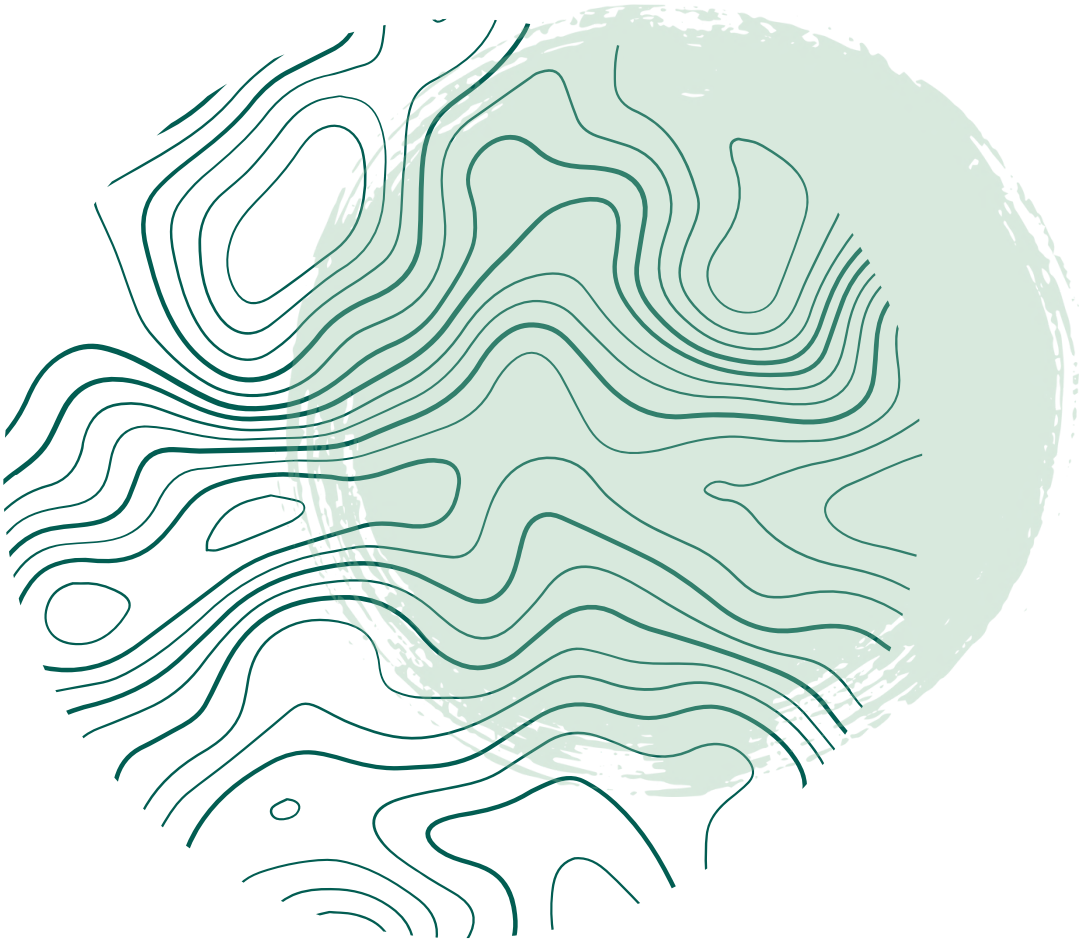
Solar Decathlon India



GAEA

BGS SCHOOL OF ARCHITECTURE AND PLANNING

FINAL DESIGN REPORT

DIVISION : OFFICE BUILDING

BGS School of Architecture and Planning
BGS Knowledge City,Kumbalgodu,Bengaluru

GAEA

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REVIEWER 1		
ENERGY PERFORMANCE	VERY GOOD	The respective revisions have been made on PAGE 18-21
WATER PERFORMANCE	VERY GOOD	The respective revisions have been made on PAGE 22-23
EMBODIED CARBON	VERY GOOD	the respective revisions have been made on PAGE 35-36
RESILIENT DESIGN	VERY GOOD	The respective revisions have been made on PAGE 29-30
ENGINEERING AND OPERATIONS	FAIR	The respective revisions have been made on PAGE 24-26
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AFFORDABILITY	FAIR	The respective revisions have been made on PAGE 31-32
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SECTION	REVIEWER'S COMMENTS	OUR RESPONSE
REVIEWER 2		
ENERGY PERFORMANCE	VERY GOOD	The respective revisions have been made on PAGE 18-21
WATER PERFORMANCE	VERY GOOD	The respective revisions have been made on PAGE 22-23
EMBODIED CARBON	FAIR	the respective revisions have been made on PAGE 35-36
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VALUE PROPOSITION	GOOD	The respective revisions have been made on PAGE 34

1.0 EXECUTIVE SUMMARY

GAEA is a group of ambitious design and engineering students with the aim of designing an office building that is a state-of-the-art sustainable building, accommodating 10,500 people.
The project is designed to reduce energy usage and incorporate net-zero design principles to reduce carbon footprint.

Starting with a client-proposed EPI goal of 65 kWh/m^2-yr, the building incorporates several energy-efficient measures to reduce its environmental impact while ensuring user comfort and affordability.

The building design process includes incorporating passive strategies and efficiently planned radiant cooling systems, using high-performance building materials, and installing energy-efficient lighting systems.
In addition, the building has been designed to maximize natural light using cut-outs within the floor plate, and occupancy sensors reducing the need for artificial lighting.

Water consumption for a large crowd of 10,500 people has been a significant consideration in the design of the building, to achieve net-zero water consumption. The facility includes multiple water-saving fixtures, rainwater harvesting systems, and greywater reuse systems to make the building more water efficient.

Comfort and user experience were also key considerations in the design process, incorporating flexible and open workspaces, green spaces, breakout zones, lounges, cafeterias, gyms and informal areas.

The building has been designed with resilience during climate change and natural disasters, encapsulating a load-bearing structure, appropriate glazing and fenestration, recoverability operations, and materials resistant to extreme weather conditions.

In conclusion, the office building project with an EPI of 60 kWh/m^2-yr is an innovative and sustainable building. The design process has been carefully considered to ensure affordability and functionality, making it a cost-effective and environmentally responsible solution for Hyderabad's growing office space requirements.

2.0 TEAM SUMMARY

2.1 TEAM NAME : GAEA

Named after the Greek Goddess Of Earth, GAEA is the idea that the earth's living and nonliving components work as a single system in which the living component governs and maintains circumstances conducive to life.

2.2 INSTITUTION NAME :

BGS SCHOOL OF ARCHITECTURE AND PLANNING

2.3 DIVISION : **OFFICE BUILDING**

2.4 TEAM MEMBERS

2.5 TEAM ORGANISATION AND APPROACH

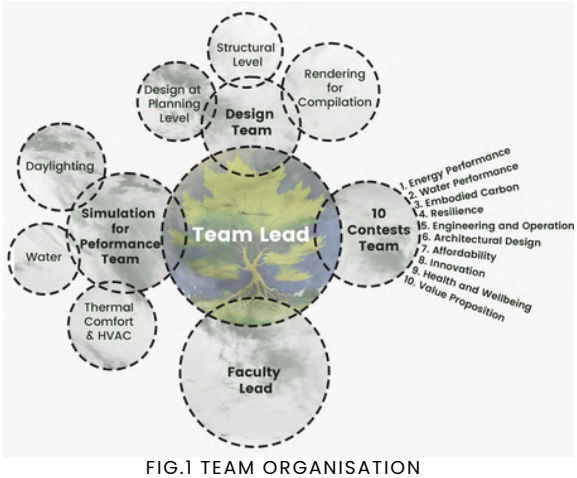


FIG.1 TEAM ORGANISATION

GAEA is a team that aims to utilize sustainability in building design and construction as the archetype for the present and the future.
Work is appropriately split between the Simulation for Performance team, the design team and the 10 contests team by the Team Lead over the span of the deliverable.
Each team is divided into multiple sub-groups to fulfil requirements for simulations, presentation and design and the 10 contests of the competition.
Frequent reviews at different points of the creation of the report take place to keep things in check.

2.6 BACKGROUND OF BGSSAP

BGS School of Architecture and Planning (BGSSAP) is dedicated to sharpening and developing students' skills in sustainable design and the creation of a sustainable built environment as responsible and sensitive Global Citizens. In order to achieve this, Bachelor of Architecture Degree is taught at BGSSAP by balancing traditional planning, and design heritage from across India with current trends in environmental awareness, processes and materials and future practices, which gives the next generation of architects and planners valuable skills to create a sustainable built environment and on the grounds of primary focus for the areas of the ten contests.

FIG 2 - BGSSAP BUILDING

2.7 FACULTY LEAD AND ADVISOR

Ar. Chetan Tippa - Assistant Professor, BGSSAP
Specialization in subjects pertaining to climatology, building construction and environmentally responsive Architecture. Faculty lead for NASA India.

Ar. Jasper - Assistant Professor, BGSSAP
Specialization in building management system and construction project management. Faculty advisor for NASA India.

FIG 3 - FACULTY LEAD AND ADVISOR

2.8 INDUSTRY PARTNERS

McD BERL (McD built environment research laboratory private limited)
Net zero energy, zero carbon and Net positive water targets on the campus. McD BERL was instrumental in figuring out the technicalities of this project.

FCC Engineers and Infrastructure
FCC Engineers and Infrastructure (FCC) is a Bangalore-based Turnkey Contracting company carrying out complete construction solutions including project management and consultancy services. They have a broad spectrum of service offerings in civil engineering and a fast-growing customer base including some of the key names in the region.

FIG 4 - INDUSTRY PARTENERS

2.9 DESIGN MANAGEMENT PROCESS

1. Team Meetings: Regular team meetings are essential for keeping everyone on the same page and ensuring everyone understands the project goals, timelines, and requirements. GAEA held regular team meetings, both online and offline in between our respective academic schedules for balanced planning and discussion of ideas.

2. Industry Partner Inclusion: Industry partners, McD BERL, brought a wealth of knowledge and experience to the design process and helped ensure that the design solution is relevant, innovative, and practical.

3. Recurrent Reviews: Throughout the design process, the team conducted regular reviews to assess the progress of the project and to gather feedback from faculty advisors, industry partners, and other team members for each topic.

4. Project Partner Discussion: Project partners provided valuable input on the feasibility and scalability of the design solution and resolved questions posed by the team.

5. Tools Used: The design team will use various tools to support the design process, including design software, project management tools, and collaboration platforms. AutoCAD, SketchUp, Lumion, design builder, photoshop, Microsoft Office applications, and Canva were the prominent ones.

FIG 5 - TOOLS USED

DESIGN PROCESS

DELIVERABLE 1
AUG 2022 - OCT 2022

- LEARNING AND UNDERSTANDING NET-ZERO DESIGN THROUGH SDI LEARNING MODULES AND WEBINARS.
- PROJECT INTRODUCTION AND DISCUSSION WITH PROJECT PARTNER
- PRELIMINARY ANALYSIS OF SITE AND UNDERSTANDING CLIENT REQUIREMENTS
- LITERATURE AND CASE STUDIES DONE BY THE TEAM
- ENCAPSULATING GOALS AND STRATEGIES
- PRELIMINARY BUDGET ESTIMATION AND COSTING, WATER AND ENERGY CALCULATION
- PRE-DESIGN ANALYSIS IN TERMS OF THERMAL COMFORT, DAYLIGHTING AND SHADING

DELIVERABLE 2
OCT 2022 - DEC 2022

- CONSIDERATION OF REVIWERS' COMMENTS AND RESPECTIVE CHANGES FOR ADDITIONS IN THE REPORT
- CONCEPTUAL ZONING AND FORM BASED ON PRELIMINARY ANALYSIS
- CONTACTING TRG AND PROJECT PARTNERS FOR ASSISSTANCE AND CLEARING DOUBTS
- COMPLETING 90% OF SDI LEARNING MODULES AND ATTENDING WEBINARS
- DESIGN IDEAS, INNOVATION AND RESILIENT BUILDING SOLUTIONS
- UPDATING GOALS AND STRATEGIES FOR ELABORATION OF AREA PROGRAMMING, WATER AND ENERGY CONSUMPTION
- EXPANDING ON CONTEXT ANALYSIS BY CONDUCTING SURVERYS

DELIVERABLE 3
DEC 2022 - FEB 2023

- FULL COMPLETION OF LEARNING MODULES AND ATTENDING WEBINARS
- CONTINUOUS DISCUSSIONS WITH INDUSTRY PARTNERS FOR ENERGY, WATER AND HVAC SOLUTIONS
- FINALISATION OF DESIGN AT PLANNING LEVEL AND MATERIALS BASED ON SIMULATION OUTPUTS
- UPDATION OF REPORT CONSIDERING REVIEWER'S COMMENTS
- FINALISING GOALS BASED ON THE 10 CONTESTS AND WORKING ON DESIGN PROCESS
- UPDATING ENERGY AND WATER CONSUMPTION, BUDGET AND HEALTH AND WELL-BEING
- EVALUATING AFFORDABILITY AND EMBODIED CARBON CALCULATION

FINAL DELIVERABLE
FEB 2023 - MAY 10

- IMPROVEMENTS BASED ON REVIEWER'S RATINGS
- DISCUSSIONS WITH INDUSTRY PARTNERS IN PREPARATION FOR THE FOR FINAL REPORT
- AVAILING FINAL ENERGY AND WATER CALCULATIONS
- OUTLINING PERFORMANCE SPECIFICATIONS
- OUTLINING IMPORTANT FACTORS IN VALUE PROPOSITION
- FINAL EDITING AND COMPILATION OF THE REPORT AND SUCCESSIVE REVIEW WITH FACULTY
- POSTER AND VIDEO FOR THE FINAL SUBMISSION

SUBMISSION AND GRAND JURY

FIG 6 - DESIGN PROCESS

3.0 PROJECT SUMMARY

3.1 PROJECT PARTNER INFORMATION

PROJECT NAME: **INFOSYS SOFTWARE DEVELOPMENT PARK**
PROJECT PARTNER**: INFOSYS LIMITED**

Infosys Limited was founded in Pune in 1981 as an Indian multinational IT company that provides business consulting, information technology and outsourcing services with more than 335k employees.
As the second-largest Indian IT company, Infosys has 82 sales and marketing offices and 123 development centres across the world with a major presence in India, the USA, China, Australia, Japan, the Middle East and Europe.

KEY INDIVIDUAL, INFOSYS : **CHETAN R (SENIOR MANAGER, GREEN INITIATIVES, INFOSYS)**

3.2 BREIF OF THE PROJECT

BRIEF OF THE PROJECT:
LOCATION: **Hyderabad**
CLIMATE ZONE: **Composite**
STATUS OF THE PROJECT: **Proposed**
PROFILE OF THE OCCUPANTS: **IT and Software Engineers**
PURPOSE OF THE PROJECT: Built and owned by Infosys and operated as an Office space.
HOURS OF OPERATION: **9 AM TO 5 PM Occupancy hours with 24/7 functioning services**(i.e. Server Rooms/Communication Room, DG Rooms, Battery Rooms keep functioning, even after working hours etc.)

SITE AREA: **65 ACRES**
PERMISSIBLE BUILT-UP AREA AND GROUND COVERAGE:

- Hyderabad Bylaws do not account for any specific FAR/FSI cap currently.
- Only setbacks and road widths regarding building heights are mentioned.

PROPOSED BUILT-UP AREA: **59,517 SQM** Including 2 blocks **(*SDB-8A AND *SDB-8B)**
SPECIFIC TARGETS MANDATED BY THE PROJECT PARTNERS:
LEED V 4.1 • WELL Standard • NET ZERO Energy & Water • Radiant Cooled Building • ECBC+ above • LCA analysis • EPI < 65 kWh/m2/year • LPD : 0.5 W/Sqft • HVAC : 750 Sqft/TR • Electrical : 3.5 W/Sqf

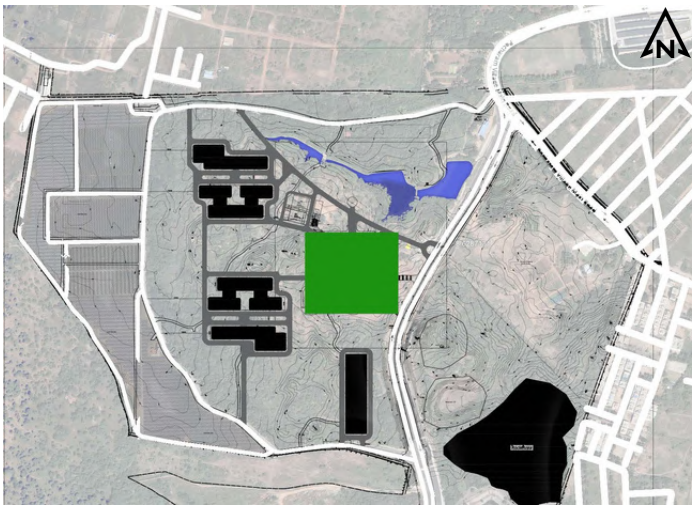


FIG 7 - INFOSYS OFFICE BUILDING SITE

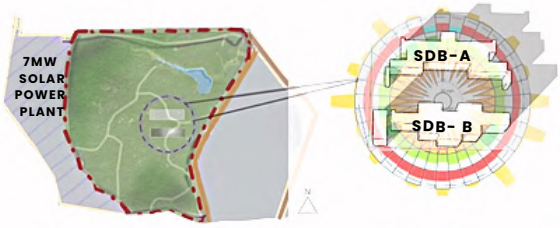


FIG 8 - BLOCK DEVELOPMENT

- In the demarcated site of 65 acres, an identified **6.6 acres** on the eastern corner of the site is provided to design the Infosys software development blocks namely SDB-8A and SDB-8B. Towards the west and northwest are plots catering to future development.
- 7MW solar power plant is located towards the west of the site, however, the generated energy cannot be used for the net zero performance of the proposed building.

CONTEXT ANALYSIS*:
the team conducted an online survey to understand the perspective of occupants, demographics, how an office environment works, the hierarchy, arrangement of spaces and accessibility to analyse what can be done to improve interaction, arrangement and overall productivity in an office space.
We found that on an account of the worldwide pandemic, most of the global IT population sits back, working from home. having experienced the flexible and comfortable environment of home as a workspace, most IT professionals are still preferring working from home. considering the shift in work culture, a designer's challenge is to consider an office environment fit for the present and the future as well as more enticing workspace design patterns.

*Please refer to **APPENDIX** for a detailed ANALYSIS

3.0 PROJECT SUMMARY

3.3 TARGET EPI

GOAL ENERGY PERFORMANCE INDEX : EPI < 65 KWH/SQM/YEAR (CLIENT REQUIREMENT)

PERFORMANCE METRIC	STANDARD DESIGN (BUSINESS AS USUAL BUILDINGS)*	EFFICIENT DESIGN (INFOSYS REQUIREMENT)*	REDUCTION %
BUILDING ENERGY CONSUMPTION	250 kWh/Sqm/yr	65 kWh/Sqm/yr	75%

TABLE 1 - GOAL ENERGY PERFORMANCE INDEX

* Average for commercial office buildings (incl. lights, AC, computers, miscellaneous)
** Total electrical load for commercial office buildings including chiller plant
Source-infosys solar decathlon India 2021

BASED ON THE ABOVE TABLE THE EFFICIENT ENERGY CONSUMPTION IS **65K WH/M2/YEAR**
THEREFORE, ENERGY REQUIRED FOR

TOWER A= 15,93,475 KWH/YEAR
TOWER B = 13,55,965 KWH/YEAR

HENCE THE TOTAL ENERGY REQUIRED BY THE BUILDING = 16,07,034 KWH/YEAR

FOR SOLAR PV INSTALLATION 50% OF THE TOTAL ROOF AREA HAS BEEN CONSIDERED. THE REST 50% SHALL CONSIST OF COOLING TOWER, CHILLERS, HEADROOMS, OVER HEAD TANKS AND CIRCULATION AROUND SOLAR PANEL FOR MAINTENANCE ETC.

RENEWABLE ENERGY SOURCE: BIFACIAL PV MODULE

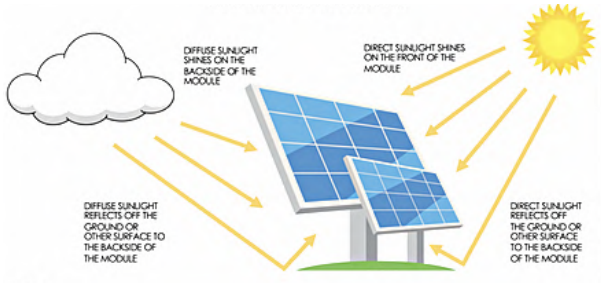


FIG 9 - MECHANISM OF BIFACIAL MODULES

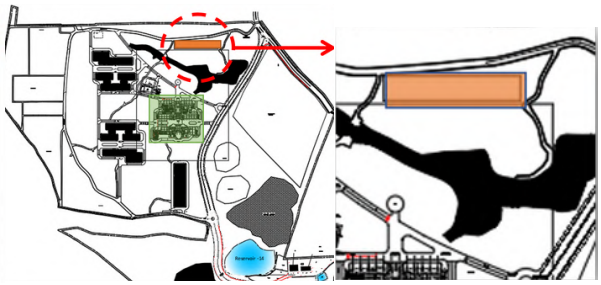


FIG 10 - LOCATION OF BIFACIAL PV MODULE

USAGE OF BIFACIAL SOLAR PANEL ON THE ROOF + BY TREATING THE ROOF WITH REFLECTIVE SURFACE (CAUSES REFLECTION OF UPTO 85% OF SOLAR LIGHT BACK)

3.4 ON-SITE RENEWABLE ENERGY GENERATION POTENTIAL

TOTAL ROOF AREA	13,635 SQ.M
USEABLE SOLAR PLANT AREA	90% OF ROOF AREA
USEABLE ROOF AREA FOR SOLAR POWER PLANT	12396 SQ.M
AREA OF ONE SOLAR PANEL	3 SQ.M
NO. OF BIFACIAL SOLAR PANELS WHICH CAN BE INSTALLED	4132 PANELS
ANNUAL ENERGY GENERATION USING ROOF TOP SOLAR PV	3704881 kWh/year
AREA COVERED WITH SOLAR PANELS AT SOLAR FARM	3985 SQM
NO. OF BIFACIAL SOLAR PANELS WHICH CAN BE INSTALLED	1129 PANELS
ANNUAL ENERGY GENERATION USING SOLAR FARM	1199183 kWh/year
ANNUAL WASTE GENERATION WITH 40% DRY WASTE	1365 TONNES
ANNUAL BIOGAS ENERGY GENERATION	696150 kWh/year

TABLE 2 - ON-SITE RENEWABLE ENERGY GENERATION POTENTIAL

THEREFORE TOTAL ENERGY GENERATED ON SITE PER YEAR = 56,00,214 KWH/YR

4.0 PERFORMANCE SPECIFICATIONS

IGBC NET ZERO BUILDING RATING SYSTEM

TOTAL CREDIT POINTS - 185

SECURED DESIGN CREDIT POINTS - 160

*REFER **APPENDIX PAGE-** FOR DETAILED SPECIFICATION

BUILDING ENVELOPE		
CATEGORY	**SYSTEM/ MATERIAL**	**TECHNICAL SPECIFICATION**
WALL	ACC WALL U VALUE-0.206	20MM PLASTER/225MM AERATED CONCRETE BLOCK/75MM FOAM/100MM AIRGAP/225MM AREATED CONCRETE BLOCK/20MM PLASTER
ROOF	EFFICIENT ROOF U VALUE-0.285	5MM ALPHAT REFLECTIVE COAT/15MM CEMENT/75MM FOAM/200MM AERATED CONCRETE BLOCK/15MM CEMENT PLASTER.
WINDOWS	DBL ELEC REF BLEACHED SHGC-0.478 VLT-0.381 U VALUE-2.665	ELECTRO CHROMATIC REFLECTIVE BLEACHED (DBL ELEC REF BLEACHED)-6MM/AIR 13MM/CLEAR 6MM
EXTERNAL FINS	PRECAST AAC	PRECAST AAC (100 MM THICKNESS X 500 DEPTH)
LIGHT SHELF	MDPI PRECAST AAC	MDPI precast lightweight
LIGHT PIPE	PRISMATIC GLASS	PRISMATIC GLASS/EXTERNAL DIFFUSER STRETCH FABRIC
SLAB	AAC SLAB U- VALUE-0.285	CASTING OF SLAB USING AIRCRETE

HVAC SYSTEM	
CATEGORY	**TECHNICAL SPECIFICATION**
LT CHILLER	399.7435897 TR
MT CHILLER	251.7436952 TR

ELECTRICAL LOAD	
CATEGORY	**TOTAL ENERGY CONSUMED**
LIGHTING	2,83,542,420 WATT/YEAR
EQUIPMENT	26,39,884,320 WATT/YEAR

PLUMBING AND SANITATION	
CATEGORY	**SPECIFICATION**
TOTAL WATER DEMAND	44235 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION
DRINKING WATER DEMAND	8190 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION
GREY WATER DEMAND	13104 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION
BLACK WATER DEMAND	16380 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION
LANDSCAPING WATER REQUIREMENT	5286 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION
COOLING WATER REQUIREMENT	1274 KILOLITRES PER YEAR FOR BOTH THE TOWERS OVER 260 DAYS OF OPERATION
TOTAL COLLECTED WATER	68869 KILOLITRES PER YEAR FOR 10,500 PEOPLE OVER 260 DAYS OF OPERATION

RENEWABLE ENERGY			
CATEGORY	**MODEL**	**NO. OF PANELS**	**ENERGY GENERATED**
ROOFTOP SOLAR PANELS	LOOM SOLAR PANEL DUAL ARRAY	4132	3,704,881 KWH
SOLAR FARM	LOOM SOLAR PANEL DUAL ARRAY	1129	1,199,183 KWH
BIOGAS	HYDROTHEMAL CARBONIZATION	-	696150 KWH/Y

TABLE 3 - PERFORMANCE SPECIFICATIONS

5.0 GOALS

1. ENERGY PERFORMANCE

AIM
To achieve thermal comfort and 85% daylighting in workspaces and lower energy consumption


Covering roof with bifacial solar panels for energy generation


Brise Soleil fin structure system for south-west facade to avoid excessive heat gain

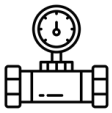

Passive strategies and biophilic approach for west facade due to heat gain in late evenings


Reflective ceiling surface and light shelfs along windows to maximize daylight


Cut-outs to maximize daylighting in the workspaces

2. WATER PERFORMANCE

AIM
To reduce water consumption by over 50% through grey water treatment, rainwater harvesting and efficient plumbing fixtures

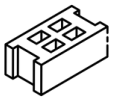

Water consumption can be regulated and monitored using metering and leak detection


Rainwater and greywater filtering, storage and re-use systems


Sensor operated and low water consuming fixtures reduce water demand and usage

3. EMBODIED CARBON

AIM
To reduce carbon emissions associated with production, transportation and construction of building materisl and products


Construction costs are reduced by usage of new and efficient materials like AAC block


Usage of regionally available materials and recyclable building materials leads to reduction in transportation costs and time


Using simulations and simple box models in early design phase to simplify MEP systems

4. RESILIENCE

AIM
To design the structure to withstand natural mishaps(flood, drought) and to function efficiently during time of crisis


MEP requirements to be placed on higher levels instead of in the basement


Water pumps, water-resistant materials and energy back-up systems


Rainwater harvesting, water recharge system and dense vegetation to recharge groundwater during droughts


RCC construction, base isolators, dampers, aerodynamic orientations, central shafts for earthquake/cyclones


Food loss crisis is prevented through appropriate refrigeration, good food behaviours, composting food waste

5. ENGINEERING AND OPERATION

AIM
Use of sensors to save 29% of building energy consumption and controllers to manage 20% of building peak load


Using temperature and occupancy sensors to control the cooling of space


Efficient BMS system to manage the controls for the building


Designing a structural system for the specific soil type

6. ARCHITECTURAL DESIGN

AIM
To enhance movement, using flexible and aesthetic workspaces, and the need for employees' wellness, context and climate parameters


Locating internal stairs in a highly visible location and enhancing them with user experience elements


Centralized copy room and drinking fountains that stimulate workers to stand up, interrupt their sitting activities


Incorporating plants into the office to improve air quality


Open space areas should be close to the wall openings. This maximizes the effect of daylight


Flexible and confortable workstations

7. AFFORDABILITY

AIM
To maximize affordability from building capital, operational and construction costs and integrating cost-impact analysis from client's perspective


Reducing energy and water demands reduce costs over time


Sensors and BMS system to keep the facility in check and to monitor the energy usage


Optimizing daylighting reduces lighting equipment load over time

8. INNOVATION

AIM
To maximize daylighting and saving energy using innovative technologies


Natural light provided without facades possibly by opening sky lights on the roofs light shelves and light tube


Smart glass technology for managing light and glare


Smart dustbins for efficient waste management

9. HEALTH AND WELL BEING

AIM
Biophilic design to capture the stress and bring nature to workspace, provide space to relax and cultivating an open workplace


Introducing native plants, natural daylight, green walls, timber exterior and patterns and colors that evokes nature.

10. VALUE PROPOSITION

AIM
Outlining the benefits and value that the design offers to the clients, and how it satisfies a net zero design


Identifying client requirements and needs


Highlighting the benefits and successes of the design


Utilizing the other contests to justify the pros and cons of the design

Justifying the design using the comparison of base case and proposed case strategies

6.0 DESIGN DOCUMENTATION

6.1 PRE-DESIGN ANALYSIS

CLIMATE ANALYSIS

Hyderabad is located in South India, in the state of Telangana. It has a composite climate, with hot and humid summers and mild winters.

Summer in Hyderabad starts in March and lasts until June, with temperatures ranging from 32°C to 40°C.

Monsoon season in Hyderabad begins in July and lasts until September. The city receives an average rainfall of 810 mm during this season. The temperature during this season ranges from 23°C to 30°C.

