A

THESIS REPORT

ON

CORPORATE OFFICE BUILDING

Department of Architecture & Planning

Malaviya National Institute of Technology Jaipur, 302017

(Session: 2017-2018)

SUBMITTED BY:

Mohit Gunwal

2013 uar 1734

X Semester, B.Arch.

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Submitted in the partial fulfilment of the requirement for the degree of Bachelor of Architecture

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CERTIFICATE

This is to certify that this report titled '**Corporate Office Building Design**' submitted by **Mohit Gunwal** (Student ID 2013UAR1734) of V year, B.Arch. (2017-2018) in partial fulfilment for the award of the degree of Bachelor of Architecture is satisfactory and approved for submission. This is a bona-fide work of the student and has not been submitted to any other university for award of any Degree/Diploma.

Student

Dr. Satish Pipralia
(Faculty Guide)

Dr. Pooja Nigam
(Thesis Coordinator)

Dr. Tarush Chandra
(Head of Department)

CANDIDATE'S DECLARATION

I, **Mohit Gunwal**, student of V year B.Arch. (Student ID: 2013UAR1734) Department of Architecture and Planning, Malaviya National Institute of Technology, Jaipur, hereby declare that my thesis report titled '**Corporate Office Building'** in partial fulfilment for the award of the degree of Bachelor of Architecture contains my original work supplemented by data from primary as well as secondary sources which have been duly acknowledged.

The matter presented in this thesis has not been submitted by me for the award of any other degree or diploma of this or any other institute.

Signature of the student

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Signature of the Supervisor

The B. Arch. End-Term Viva Voce of 'm' has been held on ..../...../2018.

Thesis Coordinator Head of the Department Jury Members

1. .....

2. .....

3. .....

ACKNOWLEDGEMENT

Firstly, I would like to express my sincere gratitude to my guide **Dr. Satish Pipralia** Sir for the continuous support of my dissertation study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this dissertation.

I would like to thank **Prof. Alok Ranjan Sir** for his insightful comments and encouragement, for also for the hard questions which made me widen my research from various perspectives.

My sincere thanks also go to **Dr. Pooja Nigam**, the course coordinator, who guided me and my classmates throughout the process.

I would like to express my infallible gratitude to **Mr. Atul Brijwasi** at Adobe Systems, the Project Manager of Adobe Systems Headquarter, who devoted his valuable time to help me understand the proper functioning of the service system and supplement my research with their valuable input.

I am most thankful to my friends for being there when needed and helping me out with my case studies and constant source of encouragement and inspiration.

Mohit Gunwal

2013UAR1734

CONTENT

ABSTRACT

This thesis project will deal with the complete stages involved in the design of an Information Technology Office Building proposed to be built at Marathahalli, Bengaluru, Karnataka. The project is an actual real life proposed project to be built on the commercial zone in Bengaluru. The scope of this thesis project only concerns design of one office building, though the site contains future expansion too. The thesis involves complete architectural designing of the site from the site planning stage onwards to final design consideration of preparing detailed working plans, sections, elevations, 3d renderings of the expected result and a comprehensive report on the complete thesis. The thesis follows a strict methodology based on widely accepted and commonly used design theories and methodologies. Such methods are mainly basically derived from a logical application of the problem. Extensive and exhaustive case studies are generally conducted afore hand to ascertain present and existing examples of such type of buildings so that all positive attributes can be include in the design thought process. The next logical step involves studying of the proposed site with respect to all attributes namely site topography, climatological factors, demographics of the place and other pertaining issues. All such parameters are correlated to form a list of requirements which are then included with typical area requirements to form the first draft. They are then worked upon and other attributes like climatology, conceptual, aesthetic considerations etc. are included in or subtracted out as depending on the context of the issue. These are basic logical methods on how this thesis work was developed. In depth analysis on each logical step has been provided and explained with appropriate examples and sketches in each step. This has been done to provide the reader with a clear concise idea of how the whole thesis was conceived from the starting to the end.

INTRODUCTION TO THESIS TOPIC

CORPORATE OFFICE BUILDING

"Information Technology and businesses are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without the talking about the other". A business enterprise in today's world functioning effectively without using Information Technologies in its services and sectors are hard to come about and the few that does not function very well at all. This is how Information technology has revolutionized and changed the very way business and the whole spectrum of life is run about. The penetration of Information Technology has also reached to the day to day life with the boom of smart phones. This shows how important Information Technology can be crucial to everyone from an ordinary layman to multinational companies.

SITE – ORACLE OFFICE, BANGALORE, KARNATAKA

90% of IT Sectors exports are from five major cities Bangalore, Hyderabad, Chennai, Delhi, and Mumbai. Bangalore is the leading IT exporter of the country and is known as the Silicon Valley of India. However, the IT sector here is undergoing a change in its trend of functioning in a metro city.

AIM

The basic aim of this thesis is to develop an IT office building of 'Oracle Systems' being proposed at Bengaluru, Karnataka. The complex would be developed from scratch strictly adhering to architectural solutions.

OBJECTIVE

- Includes exhaustive case studies about existing IT Offices in the country with the focus being mainly on specific design elements used and advance objective.
- Literature studies of Corporate Office building abroad with respect to difference in effective usage of space and functions.
- Design considerations and strategies which were developed as the direct result of these studies.
- Application of such considerations in the thesis project.
- Understanding and implying various standards and bylaws.

METHODOLOGY

The method of achieving the aim of the study is:

- Background study;
- Literature studies;
- Literature case studies and live case studies;
    - Extensive studies of IT office building in India
    - Studies of notable offices in abroad
- Studying best practices and analysing them;
- Deriving conclusions and inferences from the study;
- Site analysis;

- Formulation of area requirement;
- Design Stage;

SCOPE

- Understanding different aspects of designing office buildings with respect to site.
- The study will search what does efficient use of energy mean and what approach can be taken to achieve conservation of our natural resources, a governing purpose of design.
- To fulfil and understand the main aspects of the objective of the dissertation.
- An important aspect would be to shape buildings to reduce seasonal changes or variating in sun energy to equalise sun rays from summer to winter.
- Scope includes design of multi-tenant IT office building in Bengaluru, Karnataka.

LIMITATIONS

- Design limits to design of the main structure and office building proposed till date. It doesn't include design of future expansion.
- It will not cover any material survey and any energy auditing due to lack of time.
- The study not cover details of HVAC systems.

CHAPTER 1: LITERATURE SURVEY

Office spaces have become an important part of human lives. For a huge urban population, offices are akin to a second home. On an average, a person working in an office spends about 55 hours per week in an office. So it is important to have a workplace which is physically, psychologically and aesthetically pleasing.

1.1 Inside an Office

Relationship between an employee and his company should be always in equilibrium. Both are considered inversely proportional.

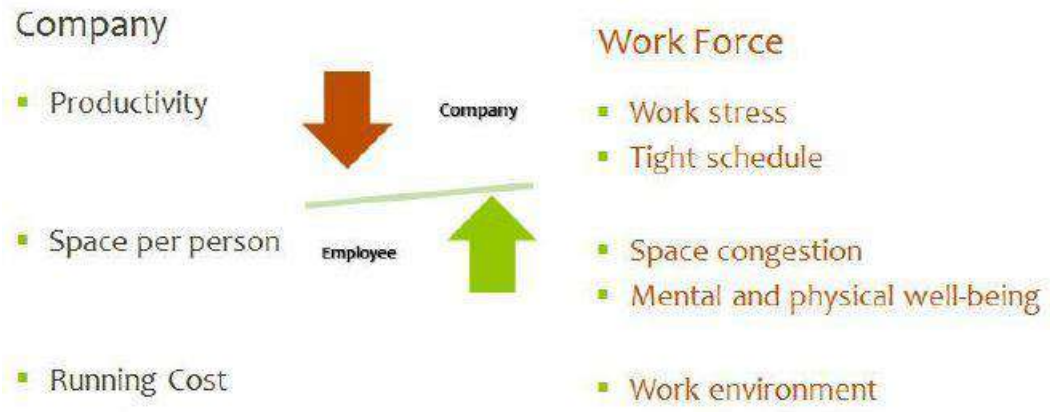


Figure 1.1: Illustration showing the relationship between a company and employee in context with office spaces.
Source: Author

Stress on productivity by a company makes the work force undergo more work stress and a tight schedule. Any compromise on space per person results in space congestion and mental and physical well-being of employee.

1.2 Designing of office spaces, Challenges and Architectural Solutions

Designing of office spaces should always begin from the interior itself. Employees are the end users of all office spaces. Their comfort should always be kept in prime priority in the design thought process.
In most of the cases the workforce has a tight schedule to complete, which invariably puts them on an edge. Thus, a work environment should be developed in such a way that it can help the work force in giving maximum productivity. There are many design elements which enhances the workability like colours, the volume, light, temperature etc. Many firms with a high level of expertise and a well-functioning management take care to provide such facilities to give maximum comfort in order to gain maximum productivity. Recent studies have shown that indoor landscaping in offices has a beneficial positive effect on the work force. Indoor landscape is such that can affect the well-being of work force.

1.3 Design Guidelines

1.3.1 Description of Building

- **COMMERCIAL BUILDING**

Commercial buildings use air-conditioning (AC) by mechanical means for providing thermally comfortable indoor conditions. This is mainly aimed at promoting productivity among occupants. However, the process is energy intensive and the running costs are generally very high. The monthly electricity bills of a typical commercial building can run into lakhs of rupees. The options for energy conservation are limited once a building is constructed, especially when aspects of optimal energy use have not been taken into account in building design.

Let's analyse an existing commercial building in Mumbai for this purpose. The building has a basement and 8 floors (ground and 7 upper floors). A block plan and section of the building is shown in Fig. 4.1. The typical cross section of the roof, wall and floor are shown in Fig. 4.2. It is a reinforced cement concrete (RCC) framed structure with brick and concrete block infill panel walls. The building is rectangular with its longer axis oriented along the northwest and southeast direction. Most of the southwest, southeast, and northwest façades are glazed. The southwest façade is fully glazed with reflective coating on the glass panels. The circulation spaces such as the lift lobbies and staircases are located on the north side of the building. While most of the spaces are open plan offices, cabins are located on the periphery of the building and are separated from the main office hall by means of glass partitions. Most of the building is generally occupied only during the daytime on weekdays. The ground, second and third floors are occupied for 24 hours throughout the week including Saturdays, Sundays and national holidays. The total built-up area of the building including the circulation and service areas (but excluding the basement) is approximately 7074 m2. Out of this area, about 5400 m2 of carpet area is centrally air-conditioned. The first to seventh floors are fully air-conditioned whereas the ground and basement are partly air-conditioned. All floors have an air change rate of one per hour except for the ground floor where it is 5 per hour. A higher air change rate is specified on the ground floor as it is used for loading and unloading of materials, entailing frequent opening of large doors at the two ends of the building.

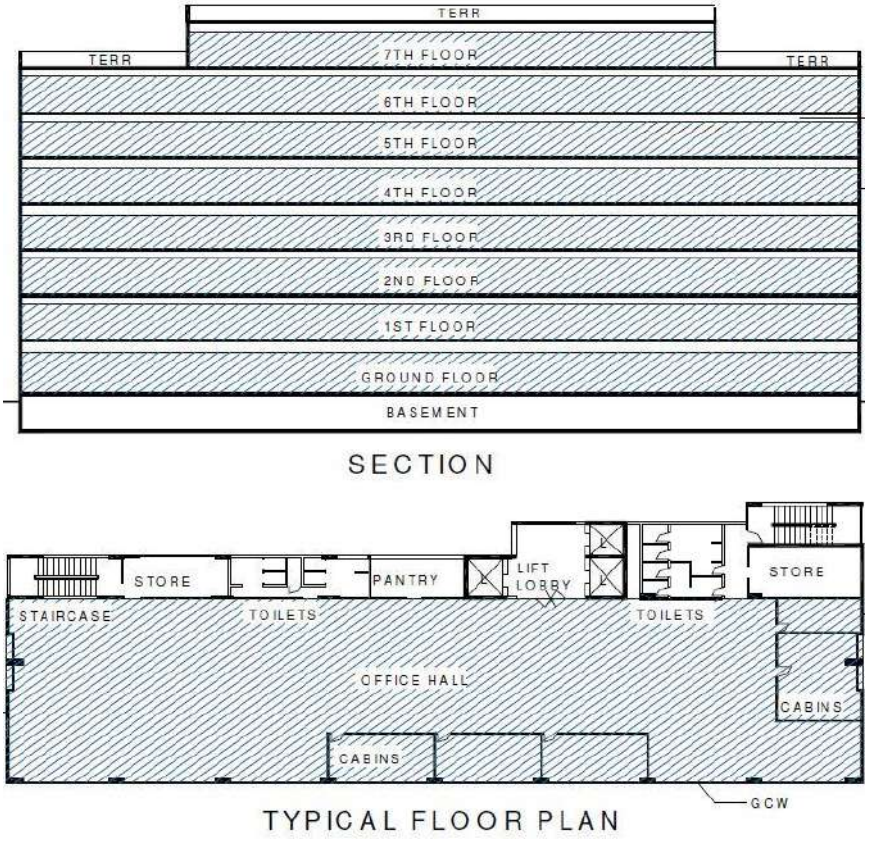


FIG. 1.2. Block plan and section of the commercial building

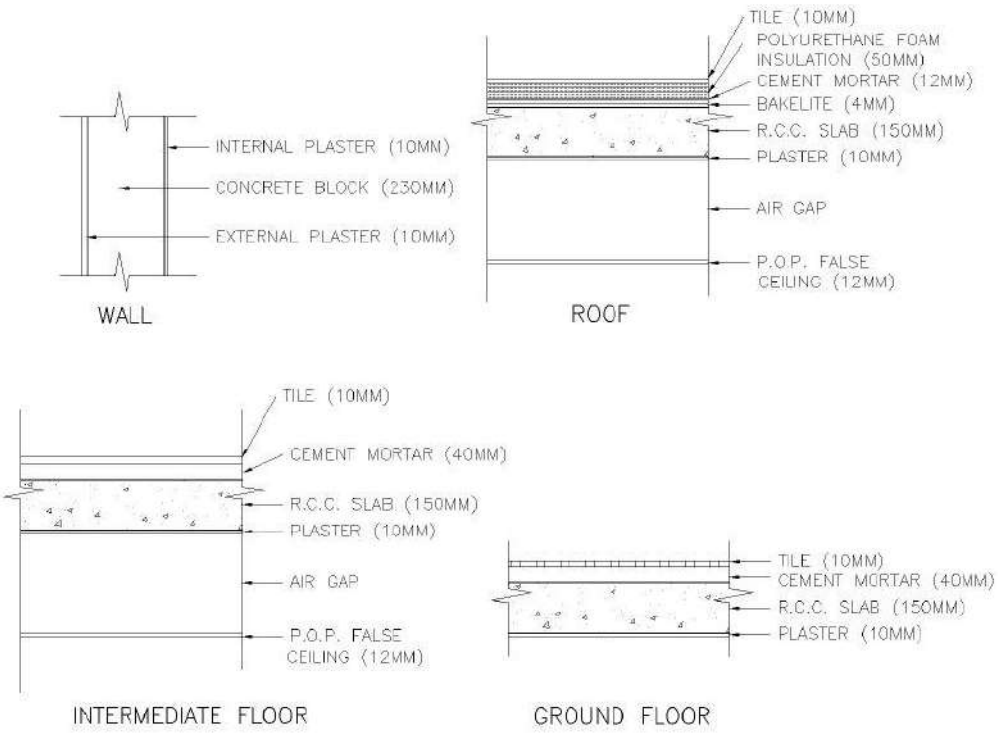


FIG. 1.3 Cross section of typical wall, roof and floor of the commercial building

Source – Tools for architectural design and simulation of building

1.3.2 General Recommendations

The general recommendations based on climatic requirements are discussed. These are applicable to almost all types of building designs.

1.3.2.1 Moderate/ Temperate Climate

- Temperatures are neither too high nor too low in regions with a moderate climate. Hence, simple techniques are normally adequate to take care of the heating and cooling requirements of the building.
- Techniques such as shading, cross ventilation, orientation, reflective glazing, etc. should be incorporated in the building.
- The thermal resistance and heat capacity of walls and roofs need not be high. These simple measures can reduce the number of uncomfortable hours in a building significantly.
- For example, in Pune, the 'uncomfortable' hours in a year can be reduced by as much as 89% by incorporating simple techniques in building design. The room temperature can be brought within the comfort limit (i.e. less than 30 ºC) even in the month of May.

The main objectives while designing buildings in this zone should be:

1. Resist heat gain by:
   (a) Decreasing the exposed surface area
   (b) Increasing the thermal resistance
   (c) Increasing the shading

2. Promote heat loss by:
   (a) Ventilation of appliances
   (b) Increasing the air exchange rate (ventilation)

In this region, the general recommendations are as follows:

- **Site**

(1) Landform: Building the structure on the windward slopes is preferable for getting cool Breezes (Fig. 1.4).

(2) Open spaces and built form: An open and free layout of the buildings is preferred. Large open spaces in the form of lawns can be provided to reduce reflected radiation.

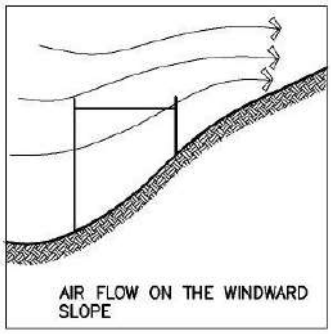


FIG. 1.4

Source – Handbook on energy conscious buildings

- **Orientation and planform**

It is preferable to have a building oriented in the north-south direction. Workspace may be located on the eastern side, and an open porch on the south - southeast side, while the western side should ideally be well-shaded. Humidity producing areas must be isolated. Sunlight is desirable except in summer, so the depth of the interiors may not be excessive.

- **Building envelope**

(a) **Roof**: Insulating the roof does not make much of a difference in the moderate climate.

(b) **Walls**: Insulation of walls does not give significant improvement in the thermal performance of a building. A brick wall of 230 mm thickness is good enough.

(c) **Fenestration**: The arrangement of windows is important for reducing heat gain. Windows can be larger in the north, while those on the east, west and south should be smaller. All the windows should be shaded with chajjas of appropriate lengths. Glazing of low transmissivity should be used.

(d) **Colour and texture**: Pale colours are preferable; dark colours may be used only in recessed places protected from the summer sun.

1.4 Specific Guidelines

The specific guidelines for a commercial building (conditioned), have been formulated.

1.4.1 Moderate Climate (Representative city: Bangalore)

- **Commercial Building**

- A distribution of the annual and monthly heating and cooling loads of the commercial building is shown in Fig. 1.5 for the Pune climate. On an annual basis, the heating load is zero and the cooling load is predominant.

- The monthly load profiles generally follow the climatic conditions; the highest cooling load occurs in May (summer) and the lowest cooling load occurs in December (winter). Relatively lower cooling loads occur during the monsoons (June to September).

- Figure 1.6 shows the distribution of percentage of loads through various building components on a monthly basis. Convective heat gain dominates from July to February (i.e. eight months). This indicates that the cooling requirements are primarily due to internal gains, which need to be dissipated.

- In contrast, in the summer months from March to June, the surface gains are more. Air exchanges help to reduce heat gains in the 8 months from July to February. In the summer months, infiltration adds to the cooling loads. Hence, a scheduling of air changes to promote ventilation from July to February and the control of infiltration in summer could reduce cooling loads.

- The floor-wise monthly and annual loads are presented in Table 4.1. It is seen that the usage pattern of the building has a significant impact on the loads.

- For instance, the maximum energy required for cooling is on the ground floor. This is because the shutters are frequently opened here, resulting in a high heat gain due to air exchanges. Additionally, there is a significant internal gain due to operation of equipment and a high occupancy level.

- The gain due to air exchanges may be reduced by preventing the leakage of hot ambient air into entering the building by sealing all cracks and providing air lock lobbies on the ground floor.

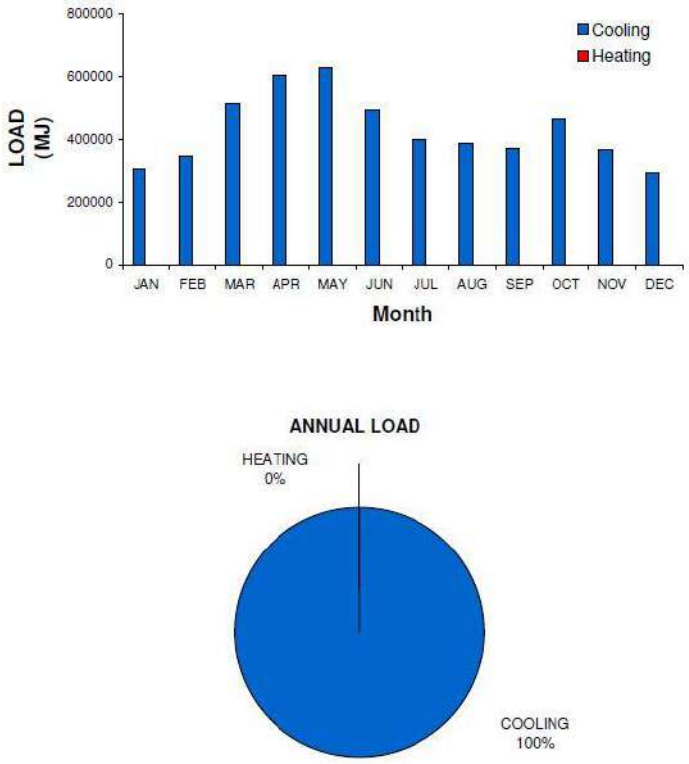


FIG. 1.5 Monthly and annual heating and cooling loads of the commercial building -Pune (moderate climate)

Source – Handbook on energy conscious buildings

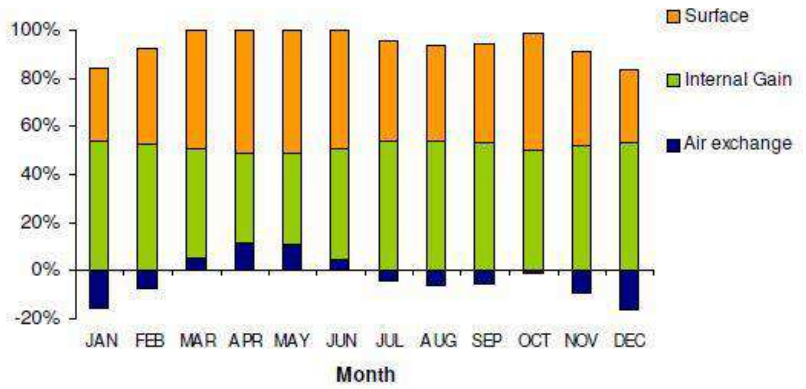


FIG. 1.6 Component-wise distribution of percentage heat gains and losses on a monthly basis of the commercial building - Pune (moderate climate)

Source – Handbook on energy conscious buildings

TABLE 1.1 Floor wise distribution of monthly and annual loads of the commercial building – Bangalore (moderate climate)

Month	Cooling load (MJ)								
	GR	F1	F2	F3	F4	F5	F6	F7	Total
JAN	39660	34426	53481	54629	39196	28498	38914	16031	304835
FEB	55746	35206	59772	60748	40034	31524	42040	19727	344797
MAR	99113	47121	88910	90530	53517	45796	59855	31536	516380
APR	130446	50901	103158	105360	58529	52711	68140	37946	607192
MAY	130746	54214	105858	107962	62307	55661	72614	39955	629316
JUN	98045	43254	86047	87731	49552	42485	56319	29027	492459
JUL	69526	38064	71601	72664	43340	34786	47184	21601	398767
AUG	62226	38774	69732	70557	43896	34530	47202	21083	388000
SEP	65412	35331	67738	68870	39982	32069	43452	20185	373038
OCT	77635	44941	80920	82089	50921	42359	56020	28044	462929
NOV	52855	38249	64760	65522	43316	33979	45314	20961	364956
DEC	39849	32095	52742	53722	36402	26735	36331	15074	292949
Total	921259	492576	904719	920382	560992	461134	613386	301171	5175618

Month	Heating load (MJ)								
	GR	F1	F2	F3	F4	F5	F6	F7	Total
JAN	0	0	0	0	0	0	0	0	0
FEB	0	0	0	0	0	0	0	0	0
MAR	0	0	0	0	0	0	0	0	0
APR	0	0	0	0	0	0	0	0	0
MAY	0	0	0	0	0	0	0	0	0
JUN	0	0	0	0	0	0	0	0	0
JUL	0	0	0	0	0	0	0	0	0
AUG	0	0	0	0	0	0	0	0	0
SEP	0	0	0	0	0	0	0	0	0
OCT	0	0	0	0	0	0	0	0	0
NOV	0	0	0	0	0	0	0	0	0
DEC	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0

GR=Ground Floor, F1=First floor, F2=Second floor, F3=Third Floor, F4=Fourth floor, F5=Fifth floor, F6=Sixth Floor, F7=Seventh floor

Source – Handbook on energy conscious buildings

The effects of building parameters on the annual loads of the commercial building are presented in Table 1.1 for Bangalore. The consequent percentage load reduction for each parameter compared to the base case are also tabulated. It may be noted that the total annual load of the building is quite high. Even a one percent reduction in this load would result in significant energy savings.

The following guidelines are recommended for a commercial building located in Bangalore, which has a moderate climate.

(a) DESIGN PARAMETERS

1. Building orientation

Appropriate orientation of the building can reduce the annual load significantly. The building (Fig.1.2) with its glazed curtain wall facing northwest shows a substantial reduction in load compared to the southwest orientation (base case) − the percentage reduction being 9.2. The west and north orientations are also better than the base case.

2. Glazing type

Single pane reflective coated glass (base case) is recommended for the moderate climate. All other glazing types increase the annual load of the building.

3. Window size

The reduction of the glazing size to a 1.2 m height, compared to a fully glazed curtain wall, decreases the annual load by 6.3%. This is due to the reduction in solar gain, and thus the use of larger expanses of glass in such a building is not desirable as it leads to higher annual loads.

4. **Shading**
   Shading of windows (by means of external projections such as chajjas) reduces solar gains and subsequently the heat gain, and hence the annual load is also reduced. If 50% of the window areas are shaded throughout the year, loads can be reduced by 10.6%.

5. **Wall type**
   A wall having a low U-value (insulating type such as autoclaved cellular concrete block) increases the load compared to the concrete block wall (base case) by 2.2%. Thus insulation of walls is not recommended.

6. **Colour of the external surface**
   Dark colours on the walls of such a commercial building should be avoided. For example, using dark grey increases the cooling load by 5% compared to white (base case).

7. **Air exchanges**
   A lower air change rate of 0.5 ach is more effective than 1, 2 and 4 ach. The percentage reduction in the annual load is 1.0 compared to the base case of 1 ach.

(b) OPERATIONAL PARAMETERS

The operational parameters such as internal gain, set point and scheduling of air changes can help in reducing the annual load of the building. The effects are summarised as follows:

1. **Internal gain**
   The lower the internal gain, the better is the performance of the building in reducing annual loads.

2. **Set Point**
   The annual load of the building reduces if the set points for comfort cooling and heating are relaxed. If cooling and heating set points of 25 and 200C respectively are used (instead of 24 and 210C), the percentage reduction in annual load is 8.7. Thus a change in the expectation of comfort can lead to significant savings.

3. **Scheduling of air exchanges**
   The scheduling of air changes to promote air entry during cooler periods (such as nights or winters) and controlling the same during warmer periods (during daytime or summer) can reduce the annual load significantly – the percentage load reduction being 3.4.

The combination of all design and operational parameters discussed (excluding building orientation and internal gain), results in a significant load reduction 24.7%.

