office building: **20** ltr/person (**15.7**ltr freshwater & 4.3ltr recycled water)
-Taps: 1.8 ltr/min
-Water Closet: 3-4 ltr./flush action

Health and well-being



Aim: The objective is to enhance and boost productivity in office space using passive design strategies.
Strategy:
-**50%/ 300** lux natural light is received in daylight spaces
-No direct sunlight on any of the workstations
-Green pockets/ balconies are accessible from every ODC for improved air quality.

Innovation



Aim: The goal is to manage direct sunlight, natural light and control glare

Strategy: A prototype parametric facade is developed.
A mobile app has been developed to integrate building automation and employee collaboration platform

GOALS AND STRATEGIES

Resilience

Aim: To be self sustainable
Strategy: Ensuring stability of the structure Providing solar energy backup and building social resilience by having a common break out spaces and green pockets that are accessible from each ODC .The building is designed with refuge areas that are provided along with emergency exits for every 30m.

Engineering design and Operation

Aim: Objective is to reduce Operational costs and employ low U value materials.
Strategy: Achieved by implementing low U value material envelope therefore reducing operating costs by using effective equipment's Designing the structure in accordance with Is456.

Market potential & Scalability

Aim: Introduction of a user focused product

Strategy: Achieved through the development of a prototype for direct sunlight & glare control Complemented by the creation of a Mobile application to integrate building automation and employee collaboration platform.

Affordability

Aim: To minimise significant construction and operational costs
Strategy: -Employing prefabricated materials leads to reduced material costs along with locally sourced materials leading to less transportation costs, proper management of scheduling and on-site feedback by incorporating BIM software - Additionally a cost impact analysis and payback assessments are conducted to evaluate the financial feasibility of the project.

Communication

Aim: Establish a benchmark model that promotes the concept of net-zero building
Strategy: -The building is oriented to face the prevailing wind for optimal ventilation, using a slender shape and operable windows to encourage natural airflow. Perforated louvre panels strategically block sunlight while allowing fresh air and ambient light to enter, and green pockets create a relaxing environment and harness natural wind for cooling.

PERFORMANCE SPECIFICATION

GENERAL	
Built up Area	94763 sqm
Average occupant density	9.025 sq/ person
Building Occupancy Hours	9:00am - 6:00pm
ENVELOPE	
Wall assembly U value	0.24 W/sq.K (Super ECBC)
Roof Assembly U value	0.22 W/sq.K (Super ECBC)
Window U value	1.0 W/m2.K (Super ECBC)
SHGC	0.12 (Super ECBC)
VLT	71%
Exterior Shading Device	Horizontal shading device with parametric panel, trellis and planter boxes
HVAC	
System Type	Radiant Cooling System (RCP - Panel type) with Dedicated Outdoor Air System (DOAS)
Cooling Capacity	934.01 TR
Operation Hours	9:00am - 6:00pm
LIGHTING	
Interior Average Lighting Power Density	0.71 W/ft2
RENEWABLE ENERGY	
Type	Monocrystalline Photovoltaic Panels
Efficiency	20 % (Industry Standard)
Generation Capacity	5559759 kWh
EPI	
Proposed EPI	58 kWh/ sqm per year
EPI Breakdown by use	
Cooling	19.63
Lighting	14.43
Equipments	19.9
WATER SYSTEM	
Total Daily Consumption	211000 Lpd
Domestic Requirement	2,02,286.7 Lpd
Flushing Requirement	5,613.3 Lpd
Treated Black-water	2,23,25,029 L/year
Treated Grey-water	5,36,10,445 L/year
Total Treated Water	75,935,475 L/year

Table 7 : Performance Specification

DESIGN PROCESS

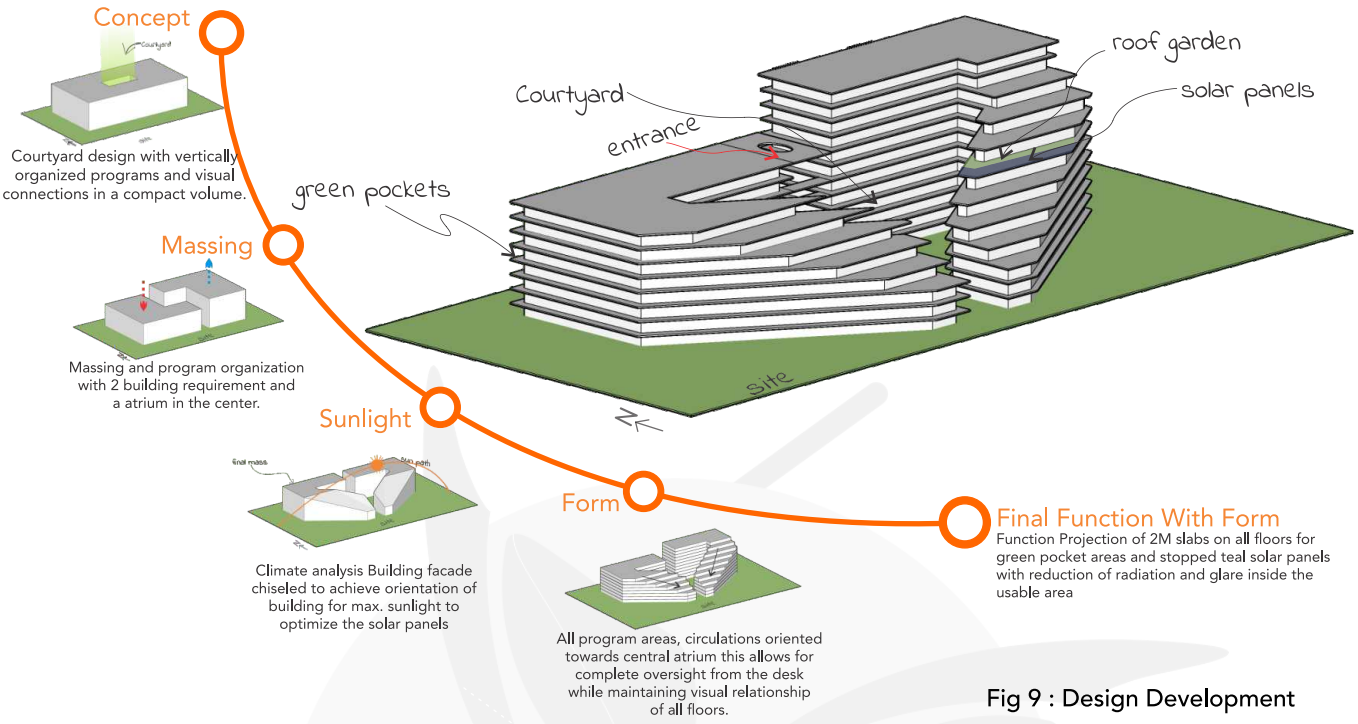


Fig 9 : Design Development

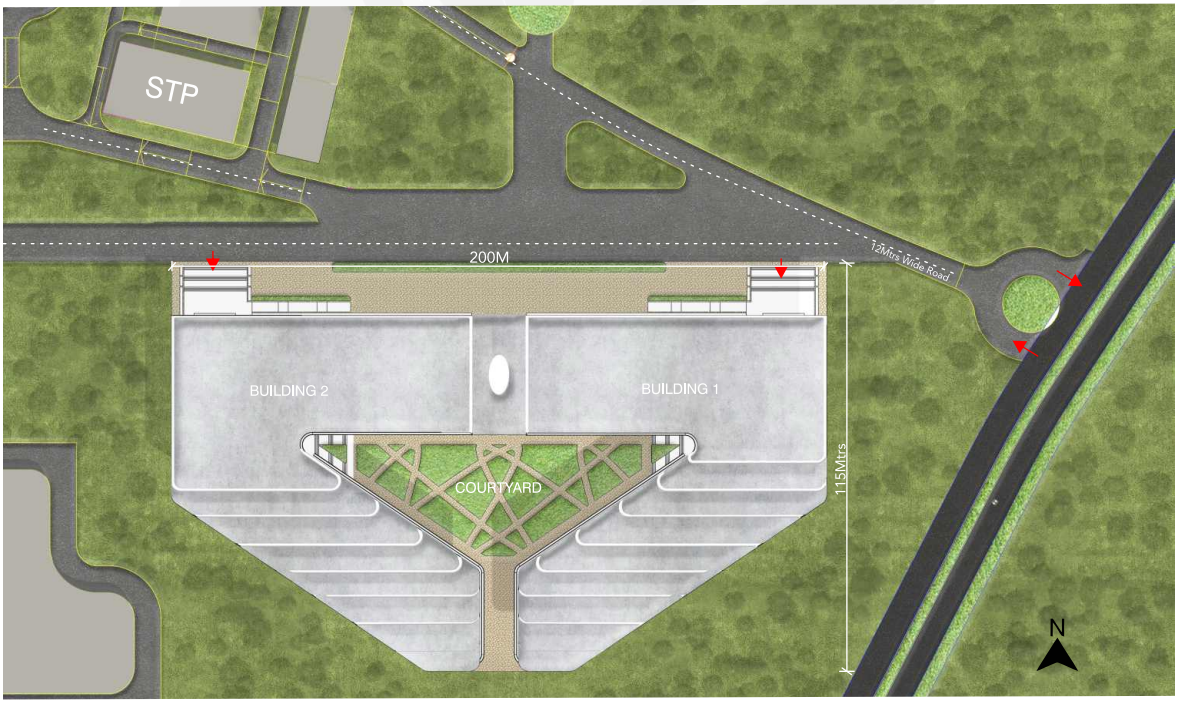


Fig 10 : Master Plan

Radiation Analysis

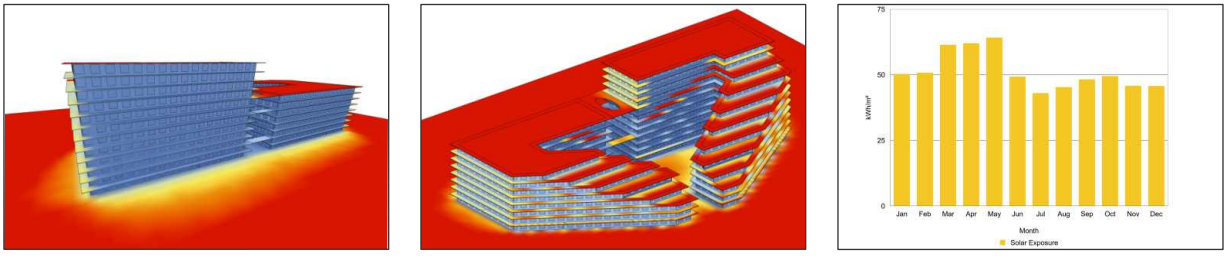
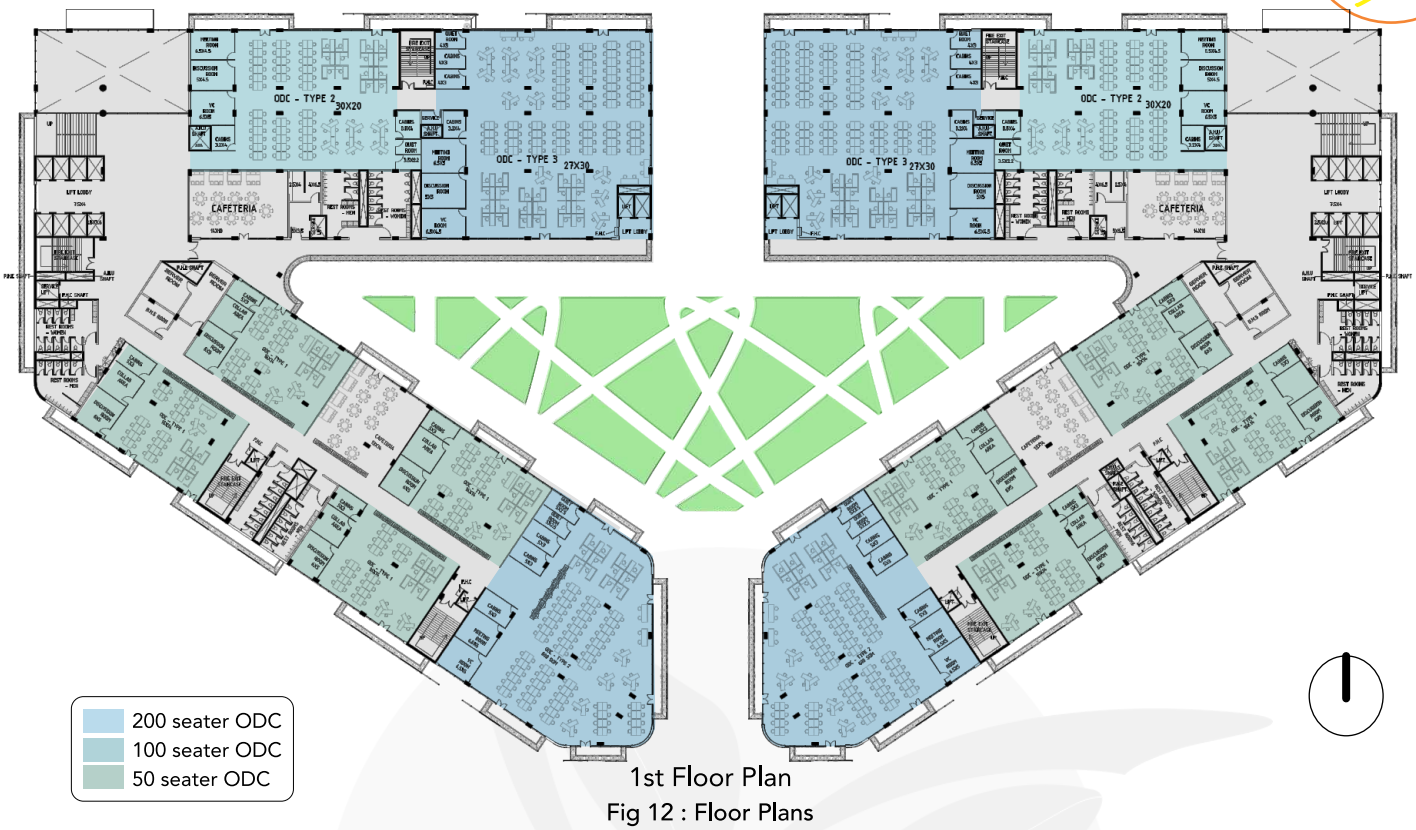


Fig 11 : Radiation Analysis



1st Floor Plan

Fig 12 : Floor Plans

In zoning we have strategically placed 200,100 seater large ODC in the northern part of the building which will be similar throughout the building and 50 seater smaller ODC are placed in the southern part of the building to achieve effective working layout as the space decreases in upper floors

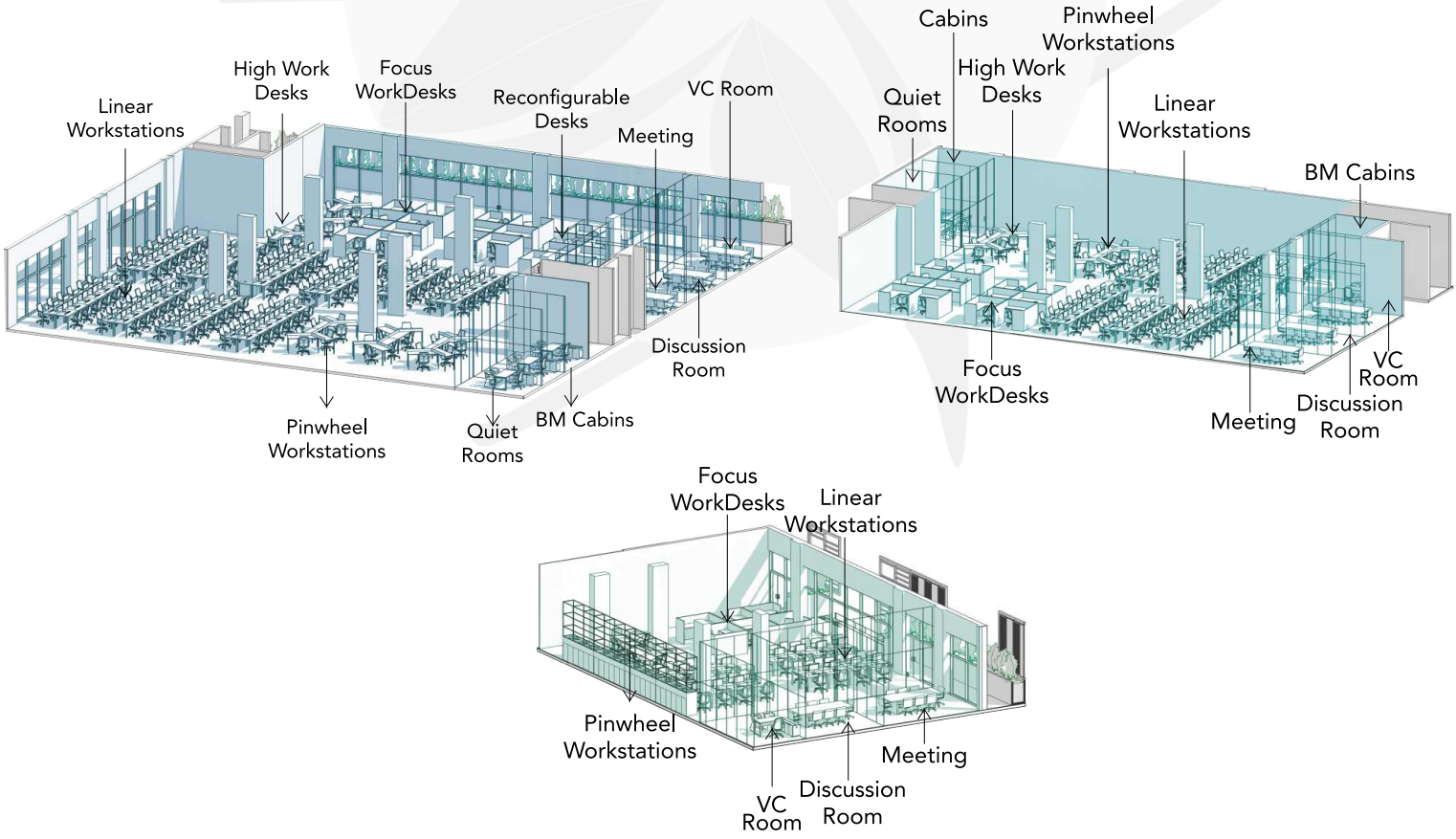
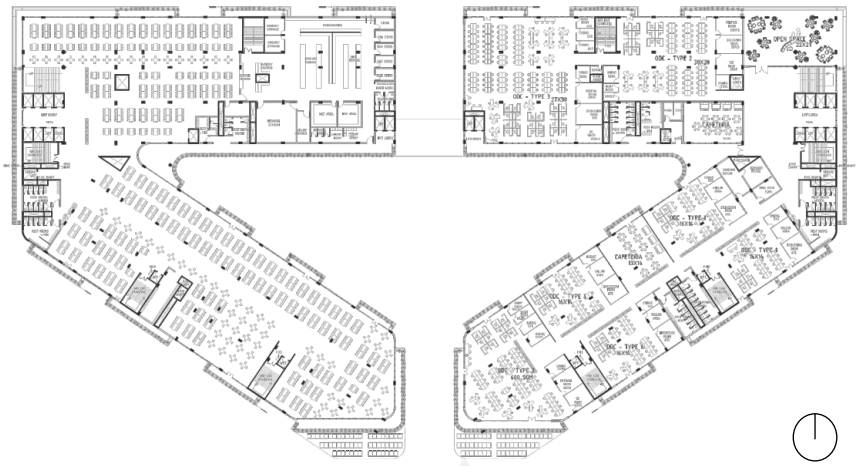
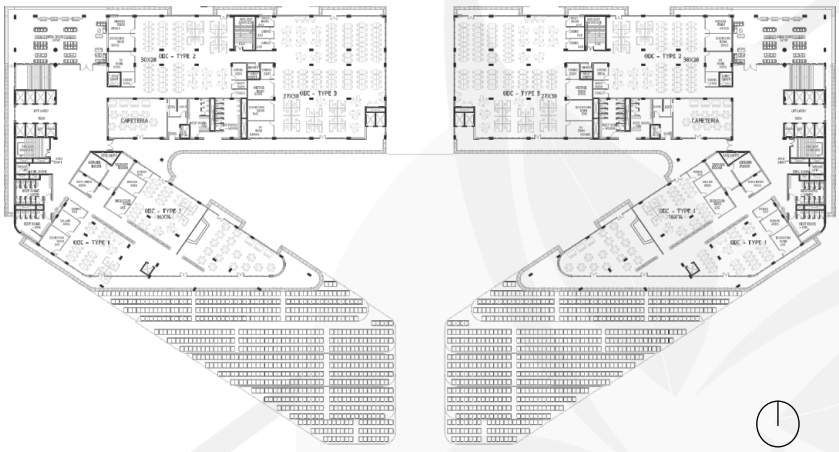


Fig 13 : ODC Distribution



3rd Floor Plan



8th Floor Plan

Fig 14 : Receding Floor Plans

Fig 15 : Balcony Projection

Green balcony spaces are provided in every floor of the building projecting 2.4m, with 0.6m being planter box and 1.8 m acting as recreational spaces. This projections act as sun breakers blocking direct sun rays entering work spaces, reducing solar heat gain, and plants used in this balconies further reduces heat gain and provide cooling effect.

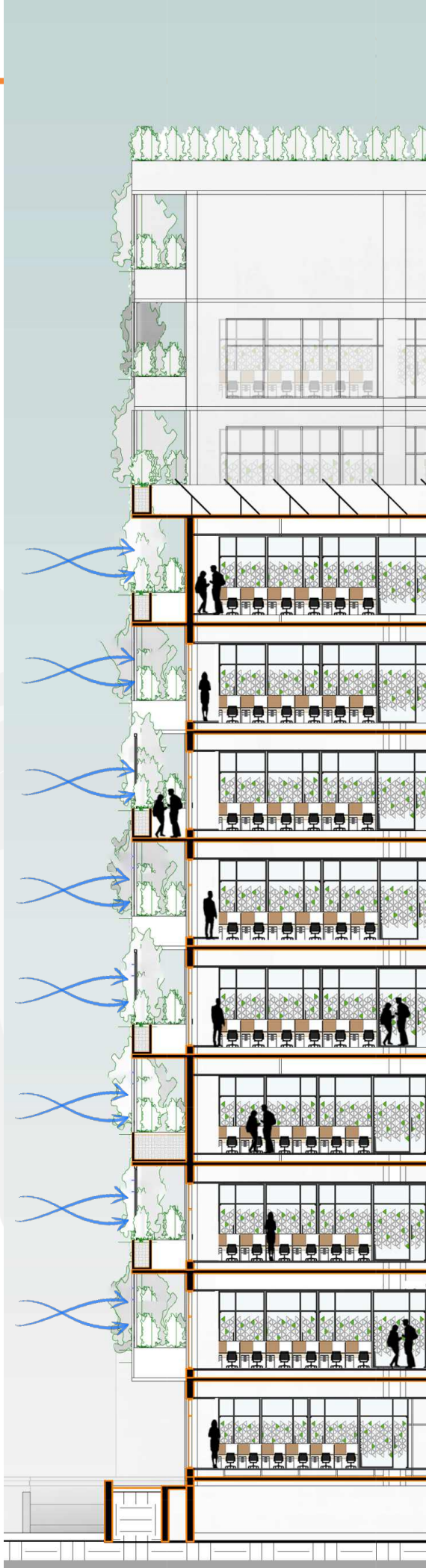


Fig 16 :Section

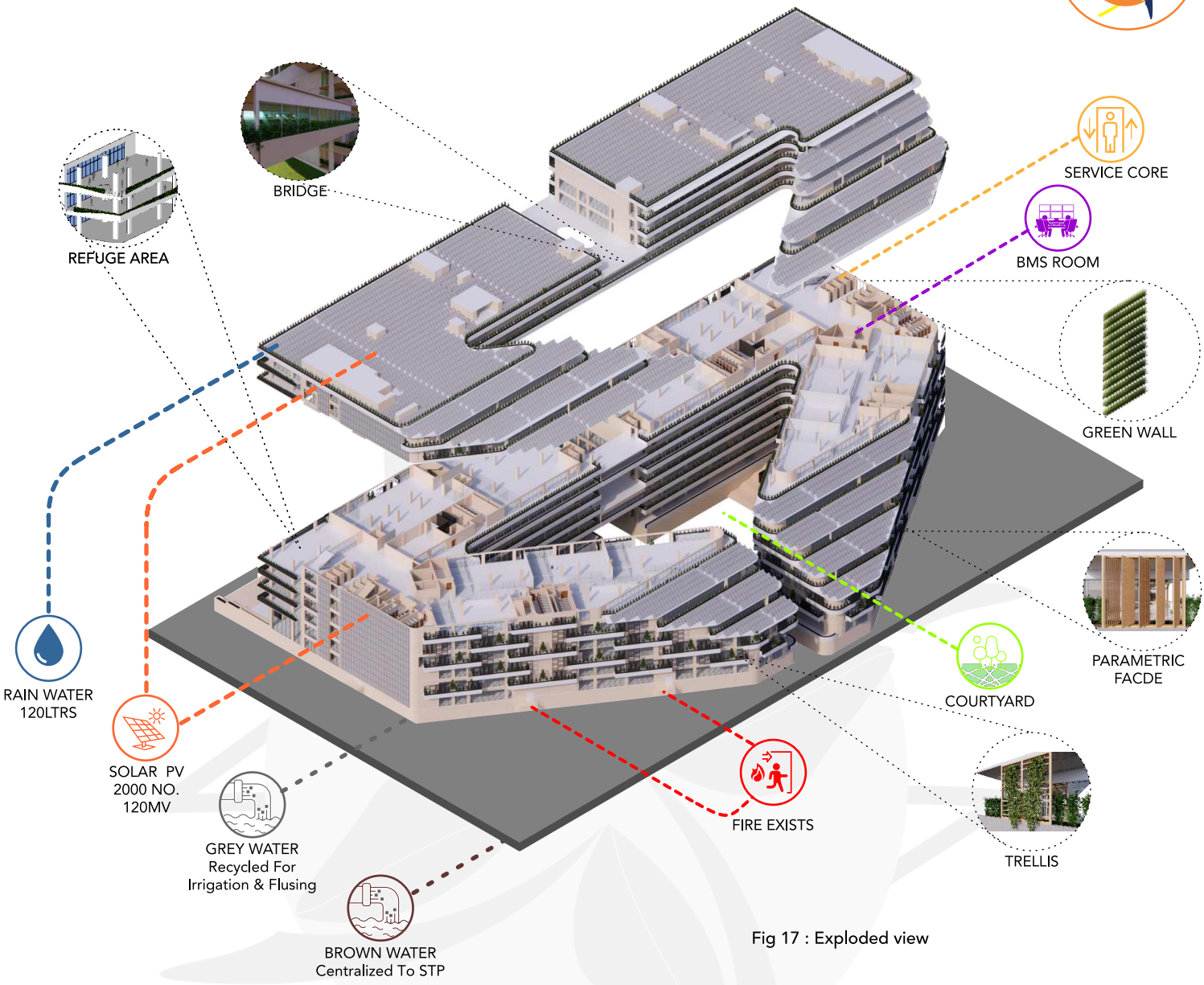


Fig 17 : Exploded view

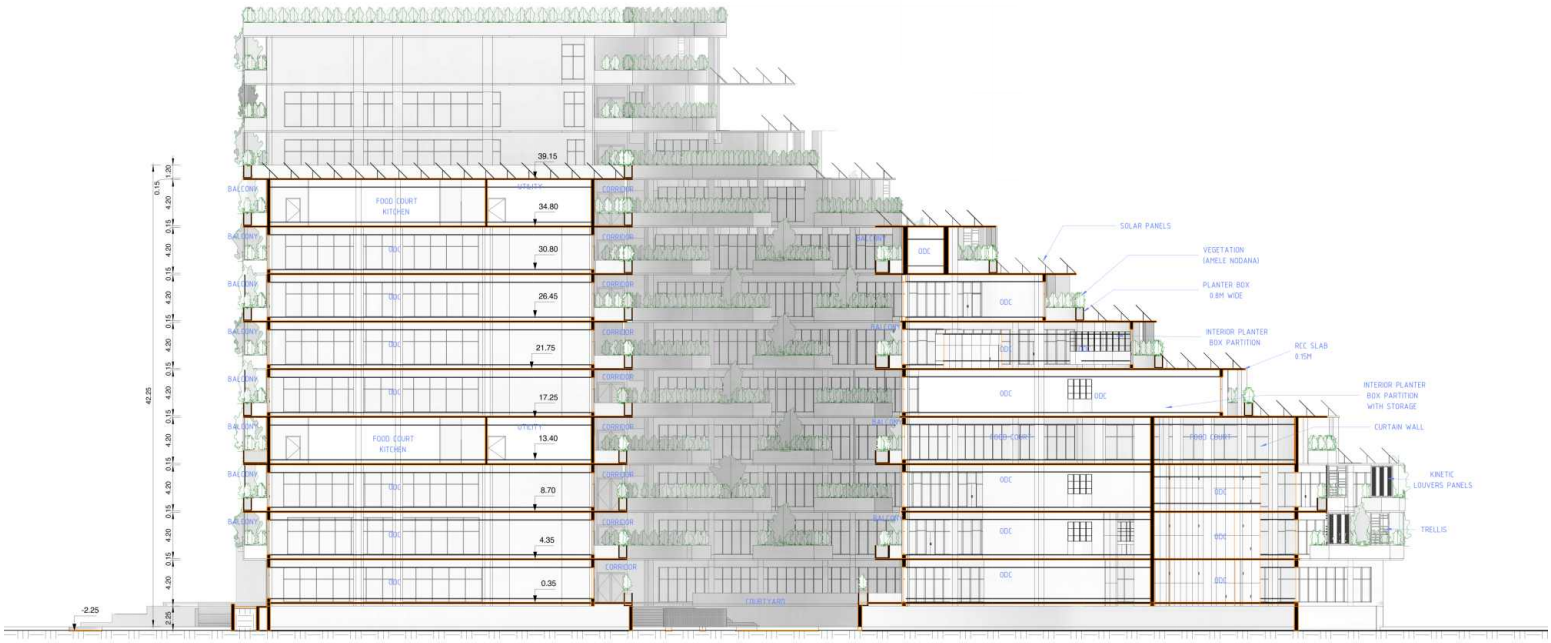
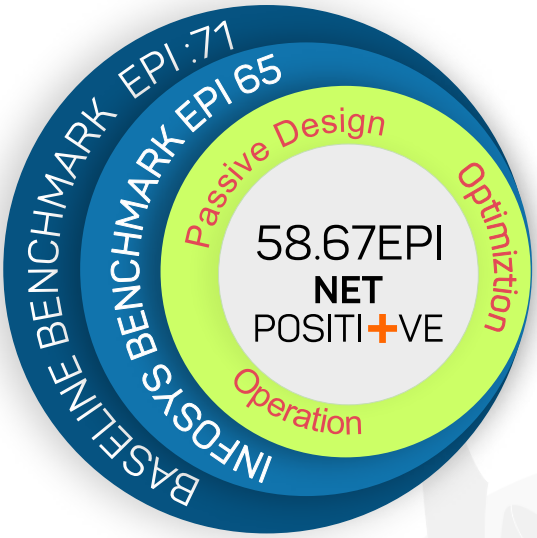


Fig 18 : Section

ENERGY PERFORMANCE



Target Energy Performance Index
- Base line benchmark EPI = 71
- Achieved EPI = 58.67

PASSIVE DESIGN
- Built Form
- orientation
- balcony projection
- green pockets
- Horizontal shading

EFFICIENCY
- Maximize Day lighting
- Efficient equipment
- Efficient lighting fixtures

OPERATION
- Radiant cooling
- Low u-value glass walls & roof

Fig 19 : The path to net zero building

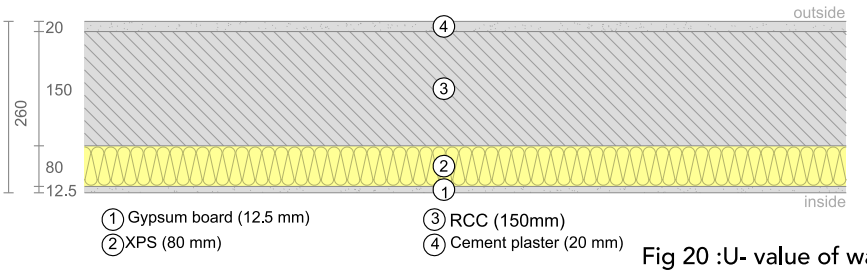
Target Energy Performance Index

All the calculations are done as per GRIHA(nationally accepted benchmark), where we have included Ventilation, space conditioning and lighting loads and equipment loads only.
The GRIHA benchmark for EPI is 71 kWh/sqm / year, and target EPI set by Infosys is 65kWh/sqm / year.
Our goal is to achieve less than or equal to at least 30% reduction in the EPI.
Target Energy Performance Index(EPI) < kWh/sqm per year.
After optimizing the equipment sand using passive design strategies, such as solar shading devices for all windows, reducing thermal conductivity and solar gain factor and considering low U-values, we are able to achieve an EPI of 55.67 which is less than the set target by infosys of EPI 65 .

Super ECBC Complaint

	WALL	ROOF	WINDOW
STANDARD DESIGN	Outer cement plaster 0.02m + brickwork 0.2m + XPS 0.08m+ gypsum board 0.01m **U VALUE - 0.4**	Cement plaster 0.02m + RCC slab 0.15m + inner cement 0.01m **U VALUE - 0.33**	6mm (solar control glass) - 12mm air gap - 6mm clear glass **U VALUE - 3**
PROPOSED DESIGN	Outer cement plaster 0.02 with AAC 0.225m +XPS 0.08m+inner cement 0.012m **U VALUE - 0.24**	Outer cement plaster 0.01m +XPS 0.08m+ RCC slab 0.15m + inner cement 0.012m **U VALUE - 0.22**	Vertical sealed double glazed window - 24mm (6mm+12mm argon 90%gas+6mm) of light coloured having SHGC 0.12 **U VALUE - 1**

Table 8 : U- value of wall,roof and glass.