Winter in Hyderabad starts in November and lasts until February. The temperature during this season ranges from 14°C to 28°C. The city experiences a cool and pleasant climate during this period

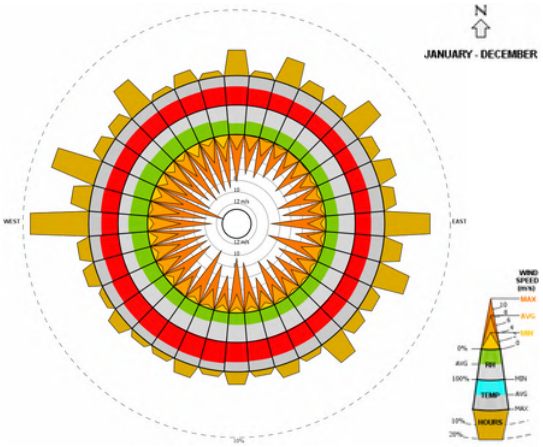


FIG 12 - ANNUAL WIND ROSE DIAGRAM

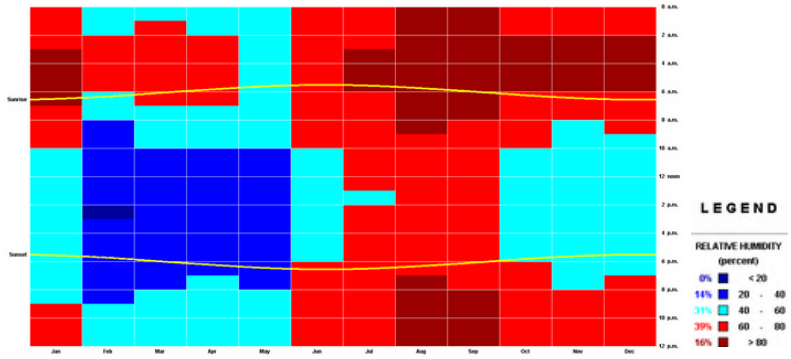


FIG 13 - MONTHLY RELATIVE HUMIDITY

THERMAL COMFORT ANALYSIS

On simulating thermal comfort analysis, the output referred to a subsequent increase in efficiency of the system on adopting the design ideas respectively.
Design idea 3 consists of adaptations from ideas 1 and 2 as well proving to be the most efficient ideology with attaining comfortable operating temperature at 24 °C.
Design idea 4 contributes to the structural concept of the design making the connectivity possible between the two software development blocks, hence it does not contribute to the thermal comfort in a greater extent

ORIENTATION	GLASS TYPE	MODEL	SHGC	VLT%	U(W/m^2K)
EAST	DAYLIGHT WINDOW	SCG COOL LITE-XTREME	0.27	59	1.04
	VISION WINDOW	SKN 454 - II	0.22	42	1.03
WEST	DAYLIGHT WINDOW	SKN 454 WITH FROSTED FILM	0.2	10	1
	VISION WINDOW	SKN 454 - II	0.22	42	1.03
NORTH	DAYLIGHT WINDOW	SCG COOL LITE-XTREME	0.27	59	1.04
	VISION WINDOW	SCG COOL LITE-XTREME	0.27	59	1.04
SOUTH	DAYLIGHT WINDOW	SCG COOL LITE-XTREME	0.27	59	1.04
	VISION WINDOW	SKN 465	0.26	50	1.03

TABLE 4 - ADOPTED GLAZING SPECIFICATION

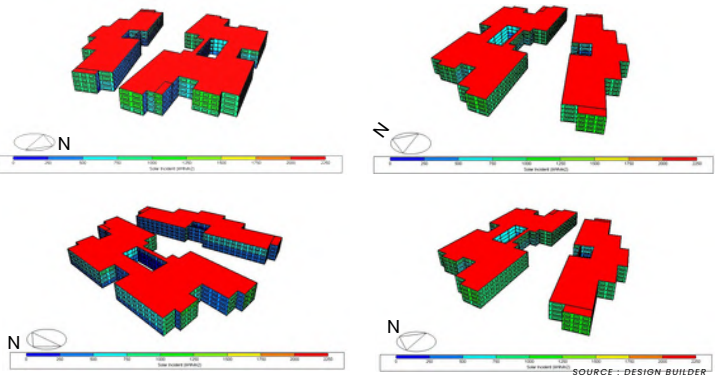


FIG 14 - THERMAL ANALYSIS

SOURCE : DESIGN BUILDER

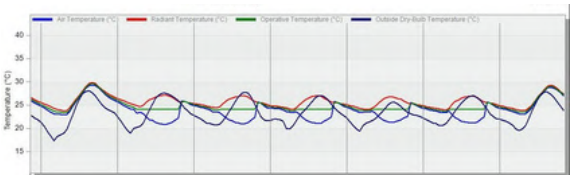


FIG 15 - TREND IN VARIATION OBSERVED OVER CONSECUTIVE DAYS

The adjoining graph B specifies the temperatures and heat gains for the run period. Graph A specifies the trend in variation observed over consecutive days adopting to peak.

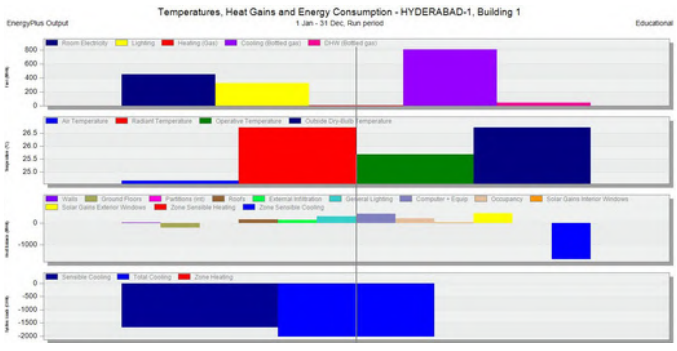


FIG 16 - TEMPERATURES, HEAT GAINS, ENERGY CONSUMPTION OUTPUT

6.0 DESIGN DOCUMENTATION

6.2 DAYLIGHTING SIMULATIONS

DAYLIGHTING PLAYS A CRUCIAL ROLE IN THE DESIGN PROCESS. ACCORDING TO WORLD GREEN BUILDING COUNCIL, DAYLIGHT IN THE WORKSPACE ENSURES HIGHER ENGAGEMENT OF EMPLOYEES. HENCE VARIOUS ITERATIONS OF DAYLIGHTING SIMULATION WERE DONE TO EVOLVE THE PLANNING AND DESIGN.

USEFUL DAYLIGHT ILLUMINANCE (UDI)-

USING UDI, WE WERE ABLE TO ANALYSE THE DAYLIGHT AVAILABILITY METRIC THAT CORRESPONDS TO THE PERCENTAGE OF THE OCCUPIED TIME WHEN 100-2000 LUX (TARGET LUX) OF ILLUMINANCE AT A POINT IN SPACE IS MET BY DAYLIGHT.

OUTCOME- THE WORKSPACE RECEIVES 100-2000 LUX FOR 60% OF FLOOR AREA FOR ATLEAST 90% OF THE POTENTIAL DAYLIT TIME

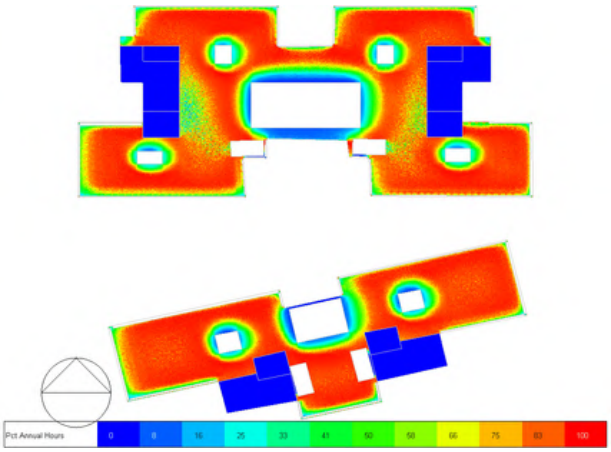


FIG 17 - USEFUL DAYLIGHT ILLUMINANCE(UDI)

ANNUAL SUNLIGHT EXPOSURE (ASE)-

ANNUAL SUNLIGHT EXPOSURE 1000,250 (ASE 1000,250) OF NO MORE THAN 10% OF REGULARLY OCCUPIED AREA IS ACHIEVED.

OUTCOME- PROVISION OF A VEGETATIVE SCREEN ALONG THESE AREAS HELPS US CREATE BUFFER AND AVOID DIRECT SUNLIGHT ON WORKSPACES.
SUNLIGHT REQUIREMENT OF THE PLANTERS ARE ALSO SATISFIED.

ILLUMINANCE-

USING ILLUMINANCE SIMULATION, WE WERE ABLE TO MEASURE THE ACHEIVED 300 LUX RECEIVED ON A SURFACE.

OUTCOME- THIS LED TO THE USE OF PERFORMANCE INDICATORS TO DETERMINE DAYLIGHT AVAILABILITY IN THE INTERIOR.
USE OF LIGHTING CONTROLS IN ARTIFICIAL LIGHTING TO ADJUST AS PER THE AVAILABLE ILLUMINANCE AND INCREASE ITS PERFORMANCE (INCREASED TO REACH TARGET LUX LEVEL)WHEN THE AVAILABLE DAYLIGHT IS LESS.

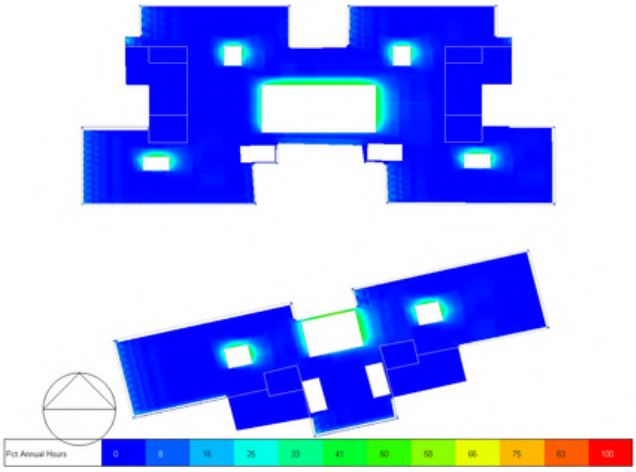


FIG 18 - ANNUAL SUNLIGHT EXPOSURE(ASE)

SPATIAL DAYLIGHTING AUTONOMY-

SPATIAL DAYLIGHT AUTONOMY 300/100% (SDA100/100%- CLIENT REQUIREMENT) OF 85% OF REGULARLY OCCUPIED AREA IS ACHIEVED.

SURFACE TYPE	REFLECTANCE
WALL	50%
CEILING	70%
FLOOR	20%
FURNITURE	50%

TABLE 5 - SURFACE REFLECTANCE

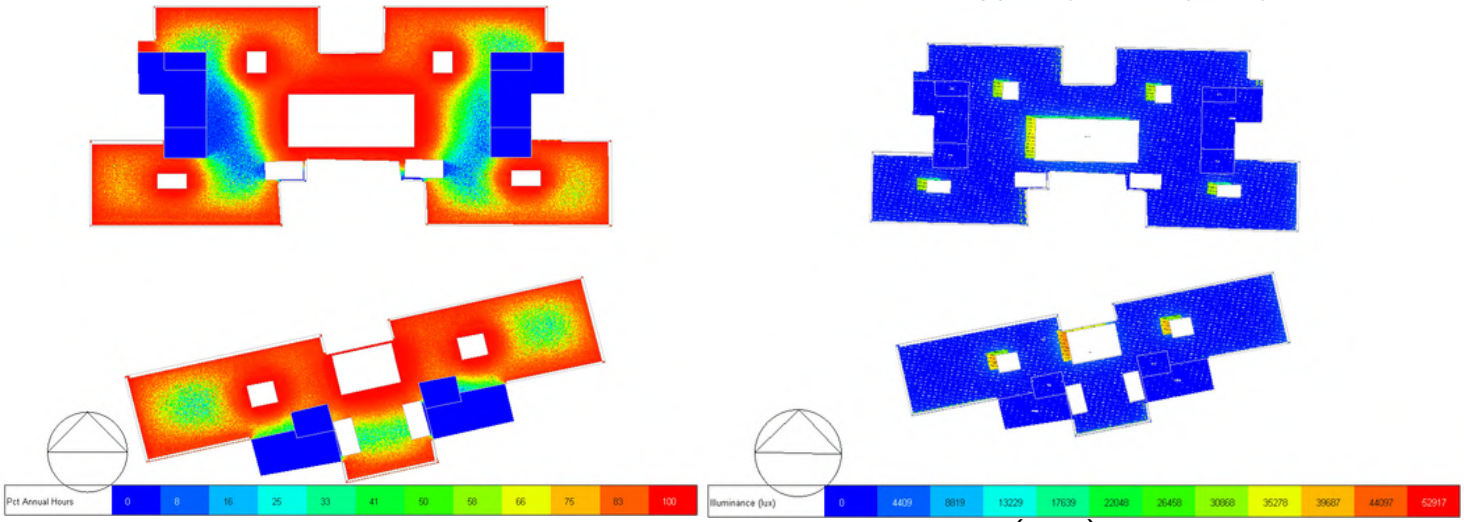


FIG 19 - SPATIAL DAYLIGHTING AUTONOMY (SDA) AND ILLUMINANCE

6.0 DESIGN DOCUMENTATION

6.3 PROPOSED HVAC SPECIFICATIONS

LOW TEMPERATURE CHILLER (LT)	
GENERAL	
NAME	CHILLER
CHILLER TEMPLATE	ELECTRIC EIR CHILLER CENTRIFUGAL CARRIER 19XR 1403KW/7.09COP/VSD
CHILLER TYPE	2-ELECTRIC EIR
REFERENCE CAPACITY (W)	1403100.00
REFRENCE COP (-)	7.090
COMPRESSOR MOTOR EFFICIENCY	1.000
CHILLER FLOW MODE	3 - NOT MODULATED
SIZING FACTOR	1.000
CONDENSER	
CONDENSER TYPE	2 - WATER COOLED
TEMPERATURES	
REFERENCE LEAVING CHILLED WATER TEMPERATURE (°C)	8.9
REFERENCE ENTERING CONDENSER FLUID TEMPERATURE (°C)	29.0
LEAVING CHILLED WATER TEMPERATURE LIMIT (°C)	2.0
FLOW RATES	
REFERENCE CHILLED WATER FLOW RATE (m^3/s)	0.034260
REFERENCE CONDENSER WATER FLOW RATE (m^3/s)	0.042520
PERFORMANCE CURVES	
COOLING CAPACITY FUNCTION OF TEMPERATURE CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL CARRIER 19XR 1403KW/7.09COP/VSD CAPFT
ELECTRIC INPUT TO COOLING OUTPUT RATIO FUNCTION OF TEMPERATURE CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL CARRIER 19XR 1403KW/7.09COP/VSD EIRFT
ELECTRIC INPUT TO COOLING OUTPUT RATIO FUNCTION OF PART LOAD RATIO CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL CARRIER 19XR 1403KW/7.09COP/VSD EIRFPLR
PART LOAD SETTINGS	
MINIMUM PART LOAD RATIO	0.170
MAXIMUM PART LOAD RATIO	1.030
OPTIMUM PART LOAD RATIO	1.000
MINIMUM UNLOADING RATIO	0.170

MEDIUM TEMPERATURE CHILLER (MT)	
GENERAL	
NAME	CHILLER 1
CHILLER TEMPLATE	ELECTRIC EIR CHILLER CENTRIFUGAL TRANE CVHF 2567 kW/11.77COP/VSD
CHILLER TYPE	2-ELECTRIC EIR
REFERENCE CAPACITY (W)	2567100.00
REFRENCE COP (-)	11.770
COMPRESSOR MOTOR EFFICIENCY	1.000
CHILLER FLOW MODE	3 - NOT MODULATED
SIZING FACTOR	1.000
CONDENSER	
CONDENSER TYPE	2 - WATER COOLED
TEMPERATURES	
REFERENCE LEAVING CHILLED WATER TEMPERATURE (°C)	16.0
REFERENCE ENTERING CONDENSER FLUID TEMPERATURE (°C)	29.0
LEAVING CHILLED WATER TEMPERATURE LIMIT (°C)	2.0
FLOW RATES	
REFERENCE CHILLED WATER FLOW RATE (m^3/s)	0.121130
REFERENCE CONDENSER WATER FLOW RATE (m^3/s)	0.151420
PERFORMANCE CURVES	
COOLING CAPACITY FUNCTION OF TEMPERATURE CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL TRANE CVHF 2567 kW/11.77COP/VSD CAPFT
ELECTRIC INPUT TO COOLING OUTPUT RATIO FUNCTION OF TEMPERATURE CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL TRANE CVHF 2567 kW/11.77COP/VSD EIRFT
ELECTRIC INPUT TO COOLING OUTPUT RATIO FUNCTION OF PART LOAD RATIO CURVE	ELECTRIC EIR CHILLER CENTRIFUGAL TRANE CVHF 2567 kW/11.77COP/VSD EIRFPLR
PART LOAD SETTINGS	
MINIMUM PART LOAD RATIO	0.110
MAXIMUM PART LOAD RATIO	1.040
OPTIMUM PART LOAD RATIO	1.000
MINIMUM UNLOADING RATIO	0.110

TABLE 6 - LT CHILLER AND MT CHILLER SPECIFICATIONS

BASE CASE
RADIANT COOLING
TOTAL AREA IN SQM FOR RADIANT COOLING = 7546 SQM
PRICE FOR RADIANT COOLING / SQFT = 550
SO, PRICE OF RADIANT COOLING/SQM = **RS 44,672,320**

1 COOLING TOWER (1148 TR) = RS 3 LAKH
1 CHILLER = RS 3.15 LAKH
20 AHU (5 TON) = RS80000 X 20 =1600000
TOTAL COST = **RS 24551160**

PROPOSED CASE
RADIANT COOLING
TOTAL AREA IN SQM FOR RADIANT COOLING = 7546 SQM
PRICE FOR RADIANT COOLING / SQFT = 550
SO, PRICE OF RADIANT COOLING/SQM = **RS 44672320**
1 COOLING TOWER (1148 TR) = RS 3 LAKH
2 CHILLER = RS 6.3 LAKH
20 AHU (5 TON) = RS 80,000 X 20 = RS 1600000
TOTAL COST = RS 24866160

THERMAL COMFORT IS ACHIEVED DURING ALL OCCUPANCY DURATION AT A SET POINT OF 21 DEGREES TO 24 DEGREES CELSIUS WITH EFFICIENT PUMPING AND WATER CHILLED SYSTEMS.

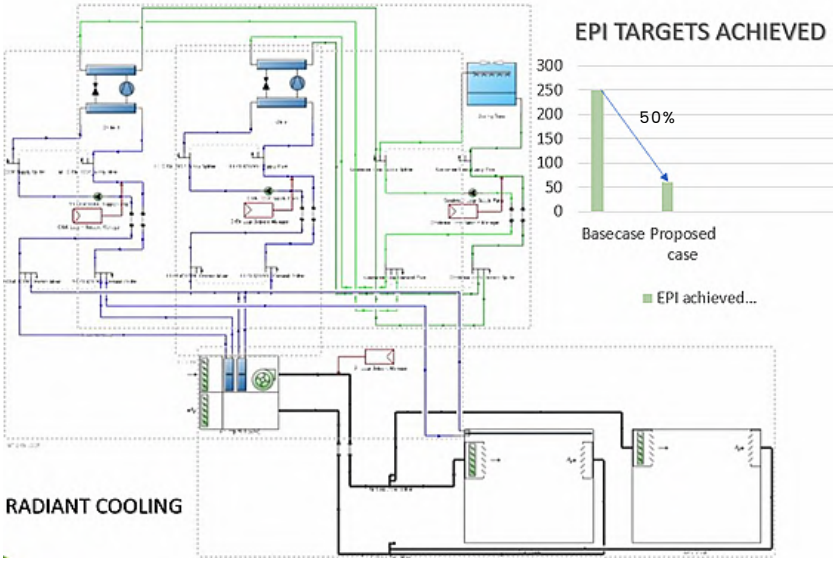


FIG 20 - RADIANT COOLING LAYOUT

6.0 DESIGN DOCUMENTATION

AHU SUPPLY FAN	
GENERAL	
NAME	AIR LOOP A AHU EXTRACT FAN
TYPE	2- VARIABLE VOLUME
FAN TOTAL EFFICIENCY	0.7000
PRESSURE RISE (Pa)	250.0
END USE SUB-CATEGORY	GENERAL
FLOW RATES	
MINIMUM FLOW RATE INPUT METHOD FOR FAN POWER	1 - FRACTION
MINIMUM FLOW FRACTION FOR FAN POWER	0.25
MAXIMUM FLOW RATE (m^3/s)	AUTOSIZE
MOTOR	
MOTOR EFFICIENCY	0.9000
MOTOR IN AIRSTREAM FRACTION	1.000
PART LOAD PERFORMANCE	
PERFORMANCE CURVE TEMPLATE	FAN PART-LOAD POWER INLET VANE DAMPERS
REFERENCE CONDENSER WATER FLOW RATE (m^3/s)	0.042520
FAN COEFFICIENTS	
FAN COEFFICIENT 1	0.3507122300
FAN COEFFICIENT 2	0.3085053500
FAN COEFFICIENT 3	-0.5413736400
FAN COEFFICIENT 4	0.8719882300
FAN COEFFICIENT 5	0.0000000000
OPERATION	
AVAILABILITY SCHEDULE	8:00 - 18:00 MONDAY TO FRIDAY

CONDENSER PUMP CONFIGURATION	
GENERAL	
NAME	CONDENSER LOOP SUPPLY PUMP
TYPE	2- VARIABLE SPEED
PUMP SETTINGS	
DESIGN POWER CONSUMPTION (W)	AUTOSIZE
DESIGN PUMP HEAD (Pa)	200000.00
DESIGN MINIMUM FLOW RATE (m^3/s)	0.00000
MOTOR EFFICIENCY	0.90
FRACTION OF MOTOR INEFFICIENCIES TO FLUID STREAM	0.00
PUMP CONTROL TYPE	2 - INTERMITTENT
PART LOAD PERFORMANCE	
PERFORMANCE CURVE TEMPLATE	PUMP PART LOAD POWER DEFAULT VARIABLE
FAN COEFFICIENTS	
FAN COEFFICIENT 1	0.00000
FAN COEFFICIENT 2	1.000000
FAN COEFFICIENT 3	0.00000
FAN COEFFICIENT 4	0.00000

HVAC TYPE-VAV WATER COOLED

IN CLOCKWISE DIRECTION :
TABLE 7 - AHU SUPPLY FAN SPECIFICATIONS, TABLE 8 - COOLING TOWER SPECIFICATIONS, TABLE 9 - MT CHILLER PUMP SPECIFICATIONS, TABLE 10 - CONDENSER PUMP SPECIFICATIONS

COOLING TOWER	
GENERAL	
NAME	COOLING TOWER
COOLING TOWER TYPE	4 - VARIABLE SPEED
EVAPORATION LOSS MODE	1 - SATURATED EXIT
DRIFT LOSS PERCENTAGE (%)	0.0080
SIZING FACTOR	1.000
AIR FLOW	
DESIGN AIR FLOW RATE (m^3/s)	AUTOSIZE
MINIMUM AIR FLOW RATE RATIO	0.2000
DESIGN FAN POWER	42000.000
MODEL TYPE	
MODEL TYPE	1 - COOL TOOLS CROSS-FLOW
WATER FLOW	
DESIGN AIR FLOW RATE (m^3/s)	AUTOSIZE
FAN POWER	
FAN POWER MODIFIER FUNCTION OF AIR FLOW RATE RATIO CURVE	VS TOWER FAN POWER MOD FUCNTION AIR FLOW RATIO
TEMPERATURE	
DESIGN INLET AIR WET-BULB TEMPERATURE (°C)	26.000
DESIGN APPROACH TEMPERATURE (DELTA C)	3.000
DESIGN RANGE TEMPERATURE (DELTA C)	5.000
FREE CONVECTION REGIME	
FRACTION OF TOWER CAPACITY IN FREE CONVECTION REGIME	0.125
BASIN HEATER SETTINGS	
BASIN HEATER CAPACITY (W/K)	0.0
BASIN HEATER SETPOINT TEMPERATURE (°C)	2.00
BASIN HEATER OPERATING SCHEDULE	ON 24/7
BLOWDOWN	
BLOWDOWN CALCULATION MODE	1 - CONCENTRATION RATIO
BLOWDOWN CONCENTRATION RATIO	3.000
MULTI-CELL TOWER SETTINGS	
NUMBER OF CELLS	4
CELL CONTROL	1 - MINIMAL CELL
CELL MINIMUM WATER FLOW RATE FRACTION	0.330
CELL MAXIMUM WATER FLOW RATE FRACTION	2.500

MT CHILLER PUMP	
GENERAL	
NAME	MT CHW LOOP SUPPLY PUMP
TYPE	2- VARIABLE SPEED
PUMP SETTINGS	
DESIGN POWER CONSUMPTION (W)	AUTOSIZE
DESIGN PUMP HEAD (Pa)	245000.00
DESIGN MINIMUM FLOW RATE (m^3/s)	0.00000
MOTOR EFFICIENCY	0.90
FRACTION OF MOTOR INEFFICIENCIES TO FLUID STREAM	0.00
PUMP CONTROL TYPE	INTERMITTENT
PART LOAD PERFORMANCE	
PERFORMANCE CURVE TEMPLATE	PUMP PART LOAD POWER DEFAULT VARIABLE
FAN COEFFICIENTS	
FAN COEFFICIENT 1	0.00000
FAN COEFFICIENT 2	1.000000
FAN COEFFICIENT 3	0.00000
FAN COEFFICIENT 4	0.00000

6.0 DESIGN DOCUMENTATION

6.4 FORM DEVELOPMENT

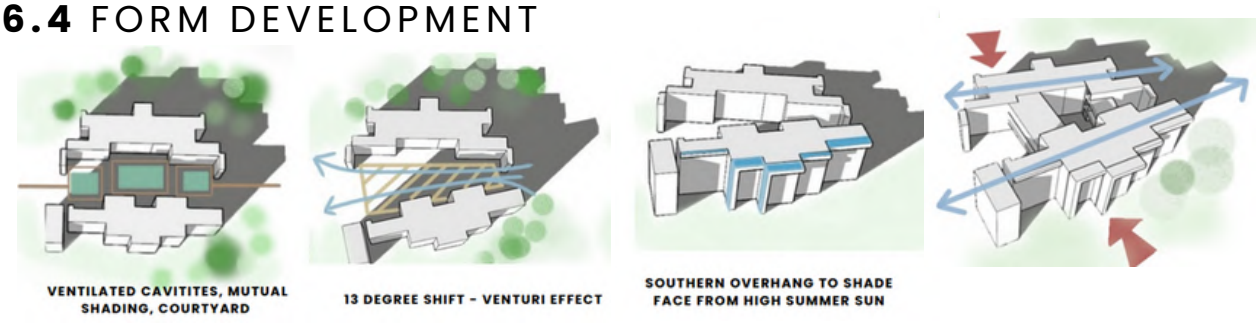


FIG. 21 FORM DEVELOPMENT

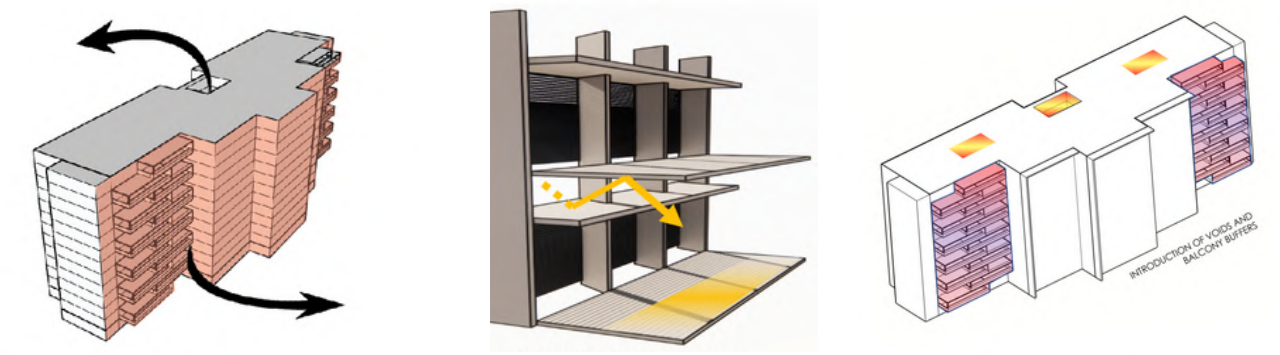


FIG. 22 ADDITIONS TO THE FORM

PROVIDING MUTUAL SHADING USING STAGGERED BALCONIES, PROVIDING VOIDS IN THE BUILDING HELPS IN VENTILATION BY AVOIDING DENSITY IN BUILDING VOLUME AND THE ATRIUM PROVIDES A STACK EFFECT IN THE BUILDING BY REDUCING HEAT GAIN IN THE BUILDING.
PROVISION OF LIGHT SHELVES WITH DAYLIGHT PANE AND VISION PANEINTEGRATED WITH REFLECTIVE CEILING SURFACE AND LIGHT SHELF ON WINDOW TOP FOR MAXIMIZING DAYLIGHT.