TABLE 1.2 Annual savings due to building design and operational parameters for the commercial building- Bangalore (moderate climate)

Parameter	Annual load (MJ)			Energy saving	
	Cooling	Heating	Total	(MJ)	(%)
Base case	5175618	0	5175618	--	--
Orientation (longer axis)					
North-south	4794997	0	4794997	380621	7.4
Northeast-southwest	4701236	0	4701236	474382	9.2
East-west	5032393	0	5032393	143225	2.8
Glazing type					
Single clear	5774996	0	5774996	-599378	-11.6
Double clear	5773435	0	5773435	-597817	-11.6
Double low-E	5413338	0	5413338	-237720	-4.6
Double reflective coated	5198221	0	5198221	-22603	-0.4
Glazing size (restricted to 1.2m height)	4847464	0	4847464	328154	6.3
Shading					
10%	5065938	0	5065938	109680	2.1
20%	4956314	0	4956314	219304	4.2
50%	4628063	0	4628063	547555	10.6
Wall type					
Autoclaved cellular concrete block	5291517	0	5291517	-115899	-2.2
Colour of external surface					
Dark grey	5434774	0	5434774	-259156	-5.0
Air exchange rate					
0.5	5123889	0	5123889	51729	1.0
2	5298637	0	5298637	-123019	-2.4
4	5604347	720	5605068	-429450	-8.3
Internal gain					
10%	2084676	0	2084676	3090941	59.7
50%	3389009	0	3389009	1786609	34.5
No internal gain	1788504	106	1788611	3387007	65.4
Set point - cooling: 25 °C - heating: 20 °C	4725865	0	4725865	449753	8.7
Scheduling of air exchanges	5004165	124	5004289	171329	3.4

Source – Handbook on energy conscious buildings

1.5 SUMMARY

CLIMATE	TECHNIQUES																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Hot and dry				•		•	•		•	•			•	•	•	•			•
Warm and humid											•	•							•
Moderate	No advanced techniques required																		•
Cold and cloudy Cold and sunny	•	•	•	•	•	•	•	•					•				•		•
Composite*																		•	•

1. Direct gain
2. Trombe wall
3. Water wall
4. Solar chimney
5. Transwall
6. Roof pond
7. Roof radiation trap
8. Solarium
9. Evaporative cooling
10. Nocturnal radiation cooling
11. Desiccant cooling
12. Induced ventilation
13. Earth berm
14. Wind tower
15. Earth-air tunnel
16. Curved roof / air vents
17. Cavity wall / insulation
18. Varytherm wall
19. Daylighting

TABLE 1.3 Design recommendations for the commercial building

Parameter	Jodhpur (Hot & Dry Climate)	Mumbai (Warm & Humid Climate)	Pune (Moderate Climate)	New Delhi (Composite Climate)	Srinagar (Cold & Cloudy Climate)	Leh (Cold & Sunny Climate)
Building Orientation (Due direction of the glazed curtain wall)	NE-SW (south east)	NE-SW (south east)	NE-SW (south east)	NE-SW (south east)	NW-SE (south west)	NW-SE (south west)
Glazing Type	Reflective coated glass (double pane)	Reflective coated glass (double pane)	Reflective coated glass (single pane)	Reflective coated glass (double pane)	Low-E glass (double pane)	Low-E glass (double pane)
Shading of glazing (percent of the total area)	50	50	50	50	0	0
Wall Type	Autoclaved cellular concrete block	Autoclaved cellular concrete block	Concrete block	Concrete block	Autoclaved cellular concrete block	Autoclaved cellular concrete block
Surface Colour (External)	White	White	White	White	Dark grey	Dark grey
Air exchanges (ach)	0.5	0.5	0.5	0.5	0.5	0.5

NE-SW: Northeast-southwest; NW-SE: Northwest-southeast

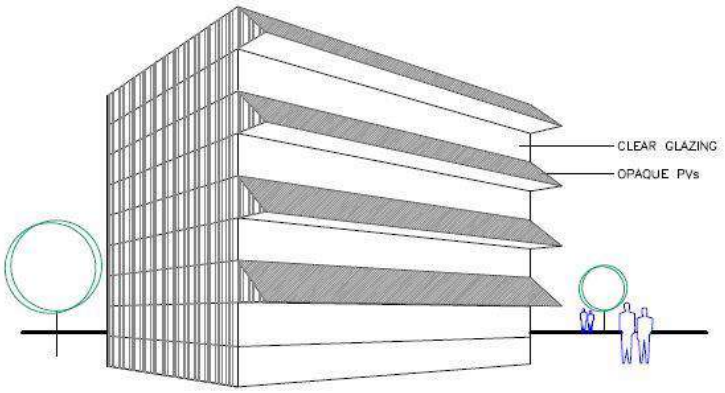
Source – Author

1.6 SOLAR PHOTOVOLTAIC DEVICES

Photovoltaic conversion is the direct conversion of sunlight into electricity by means of solar cells. The main advantage of solar photovoltaic devices is that they can produce power from microwatts up to kilowatts. Consequently, they are used in many applications such as calculators, watches, water pumps, buildings, communications, satellites, space vehicles, etc.

The photovoltaic industry is growing rapidly. As a result of technological innovations, the Building Integrated Photovoltaic (BIPV) systems have become a reality. Photovoltaic panels can be made to form components of a building. Positioned on the façades or roof of a building, PV panels can generate electricity either for internal use or for distribution to an external network. They may become elements of the architectural design. Examples of such buildings including the RETREAT, Gwal Pahari (Gurgaon).

It is desirable to use non-corrosive construction materials because small current leakages invariably occur on PV façades. Secondly, the construction should not shade the PV modules and dust and rainwater should not accumulate on it.



(a) Curtain wall with PV panels

(b) PV panels on shading devices

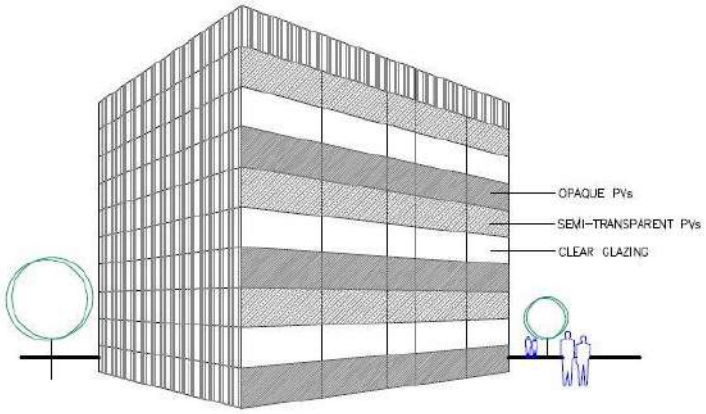


FIG. 1.7

Source – Energy efficient buildings of India

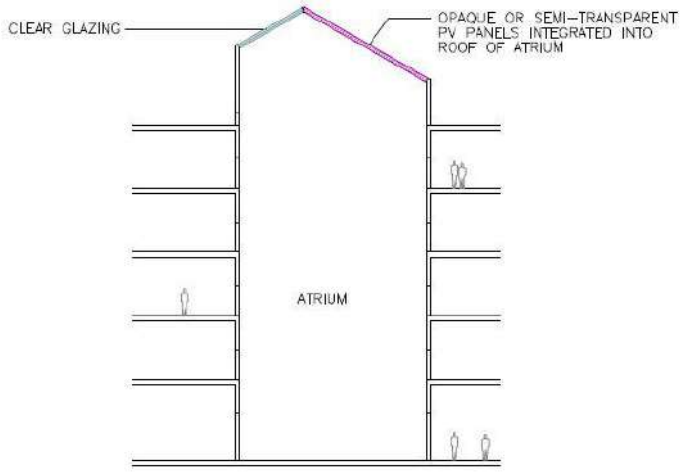


FIG. 1.8 Atrium with PV panel skylight

Source – Energy efficient buildings of India

TABLE 1.4 Suitability of PV module types for building integration

Module Type	Application suitability				
	Sloped roof	Flat roof	Wall	Windows	Shading
Standard laminates without frames	+	+	+	-	+
Standard modules with plastic or metal frame (glass multi-layer non-transparent back sheet)	+	0	0	-	0
Roofing modules (tiles/slates)	+	-	-	-	0
Glass-glass modules with predefined transparency	0	0	+	+	+
Glass modules with transparent plastic back sheet (predefined transparency possible)	0	0	+	+	+
Module with metal back sheet and plastic cover	+	+	+	-	+
Custom-designed modules	+	+	+	+	+

\+ = high suitability
0 = low suitability
\- = not suitable

Source – Energy efficient buildings of India

APPENDIX i.1

Recommended values of illumination for a few building types

Buildings and Processes	Recommended Illumination (lux)
A. Offices, Schools and Public Buildings	
Airport buildings	
Reception area (desks)	300
Customs and immigration halls	300
Circulation areas, lounges	150
Assembly and concert buildings	
Foyers, auditoria	100 to 150
Platforms	450
Corridors	70
Stairs	100
Banks	
Counters, typing, accounting book area	300
Public areas	150
Cinemas	
Foyers	150
Auditoria	50
Corridors	70
Stairs	100
Offices	
Entrance halls and reception areas	150
Conference rooms, executive offices	300
General offices	300
Business machine operation	450
Assembly halls of schools and colleges	
General	150
When used for examinations	300
Platforms	300
Class room desks	300
Class room blackboards	200 to 300
B. Homes	
Kitchens	200
Bathrooms	100
Stairs	100
Workshops	200
Garages	70
Reading (Casual)	150
Homework and sustained reading	300

Source – Energy efficient buildings of India

APPENDIX i.2

Performance parameters of conventional and low-energy buildings

Parameter	*Conventional buildings*	*Low-energy buildings*
Design features	Long facades east–west.	Long facades north–south.
	No shading.	Shading of east–west façade.
	Single glazed windows.	Mix of single and double glazed windows.
Lighting system	No daylight integration.	Daylight and artificial lighting integration.
	No lighting controls.	Occupancy sensors and dimming controls.
	Lighting power density is in the range 15–20 W/m^2.	Lighting power density is less than 15–20 W/m^2.
	Visual comfort maintained as per the National Building Code 2005.	Visual comfort was maintained as per the National Building Code 2005.
Air conditioning system	No natural ventilation or passive cooling techniques.	Circulation areas are naturally ventilated.
	Chillers used are reciprocating chillers.	Chillers used are screw and centrifugal chillers.
	Percentage of air-conditioned area to built-up area is above 60%.	Percentage of air-conditioned area to built-up area lies in the range 50%–65%.
	Chiller coefficient of performance was on the lower side.	Chiller coefficient of performance is on the higher side.
	Sqmt/TR (tonne of refrigeration) lies in the range 9–15.	Sqmt/TR lies in the range 32–42.
	Thermal comfort was maintained as per the National Building Code 2005.	Thermal comfort maintained as per the National Building Code 2005.
Energy performance	Lighting Performance Index lies in the range 37–60 kWh/m^2/year.	Lighting Performance Index lies in the range 21–28 kWh/m^2/year.
	Air Conditioning Performance Index for different climatic zones are: ▪ **Warm and humid** – 263 kWh/m^2 per year (10 hours operational) ▪ **Moderate** – 259 kWh/m^2 per year (10 hours operational) ▪ **Composite** – 183 kWh/m^2 per year (10 hours operational) ▪ **Cold** – 251 kWh/m^2 per year (24 hours operational)	Air Conditioning Performance Index for different climatic zones are: ▪ **Warm and humid** – 195 kWh/m^2 per year (24 hours operational) ▪ **Moderate** – 105 kWh/m^2 per year (10 hours operational) ▪ **Composite** – 144 kWh/m^2 per year (10 hours operational) ▪ **Cold** – 41 kWh/m^2 per year (10 hours operational)

Source – High Performance Commercial Buildings in India, Bureau of Energy Efficiency Government of India and United States Department of State

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CHAPTER 2 (i): LITERATURE CASE STUDIES

Contents:

2.1 INSPECTOR GENERAL OF POLICE (IGP) COMPLEX, GULBARGA

Location : Gulbarga, Karnataka
Climate : Hot and dry

Brief description of the building:

- This building is a ground and two-storeyed structure designed by Kembhavi Architecture Foundation to house the offices of the Inspector General of Police, Gulbarga.
- The building is constructed using innovative materials. For example, the external walls are composite walls (i.e. granite blocks on the outer side and rat-trap bond brick walls on the inner side) and the roof is made of filler slab.
- The building is roughly rectangular with the longer axis along the north-south direction. Most windows face east or west.
- Most of the offices are cooled by passive downdraft evaporative cooling (PDEC) tower system.

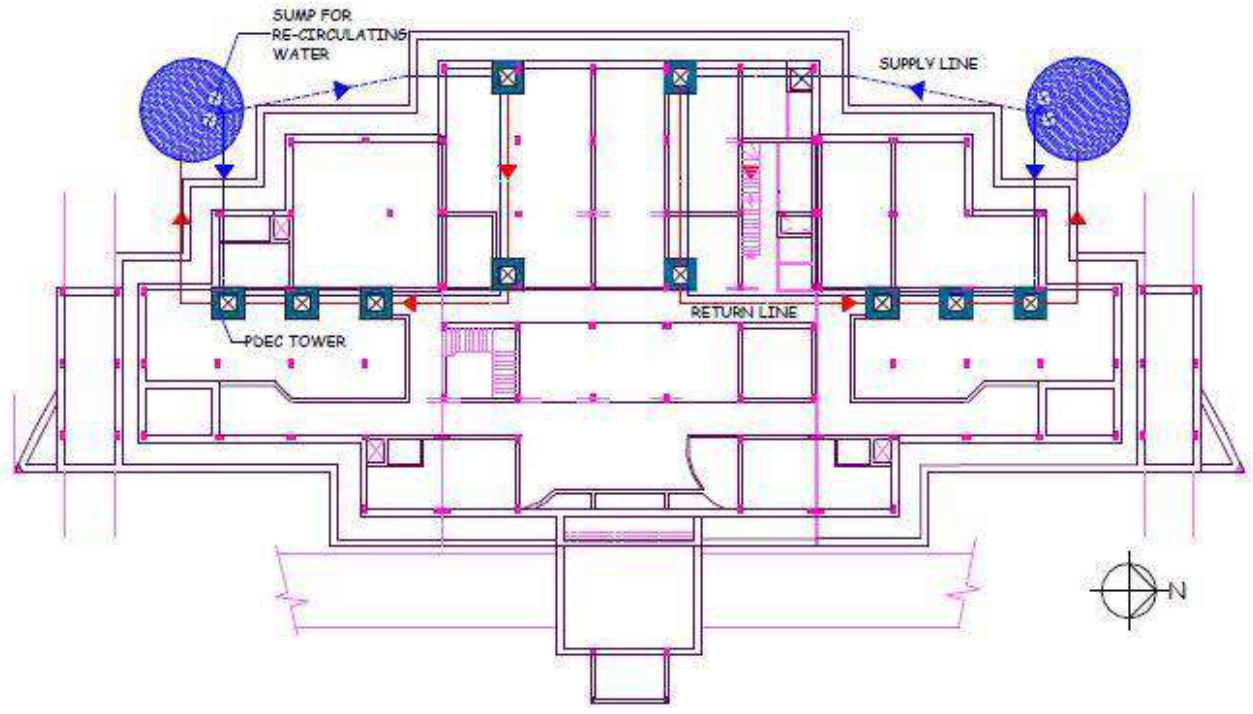


FIG. 2.1 Layout plan of I.G.P. Complex, Gulbarga
Source – Energy efficient buildings of India

Energy conscious features:

- Passive downdraft evaporative cooling (PDEC) towers for providing comfort.
- Tinted glasses to reduce glare.
- Alternative building materials such as composite walls to reduce heat gain and filler slabs to reduce the quantity of concrete in the structure.
- A central atrium to enhance cross ventilation and provide daylighting.
- Solar PV lighting and pumps, rainfall harvesting and water conservation facilities incorporated.

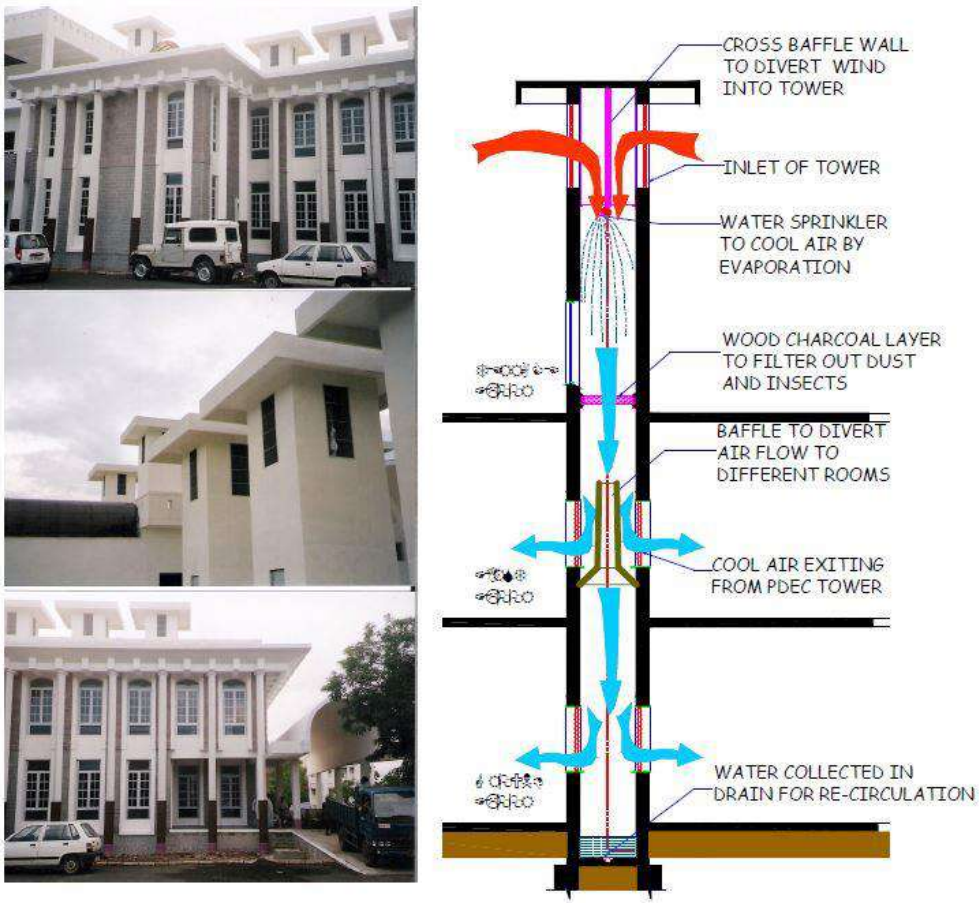


FIG. 2.2 Photographs of IGP Complex, Gulbarga and sketch showing the principle of a PDEC tower
Source – Energy efficient buildings of India

Performance of the PDEC system:

- Preliminary measurements taken in May and September, 2005 showed that the temperature of the air exiting from the tower is lower by about 10°C and 4°C respectively, compared to that of ambient air.

- Figure 2.3 presents the hourly values of the temperature of air exiting from the tower on a typical day in September. The corresponding measured values of ambient temperature are also plotted for comparison.

- Figure 2.4 shows the estimated performance of a tower in various months during daytime. It presents the results of exit temperature of air leaving the tower and the corresponding ambient dry bulb temperature.

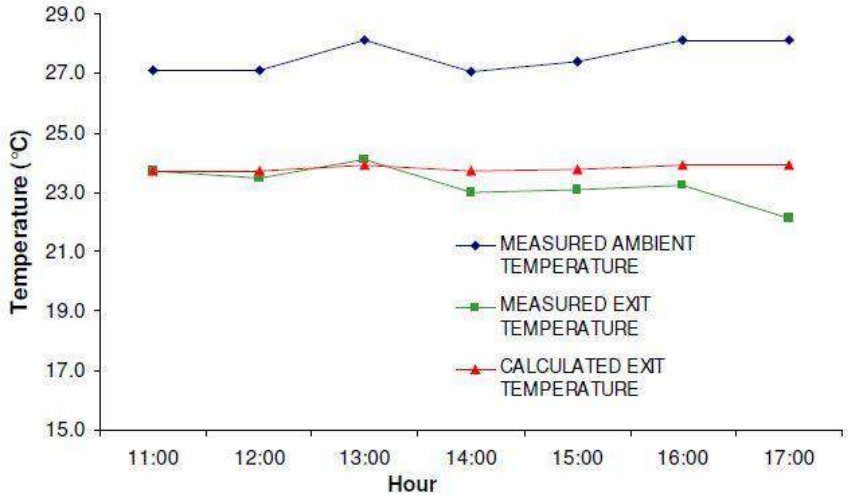


FIG. 2.3 Comparison of measured and predicted temperature of air exiting PDEC tower

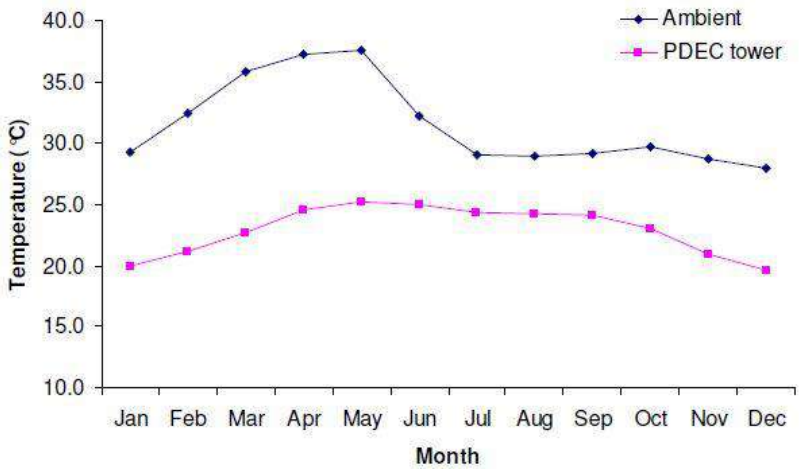


FIG. 2.4 Monthly prediction of the temperature of air exiting the PDEC tower

Source – Energy efficient buildings of India

- It is seen from the figure that the performance of the cooling tower is quite satisfactory in the summer months. The drop in temperature is about 12 - 13 °C in March, April and May. Considering that the PDEC system is used in these months, the predictions of the energy savings of the building per annum, as compared to an air-conditioned building maintained at 27.5 °C, are as follows:

Estimated Cost of PDEC system	= Rs. 17,50,000
Estimated savings per annum	= Rs. 3,52,000
Simple payback period	= 5 years (approximately)

2.2 HEADQUARTERS FOR GENZYME CORPORATION

Location : Cambridge, USA
Climate : Humid
Development Size : 3,44,000 sq.ft.

- A Leeds Platinum rated office building.
- 12 storied building
- located near river

Understanding the green building features:

- Land use and Site selection
- Energy efficiency
- Material usage
- Indoor Environment Quality

2.2.1 CONCEPT

- A highly integrated design process to develop a building from the inside out.
- A vertical city with individual dwellings.
- Daylight flooded interior, naturally illuminated workstations.

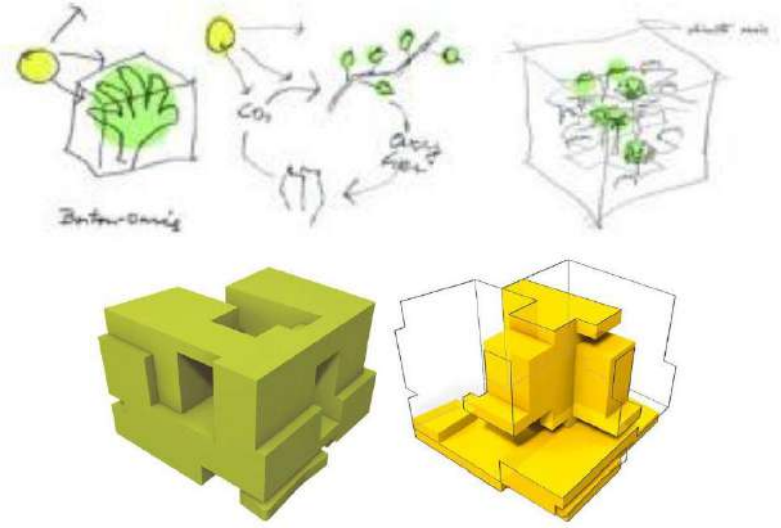


FIG. 2.5 Architect's Sketch and concept for Genzyme Office building, Cambridge, USA.
Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

Structural System Materials Used:

The structural system and materials used can be rated to provide a better rating. Genzyme centre has used the following steps for achieving a better rating:

- 70% - 80% recycled content
- 75% materials from local sources
- Wood - harvested from sustainably managed forest

2.2.2 ENERGY EFFICIENCY

- The building planning has been done in such a way that building interior is illuminated by natural light.
- The building envelope is composed largely of glass; 46 percent of the envelope is single glazed glass and 22 percent is solid cladding.
- Eight hundred windows line the building and provide ample daylight.
- Forty percent of the building's exterior is a double façade that is separated by an accessible four-foot loggia space.
- This design helps the building maintain its thermal conditions by trapping heat that is radiated from the building and blocking solar heat that would otherwise enter the building.

FIG. 2.6 Ground Floor of Genzyme Corporation at Cambridge, USA.

Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

FIG. 2.7 Second Floor Plan of Genzyme Corporation at Cambridge, USA.
Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

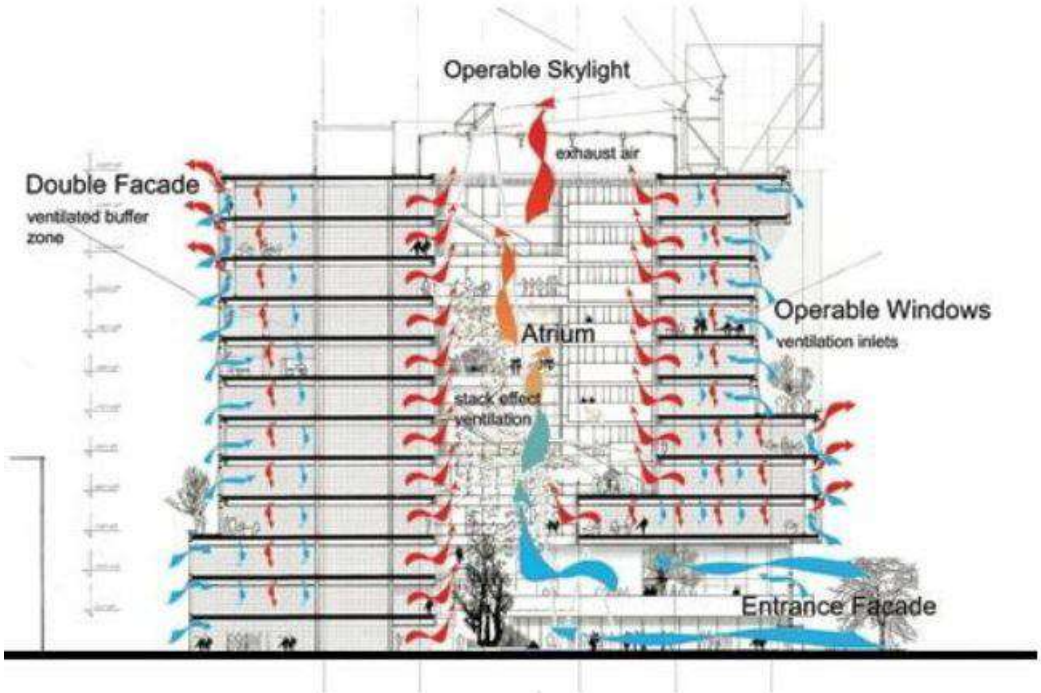


FIG. 2.8 Conceptual section of Genzyme Corporation at Cambridge, USA. showing the architectural features used for energy efficiency.
Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

Genzyme centre has also used other techniques for energy efficiency which are pointed out and listed below.

2.2.2.1 Daylight

- 75% of employees have outside view.
- 90% work space illuminated by natural lighting.