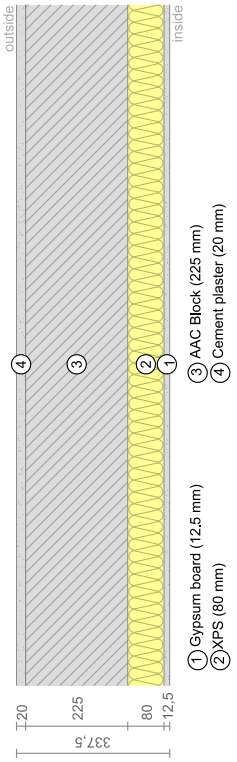


Fig 20 :U- value of wall and roof

LIGHTING LOAD CALCULATION

Images of lighting fixtures					
Type of lighting	Sereno	Ceiling mounted LED(battens)	FullGlow	GreenLED Ultima	GreenPerform
Company	Philips	Philips	Philips	Philips	Philips
Average lumen received	4000	2000	2800	1000	1600
Wattage(W)	28	16	28	10	17

Table 9 : Light Fixtures

Space Function	Target illuminanace (lux)	Type of lighting	Company	Average lumen received	Wattage (W)	Area	No.s	Hrs per day	No. of days	Total hrs	Energy consumed annually (wH)	ODC NO'S	Total Energy consumed annually (wH)
50 seater ODC													
Workstations	300	Sereno	Philips	4000	28	260	81	7	249	1743	3953124		
BM Cabins	200	FullGlow	Philips	2800	28	12	4	7	249	1743	195216		
Discussion Rooms	350	Sereno	Philips	4000	28	25	9	2	249	498	125496		
Collab Area	250	FullGlow	Philips	2800	28	25	9	4	249	996	250992		
				Total Energy consumed annually (wH)							**4524828**	**56**	**253390368**
100 seater ODC													
Workstations	300	Sereno	Philips	4000	28	612	191	7	249	1743	9321564		
BM Cabins	200	FullGlow	Philips	2800	28	12	4	7	249	1743	195216		
Meeting Rooms	350	Sereno	Philips	4000	28	30	11	2	249	498	153384		
Discussion Rooms	350	Sereno	Philips	4000	28	25	9	2	249	498	125496		
Collab Area	250	FullGlow	Philips	2800	28	25	9	4	249	996	250992		
Quiet Rooms	150	GreenLED Ultima	Philips	1000	10	12	8	4	249	996	79680		
VC Room	300	FullGlow	Philips	2800	28	30	13	2	249	498	181272		
				Total Energy consumed annually (wH)							**10307604**	**39**	**401996556**
200 seater ODC													
Workstations	300	Sereno	Philips	4000	28	930	291	7	249	1743	14201964		
BM Cabins	200	FullGlow	Philips	2800	28	12	4	7	249	1743	780864		
Meeting Rooms	350	Sereno	Philips	4000	28	30	11	2	249	498	153384		
Discussion Rooms	350	Sereno	Philips	4000	28	25	9	2	249	498	250992		
Collab Area	250	FullGlow	Philips	2800	28	25	9	4	249	996	250992		
Quiet Rooms	150	GreenLED Ultima	Philips	1000	10	12	8	4	249	996	159360		
VC Room	300	FullGlow	Philips	2800	28	30	13	2	249	498	181272		
				Total Energy consumed annually (wH)							**15978828**	**19**	**303597732**
Other Areas													
Waiting & Entrance Lobby	200	GreenPerform	Philips	1600	17	264	138	8	249	1992	4673232		**4673232**
Cafeteria 1	250	GreenPerform	Philips	1600	17	310	202	6	249	1494	5130396	18	**92347128**
Cafeteria 2	250	GreenPerform	Philips	1600	17	250	163	6	249	1494	4139874	14	**57958236**
Toilet 1	100	GreenLED Ultima	Philips	1000	10	105	44	5	249	1245	547800	18	**9860400**
Toilet 2	100	GreenLED Ultima	Philips	1000	10	117	49	5	249	1245	610050	18	**10980900**
Toilet 3	100	GreenLED Ultima	Philips	1000	10	138	58	5	249	1245	722100	10	**7221000**
Server Room	250	GreenLED Ultima	Philips	1000	10	60	63	2	249	498	313740	18	**5647320**
B.M.S Room	250	GreenLED Ultima	Philips	1000	10	18	19	8	249	1992	378480	18	**6812640**
Lift Lobby	150	GreenPerform	Philips	1600	17	118	46	4	249	996	778872	21	**16356312**
Passage 1	100	Ceiling mounted LED(battens)	Philips	2000	16	3415	711	8	249	1992	22660992		**22660992**
Kitchen and Food Court													
Kitchen	400	FullGlow	Philips	2800	28	720	429	6	249	1494	17945928	4	**71783712**
Food court 1	300	FullGlow	Philips	2800	28	11022	4921	3	249	747	102927636		**102927636**
				Total Energy consumed annually (Wh)									**1368214164**

Total (kWh)	**1368214.164**
Built up area	**94763**
EPI	**14.43827405**

Table 10 : Lighting load calculation

More effective light fixtures are utilized to generate more lumens of visible light per watt of electrical power input in order to produce the same amount of visible light as a less efficient fixture. Energy consumption are lowered as a result, and the environmental impact is minimized.

EQUIPMENTS AND ITS LOAD CALCULATIONS

Image					
Company	Lenovo Thinkpad	HP Z6 G4 Workstation	Canon	HP	Comfee
Appliances	Laptop	Desktops	Laser Printer	Inkjet Printer	Microwave
Cost in rupees	60,000	₹80000	₹12,000	₹4,108	₹6972
Power(W)	60	95	370	2	700
Image					
Company	Optoma	A O Smith	Frigidaire	Atomberg	Alpha
Appliances	Projector	Water purifier	Refrigerator	Exhaust fan	shredder
Cost in rupees	₹72000	₹32,500	₹60000	₹2,452	₹4,699
Power(W)	140	60	297 Kilowatt Hours Per Year	20	150

Table 11 : Rate of equipments used

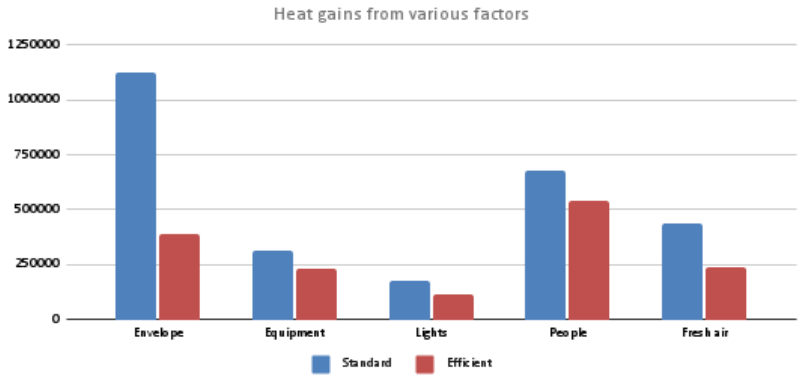
Sl No.	Appliances	Nos.	Wattage	No. of hours / day	No. of days	Energy consumed annually (kwh)
1	Desktops	3000	95	7	249	496755000
2	Laptop	7000	60	7	249	732060000
3	Laser Printer	133	2	2	249	132468
4	Inkjet Printer	58	370	2	249	10687080
5	Shredders	133	150	2	249	9935100
6	Microwave	45	700	2	249	15687000
7	Refrigerator	50	285	Kw Annual	249	14250
8	Water purifier	35	60	3	249	1568700
9	Projector	191	140	2	249	13316520
10	Pump	8	2500	8	249	39840000
11	Lift	28	10000	8	249	557760000
12	Fan	85	25	7	249	3703875
13	Exhaust fan(150mm)	126	20	7	249	4392360
			Total Energy consumed annually (Wh)			**1885852353**
					Built up Area	**94763**
					Total (kwh)	**19900.72447**
					EPI	**19.90072447**

Table 12 : Equipment Calculation

HVAC ELECTRICAL LOAD

SOLAR GAIN - GLASS							
		Building -1	Building -2				
Item	Direction	Area (ft2)	Area (ft2)	ΔT (°F)	Correction fator	SHGC	BTU / Hour
Glass	N	3590	3590	39	1.3	0.12	42067
Glass	NE	0	3038	11	1.3	0.12	5020
Glass	E	867	1839	11	1.3	0.12	4472
Glass	SE	2642	0	11	1.3	0.12	4366
Glass	S	1902	1902	11	1.3	0.12	6286
Glass	SW	0	2642	66	1.3	0.12	26196
Glass	W	1839	867	158	1.3	0.12	64230
Glass	NW	3038	0	158	1.3	0.12	72110
Skylight				107	1.3	0.12	0
SOLAR & TRANSMISSION GAIN - WALL & ROOF							
Item	Direction	Area (ft2)	Area (ft2)	ΔT (°F)	Correction	U-value	BTU / Hour
Wall	N	336	336	4	14	0.24	2903
Wall	NE			10	14	0.24	0
Wall	E	2061	195	18	14	0.24	17326
Wall	SE	1144		18	14	0.24	8786
Wall	S	610	610	16	14	0.24	8784
Wall	SW		1144	14	14	0.24	7688
Wall	W	195	2061	12	14	0.24	14077
Wall	NW			6	14	0.24	0
Roof				32	14	0.24	0
TRANSMISSION GAIN EXCEPT WALLS & ROOF							
Item		Area (ft2)		ΔT (°F)		U-value	BTU / Hour
All Glass		27756		30.9		0.12	102919
Door		0		30.9		1.13	0
Partition				25.9			0
Ceiling				25.9			0
Floor				25.9			0
INTERNAL SENSIBLE HEAT							
	Quantity	Unit rates					BTU / Hour
People	1200	215					258000
Equip (W)	55000	3.41				1	187550
Lights (W)	35000	3.41				1	119350
Supply air fan gain	5%						47606
INTERNAL LATENT HEAT							
	Quantity	Unit rates					BTU / Hour
People	1200	235					282000
OUT SIDE AIR HEAT							
	Flow rate (CFM)	ΔT(°F) & Δg/lb		Convesion factor			BTU / Hour
Sensible	6559	30.9		1.08			218888
Latent	6559	5.0		0.68			22301
Total Room Sensible heat							**1218624**
Total Room Latent heat							**304301**
Grand total heat, BTU/hr							**1522925**
AIR CONDITIONING TONNAGE							**126.91**

Table 13 : Cooling load calculations after optimisation



	Envelope	Equipment	Lights	People	Fresh air
Standard	1126694	312460	180000	675000	438144
Efficient	387230	235156	119350	540000	241189

Table 14 : Cooling load efficiency

Through the use of raised access floors with embedded tubing, the building's HVAC system uses a radiant cooling system. The chilled water source and distribution systems need little maintenance when using this cooling method. Additionally, the system uses a dedicated outdoor air system (DOAS) that significantly affects capital costs while also reducing operational costs.

After taking into account the requirements of project partners and the unique climatic conditions of Hyderabad, the HVAC system was equipped with a radiant cooling and ventilation system, which includes a Dedicated Outdoor Air System (DOAS) to provide high-quality air while reducing energy consumption.

The raised floor radiant cooling system : is an advanced solution for cooling in multi-story buildings. It uses pipes installed within the raised floor system to provide a comfortable indoor environment with temperatures close to the ambient, resulting in more efficient use of renewable energy. Additionally, this system ensures an optimized thermal indoor environment for occupants, making it an ideal choice for modern buildings.
A Dedicated Outdoor Air System (DOAS): is used to continuously supply the building with fresh, dehumidified air in order to maintain the best possible air quality. The DOAS system is required to handle latent heat loads, ensuring effective temperature and humidity control, while the radiant cooling system efficiently removes sensible heat from the building.

FLOOR	COOLING LOAD IN BTU/H			TOTAL TR			
	SENSIBLE LOAD	LATENT LOAD	TOTAL LOAD		No. of hours per day	No. of days	Energy consumed annually (kWh)
GL	1218624	304301	1522925	126.91	8	249	252804.72
1F	1208423	303261	1511684	125.97	8	249	250932.24
2F	1208423	303261	1511684	125.97	8	249	250932.24
3F	582568	151670	734238	61.19	8	249	121890.48
4F	953597	278370	1231967	102.66	8	249	204498.72
5F	496250	138839	635089	52.92	8	249	105416.64
6F	993162	228307	1221469	101.79	8	249	202765.68
7F	900460	203333	1103793	91.98	8	249	183224.16
8F	418953	89278	508231	42.35	8	249	84361.2
9F	357212	88173	445385	37.12	8	249	73943.04
10F	319011	75710	394721	32.89	8	249	65516.88
11F	310727	76243	386970	32.25	8	249	64242
TOTAL	**8967410**	**2240746**	**11208156**	**934**	**Total Energy consumed annually**		**1860528**

Table 15 : Cooling load calculation

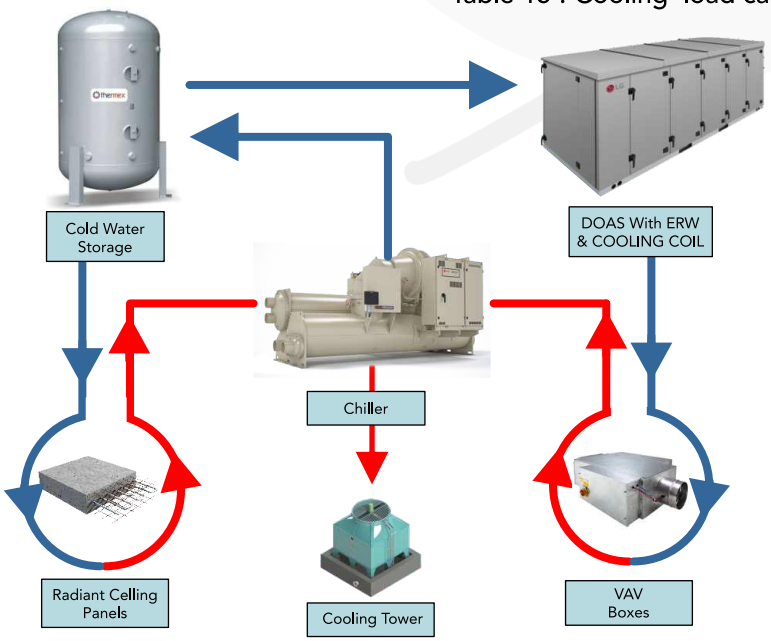


Fig 21 : HVAC Schematic Diagram

PARTICULARS	STANDARD DESIGN	EFFICIENT DESIGN
SENSIBLE LOAD IN TR	1113	747
LATENT LOAD IN TR	187	187
TOTAL COOLING LOAD IN TR	1300 TR	934 TR
PLANT FOR SENSIBLE COOLING		
CHILLERS	1500 TR Water-Cooled Chiller 1 No.S	1000 TR Water-Cooled Chiller 1 No.S
CIRCULATION PUMPS	251 LPM/20M HEAD - 54 NO.S (42 WORKING + 12 STANDBY)	182 LPM/20M HEAD - 54 NO.S (42 WORKING + 12 STANDBY)
PLANT FOR LATENT COOLING		
TREATED FRESH AIR UNIT WITH DX COIL	15000 CFM X 3 NO.	15000 CFM X 2 NO.
VAV UNIT	48 NO.	48 NO.

Table 16 : HVAC Equipment

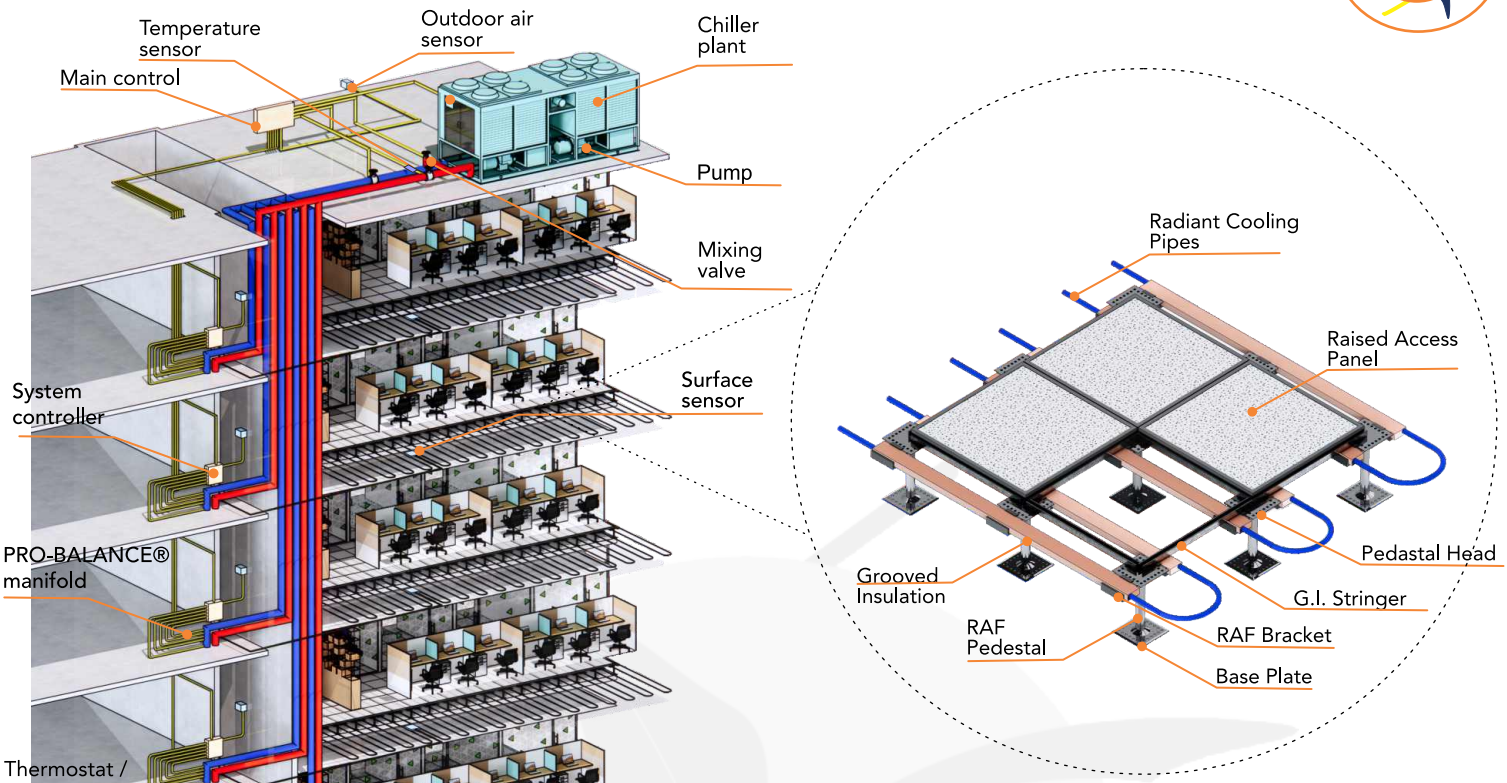


Fig 22 : HVAC Details

Fig 23 : Radiant Cooling System Details

Cooling loads are reduced through other passive design strategies, such as projected green balcony spaces, parametric facade, reducing thermal conductivity and solar gain factor and considering low U-value materials

The building is oriented to face the prevailing wind for optimal ventilation, using a slender shape and operable windows to encourage natural airflow. Perforated louvre panels strategically block sunlight while allowing fresh air and ambient light to enter, and green pockets create a relaxing environment and harness natural wind for cooling.

ENERGY POTENIAL

ROOF TOP SOLAR PANEL	
Total Roof top area	12654 sq.mt
optimum roof area for solar pv installation	8500 sq.mt
Total nos. of solar panel on roof (considering 1.6 sqm per PV panel)	5212 Nos
One solar panel can generate 540 watt electricity per hour	
electricity generated in a day	5212 x 540 x 6 = 17230320 KW
Total electricity generated in year	19238120 x 300 = 5169096000 KW
EPI (a)	**54.5476188**
WEST WALL SURFACE	
Total West Wall Surface Area	1102 sq.mt
optimum roof area for solar pv installation	1102 sq.mt
Total nos. of solar panel on roof (considering 1.6 sqm per PV panel)	689 Nos
One solar panel can generate 540 watt electricity per hour	
electricity generated in a day	689 x 540 x 3.5 = 1302210 KW
Total electricity generated in year	1302210 x 300 = 390663000 KW
EPI(b)	**4.122526725**
TOTAL EPI OF BULIDING (a)+(b) =	**58.67014552**

Table 17 : Solar panel calculation

Total roof area of the building is **12654 sqm**, and rooftop area available for solar panels after eliminating area occupied by the mumty, other service ducts and openings is **88%**. Therefore, total electricity generation from the solar energy plant is **3.01MW**, annually.

Month	Solar Radiation (kWh/m2/day)	Electricity Generation (kWh)
JAN	6.71	584229
FEB	6.93	537043
MAR	6.68	561315
APR	5.83	468657
MAY	5.85	484710
JUN	4.35	360269
JUL	3.88	335187
AUG	3.95	341715
SEP	4.37	365926
OCT	4.93	431320
NOV	6.42	547406
DEC	6.18	542140
ANNUAL	**5.51**	**5559917**

Table 18 : Annual Electricity Generation

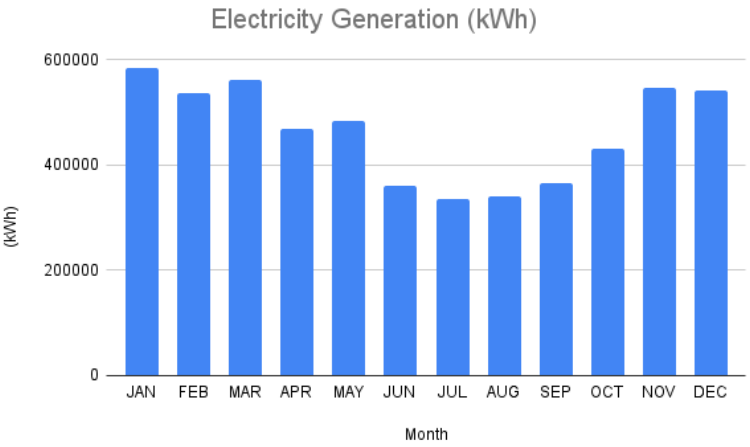


Fig 24 : Annual Electricity Generation

The building site benefits from an average daily solar irradiance of 5.51 kWh/sqm, indicating a high potential for solar energy utilization. The horizontal South Receding terraces receive the most extensive exposure to solar irradiance, while the North facade receives less. To harness this potential, solar panels are strategically placed on the Receding terraces, West Facade, and Head Room, ensuring that the building's energy demands are met in a sustainable manner. The solar energy generated on-site is calculated using the reliable and effective PV Watts method.

Fig 25 : West wall solar panels

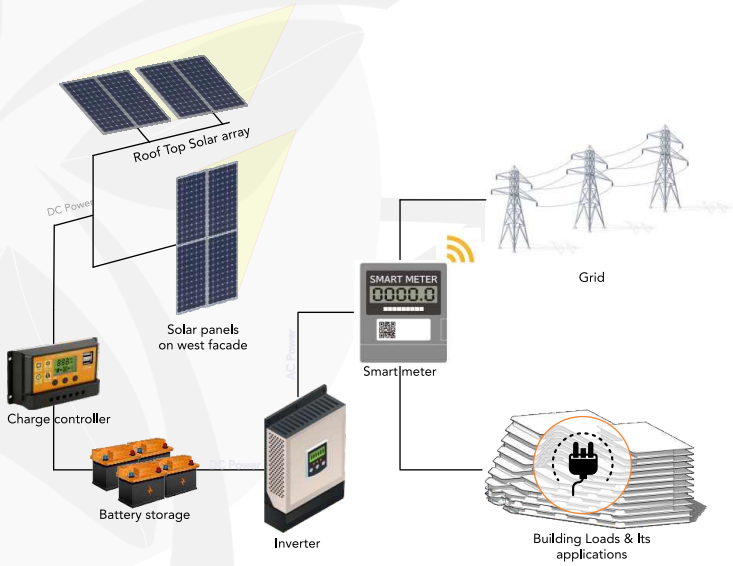


Fig 26 : Schematic working diagram of PV Panels

Fig 27 : Isometric view with solar panel

LOAD	EPI (kwh/m²/year)
LIGHTING	14.43
EQUIPMENTS	19.9
COOLING (HVAC COMPONENTS)	19.63
MISCELLANEOUS	2
TOTAL EPI (kwh/m²/year)	**55.96**

Table 18 : EPI calculation

WATER PERFORMANCE

WATER CYCLE DIAGRAM

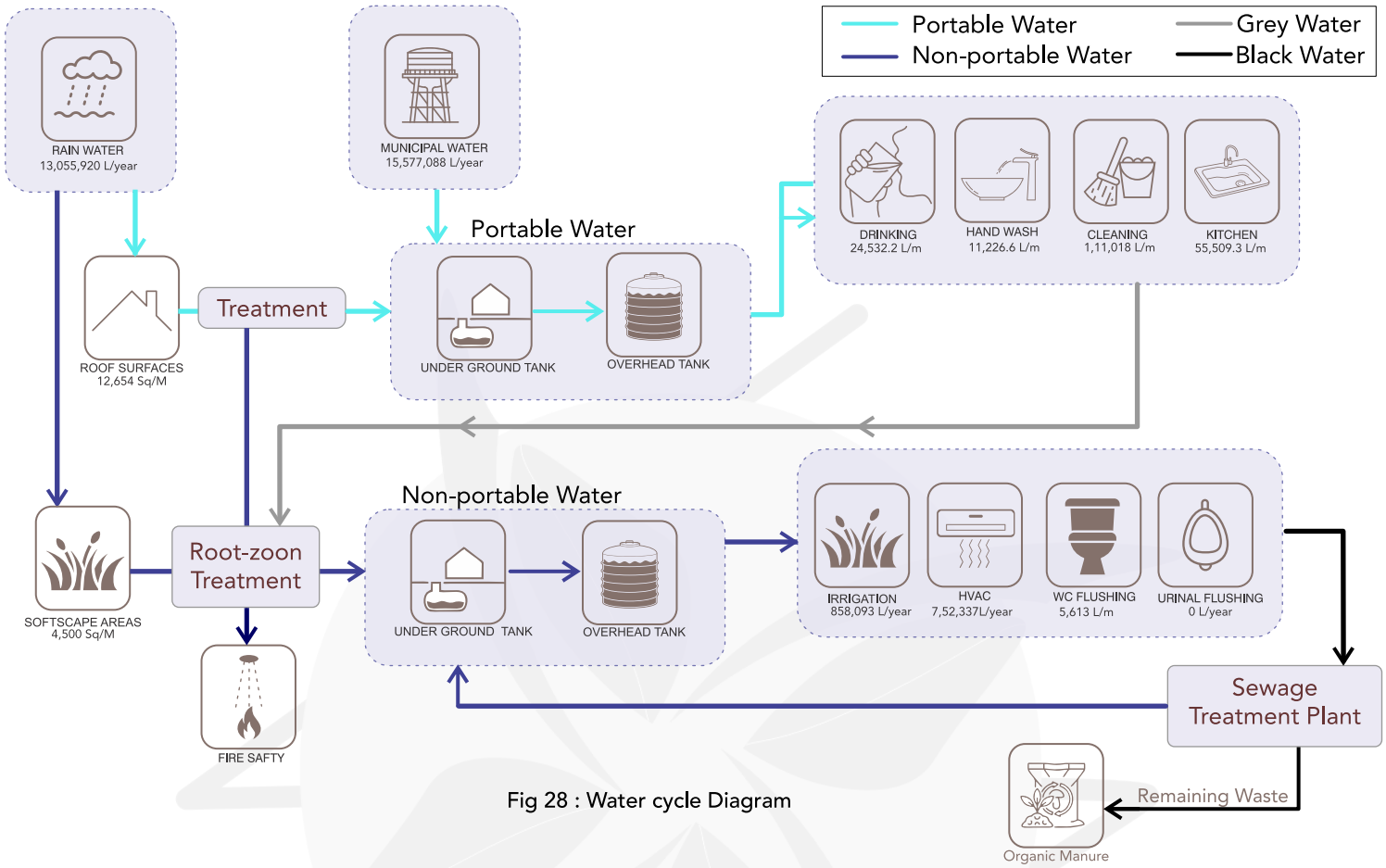


Fig 28 : Water cycle Diagram

A comprehensive approach to managing water resources has been implemented to reduce the daily demand for fresh municipal water. The strategy includes harvesting rainwater, treating grey water through root zone water treatment, and utilizing local vegetation to decrease the need for outdoor landscaping. Furthermore, during monsoon months, excess grey water is directed towards ground recharge. Together, these initiatives have created an efficient water cycle that optimizes the use of alternative water sources and minimizes reliance on freshwater.

Month	Days in month	Rainfall (mm)	Effective rain (mm)	Harvested water (l)	Muncipality water supply (l)	Primary demand (l)	Grey water generated (l)	Irrigation seasonal factor (%)	Irrigation Water demand (l)	Unused grey water (l)	Cooling tower Ussage factor (%)	Cooling tower water demand (l)	Total fresh water demand (l)	Storage (l)
July	31	170	165	2633384	6138000	6444900	3222450	50%	69750	3152700	80%	69564	6514464	2256920
August	31	189	184	2936622	6138000	6444900	3222450	50%	69750	3152700	80%	69564	6514464	2800000
September	30	157	152	2425905	5940000	6237000	3118500	50%	67500	3051000	80%	67320	6304320	2800000
October	31	87	82	1308712	6138000	6444900	3222450	15%	20925	3201525	80%	69564	6514464	2800000
November	30	29	24	383038	5940000	6237000	3118500	15%	20250	3098250	40%	33660	6270660	2800000
December	31	6	1	15960	6138000	6444900	3222450	15%	20925	3201525	40%	34782	6479682	2474278
January	31	7	2	31920	6138000	6444900	3222450	15%	20925	3201525	40%	34782	6479682	2164516
February	28	9	4	63840	5593500	5873175	2936587.5	15%	19068.75	2917518.75	40%	31697	5904872	1916984
March	31	18	13	207479	6138000	6444900	3222450	100%	139500	3082950	100%	86955	6531855	1730608
April	30	22	17	271318	5940000	6237000	3118500	100%	135000	2983500	100%	84150	6321150	1620776
May	31	40	35	558597	6138000	6444900	3222450	100%	139500	3082950	100%	86955	6531855	1785517
June	30	116	111	1771549	5940000	6237000	3118500	100%	135000	2983500	100%	84150	6321150	2800000

Table 19 : Water balance

Per Capita daily consumption (l)	Number of occupants	Total daily consumption	Grey water filter efficiency
19.8	10500	207900	75%

Table 20 : Per Capita Consumption

Water cycle of the building is maintained efficiently, while simultaneously ensuring the effective use and reuse of water, fire safety and increasing the potential of usage of water before its release into the sewage.

The usage of water efficient fixtures have resulted in about 55.55% reduction from the base case. Rainwater harvesting has been implemented in the design, and treated grey water is used for non-potable purposes. Extra grey water is used for ground recharge. These methods have helped reduce the freshwater demand by more than 80%.