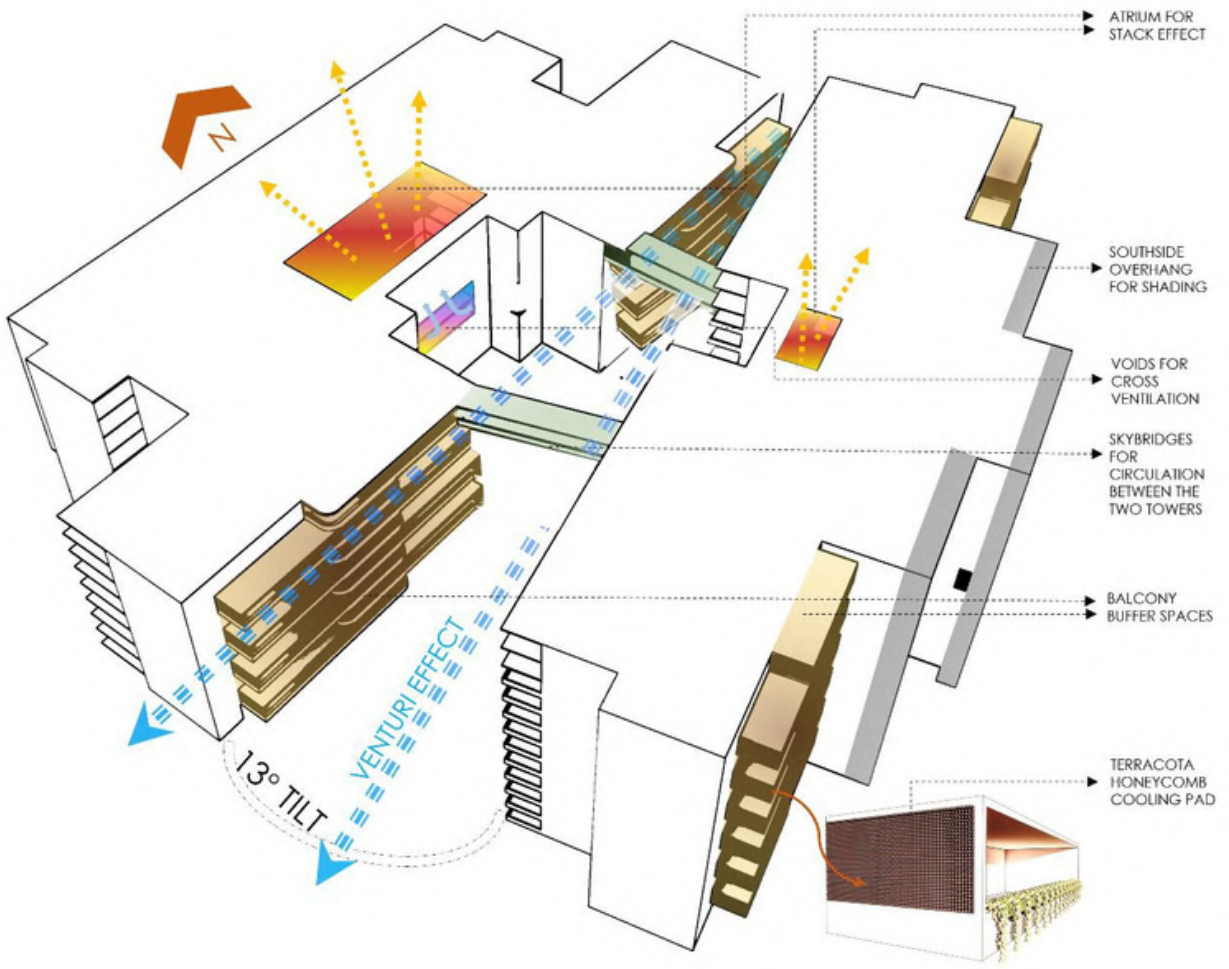


FIG. 23 PROPOSED FORM

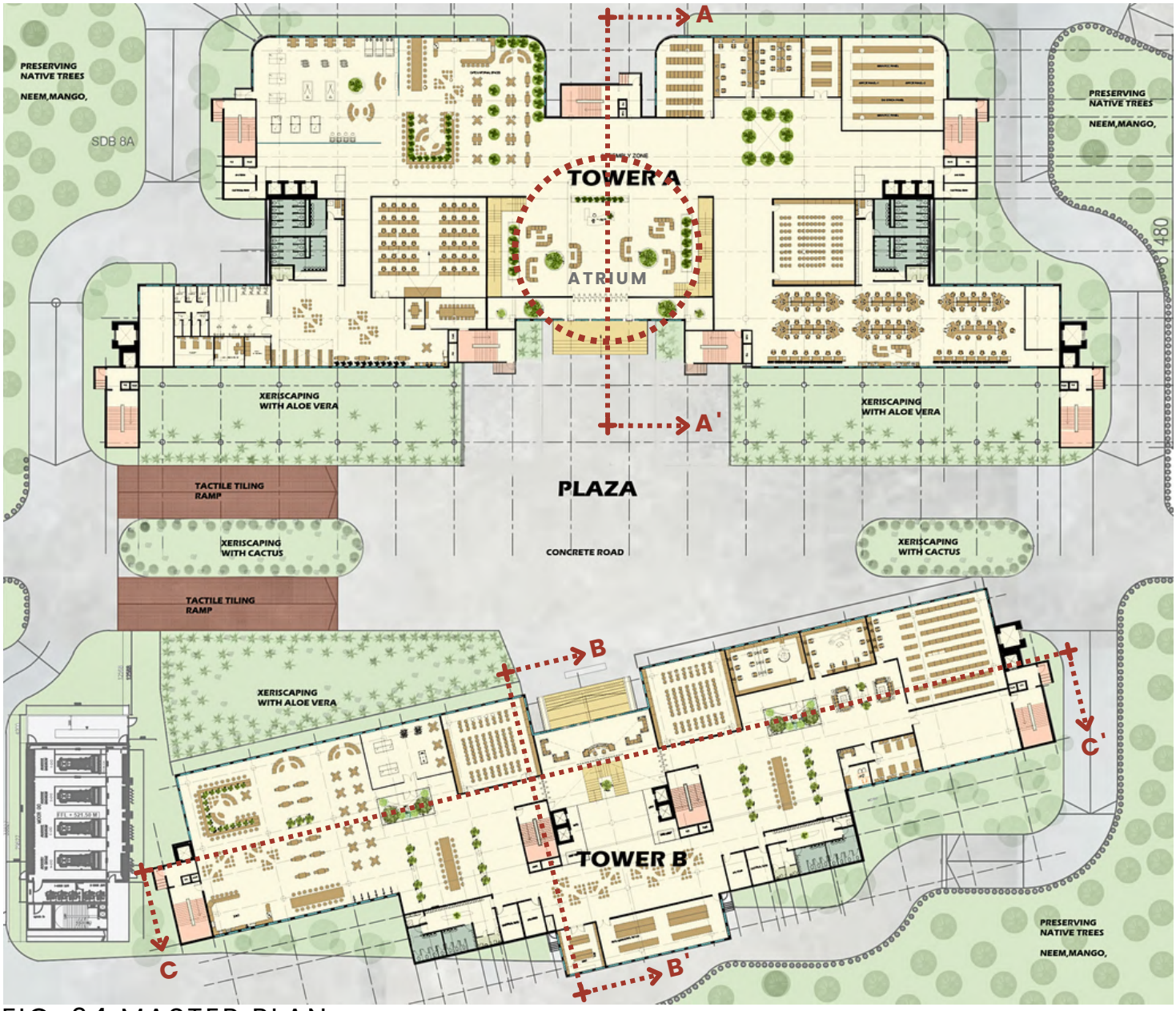


FIG. 24 MASTER PLAN

FIG. 25 TYPICAL FLOOR PLAN

FIG. 26 ATRIUM VIEWS

FIG 27. SECTION @ AA'

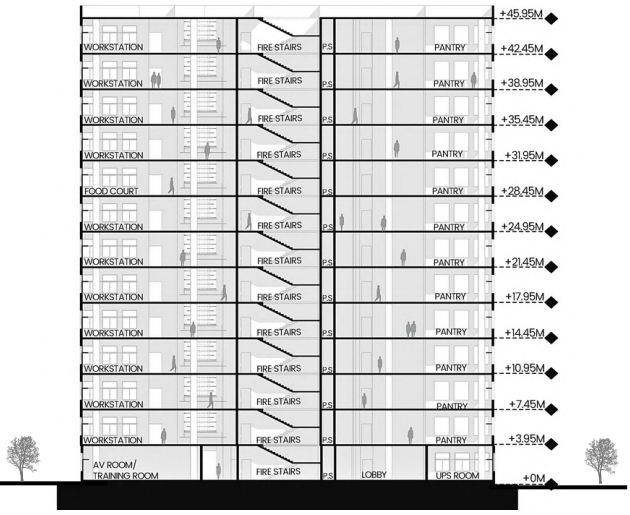


FIG 28. SECTION @ BB'

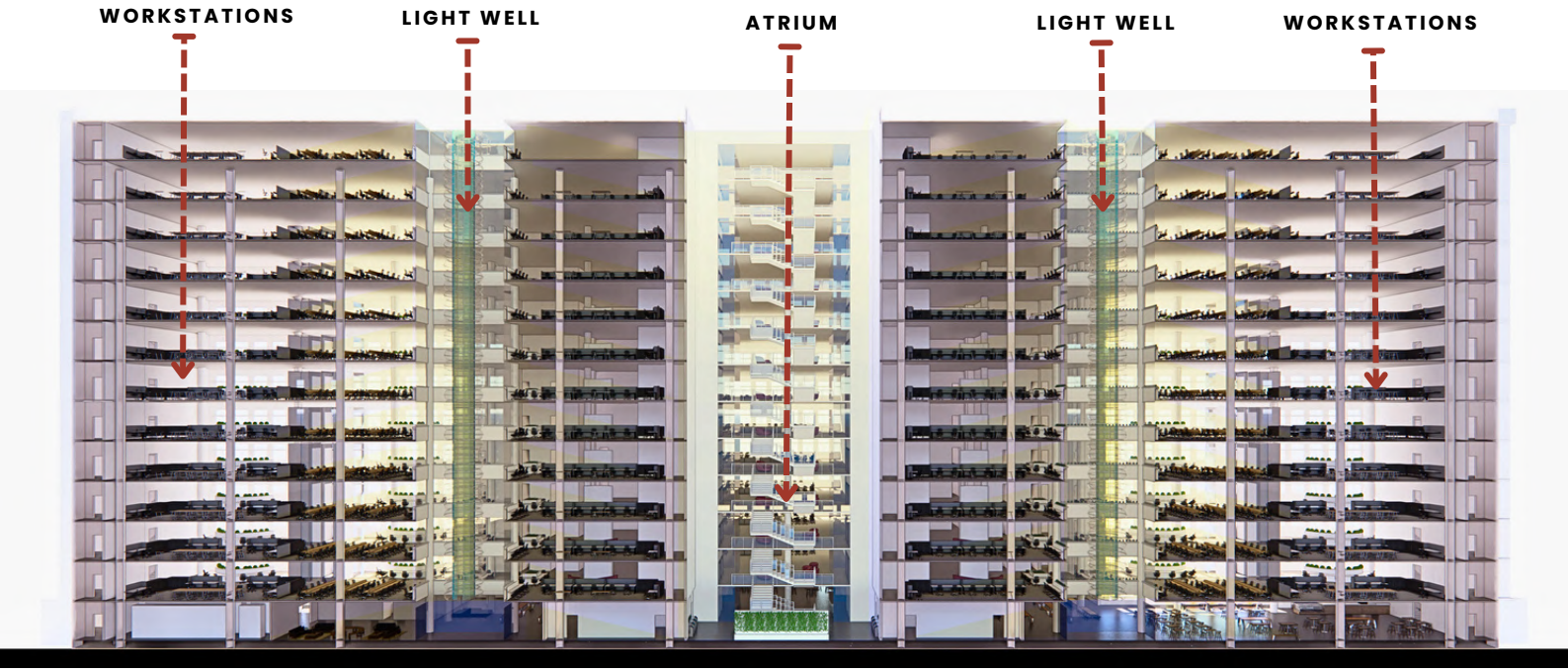


FIG 29. SECTION @ CC'

FIG 30. ELEVATION OF TOWER A

FIG 31. INTERIOR VIEWS OF WORKSTATIONS

FIG 32. STAGGERED BALCONIES

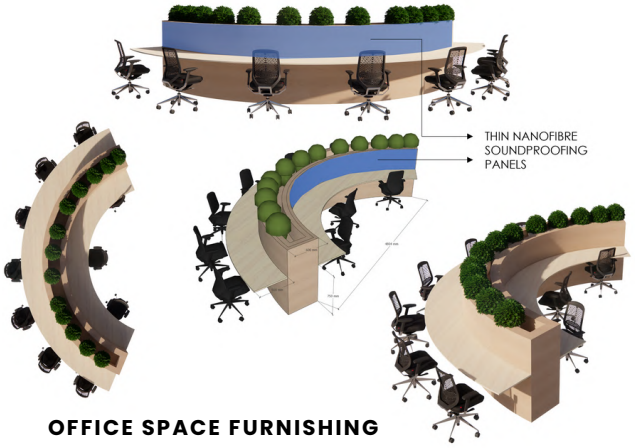
STAGGERED BALCONIES, CUT-OUTS AND PLANTERS BREAK THE MONOTONY OF THE TRADITIONAL WORKSPACE AND ADD INTRIGUE TO THE SPACE WHILE SIMULTANEOUSLY ALLOWING FOR DAYLIGHTING AND USER COMFORT. THE ATRIUM CREATES CONTINUITY BETWEEN THE LEVELS WHILE ADDING AN ELEMENT OF DAYLIGHT AND MAKING THE SPACE LOOK MONUMENTAL. WORKSPACES FOR THE REGULAR WORKSTATIONS AND ODCS CONSIST OF PINWHEEL WORKSTATIONS, MODULAR AND FLEXIBLE DESKTOPS, INFORMAL WORKING AREAS AND OPEN MEETING STATIONS

FIG 33. BUILDING MODEL

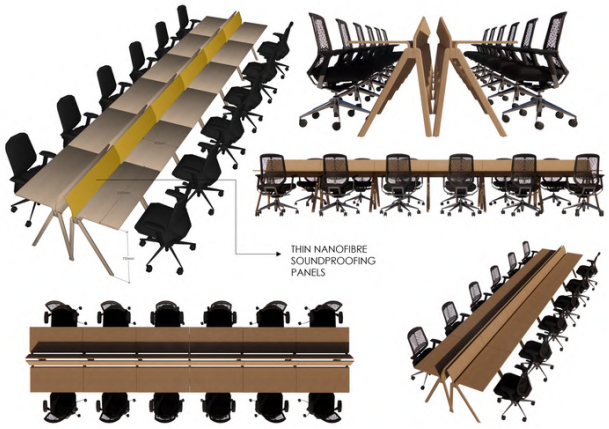
FIG 34. EXTERIOR VIEW

6.0 DESIGN DOCUMENTATION

6.5 ARCHITECTURAL DESIGN



OFFICE SPACE FURNISHING



MEETING ROOM AND CONFERENCE ROOM FURNISHING

COLLABORATIVE WORKSPACE FURNISHING

FOCUS WORK DESKS

COMMON AREA FURNISHING

OFFICE SPACE FURNISHING- COMBINATION OF LINEAR AND PINWHEEL

KNEELING CHAIR

THE KNEELING CHAIR IMPROVES SEATING POSTURE AND PROMOTES GOOD BACK HEALTH

INNOVATIVE APPROACHES:

UNICYCLE SEATING

EMPOWERS ACTIVE AND SUSTAINABLE LIFESTYLE

FIG 35. FURNITURE MODULES

6.0 DESIGN DOCUMENTATION

6.6 ENERGY PERFORMANCE

ENERGY PERFORMANCE OF THE PROJECT WAS ANALYSED USING THE SOFTWARE **DESIGN BUILDER**, WITH THE HELP OF MULTIPLE ITERATIONS AND SIMULATIONS WE WERE ABLE TO ACHIEVE AN **EPI OF 60KWH/SQM/YR** WHICH IS LESSER THAN THE TARGET EPI HENCE IMPROVING THE EFFICIENCY OF THE BUILDING. CONSIDERING THE USAGE OF THE MOST EFFICIENT SYSTEMS AND PRODUCTS FOR COOLING, LIGHTING AND REQUIRED EQUIPMENT AT ALL OCCUPANCY PERIODS WE WERE ABLE TO REDUCE THE ENERGY DEMAND FROM THE BASE CASE (EPI-120 KWH/SQM/YR- ECBC STANDARDS) TO A PROPOSED CASE (EPI-60KWH/SQM/YR). ACHIEVING **50% LESSER EPI THAN THE ECBC BASELINE** DENOTES THAT THE PROPOSED CASE IS A HIGHLY ENERGY-EFFICIENT BUILDING WITH 50% LESSER ENERGY CONSUMPTION THAN A STANDARD ECBC CASE.

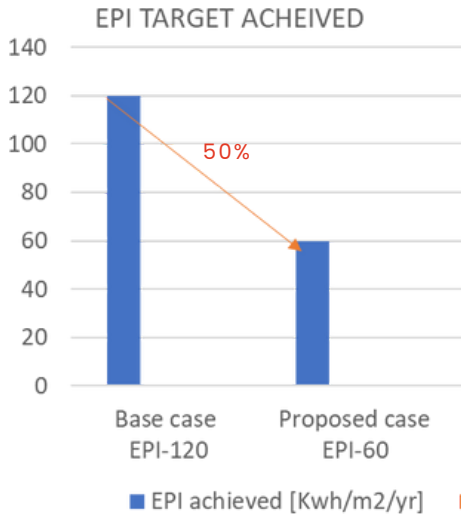


FIG 36 - EPI TARGET

BASE CASE - AS PER ECBC STANDARDS

END USES	ELECTRICITY (kWh)	PER SQ.M (kWh)
COOLING	532771.63	6.322620462
INTERIOR LIGHTING	1859417.00	22.06646771
INTERIOR EQUIPMENT	6664223.47	79.08708592
FANS	490403.51	5.819820524
PUMPS	220579.63	2.617709359
HEAT REJECTION	109620.00	1.300905709
TOTAL END USES	9877015.23	117,2146096

PROPOSED CASE-SUPER ECBC COMPLIANCE

END USES	ELECTRICITY (kWh)	PER SQ.M (kWh)
COOLING	1344981.85	15.96145381
INTERIOR LIGHTING	283542.42	3.364914732
INTERIOR EQUIPMENT	2639884.97	31.32860271
FANS	214072.41	2.540485498
PUMPS	546486.07	6.485375373
HEAT REJECTION	109619.82	1.300903573
TOTAL END USES	5138587.54	60.9817357

TABLE 11. TOTAL ENERGY DEMAND- BASE CASE VS PROPOSED CASE

END USES	TOTAL ENERGY(kWh)	ENERGY PER TOTAL BUILDING AREA [kWh/m^2]	ENERGY PER CONDITIONED BUILDING AREA [kWh/m2]
TOTAL SITE ENERGY	9877015.23	119.74	119.74
NET SITE ENERGY	9877015.23	119.74	119.74
TOTAL SOURCE ENERGY	31280507.25	379.23	379.23
NET SOURCE ENERGY	31280507.25	379.23	379.23

END USES	TOTAL ENERGY(kWh)	ENERGY PER TOTAL BUILDING AREA [kWh/m^2]	ENERGY PER CONDITIONED BUILDING AREA [kWh/m2]
TOTAL SITE ENERGY	5665453.1	60.98	70.82
NET SITE ENERGY	5665453.1	60.98	70.82
TOTAL SOURCE ENERGY	17942489.96	191.93	223.08
NET SOURCE ENERGY	17942489.96	191.93	223.08

TABLE 12. SITE AND SOURCE ENERGY- BASE CASE VS PROPOSED CASE

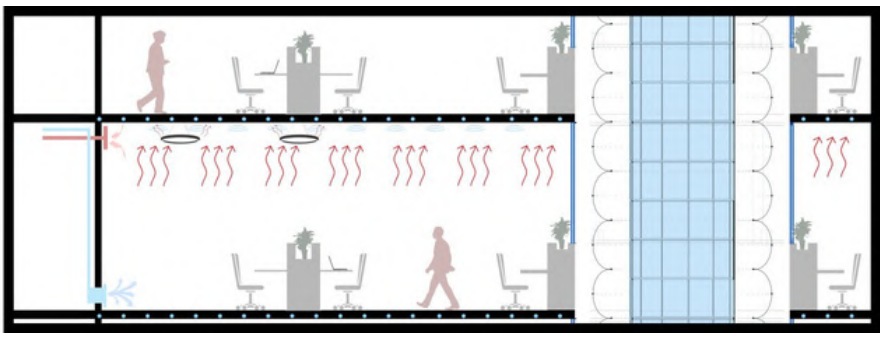
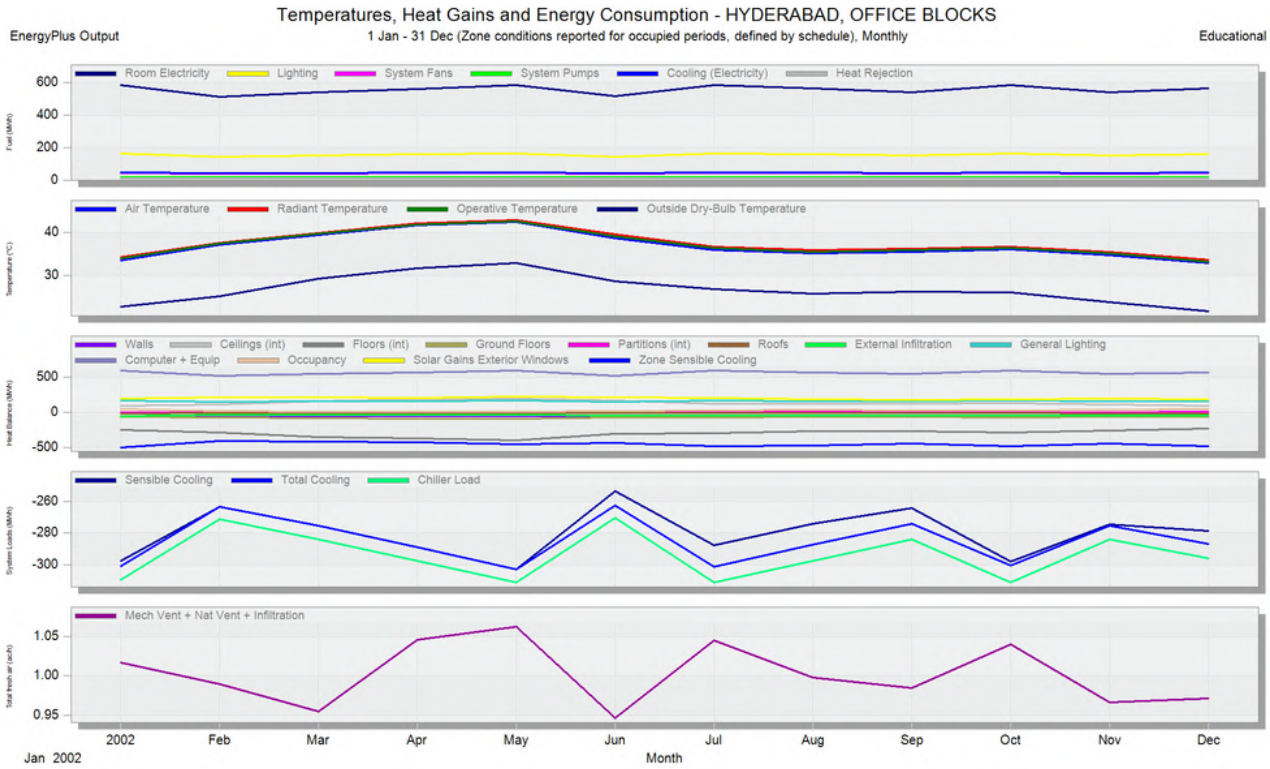


FIG 37 - RADIANT COOLING SCHEMATIC

BASE CASE -TEMPERATURES, HEAT GAIN AND ENERGY CONSUMPTION



TFIG 38. The above graphs show the monthly pattern of temperatures, heat gains and energy consumption enabling us to understand the peak loads and the annual performance of the proposed building system.

PROPOSED CASE -TEMPERATURES, HEAT GAIN AND ENERGY CONSUMPTION

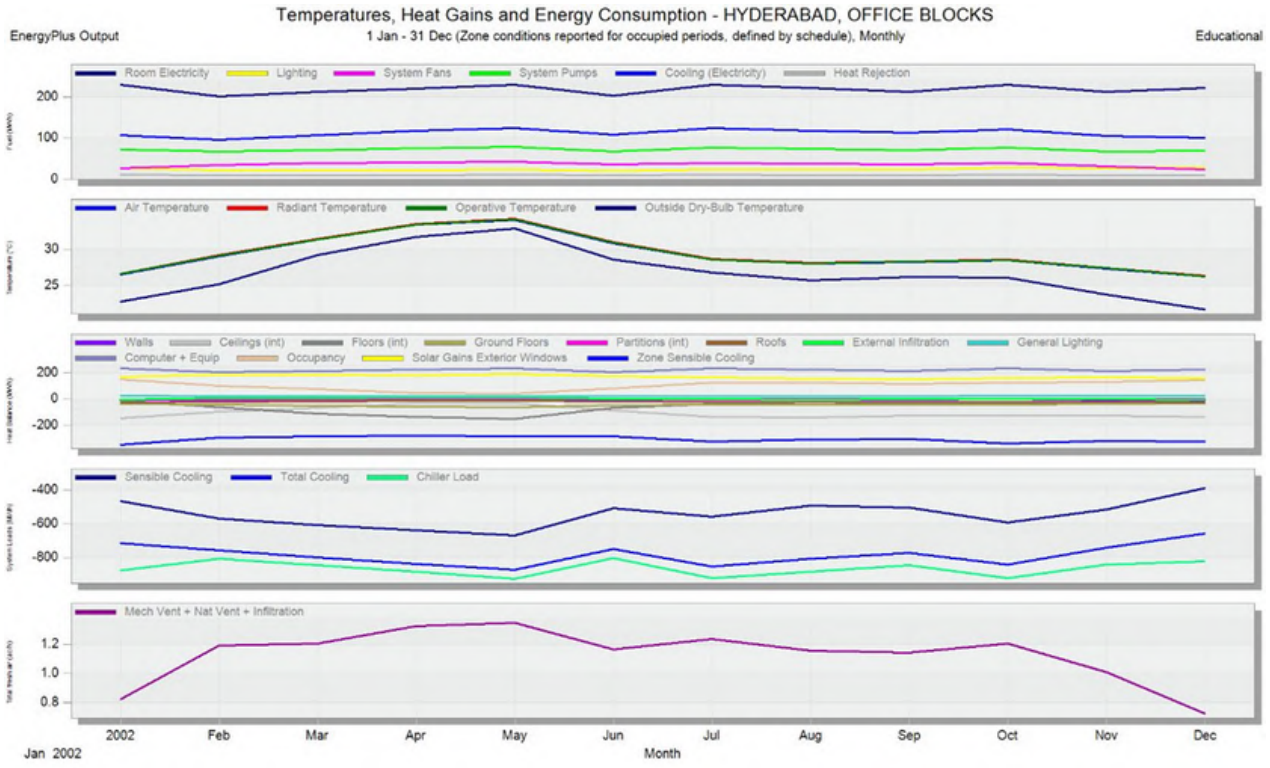


FIG 39. The above graphs show the monthly pattern of temperatures, heat gains and energy consumption enabling us to understand the peak loads and the annual performance of the proposed building system.

6.0 DESIGN DOCUMENTATION
6.6 ENERGY PERFORMANCE

SL NO.	SPACE	NOS.	AREA	TARGET LUX	TYPE OF LIGHTING	TOTAL LIGHT NO.	AVG. LUMEN	COMPANY	WATT	HOURS PER DAY	NO. OF DAYS	TOTAL HOURS	ENERGY CONSUMED ANNUALLY (Wh)
1	RECEPTION	2	24	200	PENDENT DAY WAVE	6	4000	PHILIPS	166	8	260	2080	2071680
2	LOUNGE	4	120	200	DOWN LUX LIGHT SPACE	42	1076	PHILIPS	15	8	260	2080	1310400
3	CONFERENCE	48	3220										
	30 - 40	14	120	400	PENDENT LUMI STONE	4	4000	PHILIPS	38	2	260	520	79040
					LINEAR WALL STASH	4	2179	PHILIPS	30	2	260	520	62400
	25 - 30			400	PENDENT LUMI STONE	3	4000	PHILIPS	38	2	260	520	59280
					LINEAR WALL STASH	4	2179	PHILIPS	30	2	260	520	62400
	5 - 10			400	PENDENT LUMI STONE	1	4000	PHILIPS	38	2	260	520	19760
					LINEAR WALL STASH	2	2179	PHILIPS	30	2	260	520	31200
4	TRAINING ROOM	2	216	300	RECESSED POWER	86	2800	PHILIPS	25	4	260	1040	2236000
5	CUBICLE	770	1386	400	PENDENT SCHEME ARANO	170	2258	PHILIPS	30	7	260	1820	9282000
6	CABIN (3 PEOPLE)	140	10.5	400	RECESSED POWER BALANCE	42	2800	PHILIPS	25	7	260	1820	1911000
7	WORKSTATION	8190	14742	400	PENDENT SCHEME ARANO	4095	2258	PHILIPS	30	7	260	1820	223587000
8	MANAGER	56	20	400	RECESSED POWER BALANCE	224	2800	PHILIPS	25	6	260	1560	8736000
9	REGIONAL	14	20	400	RECESSED POWER BALANCE	28	2800	PHILIPS	25	6	260	1560	1092000
10	COPY ROOM	14	25	200	DOWN LIGHT LUX SPACE	140	1076	PHILIPS	15	2	260	520	1092000
11	PANTRY	16	192	200	DOWN LIGHT LUX SPACE	320	1076	PHILIPS	15	4	260	1040	4992000
12	WASHROOM	110	15	200	RECESSED POWER BALANCE	330	2800	PHILIPS	25	8	260	2080	17160000
13	MEDICAL ROOM	4	80	200	RECESSED POWER BALANCE	6	2800	PHILIPS	25	4	260	260	156000
14	ELECTRICAL ROOM	10	8	100	RECESSED POWER BALANCE	10	2800	PHILIPS	25	1	260	260	65000
15	AHU ROOM	10	20	100	RECESSED POWER BALANCE	20	2800	PHILIPS	25	1	260	260	130000
16	SERVER ROOM	3	100	100	RECESSED POWER BALANCE	27	2800	PHILIPS	25	8	260	2080	1404000
17	SERVICE LIFT	4	4	100	RECESSED POWER BALANCE	4	2800	PHILIPS	25	8	260	2080	208000
18	FIRE ESC. STAIRCASE	20	25	100	RECESSED POWER BALANCE	40	2800	PHILIPS	25	8	260	2080	2080000
19	STAIRCASE	4	25	100	RECESSED POWER BALANCE	60	2800	PHILIPS	25	8	260	2080	2080000
20	LIFT	10	4	100	RECESSED POWER BALANCE	10	2800	PHILIPS	25	8	260	2080	3120000
21	FOOD COURTS	1	4176	200	RECESSED POWER BALANCE	348	2800	PHILIPS	25	4	260	1040	520000
	TOTAL ENERGY CONSUMED = (KILOWATTS PER YEAR)			2,83,542					TOTAL ENERGY CONSUMED = (WATTS PER YEAR)				2,83,542,420

TABLE 13. LIGHTING LOAD

SL NO.	APPLIANCES	NOS.	WATT	BRAND	HOURS PER DAY	NO. OF DAYS	TOTAL NO. OF HOURS	ENERGY CONSUMED ANNUALLY (Wh)
1	LAPTOP	10500	100	HP SPECTRE X360	8	260	2080	2184000000
2	DESKTOP	72	200	INTEL CORE i9 (ANY)	7	260	1560	22464000
3	CCTV	160	25	GODREJ HIGH DEFINITION	24	260	6240	19968000
4	PRINTER	80	5	HP SMART TANK 530	6	260	1560	624000
5	PRINTER (COMMERCIAL)	62	313	HP COLOUR LASER JET PRO MFP M183FW	2	260	520	10091120
6	MICROWAVE	50	1050	LG MICROWAVE 28L	6	260	1560	81900000
7	REFRIDGERATOR	20	114	CROMA 170L 2 STAR	6	260	1560	3556800
8	WATER PURIFIER	62	60	AQUAGUARD UV+UF+MC	8	260	2080	7737600
9	PROJECTOR	50	240	HD 4K 3D SMART ANDROID LASER PROJECTOR	4	260	1040	12480000
10	CONVECTION OVEN	15	3500	HOTMAX OVEN	4	260	1040	54600000
11	FRIDGE (COMMERCIAL)	20	616	305L HOSHIZAKI REFRIDGERATOR	24	260	6240	76876800
12	OTHER APPLIANCES							148114000
13	ELEVATOR	14	600	STANLEY	8	260	2080	17472000
				TOTAL ENERGY CONSUMPTION WH/YEAR =				2639884320
				TOTAL ENERGY CONSUMPTION KWH/YEAR =				2639884

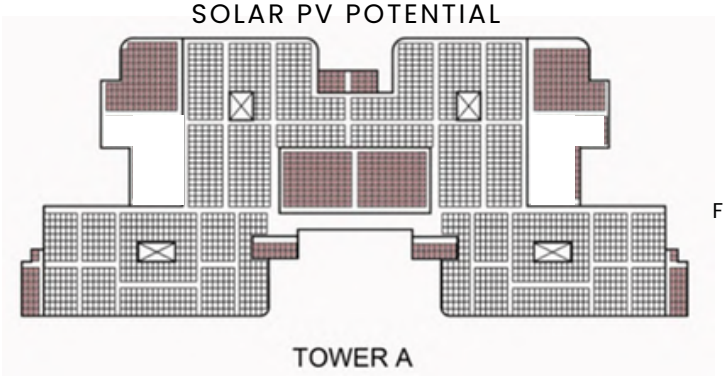
TABLE 14. EQUIPMENT LOAD

6.0 DESIGN DOCUMENTATION

6.6 ENERGY PERFORMANCE

ON-SITE RENWEABLE ENERGY GENERATION

SOLAR PV POTENTIAL



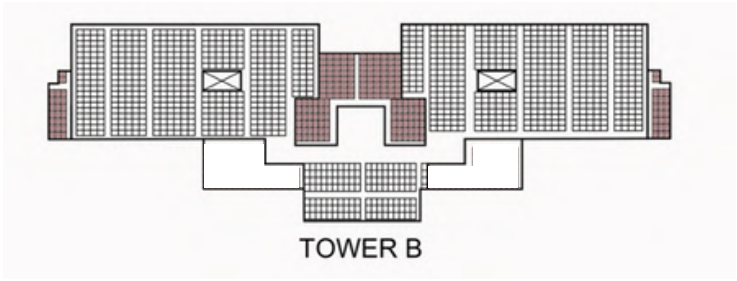


FIG. 40 Roof top solar PV placement plan- considered the opportunity to place solar PV over headrooms, mumty etc.