FIG. 2.9 Conceptual section of Genzyme Corporation at Cambridge, USA showing the surplus natural energy inside the building.
Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

2.2.2.2 Maximization of Natural Light -'U' shaped Blinds

- collect light and reflect onto metallic ceiling
- reduce glare and increase light penetration
- automated blinds tilt according to sunlight

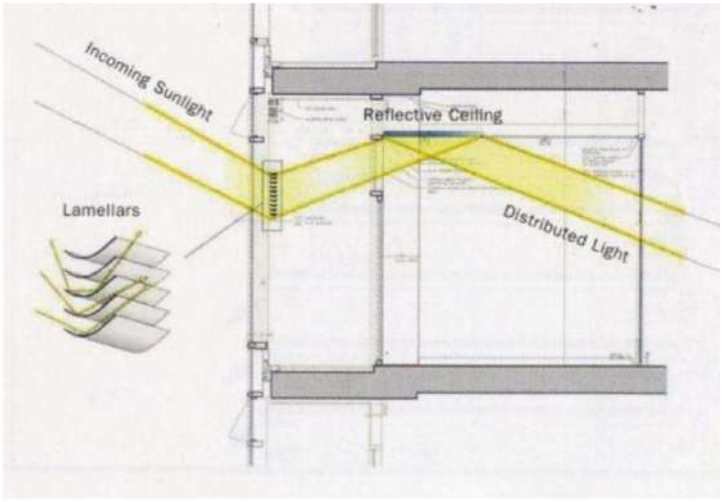


FIG. 2.10 U' shaped blinds an illustration.
Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

2.2.2.3 Heliostats

- 7 movable heliostats mirror on the roof
- increases day light in the building
- skylight louvers can be used to block strong sunlight

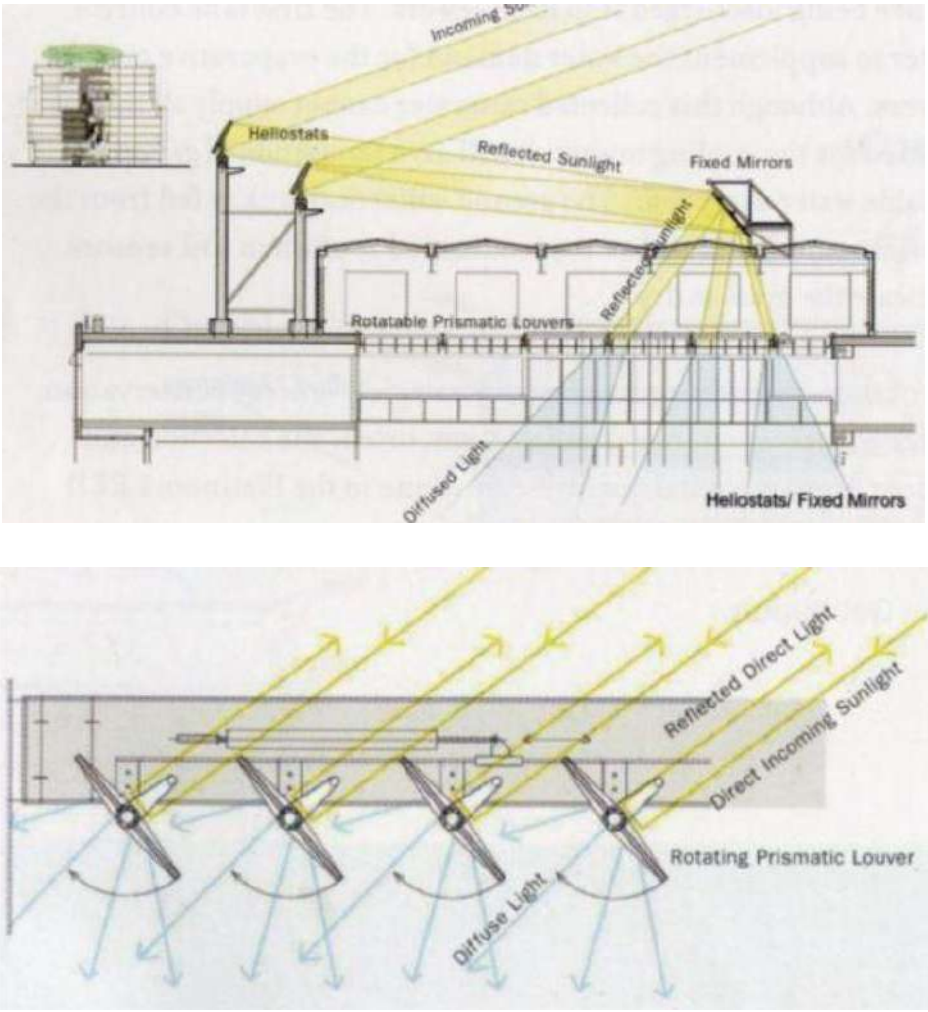
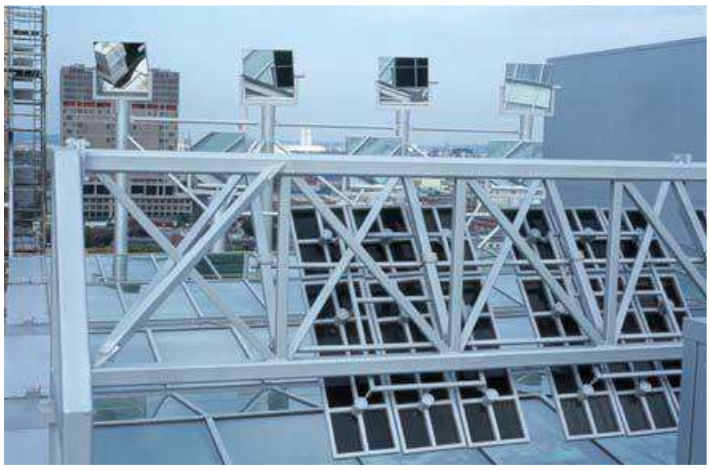


FIG. 2.11 Heliostats used in Genzyme Office Building at Cambridge, USA.
Source – www.metropolismag.com/html/content_0104/gen/index.html



Source – http://sustainability.tufts.edu/wp-content/uploads/Genzyme.pdf

2.2.2.4 Light Wall

- high gloss, reflection coated interior vertical blinds on one side of atrium
- maximizes daylight distribution

2.2.2.5 Prisms

- Light Distribution Enhanced by 768 Prismatic Plates
- Deep Penetration of Light Inside the Building
- Diffuse Light and Eliminate Glare

FIG. 2.12 Prisms being used to divert natural light inside the building.
Source – www.metropolismag.com/html/content_0104/gen/index.html

2.2.2.6 Water pool

Water pool located at ground floor further spreads light in the atrium and helps in humidifying building in dry winters

2.2.2.7 Heating and Cooling

- steam from neighbouring cogeneration plant used for cooling and heating
- reduces electricity consumption
- Building is also cooled naturally by stack effect
- Reduces load on HVAC system.
- Operable windows help heating and cooling.

2.2.2.8 Renewable Electricity

- Electricity purchased from renewable sources
- 10%wind
- 12% landfill gases
- Photovoltaic panels produce 24000-2600 kWh/year

CHAPTER 2 (ii): LIVE CASE STUDIES

Contents:

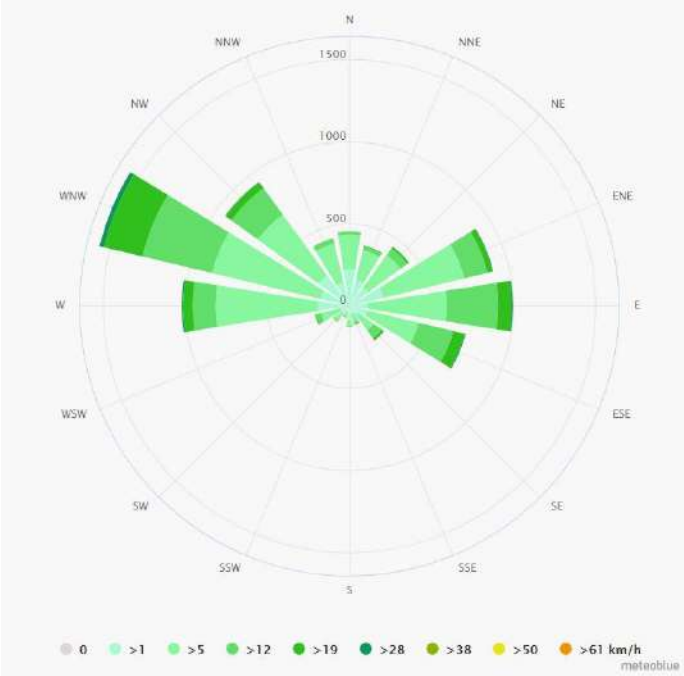
2.3 ADOBE SYSTEMS HEADQUARTER

Project Type : Office Building
Location : Sector 132, Noida
Architect : SWBI Architects
Client : Adobe Systems
Site Area : 7 acres land (28,322 sq.m.)
Built-Up Area : 4,00,000 sq.ft. (37,160 sq.m.)
F.A.R. : 1.3

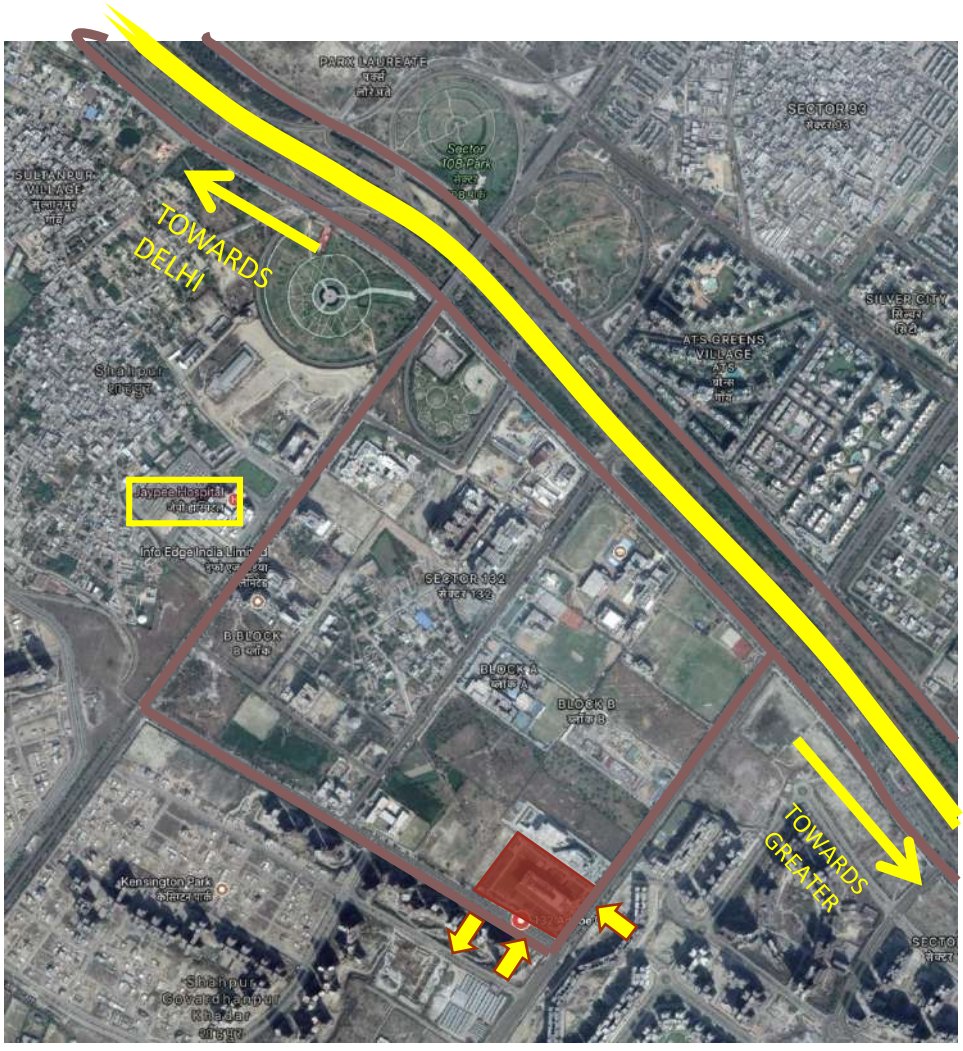
Client brief : The brief was to plan a world class Research and Development centre for Adobe Systems, an American multinational computer software company headquartered in California, United States, for over 2000 IT professionals in an energy efficient sustainable Office space.

Source - author

WIND ROSE DIAGRAM



ACCESS AND APPROACH



ADOBE HEADQUARTERS
SECTOR 132, NOIDA

NOIDA EXPRESSWAY

30M WIDE ROADS

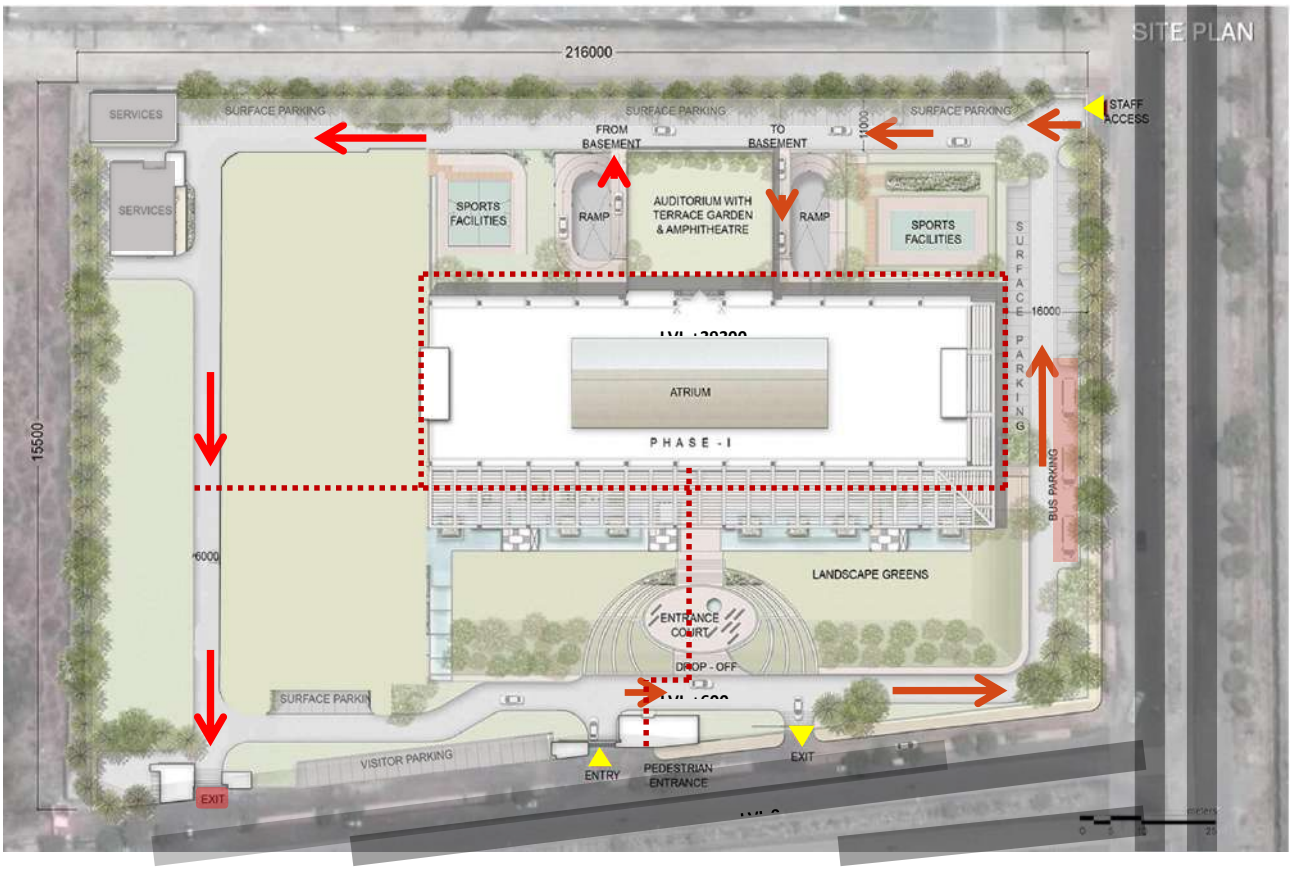
NEAREST METRO STATION-
BOTANICAL GARDEN (12KM)

1. MAIN ENTRY (STAFF PLUS VISITORS)
2. STAFF ENTRY
3. EXIT

MAJOR LANDMARK – Jaypee hospital

Climatic Zone : Composite
Avg. Temperature (High) : 31.2°C
Avg. Temperature (Low) : 18.8°C
Avg. Precipitation : 715 mm

SITE PLAN



SETBACKS: FRONT: 40 m SIDE: 30 m REAR: 40 m

FIG. 2.13 Site Plan

Source - author

CONCEPT

A LEED PLATINUM RATED project, true to its inherently green nature, an Efficient, Effective & Expressive, sustainable design.

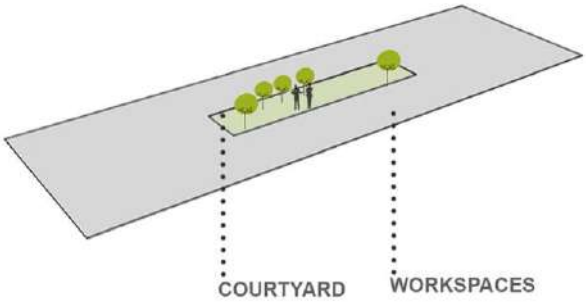
ADOBE is a Spanish word for sun dried clay bricks, common in ancient cultures and in arid lands.

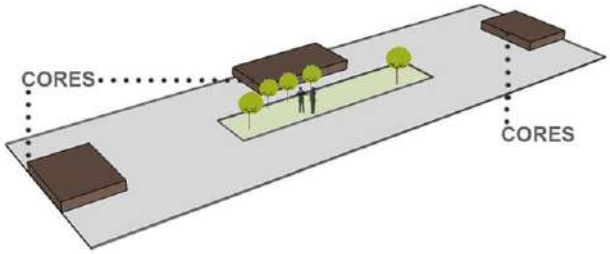
Adobe, the basic building block in mud has been reinterpreted in terracotta, engaged in creating digital /mathematical expressions. The same expressions are used as a core concept in the design of the building.

THE EVOLUTION

- TYPICAL FLOOR PLATE

The workspace, the basic building block in an office is enveloping a skylight atrium, there by enjoying ample light, access to views & greenery. Threshold gets blurred and hazy with the interwoven mesh of interiors & exteriors.



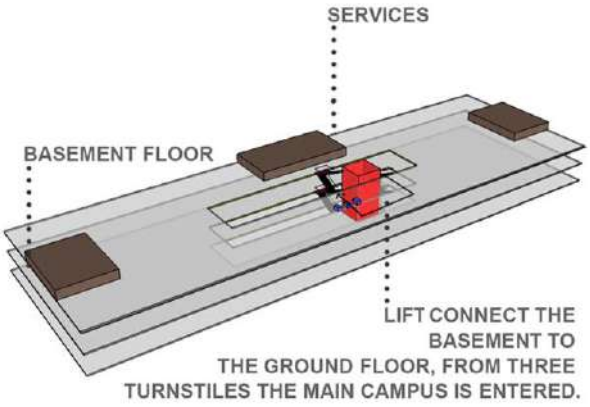


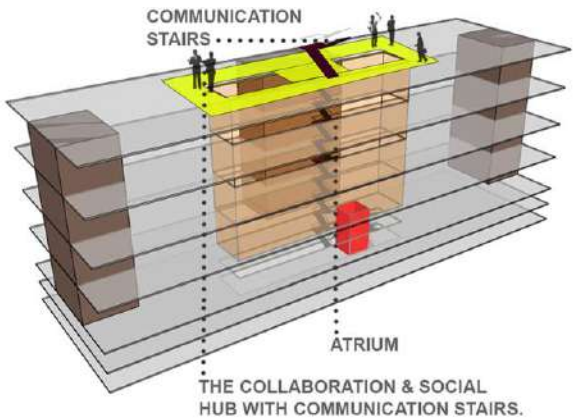
- THE EVOLUTION: CORES

Placement of circulation & service core in a distributed manner around the form plate.

- CONNECTION TO BASEMENT

Separate parking elevators and staircase connects the 3 parking levels to the main entrance floor. User pass through flap barriers to enter the main office.





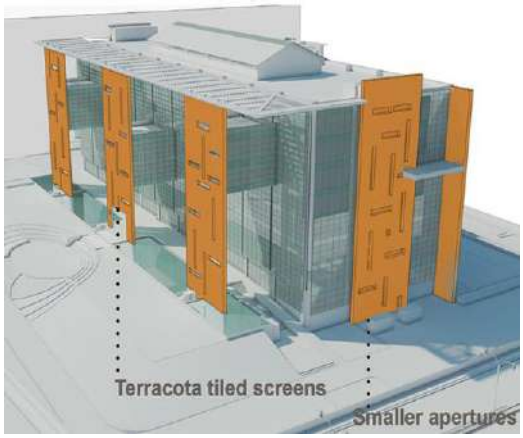
- COLLABORATION & SOCIAL HUB

Space and an atrium is placed as a coffee and a conversation zone where employees collaborate and ideate in a casual manner.

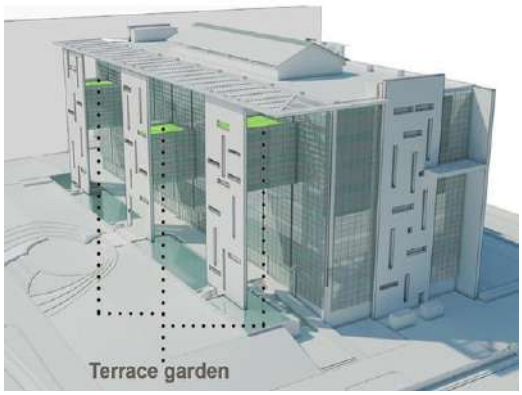
DESIGN FEATURES

Expansive sloping landscaped area in front absorbs the south sunlight leading to glare free facade which gives a clear vision from offices.

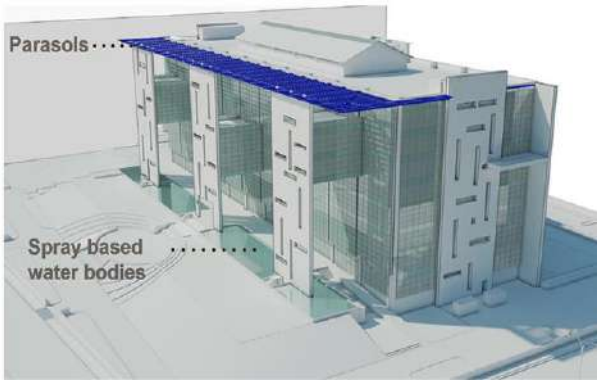
SHADED PEDESTRIAN WALKWAY planned in the campus through the use of terracotta tiled screens and covered roof parasol.



East and west facade have limited glass and smaller apertures to have a glare free working environment. Service cores have been located on these two faces.



HANGING TERRACE GARDENS AND GREEN ROOF at various levels to reduce heat island effects and also provides an excellent spill out space from the open office plan.



ROOF PARASOL shades the Façade Glazing. Wind flowing through, pick up the mist from Spray based Water bodies combined with soft landscaping and Bio Walls, significantly improve the micro- climate.

GROUND FLOOR PLAN

FIG. 2.14 Ground Floor Plan

Source - author

ENTRANCE LOBBY: Dimension: 10600 mm X 10600 mm

From the Entrance Lobby, one can access:

1. Cafeteria and Recreation
2. Indoor games
3. Public restrooms
4. Training Centre

Areas access through turnstiles:

5. Data Centre
6. Guest rooms and lounge
7. Access to upper floor levels

Source - author

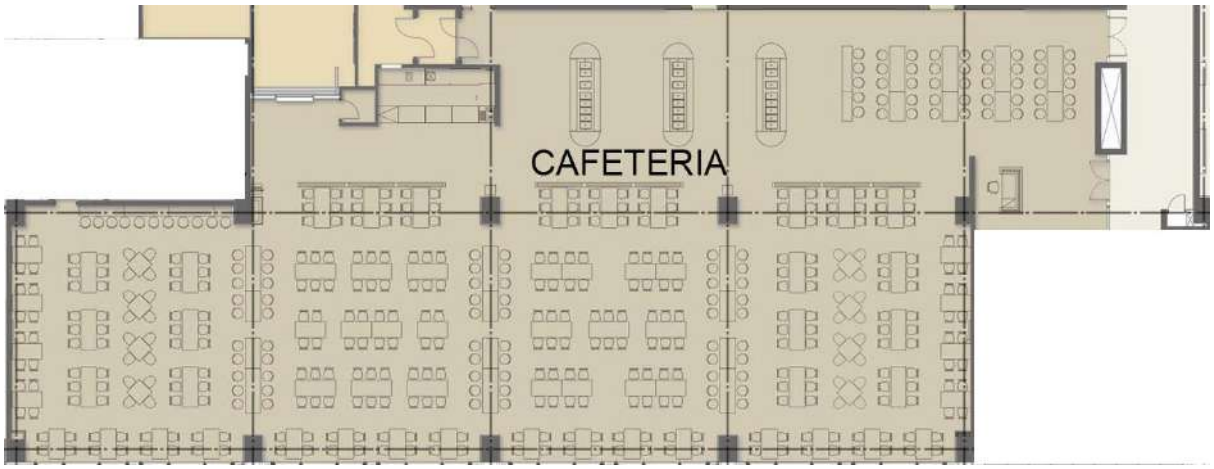
CAFETERIA AND KITCHEN

Source - author

Capacity: 460 seating

Kitchen Area: 285 Sq.m. (approx.)

Cafeteria Area: 740 Sq.m. (approx.)



Source - author

The services for Kitchen is in Stilt level (below ground) like Service Entry, Washing Area, Storage, etc.

INDOOR GAMES AND TRAINING CENTRE

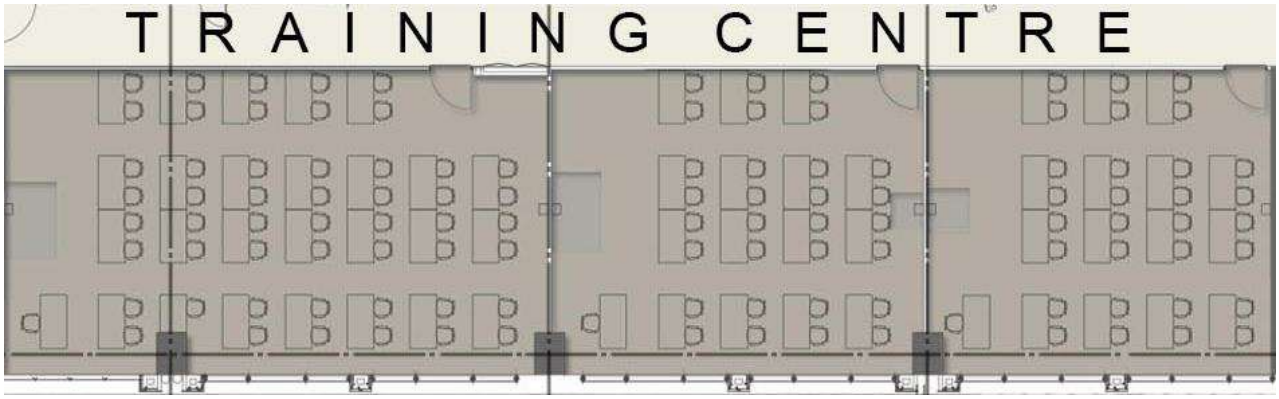
Source - author

Indoor Games + Gym

Area: 345 sq.m. (approx.)

Attached changing area:

1+1 changing rooms, 2+2 bathrooms,
1+1 WC, 3 urinals, 3+2 basins



Training Centre

Area: 315 sq.m. (approx.)

Capacity: 55 pax (3 rooms)

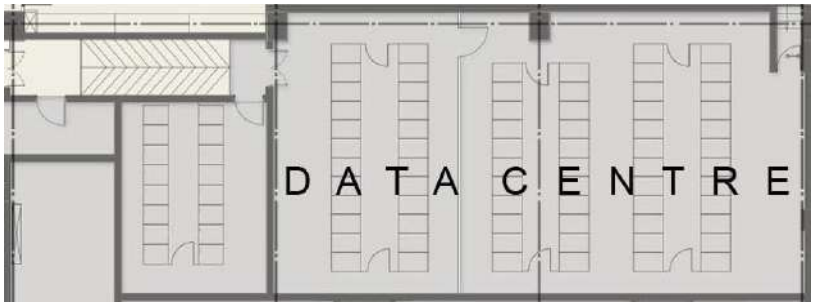
DATA CENTRE AND GUEST ROOMS

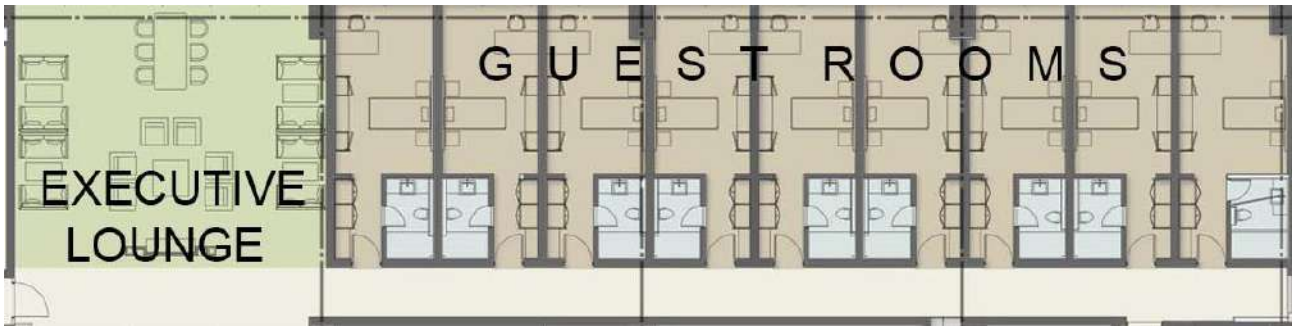
Source - author

Data Centre

Area: 275 sq.m. (approx.)

85 server system units





Guest Rooms + Exe. Lounge

Area: 365 sq.m. (approx.)