Month	Days in month	Generated black water	Generated Grey water	Filtered grey water
Jul	31	1894801	4550099	3412574.55
Aug	31	1894801	4550099	3412574.55
Sep	30	1833678	4403322	3302491.5
Oct	31	1894801	4550099	3412574.55
Nov	30	1833678	4403322	3302491.5
Dec	31	1894801	4550099	3412574.55
Jan	31	1894801	4550099	3412574.55
Feb	28	1726713	4146462	3109846.163
Mar	31	1894801	4550099	3412574.55
Apr	30	1833678	4403322	3302491.5
May	31	1894801	4550099	3412574.55
Jun	30	1833678	4403322	3302491.5
Total		22325030	53610445	40207834.01

Table 21 : Blackwater and greywater generated

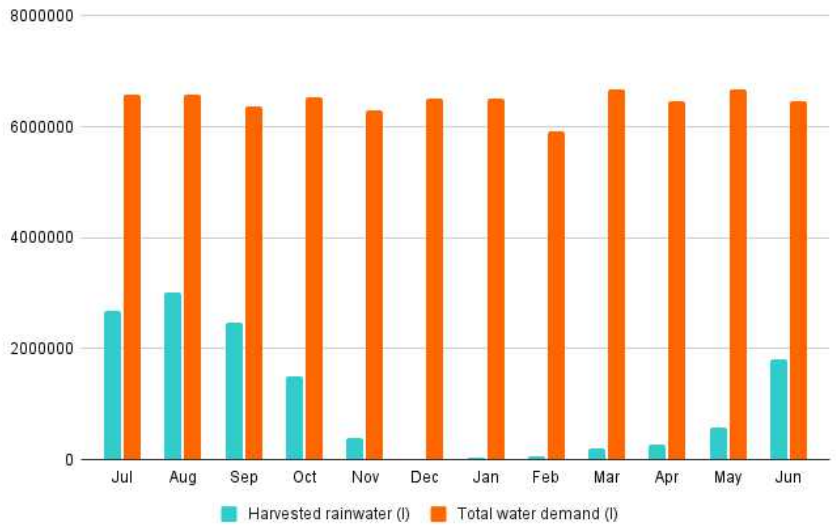


Fig 29 : Storage and Demand

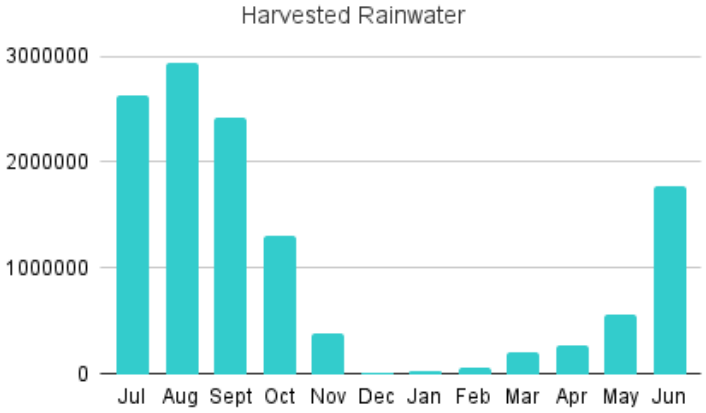


Fig 30 : Harvested Rain Water

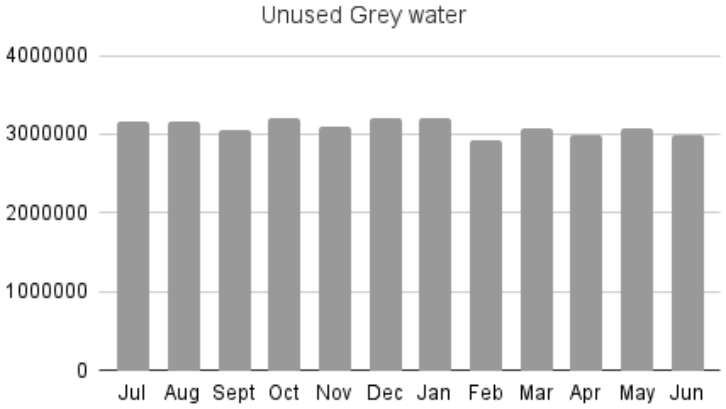


Fig 31 : Unused Grey Water

Water harvesting Sources	Area	Runoff coeff
Roof Surfaces	12654	0.85
Hardscape areas	6020	0.7
Softscape areas	4500	0.22
Effective catchment area	**15959.9**	

Harvested Rain Water (L/Year)	Recycled Grey Water (L/Year)	Municipal Water (L/Year)
13,055,920	53,610,445	15,577,088
Total Water Required (L/Year)		**77,545,906**

Table 22 : Water harvesting sources

Muncipality water supply (l/day)	198,000
Storage size (l)	2,800,000

Table 23 : Municipal supply and storage size

Water consumption point	Quantity	Liters/day
Occupants : {People x l/person}	10500	19.8
Irrigation (max) : {m2 x l/m2}	4500	1
Cooling tower (max) : {Ton x l/Ton}	935	3

Table 24 : Water consumption per day

CONSUMPTION								WATER SOURCES				
Month	Days in month	Domestic Use (L)	Cooling Use %	Cooling Use (L)	Irrigation Use %	Irrigation Use (L)	Total Consumption (L)	Municipal Water (L)	Harvested rainwater (l)	Greywater (L)	Blackwater (L)	Total Stored
Jul	31	6,444,900	80%	69,490	50%	69,750	6,584,140	450,000	2692784	4,550,099	1,894,801	1108743
Aug	31	6,444,900	80%	69,490	50%	69,750	6,584,140	450,000	3002862	4,550,099	1,894,801	2527565
Sep	30	6,237,000	80%	67,248	50%	67,500	6,371,748	450,000	2480625	4,403,322	1,833,678	3489764
Oct	31	6,444,900	80%	69,490	15%	20,925	6,535,315	450,000	1501431	4,550,099	1,894,801	3455979
Nov	30	6,237,000	40%	33,624	15%	20,250	6,290,874	450,000	391678	4,403,322	1,833,678	2410105
Dec	31	6,444,900	40%	34,745	15%	20,925	6,500,570	1,589,584	16320	4,550,099	1,894,801	2065538
Jan	31	6,444,900	40%	34,745	15%	20,925	6,500,570	1,889,584	32640	4,550,099	1,894,801	2037292
Feb	28	5,873,175	40%	31,663	15%	19,069	5,923,906	1,889,584	65280	4,146,462	1,726,713	2214710
Mar	31	6,444,900	100%	86,862	100%	139,500	6,671,262	1,889,584	212159	4,550,099	1,894,801	2195291
Apr	30	6,237,000	100%	84,060	100%	135,000	6,456,060	2,089,584	277438	4,403,322	1,833,678	2509575
May	31	6,444,900	100%	86,862	100%	139,500	6,671,262	2,089,584	571197	4,550,099	1,894,801	3049193
Jun	30	6,237,000	100%	84,060	100%	135,000	6,456,060	1,889,584	1811509	4,403,322	1,833,678	4697548
Total							77,545,906	15,577,088	13,055,920	53,610,445	22325029.65	(10,879,540

Base Case			
Per-capita consumption per day : 45 Lts			
Activities	**Domestic (Lts)**	**Percentage**	
Handwash	4.5	10	**44.4% of 45 Litres**
Drinking	1.98	4.4	
Kitchen/pantry	4.5	10	
Cleaning	9	20	
Activities	**Flushing (Lts)**	**Percentage**	
Urinal flushing	13.5	30	**55.6% of 45 Litres**
WC flushing	11.52	25.6	

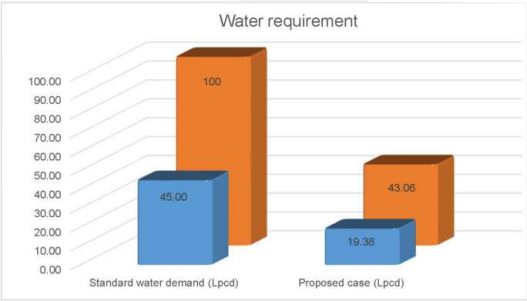
Table 25 : Base Case water consumption as per NBC

Proposed Case			
Per-capita consumption per day : 19.8 Lts			
Activities	**Domestic (Lts)**	**Percentage**	
Handwash	1.8	5.3	**84.53% of 19.8 Litres**
Drinking	1.5	11.8	
Kitchen/pantry	4.5	26.7	
Cleaning	9	53.5	
Activities	**Flushing (Lts)**	**Percentage**	
Urinal flushing	0	0	**15.47% of 19.38 Litres**
WC flushing	3	2.7	

Table 26 : Proposed Case per-capita water consumption

Occupant's Activity	Percent usage	Quantity	Grey water	Black water
Hand wash	5.40%	11226.6	100%	0%
Drinking	11.80%	24532.2	100%	0%
Kitchen/Pantry	26.70%	55509.3	0%	100%
Cleaning	53.40%	111018.6	100%	0%
Urinal flushing	0.00%	0	0%	100%
WC Flushing	2.70%	5613.3	0%	100%

Table 27 : Daily water consumption



Water saved in comparison to base case =**57%**

Image of the Sanitary fixture					
Sanitary fixtures	Sensor fauce	Health faucet	Water closet	Aqua-free Waterless Urina	Kitchen faucet
Baseline water usage LPM (1 BAR PRESSURE)	4.31Lpm	8 Lpm	6 L	2.2 Lpm	8 Lpm
Benchmark water usage LPM (1 BAR PRESSURE)	1.8 Lpm	4 Lpm	3/4 L	0 L	6 Lpm
Cost (INR)	18,200	1400	24000	5900	2,500
Company	Kohler	Jaquar	Jaquar	Verteco	Kohler

Table 28 : Flow rate of fixtures

Water sources : By adopting water-saving hardware such as waterless urinals, low-flow fixtures, and dual flush fixtures, an office building was able to reduce water consumption from 45 LPD/ head as per NBC 2016 guidelines to 19.8 LPD/head, in compliance with . These sustainable solutions provide efficient water usage and significantly minimize the environmental impact of the office building.

Flow restrictors :Flow restrictors enable taps and showers to conserve water without compromising on water flow. This innovative technology adjusts the flow in both high and low-pressure conditions and delivers a consistent voluminous flow

Sensor faucets : Innovative technology used in sensor faucets prevents water wastage by only allowing water to flow when it is required and automatically turning off when not in use.

Dual flush : Only 3/4 litres of water are required for each flush with the dual flushing system, which results in a remarkable 50–60% daily reduction in water use. This system was created specifically to flush effectively and efficiently while preserving water.

Waterless urinals :In addition to helping conserve water, waterless urinals also save a lot of time and money. Waterless urinals do not require routine flush valve repairs, waste line cleanouts, deodorizers or blockage removals, which are expensive and time-consuming maintenance tasks for traditional flush urinals. The waterless fixtures significantly lower the overall cost of ownership and require less time and resources to maintain by doing away with these upkeep requirements.

Water treatment plant : Greywater is reused for irrigation and flushing as part of a sustainable strategy. The Root Zone System thoroughly processes greywater through three stages, recycling the water with a 75% efficiency rate. This method reduces the water treatment plant environmental impact while also maximizing the use of available water resources. The building operates in an eco-friendly and responsible manner as a result of the installation of this system.

Water Tank

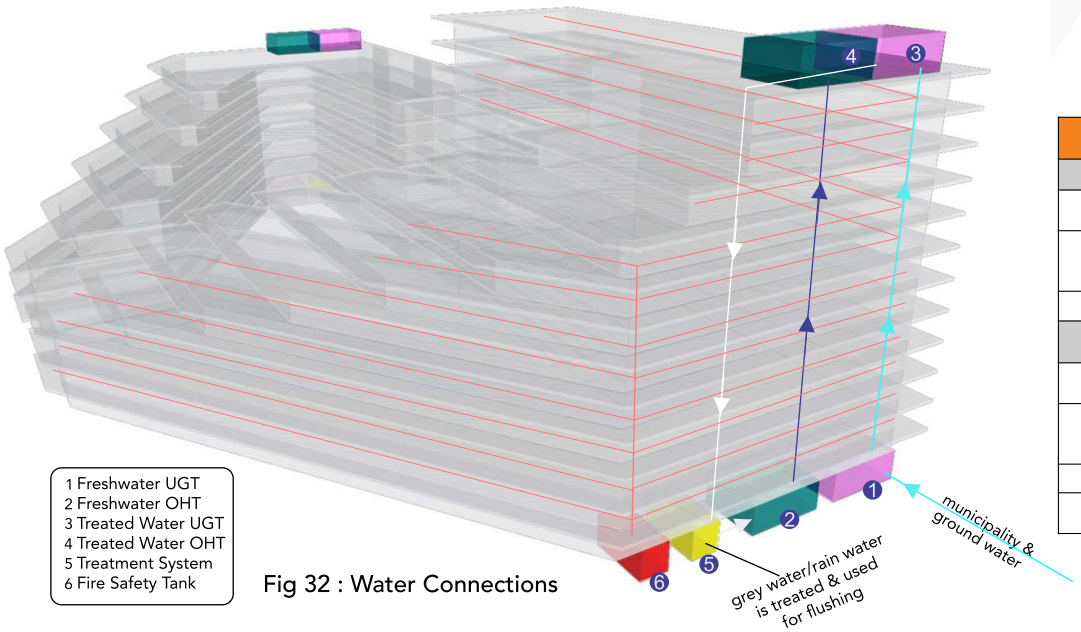


Fig 32 : Water Connections

SL. NO.	TANKS	SIZE (Litres)
UNDERGROUND TANK		**334,741**
1	Fresh water(Municipal + Treated rain water)	74,844
2	Treated Water (Recycled grey-water +Surface runoff rainwater)	59,897
3	Fire water tank	200000
OVERHEAD TANK		**93,160**
1	Fresh water(Municipal + Treated rain water)	23,263
2	Treated Water (Recycled grey-water +Surface runoff rainwater)	49,897
3	Fire water tank	20,000
TOTAL STORAGE REQUIREMENT		**855,802**

Table 29 : Tank Sizing

This diagram shows the placement and location of the water tanks. The tanks are located towards East & West with respect to 2 buildings. This scaled diagram clearly show the size of the tanks in proportion to the building.

Root Zone Treatment

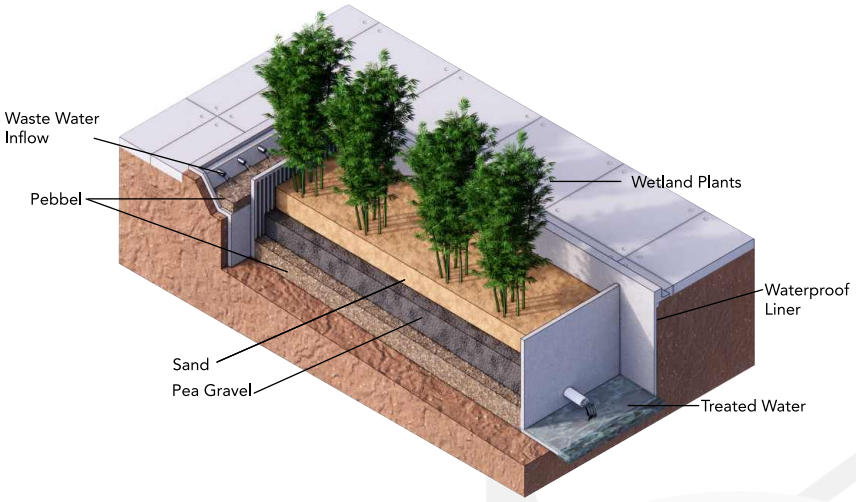


Fig 33 : Planter box irrigation system

We have executed a three phase root zone treatment on site, to treat and recycle water which can be reused further for landscaping, flushing, etc. Grey water is first stored in a pre-settler tank in order to remove all the suspended
solids through sedimentation.The water is then passed into an anaerobic filter to digest any microbial contents.Further, the water is passed into a gravel bed, where the roots of the plants water hyacinth and alligator weed treat it organically, as a last step. The treated water is then collected in a separate tank.

Root Zone Tank

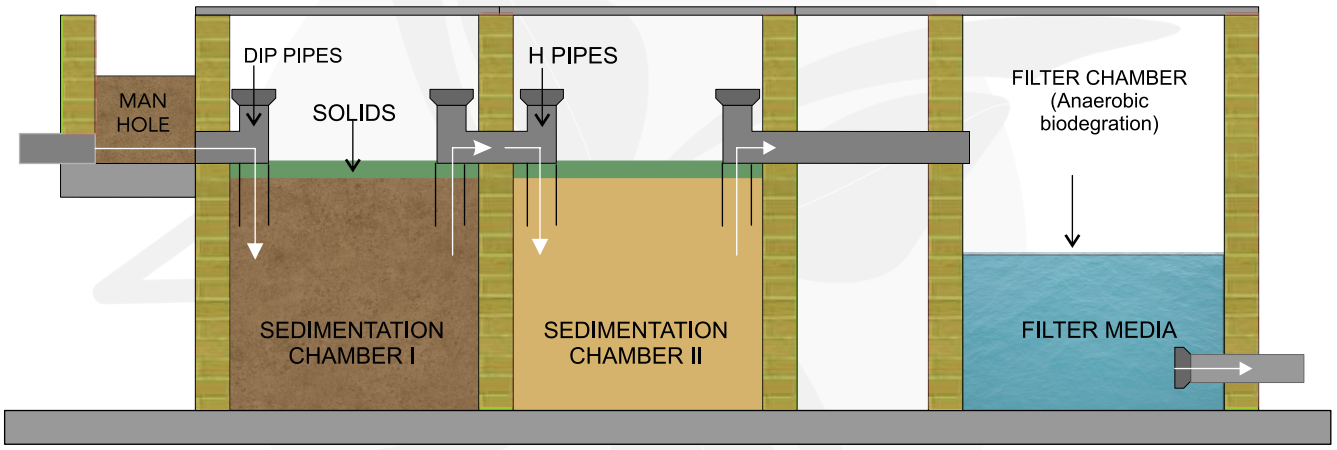


Fig 34 : Sedimentary Tank

Planter Box Irrigation System

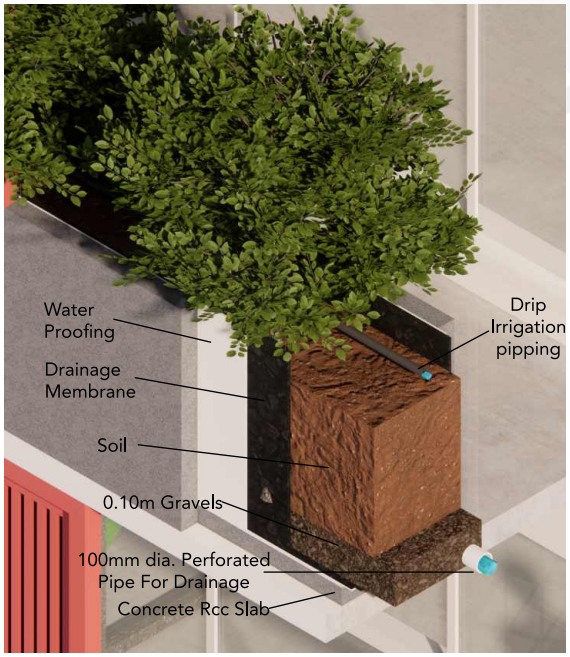


Fig 35 : Root zone treatment

Rain Water Harvesting Tank

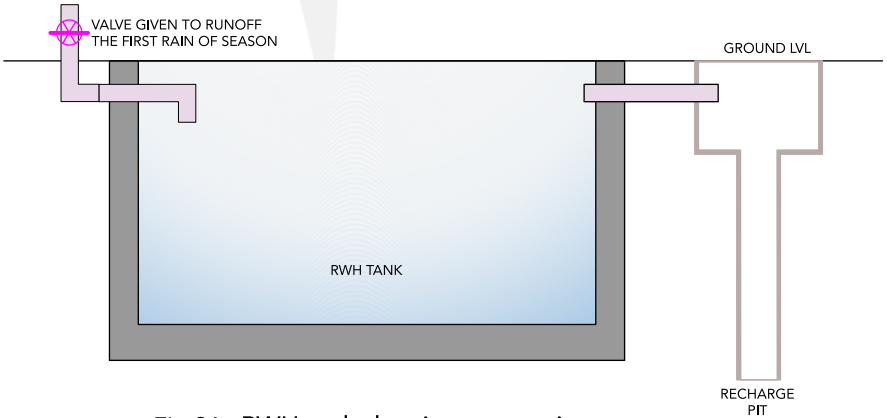
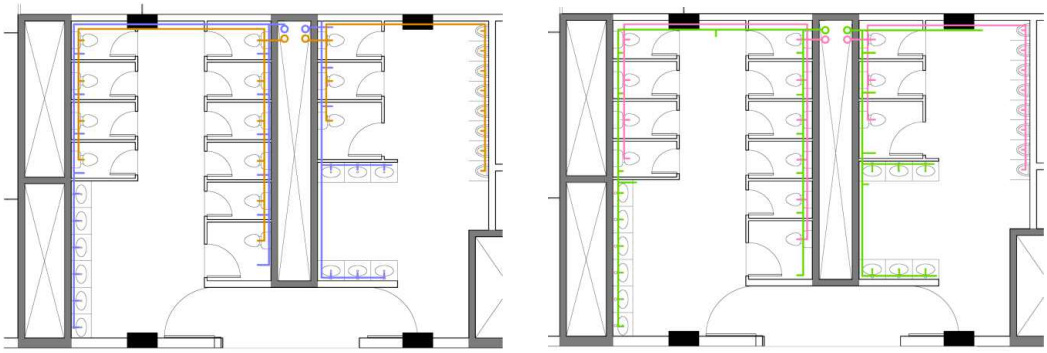


Fig 36 : RWH tank showing connection to recahrge pit

PLUMBING LAYOUT



PIPPING LEGENDS	
32mm dia. FLUSHING WATER SUPPLY PIPE	
25mm dia. DOMESTIC WATER SUPPLY PIPE	
110mm dia. SOIL CARRIER PIPE	
70mm dia. WASTE CARRIER PIPE	

Fig 37 : Plan showing water fixtures

Plumbing System: he plumbing system has been carefully designed to maximize water efficiency throughout its cycle and minimize any potential losses. The diagram below includes a thorough plumbing single-line diagram (SLD) to help the reader understand the plumbing system's operation.

EMBODIED CARBON

The embodied carbon in the proposed design has been decreased to **1934** kg Co_2e from the baseline case, which had an embodied carbon of **2110 kg** Co_2e, resulting in an **8.3%** reduction.

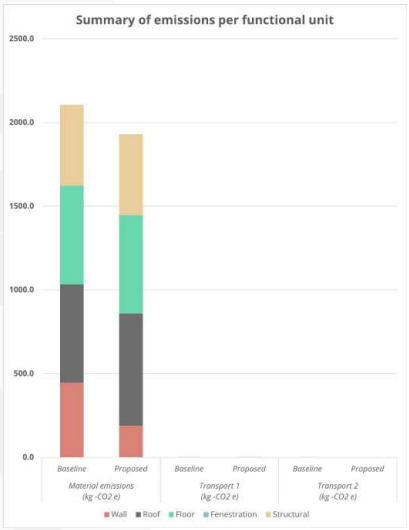


Table 30 : Embodied Carbon

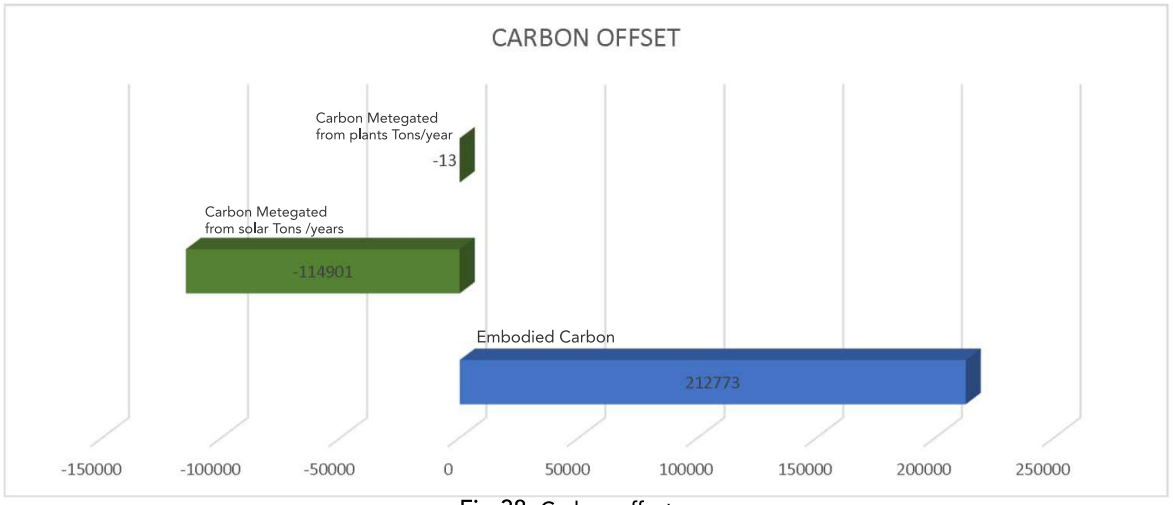


Fig 38 :Carbon offset

In just two years, the carbon emissions that are generated from constructing a building can be offset by the carbon captured through solar power generation and plants, resulting in carbon neutrality.

Over its lifetime, the installation of the solar plant will have the equivalent carbon sequestration effect as planting 181,618 teak trees.

ENGINEERING OPERATION

ETABS used for structural analysis

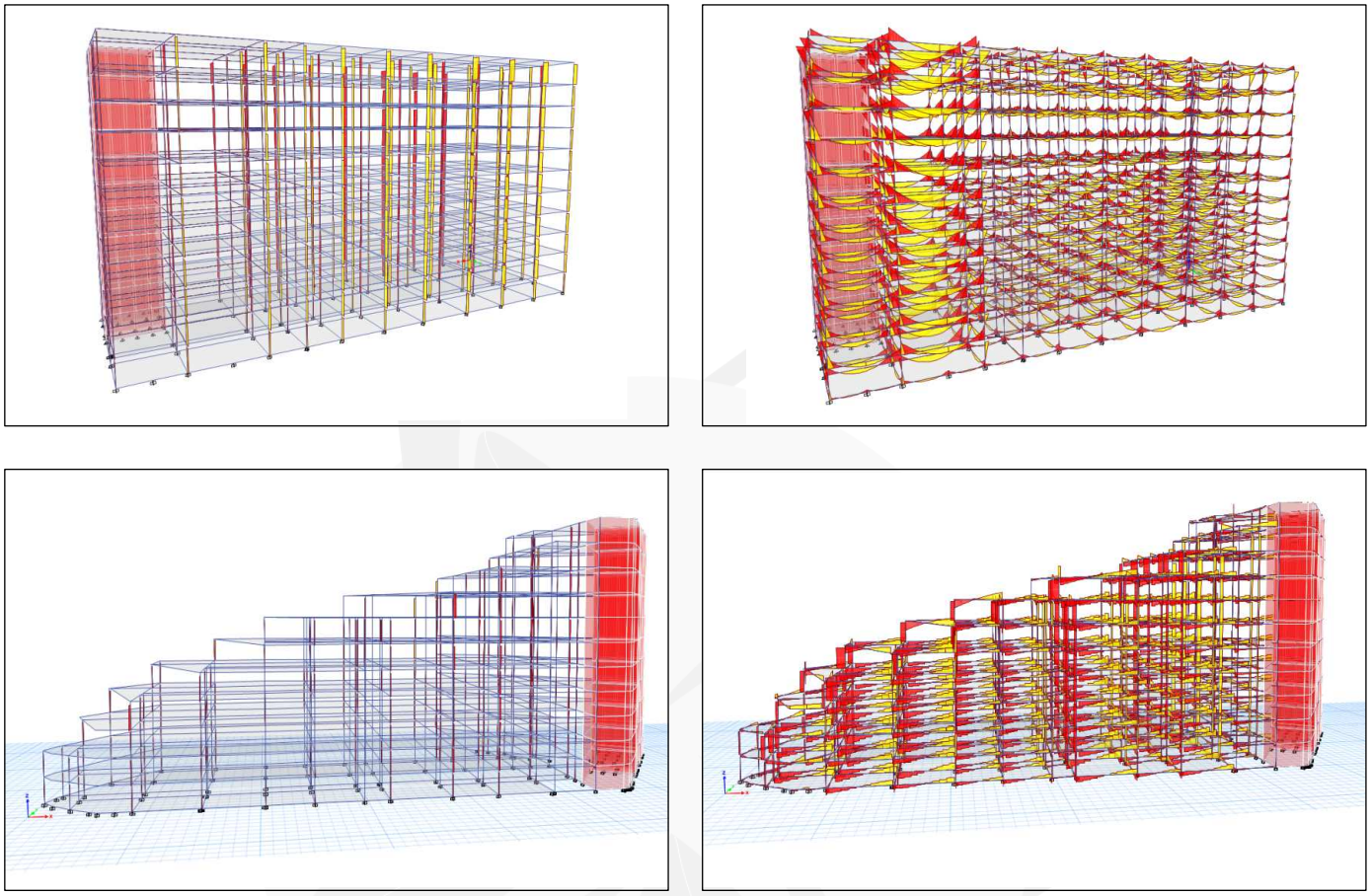


Fig 39 : Bending Moment analyses of Structural Beams and Columns (etabs)

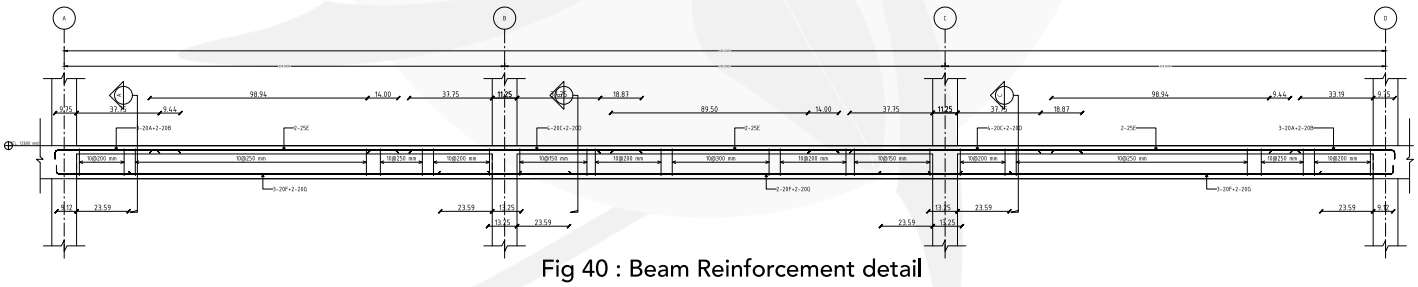


Fig 40 : Beam Reinforcement detail

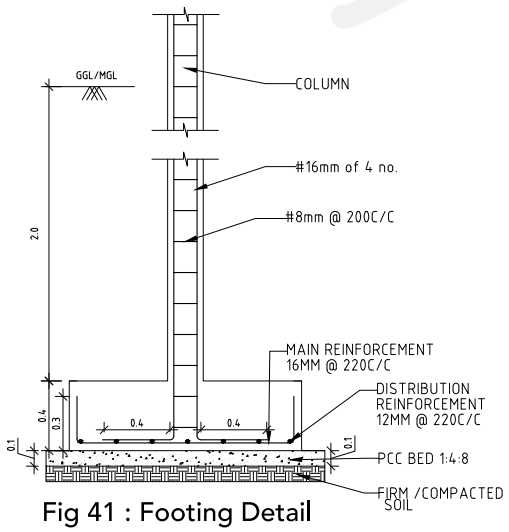


Fig 41 : Footing Detail

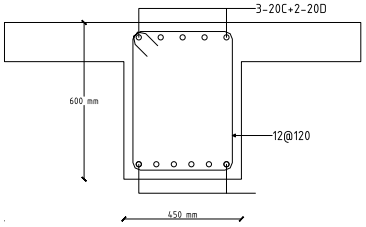


Fig 42 : Beam Reinforcement detail

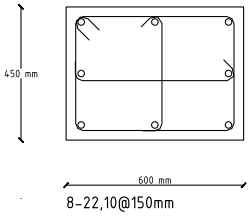


Fig 43 : Column Reinforcement detail

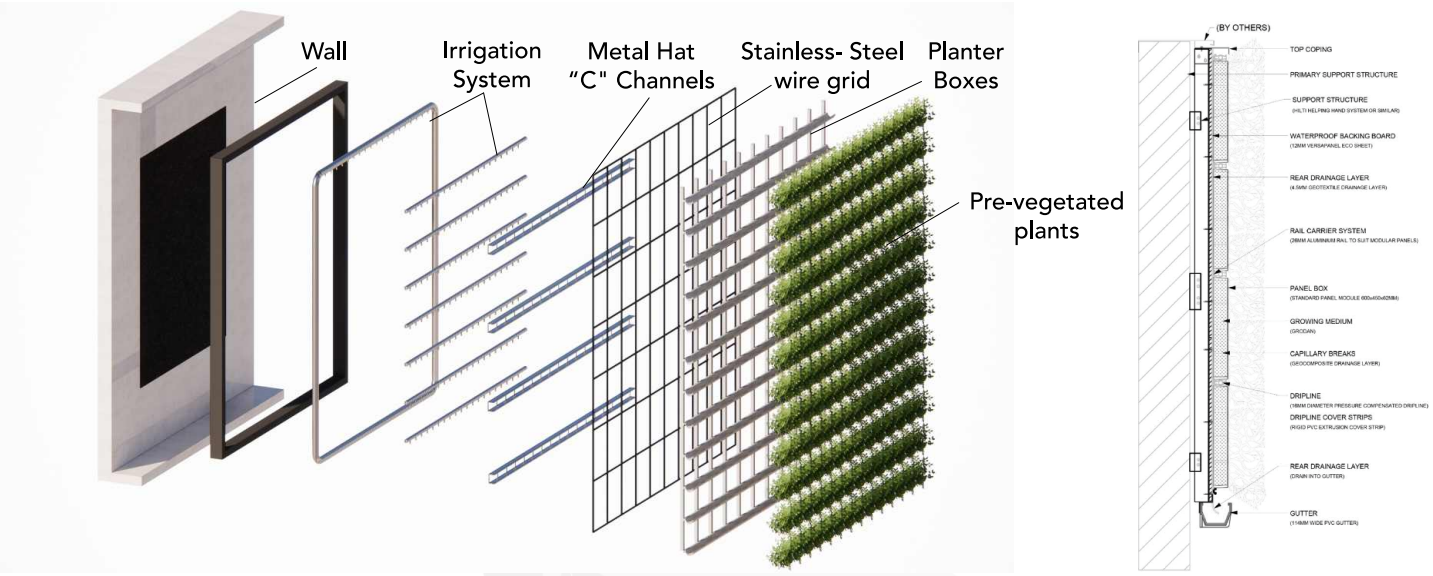


Fig 44 : Exploded view of green wall

Fig 45 : East elevation with green wall

The east wall is has 2 Bio-wall. The Bio wall hosts a variety of plant species such as Foxtail Fern, Mondo Grass, Lilyturf. with a Total of 36,000 Plants. The Size of Bio-wall is 36m high and 22m wide and 50m high and 3 m wide Respectively.it not only provides insulation to keep the internal temperature of the building consistent but also provides s soothing, serene appeal to onlooker. The wall is automated and moniteredwith natural air purification and humidification systems.it is supported by a water saving drip irrigation system to keep the wall rejuvenated and alive.

