NET-ZERO MIXED-USE BUILDING IN URBAN DEVELOPMENT

A DISSERTATION

Submitted in Fulfilment
of the Requirement for the degree of

MASTER OF ARCHITECTURE

by

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June, 2025

CERTIFICATE

Certified that **AR. JATIN KHANNA** **(1220109001**) has carried out the research work presented in this thesis entitled **“DESIGN FEATURE FOR NET ZERO ENERGY EFFICIENT BUILDING” A CASE OF A OFFICE BUILDING** for the award of **Master of Architecture** from BABU BANARASI DAS University, Lucknow under our supervision. The thesis embodies results of original work, and studies are carried out by the student himself/herself (print only that is applicable) and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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5. Faculty of the University to which the thesis is submitted:

   Respected AR. Shailesh Kr. Yadav.

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ABSTRACT

The purpose of this study is to evaluate various parameters taken to make an energy efficient office building. This analysis explores the energy consumption of an energy efficient building. For this reason an energy-efficient building has been chosen as the case model. The selected energy-efficient building is located in Gurgaon with a composite atmosphere. The analysis examines the steps taken to make every energy efficient building. The case building was analyzed by comparing different active and passive strategies of an already existing Net Zero Energy office building with better energy performance in composite climate. After analyzing various parameters, the amount of energy consumed by different means was evaluated and the parameters were selected which holds the large share of the total energy consumption of the office building. Building simulation on the existing building case model, based on the parameter, is performed to understand the strategies that should be used in enhancingthe case building's energy efficiency and reducing total energy consumption. Moreover, the data were analyzed and recommendations were made to improve the energy performance and the current building's overall EPI.

ACKNOWLEDGEMENT

I would like to express my gratitude to my Dissertation Guides Assistant Professor **AR. SHAILESH YADAV** I am very thankful fortheir support, motivation, encouragement, and patience. Both professors gave me all the encouragement, knowledge, and support I needed to complete my dissertation. They provided me with the important advice, guidance and directions that was needed for my dissertation to be completed. Secondly, I would like to thank Professor PROF.KESHAV KUMAR and Assistant Professor AR. SATYAM SRIVASTAVA for giving me all the requisite guidance and time to teach and providing me with all required guidance for my dissertation. I would also like to take this opportunity to thank my faculty teachers, who throughout the year have been extremely helpful; their teaching, experience and personal advice have been of greatvalue to me. Last but not least, I would like to extend my gratitude to my family throughout the entire process for their continuous support and encouragement.

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LIST OF ABBREVIATIONS

HVAC-Heating, Ventilation, air- conditioning BEE-Bureau of

Energy Efficiency

NZEB-Net Zero Energy Buildings PV-Photovoltaic

System

USAID- United States Agency for International Development DX-Distributed

System

LPD-Lighting Power Density TLF'-Tubular Fluorescent

Lamps WWR-Wall Window Ratio

CNG-Compressed Natural Gas

IBMS-Integrated Building Management System AAC-Autoclaved

Aerated Concrete

RMC-Ready Mix Concrete

BIPV-Building -Integrated Photovoltaics CFLs-Compact

Fluorescent Light

LEDs-Light Emitting Diode EPI-Energy Performance

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CHAPTER- 1

INTRODUCTION

INTRODUCTION :-

A Net Zero Energy Building (NZEB) is a building that:
produces as much energy on-site through renewable sources as it consumes over the course of a year.

Key Features of a Net Zero Energy Building:

- **Energy Efficiency**
- High-performance insulation
- Energy-efficient lighting (e.g., LEDs)
- Advanced HVAC systems
- Smart building controls

- **Renewable Energy Generation**
- Solar panels (most common)
- Wind turbines (sometimes)
- Biomass or geothermal systems

- **Passive Design Strategies**
- Use of natural light (daylighting)
- Proper building orientation (to reduce heating/cooling loads)
- Ventilation for fresh air and cooling

- **Water and Waste Efficiency**
- Rainwater harvesting
- Grey water reuse

Composting systems or eco-sanitation

EXAMPLES :-

- Indira Paryavaran Bhavan, New Delhi – India's first major NZEB (government building).
- Bullitt Center, Seattle – One of the greenest commercial buildings in the world.