No. of Guest rooms: 9 nos. (attached toilets)

Capacity of Lounge: 28 seatings

STAIRCASES AND LIFTS

Source - author

Central core:

Width of Staircase: 1800 mm (Ground Floor to 4th floor)

No. of lifts: 6 (stilt level to 8th floor)

Dimensions: 2400 X 2100 mm (14-person lift)

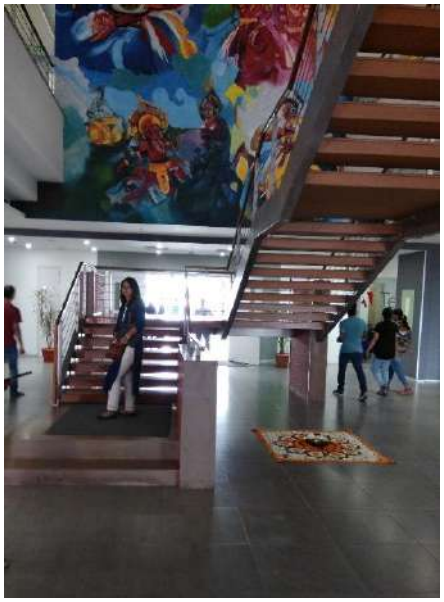
It caters around 85 persons at a time.

Core near data centre:

No. of Lifts: 2 (Basement level 2 to Ground floor)

Dimensions: 2400 X 2100 mm (14-person lift)

Width of Staircase: 1800 mm (Basement level 2 to Ground floor)



FIRST FLOOR PLAN

FIG. 2.15 First Floor Plan
Source - author

Atrium (16.6m X 7m)
116 Sqm

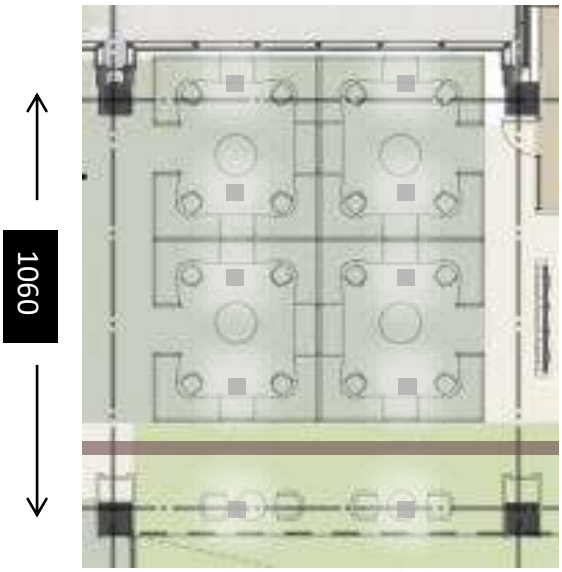
Open Collaboration Area
(Capacity 68 People))

Breakout Zone

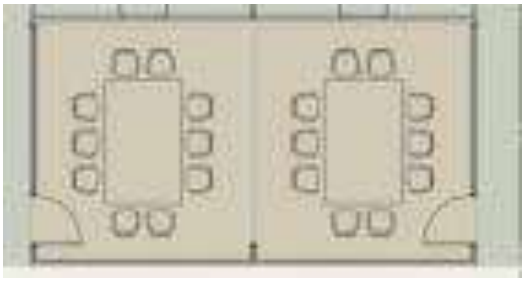
Source – author

TYPICAL FLOOR PLAN

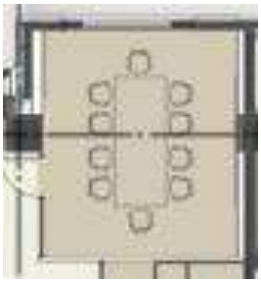
FIG. 2.16 Typical Floor Plan
Source - author



325 Workstations On Every Level
Cubicle Size – 4.3m X 4.6m



No. – 4 Size- 4.3m X 4.6 M

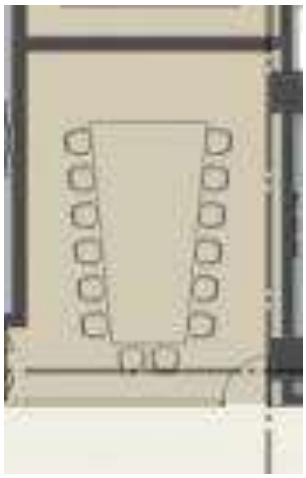


No. – 2 Size- 5m X 6m

Conference Room
(8-10 People Capacity)

- Flexible Collaborative Space
  Lcd Screen

Large Conference Room



Large Conference Room - Video conferencing with 2 screens
(14 People Capacity)

No - 1
Area – 5m X 7.5m

Open Collaboration

Open Collaboration - Studio Presentation Area
(11 People Capacity)

No – 2
Size - 5m X 8m

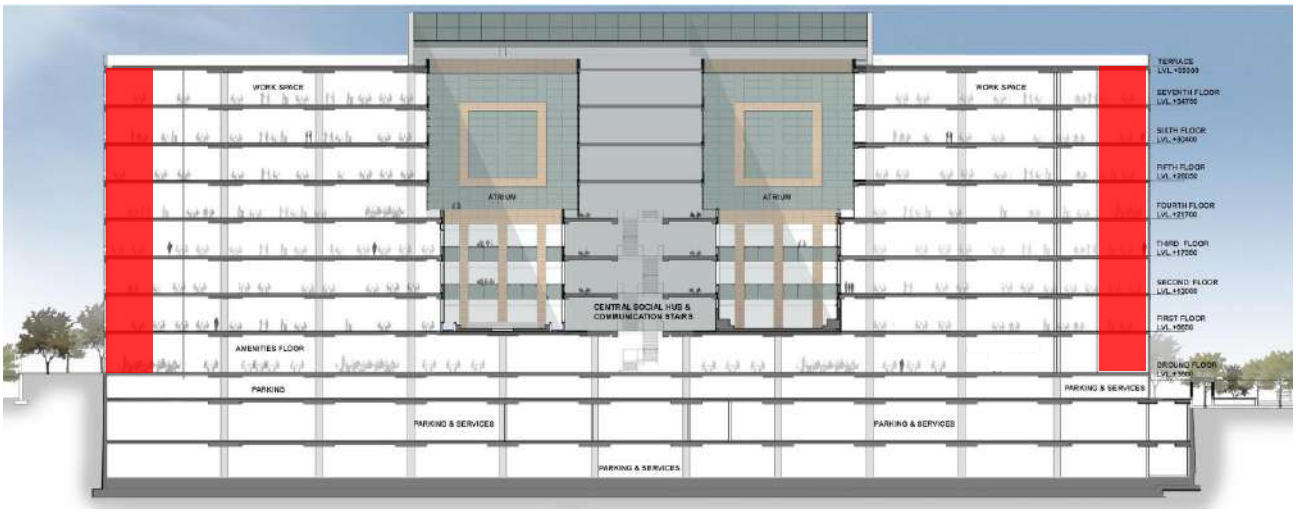
Washrooms

Male Washroom
9 WC
1 P.H WC
10 Washbasins
8 Urinals
Size - 75 Sq M

Female Washroom
10 WC
1 P.H WC
7 Washbasins
Size – 75 Sq M

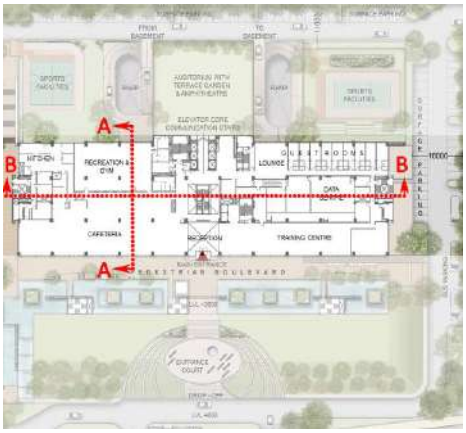
SECTIONS

Section A



Section B

FIG. 2.17 Sections
Source - author



STRUCTURE

- RCC steel structure
- Post tension slabs : Depth – 300 mm
- Beam Depth : 600 mm
- Column grid : 10.6 – 13.6 m
- Floor to floor height : 4.35 m

MATERIAL USED

- RCC
- Bricks
- Glazed glass
- Terracotta tiles
- M.S. Steel

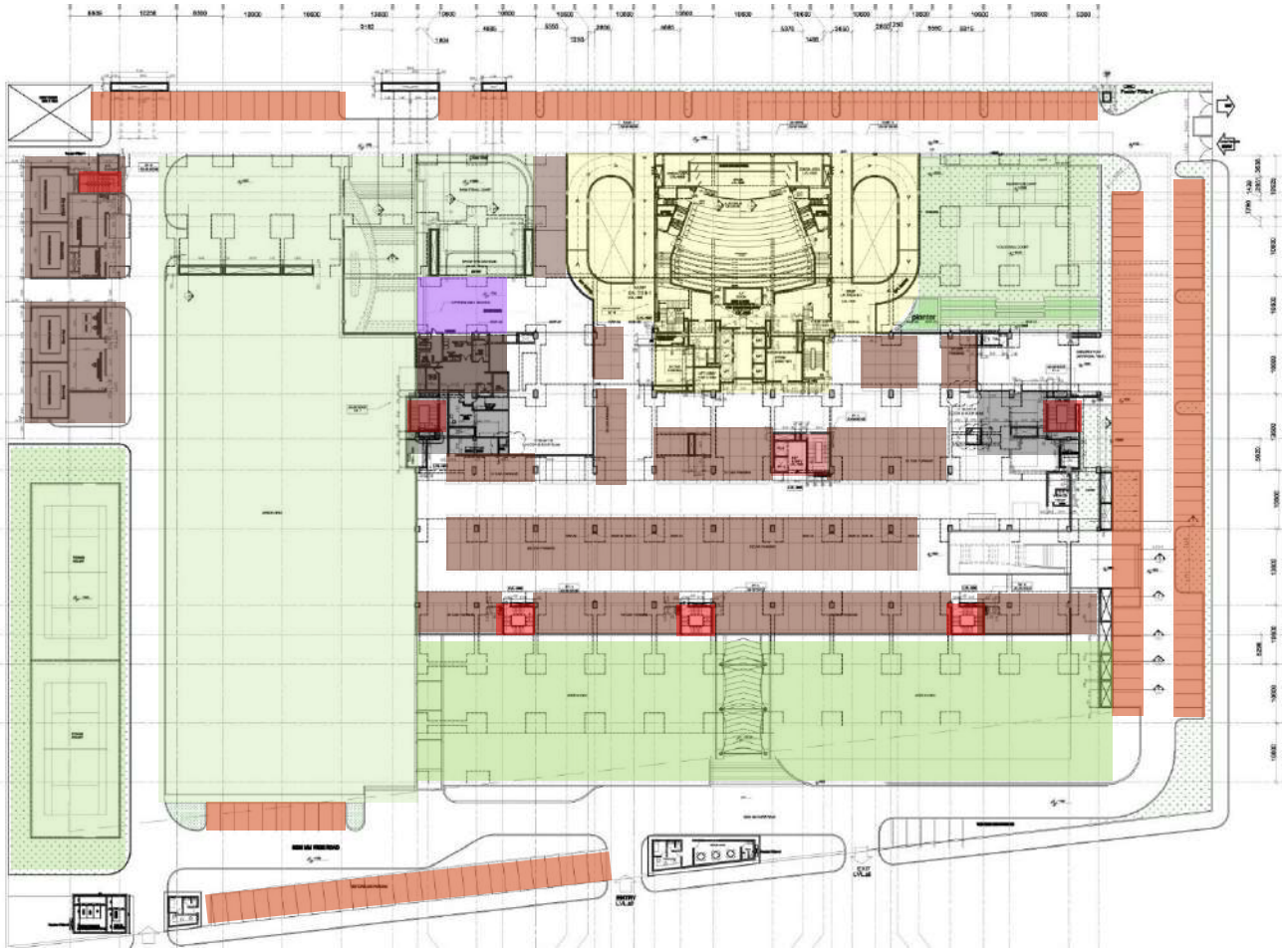


FIG. 2.18 Stilt Level Plan

Source – author

Surface Parking
130 ECU

Parking Entry
5500m Wide

Ramps to Basement Level – 1
Auditorium Entry From
Basement 1

Kitchen Sorting Area,
Storage Area,
Washrooms,
Service Lift - 14000 X 10000

Open Areas

Parking

Fire Staircase
Width – 1800mm

Electric Sub Station
21000 X 15000
(EACH)

Lift Lobby and Stairs – 1800mm
LIFT - 2400 X 2100 (14-person lift)

Kitchen
Service Entry

Core

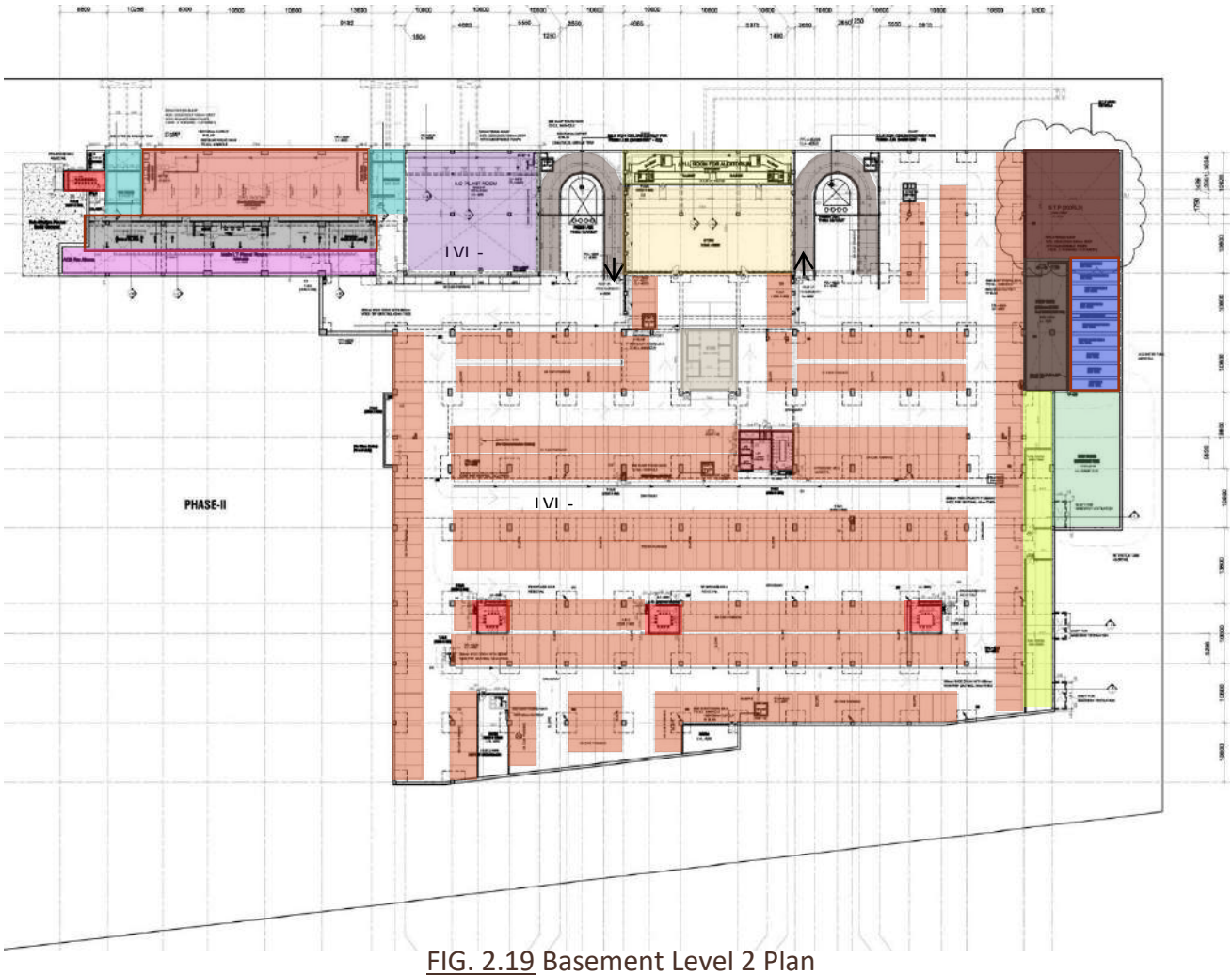


FIG. 2.19 Basement Level 2 Plan

Source – author

STP
17450 X 18900
200 KLD (Kiloliters Per Day)

Ramp
Slope – 1:10
Width - 3500

Lift Bed

D.G Room
4 D.G Sets Present
4 For Phase 2
1500 KVA Each
43300 X 13000

Pump Room
23000 X 8000

Lift Lobby and Stairs- 1800mm
Lift - 2400 X 2100 (14 Person Lift)
NO - 2

A.H.U Room For Auditorium
31340 X 5600

Control Room
Utility Panels
50200 X 4800

Pump Room
23000 X 8000

Fire Staircase
Width – 1800mm

Store
31340 X 15800

Main Lt Panel Room

Retention Tank

Parking Area - 400 ECU
4800 X 3000
Drive Way - 6000

AC Plant Room
25000 X 21500

Fan Room
6000 X 5800
Fuel Storage
6500 X 2500

Fan Room

FIG. 2.20 Basement Level 1 Plan

Source – author

Cutouts

Double Height Lobby Area
20000 X 6000

Lift Lobby and Stairs – 1800mm
LIFT - 2400 X 2100 (14 Person Lift)
NO - 2

Auditorium
480 Persons
Area – 535 Sq M

Lift Lobby
5 Lifts
14 Person Lifts

UPS Room and Battery Rooms
Critical Lighting - 50 Sq M
Workstations - 130 Sq M
Data Centre - 100 Sqm
AHU Room - 40 Sq M

2.4 INDIA GLYCOL OFFICE

Project Type	:	Office Building
Location	:	Sector 126, Noida
Architect	:	Morphogenesis
Client	:	India Glycol
Site Area	:	2,15,280 Sq. Ft. (20,200 Sq. Mt.)
Built-Up Area	:	391,700 Sq. Ft. (36,390 Sq. Mt)
F.A.R.	:	1.5
Employees	:	250

Energy-responsive design, a workplace catering requirements of the IT, Development of building techniques with modern materials.

Source – google images

India Glycol is located in sector 126 of Noida (Delhi NCR region). The site is well connected to Delhi and greater Noida by Noida expressway. The map shown above shows the access and approach of site and its distance from the airport, railway station and the bus stand.

ACCESS AND APPROACH

Glycol Headquarters
Sector 126, Noida

Noida Expressway

30m Wide Roads

Nearest Metro Station-
Botanical Garden (8.6km)

Climatic Zone	: Composite
Avg. Temperature (High)	: 31.2°C
Avg. Temperature (Low)	: 18.8°C
Avg. Precipitation	: 715 mm

SITE PLAN

Site of 200m x 100m has front, rear and side setbacks of 22m, 12m and 9m respectively with basement parking of total 400 ECU. Width of main entry/exits is 7.5m and vehicular roads are of 7.2m.

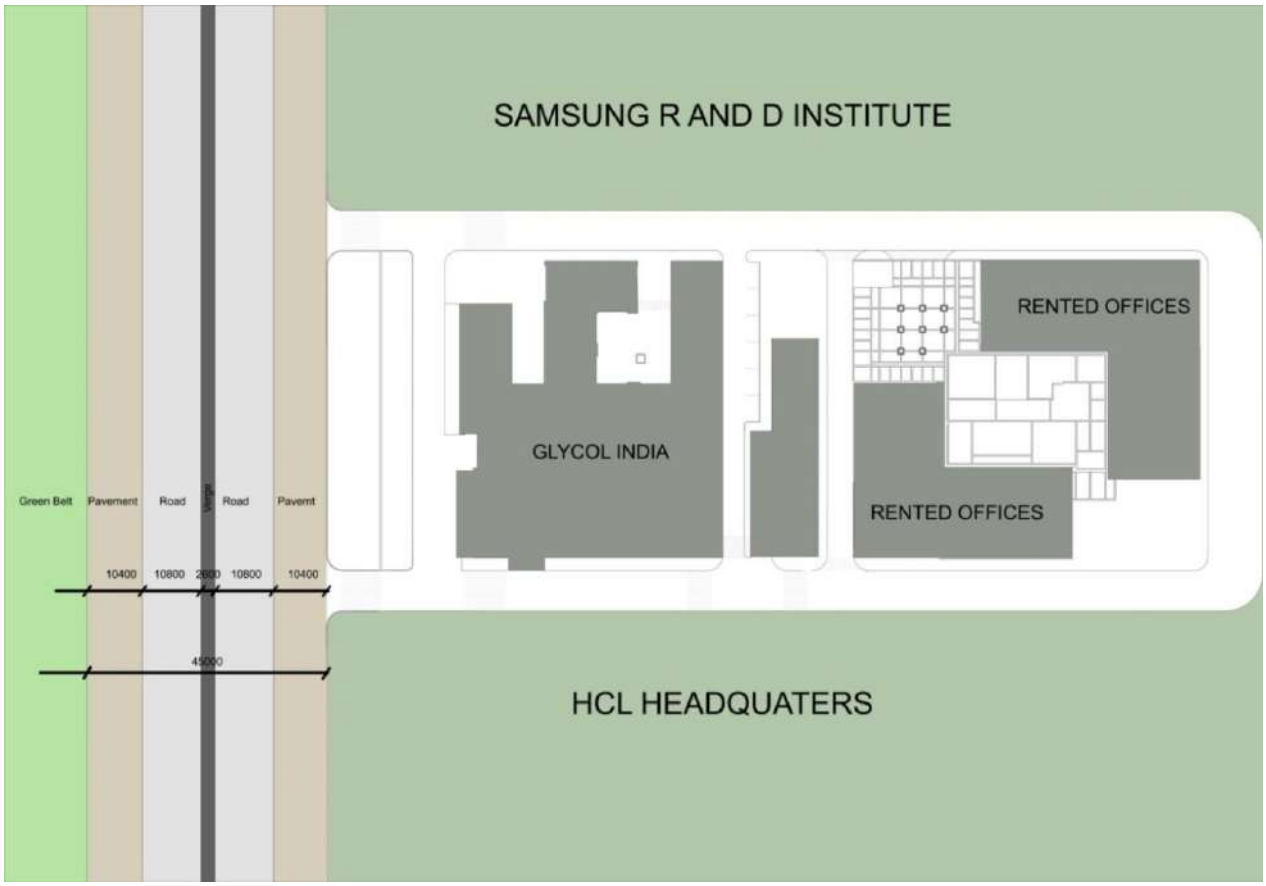
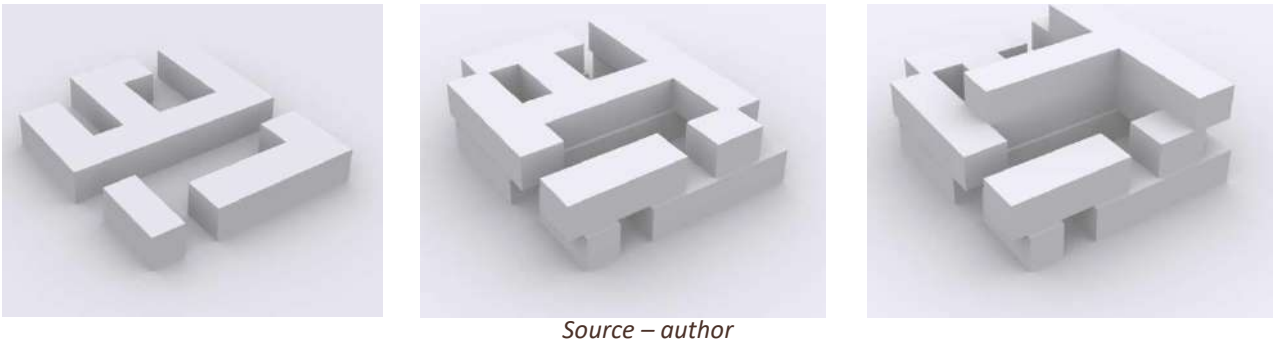


FIG. 2.21 Site Plan
Source – author

FORM EVOLUTION

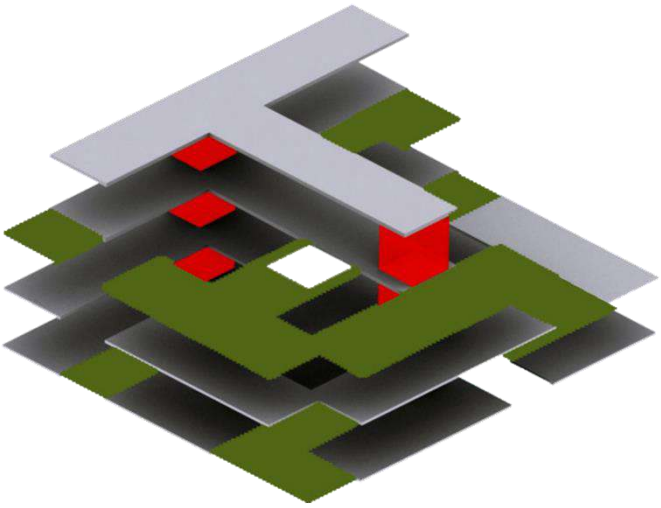
Conceived as a solid perimeter scheme with a more fluid interior, the morphology blurs the interface between the inside and outside. The site surroundings and context along with an optimum enclosed square volume enabled a built form with minimum exposed surface area. The built form configured of 8m wide office bays optimizes the natural day lighting and helps to define the programmatic requirements of the office.



Source – author

VOLUMETRIC CONFIGURATION

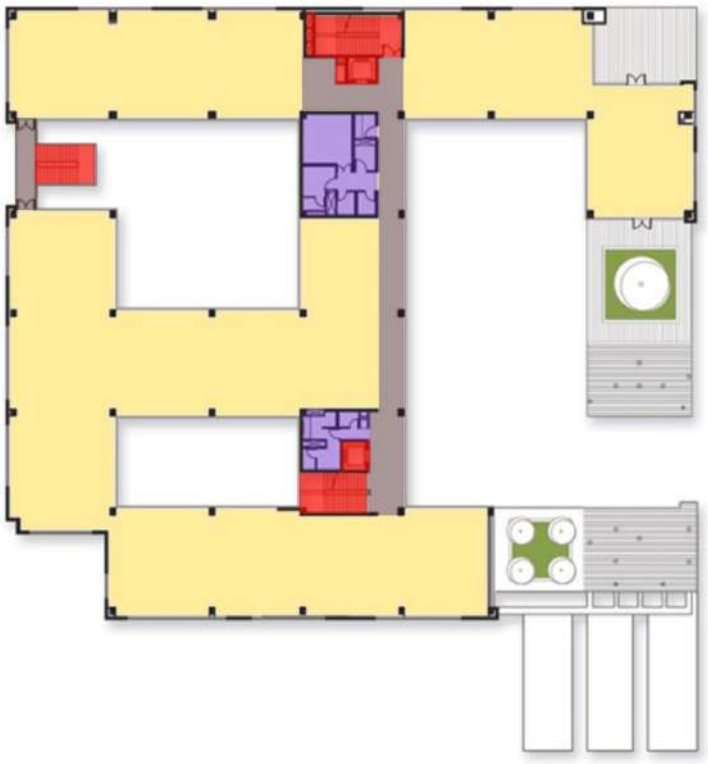
The design's conceptual strength comes from the spatial organization which creates overlaps between the exterior and the interior and between the various programmatic requirements, hence creating a vibrant and creative work environment.