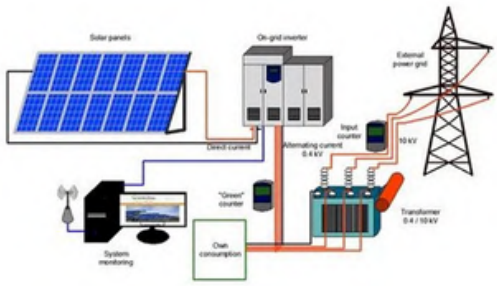
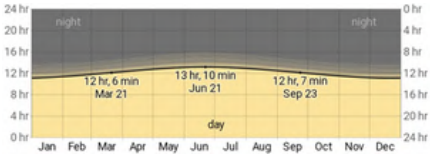


FIG 41. GENERATION TO CONSUMPTION OUTLINE



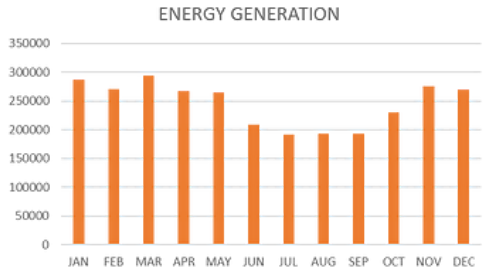


FIG 42. DAYTIME DURATION OUTLINE AND ENERGY GENERATION

RESULTS

3,031,298 kWh/Year*

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)
January	8.67	301,226
February	9.12	281,465
March	9.15	305,551
April	8.74	283,007
May	8.44	279,521
June	6.59	222,015
July	5.42	190,504
August	5.38	190,811
September	5.47	185,461
October	6.40	224,647
November	8.42	286,443
December	8.00	280,647
Annual	7.48	3,031,298

FIG 43(A)ROOF TOP ENERGY GENERATION

RESULTS

1,610,169 kWh/Year*

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)
January	8.67	160,006
February	9.12	149,509
March	9.15	162,303
April	8.74	150,328
May	8.44	148,476
June	6.59	117,930
July	5.42	101,192
August	5.38	101,355
September	5.47	98,514
October	6.40	119,328
November	8.42	152,153
December	8.00	149,074
Annual	7.48	1,610,168

FIG 43(B)SOLAR FARM ENERGY GENERATION

FIG 43. (A)SOLAR ENERGY GENERATION IN TOWER A AND TOWER B, (B) SOLAR FARM

MODULE SPECIFICATIONS:

ROOF PV PANELS:
LOOM SOLAR PANEL
SIZE: 2.1X1.5X35MM
NO. OF PANEL: 4132
AREA COVERED IN PANEL: 12,396
PROPERTIES:
SERIES: 144 CELL
MODULE EFFICIENCY: 14.5%
BIFACIAL: 0.7
OUTPUT POWER: 440-530W
TILT ANGLE: 15 DEG
DUAL ARRAY TYPE 206 UNITS

SOLAR FARM
LOOM SOLAR PANEL
SIZE: 2.1X1.5X35MM
NO. OF PANEL: 1129
AREA COVERED IN PANNEL: 3985 SQM
PROPERTIES:
SERIES: 144 CELL
MODULE EFFICIENCY: 14.5%
BIFICIAL: 0.7
OUTPUT POWER: 440-530W
TILT ANGLE: 15 DEG
DUAL ARRAY TYPE 56 UNITS

BIOGAS GENERATION:

NO. OF OCCUPANTS IN THE BUILDING = **10500 PEOPLE**

MINIMUM AMOUNT OF WASTE GENERATED PER HEAD PER DAY = **0.5KG**

AMOUNT WASTE GENERATED IN TOTAL PER DAY
= 0.5X10500
=**5250 KG**

AMOUNT OF WASTE GENERATED IN TOTAL ANNUALLY
THAT IS, 260 WORKING DAYS
= 5250X260
=1365000 KG
=**1365TON**

AS 1 TON GENERATES 510 KWH/YEAR WITH 40% DRY WASTE
=1365X510
=**696150 KWH/YEAR**

TYPE	ANNUAL GENERATION
ROOFTOP SOLAR PV	3031298 kWh/year
SOLAR FARM	1610168kWh/year
BIOGAS	696150 KWH/YR
TOTAL	**53,37,616 kWh/year**

TABLE 15. ANNUAL ENERGY GENERATION

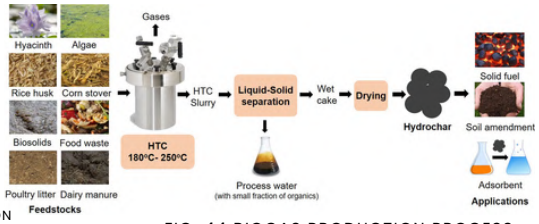


FIG. 44 BIOGAS PRODUCTION PROCESS

CONCLUSION:
ENERGY PERFORMANCE OF THE PROPOSAL BECOMES NET ZERO AT THE GENERATION OF 53,37,616 KWH/YEAR.
WHEREAS 1,99,029 KWH/YEAR CAN BE STORED AS BACK-UP ENERGY ANNUALLY

6.0 DESIGN DOCUMENTATION

6.7 WATER PERFORMANCE

DESCRIPTION	QUANTITY	UNIT
Total Occupancy	10,500	
Per Capita Water Requirement	15.35	L/capita/day
Freshwater requirement / capita / day	9	L/capita/day
Flushwater requirement / capita / day	6.35	L/capita/day
Annual Rainfall	0.8386	KL/Yr
No. of working days	260	
Total Landscaping area	8500	Sq.m
Softscaping Area	5100	Sq.m
Hardscaping area	3400	Sq.m
Landscaping water requirement	3	L/sq.m
Total cooling TR	1000	TR
Water requirement for cooling tower	7	L/day/TR
Roof area	10520	Sq.m
Additional external catchment area	40470	Sq.m or 10 Acres

TABLE 16 .WATER CALCULATION

MONTHLY AVERAGE RAINFALL OF HYDERABAD		
MONTH	NO. OF EFFECTIVE RAINY DAYS	AVERGAGE RAINFALL IN MM
JANUARY	0	7.3
FEBRUARY	0	8.4
MARCH	0	17.5
APRIL	0	21.8
MAY	0	35.9
JUNE	1	105.6
JULY	5	169.7
AUGUST	4	188.7
SEPTEMBER	3	157.2
OCTOBER	0	96.7
NOVEMBER	0	23.8
DECEMBER	0	6
AVERAGE ANNUAL RAINFALL	13	838.6

TABLE 17. MONTHLY AVG. RAINFALL OF HYDERABAD

DESCRIPTION	QUANTITY	UNIT	CONDITION
Fresh Water Demand	21294	KL/Yr	Total occupancy x freshwater/cap/day x no. of working days
Flush Water Demand	16380	KL/Yr	Total occupancy x flushwater/cap/day x no. of working days
Landscape Water Demand	5286	KL/Yr	Softscape area x landscape water requirement x non-rain days
Cooling Water Tower Requirement	1274	KL/Yr	Cooling TR x cooling water requirement x no. of working days
TOTAL WATER DEMAND	44235	KL/Yr	

TABLE 18. WATER DEMAND

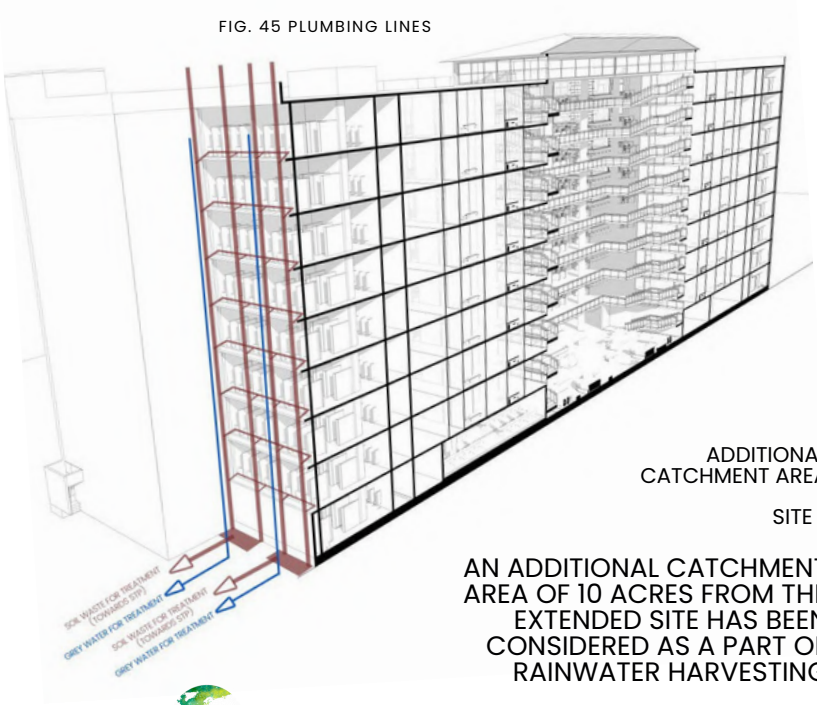
DESCRIPTION	QUANTITY	UNIT	CONDITION
Roof water harvested	7499	KL/Yr	Runoff coefficient (0.85)
Softscaping water harvested	1283	KL/Yr	Runoff coefficient (0.3)
Hardscaping water harvested	2424	KL/Yr	Runoff coefficient (0.85)
External Catchment water*	23757	KL/Yr	Runoff coefficient (0.7)
Treated water available	33906	KL/Yr	With 90% Treatment Plant efficiency
TOTAL COLLECTED WATER	68869	KL/Yr	

TABLE 19. WATER GENERATED

DRINKING WATER REQUIREMENT	3	L/ CAPITA / DAY	
TOTAL ANNUAL DRINKING WATER	8190	KL/Yr	Drinking water demand x no. of people x no. of days

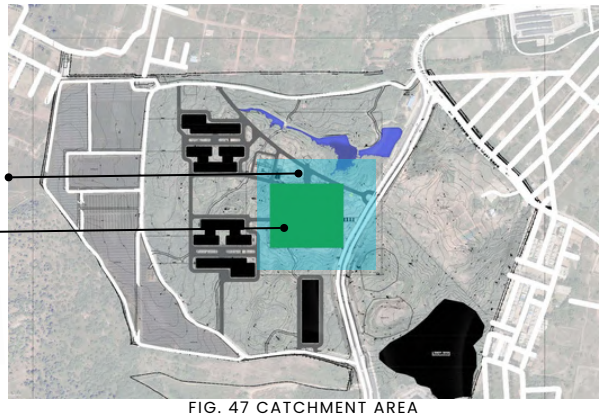
TABLE 20. DRINKING WATER REQUIREMENT

FIG. 45 PLUMBING LINES



	FULL FLUSH WC	HALF FLUSH WC	FAUCETS	HEALTH FAUCET	URINAL
BASE CASE	6 LPF	3 LPF	6 LPM	6 LPM	4 LPF
PROPOSED CASE	4 LPF	2 LPF	0.75 LPM	1.5 LPF	0.35 LPM

FIG. 46. PLUMBING FIXTURES



AN ADDITIONAL CATCHMENT AREA OF 10 ACRES FROM THE EXTENDED SITE HAS BEEN CONSIDERED AS A PART OF RAINWATER HARVESTING

FIG. 47 CATCHMENT AREA

6.0 DESIGN DOCUMENTATION

6.7 WATER PERFORMANCE

FLUSH WATER DEMAND AND FIXTURE EFFICIENCY							
				BASE CASE (NBC)		PROPOSED CASE (IGBC)	
FIXTURE TYPE	DURATION	PER CAPITA USE	NO. OF OCCUPANTS	FLOW RATE CAPACITY (LPF/LPM)	PERCENTAGE	FLOW RATE CAPACITY (LPF/LPM)	PERCENTAGE
WATER CLOSET (FULL FLUSH)	1	1	10500	6	12.24	4	32.38
WATER CLOSET (HALF FLUSH)	1	1	5250	3	6.12	2	16.19
FAUCETS	0.15	4	10500	6	48.97	0.75	24.29
HEALTH FAUCETS	0.15	2	10500	6	24.48	1.5	24.29
URINALS	1	1	5250	4	8.16	0.35	2.83
PERCENTAGE OF BLACK WATER PER PERSON					26.53 %		51.41 %
PERCENTAGE OF GREY WATER PER PERSON					73.46 %		48.58 %
PERCENTAGE OF WATER USE REDUCTION USING EFFICIENT FIXTURES	59 %						

TABLE. 21. WATER FIXTURE EFFICIENCY

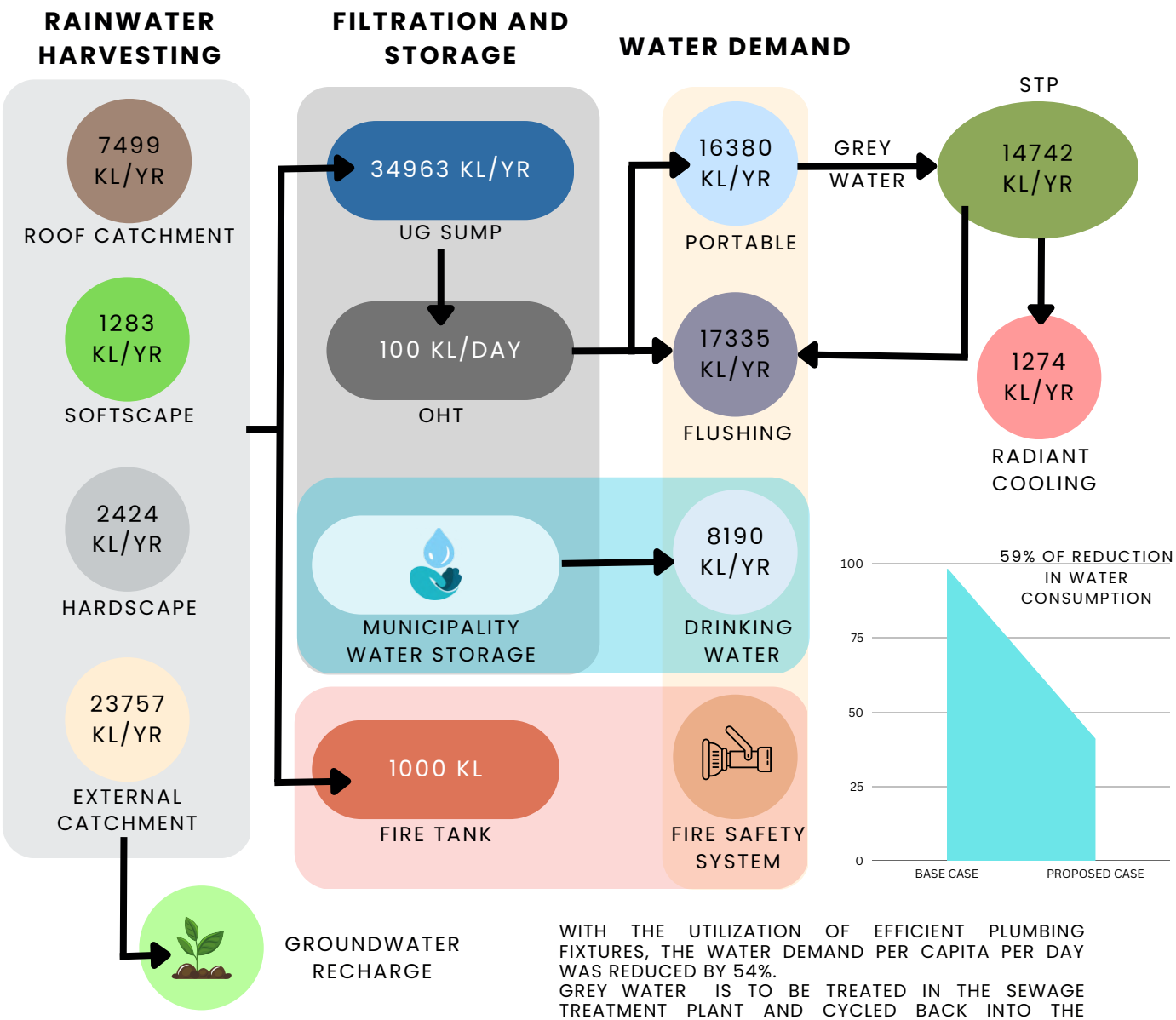


FIG 48. WATER CYCLE

WITH THE UTILIZATION OF EFFICIENT PLUMBING FIXTURES, THE WATER DEMAND PER CAPITA PER DAY WAS REDUCED BY 54%.
GREY WATER IS TO BE TREATED IN THE SEWAGE TREATMENT PLANT AND CYCLED BACK INTO THE BUILDING AS FLUSH WATER,
INCORPORATING THE TOTALITY OF RAINWATER FROM THE ROOF, SOFTSCAPING, HARDSCAPING AND ADDITIONAL EXTERNAL CATCHMENT AREA, NET ZERO STATUS WAS ACHIEVED.

6.0 DESIGN DOCUMENTATION

6.8 ENGINEERING AND OPERATION - STRUCTURE

1	SITE LOCATION	Survey No. 41 (Pt),50 (pt), Pocharam Village, Singapore Township PO, Ghatkesar Mandal, Malkajgiri, Hyderabad, 500088
2	STRUCTURE DETAILS	Software Development Building, No. Of Floors: G+8,G+12 BASEMENT: NO , EXISTING STRUCTURE : NIL
3	CURRENT GROUND COVER NATURAL	Rocky soil - the soil is rocky with high bearing capacity, Isolated footings in order to carry and spread concentrated loads

TABLE. 22 STRUCTURAL DETAILS

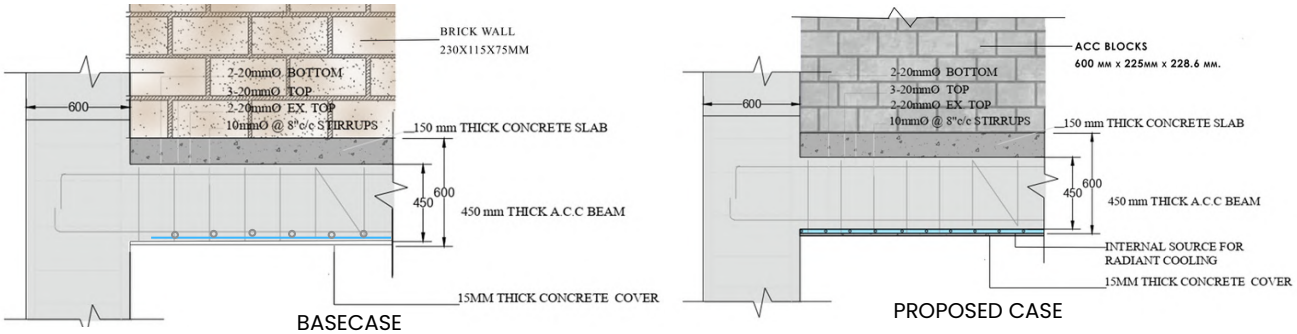
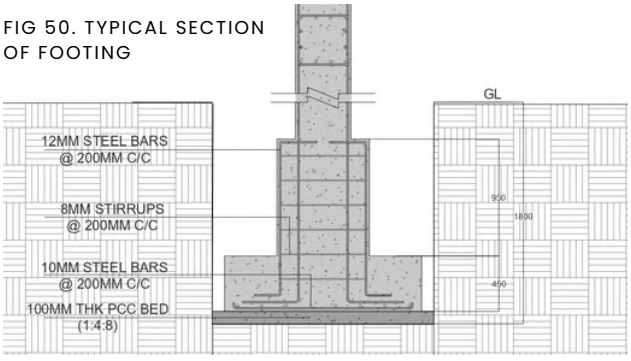


FIG 49. WALL, BEAM AND COLUMN SYSTEM - BASE CASE VS PROPOSED CASE

PROPERTIES	BASECASE : BRUNT BRICK	PROPOSED CASE : A.C.C BLOCKS
WEIGHT	Brick walls are significantly heavier than AAC block walls. This can increase the load on the foundation	AAC block is significantly lighter than burnt brick, making it easier to handle, transport, and install. This also reduces the load on the foundation of the building.
THERMAL INSULATION	Compared to AAC blocks, brick walls have lower thermal insulation properties, which means they are not as effective at retaining heat and keeping the interior of the building warm in cold weather.	AAC blocks have a better thermal insulation property, They have a lower thermal conductivity, which means they are better at retaining heat and keeping the interior of the building warm in cold weather.
FIRE RESISTANCE	Brick walls are not as fire-resistant as AAC blocks, and can crack and crumble when exposed to high temperatures. This can weaken the structural integrity of the wall and increase the risk of collapse	AAC blocks are highly fire-resistant due to their inorganic composition, which means they do not burn or release toxic fumes when exposed to fire.
SOUND INSULATION	Brick walls are not as effective at sound insulation as AAC blocks. They may allow more noise to be transmitted from outside the building to the interior.	AAC blocks have excellent sound insulation properties, which means they can significantly reduce the amount of noise transmitted from outside the building to the interior.
CONSTRUCTION TIME	Brick walls take longer to construct than AAC block walls due to their weight and the need for skilled labor. This can increase the construction time and cost.	AAC blocks come in large sizes, which means that fewer blocks are required to cover a larger area. This speeds up the construction process as there are fewer blocks to handle, transport and install.
RADIANT COOLING SYSTEMS	Radiant cooling systems that are provided outside the slab may limit design options because they require space for mechanical equipment and ductwork, which can be difficult to conceal and limit ceiling heights.	Radiant cooling systems that are installed in the ceiling can save space because the pipes are hidden and do not require additional equipment or space in the room.

TABLE 23. WALL - BASE CASE VS PROPOSED CASE

FIG 50. TYPICAL SECTION OF FOOTING



BENEFITS OF ROCKY SOIL :

BUILDING ON ROCKY SOIL CAN SAVE MONEY IN THE LONG RUN BECAUSE IT ELIMINATES THE NEED FOR EXPENSIVE FOUNDATION WORK, SUCH AS DEEP PILINGS OR UNDERPINNING. THIS CAN HELP TO LOWER THE OVERALL CONSTRUCTION COSTS OF A PROJECT.

STRUCTURES BUILT ON THE ROCKY SOIL ARE BETTER PROTECTED FROM NATURAL DISASTERS SUCH AS FLOODS, LANDSLIDES AND EARTHQUAKES AS THE ROCK IS LESS LIKELY TO ERODE OR MOVE IN THESE SITUATIONS.

BECAUSE ROCKY SOIL IS A SOLID FOUNDATION. IT DOES NOT REQUIRE ANY EXCAVATION OR PREPARATION BEFORE CONSTRUCTION CAN BEGIN. THIS CAN SAVE TIME AND MONEY IN THE CONSTRUCTION PROCESS.

TWO-WAY SLAB IS USED AS , IT REQUIRES MINIMUM STRUCTURAL DEPTH AND REDUCED FLOOR-TO-FLOOR HEIGHT .

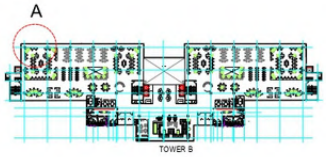


FIG. 51 KEY PLAN

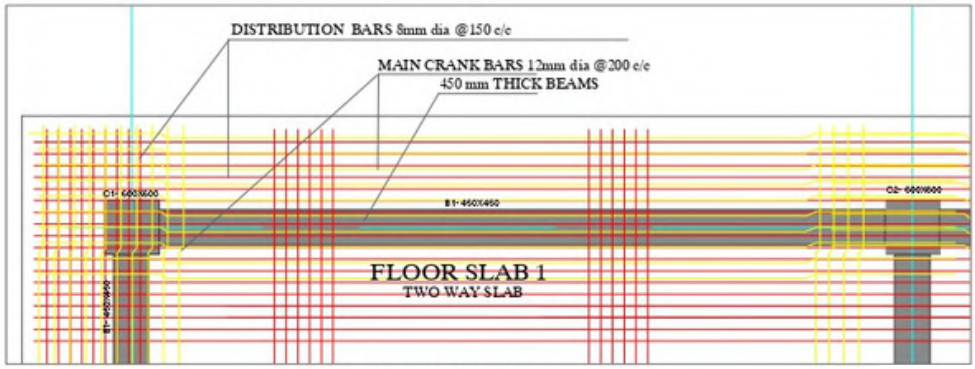


FIG 52. DETAIL AT A
TWO WAY SLAB REINFORCEMENT

6.0 DESIGN DOCUMENTATION

6.8 ENGINEERING AND OPERATION

EQUIPMENT LOADS

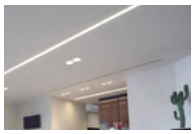
IMAGES OF FIXTURES					
TYPES OF LIGHTING	PENDENT DAY WAVE	PENDENT LUMI STONE	DOWN LIGHT LUX SPACE	LINEAR WALL WASH	RECESED POWER BALANCE
COMPANY	PHILIPS	PHILIPS	PHILIPS	PHILIPS	PHILIPS
AVERAGE LUMEN RECIEVED	4000	4000	1076	2179	2800
WATTAGE (WATT)	166	38	15	30	25

TABLE 24. LIGHTING EQUIPMENT

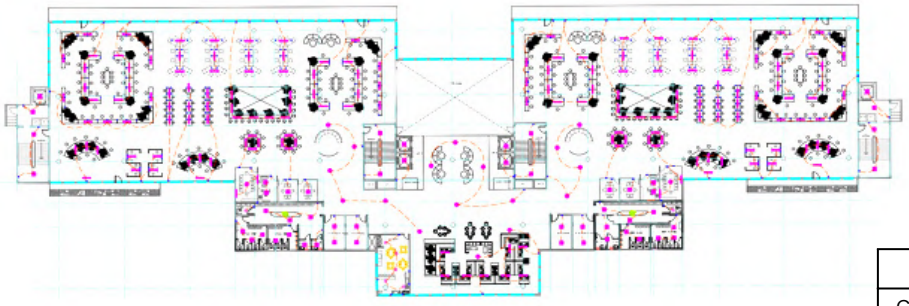


FIG 53. ELECTRICAL LAYOUT (TOWER B)

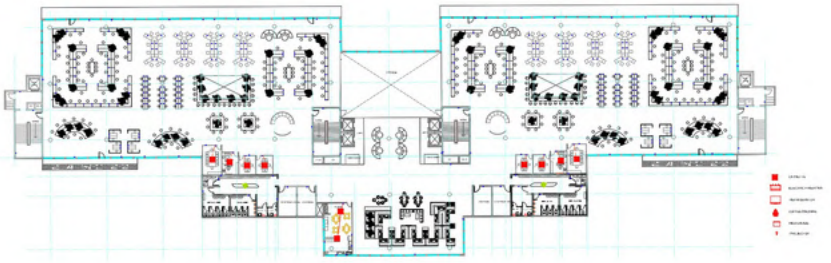


FIG 54. EQUIPMENT LAYOUT (TOWER B)

APPLIANCES	COST IN RUPEES	POWER
AQUAGUARD NEO UV+UF+MC WATER PURIFIER	15,000/-	60
DELL INSPIRON 3910 DESKTOP	65,000/-	200
LAPTOP	70,000/-	100

APPLIANCES	COST IN RUPEES	POWER
CROMA 170L 2 STAR DIRECT COOL SINGLE DOOR REFRIDGERATOE WITH SILENT OPERATION	11,994/-	114
LG 28L CONVECTION MICROWAVE OVEN	14,500/-	1050
HP IN TANK 530 COLOUR PRINTER	18,999/-	5
HP COLOUR LASERJET PRO MFP M183FW	65,712/-	313

TABLE 25. EQUIPMENT RATES

HVAC CALCULATION - BASE CASE

	TYPE	NOMINAL CAPACITY [W]	NOMINAL EFFICIENCY [W/W]	IPLV IN SI UNITS [W/W]	IPLV IN IP UNITS [BTU/W-H]	TONNAGE(TR)
CHILLER	CHILLER:ELECTRIC:EIR	1403100	7.09	7.59	25.9	399.7435897
COOLING TOWER	COOLINGTOWER:VARIABLESPEED	883620.37				251.7436952

HVAC CALCULATION - PROPOSED CASE

	TYPE	NOMINAL CAPACITY [W]	NOMINAL EFFICIENCY [W/W]	IPLV IN SI UNITS [W/W]	IPLV IN IP UNITS [BTU/W-H]	TONNAGE(TR)
LT CHILLER	CHILLER:ELECTRIC:EIR	1403100	7.09	7.59	25.9	399.7435897
MT CHILLER	CHILLER:ELECTRIC:EIR	2567100	11.77	9.77	33.34	731.3675214
COOLING TOWER	COOLINGTOWER:VARIABLESPEED	4030322.99				1148.240168

TABLE 26. HVAC CALCULATION - BASE CASE VS PROPOSED CASE

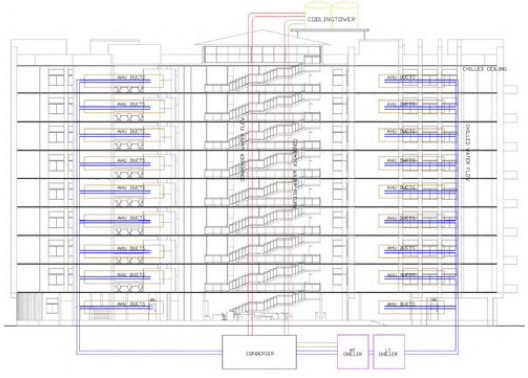


FIG 55. AIR CONDITIONING SYSTEM

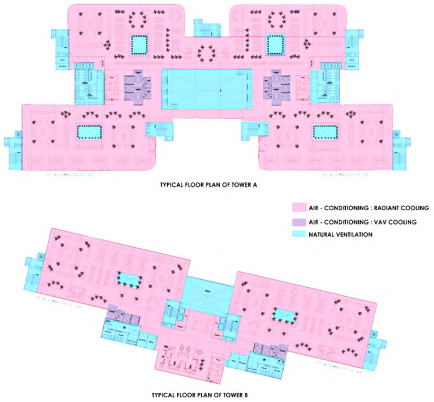


FIG 56. TYPICAL LAYOUT OF FLOOR CONDITIONING SYSTEM

6.0 DESIGN DOCUMENTATION

6.8 ENGINEERING AND OPERATION

PLUMBING LAYOUTS:

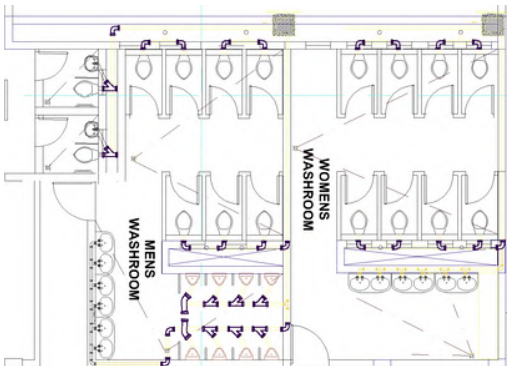


FIG 57. TOWER A BATHROOM PLUMBING LAYOUT

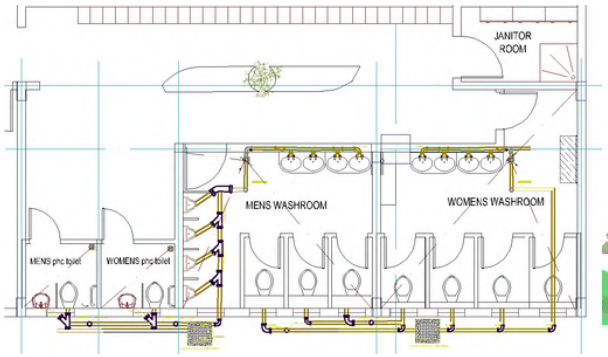


FIG 58. TOWER B BATHROOM PLUMBING LAYOUT

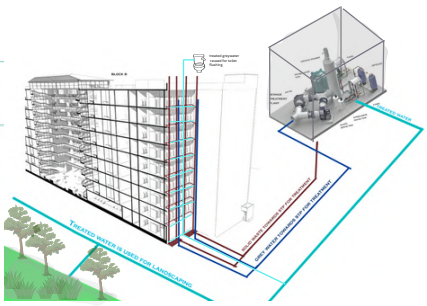
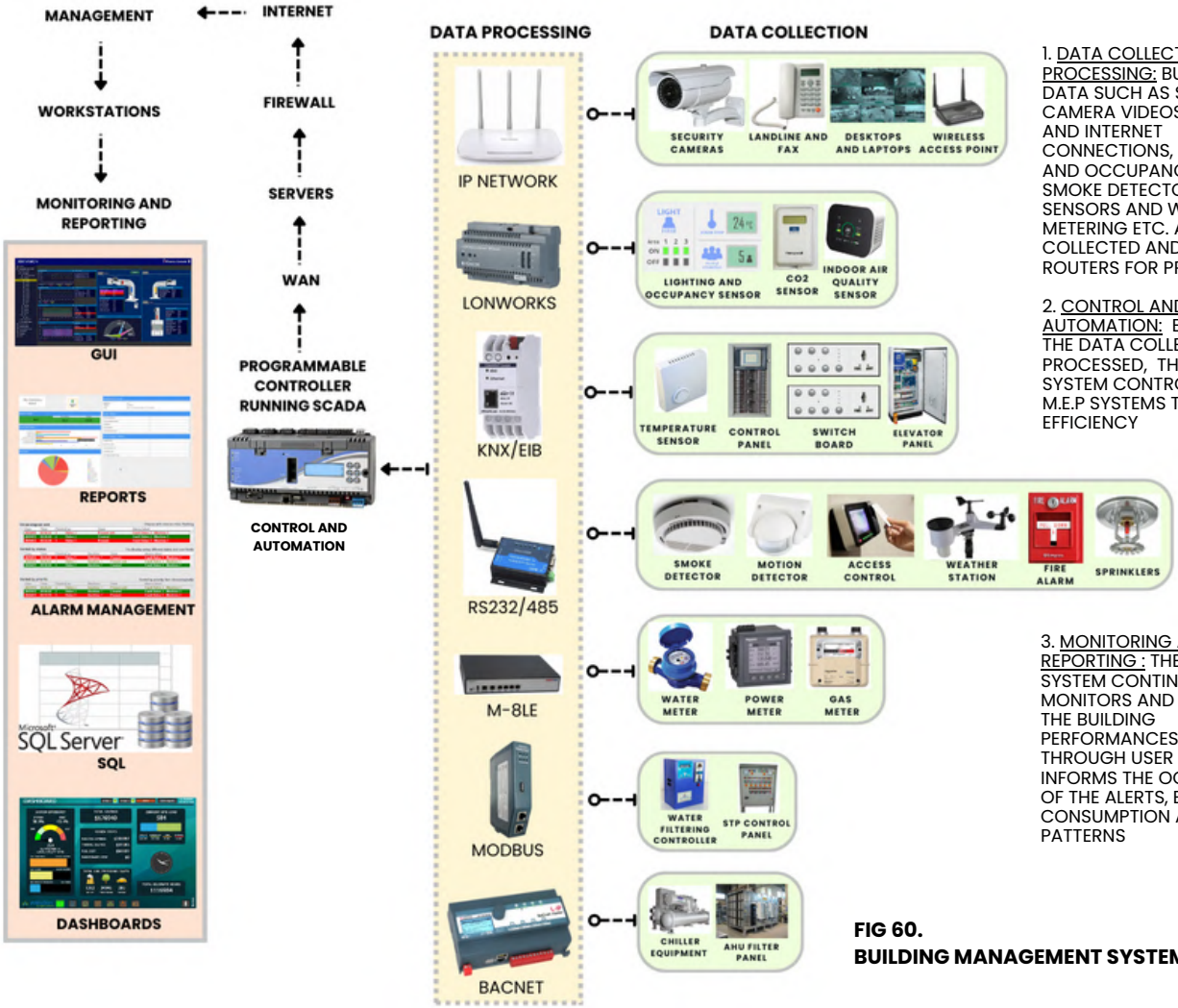


FIG 59. BUILDING PLUMBING LAYOUT

BMS SYSTEM



1. DATA COLLECTION AND PROCESSING: BUILDING DATA SUCH AS SECURITY CAMERA VIDEOS, LANDLINES AND INTERNET CONNECTIONS, LIGHTING AND OCCUPANCY SENSORS, SMOKE DETECTORS, MOTION SENSORS AND WATER METERING ETC. ARE COLLECTED AND SENT TO ROUTERS FOR PROCESSING

2. CONTROL AND AUTOMATION: BASED ON THE DATA COLLECTED AND PROCESSED, THE BMS SYSTEM CONTROLS VARIOUS M.E.P SYSTEMS TO ENSURE EFFICIENCY

3. MONITORING AND REPORTING : THE BMS SYSTEM CONTINUOUSLY MONITORS AND REPORTS THE BUILDING PERFORMANCES AND THROUGH USER INTERFACE INFORMS THE OCCUPANTS OF THE ALERTS, ENERGY CONSUMPTION AND PATTERNS

FIG 60.
BUILDING MANAGEMENT SYSTEM

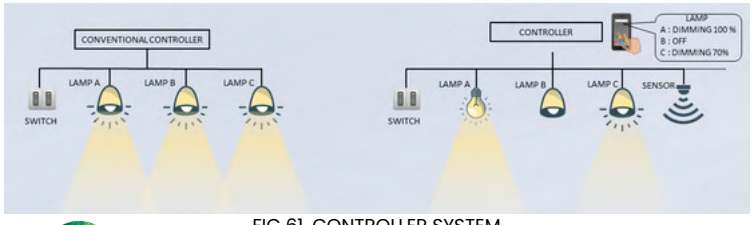


FIG 61. CONTROLLER SYSTEM

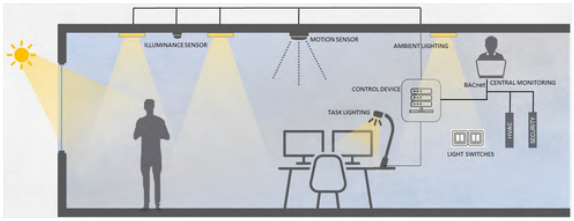


FIG 62. SENSOR SYSTEM

SOLAR LIGHT PIPE

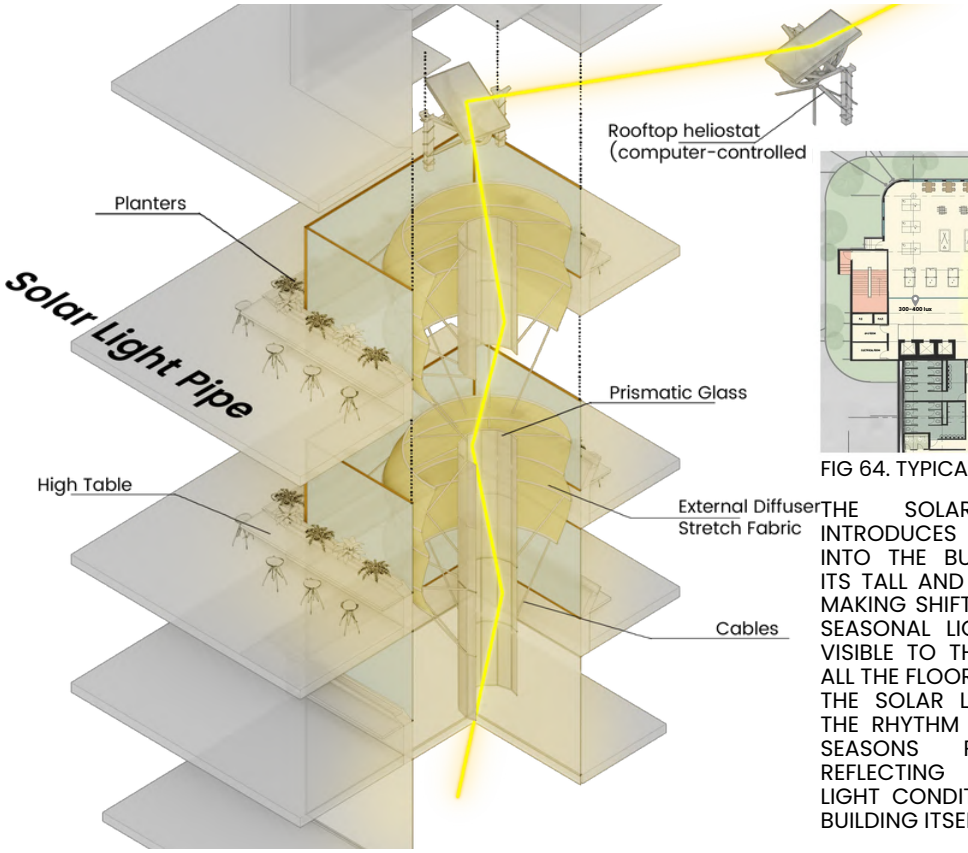


FIG 63. SOLAR LIGHT PIPE FOR THE ATRIUM

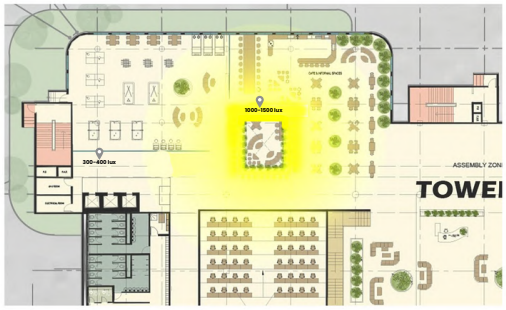


FIG 64. TYPICAL FLOOR PLAN WITH SOLAR LIGHT PIPE

THE SOLAR LIGHT PIPE INTRODUCES DAYLIGHT DEEP INTO THE BUILDING THROUGH ITS TALL AND NARROW ATRIUM, MAKING SHIFTING DIURNAL AND SEASONAL LIGHTING PATTERNS VISIBLE TO THE EMPLOYEES ON ALL THE FLOORS.
THE SOLAR LIGHT PIPE MAKES THE RHYTHM OF THE DAY AND SEASONS PERCEPTIBLE BY REFLECTING THE CHANGING LIGHT CONDITIONS WITHIN THE BUILDING ITSELF.

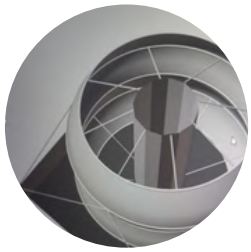


FIG 65. LIGHT PIPE VIEW

SMART GLASS

Smart glass or switchable glass is a glass or glazing whose light transmission properties dynamically alter to control the passage of solar irradiation into buildings. In general, the glass changes between transparent and translucent and vice versa, either letting light pass through or blocking some or all wavelengths of light.
Smart glass helps to create climate adaptive building shells, providing benefits such as natural light adjustment, visual comfort, UV and infrared blocking, reduced energy use, thermal comfort, resistance to extreme weather conditions, and privacy. Some smart windows can self-adapt to heat or cool for energy conservation in buildings. Smart windows can eliminate the need for blinds, shades or window treatments.

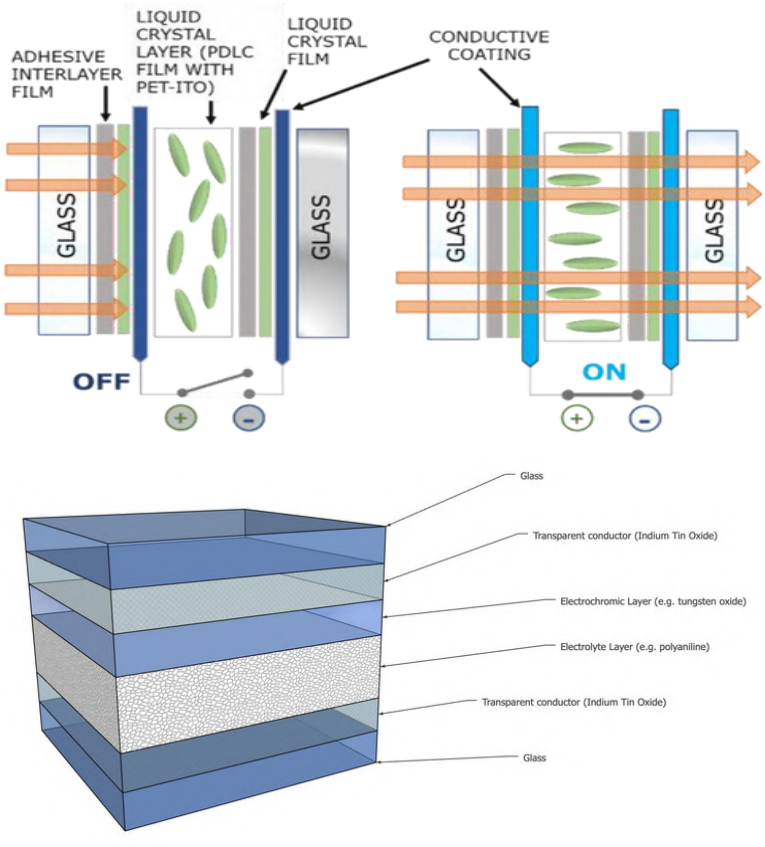


FIG. 66 SMART GLASS COMPONENTS

6.0 DESIGN DOCUMENTATION

6.9 INNOVATION

LIGHT SHELF

LIGHT SHELVES ARE AN EFFECTIVE PASSIVE DESIGN STRATEGY TO INCREASE DAYLIGHT PENETRATION AND REDUCE ENERGY CONSUMPTION. LIGHT SHELVES ARE INSTALLED AT 2100 MM HEIGHT FROM THE FLOOR AND REFLECTED DIRECT SUNLIGHT ONTO THE CEILING, WHICH WILL DIFFUSE THE LIGHT AND REDUCE GLARE. THE MATERIAL USED FOR THE LIGHT SHELF IS HIGHLY REFLECTIVE, TO MAXIMIZE THE AMOUNT OF LIGHT REFLECTED INTO THE SPACE. THE LIGHT SHELF IS 400 MM DEEP INTERNALLY.

USING SPATIAL DAYLIGHT AUTONOMY ANALYSIS, FROM THE BASE CASE TO THE PROPOSED CASE SCENARIOS, 85% OF DAYLIGHTING HAS BEEN ACHIEVED IN THE WORKSPACES DURING OCCUPANCY HOURS AS PER THE PROJECT PARTNER REQUIREMENT BY UTILIZING LIGHT SHELVES AND SOLAR LIGHT PIPE IN THE CUT-OUT.

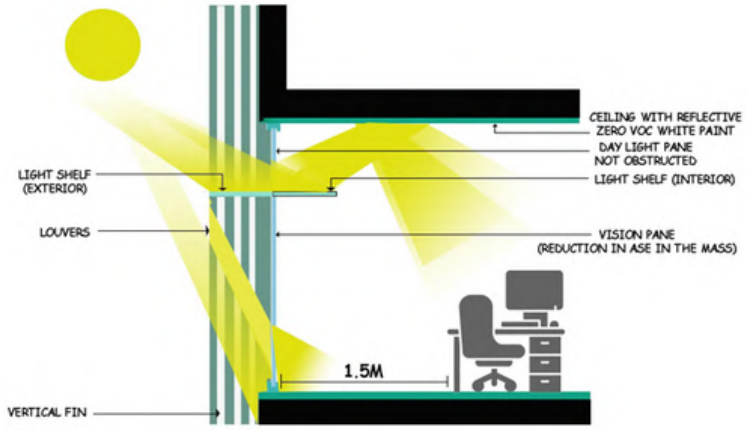


FIG 67. LIGHT SHELF

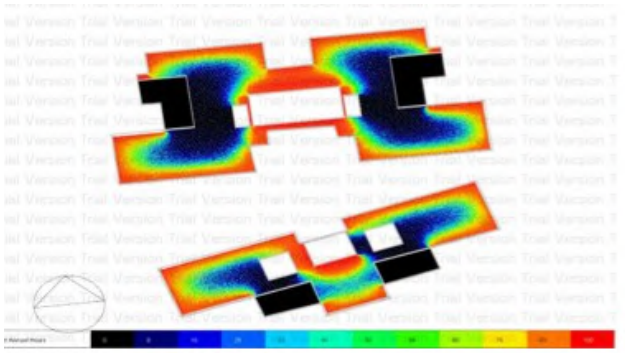


FIG 68. SPATIAL DAYLIGHT AUTONOMY(SDA)-BASECASE
WITHOUT LIGHT WELLAND LIGHT SHELVES

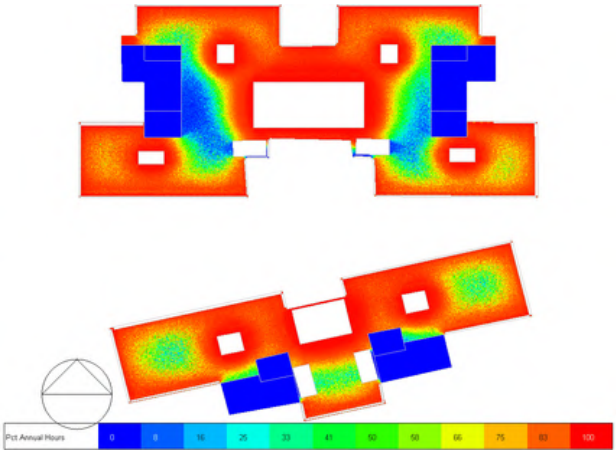


FIG 69. SPATIAL DAYLIGHT AUTONOMY(SDA)-PROPOSED CASE
WITHOUT LIGHT WELL AND LIGHT SHELVES

SMART DUST BINS

SMART DUST BINS ARE TO BE SET UP IN STRATEGIC LOCATIONS THROUGHOUT THE BUILDING, SUCH AS IN THE KITCHEN, BREAK ROOM, AND CONFERENCE ROOMS. THIS WILL MAKE IT EASIER FOR EMPLOYEES TO DISPOSE OF THEIR WASTE PROPERLY. SMART DUST BINS WITH SENSORS WILL DETECT WHEN THEY ARE FULL. THIS WILL ENABLE THE CLEANING STAFF TO KNOW WHEN TO EMPTY THEM, PREVENTING OVERFLOWING AND REDUCING THE RISK OF PESTS. THE SMART DUST BINS CAN BE CONNECTED TO A WASTE MANAGEMENT SYSTEM THAT CAN TRACK THE AMOUNT AND TYPE OF WASTE GENERATED IN THE OFFICE BUILDING. THIS DATA CAN BE USED TO IDENTIFY AREAS WHERE WASTE REDUCTION EFFORTS CAN BE FOCUSED AND TO MEASURE PROGRESS OVER TIME. DUAL COMPARTMENT SENSOR DUSTBIN HAVE TWO COMPARTMENTS FOR WET AND DRY WASTE AND USE SENSORS TO DETECT THE TYPE OF WASTE BEING THROWN. THEY CAN THEN SEGREGATE THE WASTE.

IN THIS WAY, THE BUILDING CAN MANAGE WASTE MORE EFFECTIVELY, REDUCE THEIR ENVIRONMENTAL FOOTPRINT, AND CREATE A CLEANER AND HEALTHIER WORKPLACE FOR EMPLOYEES.

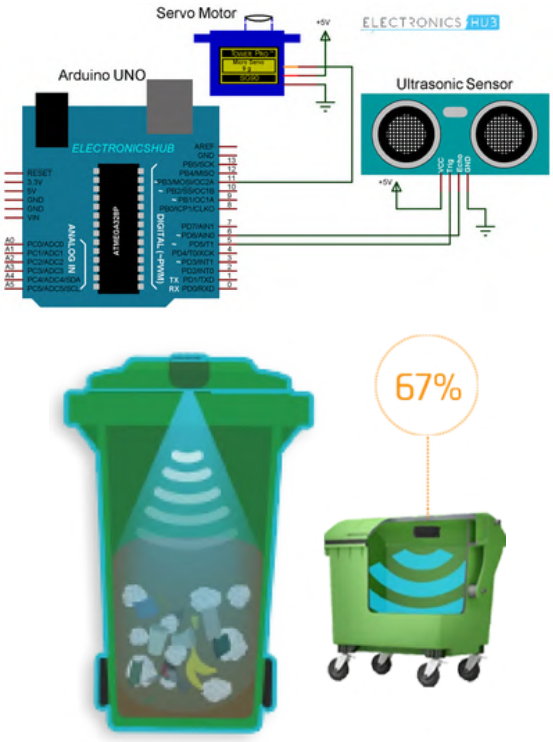


FIG 70. SMART DUSTBIN SYSTEM

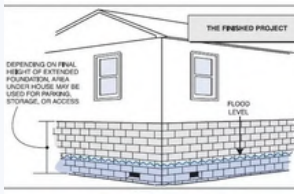
CLIMATE CHANGE

HYDERABAD'S RAPID URBANIZATION HAS INCREASED SURFACE RUNOFF, SOME NATURAL DISASTERS IN HYDERABAD, BUT THE MOST COMMON ONE IS FLOODING NEEDS TO BE CONSIDERED MAINLY, ALSO CONSIDERING ALL POSSIBLE CLIMATE HAZARDS TO ADAPT AND RESPOND TO CHANGING CONDITIONS WHILE MAINTAINING FUNCTIONALITY.

FLOODING:

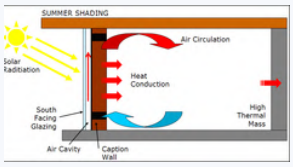
- FLOOD RESILIENT CONSTRUCTION HAS BECOME AN ESSENTIAL COMPONENT OF THE INTEGRATED APPROACH TO FLOOD RISK MANAGEMENT, NOW WIDELY ACCEPTED THROUGH THE CONCEPTS OF MAKING SPACE FOR WATER AND LIVING WITH FLOODS.
- IT CAN ALSO BE ACHIEVED BY ELEVATION OF THE BUILDING ITSELF THROUGH RAISING ON PILLARS, EXTENDED FOUNDATION WALLS OR RAISED EARTH STRUCTURES, OR FLOTATION. IN THE UNITED KINGDOM, RAISING THROUGH EXTENDED FOUNDATION IS POPULAR SOMETIMES WITH GARAGING UNDERNEATH.

SOLUTIONS :



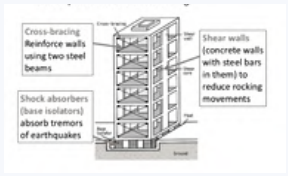
HEATWAVES:

- TELANGANA LIES IN INTERIOR PENINSULAR INDIA CLOSER TO THE TROPIC OF CANCER. THE STATE LIES IN SUCH LATITUDES THAT THE RAYS OF THE SUN ARE ALMOST PERPENDICULAR DURING THE SUMMER MONTHS. THUS, THE CITY GETS HEATED UP AT A FASTER RATE AND OBSERVES HIGHER TEMPERATURES.
- OPTIMUM ORIENTATION, APPROPRIATE WWR, TROMBE WALLS,
- APPROPRIATE GLAZING AND FENESTRATION,
- REFELCTIVE SURFACES



EARTHQUAKES, CYLONES :

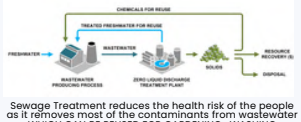
- ANDHRA PRADESH AND TELANGANA, INCLUDING HYDERABAD, ARE IN ZONE 2 AND FALL IN LOW SEISMIC RISK.
- RCC CONSTRUCTION, SIMPLER PLANS, SHEAR WALLS, BASE ISOLATORS, RUBBER BEARING SEISMIC DAMPERS AERODYNAMIC ORIENTATION, CENTRAL SHAFTS



WASTE DISPOSAL :

- ALL WASTE DISPOSAL METHODS RELEASE GREENHOUSE GASES, AND IT'S HARD TO MAKE APPLES-TO-APPLES COMPARISONS. BUT THERE'S ONLY ONE SOLUTION THAT DOESN'T CONTRIBUTE TO CLIMATE CHANGE AT ALL: NOT MAKING WASTE IN THE FIRST PLACE./ELIMINATION OF SOURCE .
- WE NEED TO ADDRESS PRODUCTION AND CONSUMPTION. ONE PLACE TO START IS FOR MANUFACTURERS TO MAKE DURABLE OR HIGHLY RECYCLABLE PRODUCTS THAT WON'T QUICKLY BECOME WASTE, OR SOURCE THEIR MATERIALS IN WAYS THAT PULL WASTE OUT OF THE SYSTEM.

Waste separation basically means **separating wet and dry waste so that the dry waste can be recycled**, and the wet waste can be composted.



Sewage Treatment reduces the health risk of the people as it removes most of the contaminants from wastewater WHICH CAN BE REUSED FOR GARDENING , WASHING VEHICLES ETC.

HEALTH HAZARDS/ DISASTER MANAGEMENT

NATURAL DISASTERS RISK IN HYDERABAD : MEDIUM

INFRASTRUCTURE RESILIENCE IS THE ABILITY TO REDUCE THE MAGNITUDE AND/OR DURATION OF DISRUPTIVE EVENTS. THE EFFECTIVENESS OF A RESILIENT INFRASTRUCTURE OR ENTERPRISE DEPENDS UPON ITS ABILITY TO ANTICIPATE, ABSORB, ADAPT TO, AND/OR RAPIDLY RECOVER FROM A POTENTIALLY DISRUPTIVE EVENT (NIAC 2009)

ABSORPTIVE CAPACITY:

IS THE ABILITY OF THE SYSTEM TO ENDURE A DISRUPTION WITHOUT SIGNIFICANT DEVIATION FROM NORMAL OPERATING PERFORMANCE. FOR EXAMPLE, FIREPROOFING FOAM INCREASES THE CAPACITY OF A BUILDING SYSTEM TO ABSORB THE SHOCK OF A FIRE.

FIRE SAFETY NORMS FOR OFFICE BUILDING :

- **CONSTRUCTION**: ·ALL MATERIALS OF CONSTRUCTIONS IN LOAD BEARING ELEMENTS, STAIRWAYS AND CORRIDORS AND FACADES SHALL BE NON-COMBUSTIBLE. ·WALLS OR STAIRCASE SHALL BE OF BRICK OR REINFORCED CONCRETE WITH A MINIMUM OF 2 H FIRE RATING, STAIRCASE SHALL BE VENTILATED TO THE ATMOSPHERE AT EACH LANDING AND A VENT AT THE TOP
- **ROAD WIDTH & BUILDING ENTRANCE :** THE ROAD WHERE A HIGH-RISE IS CONSTRUCTED SHOULD NOT BE LESS THAN 12 METRES WIDE. THIS IS TO ENSURE EASY MOVEMENT OF FIRE SERVICES VEHICLES IN CASE OF AN EMERGENCY.
- **SETBACKS :** APPROXIMATELY 7M FRONT REAR AND SIDES.
- **FIRE SAFETY PLAN :** EVERY HIGH-RISE SHOULD COMPULSORILY HAVE A FIRE SAFETY PLAN. THIS PLAN SHOULD INCLUDE THE ACTION THAT CAN BE TAKEN BY THE OCCUPANTS IN CASE OF A FIRE. THE PLAN SHOULD ALSO HAVE TELEPHONE NUMBERS OF ALL EMERGENCY SERVICES. THIS PLAN MUST BE DISTRIBUTED TO EVERY OCCUPANT IN THE BUILDING AND DISPLAYED ON EACH FLOOR.
- **STAIRCASE** WIDTH SHOULD BE MIN 1.5M -2M
- NO OPENING TO BASEMENT
- THESE STAIRCASES SHOULD BE ENCLOSED, AND AT LEAST ONE OF THEM SHOULD BE ON THE EXTERIOR WALLS OF THE BUILDING AND SHOULD OPEN DIRECTLY TO THE EXTERIOR OR INTERIOR OPEN SPACE OR TO AN OPEN SPACE OF SAFETY
- THE DISTANCE BETWEEN ONE FIRE EXIT STAIRCASE TO ANOTHER SHOULD BE 21M DIA .

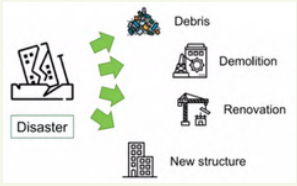
ADAPTIVE CAPACITY:

IS THE ABILITY OF THE SYSTEM TO ADAPT TO A SHOCK TO NORMAL OPERATING CONDITIONS.THE EXTRA TRANSFORMERS THAT THE ELECTRIC POWER COMPANIES KEEP ON STORE AND SHARE INCREASES THE ABILITY OF THE GRID TO ADAPT QUICKLY TO REGIONAL POWER LOSSES.

RECOVERABILITY:

THE ABILITY TO RETURN TO AND/OR RECONSTITUTE NORMAL OPERATIONS AS QUICKLY AND EFFICIENTLY AS POSSIBLE AFTER A DISRUPTION. COMPONENTS INCLUDE CAREFULLY DRAFTED CONTINGENCY PLANS, COMPETENT EMERGENCY OPERATIONS, AND THE MEANS TO GET THE RIGHT PEOPLE AND RESOURCES TO THE RIGHT PLACE.