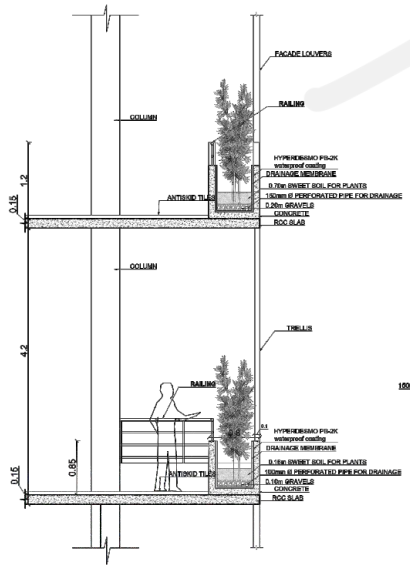


Fig 46 : Balcony details

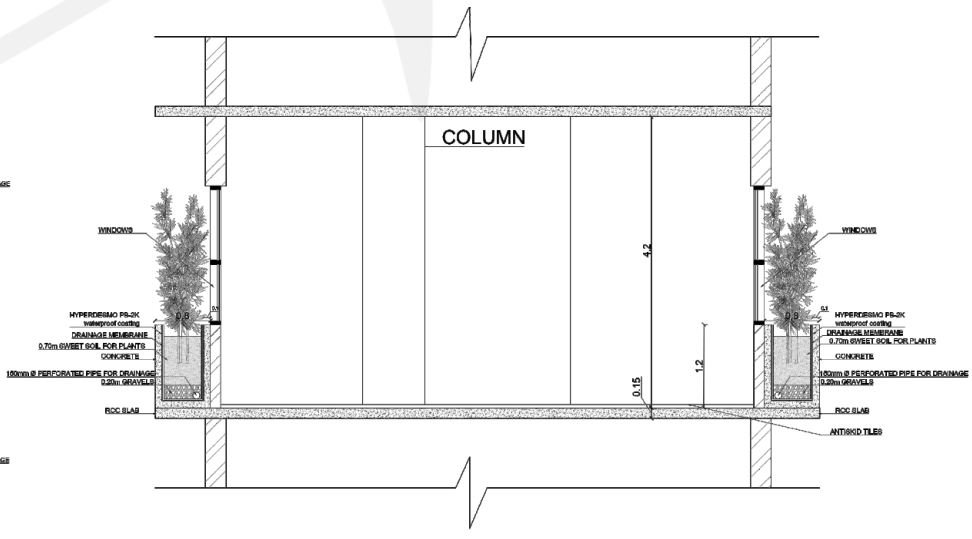


Fig 47 : Bridge details

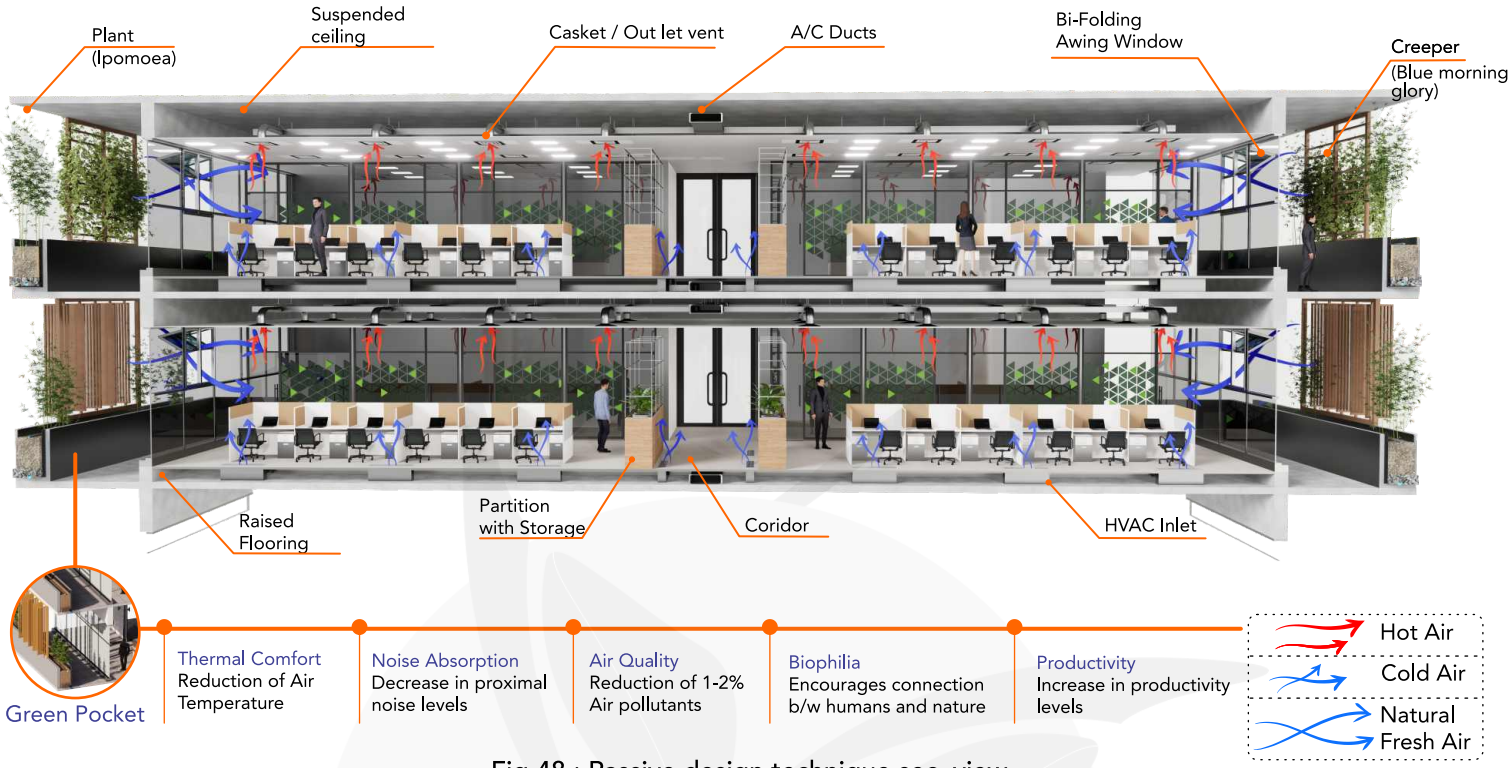


Fig 48 : Passive design technique sec. view

Orientation: The building is designed to face the direction of the prevailing wind in order to optimize its ventilation and ensure the maximum flow of fresh air throughout the structure

Building Shape: The ratio of surface area to volume is raised by using a slender building shape in the design, which aids in the structure's natural ventilation. This strategy encourages the stack effect and cross ventilation, improving airflow and fostering a more cosy and healthier interior atmosphere.

Operable Windows: The building's facade is designed to incorporate operable windows which is adjustable to regulate the flow of fresh air into the structure. This feature promotes natural ventilation and helps in maintaining a comfortable and healthy indoor environment.

Strategic use of Panels : The building's design includes a vertical shading system made of perforated louvre panels to encourage natural ventilation and create a comfortable indoor environment. These panels strategically block glaring sunlight while still allowing the interior of the building to be filled with fresh air and ambient light.
Green pocket: Green pockets and buffer zones are thoughtfully integrated next to the office space, creating a relaxing environment that promotes good mental health. These green pockets are designed as balcony projections that effectively harness prevailing natural wind air quality and convert warm air into cool breezes, which are then funneled into the building through carefully placed window openings.

Simulation based data backing through design builder analysis shows that the design, positioning of windows and building shape is achieving the Thermal Comfort.

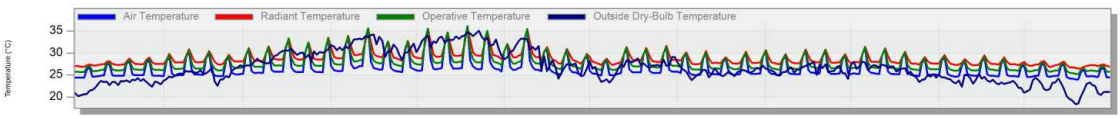


Fig 49 : Temperature Analysis

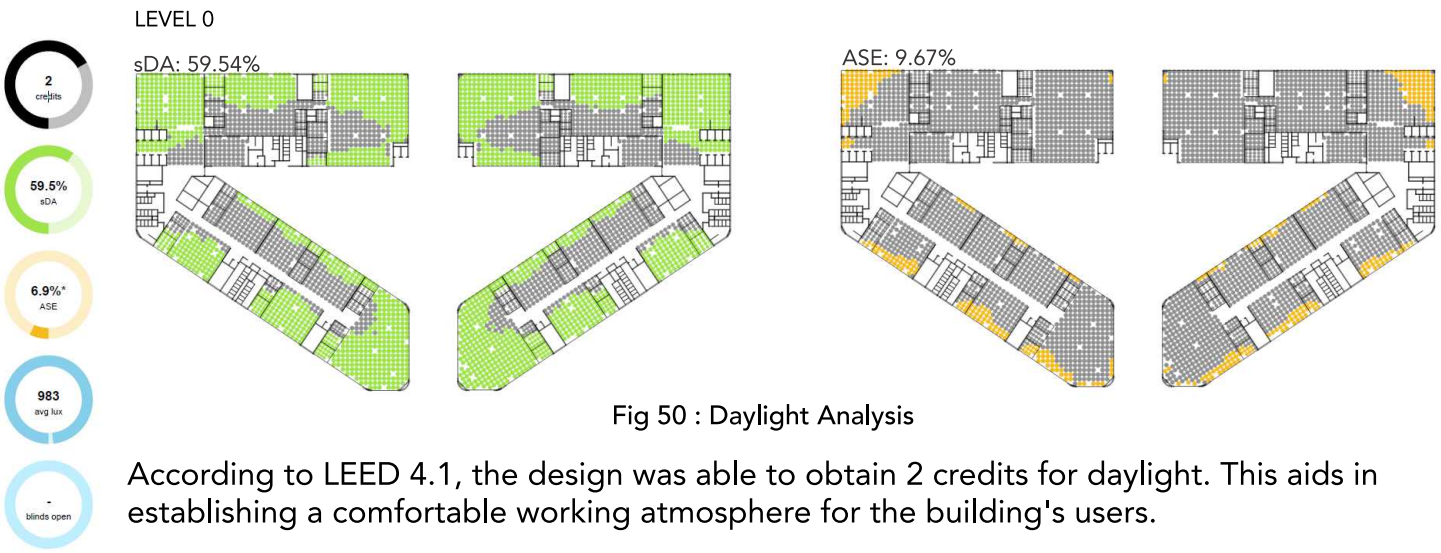


Fig 50 : Daylight Analysis

According to LEED 4.1, the design was able to obtain 2 credits for daylight. This aids in establishing a comfortable working atmosphere for the building's users.

The Balconies (2m wide)in every ODC , with a 0.6-meter planter box which has been provided to serve as buffer spaces, deflecting direct sunlight while still letting in enough of natural light for the building's interiors. A parametric facade system that responds to sun rays is installed on the balconies. This significantly minimizes the building's heat gain, which in turn lowers the usage and energy consumption of HVAC systems.

This plants aid in lowering the amount of outside noise that enters the structure, which in turn lowers interior ambient noise levels.
They also lessen the amount of air pollutants that enter the building—roughly 1% to 2% less. This improves the building's indoor air quality.
With the help of this biophilic design, users are encouraged to connect with nature, which boosts productivity.

RESILIENCE

Fire hazards: Emergency exits have been provided at 30m interval , Refuge area according to NBC and fire rated lifts are provided.

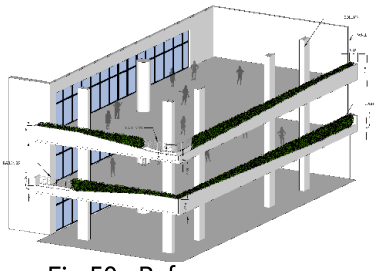
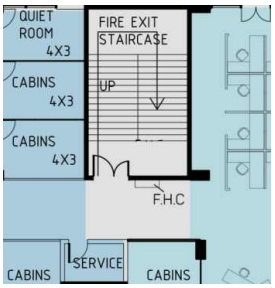


Fig 50 : Refuge area



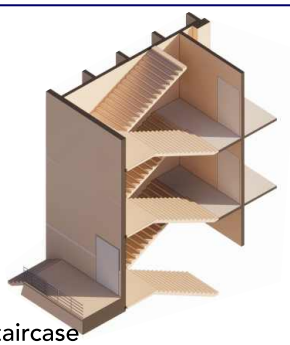


Fig 51 : Fire safety staircase

Sl no.	Fire Protection	brief
1	fire safety staircase	1 per every 30m
2	Fire shaft	4 Fire rated lift and staircase
3	Fire Extinguisher	1 per every 15m
4	Automatic detection and Alarm System	For the entire building
5	Wet Riser	For all the floors
6	Automatic Sprinkler system	For all the floors
7	Underground and overhead water tank	UGT – 2,00,000 litres OHT – 20,000 litres
8	Yard Hydrant	around the perimeter of the building
9	Emergency Lights	exit routes, signals and staircase

Table 31 : Fire Safety Requirements

Grid disruption and blackouts : Solar power backup is provided . Passive design strategies have been taken into consideration to ensure there is ample amount of light and ventilation in case of longer power cuts.

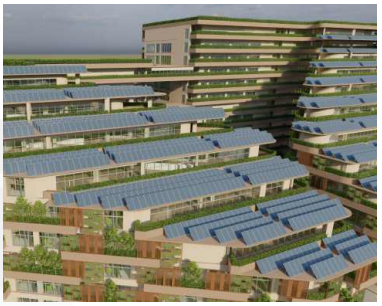


Fig 52 : Rooftop solar panels

Sewage Treatment Plant : Membrane Bio -Reactor system is used which is automated which results in zero discharge

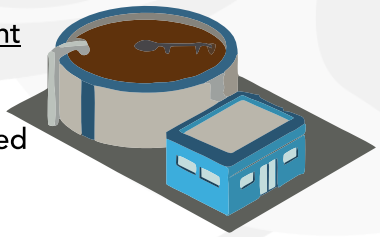


Fig 53 : Sewage treatment

Stability of structure: Structure is designed according to IS 456.

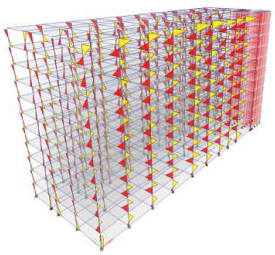


Fig 54 : etabs

Heat waves: low u-value material for construction, balconies with green pockets & perforated panels facade have been provided to ensure reduced heat gain inside the structure.

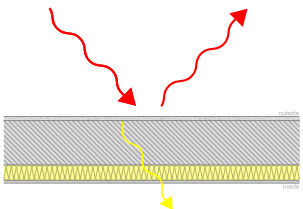


Fig 55 : u-value of material

Social resilience: Breakout and recreational spaces are provided which increase efficiency of the occupant & ensures mental well-being

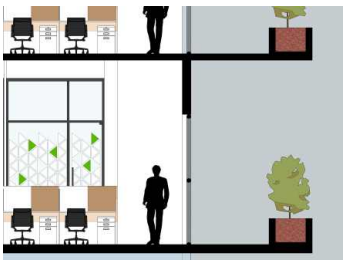


Fig 56 : Section of balcony

INNOVATION

Architectural Inovation | Dynamic facade | Technical Innovation

1)Architectural inovation :

The building's design was intentionally created to emphasize and optimize the southern facade to receive an abundance of daylight. To further harness the potential of this orientation, solar panels have been strategically positioned in this area of the building to effectively capture sunlight.

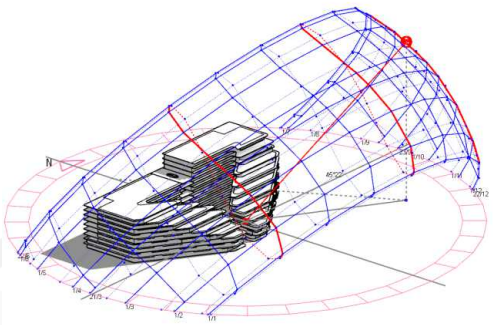


Fig 57 : 3d sun path diagram

2) Dynamic facade :

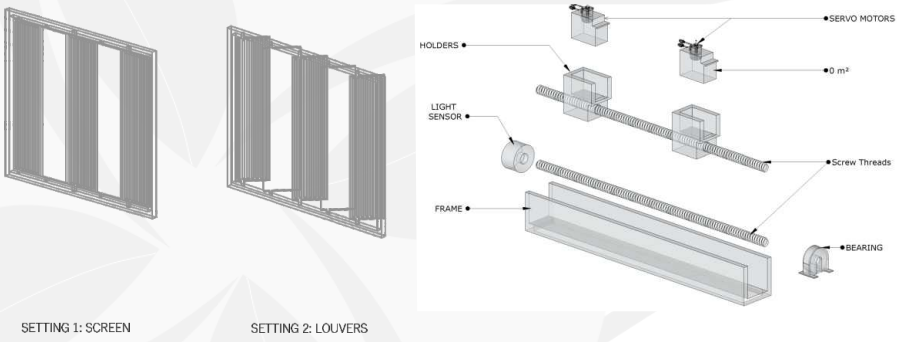


Fig 58 : Details of parametric facade

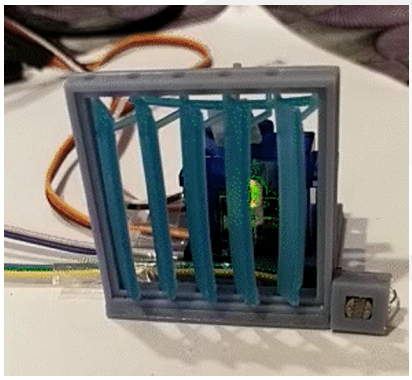


Fig 59 : Prototype

The building's Parametric facade is an example of responsive parametric design that utilizes sensors to detect the direction and intensity of light and rotate accordingly. This prevents direct sunlight from entering the building's interiors, which lowers heat gain and improves thermal comfort.

The light sensor monitors the intensity of light and adjusts the rotation of the panel to maintain a comfortable level of illumination indoors

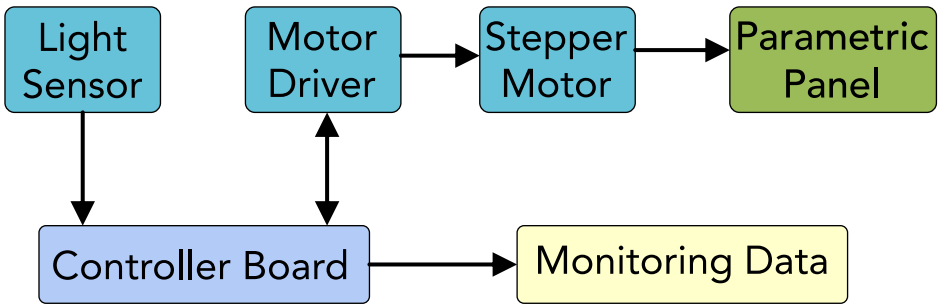


Fig 60 : Flow chart

Scan To Watch Prototype

HARDWARES

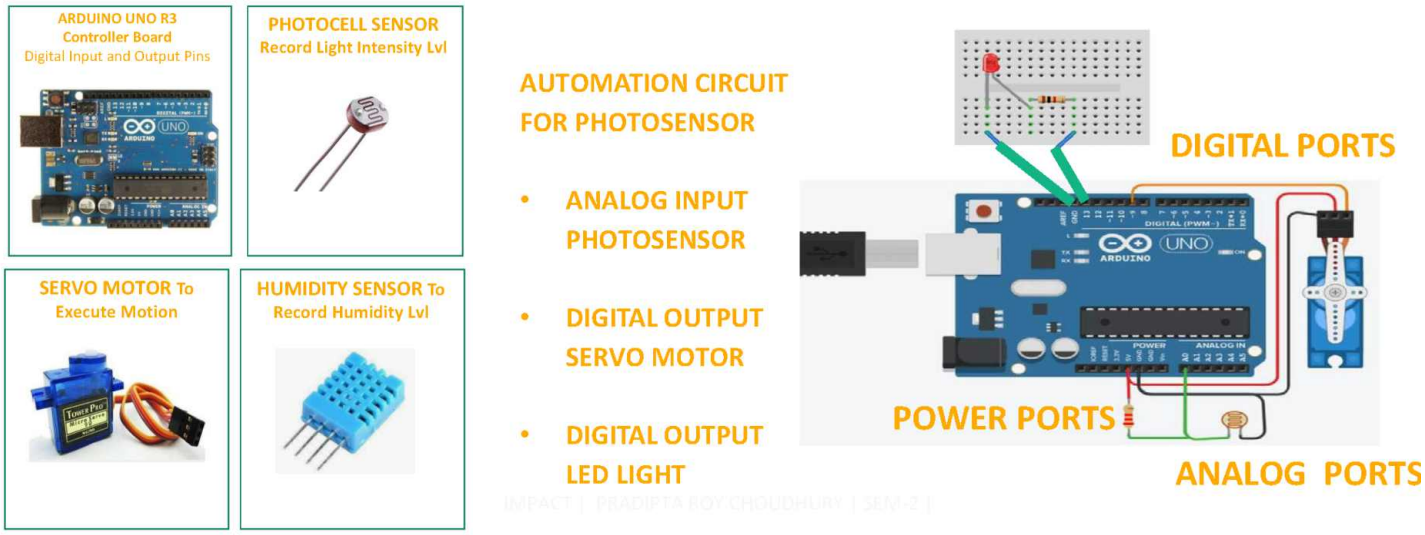


Fig 61 : Arduino circuit

3)Technical Innovation :

INFO ONE (**I**ntelligent **N**etworks **F**or **O**ffice) is a app developed to Integrate Building Automation, Biometric, well-being & Productivity Through IOT & Ai makes employs to monitor their daily activity stats from their mobile devices allowing building occupants to control and monitor various systems within the building & increasing the productivity.

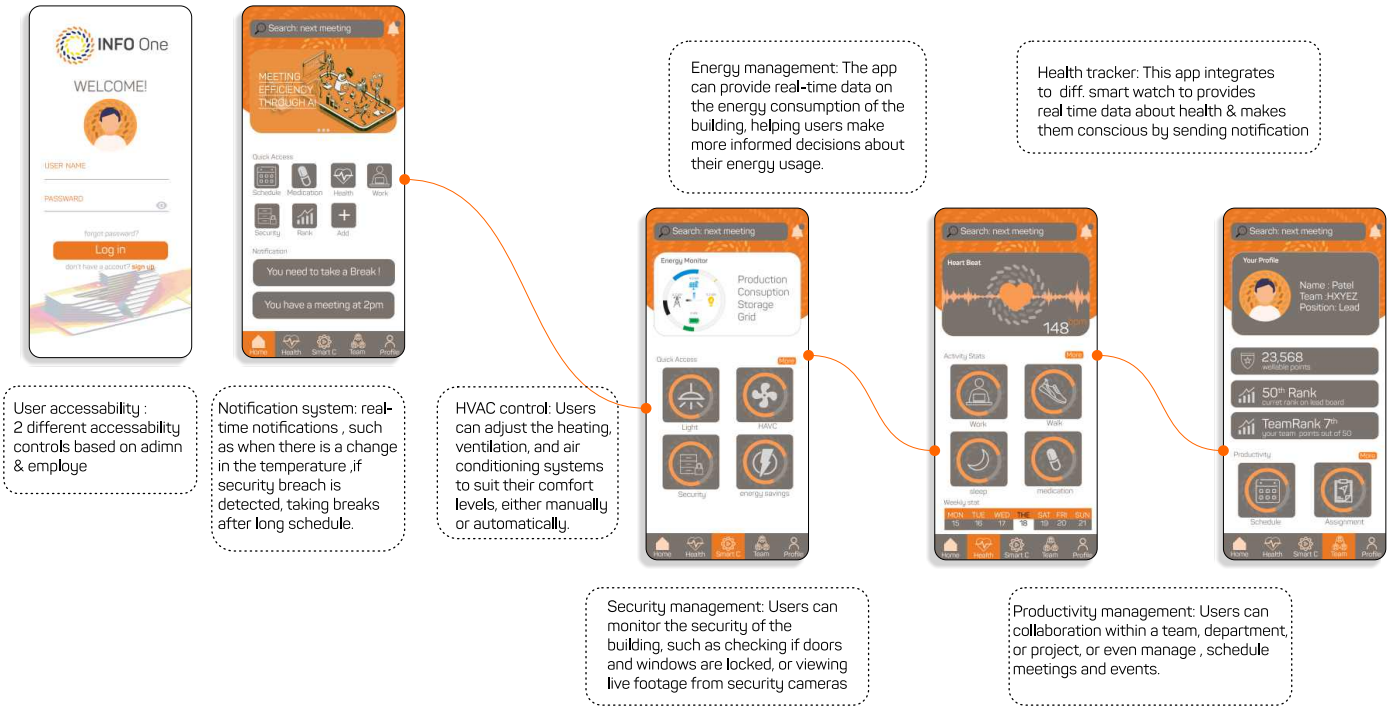


Fig 62 : INFO ONE prototype user interface

MARKET POTENTIAL & SCALABILITY

Many offices & industries requires abundant daylight with minimum to no glare to boost productivity, reduce electricity & HVAC loads. pre-exiting building in areas receiving harsh sunlight have not been optimized to reduce glare and direct sunlight ,which in turn affects the productivity of th employees inside the building.

The facade regulates natural light entering the building to improve productivity & comfort during peak hours. this results in reduced artificial light & HVAC load required during the day which results in reduced electricity bill.

The facade opens and closes according to the intensity of incident light and natural light requirements within the building, there by reducing glare, heat and HVAC loads.

The facade is fully automated with customizable size according to clints requirement, this can easily be installed in newly constructed building as well retrofit to old buildings. Potential market Contractors Developers, Architects, Engineers, Tenants, Investors, similar scale project.

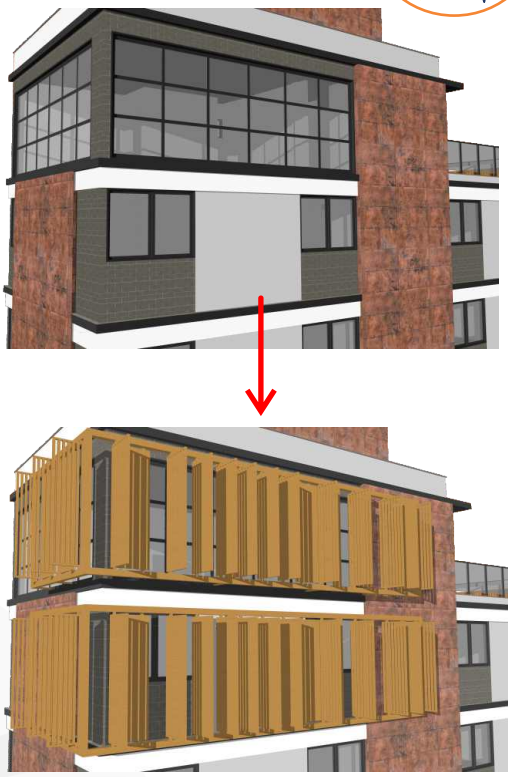


Fig 63 : Innovative panel adaptation

AFFORDABILITY

PROJECT SUMMARY								
S.No.	Particulars	Definition	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
			Amount in Million INR	%	Amount (INR per sqm)	Amount in Million INR	%	Amount (INR per sqm)
1	Land	Cost of land purchased or leased by the Project Partner	-	-	-	100	0	1,055
2	Civil Works	Refer Item A, Civil works in Cost of construction worksheet	615	0	6,494	583	0	6,149
3	Internal Works	Refer Item B, Civil works in Cost of construction worksheet	319	0	3,366	329	0	3,475
4	MEP Services	Refer Item C, Civil works in Cost of construction worksheet	499	0	5,261	669	0	7,061
5	Equipment & Furnishing	Refer Item D, Civil works in Cost of construction worksheet	562	0	5,935	562	0	5,935
6	Landscape & Site Development	Refer Item E, Civil works in Cost of construction worksheet	0	0	4	8	0	86
7	Contingency	Amount added to the total estimate for incidental and miscellaneous expenses.	100	0	1,053	108	0	1,135
	TOTAL HARD COST		2,095	1	22,112	2,359	1	24,896
8	Pre Operative Expenses	Cost of Permits, Licenses, Market research, Advertising etc	10	0	106	10	0	106
9	Consultants	Consultant fees on a typical Project	10	0	106	10	0	106
10	Interest During Construction	Interest paid on loans related to the project during constructi	40	0	422	18	0	188
	TOTAL SOFT COST		60	0	633	38	0	399
	TOTAL PROJECT COST		2,155	1	22,745	2,397	1	25,296

Table 32 : Total project cost

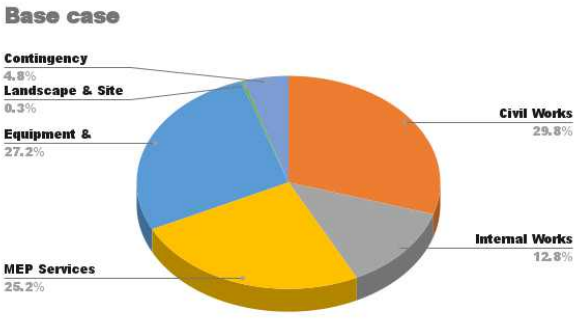


Fig 64 : Base case pie chart

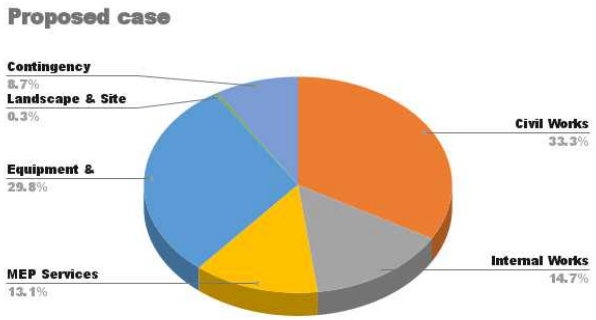


Fig 65 : Proposed case poe chart

The proposed cost of the project is more than the baseline cost, but the total operational cost is lesser than the baseline, this is due to installation of radial cooling, solar panels on roof top and west facade, 5 star rated equipment, increased building performance.

COMMUNICATIONS

EXHIBITION & SOCIAL MEDIA

Fig 66 : Photos of presentation

In addition to creating a net-zero energy building, we, Team Poiesis, also want to educate people about sustainable practice and the idea of net-zero energy buildings. We have exhibited our work to all of our faculty members and college classmates in order to accomplish this.
We have also launched a Team Poiesis Instagram profile, for the public, where we post our updates and other educational posts about our work. We want to convey knowledge about net-zero and green buildings, as well as how better planning and building techniques can benefit both users and the environment.
Due to the fact that it is a professional account, we have access to analytics, public participation, and impressions.