Source – author

ZONING PLANS

(a) Ground Floor Plan



Corridor
Office
Service core
Washroom

(b) First Floor Plan

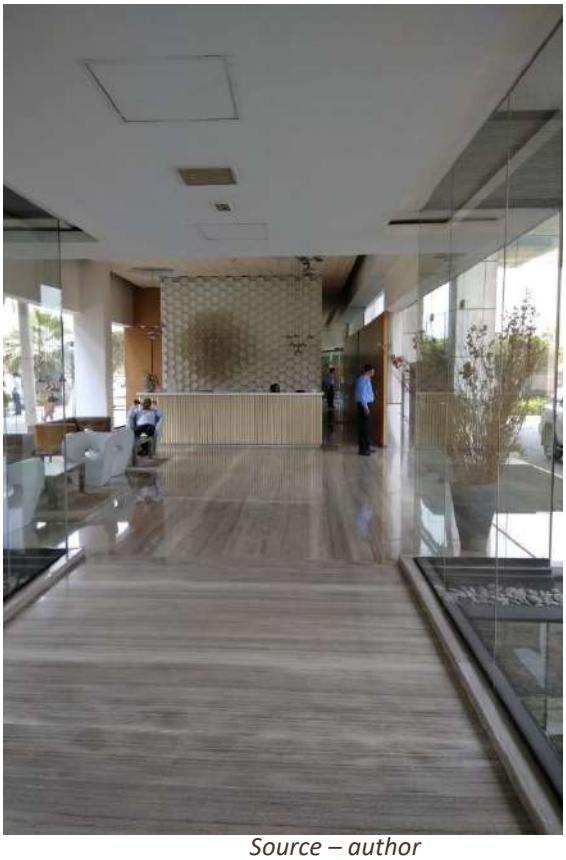
Corridor
Office
Service core
Washroom
Terrace Garden

(c) Second Floor Plan

FIG. 2.22 Zoning plans
Source – author

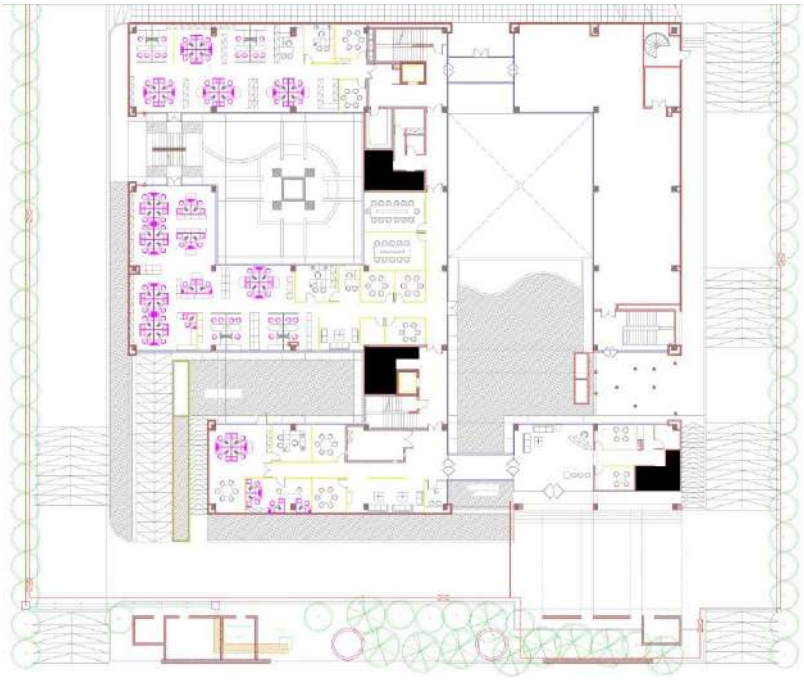
RECEPTION

Area – 70 sqm



Source – author

SERVICES



AHU Room Area - 17 Sqm / Room

Pantry Area - 4 Sqm / Room

Staircase
- Width 1500 mm
- Tread 300 mm
- Riser 150 mm

Lifts Area – 4 Sqm / Lift Room

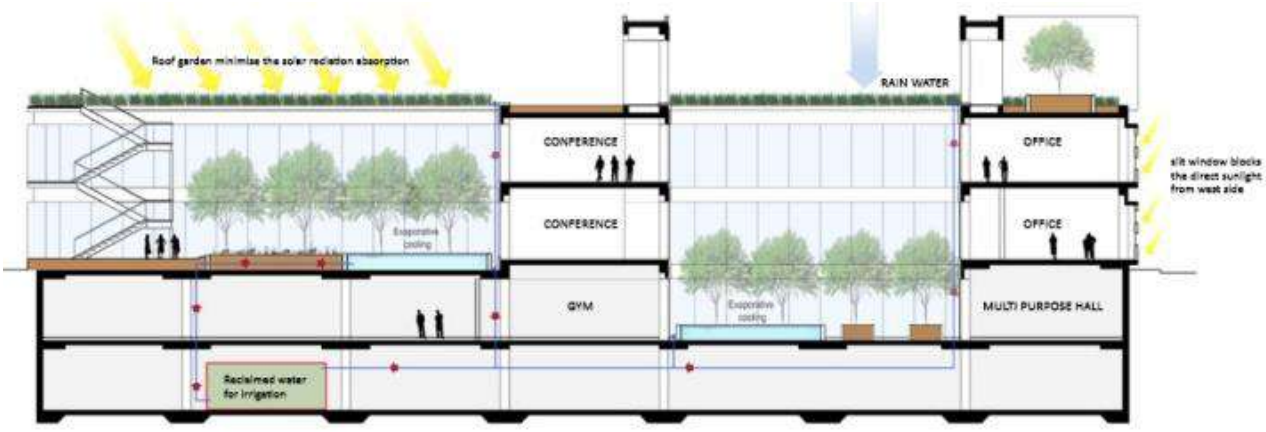
No. Of Washrooms
- Male 04
- Female 03

Source – author

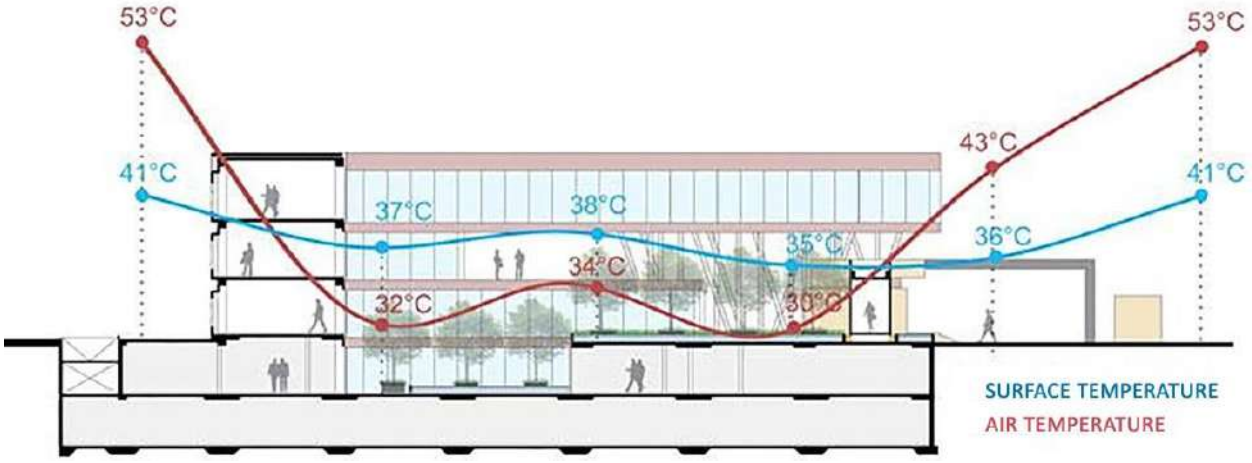
KEY PLAN FOR SECTIONS

VERTICAL CIRCULATION

- A stacking system is used to generate a variety of open spaces; courtyards, verandahs, terraces, green roofs etc. that help to structure the office spaces.
- A central spine traversing the built volume serves as the common activity zone, with other departments branching out.
- The design's conceptual strength comes from the spatial organization which creates overlaps between the exterior and the interior and between the various programmatic requirements, hence creating a vibrant and creative work environment.



(a) Section A



(b) Section B

FIG. 2.23 Sections
Source – author

GREEN FEATURES

Program, Form Optimization, Morphology, and Orientation

- Energy Consciousness dictates the internal spatial and programmatic composition through a series of open and semi-open spaces.
- Instead of an overlay of an environmental layer, Passive design techniques are employed throughout the scheme.
- The site surroundings and context along with an optimum enclosed square volume enabled a built form with minimum exposed surface area.
- Solar exclusion is achieved by means of a solid external perimeter with minimum fenestration, which only permits diffused daylight into the office environs.

Source – author

Passive Solar/Shading and Insulation

- Shaded Outer façade with air cavity construction, very small slit windows on the outside.
- courtyards with microclimate controls (shading and mist gardens, water bodies and plantations) all aid in reducing the solar ingress.
- Green Roofs and terrace gardens also provide a high level of thermal insulation.

Source – author

Courtyards and Terraces

- External Spaces are tempered using courtyards and terrace gardens that facilitate thermal insulation.
- The courtyards help to keep the solar ingress out.
- Control the temperatures of a multitude of spaces throughout the building while also allowing for sufficient day lighting into the workspaces.


Source – author

Evaporative Cooling

Water bodies aid in evaporative cooling thereby reducing dependence on artificial means of cooling.


Source – author

Day-lighting and Ventilation

- The reliance on artificial Lighting is substantially reduced as courtyards are used to increase natural light levels on the floor plates.
- During the day, there is no need for any artificial light which is a result of the narrow 8m floor plate which permits maximum light into the building.

Source – author

ANALYSIS OF CASE STUDIES

Comparison the case studies with the standards

No.	Tiltle	Acc. To CPWD / NBC 2005	adobe	glycol india
1	**WORK STATION**			
	Employees- workspace/workstation	9.29 sqm	11.5 sqm	2.2sqm
	Manager's Office	9.29 sqm	11.5 sqm	11.8sqm
	Senior Manager off.	18.58 sqm		20sqm
	Director's Office	23.22 sqm		37sqm
	(with 4 person meeting table)			
	4 person meeting room	9.29 sqm		10.5sqm
	8 person meeting room	11.61 sqm	11.5 sqm	24sqm
	Board Room	20.43 sqm		24sqm
	30 Person/conference room	22sqm-44sqm		150sqm for 100
	Pantry	9.29 sqm		4.2sqm x 2
	1 Server rack Server room	3.72 sqm		NIL
	4 Server rack Server room	11.5 sqm		NIL
	Visitor's lounge	<44sqm	45 sqm	39sqm
	Receptionist/For Staff Security	11sqm		14.5sqm
	Canteen	0.09sqm / person	1.5 sqm	2.1 sqm / person
2	**CIRCULATIONS**			
	Lift No.		6+2	2
	Lift Well		5.04 sqm/lift	4.07 sqm / Lift
	Lift Door Width	0.9m	0.9 m	1m
	Lobby in front of elevator			
	elevator on one side	1.8m	Nil	2.23m
	elevator on two side	3.1m	3.3 m	Nil
	CORRIDORS			
	Substantial traffic	1.6m	2 m	2.6m
	Moderate traffic	1.2m	1.5 m	2.2m
	Secondary Traffic	1m	1.8 m	1.5m
	STAIRCASE STANDARDS			
	Minimum width	>=1.2m	1.8	1.5m
	Minimum tread	30cm	30 cm	30cm
	Height of Riser	<=15cm	15 cm	15cm
	Hand rail Height	>=90cm	90 cm	90cm

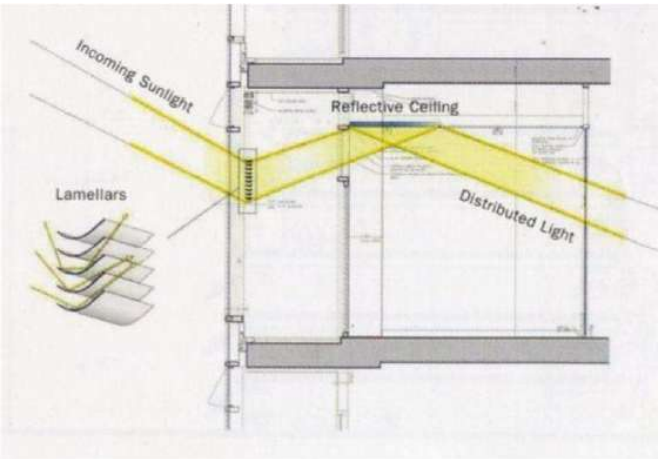
3	**HEIGHT STANDARDS**			
	Floor to Floor Height	3.6m	4.35 m	3.6m
	Minimum Clearance Height	2.43m	3.75 m	2.43m
4	**WET AREA REQUIREMENTS**			
	Area of Toilet/ Latrine - handicapped	3.5sqm		NIL
	Area of Toilet/ Latrine - common man	1.5sqm		2.2sqm
5	**FIRE SAFETY**			
	Main Entrance Width(for fire vehi.)	>6m	6 m	7.5m
	Turning Radius	9m		9m
	CORRIDORS			
	A corridor/verandah which has access to streets.	yes/no	no	yes
	Obstruction free	yes/no	yes	yes
	Clearly visible exit routes	yes/no	yes	yes
	Fire exits Width	>1m	1.8 m	1m
	No. of exits	Mini. Two staircase (Height of building>15m)	2+1	2
	external staircase connected to the ground level	yes/no	yes	yes
	EXTERNAL STAIRCASE			
	Width	>1250mm		1500mm
	Tread	>250mm		300mm
	risers	<190mm		150mm
	no. of risers per flight	<=15		12
6	**PARKING**			
	Min. Area for vehicle			
	Cars	13.75sqm	13.75	13.75sqm
	Two wheeler	3sqm	3	3sqm
	cycle	1.5sqm		NIL
7	**Methods of Ventilation**			
	Natural supply and natural exhaust of air	yes/no		
	Natural supply and mechanical exhaust of air;	yes/no		
	Mechanical supply and natural exhaust of air,	yes/no		
	Mechanical supply and mechanical exhaust of air.	yes/no	yes	yes

Understanding the green building features

- Land use and Site selection
- Energy efficiency
- Material usage
- Indoor Environment Quality

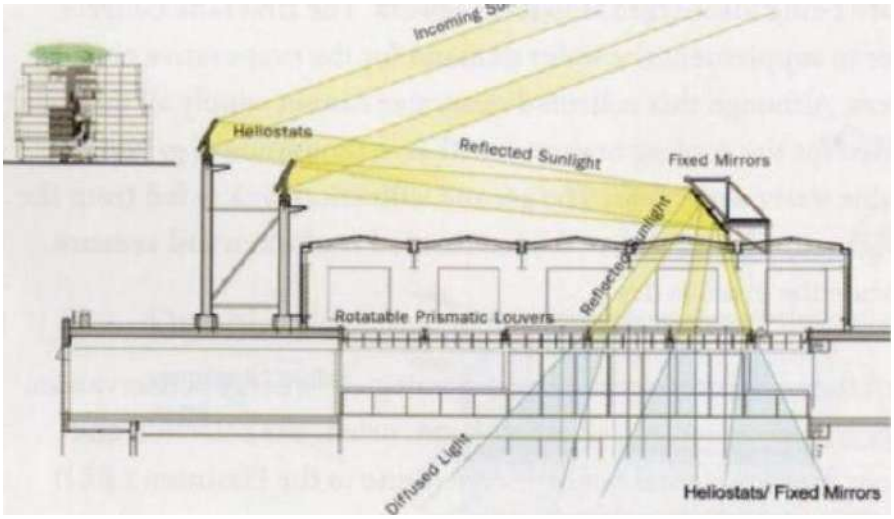
Maximization of Natural Light -'U' shaped Blinds

- collect light and reflect onto metallic ceiling
- automated blinds tilt according to sunlight



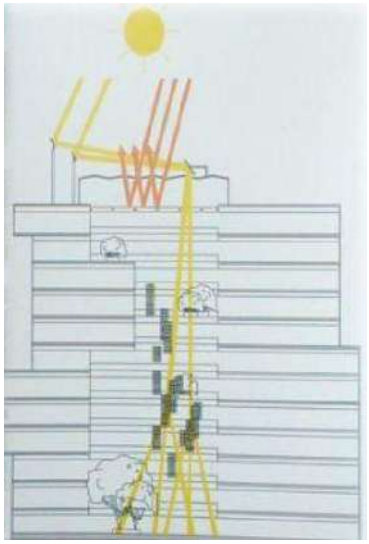
Heliostats

- increases day light in the building
- skylight louvers can be used to block strong sunlight



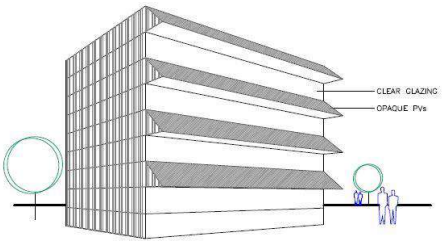
Prisms

- Deep Penetration of Light Inside the Building
- Diffuse Light and Eliminate Glare

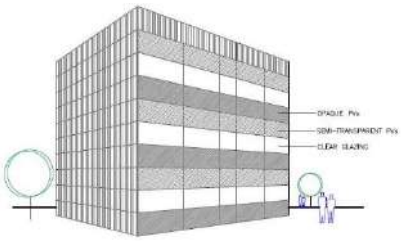


Solar Photovoltaic Devices

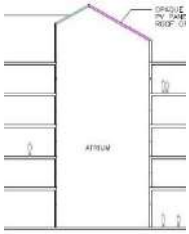
Photovoltaic panels can be made to form components of a building.



Curtain wall with PV panels



PV panels on shading devices



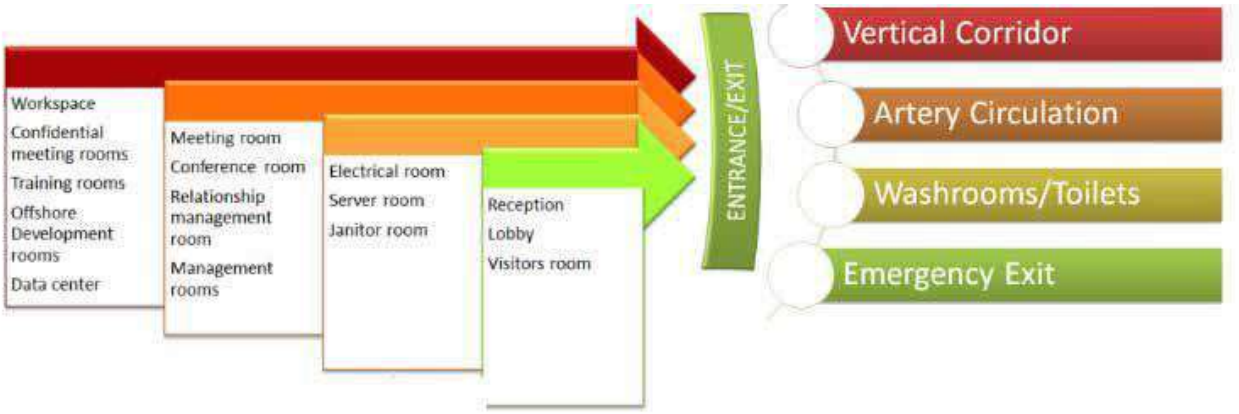
Atrium with PV panel skylight

DESIGN INFERENCES FROM CASE STUDIES

Spatial relationship

Office buildings are strongly linked to service and utility buildings and the open space, parking complex and food courts.

Inside an office the spaces again need to arranged according to the privacy of the areas.



The work type of office space is again inter linked. Mainly three type of work are done in an IT office Software development, production and software testing. However, these works are done in one office itself as they are not supposed to be placed together.

Access

- The width of the main street on which the building abuts shall not be less than 12 meter and one end of this street shall join another street not less than 12 meter in width;
- The approach to the building and open spaces on all its sides up to 6-meter width and the same shall be hard surface;

Parking

Minimum area for vehicle parking

- cars: 13.75 square meters
- Scooter: 3 square meters
- cycle: 1.5 square meters

Minimum parking allotments required for cars in a Business/Office Building:

- One parking space for every fraction of 100 square meters of carpet area.

Capacity of Exits

- The unit of exit width, used to measure the capacity of any exit, shall be 500 mm.

Number of Exits

- All building above 15 m in height, having more than 500 square meter on each floor shall have minimum of two staircases.

Lighting

Type of activity and range of service luminance in Lux

General offices	: 300-500-750
Deep plan general offices	: 300-500-750
Computer work stations	: 300-500-750
Conference rooms, executive offices	: 300-500-750
Computer and data preparation rooms	:300-500-750
Filing rooms	: 200-300-500

OFFICES - GENERAL STANDARDS

IT industries especially in India follow a thumb rule of 7.9 sqm per person.

Work station

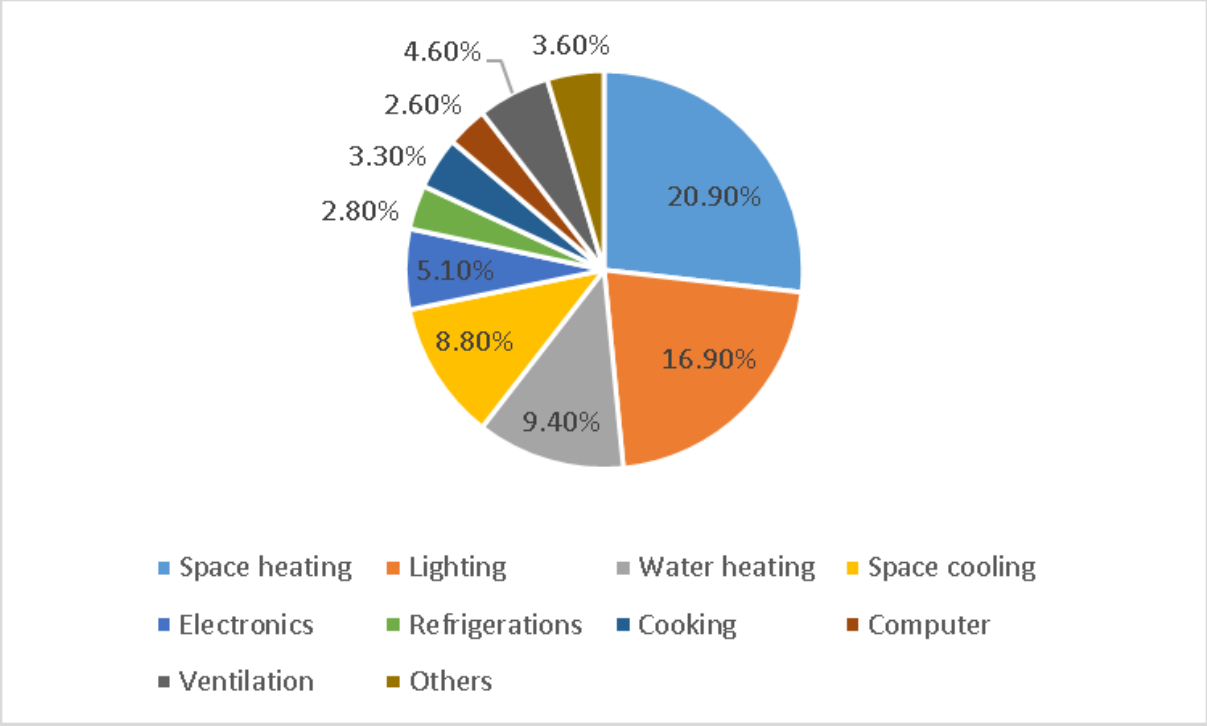
- EMPLOYEES - Efficient use of space - 6.50 sqm per person
- EMPLOYEES - Generous use of space - 9.29 sqm per person
- MANAGER'S OFFICE - 9.29 sqm
- SENIOR MANAGER'S OFFICE - With small meeting table - 18.58 sqm
- DIRECTOR'S OFFICE - With 4 person meeting table - 23.22 sqm
- SMALL MEETING ROOM - 4 person - 9.29 sqm
- LARGE MEETING ROOM - 8 person - 11.61 sqm
- BOARD ROOM - 20 person - 20.43 sqm
- TRAINING/CONFERENCE ROOM - 30 person - 25.55 sqm
- PANTRY - 9.29 sqm
- SMALL IT SERVER ROOM - One server rack - 3.72 sqm
- LARGE IT SERVER ROOM - Four server racks - 11.15 sqm

INSIDE AN OFFICE – COMPONENTS

- General work station
- Manager's office
- Senior manager's
- Director's office
- Small meeting room
- Large meeting room
- Board room
- Training/conference room
- Pantry
- IT server room

SOME ISSUES

Energy Consumption in Office Building



*Includes service station equipment, ATMs, telecommunication equipment, medical equipment, pumps, emergency electric generator, combined heat and power in commercial buildings, and manufacturing performed in commercial buildings.

Fabric Issues

An important aspect of building materials is the **building insulation**. This includes materials to reduce both conduction and radiation of energy.

Without insulation, the energy flow in buildings would be too immense to preserve comfortable conditions via passive means. i.e., without the use of mechanical techniques for heating and cooling.

Thermal resistance (R) is a measure of the effectiveness of the insulating material, the larger the "R - value" of a material, the better.

For the purpose of calculation of total energy transfer, the reciprocal of the thermal resistance is the "**U - value**", and is measured in W/^{o}C/m. The smaller the U - value, the larger the thermal resistance.

SPECIFIC GUIDELINES AND RECOMMENDATIONS

DESIGN PARAMETERS

- **Building orientation**

- **Glazing type**

  Single pane reflective coated glass (base case) is recommended for the moderate climate. All other glazing types increase the annual load of the building.

- **Shading**

  Shading of windows (by means of external projections such as chajjas) reduces solar gains and subsequently the heat gain, and hence the annual load is also reduced. If 50% of the window areas are shaded throughout the year, loads can be reduced by 10.6%.

- **Wall type**

  A wall having a low U-value (insulating type such as autoclaved cellular concrete block) increases the load compared to the concrete block wall (base case) by 2.2%. Thus insulation of walls is not recommended.

- **Colour of the external surface**

  Dark colours on the walls of such a commercial building should be avoided. For

  example, using dark grey increases the cooling load by 5% compared to white (base case).

CHAPTER 3: SITE ANALYSIS

3.1 BANGALORE

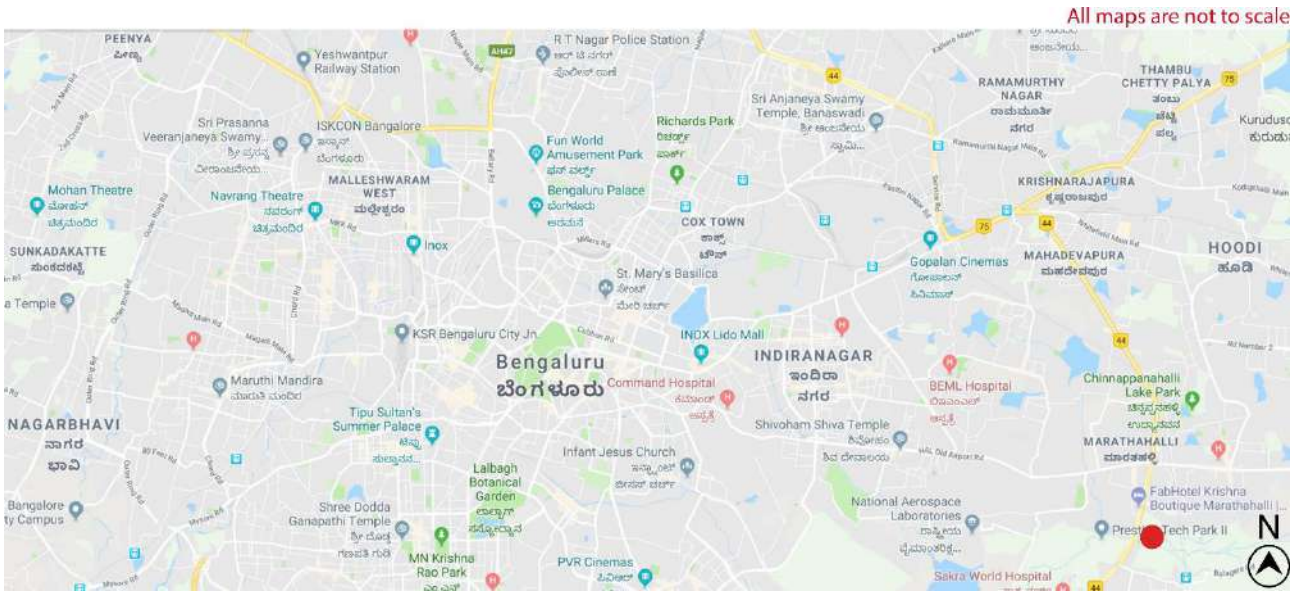
Once called the "Garden City of India" and the "Pensioner's Paradise", these epithets no longer apply to Bangalore, which is now a large, cosmopolitan city with diminishing green spaces and a large working population. Cosmopolitan Bengaluru (formerly Bangalore) is one of India's most progressive and developed cities, blessed with a benevolent climate and a burgeoning drinking, dining and shopping scene. Though there are no world-class sights, you'll find lovely parks and striking Victorian-era architecture. The past decade has seen a mad surge of development, coupled with traffic congestion and rising pollution levels. But the central district (dating back to the British Raj years) remains little changed, and the landmark corporate HQs and business parks of the city's booming IT industry are mostly in the outer suburbs.

A day at work doesn’t always have to be about work. In today’s busy daily schedules, we sometimes have to remind ourselves to take a step back and live a little. Imagine how much easier it would be to take a quick break from work to refresh the mind, if the workplace itself gave you the opportunity to enjoy a moment of leisure. With a diverse range of premium retail outlets, restaurants and various avenues for recreation, this corporate campus will present the ideal urban centre just a short walk from your office, redefining convenience and our perceptions about what a workplace can be.