SOLUTIONS :

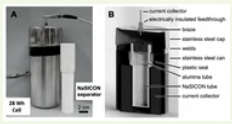


DISASTER SUPPLY KIT

FIRE EXTINGUISHERS, MEDICAL KITS, SANITIZERS, WATERPROOF COMMUNICATION DEVICES SUCH AS HIGH FREQUENCY RADIOS, FOOD

GRID SCALE ENERGY STORAGE USING SODIUM-NICKEL-BASED BATTERIES

THESE BATTERIES ENABLE END USERS TO REDUCE DAILY OPERATIONAL COSTS AND, WHEN THE NEXT DISASTER STRIKES, PROVIDE AN ADDITIONAL LEVEL OF RESILIENCY TO THE ELECTRICAL GRID OR HOST FACILITY



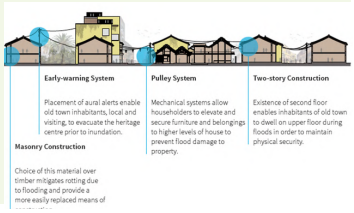
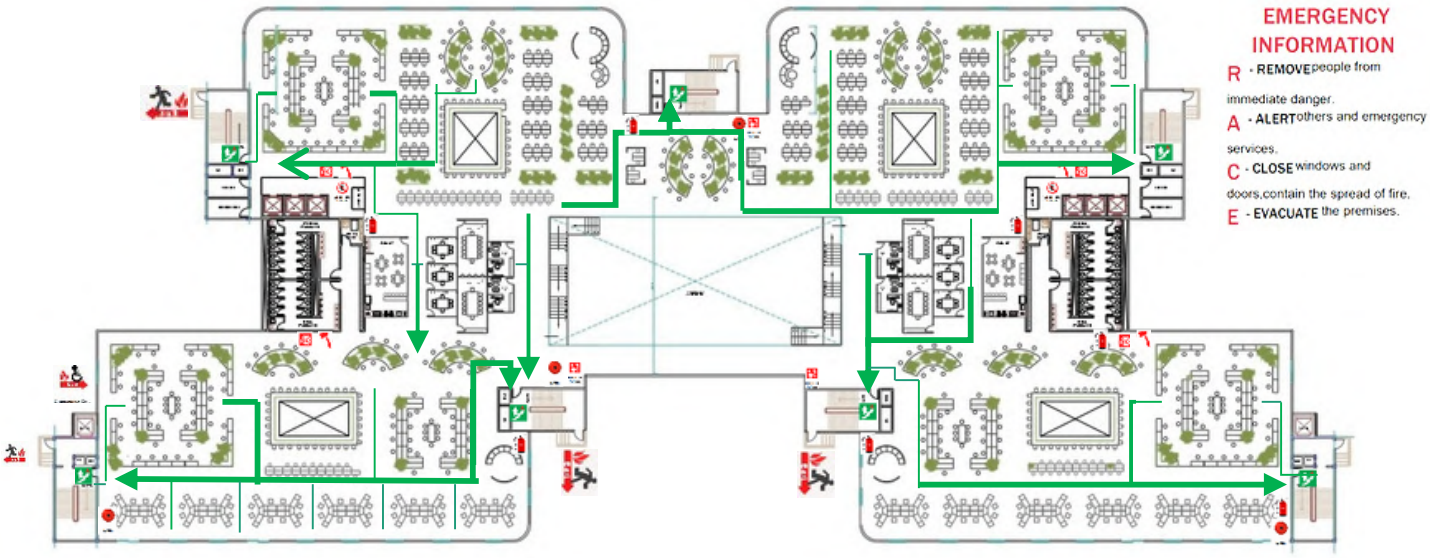
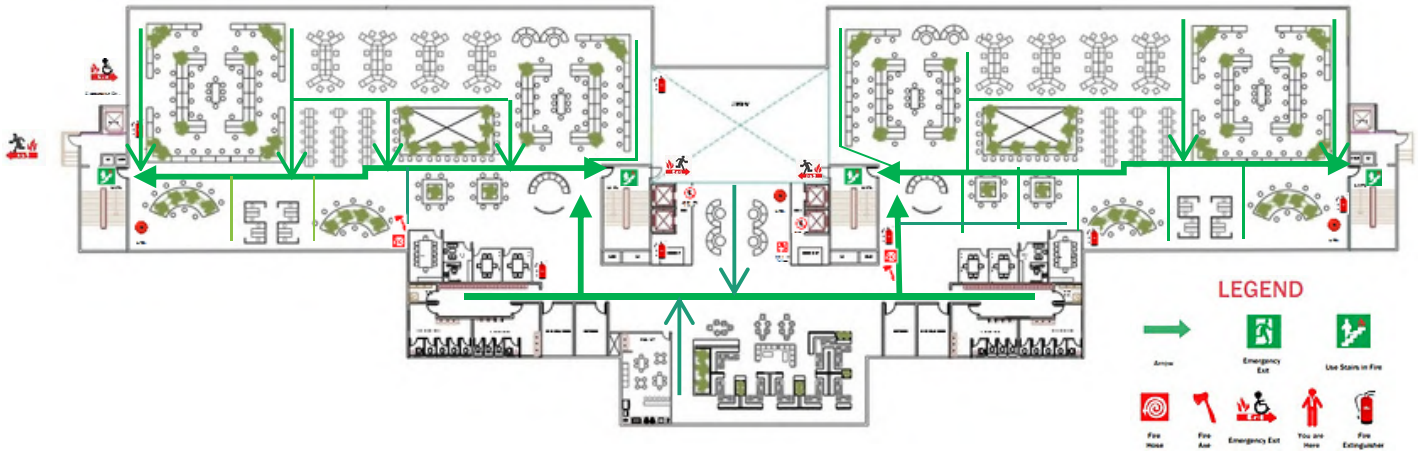


TABLE. 27. RESILIENCE SOLUTIONS



TYPICAL EVACUATION PLAN OF TOWER A



TYPICAL EVACUATION PLAN OF TOWER B

FIG. 71 TYPICAL FIRE EVACUATION PLAN

FIRE PREPAREDNESS:

IF BUILDING FIRE ALARM IS ACTIVATED OR SOMEONE INFORMS YOU OF A FIRE

- WALK TO THE NEAREST EXIT. DO NOT USE THE ELEVATORS.
- IF ABLE, ASSIST PEOPLE WITH SPECIAL NEEDS.
- NOTIFY EMERGENCY PERSONNEL IF YOU KNOW OR SUSPECT SOMEONE IS TRAPPED OR STILL INSIDE THE BUILDING.
- ASSEMBLE OUTSIDE AT THE AREA OF GATHERING AWAY FROM THE BUILDING AND DO NOT ATTEMPT TO RE-ENTER THE BUILDING UNTIL AUTHORIZED TO DO SO BY THE EMERGENCY RESPONDERS.
- DO NOT USE THE ELEVATORS

IF CAUGHT IN SMOKE

- DROP TO HANDS AND KNEES AND CRAWL TOWARDS THE NEAREST EXIT.
- STAY LOW, SMOKE WILL RISE TO CEILING LEVEL FIRST.
- HOLD YOUR BREATH AS MUCH AS POSSIBLE; BREATHE THROUGH YOUR NOSE AND USE A FILTER SUCH AS A SHIRT, TOWEL OR HANDKERCHIEF.

IF TRAPPED IN A ROOM

- CLOSE AS MANY DOORS AS POSSIBLE BETWEEN YOU AND THE FIRE.
- WET AND PLACE CLOTH MATERIAL AROUND OR UNDER THE DOOR TO HELP PREVENT SMOKE FROM ENTERING THE ROOM.
- IF THE ROOM HAS AN OUTSIDE WINDOW, BE PREPARED TO SIGNAL TO SOMEONE OUTSIDE.

CLOTHING ON FIRE (STOP, DROP AND ROLL)

- DIRECT OR ASSIST A PERSON TO ROLL AROUND ON THE FLOOR TO SMOTHER THE FLAMES.
- ONLY DRENCH WITH WATER IF A LABORATORY SAFETY SHOWER IS IMMEDIATELY AVAILABLE.
- OBTAIN MEDICAL ATTENTION. CALL EMERGENCY SERVICES

RECOVERY PLAN IN THE FIRST 24 TO 48 HOURS –

HAVING ACCESS TO AN IMMEDIATE POWER SUPPLY IS ESSENTIAL UNDER THESE CIRCUMSTANCES. THIS INCLUDES TEMPORARY LIGHTING IN THE FACILITY, BACKUP SYSTEM OPERATIONS, AND POWER FOR EMERGENCY EQUIPMENT.

STABILIZATION OF FIRES, CLEANING OF IMMEDIATE SURROUNDINGS AND RELOCATION OF OCCUPANTS TO MEDICAL FACILITIES FOR EXAMINATION

CRITICAL BARRIERS/CONTAINMENTS AND ENVIRONMENTAL CONTROLS AROUND THE FACILITY TO PREVENT CONTAMINATION

ASSESSING THE DAMAGES TO THE STRUCTURE AND ITS SURROUNDINGS AND INVOLVING INSURANCE

PACKING, FILE MANAGEMENT, CATALOGUING OFFICE AND CRITICAL DOCUMENTS, DEMOLITION, DEBRIS AND INSULATION REMOVAL, STRUCTURAL DRYING AND MITIGATION SERVICES SMOKE ODOR REMOVAL, STRUCTURAL CLEANING, ENCAPSULATION AND DEODORIZATION

6.0 DESIGN DOCUMENTATION

6.11 AFFORDABILITY

THE **CAPEX COST & OPEX SAVINGS COST** OF THE BUILDING IS **CALCULATED ONLY ON THE INSTALLATION COST OF THE MEP SERVICES**, AS THE LAND IS ALREADY OWNED BY THE PROJECT PARTNER, SO THE BUILDING CONSTRUCTED IS OCCUPIED BY THE OWNER ITSELF AND IT IS NOT LEASED OR RENTED OUT TO A TENANT.

CAPITAL EXPENDITURE (CAPEX COST) :

THE CAPEX COST OF THE MEP SERVICES INCLUDES THE COST OF - **HVAC, ELECTRICAL & ALLIED SERVICES, PLUMBING & SANITATION, FIRE FIGHTING, IBMS & SECURITY SYSTEMS, AND INSTALLATION OF LIFT** - THE RATES OF THESE INDIVIDUAL COMPONENTS ARE MENTIONED IN THE APPENDIX ON PG (X)

THEREFORE THE CAPEX COST WOULD BE **46.31 CRORES** AS THE INITIAL INVESTMENT AS PER THE COST ESTIMATION OF MEP SERVICES ONLY.

OPERATIONAL EXPENDITURE (OPEX COST) :

RENEWABLE ENERGY SOURCES SUCH AS **ROOFTOP SOLAR PANELS, AND ONSITE BIOGAS ENERGY GENERATION** CAN HELP OPTIMIZE OPERATIONAL COSTS AND REDUCE OVERALL EXPENSES. THIS CAN OFFSET MOST OF THE ELECTRICITY CONSUMPTION FROM THE GRID, RESULTING IN **LOWER OPERATING COSTS OVER TIME**.

THAT BEING THE CASE, **ENERGY CONSUMED** ANNUALLY IS **5138587 KWH/YEAR**, AND **ENERGY GENERATED** ONSITE IS **5600214 KWH/YEAR.**
SO, THE ENERGY PERFORMANCE OF THE PROPOSAL BECOMES NET ZERO AT THE GENERATION OF **5138587 KWH/YEAR**.
WHEREAS **461627 KWH/YEAR** IS **STORED ONSITE FOR BACKUP** PURPOSES OR ANY EMERGENCY CONDITIONS.

CONSIDERING **120 EPI FOR THE BASE CASE** PROPOSAL, THE ENERGY CONSUMPTION OF THE BUILDING IS **8002440 KWH/YEAR** WHEREAS **60 EPI FOR THE PROPOSED CASE**, AT WHICH THE ENERGY CONSUMPTION IS **5138587 KWH/YEAR.**

OPEX SAVINGS COST IS BASED ON THE **ELECTRICITY BILLS AND WATER BILLS** UPON WHICH THE **RETURN OF INVESTMENT (ROI)** IS CALCULATED. ALONG WITH 1% OF THE TOTAL CONSTRUCTION COST AS THE MAINTENANCE COST.
THE WATER AND ELECTRICITY BILL CALCULATIONS ARE MENTIONED IN THE APPENDIX ON PG (X) - (XI)

RETURN OF INVESTMENT (ROI) :

ROI IS A **FINANCIAL PERFORMANCE METRIC** THAT MEASURES THE PROFITABILITY OF AN INVESTMENT RELATIVE TO ITS COST. WE CONSIDER **ROI ONLY USING MEP SERVICES IN AN OFFICE BUILDING**. TO CALCULATE THE ROI FOR MEP SERVICES IN AN OFFICE BUILDING, WE WOULD NEED TO COMPARE THE EXPECTED **NET RETURNS TO THE TOTAL INITIAL INVESTMENT COSTS OVER A SPECIFIC PERIOD**

ROI = NET RETURNS / INVESTMENT AMOUNT X 100

NET RETURNS(OPEX SAVINGS COST) = ELECTRICITY AND WATER BILLS OF **BASE CASE - PROPOSED CASE**
(NET RETURN CALCULATION MENTIONED IN THE APPENDIX ON PG (XI))
INVESTMENT AMOUNT = 46.31 CRORES (AS PER COST ESTIMATION)

ROI = 31043634.72 / 463100000 X 100

ROI = 0.06703 X 100 = 6.70%

THEREFORE, THE RETURN OF INVESTMENT ON MEP SERVICES IS 6.70% EVERY YEAR

6.0 DESIGN DOCUMENTATION

6.11 AFFORDABILITY

TOTAL ENVELOPE AREA BY EXCLUDING FENESTRATION

BASE CASE MATERIAL – BURNT BRICK

IN TOWER A - 3218.3SQM

BASE CASE MATERIAL – BURNT BRICK
SIZE OF BRICK - 0.22M X 0.10M X 0.07M
NUMBER OF BRICKS IN 1 SQM = 130
COST/BRICK = RS 9
HENCE, THE TOTAL NUMBER OF BRICKS = 3218.3 X 130 = 418379SQM
HENCE, TOTAL COST = 418379 X RS 9
= RS 37,65,411

MINERAL WOOL INSULATION SHEET PER SQ FEET= RS 165
MINERAL WOOL INSULATION SHEET PER SQM = RS1776
HENCE, THE TOTAL COST OF MINERAL WOOL INSULATION SHEET = 1776 X 3218.3
=5715700.8

IN **TOWER B – 2509.8SQM**

BASE CASE MATERIAL – BURNT BRICK
SIZE OF BRICK - 0.22M X 0.10M X 0.07M
NUMBER OF BRICKS IN 1 SQM = 130
COST/BRICK = RS 9
HENCE, THE TOTAL NUMBER OF BRICKS = 2509.8 X 130 = 326274 SQM
HENCE, TOTAL COST = 225882 X RS 9 = RS 29,36,466

MINERAL WOOL INSULATION SHEET PER SQ FEET= RS 165
MINERAL WOOL INSULATION SHEET PER SQM = RS1776
HENCE , THE TOTAL COST OF MINERAL WOOL INSULATION SHEET = 1776 X 2509.8
=4457404.8

PROPOSED CASE MATERIAL – AAC BLOCK

IN TOWER A

PROPOSED CASE MATERIAL – AAC
SIZE OF AAC - 0.6M X 0.1M X0.1M
NUMBER OF AAC IN 1 SQM = 32
COST/AAC = RS 32
HENCE ,TOTAL NUMBER OF AAC BLOCK = 3218.3 X 32 = 102985.6
HENCE,TOTAL COST = 102985.6 X RS 32 = RS 32,95,539.2

MINERAL WOOL INSULATION SHEET PER SQ FEET= RS 165
MINERAL WOOL INSULATION SHEET PER SQM = RS1776
HENCE , THE TOTAL COST OF MINERAL WOOL INSULATION SHEET = 1776 X 2509.8=4457404.8

IN TOWER B

PROPOSED CASE MATERIAL – AAC
SIZE OF AAC - 0.6M X 0.1M X0.1M
NUMBER OF AAC IN 1 SQM = 32
COST/AAC = RS 32
HENCE, THE TOTAL NUMBER OF AAC BLOCKS = 2509.8 X 32 = 80,313.6
HENCE,TOTAL COST = 80313.6 X RS32
= RS 25,70,035.2

MINERAL WOOL INSULATION SHEET PER SQ FEET= RS 165
MINERAL WOOL INSULATION SHEET PER SQM = RS1776
HENCE,TOTAL COST OF MINERAL WOOL INSULATION SHEET = 1776 X 2509.8

=4457404.8

THEREFORE, BY USING ACC BLOCK INSTEAD OF BURNT BRICK, THERE IS A SAVINGS OF APPROXIMATELY 12.4% OF MATERIAL COST.

AFFORDABILITY - CONSTRUCTION METHOD

TOTAL PARTITION WALL AREA EXCLUDING DOOR

BASE CASE – BRICK MASONARY USING ENGLISH BOND

IN TOWER A = 2534.8SQM

BASE CASE MATERIAL – BRICK MASONRY USING ENGLISH BOND
SIZE OF BRICK - 0.22M X 0.10M X 0.07M
NUMBER OF BRICKS IN 1 SQM = 65
COST/BRICK = RS 9
HENCE, THE TOTAL NUMBER OF BRICKS = 2534.8 X 65 = 11,64,762 SQM
HENCE, TOTAL COST = 1,64,762 X RS 9X
= RS 14,82,858

IN TOWER B = 4153.95SQM

BASE CASE MATERIAL – BURNT BRICK
SIZE OF BRICK - 0.22M X 0.10M X 0.07M
NUMBER OF BRICKS IN 1 SQM = 65
COST/BRICK = RS 9
HENCE,TOTAL NUMBER OF BRICK = 4153.95 X 65 = 2,70,006.75 SQM
HENCE, TOTAL COST = 2,70,006.75 X RS 9 = RS24,30,060.75

PROPOSED CASE – DRY WALL/THERMAL & ACOUSTIC GYPSUM PARTITION

IN TOWER A

PROPOSED CASE MATERIAL – THERMAL & ACOUSTIC GYPSUM PARTITION
COST PER SQ FT = RS 80
COST PER SQM = RS 889
HENCE TOTAL COST – 2534.8 SQM X RS 889 = RS 2,253,437.2

TOWER B :

COST PER SQ FT = RS 80
COST PER SQM = RS 889
HENCE TOTAL COST = 4153.95 SQM X RS 889 = RS 3,692,861.55

THEREFORE, BRICK MASONRY WITHOUT INSULATION WILL COST 64.1 % MORE THAN THAT OF A GYPSUM PARTITION

AFFORDABILITY - BUILDING ENVELOPE

TOTAL AREA OF FENESTRATION IN ENVELOPE

BASE CASE TECHNIQUE : INSULATING TOUGHNED GLASS

IN TOWER A = 1379.28SQM

BASE CASE MATERIAL = INSULATING TOUGHNED GLASS
COST/SQFT = RS250
COST/SQM =RS2778
TOTAL COST = RS38,31,639.84

IN TOWER B = 1075.62SQM

BASE CASE MATERIAL = INSULATING TOUGHNED GLASS
COST/SQFT = RS250
COST/SQM =RS2778
TOTAL COST = RS29,88,072.36

PROPOSED CASE TECHNIQUE = SMART GLASS

IN TOWER A :

PROPOSED CASE MATERIAL = SMART GLASS
CPST/SQFT = RS2500
COST/SQM = RS27778
TOTAL COST = RS 38,313,639.84

IN TOWER B :

PROPOSED CASE MATERIAL = SMART GLASS
CPST/SQFT = RS2500
COST/SQM = RS27778
TOTAL COST = RS29,878,572.36

THEREFORE, BY USING SMART GLASS INSTEAD OF INSULATING TOUGHNED GLASS , THERE IS 2% PROFIT AND SMART GLASS IS AN EFFICIENT TECHNOLOGY COMPARED TO CONVENTIONAL GLASS

FACTOR	SOURCE	SOLUTION
TEMPERATURE AND HUMIDITY EXTREMES	Extreme temperatures of Hyderabad	Radiant cooling throughout workspaces
STAGNANT SPACES	Continuous stretches of desktop modules can be stagnant and demotivating	the Atrium can be used as light court to utilize daylighting to reduce energy use through skylights and window walls and to provide a healthy interior environment
LIGHTING	Artificial lighitng can strain the eyes over long term usage	Daylight not only replaces artificial lighting, reducing lighting energy use, but also influences cooling loads and is easier on the eyes when regulated
STUFFINESS	Office spaces need break-out spaces and openings for fresh air to prevent restlessness	Apart from their functional role and their active contribution to the external appearance of the building, balconies also play a dynamic role in shaping the occupancy comfort
ODOUR, COMFORT AND CARBON DIOXIDE LEVELS	Polution, body odour	Common indoor plants can prove to be a valuable weapon when it comes to fighting the rising levels of indoor pollution Plants like aloe vera, spider plant, pothos and bamboo can reduce carbon via the carbon cycle as well as provide a green view and reduce odour

TABLE 28. FACTORS AFFECTING INDOOR AIR QUALITY

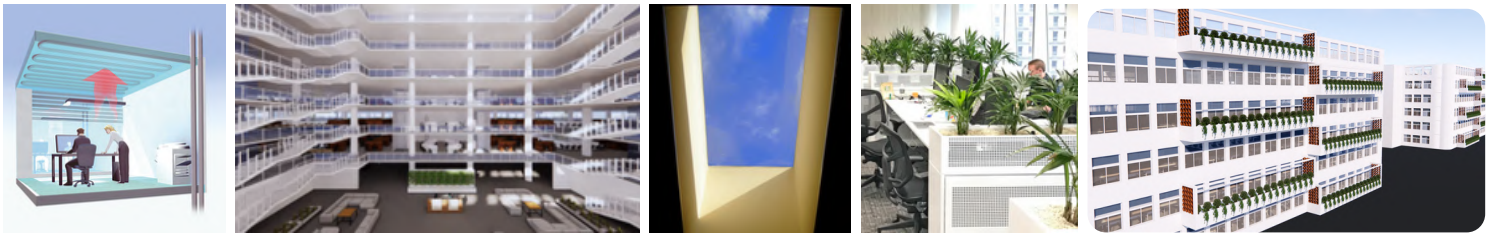


FIG. 72 HEALTH AND WELL-BEING SOLUTIONS

Using cbe tool , the thermal comfort within the space was analysed
In two conditions , namely without hvac and with hvac. With the thermal condition in hyderabad, it is important to acheive thermal comfort satisfying the employees for an efficient productivity.

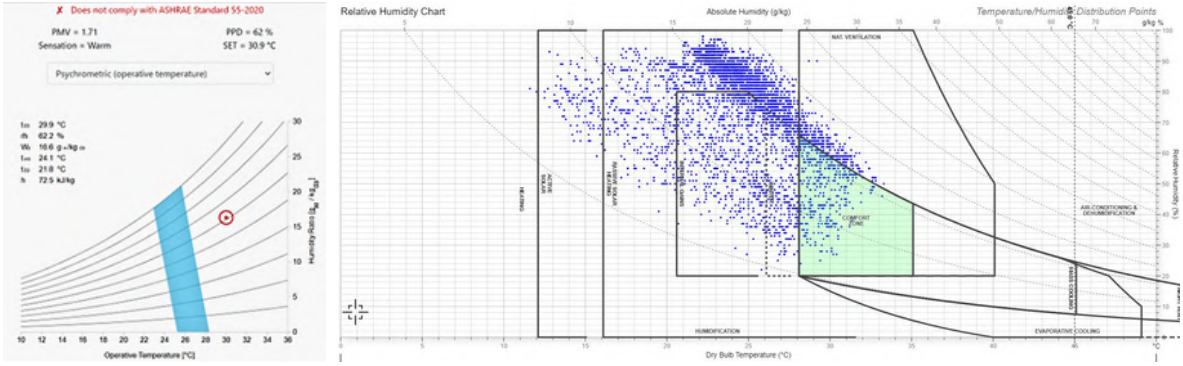


FIG 73. WITHOUT HVAC

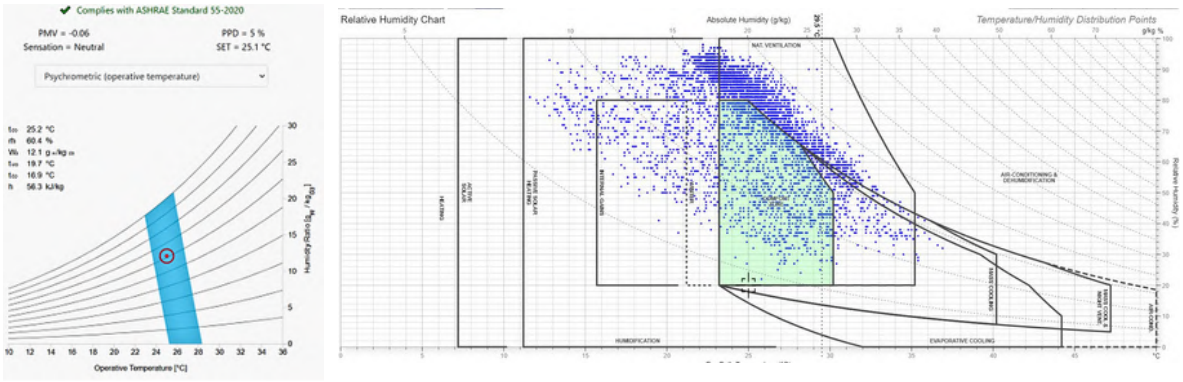


FIG 74. WITH HVAC

Wihout the proposed HVAC , the predicted percentage of dissatisfied index(PPD)is 62% while the condition with HVAC, PPD is 5% and occupants will have a neutral sensation of comfort.

The adjoining psychometric chart for both the conditions shows an increate in thermal comfort even at a minimum efficiency of the hvac system.

Hence with the target occupants the thermal comfort within the space is ensured inorder to facilitate the betterment in the health and well being of the users.

*givoni pyschometric chart tool

6.0 DESIGN DOCUMENTATION

6.13 VALUE PROPOSITION

THE VALUE PROPOSITION FOR AN NET ZERO OFFICE BUILDING REFERS TO THE UNIQUE BENEFITS OR ADVANTAGES THAT THE BUILDING OFFERS TO THE PROJECT PARTNER AND THE USERS. IT CAN INCLUDE A COMBINATION OF FACTORS THAT MAKE THE BUILDING ATTRACTIVE AND VALUABLE TO BUSINESS.

WHAT IS OUR AIM AND APPROACH TO FULFILL THE NEEDS OF THE PROJECT PARTNER?

FACTORS LIKE TANGIBLE BENEFITS BASICALLY CAN BE MEASURED OR QUANTIFIED. THESE BENEFITS ARE OFTEN RELATED TO FEATURES SUCH AS PRICE, QUALITY, SPEED, CONVENIENCE, AND RELIABILITY.

HEALTHIER WORK ENVIRONMENT: NET ZERO ENERGY BUILDINGS ARE DESIGNED TO PROMOTE GOOD INDOOR AIR QUALITY AND THERMAL COMFORT. THIS MEANS THAT OCCUPANTS ARE LESS LIKELY TO EXPERIENCE ALLERGIES, RESPIRATORY ILLNESSES, OR OTHER HEALTH ISSUES THAT CAN BE CAUSED BY POOR AIR QUALITY OR UNCOMFORTABLE TEMPERATURES. AS A RESULT, THE COMPANY MAY EXPERIENCE FEWER SICK DAYS AND HIGHER PRODUCTIVITY. THE DESIGNED OFFICE WORKSTATIONS HAVE PLANTERS THAT IMPROVE AIR QUALITY, REDUCE STRESS LEVELS, INCREASE PRODUCTIVITY, AND CREATE A MORE POSITIVE ATMOSPHERE, WHICH CAN HELP TO BOOST EMPLOYEE MORALE AND CREATE A MORE ENJOYABLE WORK ENVIRONMENT.

REDUCED ENVIRONMENTAL IMPACT: BY GENERATING ALL ITS ENERGY NEEDS FROM RENEWABLE SOURCES, A NET ZERO ENERGY BUILDING REDUCES ITS CARBON FOOTPRINT AND OTHER ENVIRONMENTAL IMPACTS. THIS CAN BE AN IMPORTANT CONSIDERATION FOR ENVIRONMENTALLY CONSCIOUS TENANTS WHO WANT TO MINIMIZE THEIR IMPACT ON THE PLANET. THE USE OF BIFOCAL SOLAR PANELS TO GENERATE ONSITE RENEWABLE ENERGY MAKES THE BUILDING ENERGY INDEPENDENT. THEREFORE SIGNIFICANTLY REDUCING OR ELIMINATING ENERGY BILLS. ALSO, CERTAIN GOVERNMENTS OFFER INCENTIVES AND SUBSIDIES FOR THE INSTALLATION OF SOLAR PANELS, MAKING IT AN EVEN MORE ATTRACTIVE OPTION TO SAVE MONEY AND REDUCE THEIR ENVIRONMENTAL IMPACT.
THE AAC BRICKS ARE LIGHTWEIGHT, ENERGY EFFICIENT,DURABLE AND FIRE RESISTANT. POLYISOCYANURATE FOAM HAS A HIGH R-VALUE, WHICH MEANS IT PROVIDES EXCELLENT THERMAL INSULATION. IT HELPS TO KEEP THE BUILDING WARM IN WINTER AND COOL IN SUMMER. THIS LEADS TO A SMALLER CARBON FOOTPRINT.

FACTORS LIKE **INTANGIBLE BENEFITS** ARE THOSE THAT ARE MORE DIFFICULT TO MEASURE OR QUANTIFY AND ARE OFTEN RELATED TO THE EMOTIONAL OR PSYCHOLOGICAL ASPECTS. THESE BENEFITS MAY INCLUDE THINGS LIKE A SENSE OF BELONGING, STATUS, OR SOCIAL APPROVAL.

1. REPUTATION AND BRANDING: COMPANIES THAT OCCUPY A NET ZERO ENERGY BUILDING CAN ENHANCE THEIR REPUTATION AND BRAND, AS WELL AS THEIR IMAGE AS SOCIALLY RESPONSIBLE ORGANIZATIONS. THIS CAN BE IMPORTANT FOR COMPANIES THAT ARE COMPETING FOR CUSTOMERS WHO PRIORITIZE SUSTAINABILITY AND ENVIRONMENTAL RESPONSIBILITY.

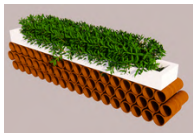
2.ATTRACT AND RETAIN TALENT: NET ZERO ENERGY BUILDINGS CAN HELP ATTRACT AND RETAIN EMPLOYEES WHO ARE PASSIONATE ABOUT SUSTAINABILITY. SUCH BUILDINGS ARE SEEN AS INNOVATIVE AND FORWARD-THINKING AND CAN BE A ALLURE FOR EMPLOYEES WHO WANT TO WORK FOR SOCIALLY RESPONSIBLE ORGANIZATIONS.

3.POSITIVE IMPACT ON THE COMMUNITY: BY PROMOTING RENEWABLE ENERGY AND REDUCING ITS ENVIRONMENTAL IMPACT, A NET ZERO ENERGY BUILDING CAN BE SEEN AS A POSITIVE FORCE IN THE COMMUNITY. THIS CAN CONTRIBUTE TO A SENSE OF CIVIC PRIDE.