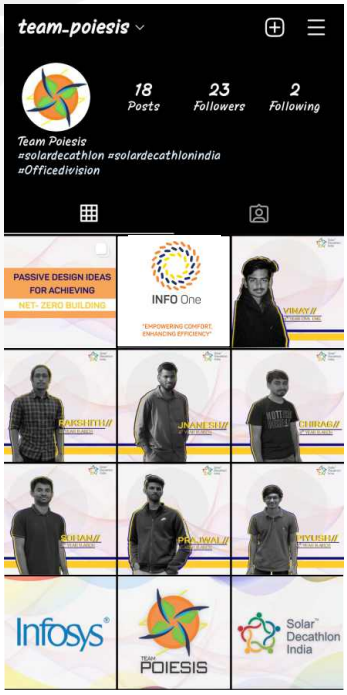


Fig 67 : Instagram page

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APPENDIX

Detailed Building Area Program

ODC DISTRIBUTION							
Description	50 seater ODC		100 seater ODC		200 seater ODC		HVAC Provision
	Capacity	Area	Capacity	Area	Capacity	Area	
WORKSTATION							
Linear Workstations	32	210sq/m	65	470sq/m	130	765sq/m	Mixed
Pinwheel Workstations	7.5		15		30		
Focus Work Desks	5		10		20		
High Work Desks	2		3		6		
Reconfigurable Desks	3		5		10		
INTERACTION SPACE							
BM Cabins	1	12sq/m	2	12sq/m	4	12sq/m	Conditioned
10 Pax Meeting Rooms	-	30sq/m	1	30sq/m	1	30sq/m	
4/6 Pax Discussion Rooms	1	25sq/m	1	25sq/m	2	25sq/m	
Collab Area	4 seats	25sq/m	4 Seats	25sq/m	4-5 Seats	25sq/m	
Quiet Rooms	-	12sq/m	1	12sq/m	2	12sq/m	
VC Room	-	30sq/m	1	30sq/m	1	30sq/m	

ODC Distribution Table

ODC				
Floor	Building	25-50 seat ODC	50–100 seat ODC	150- 200 seat ODC
GL	Building 1	4	2	1
	Building 2	4	2	1
1 Floor	Building 1	4	2	1
	Building 2	4	2	1
2 Floor	Building 1	4	2	1
	Building 2	4	2	1
3 Floor	Building 1	4	2	1
	Building 2	Food Court		
4 Floor	Building 1	4	2	1
	Building 2	4	2	1
5 Floor	Building 1	Food Court		
	Building 2	4	2	1
6 Floor	Building 1	3	1	1
	Building 2	3	1	1
7 Floor	Building 1	3	1	1
	Building 2	3	1	1
8 Floor	Building 1	2	1	1
	Building 2	Food Court		
9 Floor	Building 1	1	1	1
10 Floor	Building 1		1	1
11 Floor	Building 1	Food Court		

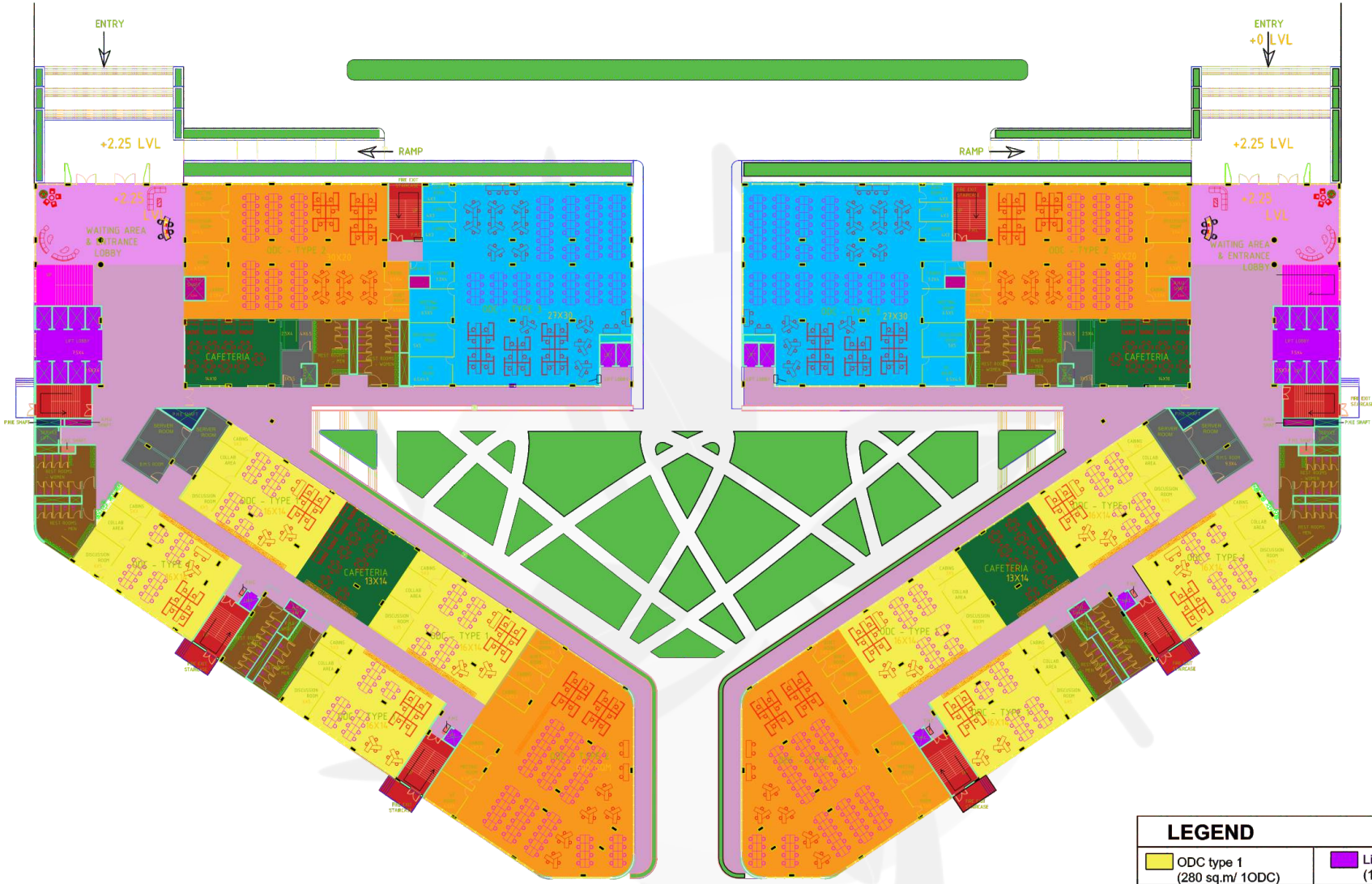
Floor wise ODC Distribution

GN FLOOR PLAN

N

SCALE 1:300
ALL DIMENSION ARE IN METERS

ZONING



LEGEND	
ODC type 1 (280 sq.m/ 1ODC)	Lift lobby (135 sq.m/ 1lobby)
ODC type 2 (630 sq.m/ 1ODC)	Cafeteria (150 sq.m/ 1pantry)
ODC type 3 (930 sq.m / 1ODC)	Service space 156 sq.m/ 1 building)
Fire exit staircase (43 sq.m/ 1staircase)	Entrance lobby 264 sq.m/ 1 building)
Washroom (120sq.m /1w/c block)	Circulation space
Staircase (58 sq.m/ 1staircase)	Green space
FHC Ducts	PHE Shaft

N

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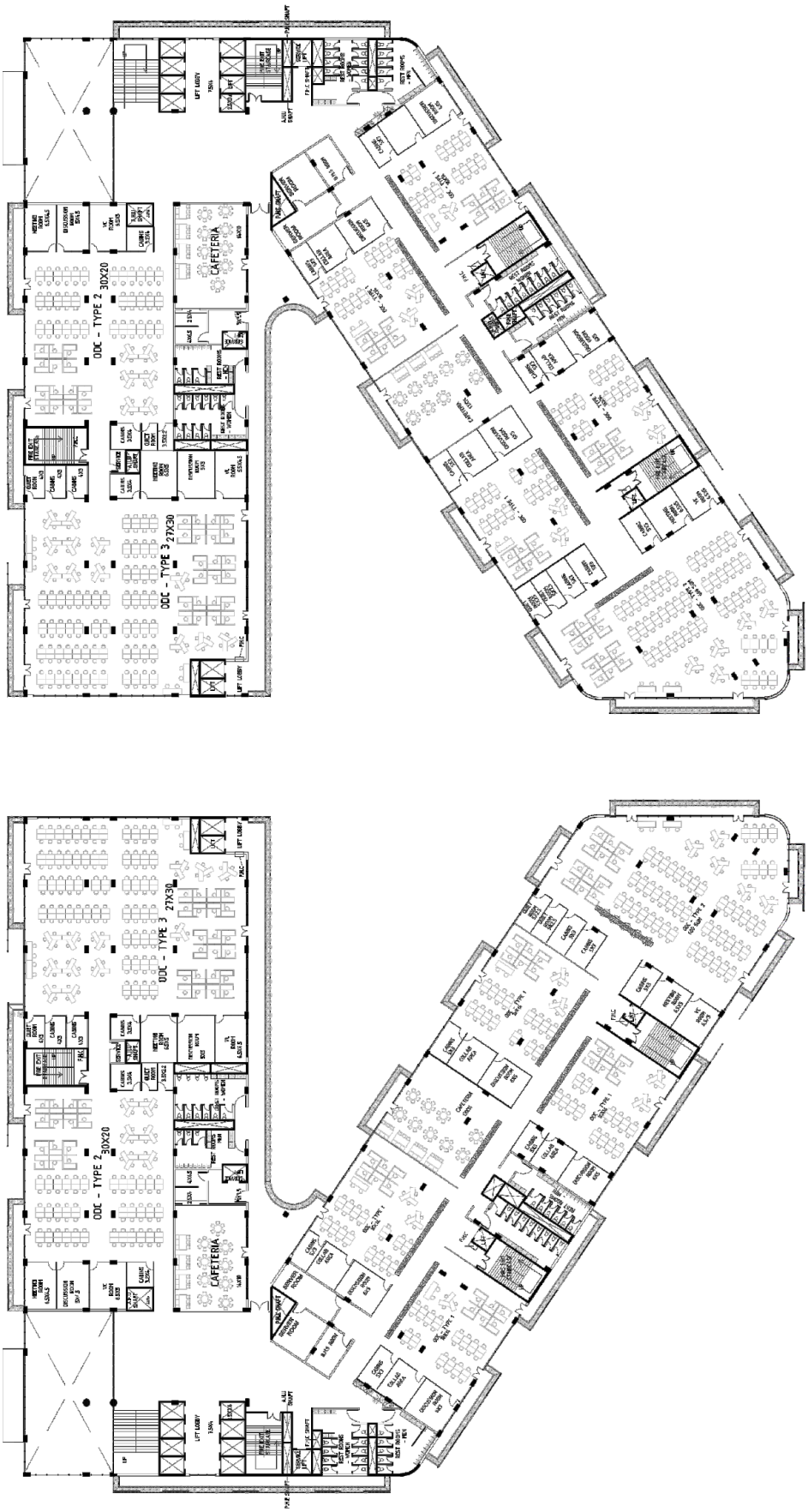
FLOOR PLANS



N

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ALL DIMENSION ARE IN METERS

1st FLOOR PLAN

FLOOR PLANS

N

SCALE 1:300
ALL DIMENSION ARE IN METERS

2nd FLOOR PLAN

SCALE 1:300
ALL DIMENSION ARE IN METERS

3rd FLOOR PLAN

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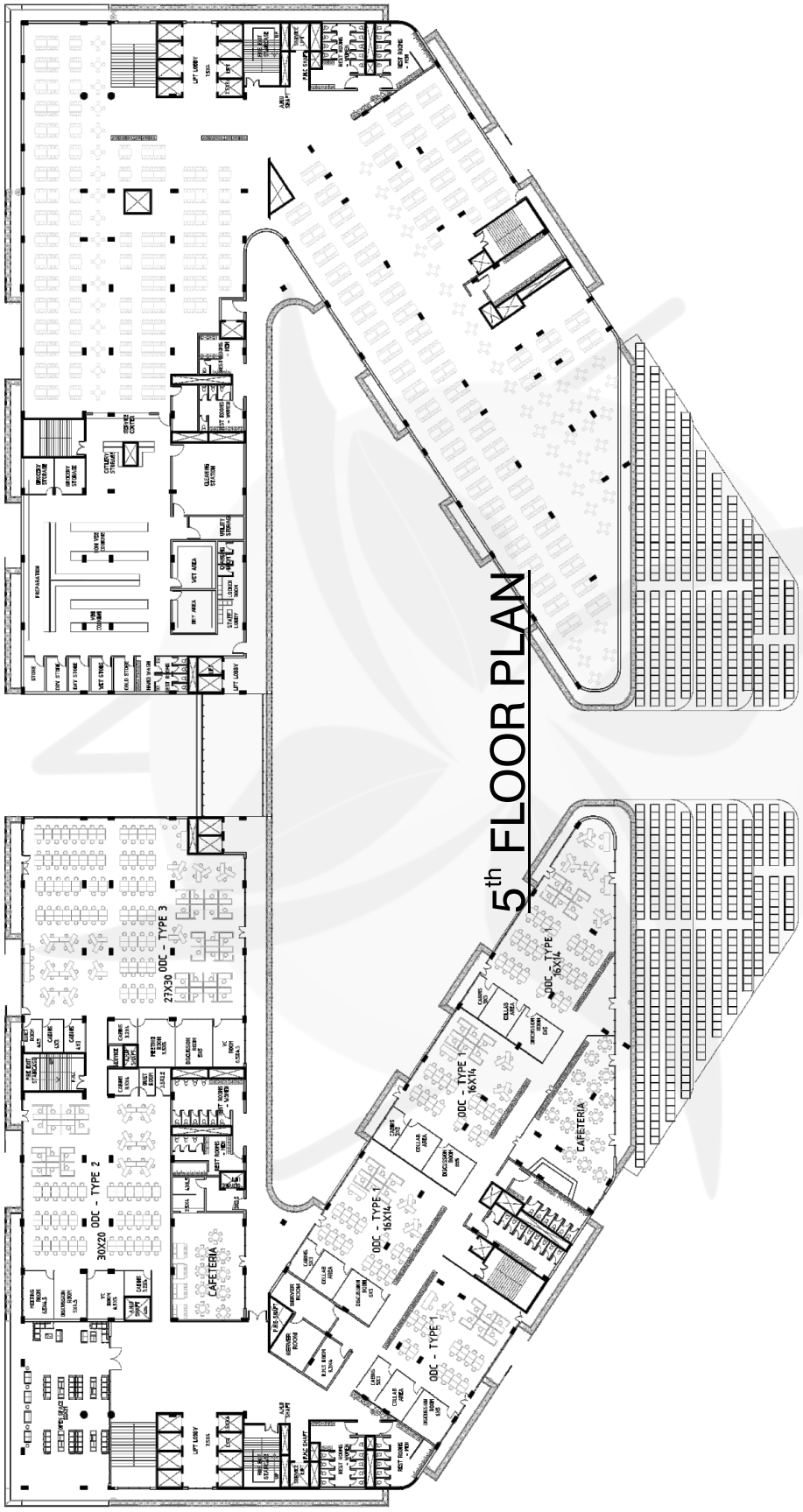
SCALE 1:300
ALL DIMENSION ARE IN METERS

4th FLOOR PLAN

FLOOR PLANS



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SCALE 1:300
ALL DIMENSION ARE IN METERS

6th FLOOR PLAN

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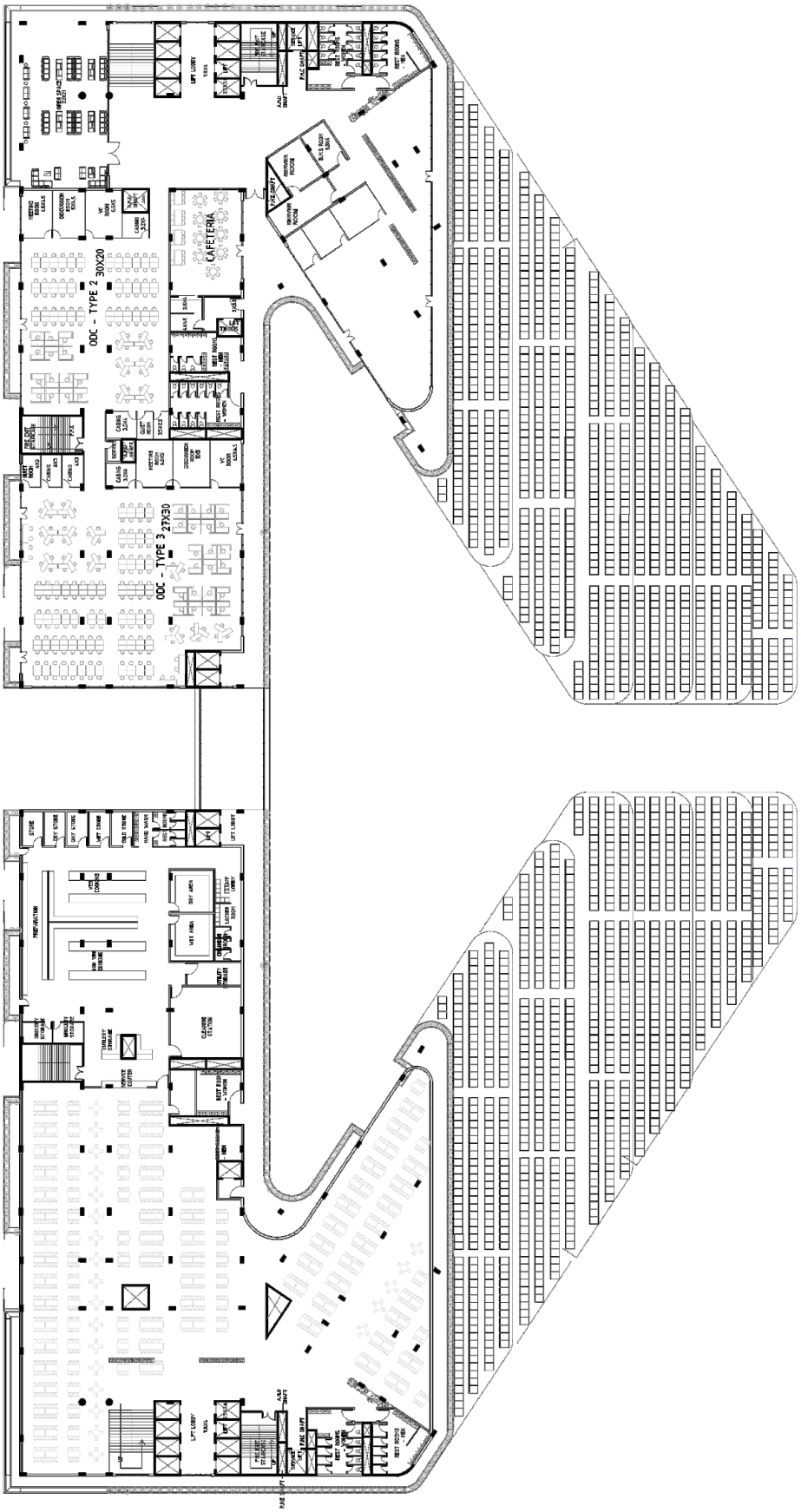
SCALE 1:300
ALL DIMENSION ARE IN METERS

7th FLOOR PLAN



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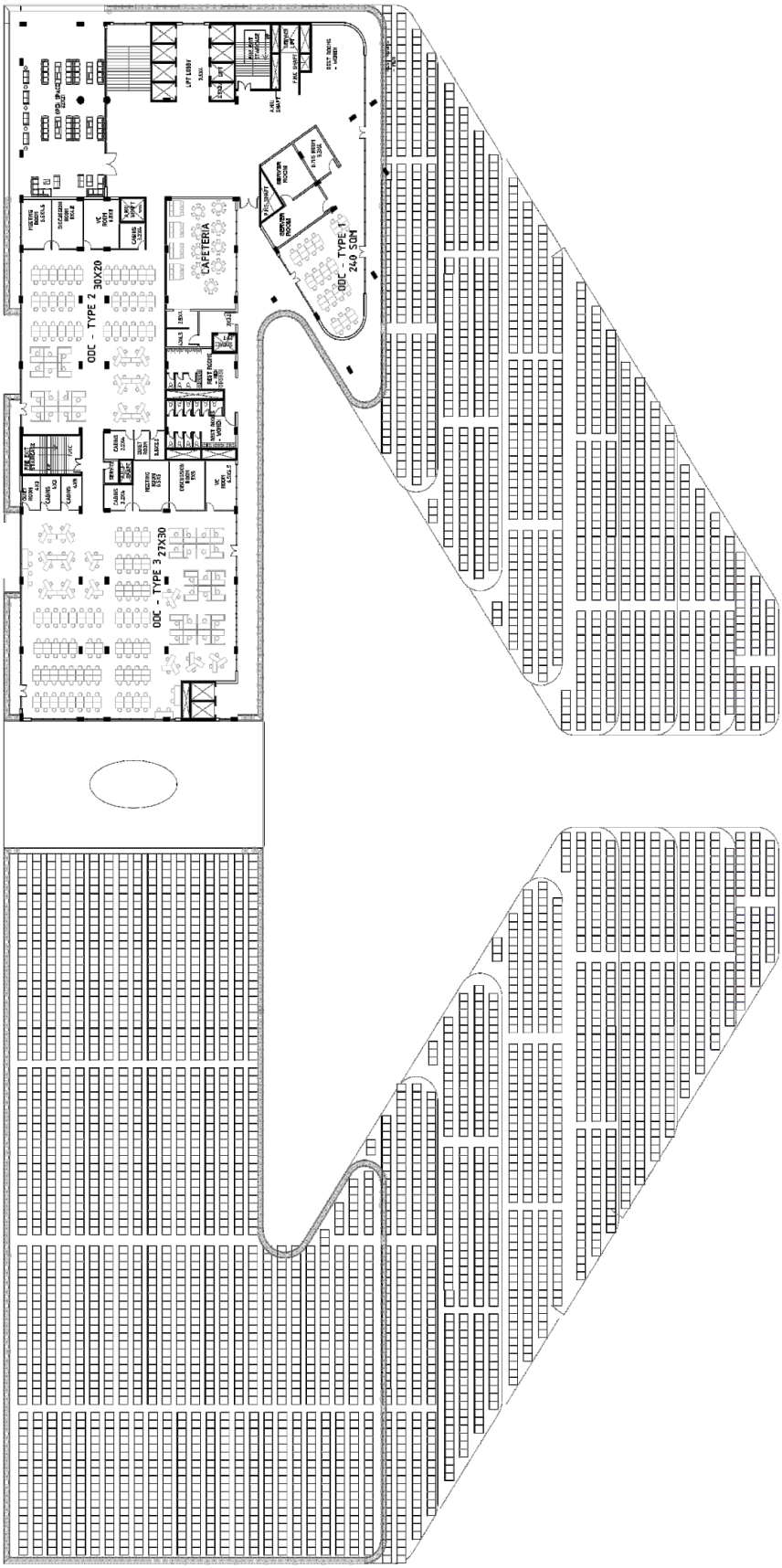
8th FLOOR PLAN



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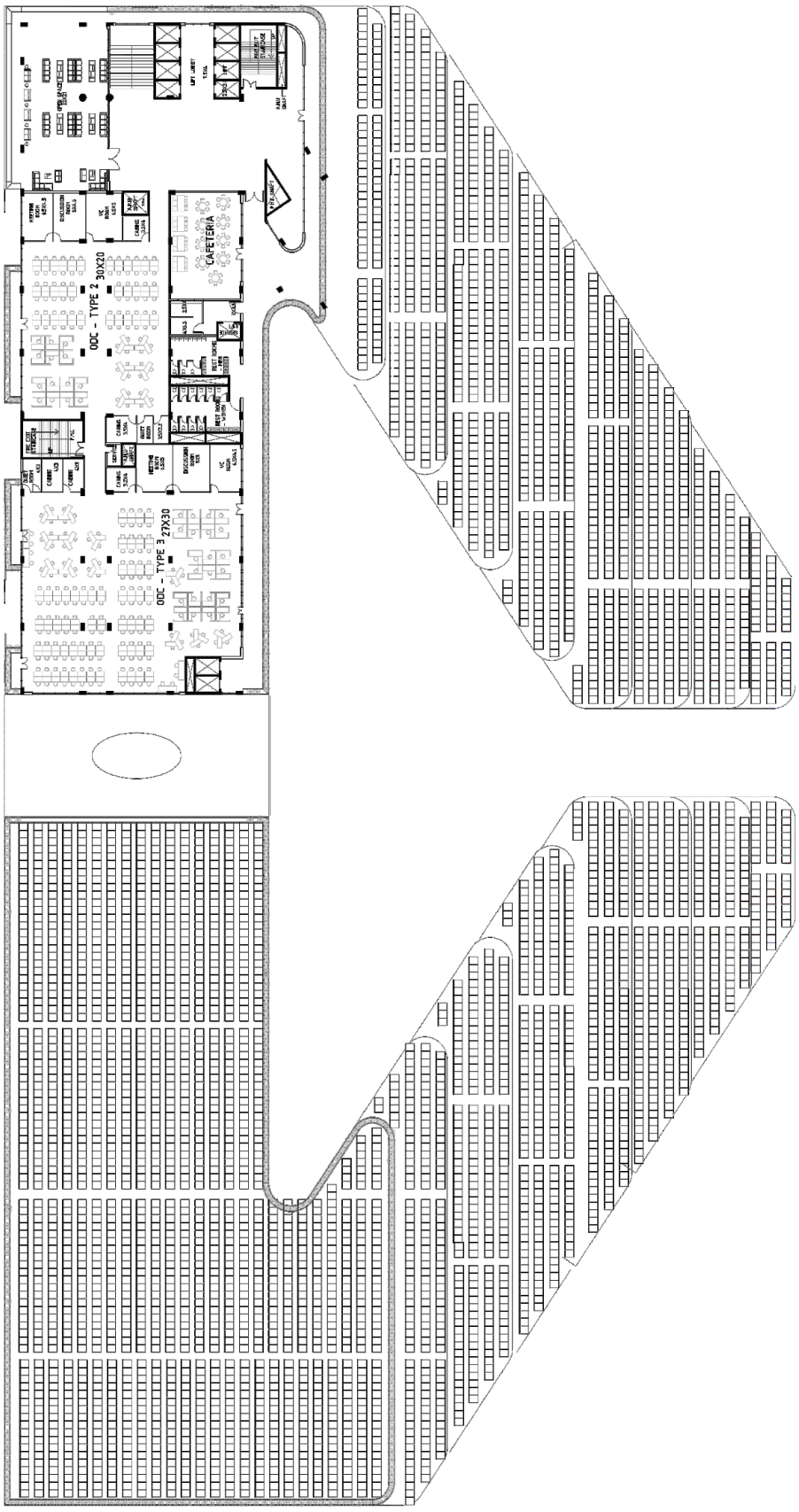
9th FLOOR PLAN



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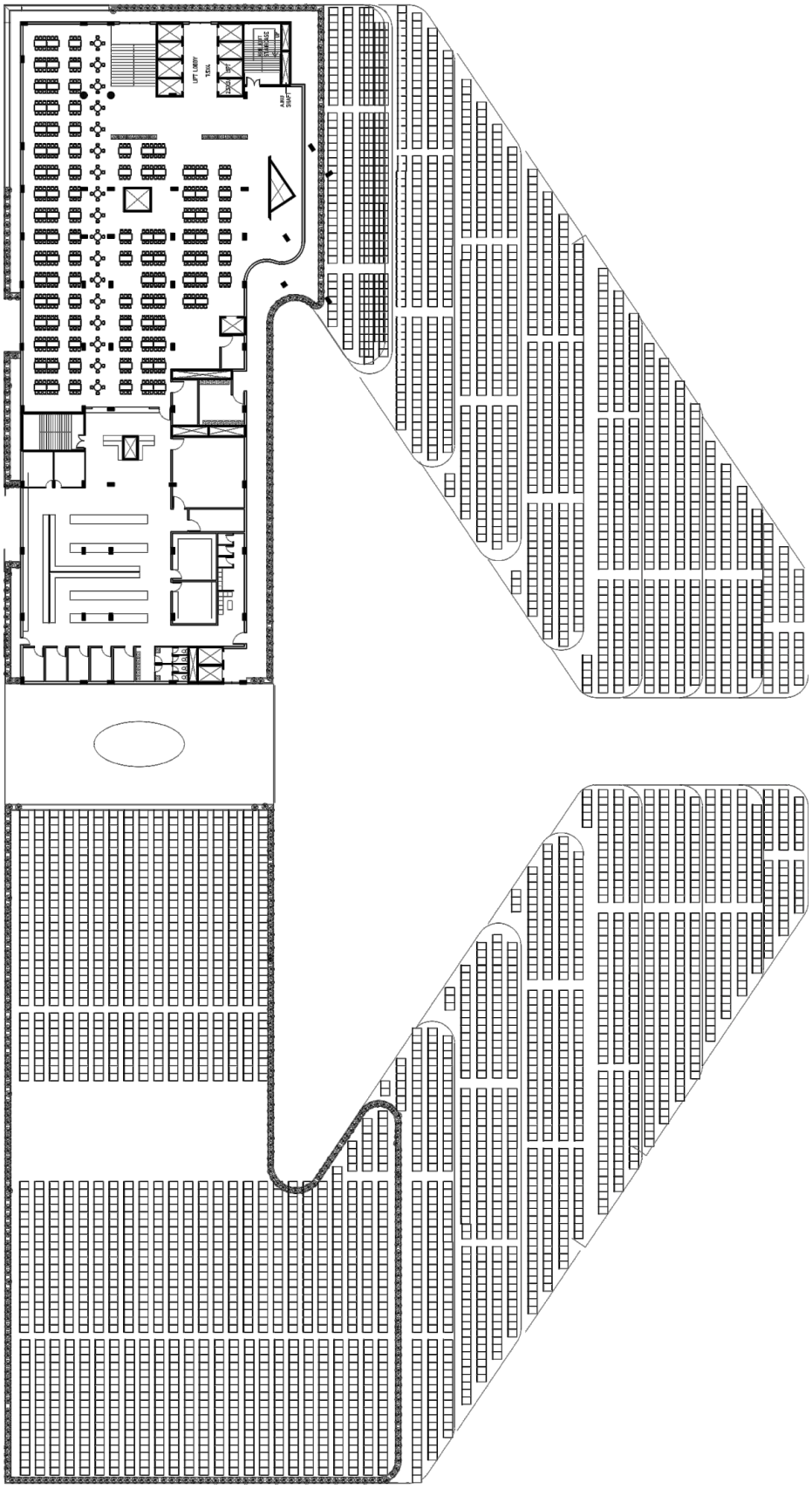
10th FLOOR PLAN



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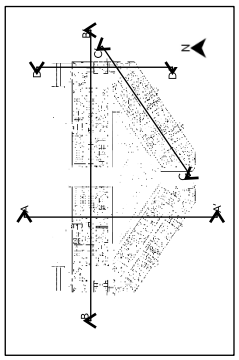
11th FLOOR PLAN

SECTIONS



KEY PLAN

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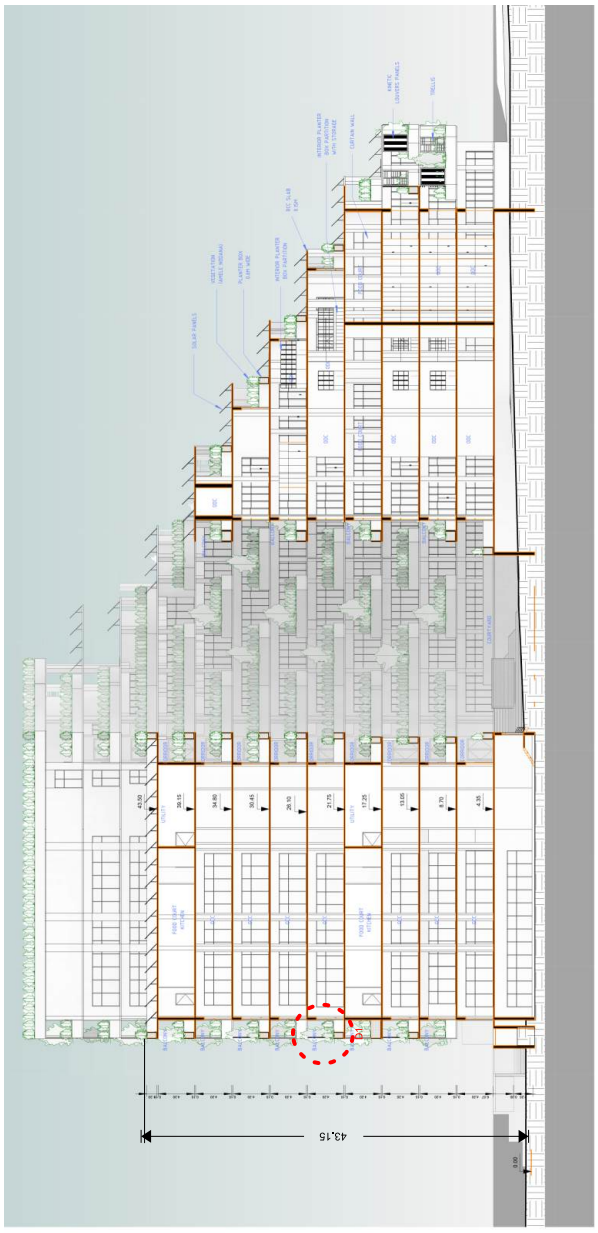

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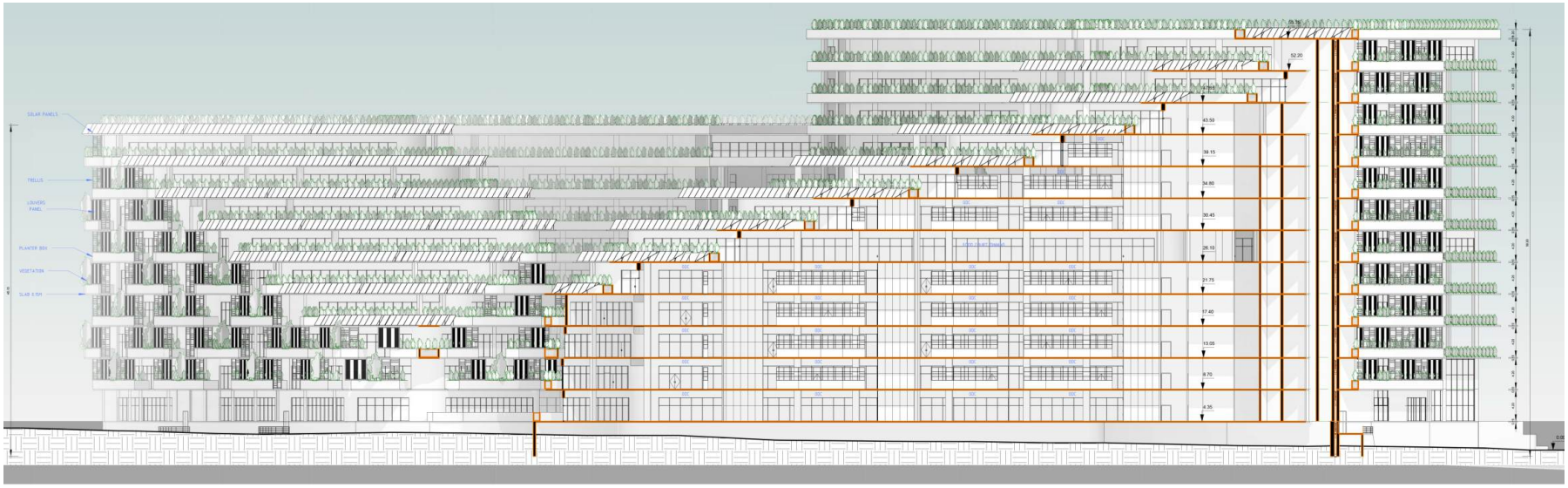
SECTION BB
2 : 300



SECTION CC
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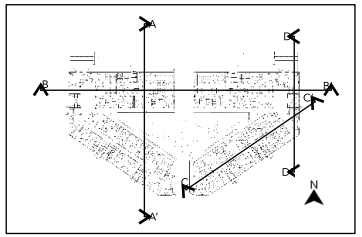
2 SECTION DD
1 : 300