The modern campus, whether horizontal and multi-building or vertical and multi-story, should build on three ideas about 21st century organizations and their workers. First, the campus is a crucial means of driving collaboration, innovation, and culture. Second, its urbanity is a given, even beyond the city. Third, it’s resilient—sustainable, supportive, and able to flex without big outlays of time and money.



3.2 LOCATION OF SITE IN BANGALORE CITY



3.3 CLIMATIC ANALYSIS

- Bangalore city Altitude - 890 m above sea level in the S-E part of Karnataka, India.

  With Moderate type of climate -

  * Temperature 14°C(Winter) and 36° C(Summer)
  * Rainfall 970mm annually
  * Seismicity Zone II (stable) with max. magnitude of 6.4
  * Groundwater Silty-Sandy layers of alluvial sediments
  * Soil- Red Laterite / red, fine loamy to clayey soils
  * Vegetation - Big to medium Canopy trees(girth<40m)
    -Large deciduous canopy and mostly coconut trees

- The city of Bangalore experiences a very favourable weather throughout the year. Bangalore in the winter months, between September and March, temperature roves in between 28 to 32 degrees Celsius (82 to 90° Fahrenheit). In summers from March to May you can see maximum temperature rise up to 38 degrees Celsius (100° Fahrenheit).

  Here are some annual weather facts collected from historical climate data:

  *During the months June, July, August, September and October you will experience pleasant weather with a nice average temperature.

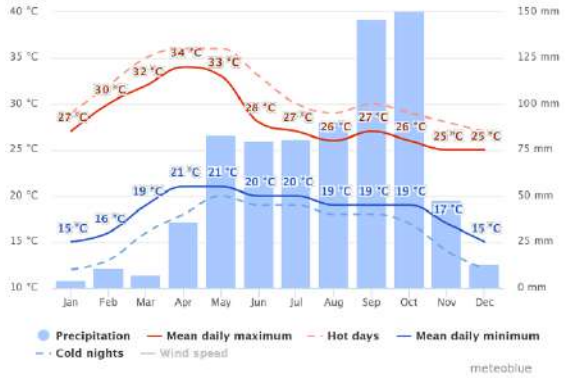
  *A lot of rain (rainy season) falls in the months: May, June, July, August, September and October.

*Bangalore has dry periods in January, February, March and December.

*On average, the warmest month is May.

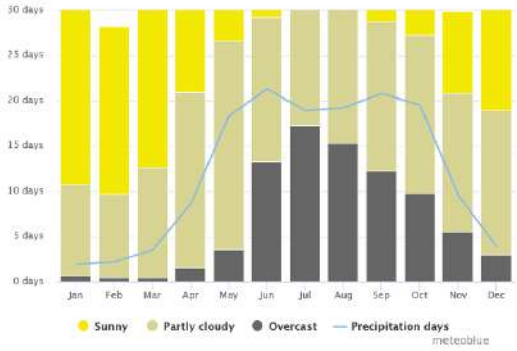
*On average, the coolest month is January.

Average temperatures and precipitation



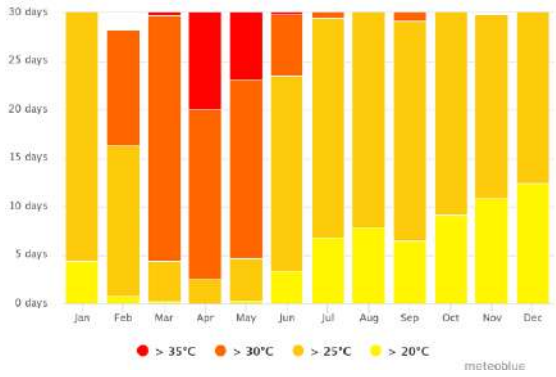
The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Bangalore. Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years.
Monthly precipitations above 150mm are mostly wet, below 30mm mostly dry.

Cloudy, sunny, and precipitation days

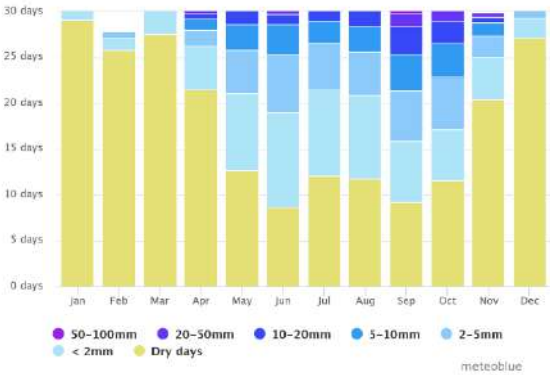


The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

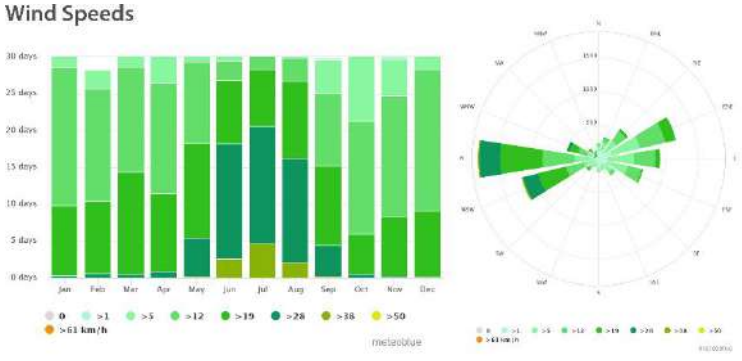
Maximum temperatures



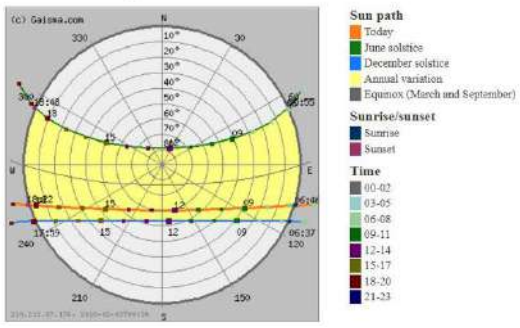
Precipitation amounts

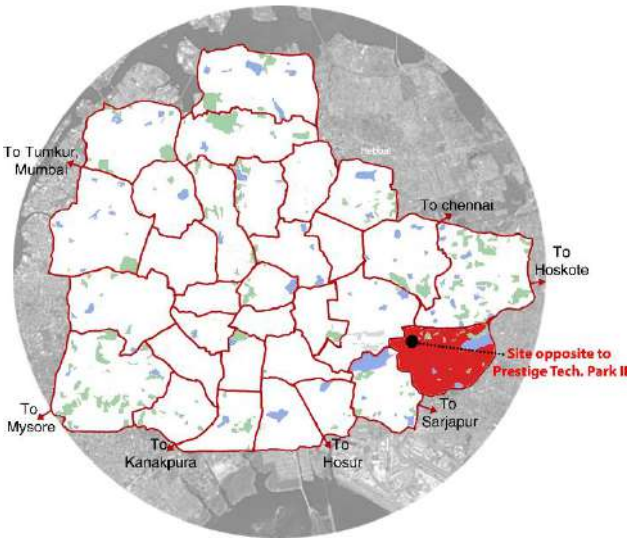


Wind Speeds



Sun Path Diagram

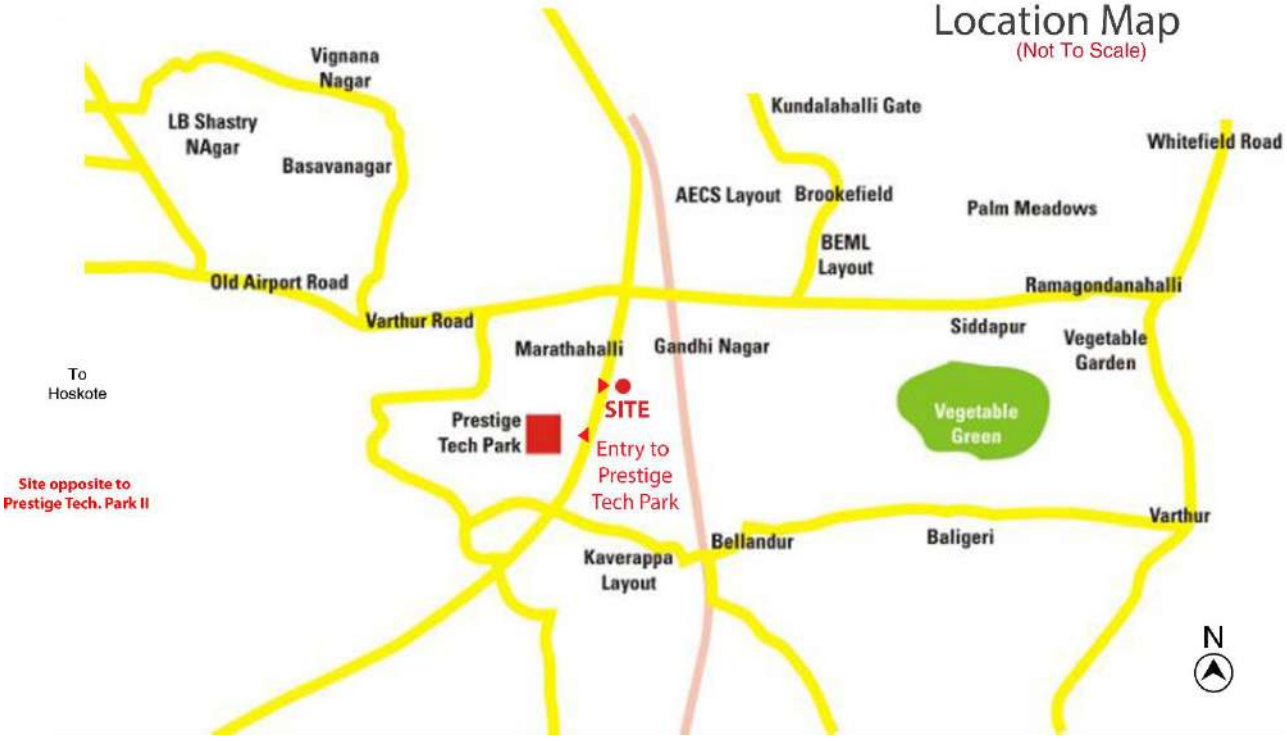


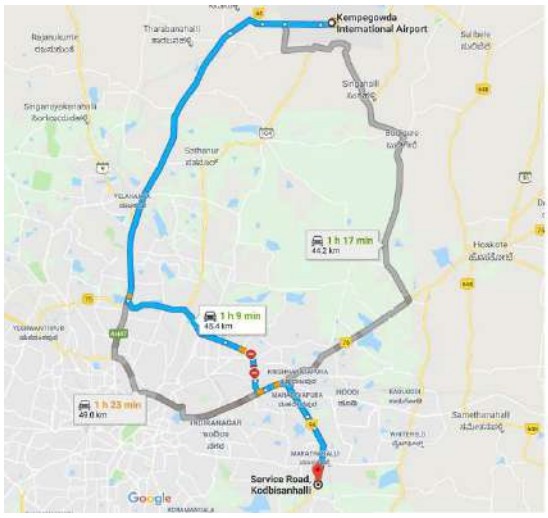


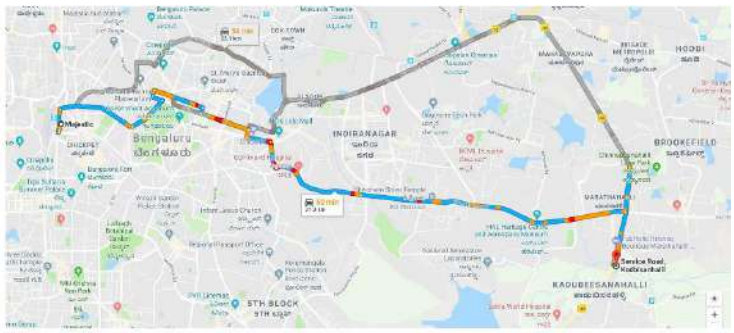
Prestige Tech. Park 2 is a software technology park in Bangalore, Karnataka India. The Oracle is the extension of Prestige Tech. Park, situated opposite to tech park in kadubeesanahalli (near Marathahalli) on Outer Ring Road, and has an area of 8 acres.

Major anchors points of city and their distances from the site:

* Kempegoda International airport	29.05 Km
* Majestic Bus Station (ISBT)	14.08 Km
* Bangalore City Railway Station	14.50 Km
* Marathahalli	1.81 Km
* Kadubisanhalli	0.80 Km
* Ibblur village	3.88 Km
* Sarjapur road cross	3.92 Km
* HAL	3.04 Km







Bangalore city Railway Station AND Majestic Bus Station - 14 KM

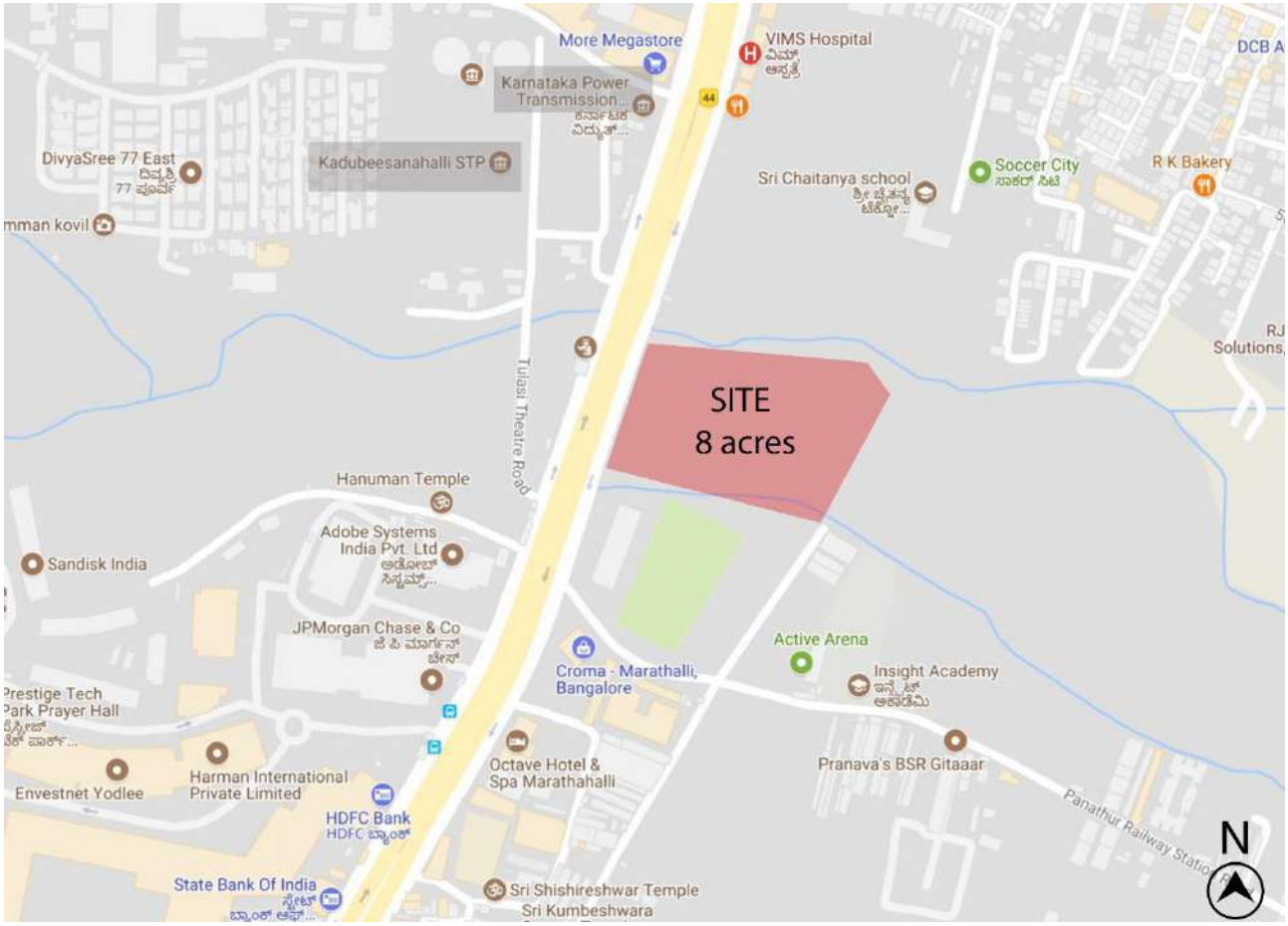
Kempegoda International Airport - 29.05 KM

3.4 SERVICES AND AMENITIES NEARBY

A number of services and amenities are available near the proposed site for Oracle India.

This includes bus stops, Grocery stores, shopping stores, banks, pharmacy and hospitals, petrol pumps and schools & study centres.

STP (Sewage Treatment Plant) of Kadubeesanahalli area and Karnataka Power Transmission plant are in the locality of the proposed site.
So, the problem of treating sewage waste and electricity power requirement are easily fulfilled.



3.5 CORPORATE BUILDING INSPIRED BY NATURE

PROJECT BRIEF - ORACLE INDIA PVT. LTD. has planned to open its campus outside the US in Bangalore, marking a significant investment by the US-based online retailer in one of its fastest growing markets. Spanning 8 acres., the state-of-the-art campus will have “thousands” of employees managing back-end operations of Oracle’s global businesses.

The design for Oracle corporate campus creates an integrated and sustainable vision of merging landscape and architecture to create a new form of symbiotic living and working. The building’s design will directly respond to the site’s climate, rich cultural heritage and client’s goal of further elevating itself as a global leader in business consulting, IT, software engineering and outsourcing services.

3.5.1 Geographical Features

The site’s northern boundary edge is the nala. This gives a barrier in viewpoint and activities. But can be intervene for opportunity of interactive open spaces in the design. The site is opened mainly from western side only. A kuccha road is there at eastern side which can be used as service road.

The site is accessed from NH 44.

1. The top soil of 0.3m is non-uniform.

2. The underlying layer is laterite up to 2.5 to 6.0m followed by disintegrated rock.

3. At some locations medium rock was met with at depths varying from 11.0 to 14.0 m. At other locations even at 15.0m medium rock was not met with.

4. No water table was met with in the boreholes at the time of exploration. However, perched water table is likely to occur during rainy season.

5. For the proposed structure shallow foundations can be given at any depth from 1.5m, resting the foundation on the laterite / disintegrated rock layer.


210 M
40 M
150 M
150 M
200 M
SITE
8 Acres
Service Road
Outer Ring Road
Service Road
Outer Ring Road
9 M WIDE
Rainbow Layout
Salarpuria Sattva
N
not to scale
SITE
Site coordinates- 12.9716° N, 77.5946° E
Village - Kadubeesanahalli
Taluk - Bengaluru East Taluku
Total Area - 8 acres (32,000 sq.m.)

3.6 NEIGHBOURHOOD

NEIGHBOURING BUILDINGS AND
PLOTS TYPOLOGY:

1. Salarpuria Sattva - Office building
2. Active Arena - Sports academy
3. STP Plant - Services
4. Power Transmission Plant - Services
5. Kadubeesanahalli Police Station - Public
6. Prestige Tech Park II - IT park

3.7 ROAD CONNECTIVITY TO PROJECT SITE

The project site is located along Outer ring road, which connects to Marathalli on one side and silk board on another side.

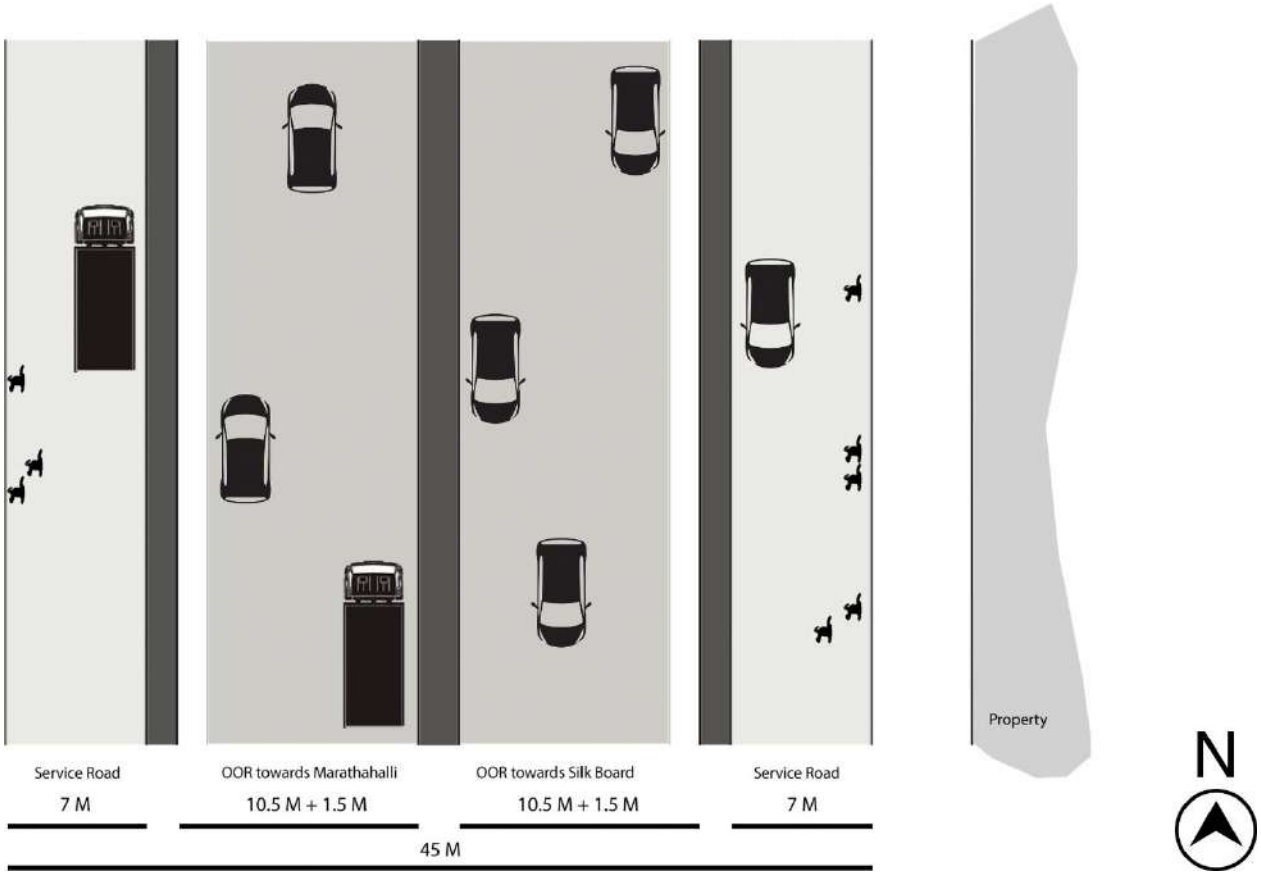
The Entry/Exit of the project site is provided to service road of Outer Ring Road and another entry / exit is made available for service vehicles along Kariyammana Agrahar Road.

The Outer Ring Road measures 45m and a few locations it measures 52 m. Presently ORR is facilitating (3+3) lanes main CW with 2 lanes service roads on both directions.

The project is well accessed from Hosur road via ORR, Marathhalli, old airport road via ORR, KR Puram and ITPL Road, Sarjapur Road as well as Graphite India Road.

The project site is near to the major areas of the Bangalore
such as:
Marathhalli, Nagundanahalli, Koramangala, Kadubeesanahalli, Devarabisanahalli and etc.

3.7.1 Outer Ring Road Detail



ANALYSIS:

All maps are not to scale

TRAFFIC MOVEMENT

OUTER RING ROAD - Heavy Veh. Traffic

SERVICE ROAD - Light Veh. Traffic + Pedestrian

VEGETATION

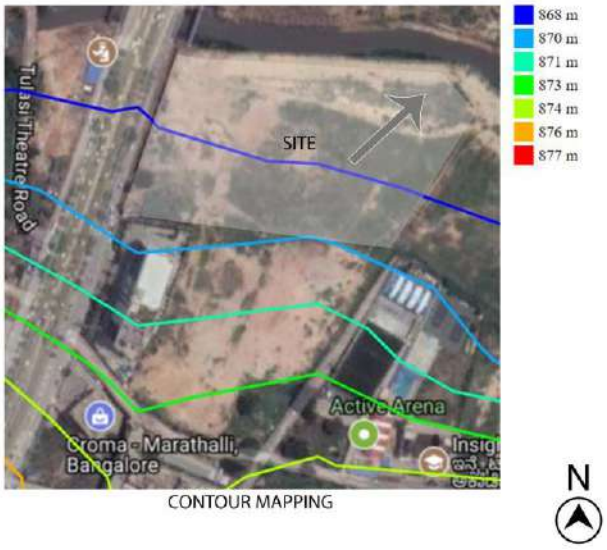
Wild Vegetation (Shrubs)

There are only wild shrubs present on the site. No trees are there.

SERVICES

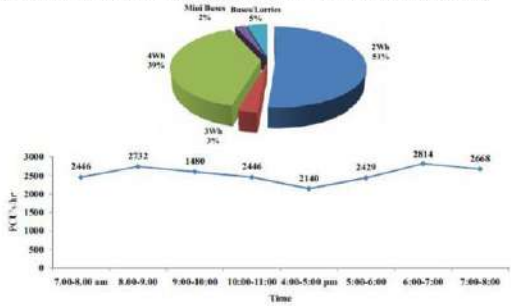
Electricity Poles

Government Water supply pipes are laid along the service road in 1.5 m wide drain. This drain is below the electricity pole line.

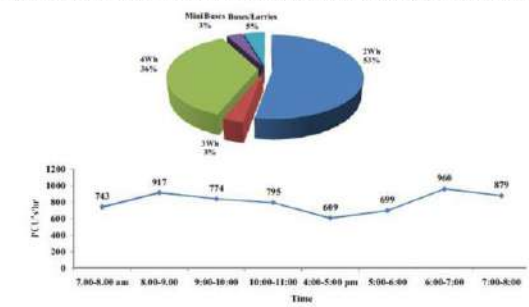


CONTOUR MAPPING

Vehicle Composition along OOR towards Silk Board (3 lanes)



Vehicle Composition along OOR towards Silk Board (Service road 2 lanes)



3.8 BYLAWS FOR THE PROJECT
(Reference- Master Plan 2025, Bangalore Bylaws)

* Permissible F.A.R	2.50
* Permissible Ground Coverage	45%
* Max. Permissible Height	45m
* Park and Greenbelt	22%
* Setbacks	13m (front, rear) - 6m(sides)
* Parking	1 ECU per 50sqft of area

* For property of more than 1000 sqm basement can only be constructed after leaving 6m in front and 3.6m in all other sides.

* For building more than 12m of height balconies can be 1.8m in setbacks.

* In setbacks- transformers, generator rooms, pump room, electric panel room, switch room, PBS, drainage, gutter garbage shoot, guard room, sewage treatment plant, gas bank, swimming pool - 7% of the total FAR.

* For basement and floor ramps in setbacks are allowed only if there is clear space of 3.6m for fire extinguisher vehicle. Ramp can be used for fire extinguisher path only if it is not covered.

* Boundary wall in front must be constructed after leaving 6m from the road.

Parking

Minimum area for vehicle parking
1. cars: 13.75 square meters
2. Scooter: 3 square meters
3. cycle: 1.5 square meters

3.8.1 Height Norms according to Road width
(Reference- Master Plan 2025, Bangalore Bylaws)

Height of Building (m)	Minimum abutting road width required (m)
* Upto 21 m	12.2
* Above 21 m & up to 24 m	12.2
* Above 24 m & up to 27 m	18.0
* Above 27 m & up to 30 m	18.0

* Above 30 m & up to 35 m 24.0
* Above 35 m & up to 40 m 24.0
* Above 40 m & up to 45 m 24.0

3.8.2 S.W.O. T ANALYSIS

Strengths

* Site is located in the vicinity of top commercial zone of Bangalore.
* Access to the site is from the Outer Ring Road towards Silk Board (NH 44).
* Site is not directly on OOR, but a 2 lane Service Road is there.
* Easily accessible from various bus stops, cab stations, thus promoting public transport. Presence of important buildings in the precinct allows the project to function as a part of larger network.

Weaknesses

* Site is only accessible from Outer Ring Road. Although there is a kuccha road at eastern side of the site, but maybe only be used as service road.
* There is nala present on northern side of the site. So, need to be intervened from foul smell and unpleasant view.
* If someone is coming from Silk Board, it is difficult to find any cut in median to come in the site. There is a roundabout at Marathahalli cross road around 1.5 km away.