WHAT IS OUR SOLUTIONS TO THE NEEDS OF THE PROJECT PARTNER?

ENERGY EFFICIENCY: INCORPORATING ENERGY-EFFICIENT DESIGN FEATURES AND TECHNOLOGIES IS A CRITICAL STRATEGY IN ACHIEVING A NET-ZERO AND SUSTAINABLE OFFICE BUILDING. THESE FEATURES MAY INCLUDE HIGH-EFFICIENCY HVAC SYSTEMS, LIGHTING, AND APPLIANCES. BY REDUCING THE ENERGY DEMAND OF A BUILDING, RENEWABLE ENERGY SYSTEMS CAN PROVIDE A LARGER PERCENTAGE OF THE TOTAL ENERGY REQUIRED, WHICH LEADS TO GREATER ENERGY SELF-SUFFICIENCY.

RENEWABLE ENERGY: NET-ZERO BUILDINGS AIM TO PRODUCE ALL THE ENERGY THEY NEED THROUGH ON-SITE RENEWABLE ENERGY SOURCES, SUCH AS SOLAR PANELS OR WIND TURBINES. SUSTAINABLE BUILDINGS INCORPORATE THESE SOURCES TO OFFSET THE ENERGY CONSUMED BY THE BUILDING, AND TO REDUCE RELIANCE ON FOSSIL FUELS. IN SOME CASES, A BUILDING MAY GENERATE MORE ENERGY THAN IT NEEDS, AND THE EXCESS ENERGY CAN BE SOLD BACK TO THE GRID.

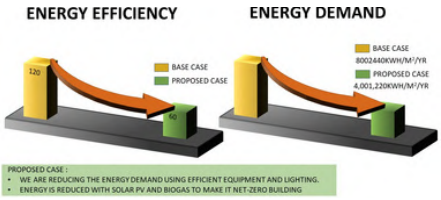


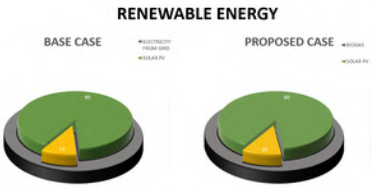
BIFOCAL SOLAR PANEL

AERATED CONCRETE BRICKS

POLYISOCYANURATE FOAM

FIG 75. FACTORS OF VALUE PROPOSTITION



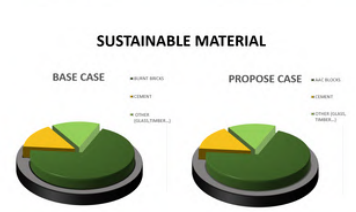


SUSTAINABLE MATERIALS: USING SUSTAINABLE MATERIALS SUCH AS RECYCLED OR LOCALLY SOURCED MATERIALS IN THE CONSTRUCTION OF THE BUILDING CAN SIGNIFICANTLY REDUCE THE ENVIRONMENTAL IMPACT. SUCH MATERIALS MAY ALSO CONTRIBUTE TO A HEALTHIER INDOOR ENVIRONMENT BY REDUCING EXPOSURE TO HARMFUL CHEMICALS. SUSTAINABLE MATERIALS MAY INCLUDE LOW-VOC PAINTS AND ADHESIVES, NON-TOXIC BUILDING MATERIALS, AND ENVIRONMENTALLY FRIENDLY INSULATION.

WATER CONSERVATION: WATER CONSERVATION IS ANOTHER CRUCIAL STRATEGY TO ACHIEVE A NET-ZERO AND SUSTAINABLE OFFICE BUILDING. INCORPORATING WATER-SAVING FEATURES SUCH AS LOW-FLOW TOILETS AND FAUCETS, AND USING WATER-EFFICIENT LANDSCAPING, CAN HELP REDUCE THE BUILDING'S OVERALL WATER USAGE. ADDITIONALLY, RAINWATER HARVESTING SYSTEMS CAN BE USED TO CAPTURE AND REUSE RAINWATER FOR NON-POTABLE PURPOSES SUCH AS IRRIGATION.

INDOOR ENVIRONMENTAL QUALITY: CREATING A HEALTHY INDOOR ENVIRONMENT FOR OCCUPANTS CAN CONTRIBUTE TO THEIR OVERALL WELLBEING, COMFORT, AND PRODUCTIVITY. STRATEGIES SUCH AS PROPER VENTILATION, NATURAL LIGHTING, AND NON-TOXIC BUILDING MATERIALS CAN HELP ACHIEVE THIS GOAL. IMPROVED INDOOR AIR QUALITY CAN ALSO RESULT IN FEWER RESPIRATORY AND OTHER HEALTH ISSUES RELATED TO INDOOR AIR POLLUTION.

OCCUPANT ENGAGEMENT: EDUCATING AND ENGAGING OCCUPANTS IN SUSTAINABLE PRACTICES CAN ALSO HELP REDUCE THE ENVIRONMENTAL IMPACT OF THE BUILDING. STRATEGIES MAY INCLUDE COMMUNICATION ON ENERGY-SAVING TIPS, WASTE REDUCTION PRACTICES, AND RECYCLING PROGRAMS. ADDITIONALLY, ENGAGING BUILDING OCCUPANTS IN SUSTAINABILITY PRACTICES CAN LEAD TO INCREASED SATISFACTION AND A SENSE OF COMMUNITY WITHIN THE BUILDING.



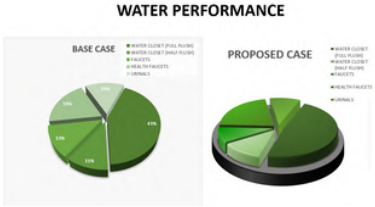


FIG 76. ENVIRONMENTAL AND PERFORMANCE GRAPHS

E.S.G PRIORITIES

SOCIAL

GOVERNANCE

ENVIRONMENTAL

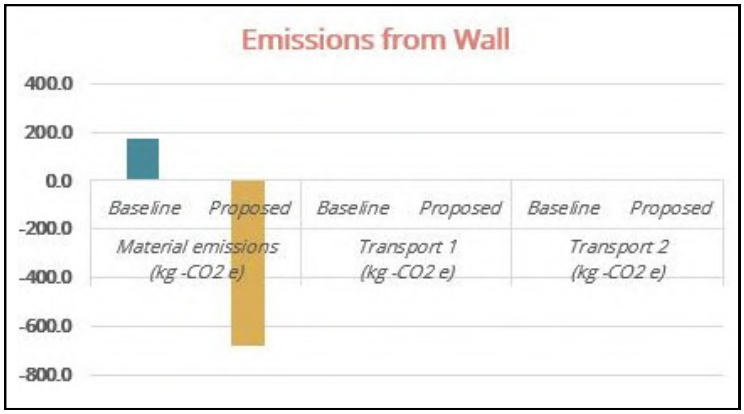
6.0 DESIGN DOCUMENTATION

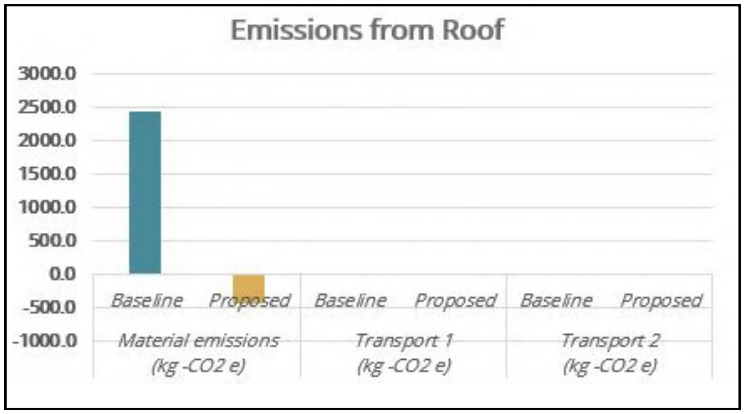
6.14 EMBODIED CARBON

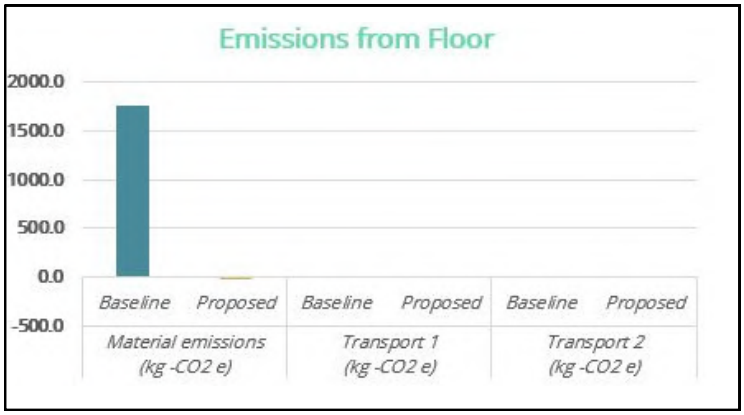
THIS CONTEST INCLUDES THE EVALUATION OF THE DESIGN FOR THE USE OF BUILDING MATERIALS AND THEIR CARBON EMISSIONS. REFER DETAILED MATERIAL EMISSION TABLE IN APPENDIX PAGE (VIII) AND (IX)

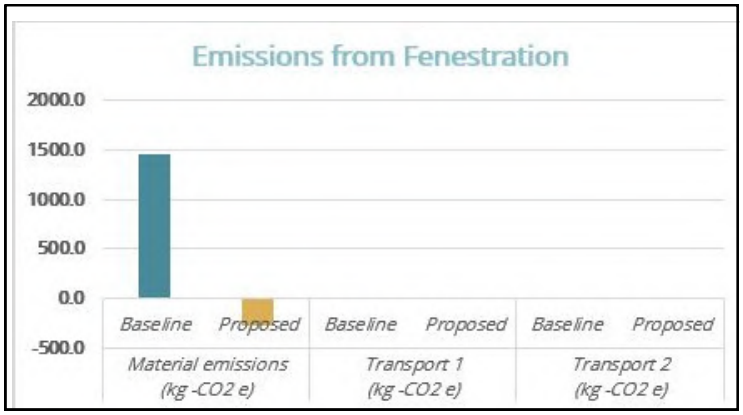
System Type	Baseline				Proposed			
	Material emissions ($kg\text{-}CO_2\ e$)	Transport 1 ($kg\text{-}CO_2\ e$)	Transport 2 ($kg\text{-}CO_2\ e$)	Total ($kg\text{-}CO_2\ e$)	Material emissions ($kg\text{-}CO_2\ e$)	Transport 1 ($kg\text{-}CO_2\ e$)	Transport 2 ($kg\text{-}CO_2\ e$)	Total ($kg\text{-}CO_2\ e$)
Wall	173.0	0.0	0.0	173.0	-684.0	0.0	0.0	-684.0
Roof	2425.0	0.0	0.0	2425.0	-458.0	0.0	0.0	-458.0
Floor	1754.0	0.0	0.0	1754.0	-23.0	0.0	0.0	-23.0
Fenestration	1444.0	0.0	0.0	1444.0	-269.0	0.0	0.0	-269.0
Structural	18.0	0.0	0.0	18.0	15.0	0.0	0.0	15.0
Grand Total emissions per functional unit ($kg\text{-}CO_2\ e$)				5814.0	Grand Total emissions per functional unit ($kg\text{-}CO_2\ e$)			-1419.0

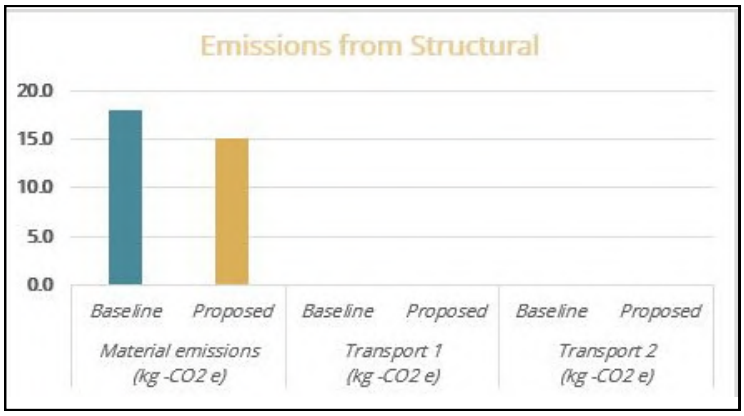
SUMMARY OF EMISSIONS PER FUNCTIONAL UNIT:

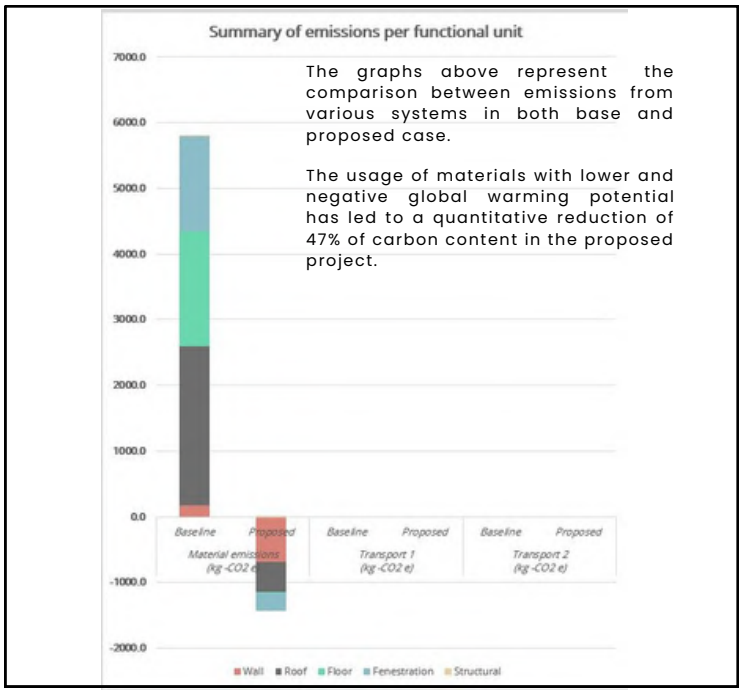












The graphs above represent the comparison between emissions from various systems in both base and proposed case.

The usage of materials with lower and negative global warming potential has led to a quantitative reduction of 47% of carbon content in the proposed project.

STRATEGIES USED FOR CARBON EMISSION REDUCTION

1.CONCEPTUAL DESIGN
- USED LOW CARBON LOCALLY AVAILABLE MATERIALS AND BUILDING SYSTEMS
-OPEN PLANNING IS DONE TO RIGHT SIZE STRUCTURAL SYSTEMS
-EFFICIENT MASSING , ENVELOPE AND LANDSCAPE WERE CONSIDERED.

STRATEGIES USED FOR CARBON EMISSION REDUCTION

2. DETAILED DESIGN
-REPLACED HIGH EMBODIED CARBON MATERIALS WITH MATERIALS WITH LOW GLOBAL WARMING POTENTIAL
-REFINING ARCHITECTURAL AND STRUCTURAL DESIGNS

TABLE 29. EMBODIED CARBON

6.0 DESIGN DOCUMENTATION

6.14 EMBODIED CARBON

THE PROPOSED CASE ATTAINED NET ZERO CARBON AND THE TOTAL MATERIAL EMISSIONS ARE CARBON NEGATIVE(-1419 KGCO2E)

The above embodied carbon summary is the result of the calculation carried forward considering the total quantities of materials required for the project. One functional unit denotes 1 square meter of the surface area of the component. The proposed design is 125% more efficient than the base case. Advantageously there is a local availability of the proposed materials which cuts down a major contribution to carbon emission by lowering emissions through the use of fuel for transportation from supplier to site.

MATERIAL COMPOSITION OF BASE CASE AND PROPOSED CASE ARE GIVEN BELOW-

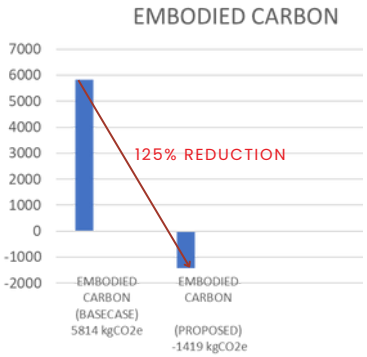


FIG ADJACENT GRAPH SHOWS THE VALUE REDUCTION IN EMBODIED CARBON

FIG 77. SLAB COMPOSITION- BASECASE:

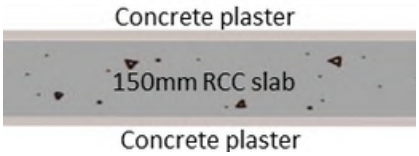


FIG 78. ROOF COMPOSITION- BASECASE:

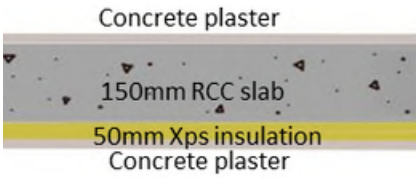


FIG 79. WALL COMPOSITION- BASECASE:

Fenestration systems in base case uses aluminium window frames with glazing and other structural system uses reinforced concrete as a prime requirement

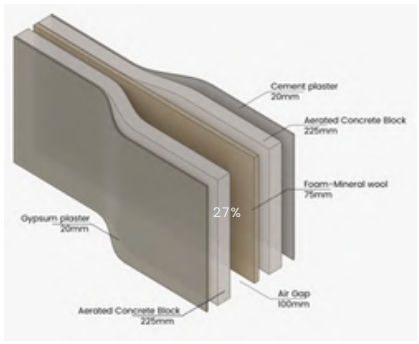


FIG 80. WALL COMPOSITION- PROPOSED

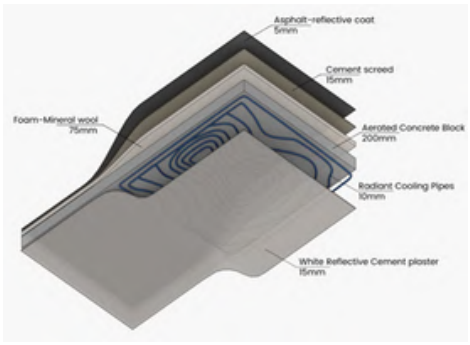


FIG 81. ROOF COMPOSITION- PROPOSED

STRATEGY ADOPTED TO REDUCE EMBODIED CARBON-

By replacing reinforced concrete and brick with AAC , XPS insulation with carbon-negative plant-based insulation (cellulose, mineral wool) , aluminium window framing with timber frames, particle/chipboard for internal partitions and the usage of aircrete helped reduce a significant amount of the embodied carbon in the structures. the adoption does not compromise on the structural importance of the respective materials.

6.9 LIFE CYCLE ASSESSMENT

Life cycle assessment using one click lca software was done in order to check for the net carbon emissions in the project, usage of carbon negative materials enabled us to acheive a higher reductions in embodied carbon.

TABLE 30. NET ZERO ASSESSMENT

	Result category	Carbon emissions kg CO_2e	Biogenic carbon kg CO_2e bio	Carbon savings from materials reuse kg CO_2e	Carbon savings from exported energy kg CO_2e	Carbon offsets kg CO_2e	Net Carbon kg CO_2e
A1-A5	Upfront carbon	2,260,437	-2,116,608	-61			143,767
B1-B7	Operating carbon	65,696		0			65,696
C-D	End of life	57,601	2,116,608	-2,689,334			-515,125
	Total	**2,383,735**	**0**	**-2,689,396**			**-305,661**
	Results per denominator						
	Gross Internal Floor Area (ASHRAE) 66687.0 m^2	36	0	-40			-5
	Gross Internal Floor Area (IPMS/RICS) 66687.0 m^2	36	0	-40			-5

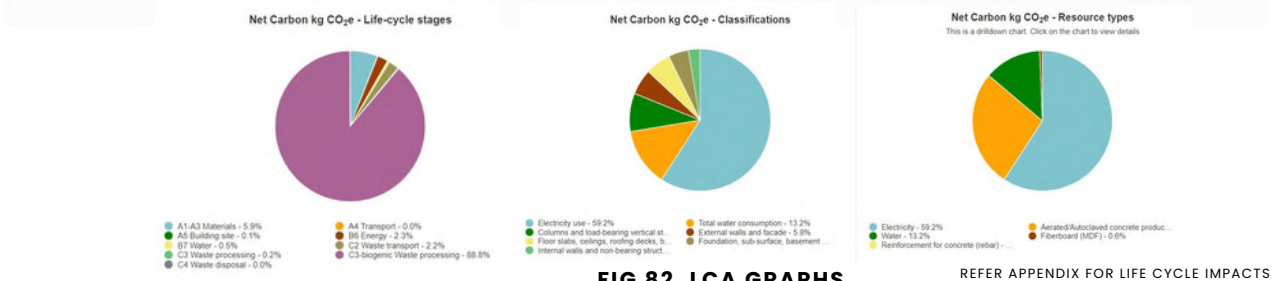


FIG 82. LCA GRAPHS

REFER APPENDIX FOR LIFE CYCLE IMPACTS BY STAGE PAGE (VI)

REFERENCES

1. ASHRAE STANDARD 55-2017, THERMAL ENVIRONMENTAL CONDITIONS FOR HUMAN OCCUPANCY
2. MINISTRY OF ENERGY EFFICIENCY. (2017) ECBC BUILDING GUIDE
3. MINISTRY OF ENERGY EFFICIENCY. (2017) ENERGY CONSERVATION BUILDING GUIDE
4. INDIAN GREEN BUILDING COUNCIL (IGBC) GUIDELINES
5. ESG GUIDELINES
6. LEED V 4.1
7. WELL STANDARD
8. LCA ANALYSIS
9. HYDERABAD METROPOLITAN WATER SUPPLY AND SEWERAGE BOARDS
10. TELANGANA STATE SOUTHERN POWER DISTRIBUTION COMPANY LIMITED

Mc D Built Environment Research Laboratory Pvt. Ltd.
#12, "SUBRAMANYA ARCADE", TOWER-B Ground Floor, Bannerghatta Main Road, OLd
Gurappanapalya, Bangalore 560029
CIN: U73100KA2008PTC046300

22.02.2023

To,

The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organisation, McD Built Environmental Research Laboratory Pvt Ltd is collaborating with the participating team led by BGS School of Architecture and Planning on an Office Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be technical assistance and guidance to achieve a net zero design.

We would like to have a representative from our organisation attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

We would like our organisation's logo to be displayed on the Solar Decathlon India website, recognising us as one of the Industry Partners for the 2022-23 competition.

With warm regards,

Ms. Chaithra Rajshekar
Operations Manager
McD Built Environmental Research Laboratory Pvt Ltd
Chaithra@mcdberl.com
080 - 41214020

Ph: 080 41214020, Email: admin@mcdberl.com
www.mcdberl.com

APPENDIX – INSTITUTION CONFIRMATION LETTER 1

II Jai Sri Gurudev II
SRI ADICHUNCHANAGIRI SHIKSHANA TRUST ®

BGS SCHOOL OF ARCHITECTURE & PLANNING

(Approved by Council of Architecture, New Delhi and
Affiliated to Vishveswaraya Technological University, Belgavi, Karnataka, India)

BGS Knowledge City Campus, Nityanandanagar, K.Gollahalli Post,
Bengaluru South - 560 074. Karnataka, INDIA

BGS SAP

TEL : +91-80-28437582/9739192140
FAX : +91-80-28437657
Website : www.bgssap.edu.in

Email : principal@bgssap.edu.in
hod@bgssap.edu.in
info@bgssap.edu.in

Ref. : BGSSAP/SC-SD/2022-23/001

Date : 20/02/2023

TO WHOMEVER IT MAY CONCERN

This is to certify that the following students from BGS School of Architecture and Planning are full time students enrolled in the Bachelor's degree in Architecture course affiliated with Visvesvaraya Technological university (VTU) in Bangalore, Karnataka. The student names and respective semesters as per the academic session 2022-2023 are given below-

1. R. Niveditha- 8th Semester
2. Surabhi. P -8th Semester
3. Jaydeep. R-8th Semester
4. Shalini. R- 8th Semester
5. Nadia – 8th Semester
6. Rahul. R- 8th Semester
7. Saurav. S Pillai-8th Semester
8. Meenakshi Paul- 8th Semester
9. Anjan. K -6th Semester
10. Prathiksha. R -6th Semester
11. Rithesh P- 6th Semester
12. Bhuvan. L- 6th Semester
13. Vandita Kumari- 6th Semester
14. Lesha. S- 4 th Semester

The above students are participating in the Solar Decathlon India competition and this certificate is issued for the purpose of verification for the competition.

Principal
BGS School of Architecture & Planning
BGS Knowledge City Campus
Nityanandanagar, Bengaluru - 560 074

Prof. Ar. Nitin Saolapurkar

Principal

BGSSAP

20/02/2023

APPENDIX – INSTITUTION CONFIRMATION LETTER 2

Dayananda Sagar Academy of Technology & Management

Affiliated to Visvesvaraya Technological University, Belagavi,
Approved by All India Council for Technical Education (AICTE), New Delhi.
All UG Courses Accredited by National Board of Accreditation (NBA), New Delhi.

Date: 21/02/2023

Ref: Bonf/2022-23/010

BONAFIDE CERTIFICATE

This is to certify that **Ms. K HARSHITHA,** D/o Mr. D KESHAVA MURTHY, bearing USN 1DT19CV021, is a bonafide student of this Institution studying IV year B.E. in Civil Engineering branch during the year 2022-2023.

As she is participating in the Solar Decathlon India competition and this certificate is issued for the purpose of verification for the competition.

21/2/23

Principal

Dr. M. Ravishankar
Principal
Dayananda Sagar Academy of Technology & Management
Udayapura, Opp. Art of Living,
Kanakapura Road Bangalore-560 082.

Udayapura,Kanakapura Road,Opp.Art of Living, Bangalore - 560 082.
Phone : +91 80 28432999 / 28432777, Fax : 080-28432909
Website : www.dsatm.edu.in

CONTEXT ANALYSIS

Hyderabad, a historic city in India, has transformed into a central hub for Information Technology and IT-enabled services, with the presence of top 500 IT companies and remarkable export growth. The development of HITEC City, equipped with advanced technologies, has attracted numerous IT and ITES companies to establish operations in Hyderabad. The city's IT & ITeS, BPO cluster has key characteristics such as 34% of companies earning over 50% of their revenue from international markets, and 40% of companies benefitting from advantageous factors like manpower, training, and technology.

SITE LOCATION :

The site is located in Pocharam Village, Singapore Township PO, Ghatkesar Mandal, Malkajgiri, Hyderabad. It is approximately 4.4km away from the nearest Nehru Outer Ring Road, which connects to various major hubs. As of the 2011 census of India, the urban district is the second most populous in the state, with a population of 2,440,073. The location is convenient, with access to bus stops, restaurants, hospitals, and police stations within a 5km radius.

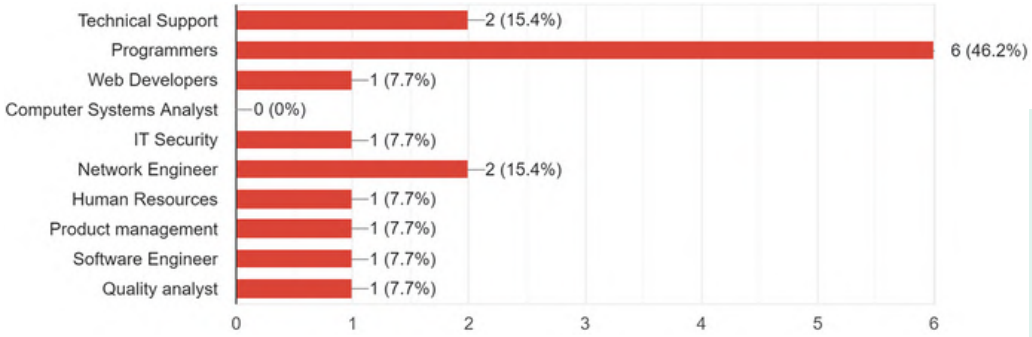
LOCAL MATERIALS :

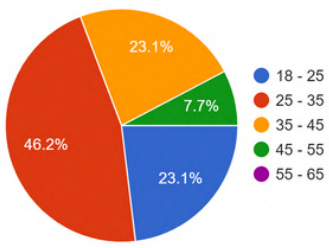
Hyderabad, also known as the "Pearl City," is famous for its sparkling pearls and glass-embedded bangles. The city has abundant coal reserves that are used for factory and thermal power plant purposes. Additionally, it has sufficient deposits of limestone, clay, bauxite, and mica for various industries.

PUBLIC SURVEY - OCCUPANT PREFERENCES AND CONCERNS :

The team performed an online survey to gain insights into the occupants' perspectives, demographics, office environment work patterns, hierarchy, spatial arrangements, and accessibility, with the aim of analyzing and identifying ways to enhance interaction, spatial arrangement, and overall productivity within the office space.

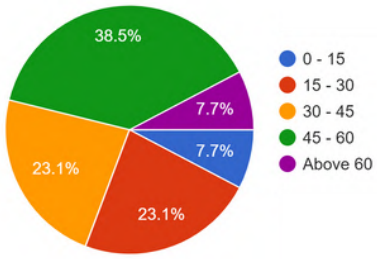
INFERENCES FROM RESPONSE FOR IDEAL WORK ENVIRONMENT :





- Enclosed work cubicles are preferred to increase privacy in the workspace.
- Recreational spaces should be provided to allow for relaxation.
- Collaborative spaces should be added to encourage informal discussions and idea sharing.
- Passive workstations that allow for adjustments in desk and view should be provided.
- Conference rooms of varying sizes should be available.
- A healthy work environment can be achieved by ensuring a constant influx of fresh air

CONCLUSION :



Due to the global pandemic, a large portion of the IT population is now working from home. With the comfort and flexibility of home as a workspace, many IT professionals are finding that they still prefer to work remotely. As work culture continues to shift, designers face the challenge of creating an office environment that is not only suitable for the present but also for the future, with appealing workspace designs that attract and retain employees.