CHARECTERISTICS OF A NET ZERO ENERGY BUILDING :-

1. Ultra-Low Energy Consumption

- Uses efficient lighting, appliances, and building systems to reduce energy demand.
- Energy use is minimized through high-performance insulation, windows, and building envelope design.

2. Renewable Energy Generation

- Generates energy on-site using systems like:
- Solar photovoltaic (PV) panels
- Solar thermal systems
- Wind turbines
- Geothermal systems

3. Energy Balance

- The total annual energy consumption is equal to or less than the energy produced on-site.
- Achieves net zero energy on a yearly basis—not necessarily daily or monthly.

4. Smart Energy Management

- Incorporates automation systems, smart meters, and energy monitoring to optimize usage.
- Real-time control of heating, cooling, lighting, etc., to reduce waste.

5. Passive Design Strategies

- Orientation, shading, natural lighting, and ventilation are used to lower the need for artificial heating/cooling.
- Buildings often use green roofs or thermal mass materials for energy efficiency.

6. High-Performance Building Envelope

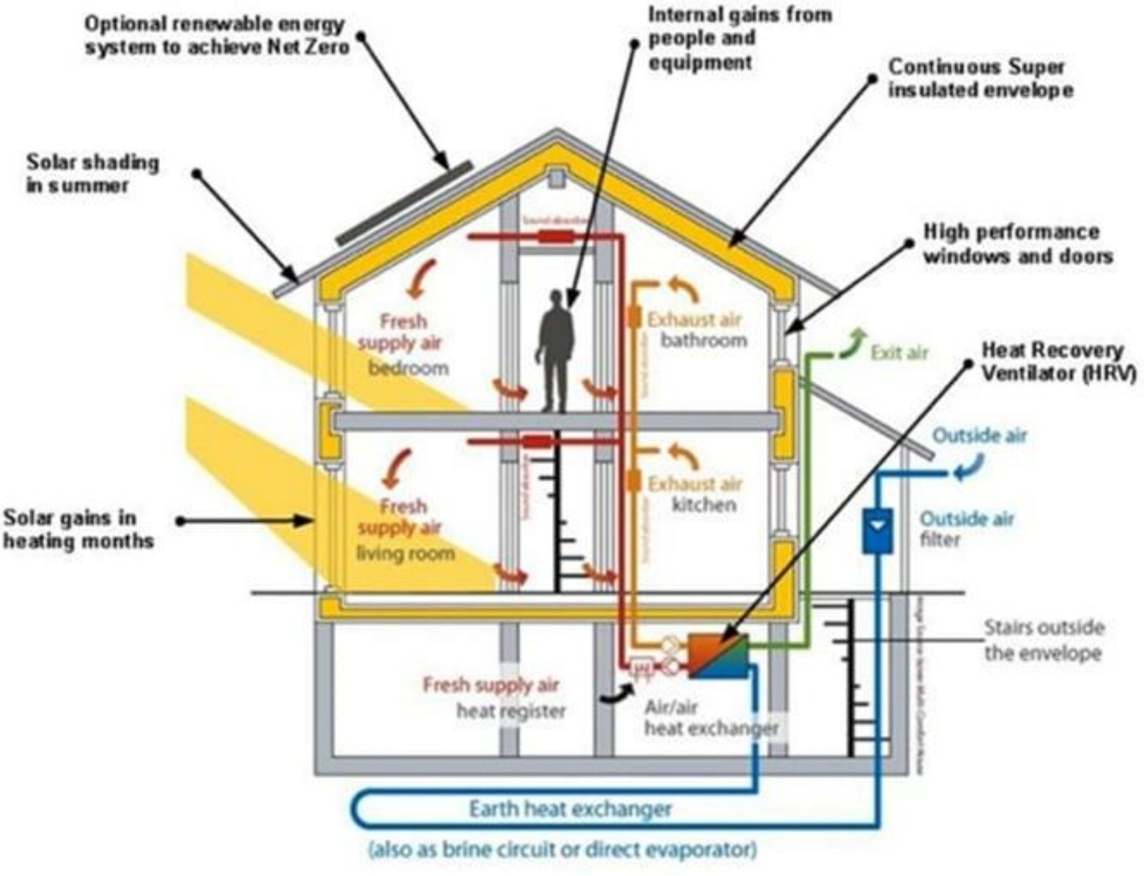
- Walls, roofs, and windows are designed for minimal heat gain or loss.
- Often includes airtight construction to avoid energy leaks.