KEY PLAN

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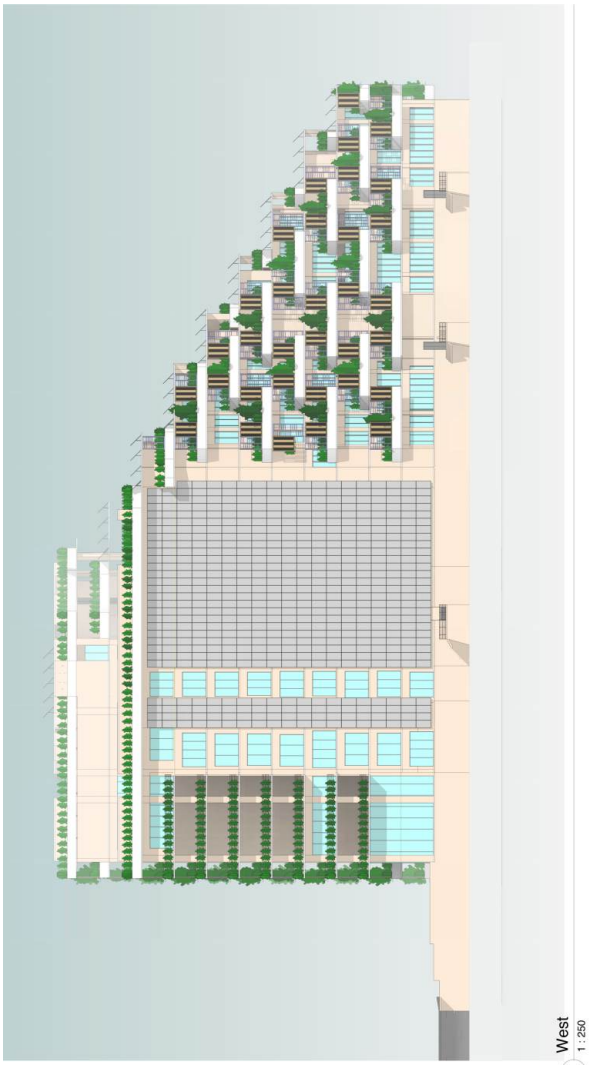
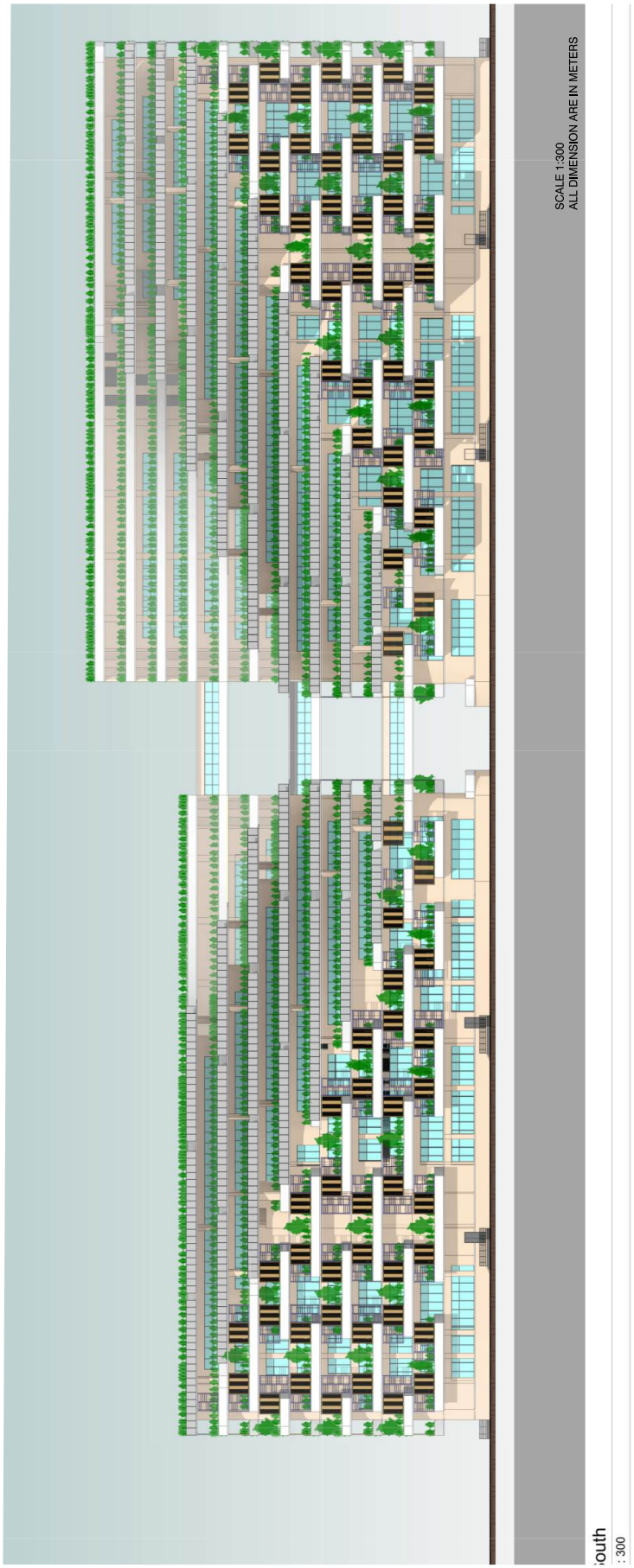
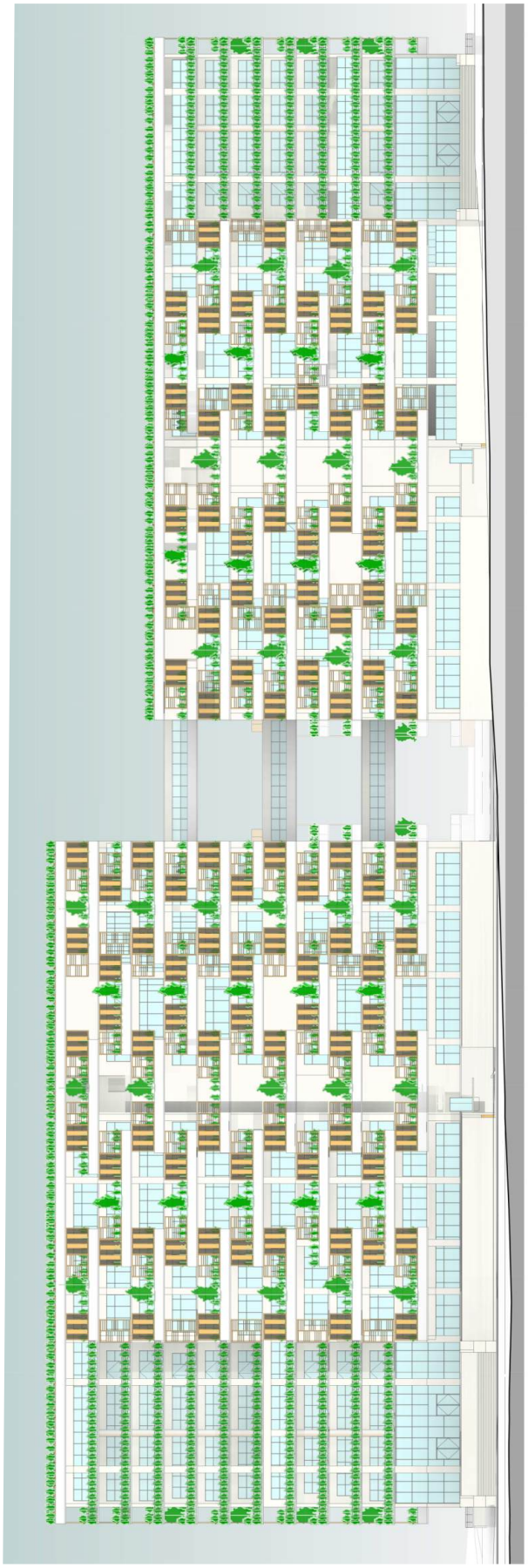
ELEVATION



West
1 1 : 250

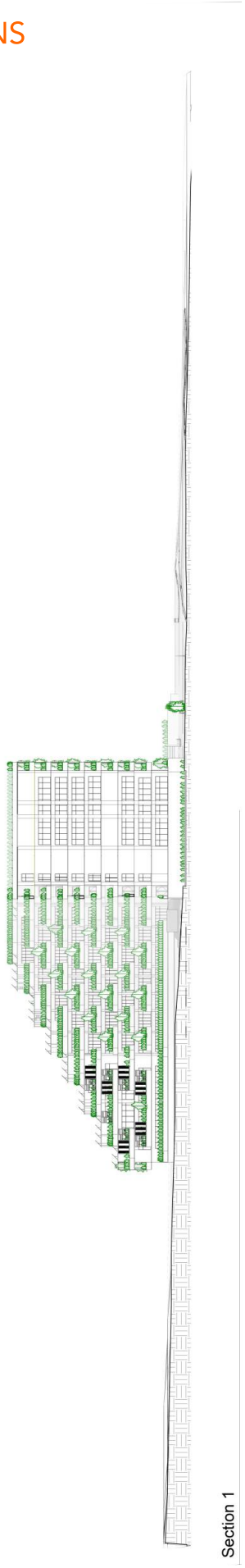


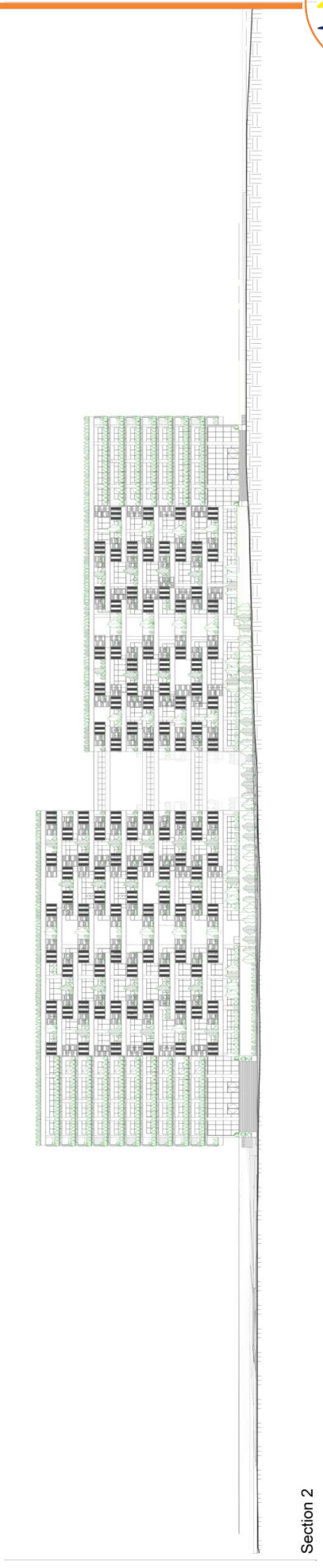
ELEVATION



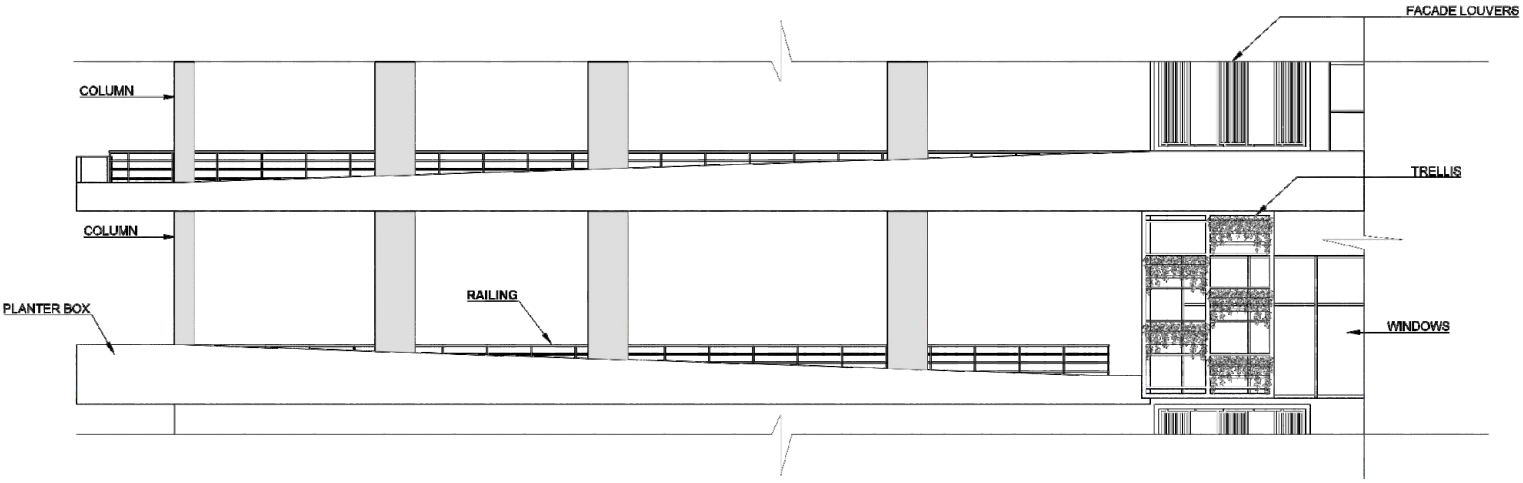
north
1 1 : 300

SITE SECTIONS

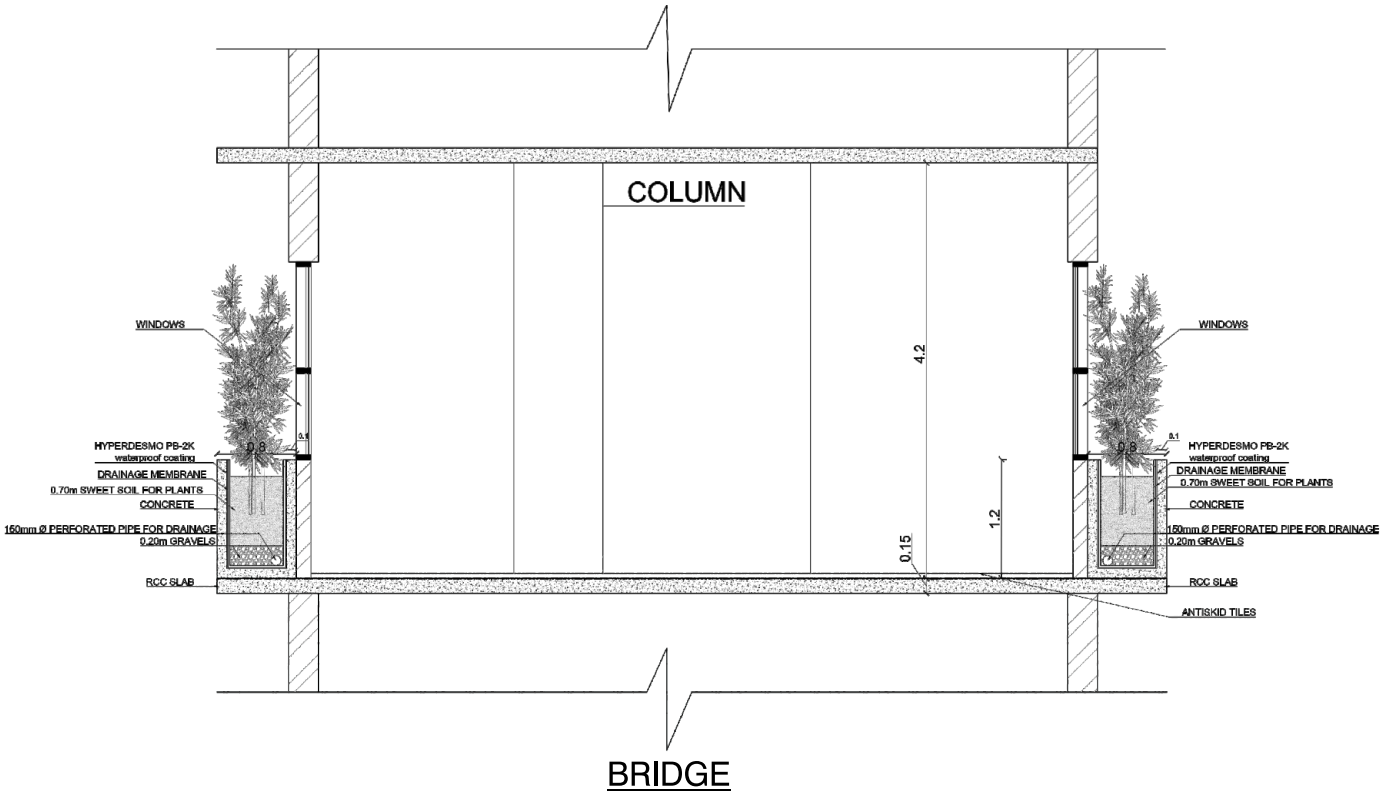




SITE SECTIONS

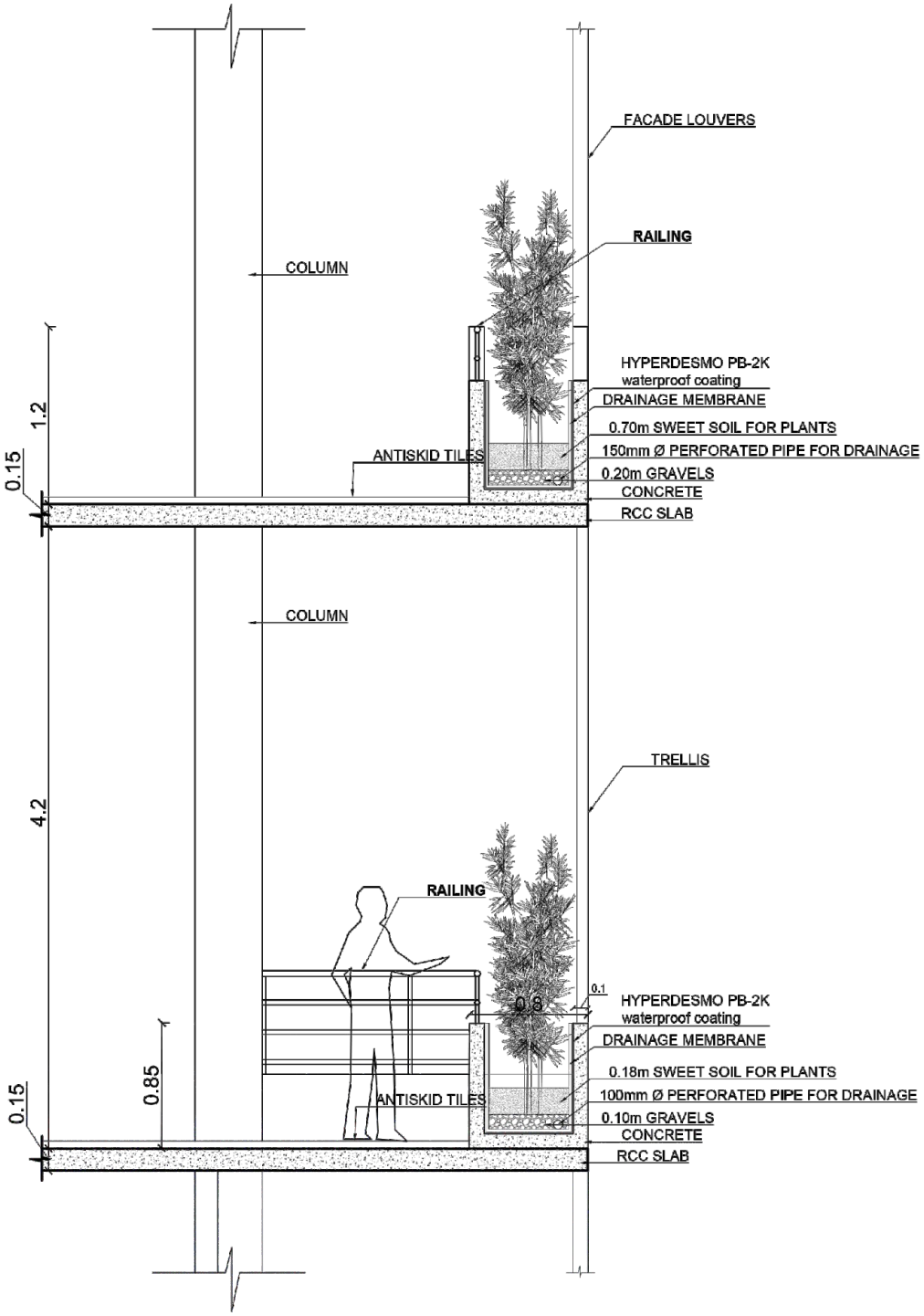


SECTION @ D2
SCALE 1:75



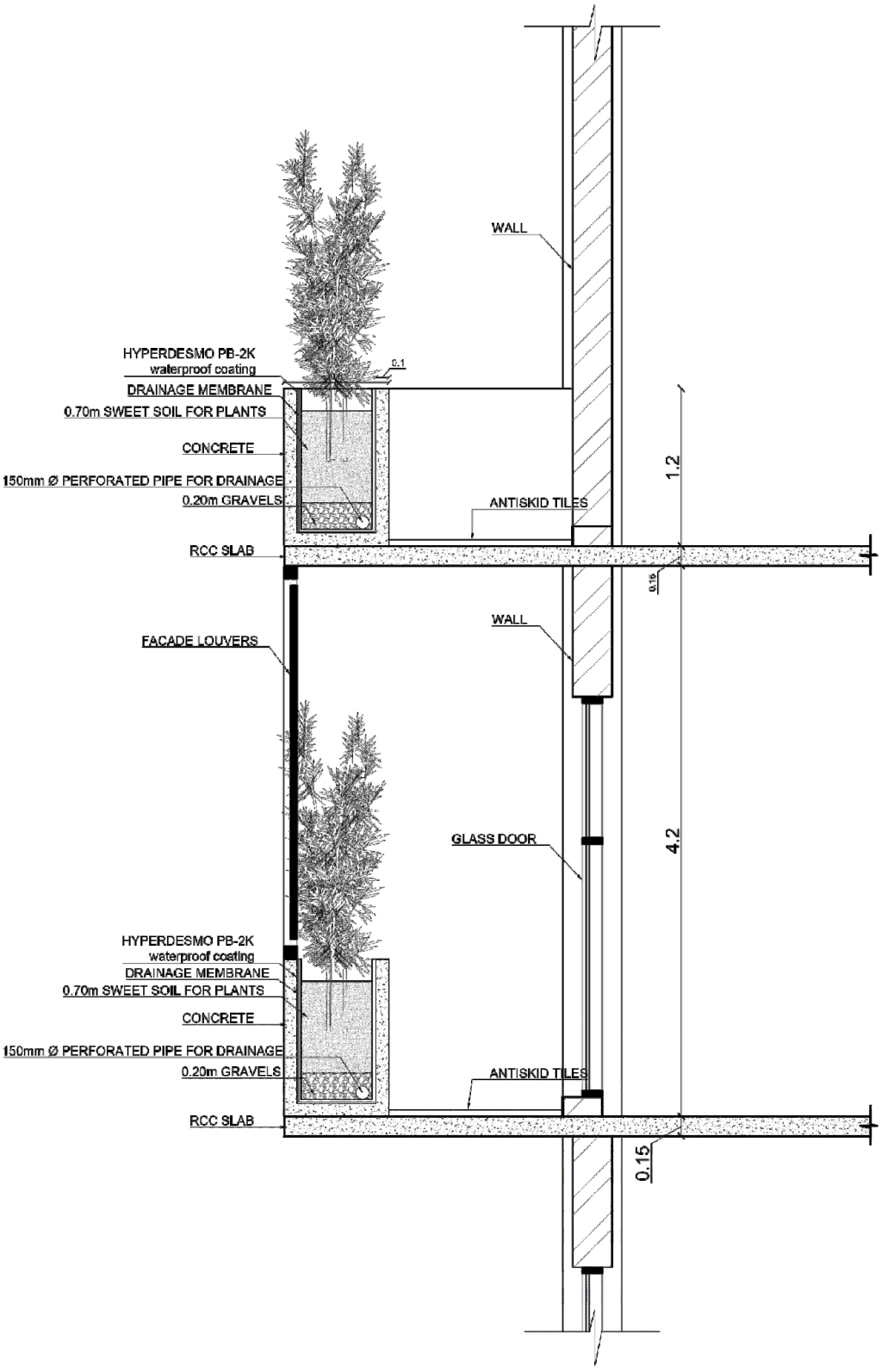
BRIDGE

BRIDGE



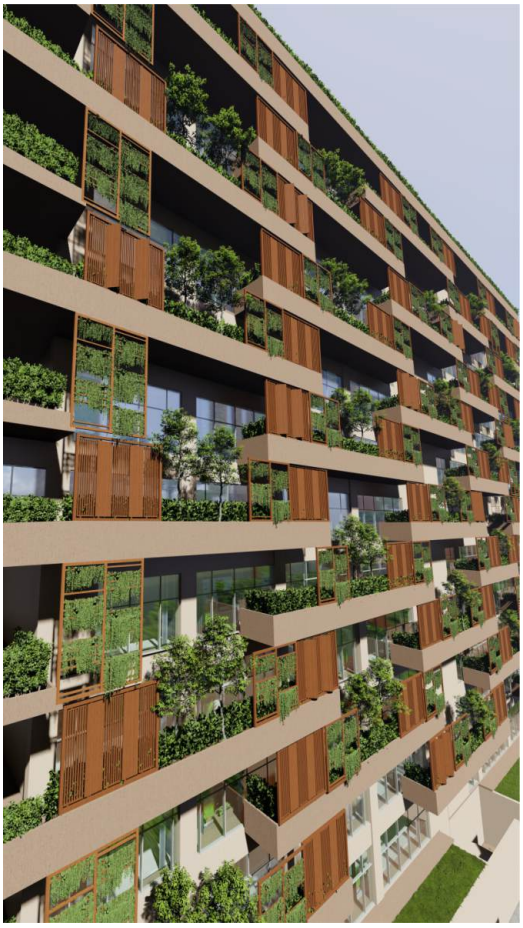
SECTION @ D2

SCALE 1:30
ALL DIMENSION ARE IN METERS


WALL
HYPERDESMO PB-2K
waterproof coating
DRAINAGE MEMBRANE
0.70m SWEET SOIL FOR PLANTS
CONCRETE
150mm Ø PERFORATED PIPE FOR DRAINAGE
0.20m GRAVELS
RCC SLAB
0.1
ANTISKID TILES
1.2
0.15
WALL
FACADE LOUVERS
GLASS DOOR
4.2
HYPERDESMO PB-2K
waterproof coating
DRAINAGE MEMBRANE
0.70m SWEET SOIL FOR PLANTS
CONCRETE
150mm Ø PERFORATED PIPE FOR DRAINAGE
0.20m GRAVELS
RCC SLAB
ANTISKID TILES
0.15