AREA PROGRAMMING

SITE AREA : 65 ACRES
USERS : 10,500 PPL
BUILD UP : 66,687 sqm

NO OF BLOCK : 2 (TOWER A & B)
NO OF FLOORS : TOWER A - 8 FLOORS
TOWER B - 12 FLOORS

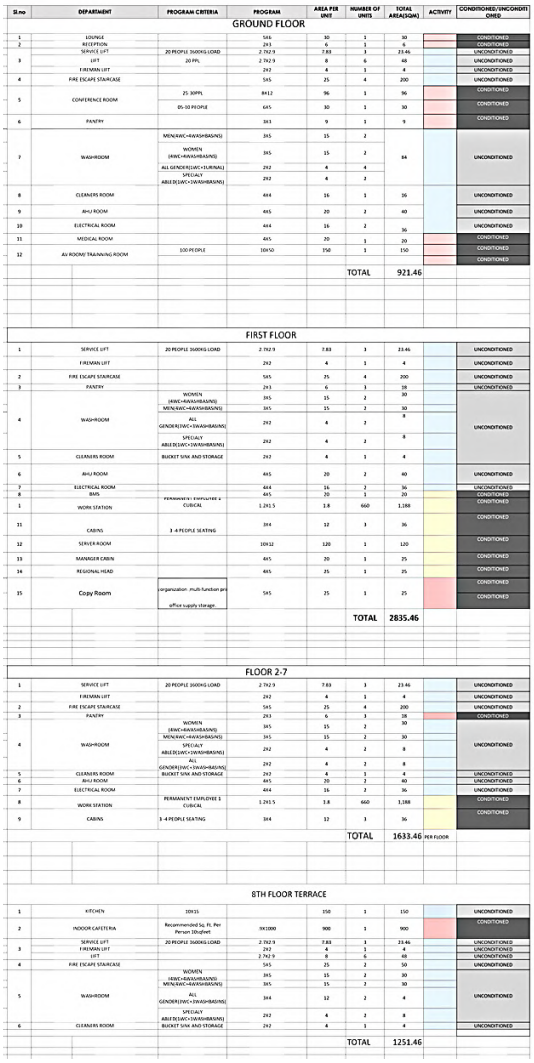


TABLE 10 . TOWER A AREA PROGRAMMING

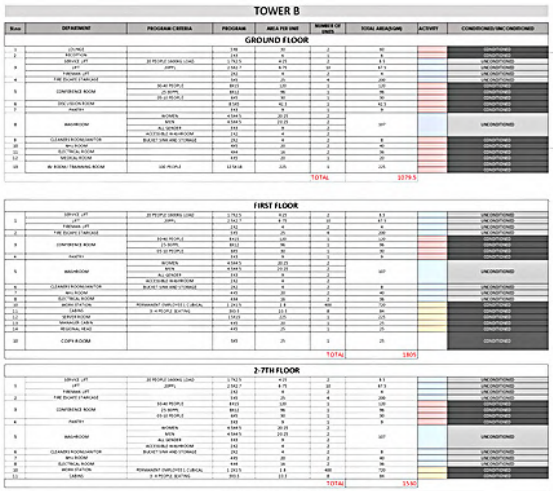


TABLE 11 . TOWER B AREA PROGRAMMING

TABLE 12 . FOOD COURT AREA PROGRAMMING

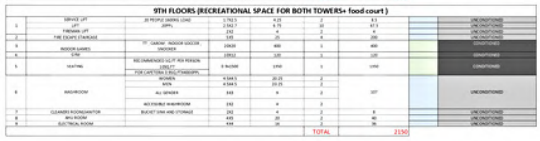


TABLE 13 .RECREATIONAL SPACE AREA PROGRAMMING

TABLE 13 .ODC AREA PROGRAMMING

TOTAL BUILT UP OF TOWER A	
GROUND FLOOR	1202
1ST FLOOR	2435
2ND FLOOR	2435
3RD FLOOR	2435
4TH FLOOR	2435
5TH FLOOR	2435
6TH FLOOR	2435
7TH FLOOR	2435
TOTAL	18247
CIRCULATION	25%
GRAND TOTAL	22,810sqm

TABLE 14. TOTAL BUILT UP TOWER A

TOTAL BUILT UP OF TOWER B	
GROUND FLOOR	1080
1ST FLOOR	1805
2ND FLOOR	1530
3RD FLOOR	1530
4TH FLOOR	1530
5TH FLOOR	1530
6TH FLOOR	1530
7TH FLOOR	1530
8TH FLOOR	2150
9TH FLOOR	2350
10TH FLOOR	1944
11TH FLOOR	1920
12TH FLOOR	1920
TOTAL	22349
CIRCULATION	25%
GRAND TOTAL	279363sqm

TABLE 14. TOTAL BUILT UP TOWER B

DIVISION OF SPACE -ACTIVITY

SERVICE CORE
WORKING
COMMON SPACES
RECREATIONAL SPACES

DIVISION OF SPACE -CONTIDIONING

CONDITIONED SPACES = 40,217 SQM

UNCONDITIONED SPACES = 11,081 SQM

TOTAL

Sl.no	DEPARTMENT	PROGRAM CRITERIA	PROGRAM	TOTAL AREA(SQM)
	TOWERS			
1	TOWER A			22,810.00
2	TOWER B			27936 .00
	MANAGEMENT			
1	SECURITY	3x3.5		10.5
2	ELECTRICAL	3x3.5		10.5
3	TECHNICAL ENGINEER	3x3.5		10.5
4	PROJECT MANAGERS	3x3.5		10.5
	SERVICES			
1	CONTROL ROOM	5X6	30	30
2	UPS ROOM	10X15	150SQM	150
3	DG :	8x15	120sqm	120
	Total capacity: 7500kva			
5	STP:	7X30	210	210
	Plant capacity: 350KLD			
	Treated water: 100000lts			
8	ELECTRICAL ROOM	4x4	16 x no of floors (21)	336
10	LPG ROOM	2X 6M	12M	12
11	TRANSFORMER: 1600KVA	15X20		300
			TOTAL	51,298
				51,298
				51,298+ 30%
				66,687 sqm

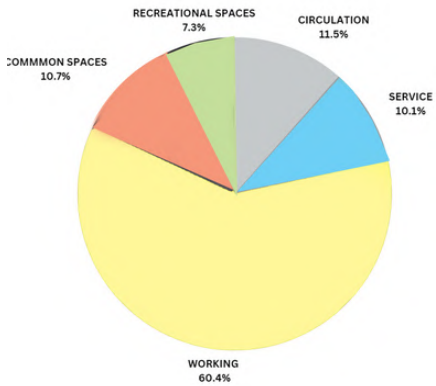
TABLE 14. TOTAL BUILT UP

TOTAL AREA :	**51,298**
CIRCULATION	**51,298+ 30%**
TOTAL BUILD UP	**66,687 sqm**

TABLE 15 - TOTAL AREA CALCULATION

AREA OF PROPOSED FOOTRPINT	65 ACRES (263046 Sqm)
PROBABLE AREA FOR LANDSCAPE	10 ACRES (40468 Sqm)

TABLE 16 - TOTAL LANDSCAPE



TOTAL SITE AREA : 65 ACRES (2,63,046 Sqm)
AREA OF PROPOSED FOOTPRINT : 2.4 ACRES (10,000 approx sqm)
LANDSCAPING AREA : 10 ACRES (40,468 Sqm)

IGBC BUILDING RATING-

THE FOLLOWING CREDITS ARE THE IGBC NET ZERO BUILDING RATE POINT'S CALCULATION-

IGBC NET ZERO BUILDING RATING SYSTEM

TOTAL CREDIT POINTS - 185
SECURED DESIGN CREDIT POINTS - 160

CREDIT 01 ---EXCELLENCE IN ENERGY PERFORMANCE --- POINTS - 75
CREDIT 2.1 ----ENERGY EFFICIENT BUILDING ENVELOPE

ROOF ASSEMBLY -
U VALUE OF ROOF - 3 POINTS (U=0.26)
SRI VALUE OF ROOF - 1 POINT (U=2.8)

WALL ASSEMBLY -
U VALUE OF WALL - 5 POINTS

GLAZING ASSEMBLY -
U VALUE OF GLAZING - 2 POINTS
VLT / SHGC RATIO - 2 POINTS

CREDIT 2.2 ---AIR CONDITIONING SYSTEM
PERFORAMNCE OF CHILLERS - 26 POINTS

AUXILLARIES
PUMPS - 3 POINTS
FANS - 3 POINTS
MOTORS - 2 POINTS
VARIBLE FLOW CONTROL - 4 POINTS

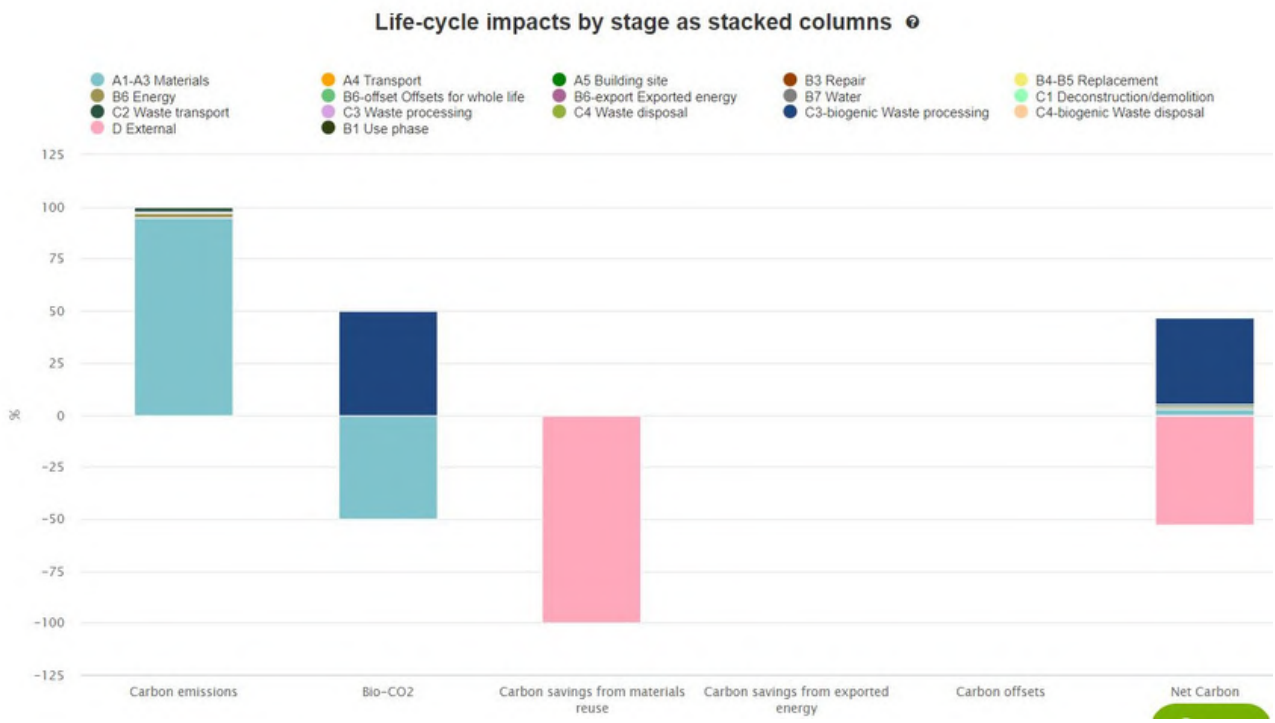
CREDIT 2.3 LIGHTING
DAYLIGHTING - 2 POINTS
ARTIFICIAL LIGHTING - 4 POINTS

CREDIT 2.4 APPLICANCES
COMPILANCE OPTIONS - 6 POINTS

CREDIT 3 --RENEWABLE ENREGY
COMPLIANCE OPTION - 22 POINTS

6.9 LIFE CYCLE ASSESSMENT

THE FOLLOWING IS THE LIFE CYCLE IMPACTS BY STAGE AS STACKED COLUMN
VIA- ONE CLICK LCA



6.6 AFFORDABILITY

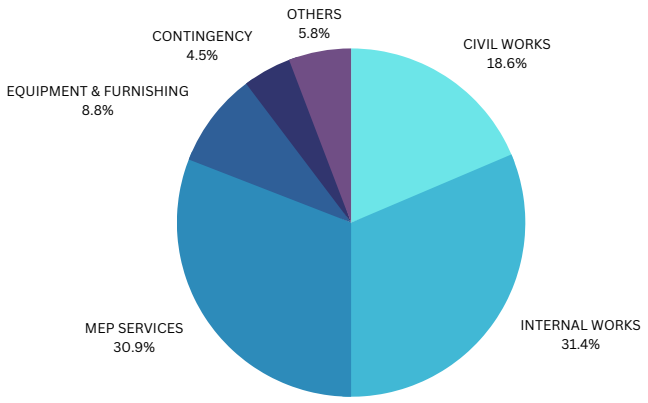
THE COST OF THE PROPOSED CASE IS LOWER THAN THE BASELINE ESTIMATES INSTEAD OF ADDITIONAL INSTALLATION COST TO REDUCE THE EMBODIED ENERGY, SUCH AS PV PANELS, ALTERNATIVE MATERIALS AND HYBRID CONSTRUCTION. SINCE THE USE OF AERATED CONCRETE BLOCK HELPS IN THE REDUCTION OF UNNECESSARY DEAD LOAD AND EFFICIENT MEP SERVICES, INTERNAL WORKS REDUCE THE OVERALL COST OF THE PROJECT

Project Summary

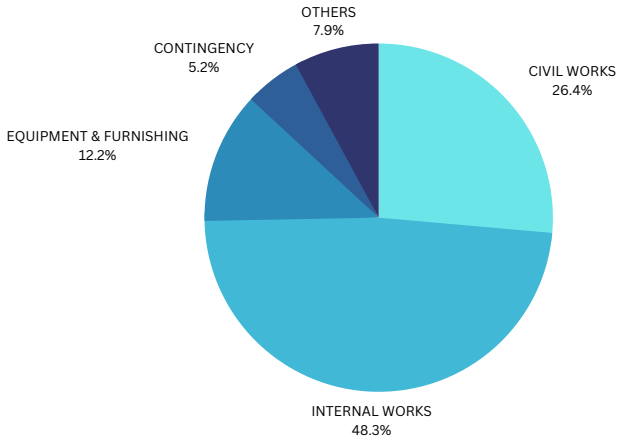
Project Project Information

Team:	GAEA				
Division:	OFFICE BUILDING		Land Cost:	0	Million INR
	Site Area (sqm)	26,709	City:	HYDERABAD	
	Built-up Area (BUA) (sqm)	114,695	State:	TELANGANA	
	Ground Coverage (Plinth Area) (sqm)	9,915			

S.No.	Particulars	Definition	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
			Amount (Million INR)	%	Amount (INR per sqm)	Amount (Million INR)	%	Amount (INR per sqm)
1	Land	Cost of land purchased or leased by the Project Partner	0.00	0.0%	-	0.00	0.0%	-
2	Civil Works	Refer Item A, Civil works in Cost of construction worksheet	126.17	18.6%	1,100	105.80	26.4%	922
3	Internal Works	Refer Item B, Civil works in Cost of construction worksheet	213.30	31.4%	1,860	193.78	48.3%	1,689
4	MEP Services	Refer Item C, Civil works in Cost of construction worksheet	210.02	30.9%	1,831		0.0%	-
5	Equipment & Furnishing	Refer Item D, Civil works in Cost of construction worksheet	59.51	8.8%	519	48.81	12.2%	426
6	Landscape & Site Development	Refer Item E, Civil works in Cost of construction worksheet	0.20	0.0%	2	0.14	0.0%	1
7	Contingency	Amount added to the total estimate for incidental and miscellaneous expenses.	30.46	4.5%	266	21.00	5.2%	183
	TOTAL HARD COST		**639.7**	**94%**	**5,577**	**369.5**	**92%**	**3,222**
8	Pre Operative Expenses	Cost of Permits, Licenses, Market research, Advertising etc	10.00	1.5%	87	10.00	1.5%	87
9	Consultants	Consultant fees on a typical Project	10.00	1.5%	87	10.00	1.5%	87
10	Interest During Construction	Interest paid on loans related to the project during construction	20.25	3.0%	177	11.72	1.7%	102
	TOTAL SOFT COST		**40.3**	**6%**	**351**	**31.7**	**5%**	**277**
	TOTAL PROJECT COST		**679.9**	**100%**	**5,928**	**401.2**	**100%**	**3,498**



BASE CASE



PROPOSED CASE

TABLE. 31. COST ESTIMATION - BASE AND PROPOSED CASE

WATER INTERVENTIONS

64% OF TOTAL WATER DEMAND IS FULFILLED THROUGH RAINWATER HARVESTING. THE USE OF HARVESTED RAINWATER CONTRIBUTES TO THE REDUCTION OF MUNICIPAL WATER USE AND HAS THE POTENTIAL TO SAVE A SIGNIFICANT AMOUNT OF WATER PER YEAR.

TOTAL COLLECTED WATER FROM ROOF WATER HARVESTING, SOFTSCAPE & HARDSCAPE WATER HARVESTING,EXTERNAL CATCHMENT WATER AND TREATED WATER AVAILABLE IS AROUND 29% MORE THAN THE TOTAL WATER DEMAND PER YEAR

AND EFFICIENT FIXTURES ARE USED TO REDUCE WATER DEMAND THEREBY ALSO REDUCING OVERHEAD TANK SIZES.

6.9 EMBODIED CARBON

BASE CASE

MATERIAL EMISSIONS FROM THE COMPONENTS OF THE BUILDING

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier					Transport 2 | Supplier --> Site				
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Roof	Cement (ordinary Portla	kg	3919500	0.91	3566745	HGV Lorry/ Truck	12	98	1176	196	557	HGV Lorry/ Truck	16	98	1568	261	742
	Steel reinforcement (ste	kg	261300	2.6	679380	HGV Lorry/ Truck	12	7	78	13	37	HGV Lorry/ Truck	16	7	105	17	49
	Expanded polystyrene in	kg	2177500	2.9	6314750	HGV Lorry/ Truck	12	54	653	109	309	HGV Lorry/ Truck	16	54	871	145	412
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	2425					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-ROOF

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier					Transport 2 | Supplier --> Site				
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Wall	Brick - High draught/zigz	kg	14,89,020	0.59	878522	HGV Lorry/ Truck	17	37	633	105	300	HGV Lorry/ Truck	16	37	596	99	282
	Cement based plaster	kg	172000	0.44	75680	HGV Lorry/ Truck	15	4	65	11	31	HGV Lorry/ Truck	16	4	69	11	33
	Ready mix concrete with	kg	346500	0.11	38115	HGV Lorry/ Truck	15	9	130	22	62	HGV Lorry/ Truck	16	9	139	23	66
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	173					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-WALL

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier					Transport 2 | Supplier --> Site				
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Fenestration	Float glass	kg	2944800	1.2	3533760	HGV Lorry/ Truck	17	74	1252	209	592	HGV Lorry/ Truck	16	74	1178	196	558
	Aluminum extruded profi	kg	368	26	9568	HGV Lorry/ Truck	17	0	0	0	0	HGV Lorry/ Truck	16	0	0	0	0
	Adhesive for parquet	l	0	6.7	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit	1444					Total Transport 1 emissions per	0					Total Transport 2 emissions per	0

SYSTEM TYPE-FENESTRATION

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier					Transport 2 | Supplier --> Site				
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Floor	Adhesive for parquet	l	19,612	6.7	131400	HGV Lorry/ Truck	7	0	3	1	2	HGV Lorry/ Truck	16	0	8	1	4
	Vitrified ceramic floor tile	kg	932000	0.68	633760	HGV Lorry/ Truck	10	23	233	39	110	HGV Lorry/ Truck	16	23	373	62	176
	Granite	kg	12264	0.31	3802	HGV Lorry/ Truck	10	0	3	1	1	HGV Lorry/ Truck	16	0	5	1	2
	Cement (ordinary Portla	kg	4,31,14,500	0.91	39234195	HGV Lorry/ Truck	12	1078	12934	2156	6122	HGV Lorry/ Truck	16	1078	17246	2874	8163
	Steel reinforcement (ste	kg	28,74,300	2.6	7473180	HGV Lorry/ Truck	12	72	862	144	408	HGV Lorry/ Truck	16	72	1150	192	544
	Expanded polystyrene in	kg	2,39,52,500	2.9	69462250	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	1754					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-FLOOR

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier					Transport 2 | Supplier --> Site				
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Structural	Cement (ordinary Portla	kg	600000	0.91	546000	HGV Lorry/ Truck	12	15	180	30	85	HGV Lorry/ Truck	16	15	240	40	114
	Steel reinforcement (ste	kg	260000	2.6	676000	HGV Lorry/ Truck	12	7	78	13	37	HGV Lorry/ Truck	16	7	104	17	49
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select materiab		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	18					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-STRUCTURAL

System Type	Baseline				Proposed			
	Material emissions (kg -CO2 e)	Transport 1 (kg -CO2 e)	Transport 2 (kg -CO2 e)	Total (kg -CO2 e)	Material emissions (kg -CO2 e)	Transport 1 (kg -CO2 e)	Transport 2 (kg -CO2 e)	Total (kg -CO2 e)
Wall	173.0	0.0	0.0	173.0	-684.0	0.0	0.0	-684.0
Roof	2425.0	0.0	0.0	2425.0	-458.0	0.0	0.0	-458.0
Floor	1754.0	0.0	0.0	1754.0	-23.0	0.0	0.0	-23.0
Fenestration	1444.0	0.0	0.0	1444.0	-269.0	0.0	0.0	-269.0
Structural	18.0	0.0	0.0	18.0	15.0	0.0	0.0	15.0
Grand Total emissions per functional unit (kg -CO2 e)				5814.0	Grand Total emissions per functional unit (kg -CO2 e)			-1419.0

SUMMARY OF EMISSIONS PER FUNCTIONAL UNIT

6.9 EMBODIED CARBON

PROPOSED CASE

MATERIAL EMISSIONS FROM THE COMPONENTS OF THE BUILDING

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier						Transport 2 | Supplier --> Site					
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Roof	Aircrete (autoclaved aer	kg	3,48,400	0.5	174200	HGV Lorry/ Truck	12	9	105	17	49	HGV Lorry/ Truck	11	9	96	16	45
	Steel reinforcement (ste	kg	87,100	2.6	226460	HGV Lorry/ Truck	12	2	26	4	12	HGV Lorry/ Truck	11	2	24	4	11
	Cellulose insulation	kg	21,77,500	-1.1	-2395250	HGV Lorry/ Truck	10	54	544	91	258	HGV Lorry/ Truck	11	54	599	100	283
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	-458					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-ROOF

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier						Transport 2 | Supplier --> Site					
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Wall	AAC	kg	1466112	0.5	733056	HGV Lorry/ Truck	12	37	440	73	208	HGV Lorry/ Truck	11	37	403	67	191
	Cellulose insulation	kg	42,95,250	-1.1	-4724775	HGV Lorry/ Truck	10	107	1074	179	508	HGV Lorry/ Truck	11	107	1181	197	559
	Aircrete (autoclaved aer	kg	1,46,611	0.5	73306	HGV Lorry/ Truck	12	4	44	7	21	HGV Lorry/ Truck	11	4	40	7	19
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	-684					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-WALL

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier						Transport 2 | Supplier --> Site					
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Floor	Adhesive for parquet	l	19612	6.7	131400	HGV Lorry/ Truck	5	0	2	0	1	HGV Lorry/ Truck	11	0	5	1	3
	Vitrified ceramic floor tile	kg	932000	0.68	633760	HGV Lorry/ Truck	10	23	233	39	110	HGV Lorry/ Truck	7	23	163	27	77
	Granite	kg	12264	0.31	3802	HGV Lorry/ Truck	10	0	3	1	1	HGV Lorry/ Truck	7	0	2	0	1
	Aircrete (autoclaved aer	kg	33114500	0.5	16557250	HGV Lorry/ Truck	12	828	9934	1656	4702	HGV Lorry/ Truck	11	828	9106	1518	4310
	Steel reinforcement (ste	kg	2874300	2.6	7473180	HGV Lorry/ Truck	12	72	862	144	408	HGV Lorry/ Truck	11	72	790	132	374
	Cellulose insulation	kg	23952500	-1.1	-26347750	HGV Lorry/ Truck	12	599	7186	1198	3401	HGV Lorry/ Truck	11	599	6587	1098	3118
				Total material emissions per functional unit (kg -CO2 e)	-23					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-FLOOR

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier						Transport 2 | Supplier --> Site					
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Fenestration	Clear glass (6mm)	kg	2944800	0.6	1766880	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	electrochromatic reflect	kg	2944800	0.8	2355840	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	Air-dried sawn timber	kg	3680000	-1.3	-4784000	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	-269					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-FENESTRATION

			Material manufacturing emissions			Transport 1 | Manufacturer --> Supplier						Transport 2 | Supplier --> Site					
	Material	Unit	Quantity	Emissions Factor	Material Emissions (kg -CO2 e)	Type of Vehicle used	(1) Distance from Factory to Retail shop	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 1 (kg -CO2 e)	Type of Vehicle used	(1) Distance from Retail shop to Site (km)	(2) No. of trips	(3) Total distance = (1)* (2) (km)	(4) Total Fuel Consumed = (3)/Mileage (litres)	Transport Emissions 2 (kg -CO2 e)
System Type Structural	Aircrete (autoclaved aer	kg	600000	0.5	300000	HGV Lorry/ Truck	12	15	180	30	85	HGV Lorry/ Truck	11	15	165	28	78
	Steel reinforcement (ste	kg	260000	2.6	676000	HGV Lorry/ Truck	12	7	78	13	37	HGV Lorry/ Truck	11	7	72	12	34
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
	<select material>		0	0	0	<select vehicle>	0	0	0	0	0	<select vehicle>	0	0	0	0	0
				Total material emissions per functional unit (kg -CO2 e)	15					Total Transport 1 emissions per functional unit	0					Total Transport 2 emissions per functional unit	0

SYSTEM TYPE-STRUCTURAL

System Type	Material emissions	Transport 1 (kg -CO_2 e)	Transport 2 (kg -CO_2 e)	Total (kg -CO_2 e)
Wall	71.0	1.0	0.0	72.0
Roof	13.0	1.0	0.0	14.0
Floor	75.0	1.0	0.0	76.0
Fenestration	17.0	1.0	0.0	18.0
Structural	172.0	1.0	0.0	173.0
Grand Total emissions per functional unit (kg -CO_2 e)				353.0

PROPOSED CASE-
SUMMARY OF EMISSIONS PER FUNCTIONAL UNIT

C. MEP SERVICES											
11	HVAC										
11.1	Radiant Chilled Water Piping & Controls	Sqm			40.6	50,713			40.6	50,713	NO	
11.2	Cooling Tower (1148 TR)	Nos	1	3,00,000	0.3	375	1	3,00,000	0.3	375	NO	
11.3	Chillers	Nos	1	3,15,000	0.3	394	2	3,15,000	0.6	788	YES	
11.4	Air Handling Units (5 TON)	Nos	20	80,000	1.6	2,000	20	80,000	1.6	2,000	NO	
	"Insert Row" above this row to add more items											
12	ELECTRICAL & ALLIED SERVICES											
12.1	Substation Equipment & HT Cabling (Including Transformers)	KVA	652	16,250	10.6	13,244	652	15,000	9.8	12,225	YES	
12.2	Internal Electrical Installations	BUA Sqm			148.5	1,85,671			121.6	1,52,013	YES	12.5% X (A.CIVIL WORKS) + 20% (AS PER 2023 rates)
12.3	Earthing & Lightning Protection	BUA Sqm			50.6	63,291			38.1	47,569	YES	3.75% X (A.CIVIL WORKS) + 20% (AS PER 2023 RATES)
12.4	D.G. Sets	KVA	3,500	13,000	45.5	56,875	3,500	12,000	42.0	52,500	YES	1st UNIT - 2000KVA / 1500KVA (STAND BY) 2nd UNIT -
	"Insert Row" above this row to add more items											
13	PLUMBING & SANITATION											
13.1	Internal Water Supply & Sanitary Installations	BUA Sqm			51.5	64,361			38.4	47,990	YES	4% X (A.CIVIL WORKS) + 20% (AS PER 2023 rates)
13.2	Internal Drainage	Sqm	240	4,355	1.0	1,307	240	4,020	1.0	1,206	YES	
13.3	External Drainage	Sqm	290	4,355	1.3	1,579	290	4,020	1.2	1,457	YES	
13.4	Storm Water Drain	Sqm	810	11,600	9.4	11,745	810	10,700	8.7	10,834	YES	
13.5	STP	KLD	66	92,775	6.1	7,654	66	92,775	6.1	7,654	NO	
13.6	Rainwater Storage tank & system	Cu.m	1,00,000	25	2.5	3,125	1,00,000	25	2.5	3,125	NO	
	"Insert Row" above this row to add more items											
14	FIRE FIGHTING											
14.1	Plant Room	BUA Sqm	190	29,800	5.7	7,078	190	27,500	5.2	6,531	YES	
14.2	Fire Hydrant & Sprinkler System	Total BUA	66,687	1,560	104.0	1,30,040	66,687	1,440	96.0	1,20,037	YES	
	"Insert Row" above this row to add more items											
15	IBMS AND SECURITY SYSTEM											
15.1	Fire Alarm System	BUA Sqm	24,176	780	18.9	23,572	24,176	720	17.4	21,758	YES	
15.2	Access Control System	BUA Sqm	24,176	260	6.3	7,857	24,176	200	4.8	6,044	YES	
15.3	CCTV System	BUA Sqm	24,176	300	7.3	9,066	24,176	240	5.8	7,253	YES	
15.4	Building Management System	BUA Sqm	24,176	520	12.6	15,714	24,176	480	11.6	14,506	YES	
	"Insert Row" above this row to add more items											
16	INSTALLATION OF LIFT											
16.1	Service Elevator	BUA Sqm	4	5,50,000	2.2	19	4	4,50,000	1.8	16	YES	
16.2	Passenger Elevator	BUA Sqm	10	8,50,000	8.5	74	10	8,00,000	8	70	YES	
	"Insert Row" above this row to add more items											
	SUB-TOTAL (C)				535.2	6,69,034			463.1	5,78,827		

TABLE DEPICTING THE INITIAL INVESTMENT COST FOR INSTALLING MEP SERVICES

BASE CASE	PROPOSED CASE
ENERGY CONSUMED = 8002440 KWH/YEAR	ENERGY CONSUMED = 5138587 KWH/YEAR
*TARIFF RATES = RS.8/- PER KVAH	*TARIFF RATES = RS.8/- PER KVAH
ANNUAL ENERGY BILL = RS.7,11,32,832/-	ANNUAL ENERGY BILL = RS.4,56,76,320/-

OPEX COST - ANNUAL ELECTRICITY BILLS
*TARIFF RATES AS PER TELANGANA STATE SOUTHERN POWER DISTRIBUTION COMPANY LIMITED (TSSPDCL)

CONVERSION OF KWH/YEAR TO KVAH/YEAR:
KVAH = KWH/POWER FACTOR
HERE, THE POWER FACTOR CONSIDERED IS 0.9

BASE CASE	PROPOSED CASE
WATER DEMAND = 76836.5 KL/YEAR (BASED ON NBC)	WATER DEMAND = 43409.5 KL/YEAR (BASED ON IGBC)
**TARIFF RATES = RS.180/- PER KL	**TARIFF RATES = RS.180/- PER KL
ANNUAL WATER BILL = RS.1,38,30,570/-	ANNUAL WATER BILL = RS.85,50,810/-

OPEX COST - ANNUAL WATER BILLS
**TARIFF RATES AS PER HYDERABAD METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (HMWSSB)

NET RETURNS = TOTAL BILLS OF BASE CASE - TOTAL BILLS OF PROPOSED CASE

NET RETURNS = (RS.7,11,32,832 + RS.1,38,30,570**) - (**RS.4,56,76,320 + RS.85,50,810**)**

NET RETURNS = RS.8,49,63,402 - RS.5,42,27,130

NET RETURN = RS.3,07,36,272/-

FURTHER, **ADD 1% TO THE NET RETURNS AS ANNUAL MAINTENANCE COST**

1% X RS.3,07,36,272 = 3,07,362.72/-

THEREFORE FINAL NET RETURN TO BE CONSIDERED = RS.3,07,362.72 + RS.3,07,36,272

FINAL NET RETURNS = RS.3,10,43,634.72