7. Water and Waste Efficiency

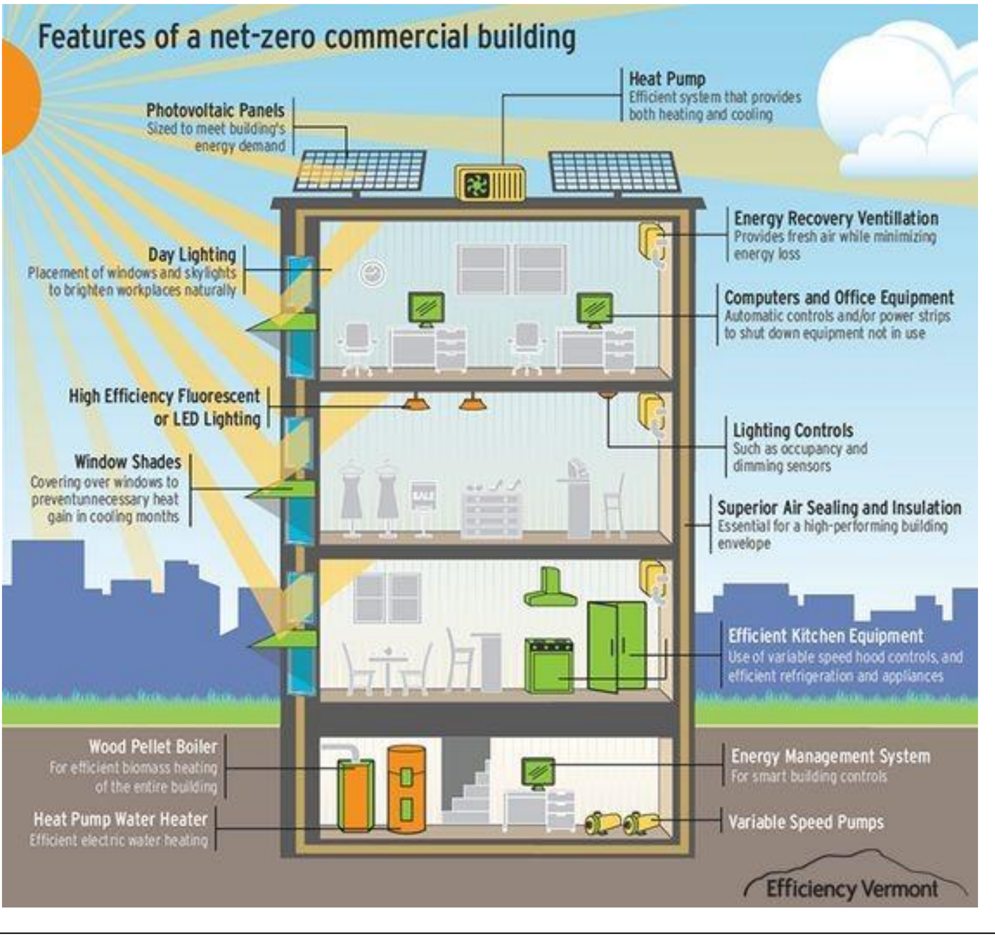
- May include rainwater harvesting, low-flow fixtures, and greywater reuse.
- Supports an overall sustainable and eco-friendly lifestyle.