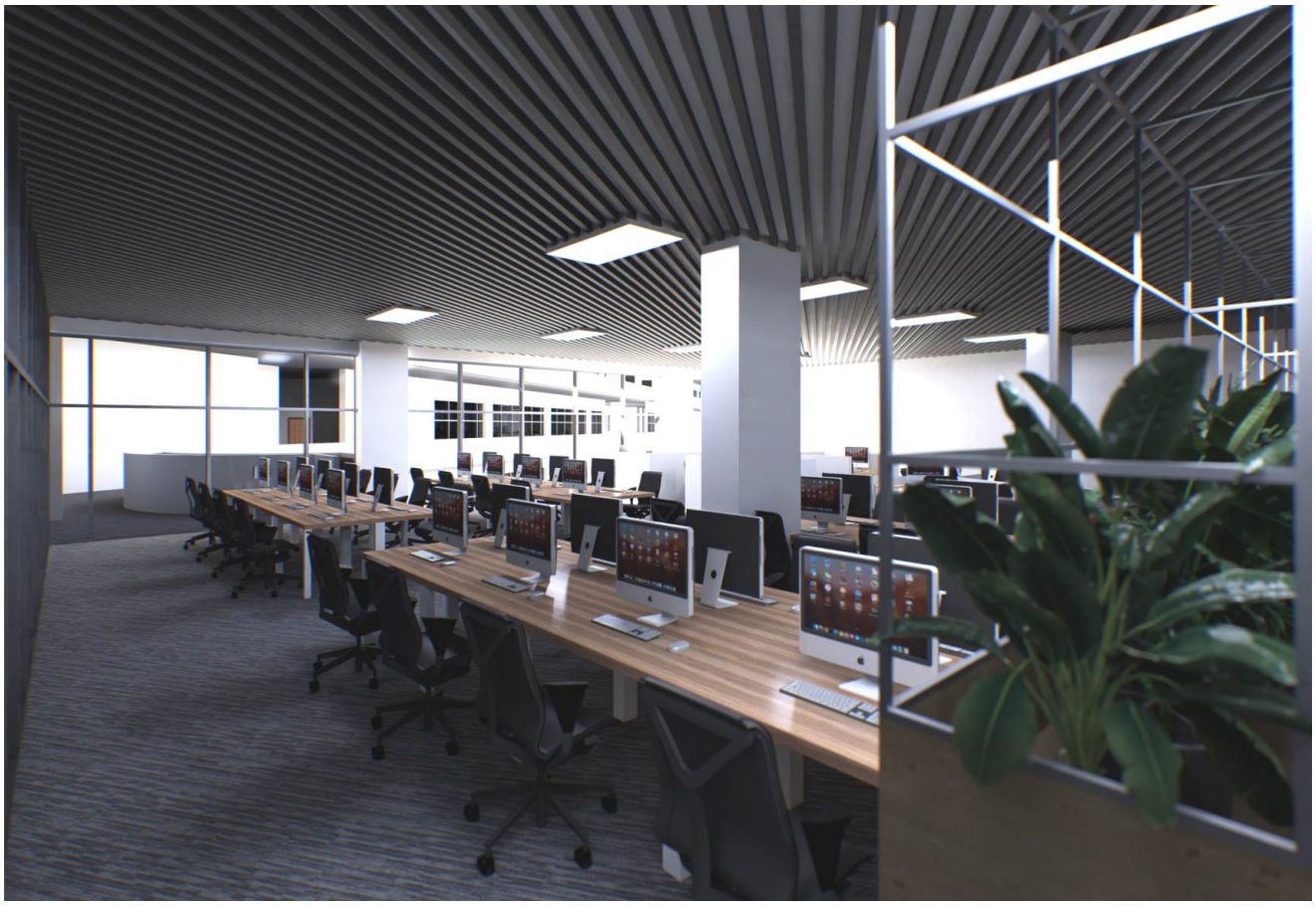
SECTION @ D1

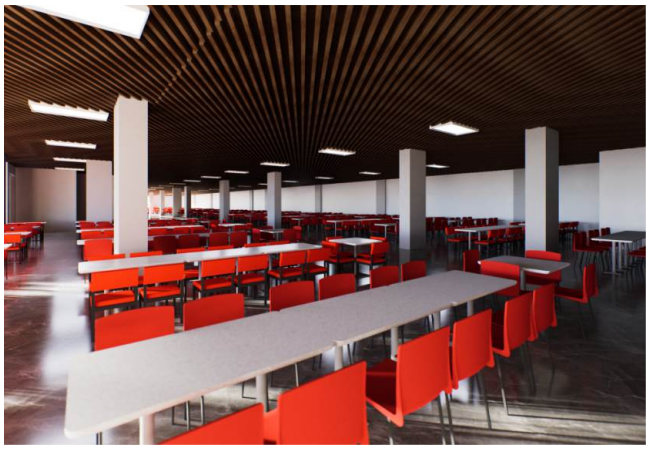
EXTERIOR RENDER VIEW



Exterior Render

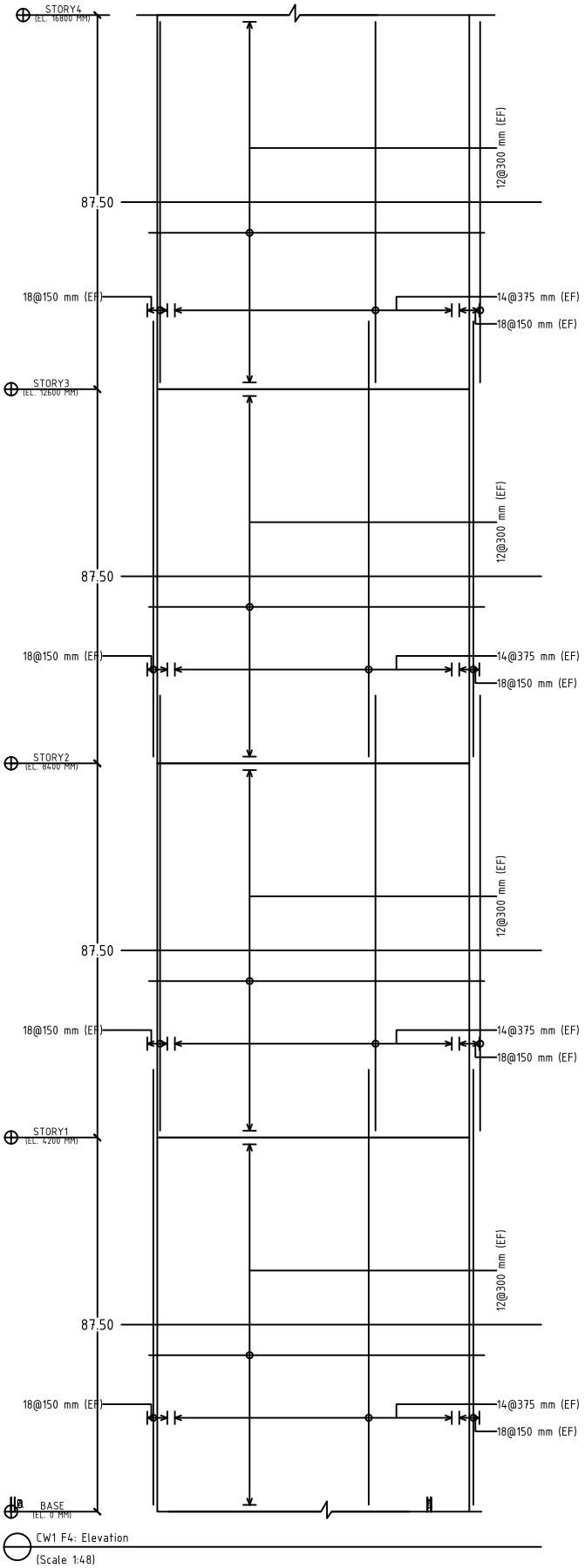
INTERIOR RENDER VIEW



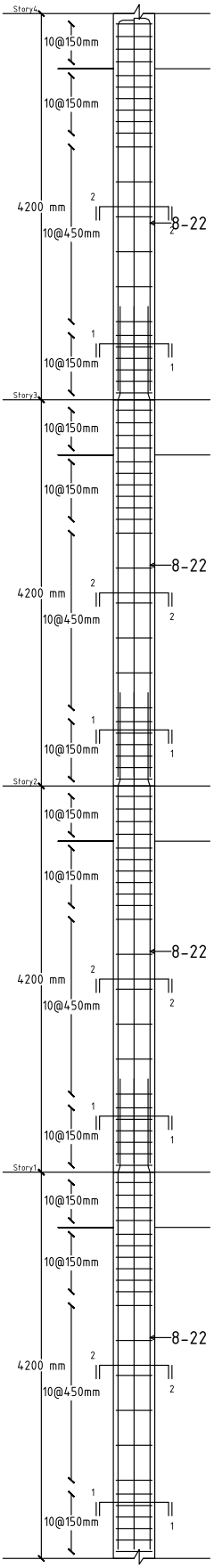


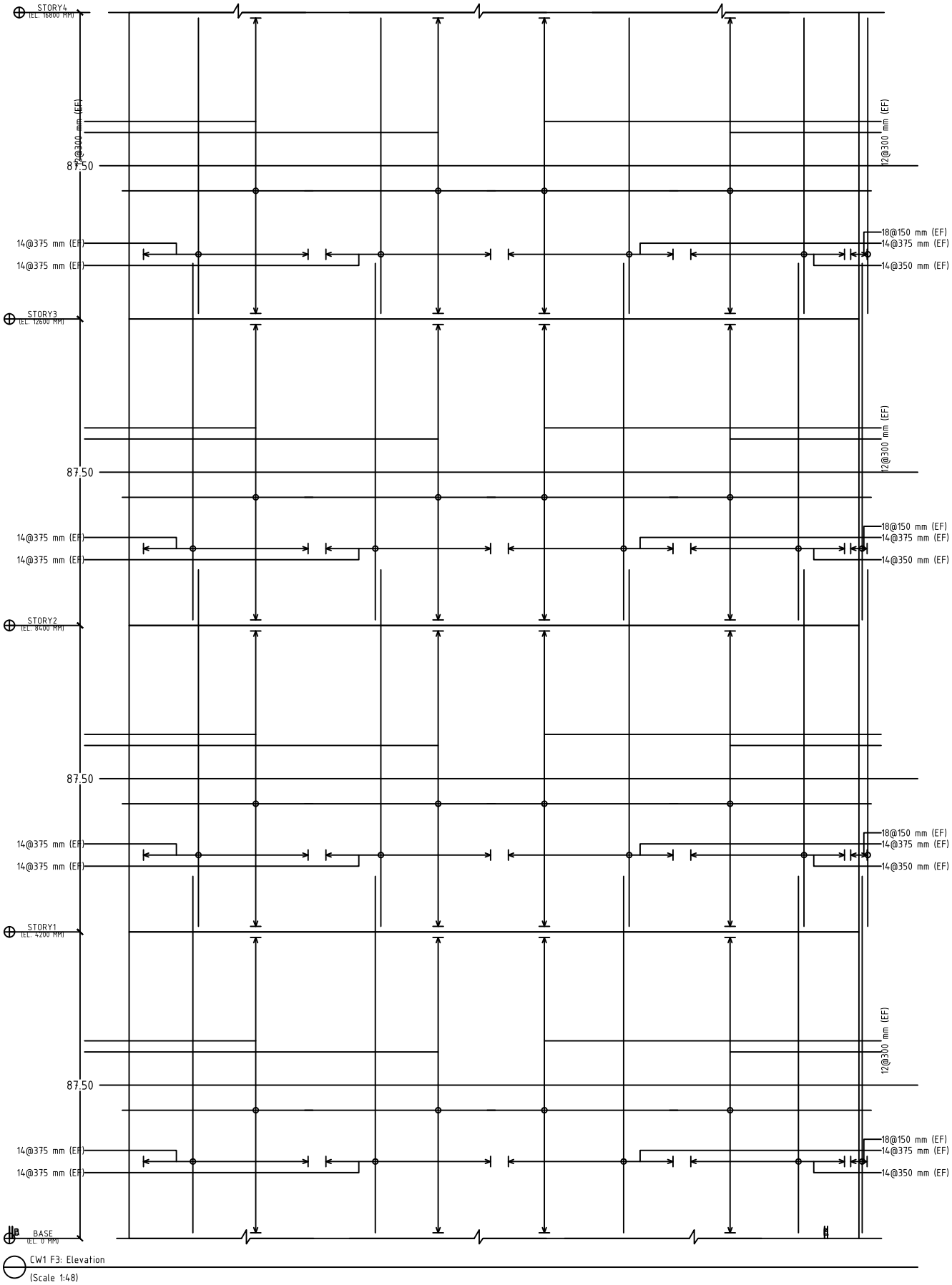
Interior Render

ENGINEERING DRAWINGS



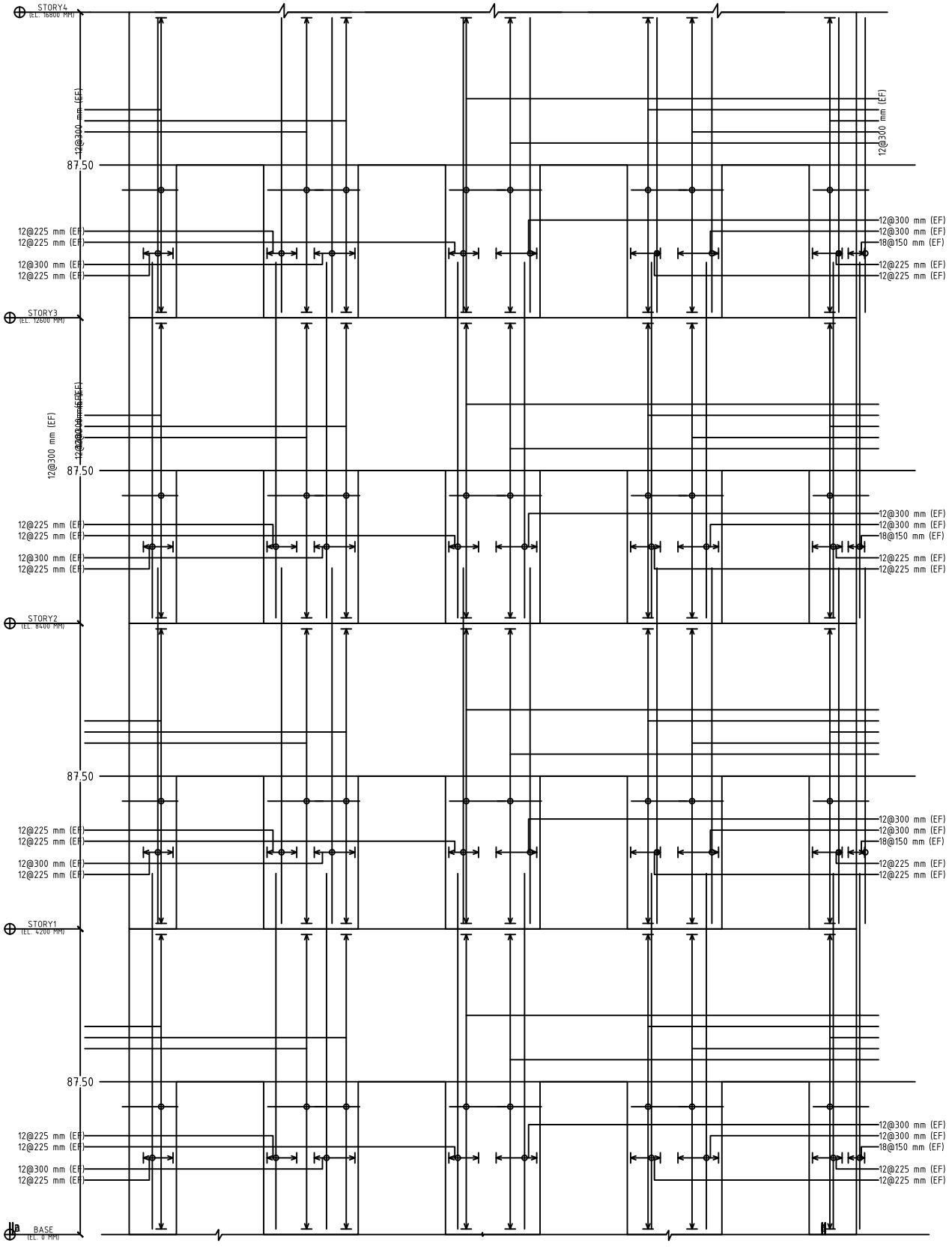
CW1 F4: Elevation
(Scale 1:48)





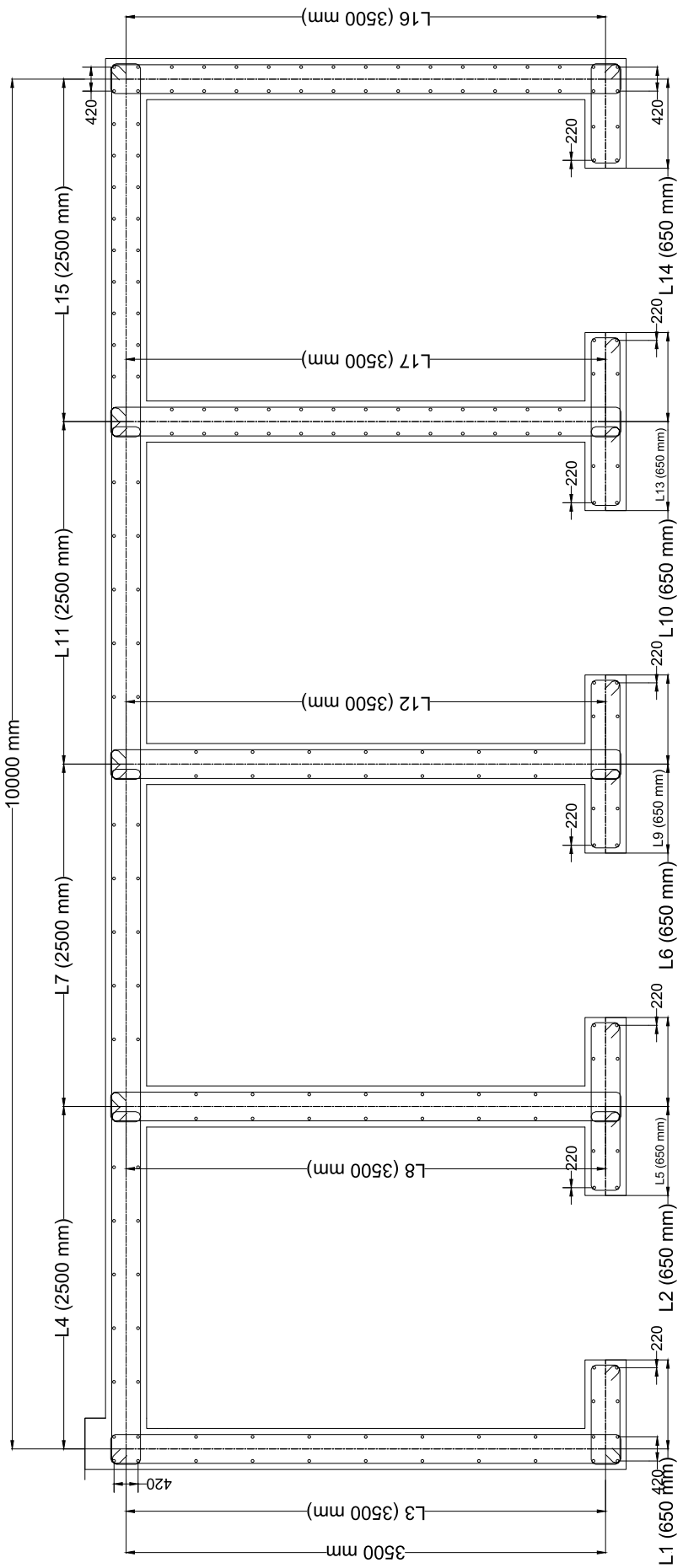
CW1 F3: Elevation

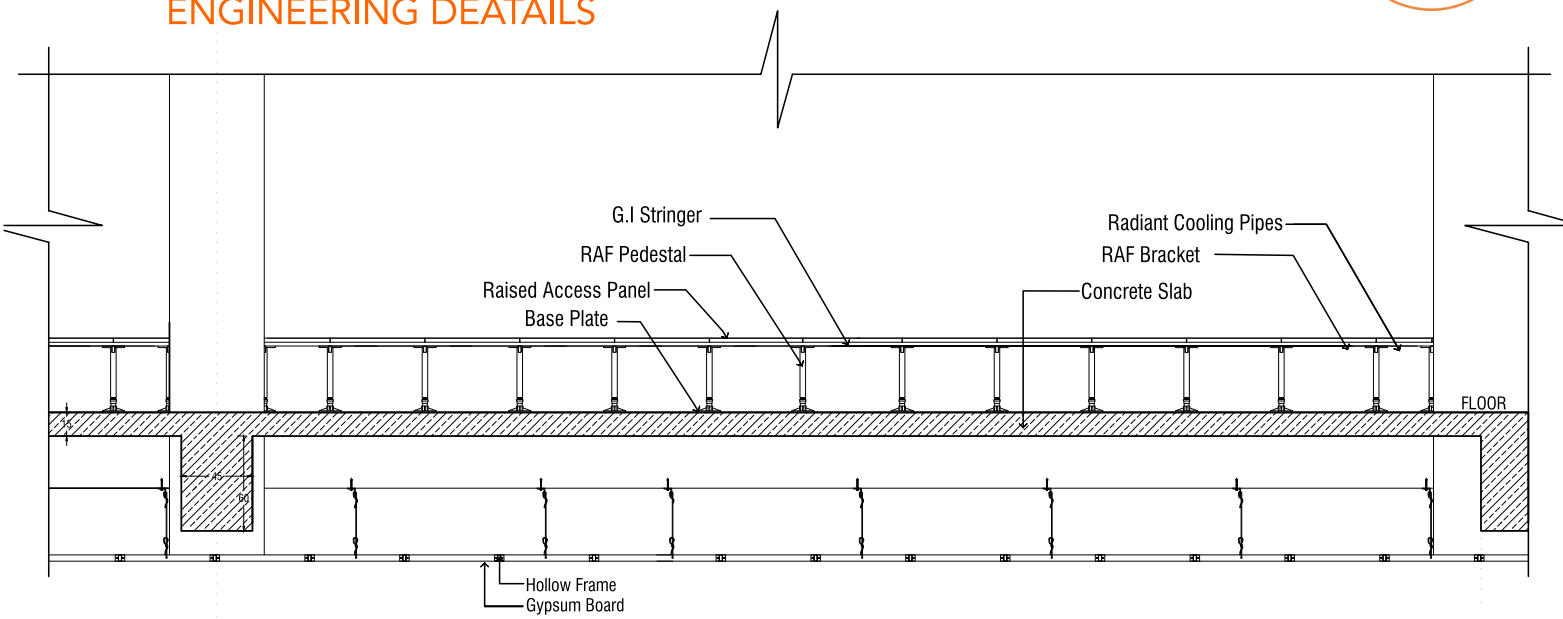
(Scale 1:48)



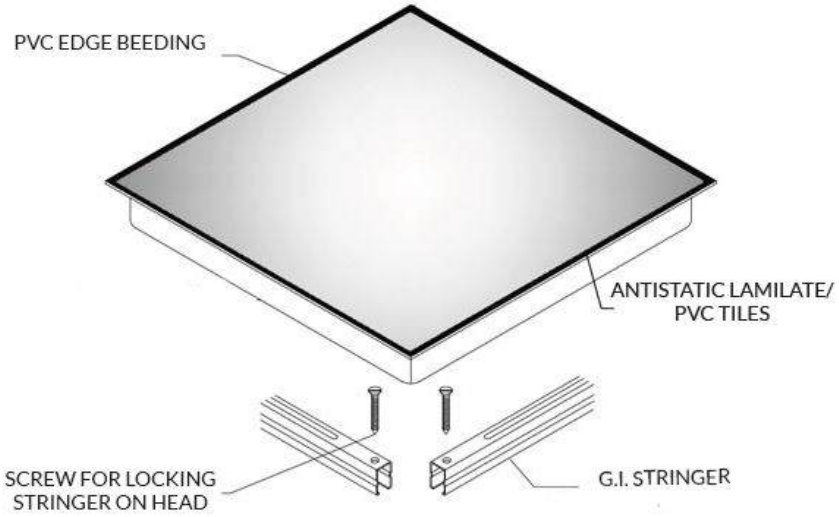
CW1 F1: Elevation

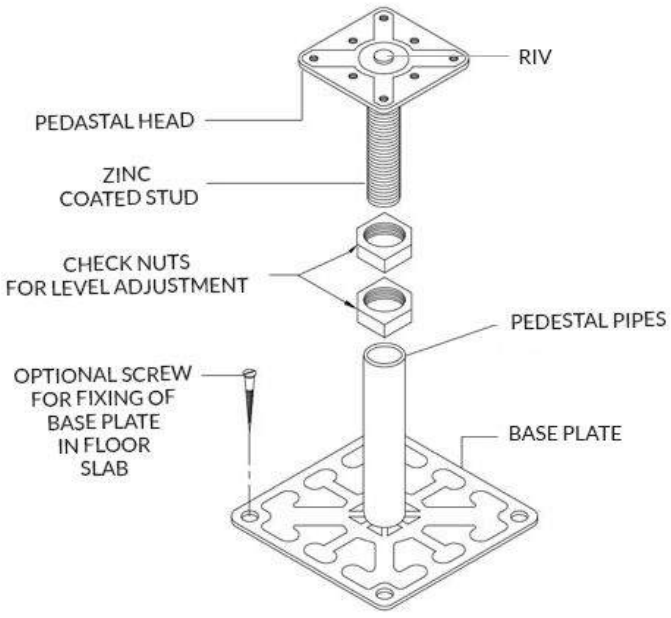
(Scale 1:48)


L16 (3500 mm)
420
220
420
L14 (650 mm)
L15 (2500 mm)
220
L17 (3500 mm)
220
L13 (650 mm)
L10 (650 mm)
L11 (2500 mm)
220
L12 (3500 mm)
220
L9 (650 mm)
L6 (650 mm)
L7 (2500 mm)
220
L8 (3500 mm)
220
L5 (650 mm)
L2 (650 mm)
L4 (2500 mm)
220
420
L1 (650 mm)
10000 mm
420
L3 (3500 mm)
3500 mm



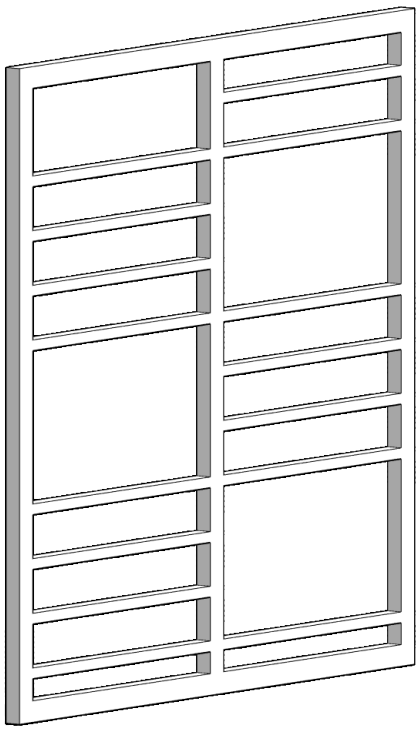
Raised Floor System Section



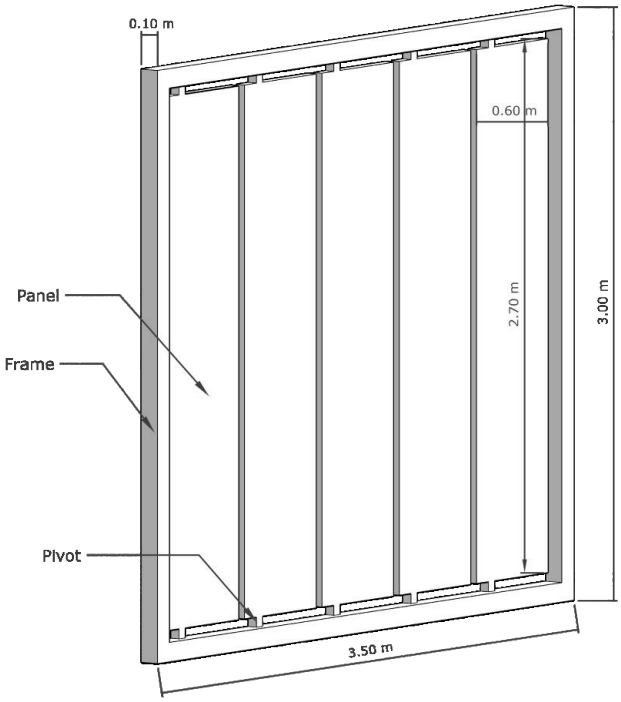


Exploded View Of Raised Floor System

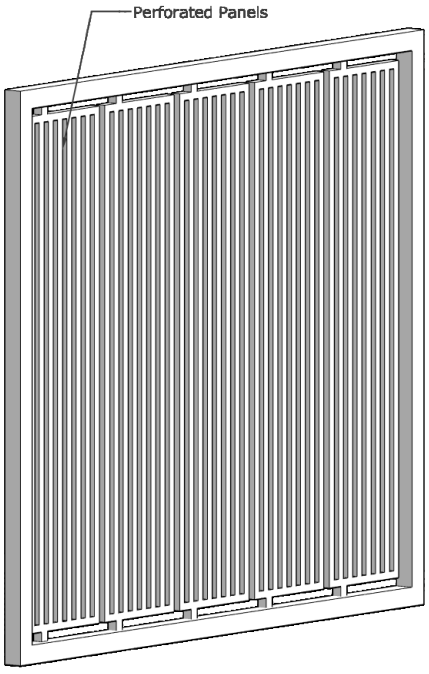
OPTIONS FOR PARAMETRIC PANELS



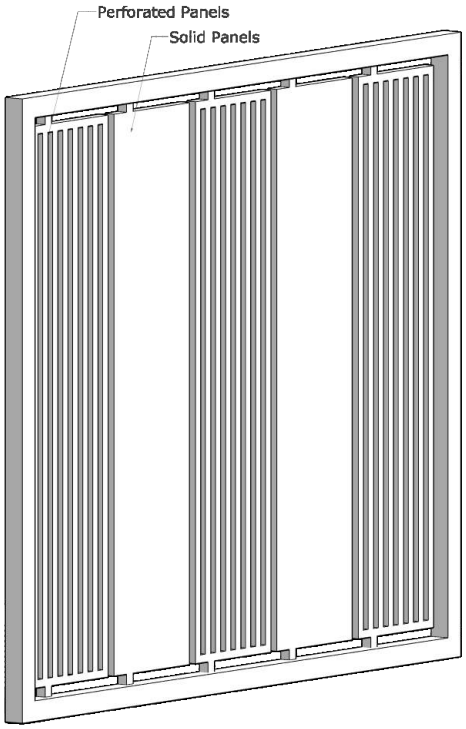
TRELLIS



FULLY SOLID PARAMETRIC PANEL



FULLY PERFORATED PARAMETRIC PANEL



SEMI PERFORATED PARAMETRIC PANEL

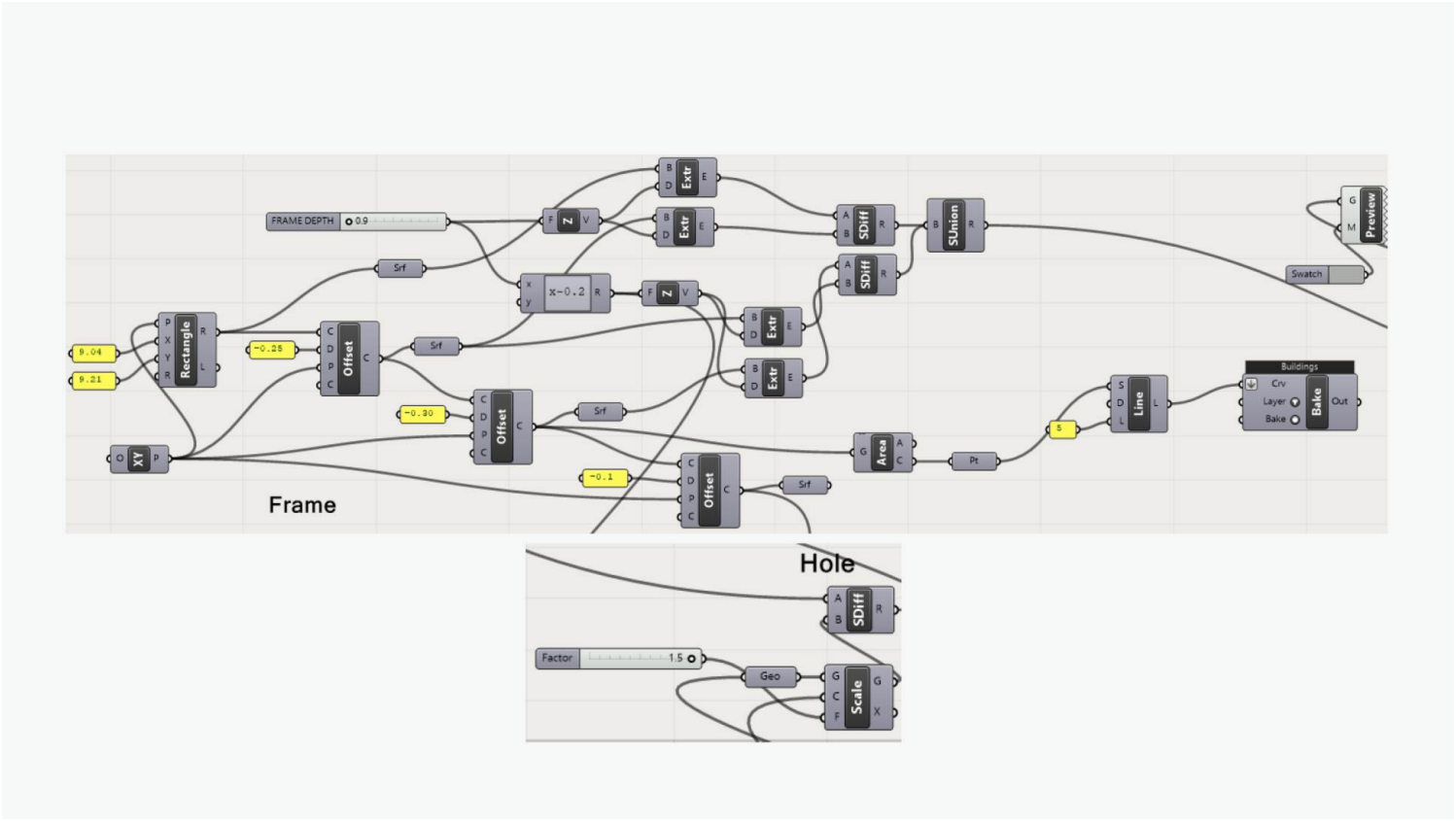
Options for Parametric Panels

DYNAMIC PANELS

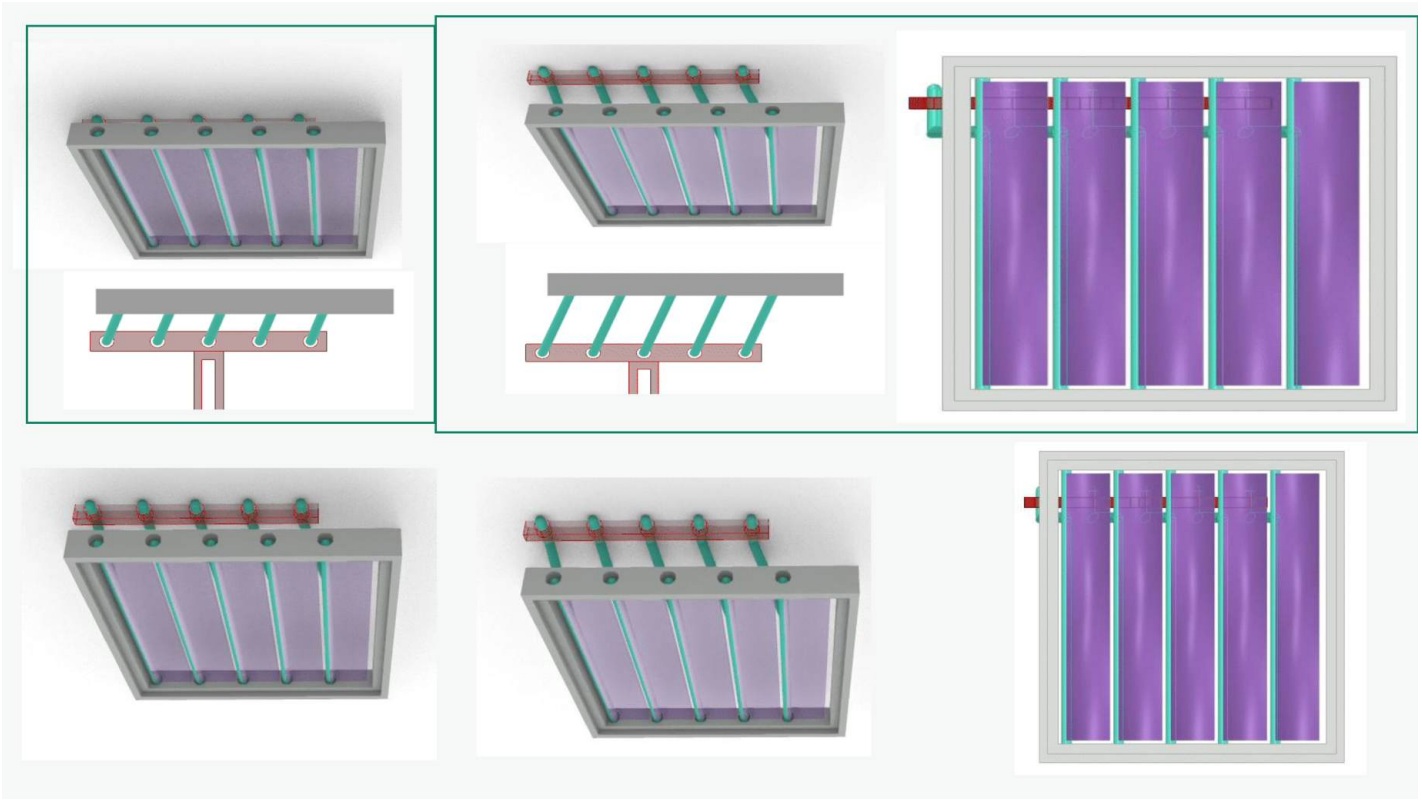
Image	Cost	Name	Power
	₹1,334.77	Ambient Light sensor	Supply Current- 50 mA, Supply Voltage Max.- 1V watt- 0.05 w
	₹2,999/-	Bipolar Stepper Motor High Torque	Rated Voltage - 3.6 V Rated Current/Phase - 3 A watts-10.8 W
	₹ 100/ Sq ft = ₹ 1500 /-	Cnc Laser Cutting Services	
	₹ 26,500/-	steel	
	₹ 500//-	ARDUINO UNO R3	
Total cost of one parameteric facade panel = ₹35,000/-			

Dynamic Panel Detail

GRASSHOPPER SCRIPT FOR DYNAMIC

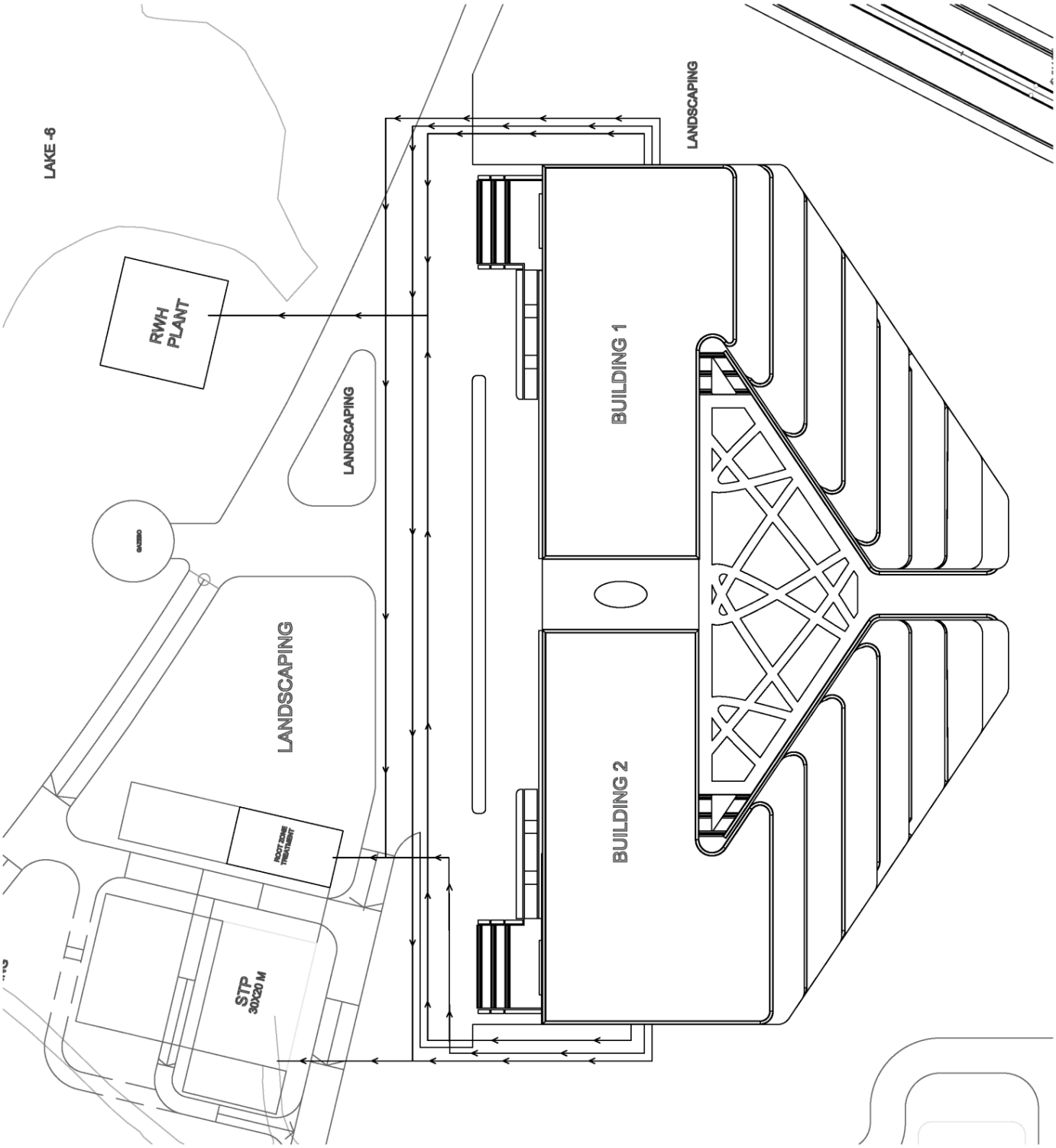


Grasshopper Script For Dynamic Panels



Views of Dynamic Panel Model

RWH SWM PLANT



RWH Plant Layout

LIST OF INPUT PARAMETER

Input Parameters	Units	Proposed Design Values	
General			
Building Area	m²	94763	
Conditioned Area	m²	65475	
Electricity Rate	INR/kWh	3.7	
Natural Gas Rate	INR/GJ	-	
Building Occupancy Hours	-	9am - 6pm	
Average Occupant Density	m² / person	9.025	
Interior Average Lighting Power Density	W/m²	7.61	
List of Lighting Controls	-	-	
Average Equipment Power Density	W/m²	0.00	
Minimum OA Ventilation (Building Average)	l/sec.m²	2.5	
Envelope			
Roof Assembly U value	W/m².K	0.33	
Roof Assembly SRI	%	75	
Average Wall Assembly U value	W/m².K	0.24	
Window to Wall Area Ratio (WWR)	%	70	
Windows U value	W/m².K	0.24	
Windows SHGC		0.12	
Windows VLT	%	71	
Infiltration Rate	ac/h	5	
Describe Exterior Shading Devices		Use of projected green balconies as shading element with parametric facade panels and trellis	
HVAC System			
HVAC System Type and Description	-	Radiant cooling system	
Describe Mixed mode strategy in operation/controls of AC and windows	-	Radiant cooling system(RCP-panel type) with Dedicated Outdoor Air System(DOAS)	
Heating Source	-	None	
Heating Capacity	kW	None	
Heating COP		None	
Cooling Source	-	Electric	
Cooling Capacity	kW	3284.74	
Cooling COP		3	
Operation Hours		8 Hours	
Heating Set Point	ºC	-	
Cooling Set Point	ºC	24	
Relative Humidity Setpoint	%	65	
Output Parameters	**Units**	**Proposed Design Values**	
Proposed EUI (Total)	kWh/m²/ yr	55	
EUI Breakdown by End Use			
Heating	kWh/m²/ yr	-	
Cooling	kWh/m²/ yr	31	
Fans	kWh/m²/ yr	2-3	
Pumps	kWh/m²/ yr	3-4	
Heat Rejection	kWh/m²/ yr	-	
Service Hot Water	kWh/m²/ yr	-	
Lighting	kWh/m²/ yr	14.43	
Equipment	kWh/m²/ yr	19.9	
Total Envelope Heat Gain (Peak)	W/m²	857	
Cooling Load of Conditioned Area	SF/ Tr	750	
Building Electric (Peak)	W/m²	153.3	
Annual Operating Energy Cost	INR/m²	102.5	
Annual Unmet Hours	-	-	
Cooling Capacity	Tr	934	
Annual Hours of Comfort without Air Conditioning		1519	
Monthly Energy Performance		**Generation**	**Consumption**
Jan	kWh	584229	559600
Feb	kWh	537043	556060
Mar	kWh	561315	543020
Apr	kWh	468657	544441
May	kWh	484710	536440
Jun	kWh	360269	529631
Jul	kWh	335187	522642
Aug	kWh	341715	534430
Sep	kWh	365926	527642
Oct	kWh	431320	528542
Nov	kWh	547405	546542
Dec	kWh	543140	543442