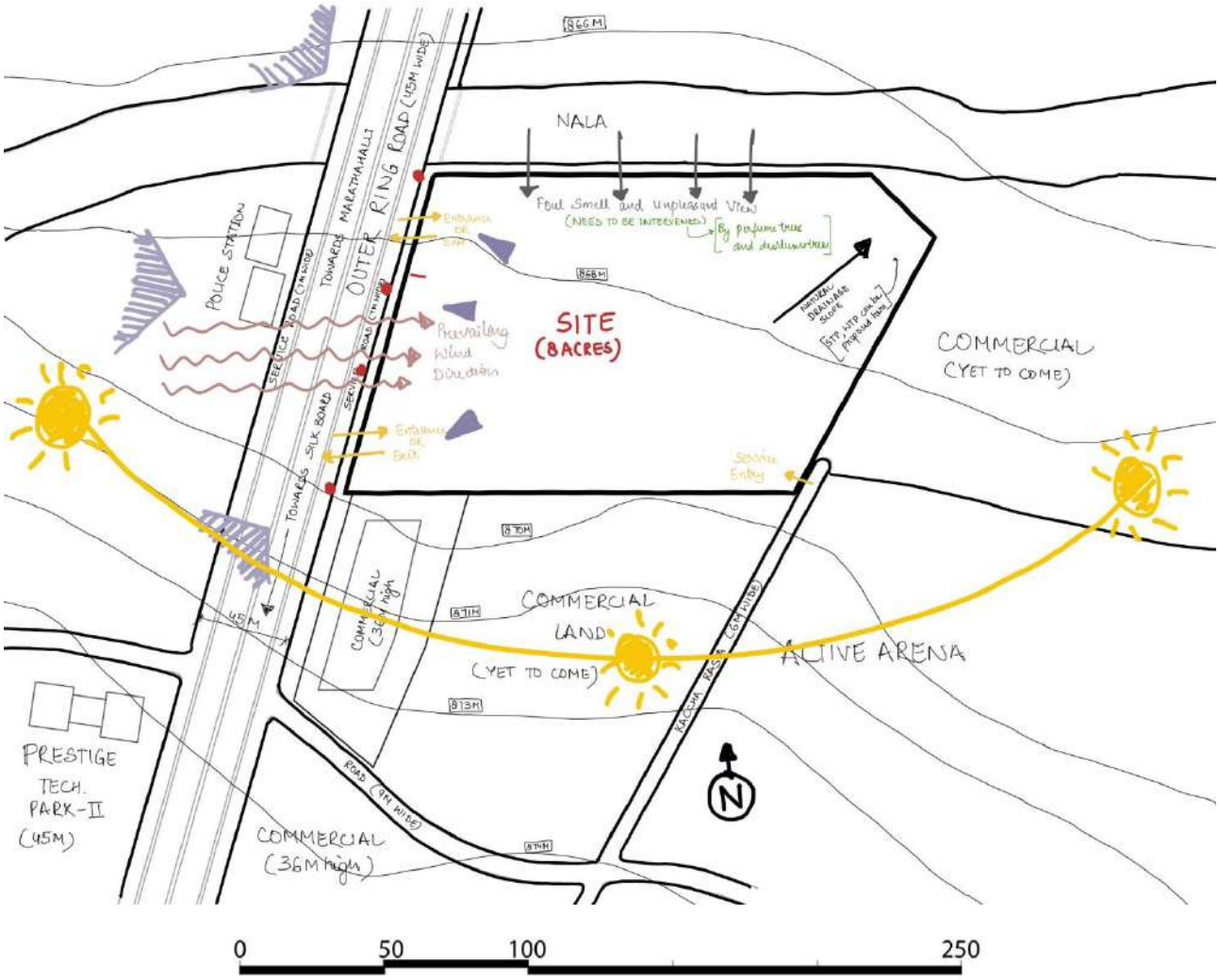
Opportunities

* Site has the potential to direct the kind of development that will come up in the future.
* There are negligible contours. So less difficulty in design good campus.
* Gentle slope of site is favourable for the creation of green spaces next to the nala, preventing foul smell and unpleasant view.

Threats

* For the scheme to be success, green network of the future project should mingle with it. For better or worse, much of the project's impact on surroundings depends on the what lies the store for the neighbouring plots.

3.8.3 INFERENCES FORM SITE ANALYSIS



CHAPTER 4: AREA STATEMENT

- Total Site Area = 32,235 sqm i.e. 7.96 acre
- Permissible Setbacks = Front and Rear – 13 m, Sides – 6 m
- Permissible Ground Coverage = 35%

  Achieved Ground Coverage = 6100 sqm i.e. 18.9% (approx.)

  (Remaining Ground coverage will be used for future expansion)
- Permissible height = 45 m

  Achieved Height = 45 m
- Total built up Area = 43,200 sqm (8 floors)
- Permissible FAR = 2.50

  Achieved FAR = 1.26

  (Remaining FAR will be used in future expansion)

OFFICE UNIT

Spaces	Proposed Area(sqm)
Reception	15
Waiting Area	50
Entrance Lobby	250
Workstations	4.0 - 4.5 sqm per person
Cubicles	35 @ 10 sqm
Conference Rooms	40 - 50
Meeting Rooms	5-6 @ 30 sqm (10pax)
Presentation Areas	2 @ 60 sqm

Spaces	Proposed Area(sqm)
Washrooms	150 – 180
Utility rooms	10
Mech. Room (AHU)	4 @ 35 sqm
Intermediate Distribution Frame (IDF)	2 @ 15-20 sqm
Labs (Control Room)	2 @ 35 sqm
Electrical Room	2 @ 35 sqm

INSTITUTION FACILITIES

Spaces	Proposed Area(sqm)
Training Centre	300 - 350
Indoor Games	500
Gym	300
Visitor's Suites (9)	350
Mini Bank	150 sqm
Travel Services	45 - 50
Medical Services	150 - 200
Shops	150 - 200
Food Court (Cafeteria)	1000 - 1200
Auditorium	1200 – 1500 (800-850 pax)

SERVICES

Spaces	Proposed Area(sqm)
Generator Room (DG room)	250
Control Room of DG	100
Pump Room	150
STP	300
WTP	150
Retention Tank	250 - 280
LT Panel Room	100
A.C. Plant Room	500 - 550
Electric Sub-Station	300 - 315
Store	500
Audi Store	400 - 450
Audi A.H.U. Room	150 - 200
Fan Room	250
Battery Rooms	300 - 320
Kitchen Service Area	200
Data Center	250 - 275
Parking	1100 (950 basement + 150 surface)

CHAPTER 5: DESIGN CONCEPT

CONTEMPORARY GARDEN

'Once called the "Garden City of India", this is no longer applicable to Bangalore, which is now a large, cosmopolitan city with diminishing green spaces and a large working population.' This change is evident by the changing climate and environment quality.

LAND SUSTAINABILITY

Bengaluru is one of India's most progressive and developed cities, blessed with a pleasant climate. The past decade has seen a mad surge of development, coupled with traffic congestion and rising pollution levels. The space is being compromised as IT buildings are coming up on very acre of land and the green belt is depleting at a very high rate.

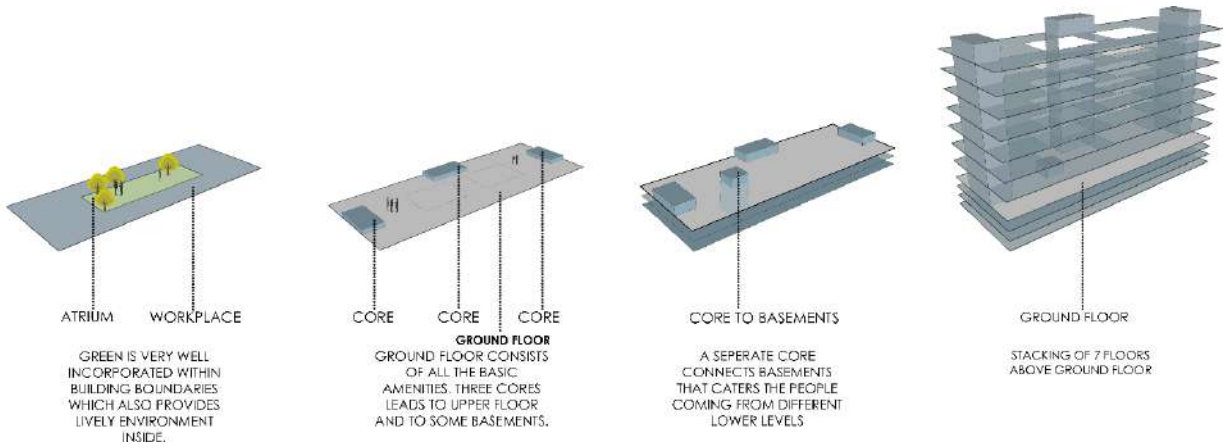
Hence, the cost ability to improve adverse condition has decreased due to shortage of land and the opportunity of taking up the garden vertically rises.

After understanding the depth of green land sustainability, concept of vertical gardens came into existence. It means incorporating green vegetation in buildings vertically to minimise the effect of global warming.

A vertical garden is a garden that grows upward (vertically) using some support system, rather than on the ground. Climbing plants and vines are some options that are used in vertical gardening. Scaffolding, shelving systems, etc came be used to create a surface.

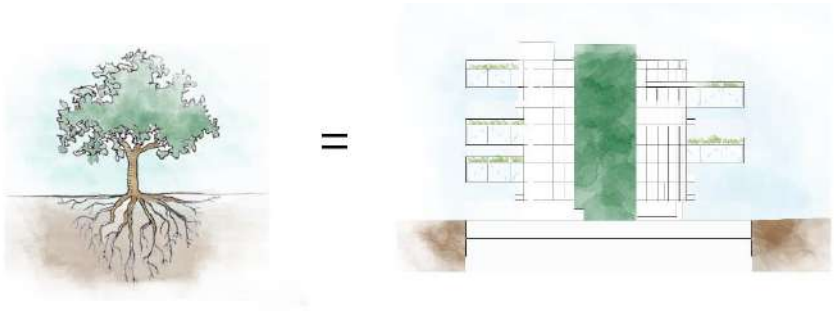
FORM EVOLUTION

VERTICAL STACKING



TREE THEORY TO DESIGN BUILDING

'The building is designed to be like a tree' with strong and heavy roots that has all services incorporated and the 'rest of the levels are projecting out like branches of the tree'



Structure of the building is compared to a tree as; the basement is root where main service functioning takes place, the cantilever act as branches to take in natural sunlight and finally the bio wall acts leaves foliage that are also prevents heat to enter and regulates temperature within the building.

TREES PLANTED FOR FRAGRANCE

1.Magnolia Champaca

2. Kadamba Tree

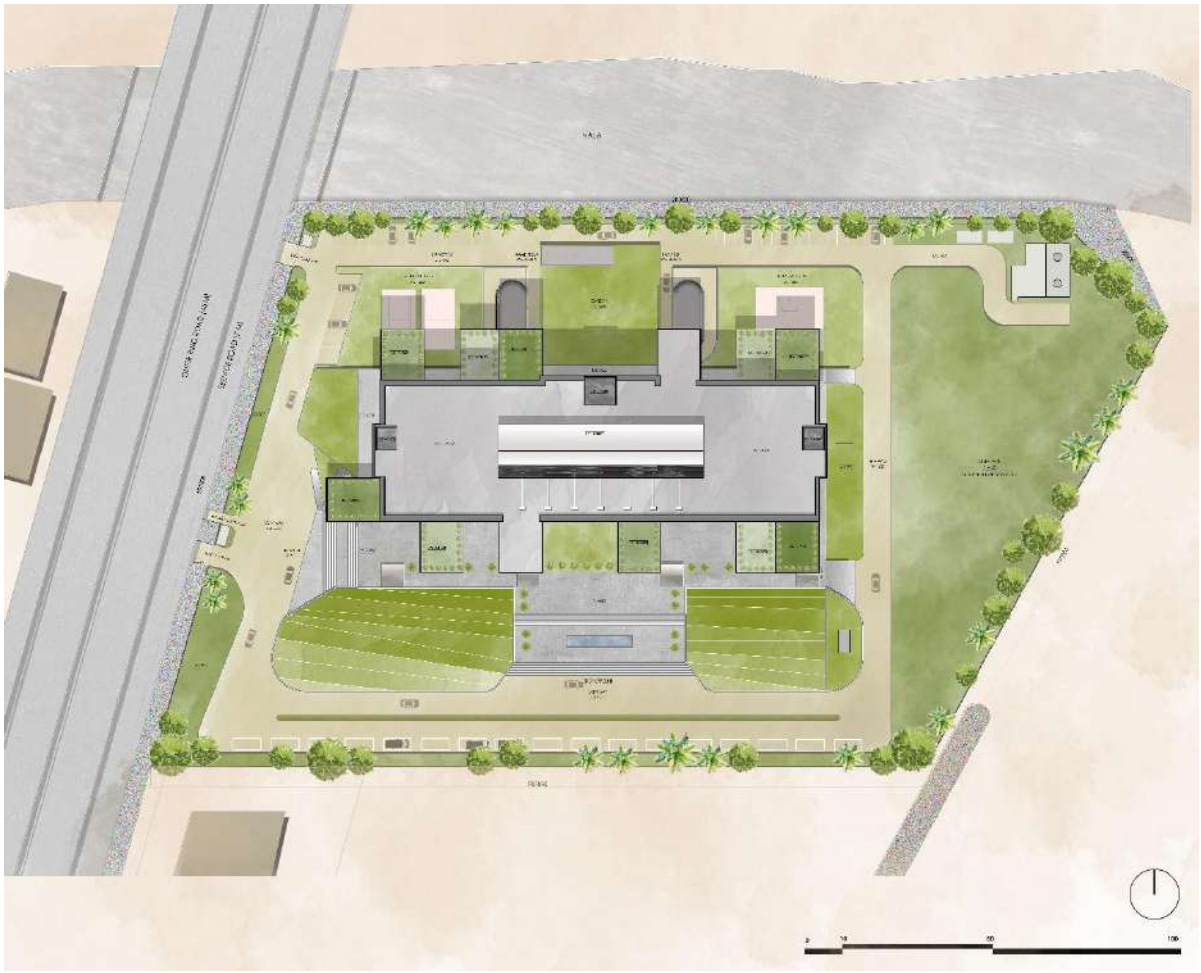
3.Alexandria laurel

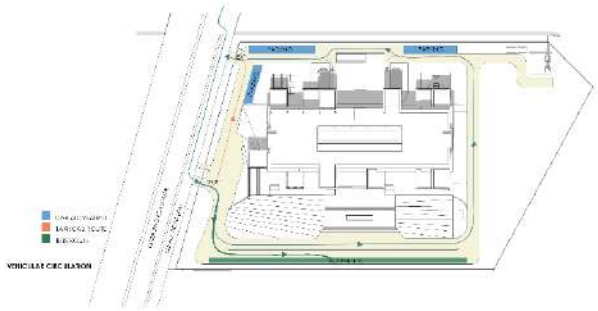
4.Champa tree

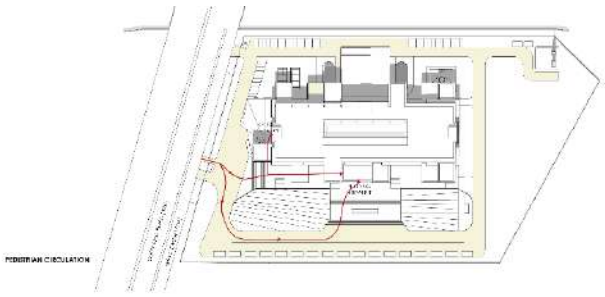
5.Coconut Palm Tree

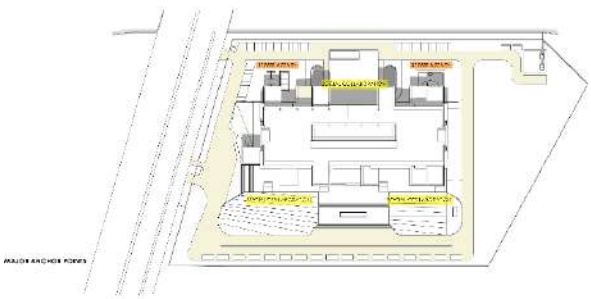
CHAPTER 6: DRAWINGS

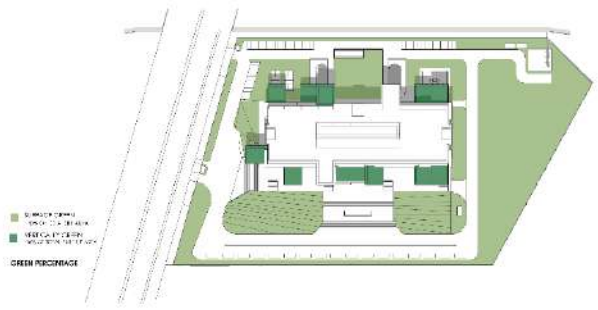
SITE PLAN



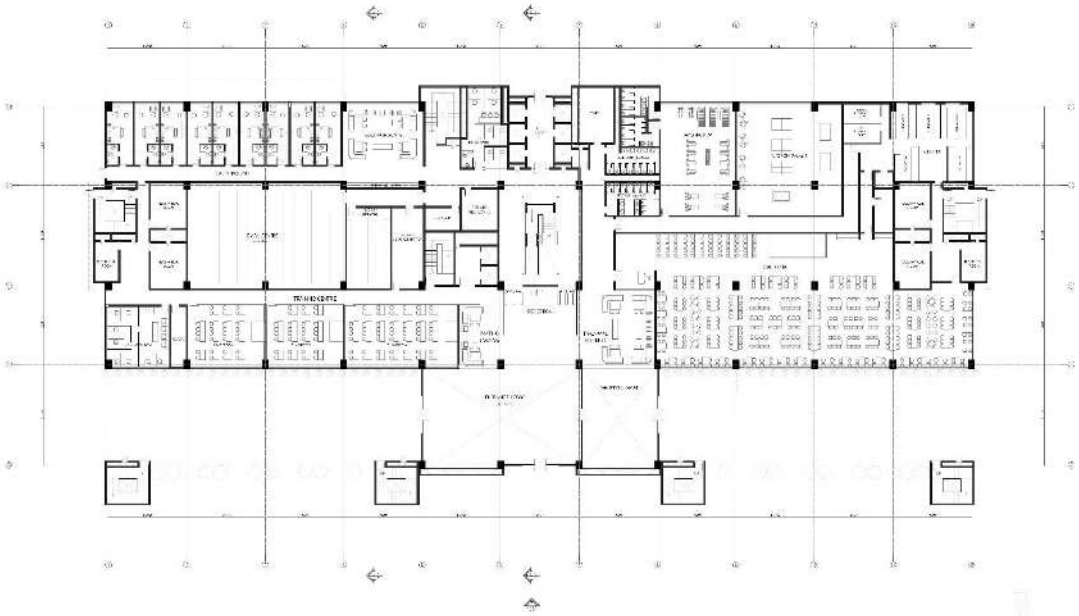




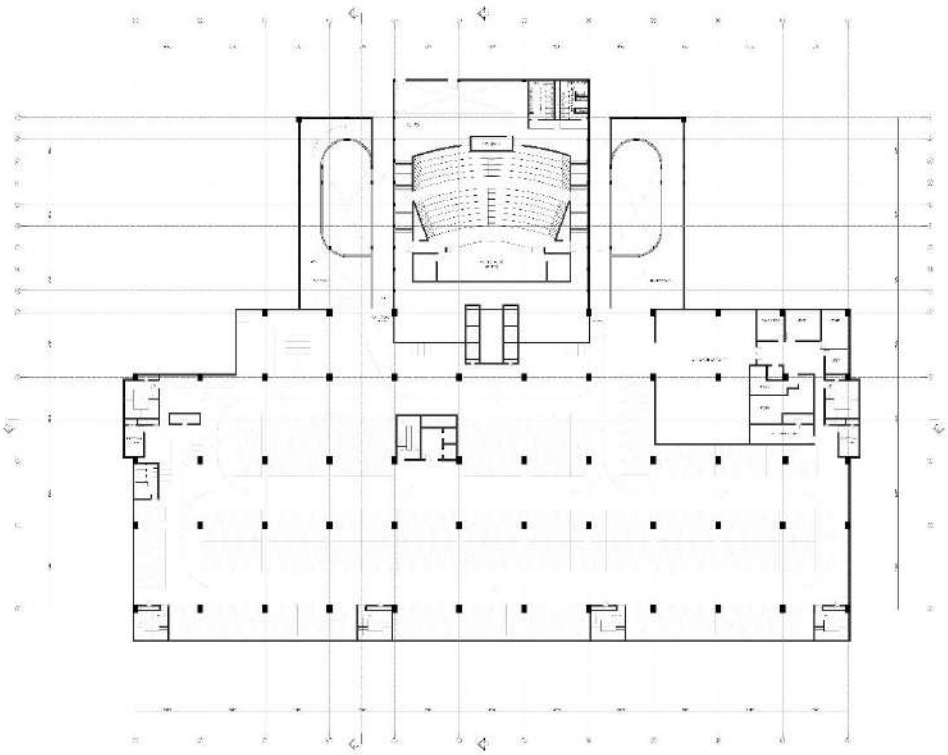




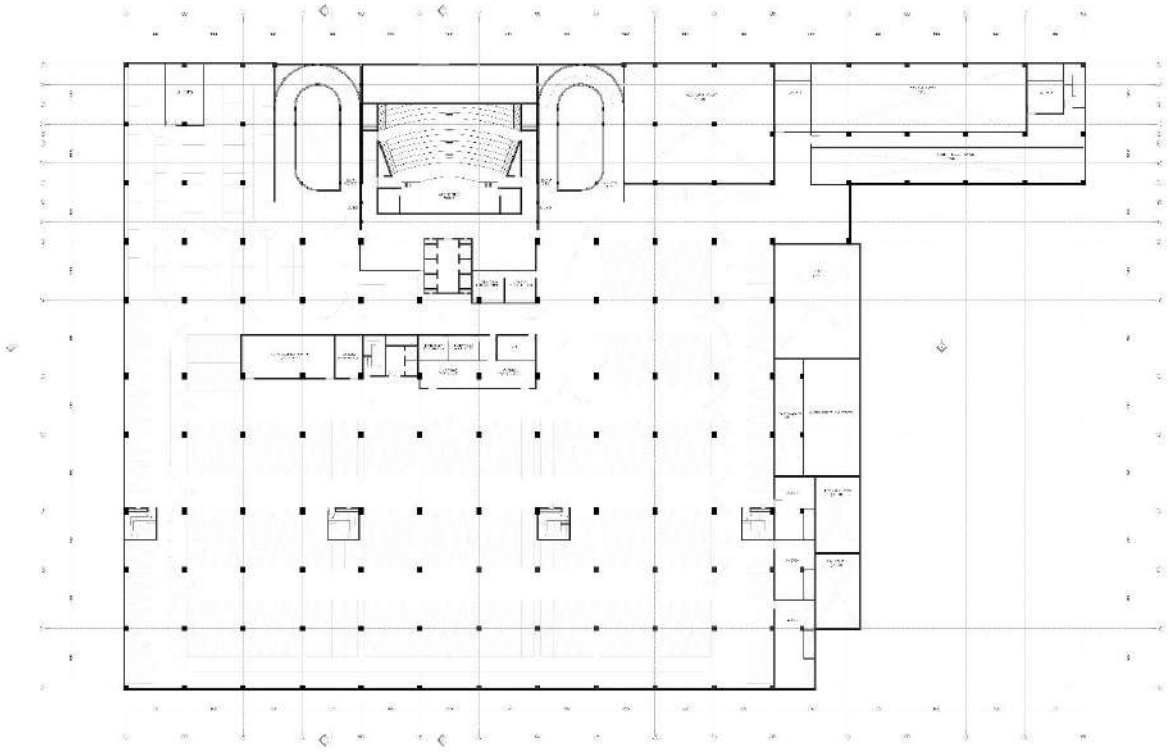
GROUND FLOOR PLAN (1:200)



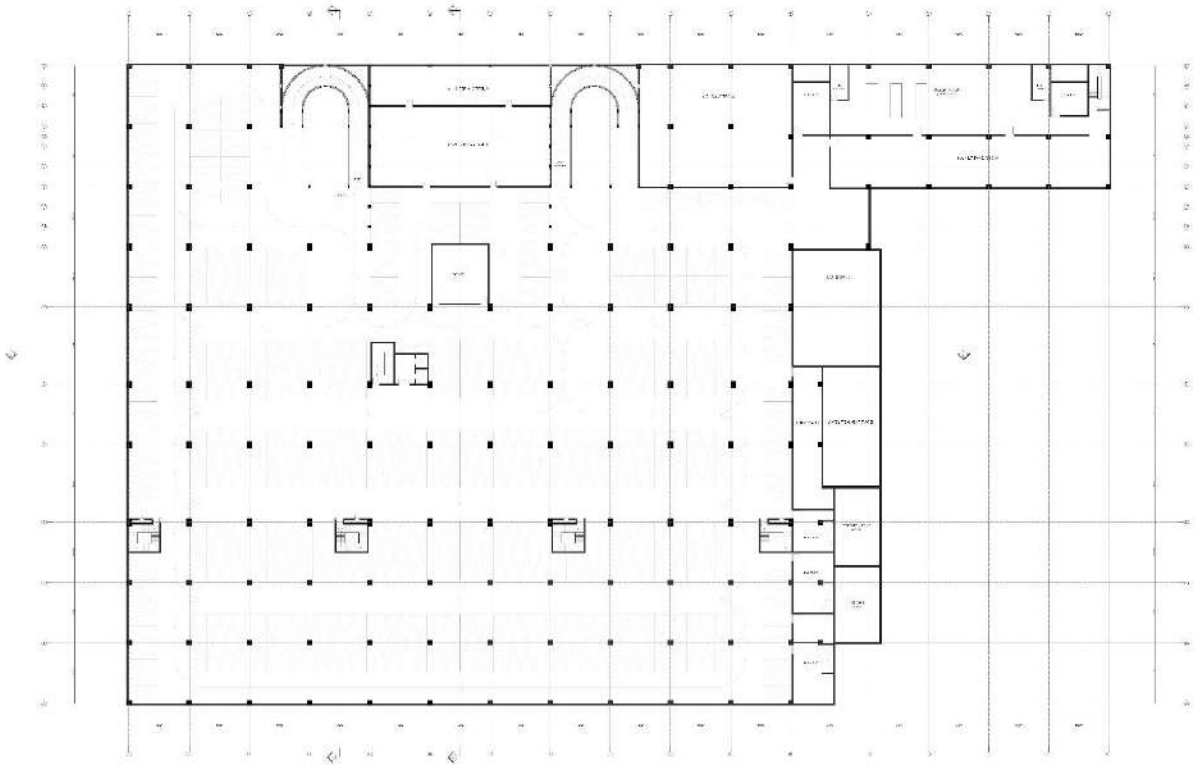
STILT FLOOR PLAN (1:200)



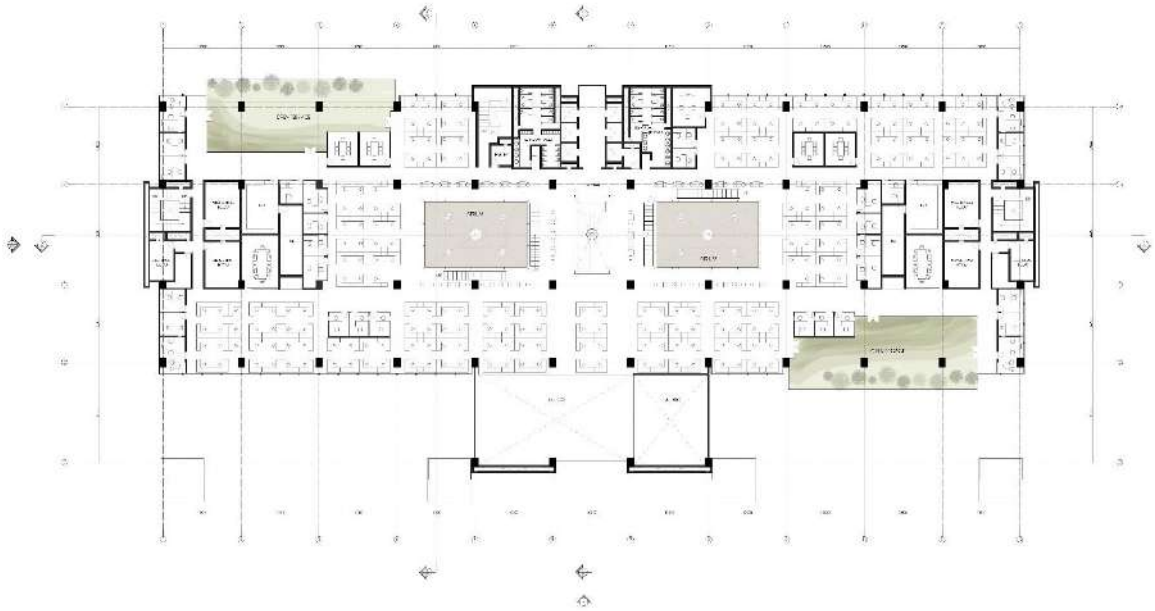
BASEMENT 1 PLAN (1:200)