8. Environmental Impact Reduction

- Designed to significantly reduce carbon emissions and dependence on fossil fuels.
- Often certified under green building rating systems (e.g., LEED, GRIHA).



Optional renewable energy system to achieve Net Zero
Internal gains from people and equipment
Continuous Super insulated envelope
Solar shading in summer
High performance windows and doors
Fresh supply air bedroom
Exhaust air bathroom
Exit air
Heat Recovery Ventilator (HRV)
Outside air
Fresh supply air living room
Exhaust air kitchen
Solar gains in heating months
Outside air filter
Stairs outside the envelope
Fresh supply air heat register
Air/air heat exchanger
Earth heat exchanger
(also as brine circuit or direct evaporator)



Features of a net-zero commercial building
Heat Pump
Efficient system that provides both heating and cooling
Photovoltaic Panels
Sized to meet building's energy demand
Energy Recovery Ventillation
Provides fresh air while minimizing energy loss
Day Lighting
Placement of windows and skylights to brighten workplaces naturally
Computers and Office Equipment
Automatic controls and/or power strips to shut down equipment not in use
High Efficiency Fluorescent or LED Lighting
Lighting Controls
Such as occupancy and dimming sensors
Window Shades
Covering over windows to preventunnecessary heat gain in cooling months
Superior Air Sealing and Insulation
Essential for a high-performing building envelope
Efficient Kitchen Equipment
Use of variable speed hood controls, and efficient refrigeration and appliances
Wood Pellet Boiler
For efficient biomass heating of the entire building
Energy Management System
For smart building controls
Heat Pump Water Heater
Efficient electric water heating
Variable Speed Pumps
Efficiency Vermont

CHAPTER- 2

LITERATURE STUDY

Definition

Energy-efficient buildings are buildings that essentially have energy consumption reduction measures compared to conventional buildings of similar size and occupancy.

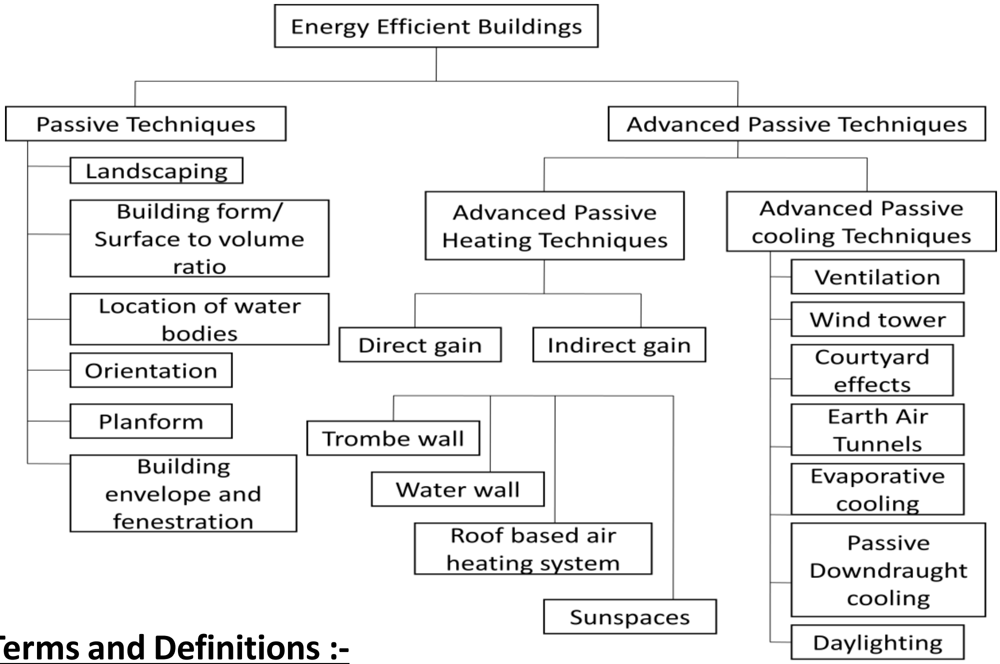
This efficiency is achieved by:

Design elements (Landscaping, building form, orientation, building envelope and fenestration, materials and construction techniques etc.).