List Of Input Parameter

WATER CALCULATIONS

Months	Rainfall (mm)	Effective rain (mm)	Harvested rainwater (l)
July	170	165	2692784
August	189	184	3002862
September	157	152	2480625
October	97	92	1501431
November	29	24	391678
December	6	1	16320
January	7	2	32640
February	9	4	65280
March	18	13	212159
April	22	17	277438
May	40	35	571197
June	116	111	1811509

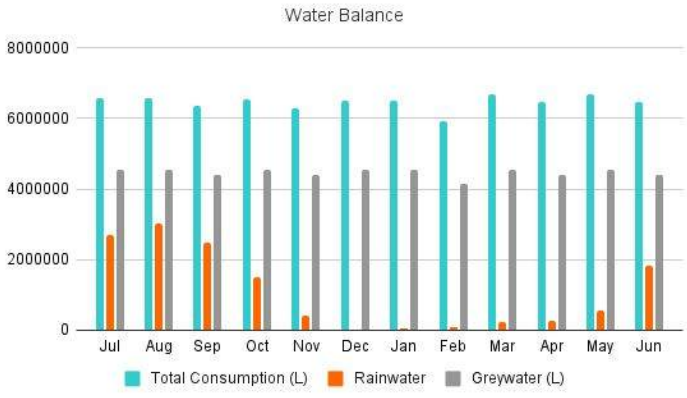
Domestic Use		Cooling Use	
Use LPD/Head	19.8	L/Tr	934
Number of people	10500	Tr per Day (peak)	3
Total LPD	207900	Max LPD	2802

Irrigation Use	
L/m2	1
Area m2	4500
Max LPD	4500

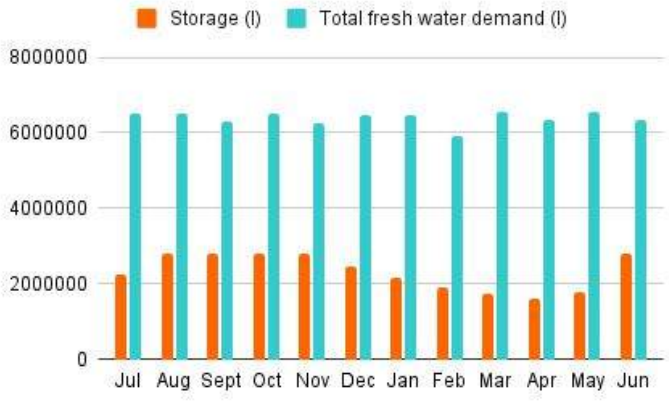
Rainfall Water Table

Month	Days in month	Generated black water	Generated Grey water	Filtered grey water	Month	Days in month	Occupant demand	Irrigation seasonal factor (%)	Irrigation demand	Cooling tower Usage factor (%)	Cooling tower water demand (l)	Total water demand (l)
Jul	31	1894801	4550099	3412574.55	July	31	6444900	50%	69750	80%	69490	6584140
Aug	31	1894801	4550099	3412574.55	August	31	6444900	50%	69750	80%	69490	6584140
Sep	30	1833678	4403322	3302491.5	September	30	6237000	50%	67500	80%	67248	6371748
Oct	31	1894801	4550099	3412574.55	October	31	6444900	15%	20925	80%	69490	6535315
Nov	30	1833678	4403322	3302491.5	November	30	6237000	15%	20250	40%	33624	6290874
Dec	31	1894801	4550099	3412574.55	December	31	6444900	15%	20925	40%	34745	6500570
Jan	31	1894801	4550099	3412574.55	January	31	6444900	15%	20925	40%	34745	6500570
Feb	28	1726713	4146462	3109846.163	February	28	5873175	15%	19068.75	40%	31663	5923906
Mar	31	1894801	4550099	3412574.55	March	31	6444900	100%	139500	100%	86862	6671262
Apr	30	1833678	4403322	3302491.5	April	30	6237000	100%	135000	100%	84060	6456060
May	31	1894801	4550099	3412574.55	May	31	6444900	100%	139500	100%	86862	6671262
Jun	30	1833678	4403322	3302491.5	June	30	6237000	100%	135000	100%	84060	6456060

Water Consumption Table



Water Balance



Total Fresh Water Demand

VEGETATION USED ON SITE & DETAILS

PIC	Name	Scientific name	Type	Water requirement
	Blue morning glory	Ipomoea tricolor	Creeper	1 to 2 times a week
	Morning glory	Ipomoea	Shrub or small tree	1 to 2 times a week
	Asparagus fern	Asparagus setaceus	Shrub	Every week
	Mogra plant	Jasminum sambac	Plant	Every week
	Arrowhead plant	Syngonium podophyllum	Plant	once every 10 days
	Umbrella plant	Schefflera arboricola	Plant	once every 10 days
	Champa	Plumeria Alba	Tree	1 to 2 times a week
	Neem	Azadirachta indica	Tree	Once every week

Vegetation Used On Site & Detail

CONSTRUCTION COST CALCULATIONS

Constuction Cost Summary - Hard Cost

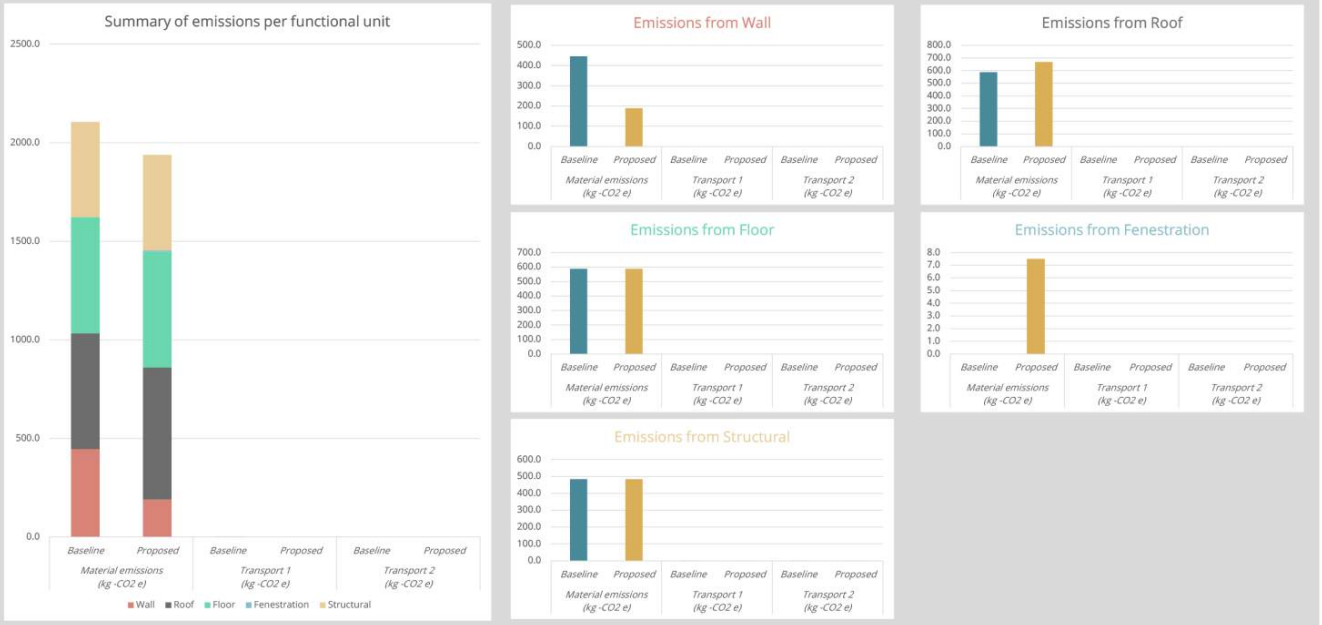
No.	Item Description	Unit	Baseline Estimate (Project Partner / SOR basis)				Proposed Design Estimate				Notes Required ?	Justification / Notes
			Quantity	Rate (Rs)	Amount (Rs. Millions)	Cost per sqm. (Rs)	Quantity	Rate	Amount	Cost per sqm		
A. CIVIL WORKS												
1	**EXCAVATION**											
1.1	Excavation In Soil	Cu.m	57,700	800	46.2	57,700	57,700	800	46.2	57,700	NO	
1.2	Excavation In Hard rock	Cu.m	24,300	1,600	38.9	48,600	24,300	1,200	29.2	36,450	YES	
1.3	Rubble Soling	Sq.m			-	-			-	-	NO	
1.4	Backfilling+ Compaction	Cu.m			-	-			-	-	NO	
1.5	Antitermite treatment	Sq.m			-	-			-	-	NO	
	"Insert Row" to add more items											
2	**RCC WORK**											
2.1	PCC Plinth M10	Cu.m	1,743	7,000	12.2	129	1,743	4,000	7.0	74	YES	
2.2	PCC For Footing M10	Cu.m	431	2,200	0.9	10	431	2,200	0.9	10	NO	
2.3	RCC (M25 grade) staircase	Cu.m	21,000	7,500	157.5	1,662	21,000	7,500	157.5	1,662	NO	
2.4	RCC (M25 grade) columns and shear walls	Cu.m	3,269	7,500	24.5	259	3,269	7,500	24.5	259	NO	
2.5	RCC(M25 grade) beams, plinth beams, footings	Cu.m	7,093	7,500	53.2	561	7,093	7,500	53.2	561	NO	
2.6	RCC(M25 grade) slab	Cu.m	5,000	280	1.4	15	5,000	280	1.4	15	NO	
2.7	Cement (1:1:2)	Cu.m	4,278	41,500	177.5	1,873	4,278	41,500	177.5	1,873	NO	
2.8	Reinforcement ,TMT Fe 500 Plus Labour	M.Ton			-	-			-	-	NO	
	"Insert Row" to add more items											
3	**SHUTTERING WORK**											
3.1	Shuttering Area	Sq.m	1,49,422	300	44.8	473	1,49,422	180	26.9	284	YES	
	"Insert Row" to add more items											
4	**STRUCTURAL STEEL WORK**	**Sq.m**										
4.1	Structural steel for column sections,Fe 590B	M.Ton			-	-			-	-	NO	
4.2	16 mm dia holding down bolts for column grade8.8	M.Ton			-	-			-	-	NO	
4.3	Structural steel for primary beams (BUILT UP SEC),Fe 590B	M.Ton			-	-			-	-	NO	
4.4	Structural steel for secondary beams -Castellated Sections(rolled sections),Fe 590B	M.Ton			-	-			-	-	NO	
4.5	Steel Deck for composite floor,ComFlor 60-1.2 mm thick	Sqm			-	-			-	-	NO	
4.6	Fire Proof Painting	Sqm			-	-			-	-	NO	
	"Insert Row" to add more items											
5	**FAÇADE WORK**											
5.1	337 mm Thick Acc block with insulation	Sqm			-	-	13,761	760	10.5	110	YES	
5.2	230mm Thick clay brick	Sqm	13,761	500	6.9	73			-	-	YES	
5.3	Parametric facade	Sqm	7605	450	3.4	36			-	-	YES	
5.4	External Plaster	Sqm	17,588	250	4.4	46	17,588	250	4.4	46	NO	
5.5	Glass façade	Sqm	17,403	2,500	43.5	459	17,403	2,500	43.5	459	NO	
	External Aluminum Cladding	Sqm										
	"Insert Row" above this row to add more items											
	SUB- TOTAL (A)				**615.4**	**6,494**			**582.7**	**6,149**		
B. INTERNAL WORKS												
6	**INTERNAL WALLS , FINISHES**											
6.1	200 mm Thick Acc block Wall	Sqm			-	-	14,172	900	12.8	135	YES	
	150mm Thick clay brick	Sqm	14,172	1,000								
6.2	Internal Plaster - Walls	Sqm	59,892	250	15.0	158	59,892	250	15.0	158	NO	
6.3	Painting of Internal Wall +Ceiling	Sqm	1,02,875	320	32.9	347	1,02,875	320	32.9	347	NO	
	Interior gypsum board	Sqm	13,675	290			13,675	290				
	Interior Glass Partitions	Sqm	19,296	4,000			19,296	4,000				
	"Insert Row" above this row to add more items											
7	**WATERPROOFING**											
7.1	Toilet	Sqm	4,365	3,000	13.1	138	4,365	2,500	10.9	115	YES	
7.2	Raft	Sqm	11,791	15,000	176.9	1,866	11,791	15,000	176.9	1,866	NO	
7.3	Retaining Wall	Sqm	1,533	15,000	23.0	243	1,533	15,000	23.0	243	NO	
7.4	Top terrace	Sqm	7,148	2,200	15.7	166	7,148	2,200	15.7	166	NO	
	"Insert Row" above this row to add more items											
8	**TILING WORK**											
8.1	Balcony	Sqm	9,272	1,000	9.3	98	9,272	1,000	9.3	98	NO	
8.2	Flooring - Lobbies	Sqm	4,342	5,350	23.2	245	4,342	5,350	23.2	245	NO	
8.3	Ceramic 12 x 12 Toilets	Sqm	4,365	590	2.6	27	4,365	590	2.6	27	NO	
8.4	Staircase - Tread	Sqm	1,806	700	1.3	13	1,806	650	1.2	12	YES	
8.5	Staircase - Riser	Sqm	931	700	0.7	7	931	650	0.6	6	YES	
8.6	Staircase - landing	Sqm	1,104	700	0.8	8	1,104	650	0.7	8	YES	
8.7	Dado - Lift	Sqm	726	700	0.5	5	726	700	0.5	5	NO	
8.8	Dado - Toilet	Sqm	3,358	700	2.4	25	3,358	700	2.4	25	NO	
	"Insert Row" above this row to add more items											
9	**DOORS**											
9.1	D1(entrance door for toilet)- 1.5 *2.1	Sqm	473	800	0.4	4	473	800	0.4	4	NO	
9.2	FD1(door for fire staircase)- 1.8*2.1	Sqm	242	800	0.2	2	242	800	0.2	2	NO	
9.3	Main door glass	Sqm	36	800	0.0	0	36	800	0.0	0	NO	
9.4	Service door	Sqm	252	800			252	800				
	"Insert Row" above this row to add more items											
10	**FABRICATION**											
10.1	Railing for Staircase	Rm	941	1,200	1.1	12	941	1,200	1.1	12	NO	
	"Insert Row" above this row to add more items											
	SUB-TOTAL (B)				**318.9**	**3,366**			**329.3**	**3,475**		
C. MEP SERVICES												
11	**HVAC**											
11.1	Chilled Water Piping	BUA Sqm	8,000	800	6.4	68	8,000	800	6.4	68	YES	
11.2	AHU, Ducting & Insulation, etc	BUA Sqm	48,000	2,500	120.0	1,266	48,000	2,500	120.0	1,266	NO	
11.3	Ventilation Fans	BUA Sqm	20,000	2,500	50.0	528	20,000	2,500	50.0	528	NO	
11.4	High Side	BUA Sqm	50	5,000	0.3	3	50	5,000	0.3	3	NO	

11.5	DOAS, Ducting & Insulations, etc.	BUA Sqm	25,000	3,500	87.5	923	25,000	3,500	87.5	923	NO
11.6	Radiant Pipes and Controls	BUA Sqm			-	-	6,58,000	120	79.0	833	YES
	"Insert Row" above this row to add more items										
12	**ELECTRICAL & ALLIED SERVICES**										
12.1	Substation (Including Transformers)		3	10,00,000	3.0	32	1	10,00,000	1.0	11	YES
12.2	Panels / Distribution Boards & Switch Gears – Main Panels / Distribution Boards & Switchgears – Sub Distribution	BUA Sqm	225	70,000	15.8	166	225	70,000	15.8	166	NO
12.3	Cabling	BUA Sqm	400	800	0.3	3	400	800	0.3	3	NO
12.4	Light Fittings	BUA Sqm	40,000	1,200	48.0	507	40,000	1,200	48.0	507	NO
12.5	Internal Wiring	BUA Sqm	12,00,000	50	60.0	633	12,00,000	50	60.0	633	NO
12.6	Earthing & Lightning Protection	BUA Sqm	40	35,000	1.4	15	40	35,000	1.4	15	NO
12.7	*Solar panel*	BUA Sqm					5,901	18,000			
12.8	D.G. Sets 4000 KVA	BUA Sqm	8	15,00,000	12.0	127	5	15,00,000	7.5	79	YES
	"Insert Row" above this row to add more items										
13	**PLUMBING & SANITATION**										
13.1	Fixtures and Fittings	BUA Sqm	750	9,500	7.1	75	750	9,500	7.1	75	NO
13.2	Internal Drainage	BUA Sqm	120	5,750	0.7	7	120	5,750	0.7	7	NO
13.3	External Drainage	BUA Sqm	80	2,500	0.2	2	80	2,500	0.2	2	NO
13.4	STP and ETP	BUA Sqm	1	28,10,000	2.8	30	1	28,10,000	2.8	30	NO
13.5	Water Treatment and Distribution	BUA Sqm	2,10,000	35	7.4	78	2,10,000	350	73.5	776	YES
13.6	Domestic & Flushing water lift pumps, tank, panels	BUA Sqm	60,000	12	0.7	8	60,000	12	0.7	8	NO
13.7	Irrigation system	BUA Sqm	6,000	25	0.2	2	6,000	25	0.2	2	NO
13.8	Rainwater Storage system	BUA Sqm	1	1,00,00,000	10.0	106	1	1,50,00,000	15.0	158	YES
13.9	Solar water heating system	BUA Sqm			-	-			-	-	NO
	"Insert Row" above this row to add more items										
14	**FIRE FIGHTING**										
14.1	Plant Room	BUA Sqm			-	-			-	-	NO
14.2	Fire Hydrant System	BUA Sqm	8	60,000	0.5	5	8	60,000	0.5	5	NO
14.3	Sprinkler System	BUA Sqm	23,700	900	21.3	225	23,700	900	21.3	225	NO
14.4	Fire Extinguishers & Buckets	BUA Sqm	160	8,500	1.4	14	160	8,500	1.4	14	NO
	"Insert Row" above this row to add more items										
15	**IBMS AND SECURITY SYSTEM**										
15.1	Fire Alarm System	BUA Sqm	1,890	3,000	5.7	60	1,890	3,000	5.7	60	NO
15.2	Public Address System	BUA Sqm	1,000	2,500	2.5	26	1,000	2,500	2.5	26	NO
15.3	Access Control System	BUA Sqm	10	2,50,000	2.5	26	10	2,50,000	2.5	26	NO
15.4	CCTV System	BUA Sqm	750	13,000	9.8	103	750	13,000	9.8	103	NO
15.5	Building Management System	BUA Sqm	1	11,00,000	1.1	12	1	11,00,000	1.1	12	NO
15.6	Waterleak detection system	BUA Sqm	20	1,10,000	2.2	23	20	1,10,000	2.2	23	NO
	"Insert Row" above this row to add more items										
16	**INSTALLATION OF LIFT**										
16.1	Service Elevator	BUA Sqm	10	9,00,000	9.0	95	25	9,00,000	22.5	237	YES
16.2	Passenger Elevator	BUA Sqm	10	9,00,000	9.0	95	25	9,00,000	22.5	237	YES
	"Insert Row" above this row to add more items										
	SUB-TOTAL (C)				**498.6**	**5,261**			**669.2**	**7,061**	
D. EQUIPMENT & FURNISHING											
17	**Office Interiors:**										
17.1	Furninshing	Carpet Area (Sq.m)	66,300	3,500	232.1	2,449	66,300	3,500	232.1	2,449	NO
17.2	False Ceiling	Sqm	66,300	1,500	99.5	1,049	66,300	1,500	99.5	1,049	
17.3	Internal Electrification		94,763	1,200	113.7	1,200	94,763	1,200	113.7	1,200	
17.4	Ducting		50,000	850	42.5	448	50,000	850	42.5	448	
17.5	Lighting		39,324	1,900	74.7	788	39,324	1,900	74.7	788	
	"Insert Row" above this row to add more items										
	SUB-TOTAL (D)				**562.4**	**5,935**			**562.4**	**5,935**	
E. LANDSCAPE & SITE DEVELOPMENT											
18	**SITE DEVELOPMENT**										
18.1	Roads and Walkways	Sq.m	3,000	50	0.2	2	3,000	50	0.2	2	NO
19	**LANDSCAPING**										
19.1	Landscaping and Hardscape	Sq.m	200	1,000	0.2	2	7,500	1,000	7.5	79	YES
19.2	Balcony with planters	Sq.m			-	-	3,965	120	0.5	5	YES
19.3	Green wall	Sq.m									
	"Insert Row" above this row to add more items										
	SUB-TOTAL (E)				**0.4**	**4**			**8.1**	**86**	
	CONTINGENCY (E)		5%		**99.8**	**1,053**	5%		**107.6**	**1,135**	
	TOTAL				**2,095.4**	**22,112**			**2,259.3**	**23,841**	

Construction Cost Calculation

CARBON CALCULATIONS

System Type	Baseline				Proposed			
	Material emissions ($kg\text{-}CO_2e$)	Transport 1 ($kg\text{-}CO_2e$)	Transport 2 ($kg\text{-}CO_2e$)	Total ($kg\text{-}CO_2e$)	Material emissions ($kg\text{-}CO_2e$)	Transport 1 ($kg\text{-}CO_2e$)	Transport 2 ($kg\text{-}CO_2e$)	Total ($kg\text{-}CO_2e$)
Wall	445.6	0.5	0.2	446.3	189.7	0.1	0.0	189.8
Roof	588.3	0.7	0.3	589.3	669.1	0.7	0.3	670.2
Floor	588.3	0.7	0.3	589.3	588.3	0.7	0.3	589.3
Fenestration	0.0	0.0	0.0	0.0	7.5	0.0	0.0	7.5
Structural	483.9	0.8	0.4	485.1	483.9	0.8	0.4	485.1
Grand Total emissions per functional unit ($kg\text{-}CO_2e$)				2110.0	Grand Total emissions per functional unit ($kg\text{-}CO_2e$)			1941.8



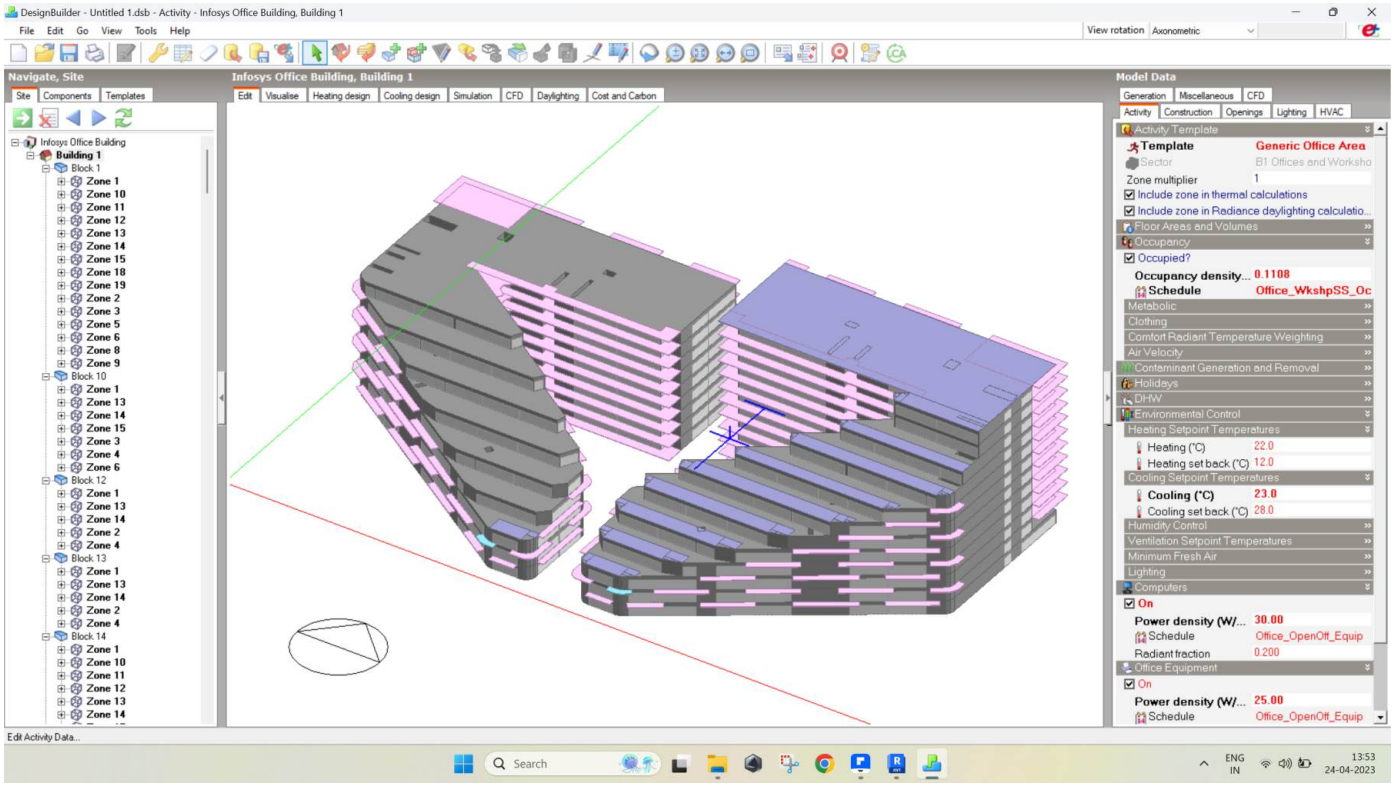
Carbon Calculation

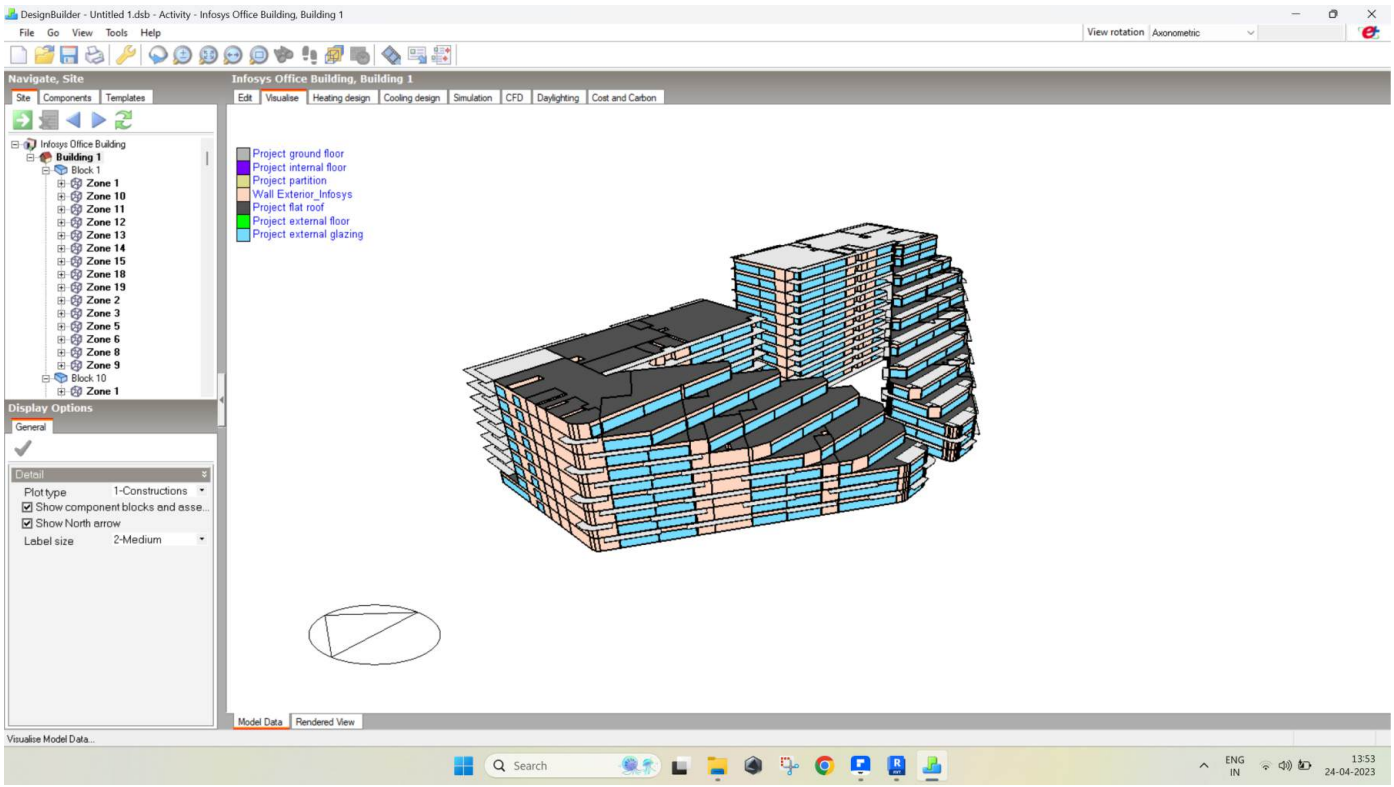
DO's & Don't's For Proposed Building systems

Don't block air vents or ducts, which can affect the distribution of conditioned air and reduce energy efficiency.
Don't overload electrical outlets, which can damage the electrical system and equipment.
Don't use cleaning products or air fresheners that contain harmful chemicals or release volatile organic compounds (VOCs).
Don't leave doors or windows open when the HVAC system is running, as it can waste energy and affect indoor air quality.
Don't adjust or tamper with any building equipment or controls without proper authorization or training.

Do use energy-efficient equipment and appliances and avoid using personal appliances that consume a lot of energy.
Do use the recycling and composting bins to properly dispose of waste and reduce the amount of waste sent to landfills.
Do report any unusual noises, vibrations, or smells to the building management to prevent potential equipment damage.
Do turn off lights and electronics when leaving the room or at the end of the workday.
Do use natural light when possible and adjust shades and blinds as needed to control glare and temperature.
Do set the thermostat to the recommended temperature range to avoid overcooling or overheating the building.

DESIGN BUILDER MODEL





Design Builder Models

LETTERS OF CONFIRMATION

Our project partner was assigned to us by the Solar Decathlon India Organizers. The details are as follows:

- Organization Name: Infosys Limited
- Project Name: Infosys Hyderabad office
- Project Location: Survey No. 41 (Pt),50 (pt), Pocharam Village, Singapore Township PO, Ghatkesar Mandal, Malkajgiri, Hyderabad, 500088

☎: 08232-220043
Fax : 08232-222075
Email : principal@pesce.ac.in.

P.E.S. COLLEGE OF ENGINEERING

(An-Autonomous Institution Under VTU, Belagavi)

(Affiliated to Visveswaraiah Technological University, Belagavi and approved by AICTE, New Delhi.)

MANDYA-571 401. KARNATAKA, INDIA.

NO. PES/ADM/2022-23 DATE 13/06/2022

STUDY CERTIFICATE

This is to Certify that Mr./Mrs. VINAY KUMAR.R

is a bonafide student of this Institution studying in VII th sem (4th year)

APS19CV103 Civil during the current academic

year 2021-22 He/She bears good character and conduct.

Principal

PES College of Engineering
MANDYA-571 401.

13/06/22

IMPACT
SCHOOL OF
ARCHITECTURE

COA Approved | VTU Affiliated

PROGRAMMES OFFERED
Bachelor of Architecture – B. Arch 5 Years Undergraduate Program
Master of Architecture – M. Arch (Digital Architecture) 2 Years Post-graduate Program

Ref: ISA/Bona/2022-02

Date: 10th October 2022

Bonafide Certificate

I certify that the following list of students are bonafide students of 4th year B. Arch of **IMPACT SCHOOL OF ARCHITECTURE** Bengaluru who are going to participate in the solar Decathlon India (2022-23)

Name of students :

1. Chirag – 1IS19AT008
2. Jnanesh Preethan – 1IS19AT015
3. Piyuish – 1IS19AT028
4. Prajwal C P – 1IS19AT029
5. Rakshith Patel N K – 1IS19AT032
6. Sohan Preethu D R – 1IS19AT041

Director

Director
IMPACT SCHOOL OF ARCHITECTURE

Impact School of Architecture Bangalore 560 092

Impact Campus; Near Chairman's Club, Kodigehalli, Sahakara Nagar South, Bengaluru, Karnataka 560092.
M +91 88808 10015; +91 80500 11855/66/77; info@impact.ac.in; admissions@impact.ac.in;