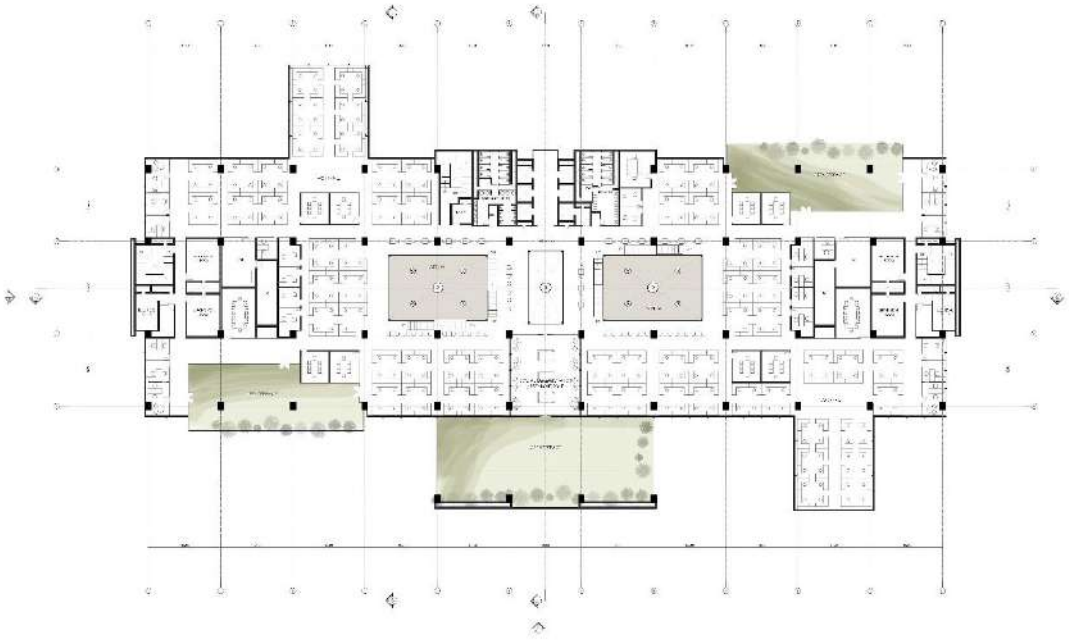
BASEMENT 2 PLAN (1:200)



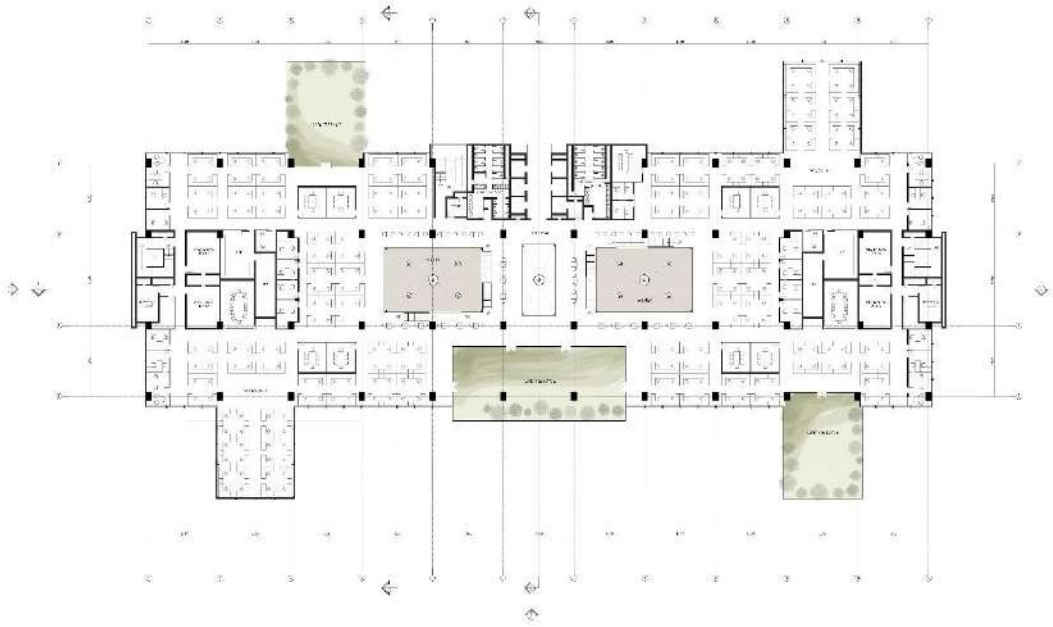
FIRST FLOOR PLAN (1:200)



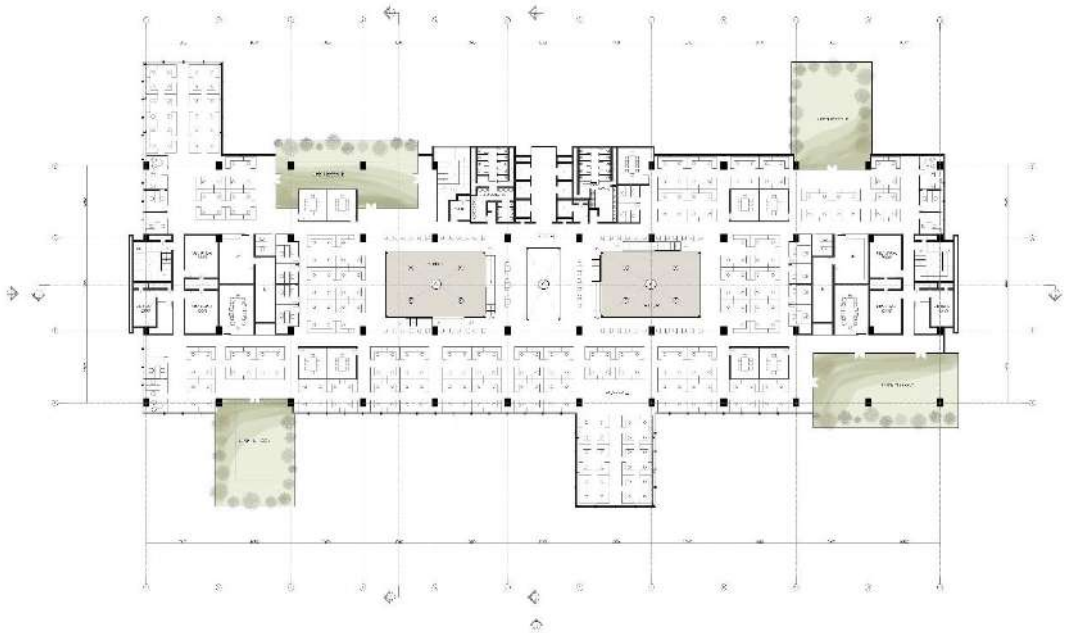
SECOND FLOOR PLAN (1:200)



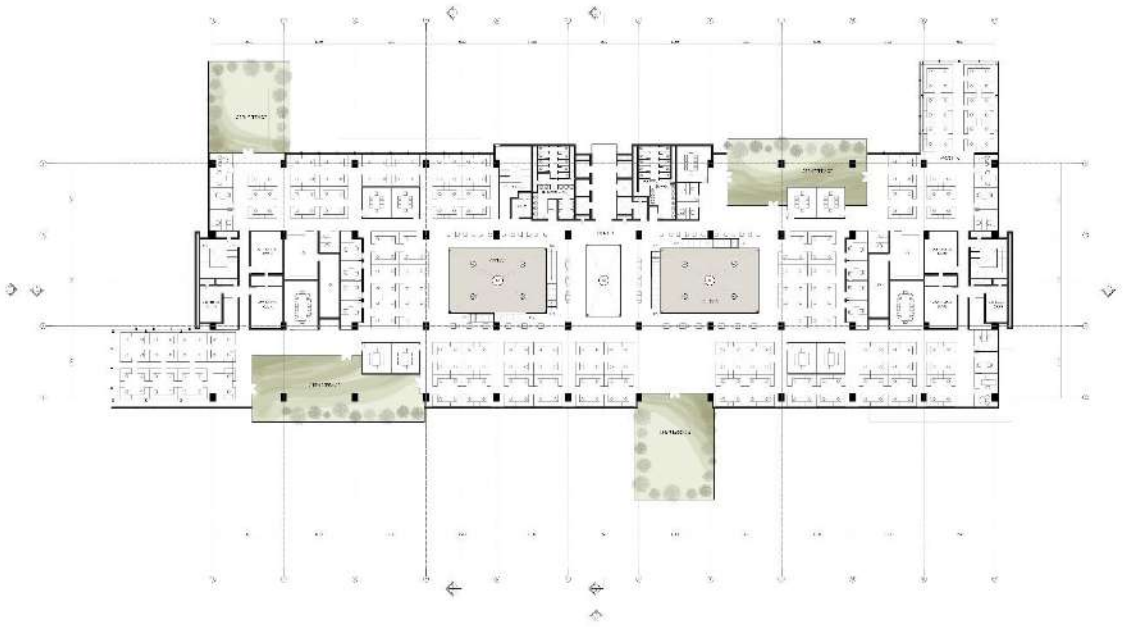
THIRD FLOOR PLAN (1:200)



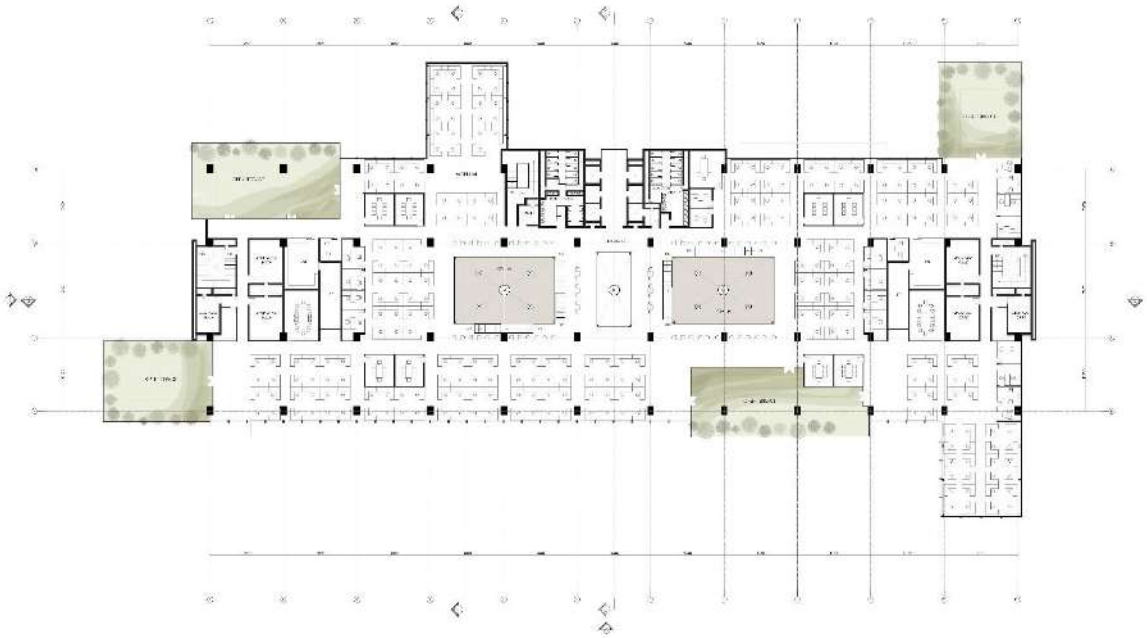
FOURTH FLOOR PLAN (1:200)



FIFTH FLOOR PLAN (1:200)

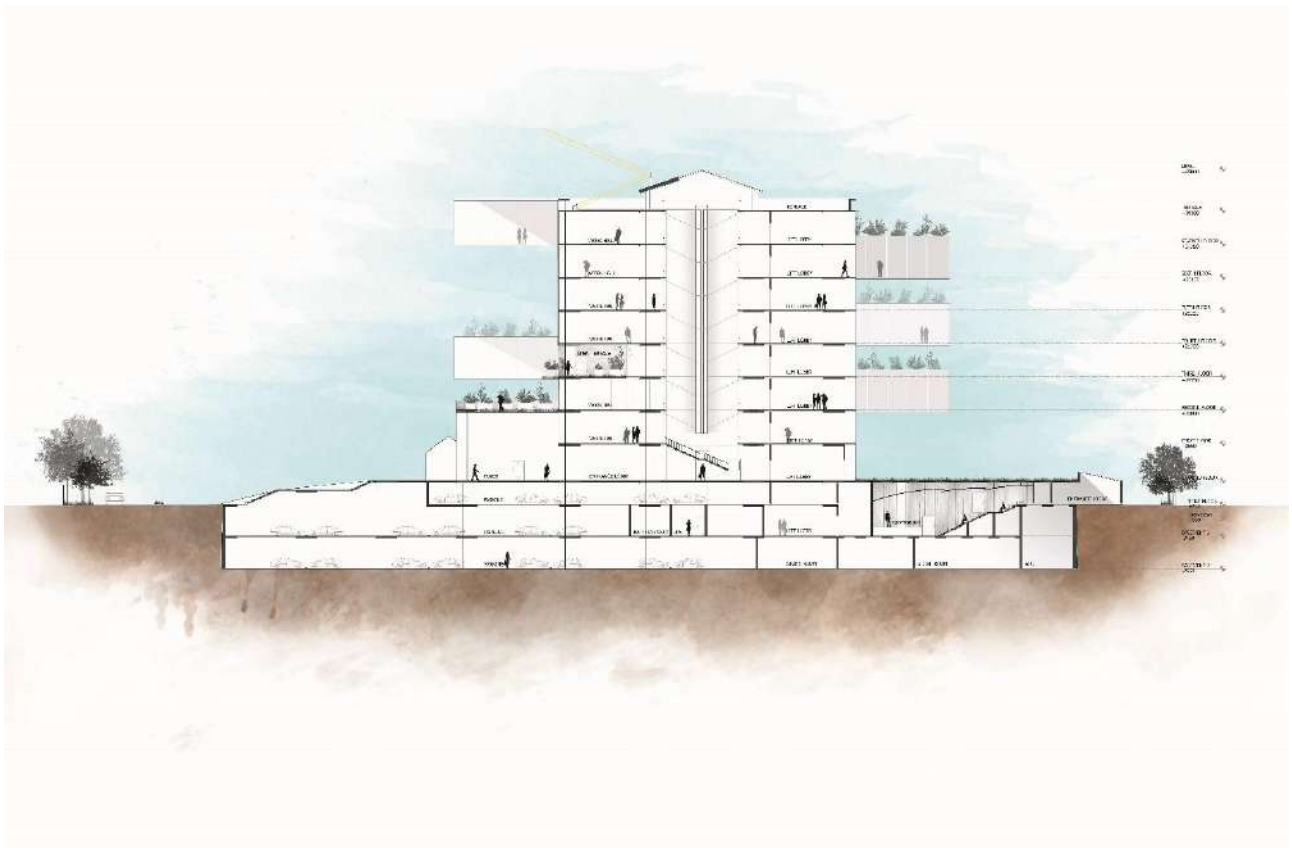


SIXTH FLOOR PLAN (1:200)

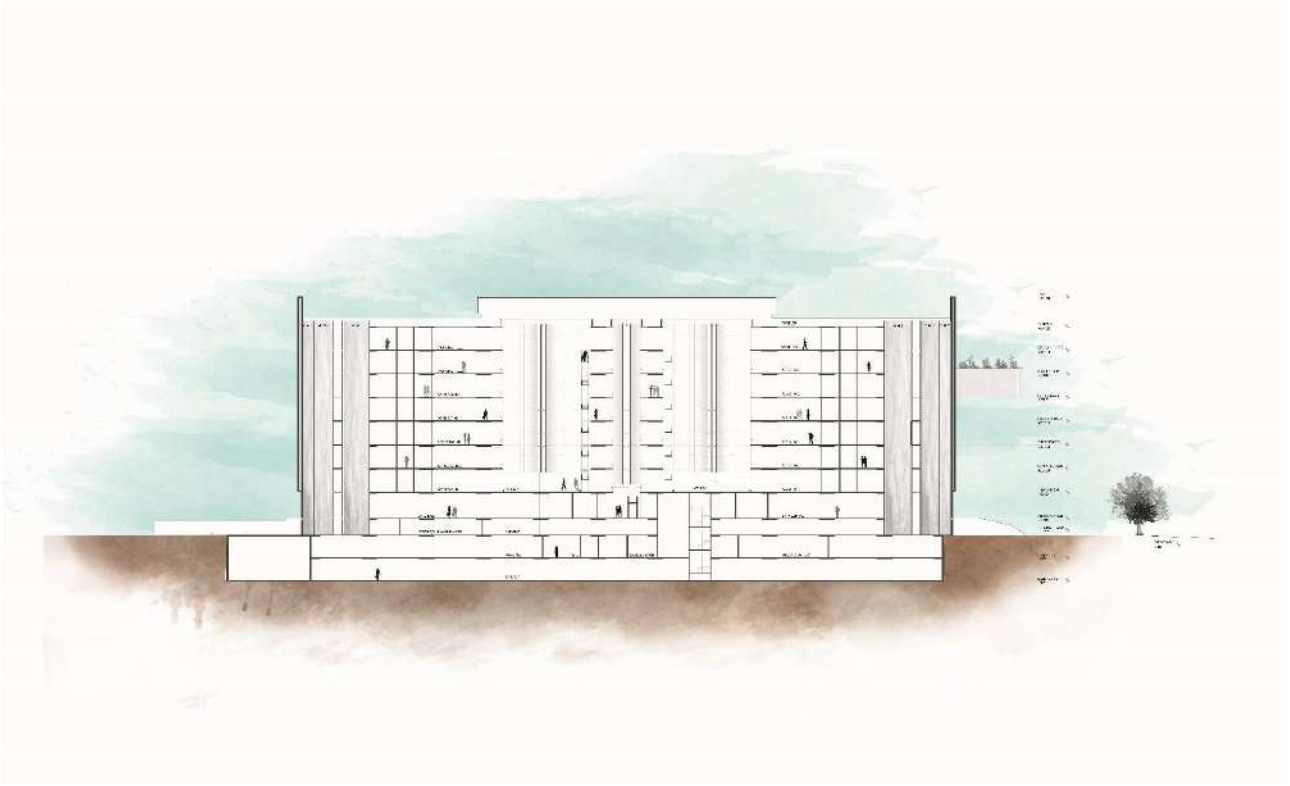


SEVENTH FLOOR PLAN (1:200)

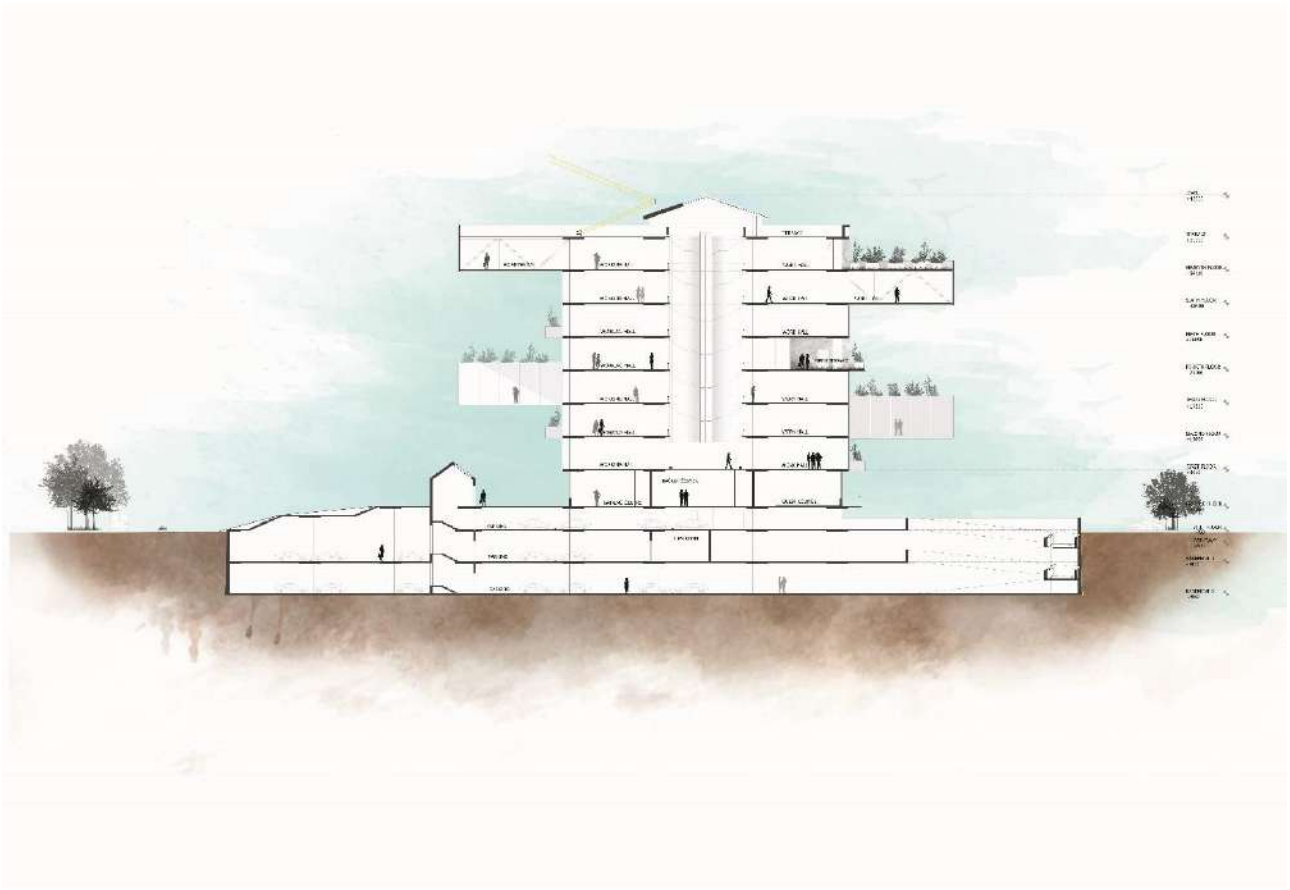
SECTION AA’ (1:200)



SECTION BB’ (1:200)

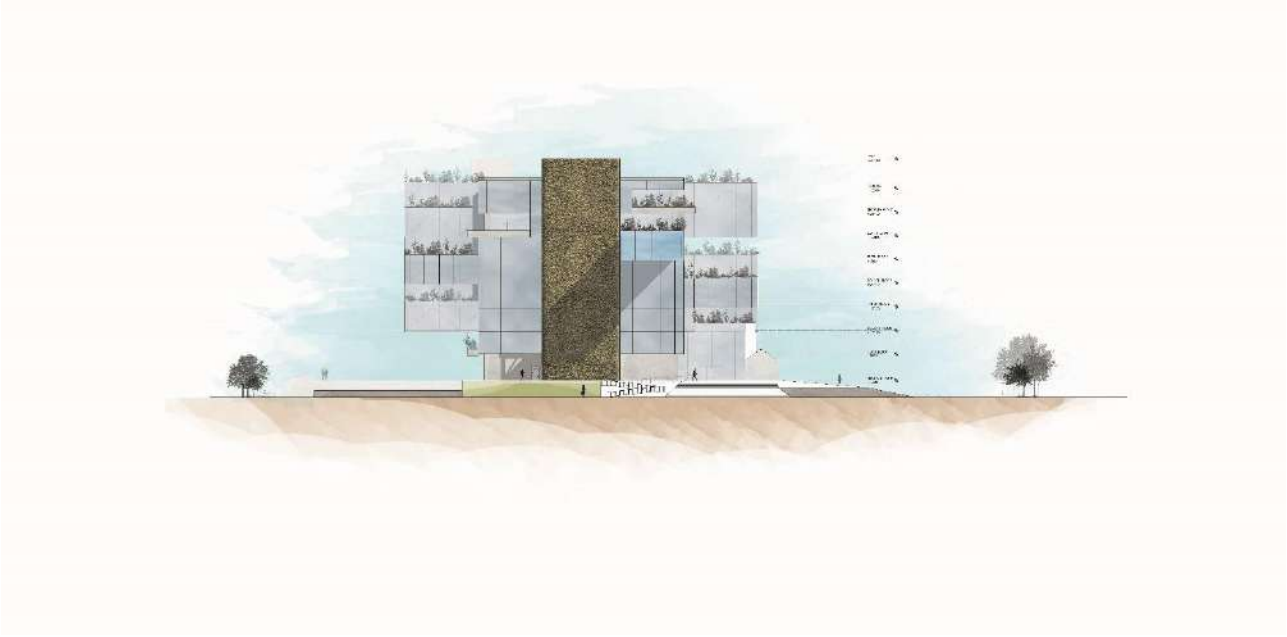


SECTION CC’ (1:200)



NORTH ELEVATION (1:200)

EAST ELEVATION (1:200)



ADVANCE OBJECTIVE

Double plane glass with outer glass is Transparent Luminescent Solar Concentrator (TLSC) and inner glass is Electric Glass.

Switch Glass: Layer of film between two glass.
1. very durable
2. can be used as projector screen
3. can last for 15 - 20 years
4. 98% UV protection
5. 40% solar reduction

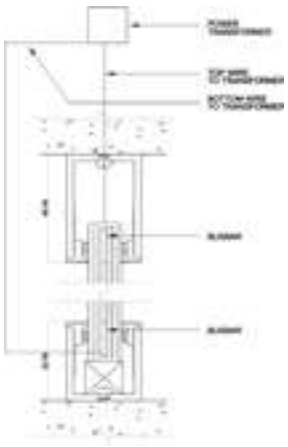
EXHAUST AIR FACADE

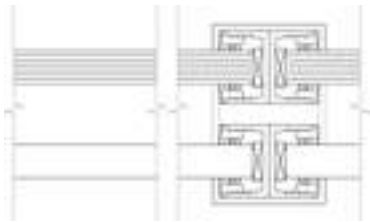
To collect air from tower office, and instead of allowing it to escape into the atmosphere, redirect it back down the double glass skin cavities.
Sensors within cavities will modulate dampers at the top of the building, directing the air to the optimal zones of the cavities depending on the time of day and outdoor temperature.

45 degree Celsius - 30 degree Celsius

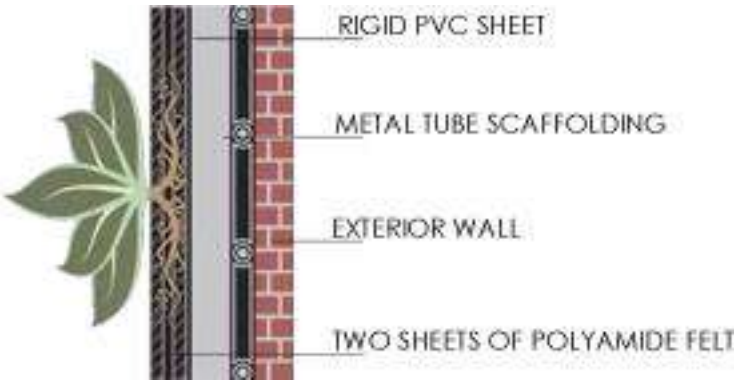
Additional dampers will allow filtered exterior air to enter directly into cavity during economising periods, such as at night and winter when the outdoor air is lower in temperature then the collected exhaust air.

DETAIL 1





DETAIL 2

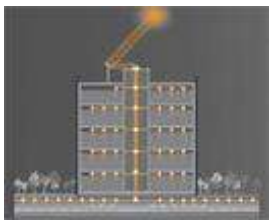


DETAIL 3

Air Purifying Trees

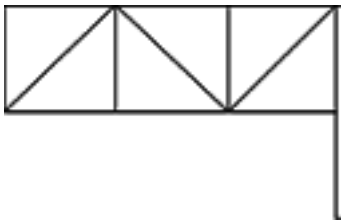
DETAIL 4

Introducing Daylight at any time




this is a day lighting system that collects natural light with a parabolic dish concentrator and delivers it through pipes to any place in the building. The collector re-directs the light into an “ULTRA SUN LIGHT CONCENTRATOR”, which channels it into the aperture of a small light pipe. Because of the latest technology uses “I.R. CUT COATING TECHNOLOGY, there is no heat loss or gain associated with the transmitted day light”, which reduces heating and air-conditioning cost.

TRUSS SYSTEM



There are two ties in the back span of the truss. the top and the bottom slab will be acting as a chord and tie of the truss respectively. these trusses are definitely located on both the sides of the slab.

VIEWS