Specific strategies for passive, active and renewable energy.

Parameters of Euergy Efficient Buildings.

Passive systems provide thermal and visual comfort by using natural energy sources and sinks, such as solar radiation, oundoor air, sky, moist surfaces, vegetation, and internal gains. This reduces the load on conventional systems (heating, cooling.ventilation, and lighting). Passive solar systems change based on climate.. Creale HVAC (heating, ventilation, and air conditioning) and lighting systems that useless energy. When passive solar architecture prineiples are incorporated into a design,the need for traditional syslems (HVAC and lighting) decreases.. Use renewable energy technologies to meet some of the building load, such as solarwaller healing or photovoltaic syslems.. Use energy-efficient building malerials and construction techniques while reducingenergy demand for transportation. - Strive for efficient construction and use lesscnergy-intensive building materials (such as glass, steel, and aluminium) and morelow-energy ones.. An energy efficient building provides an optimal mix of passive solar techniques,energy efficient lechnology, and renewable energy sources to balance all aspects ofenergy use in a building, including lighting, air conditioning, and ventilation. Anenergy efficient building design (TERI) also relies heavily on the use of low energy materials.



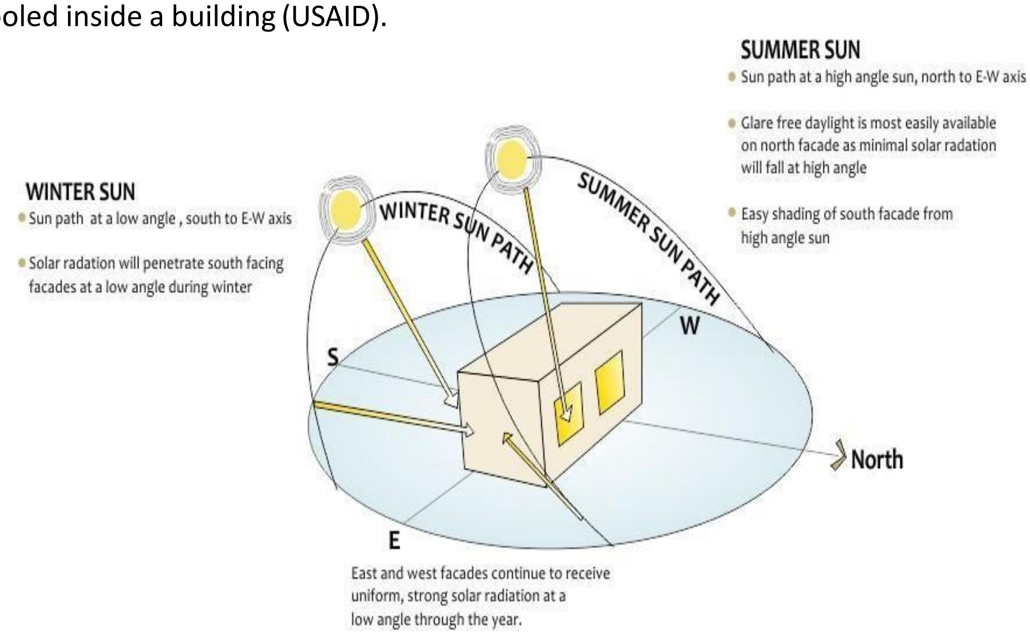
Terms and Definitions :-

➢ **Passive Design Strategies**

- Considering the building's geographical and meteorological conditions, passive approaches to reduce the building energy demand are implemented during construction layout. Factors that are considered in passive design strategies are (USAID):

➢ **Form and Orientation**

- Form and orientation are two of the most important passive development techniques to reduce energy consumption and improve the thermal comfort of a building's occupants. The design of the building varies depending on its location and environment (USAID).
- The form of the building determines the volume of space that needs to be heated or cooled inside a building (USAID).



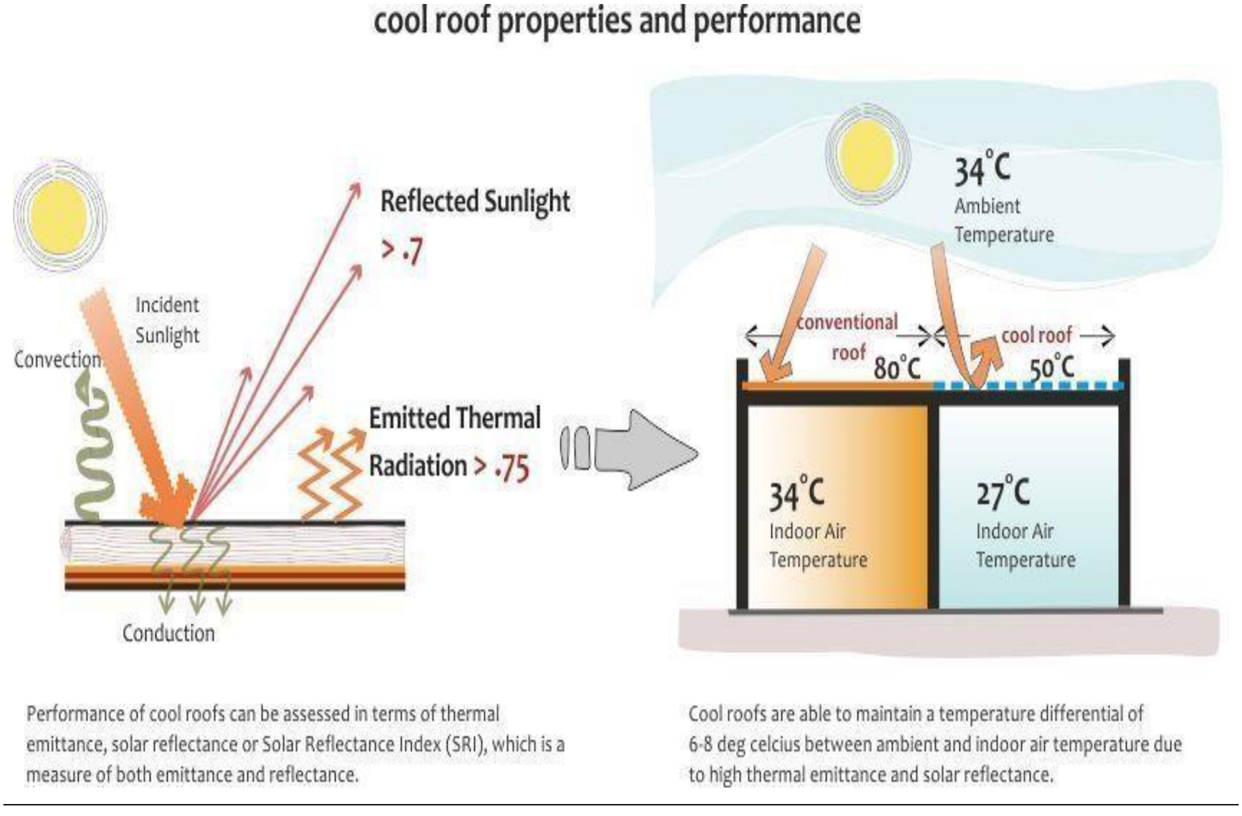
➢ **Shading :-**

Extemal shading systems, for example, are important structural measures that eitherprevent or greatly minimise the need for mechanical heating and cooling to providethermall comfort in buildiings by limiting heat absorption through openings.Consequently, external and internal shading systems can be used as a necessary optionto achieve energy efficieney. Opening proposals (USAID, Nel-zero buildings).

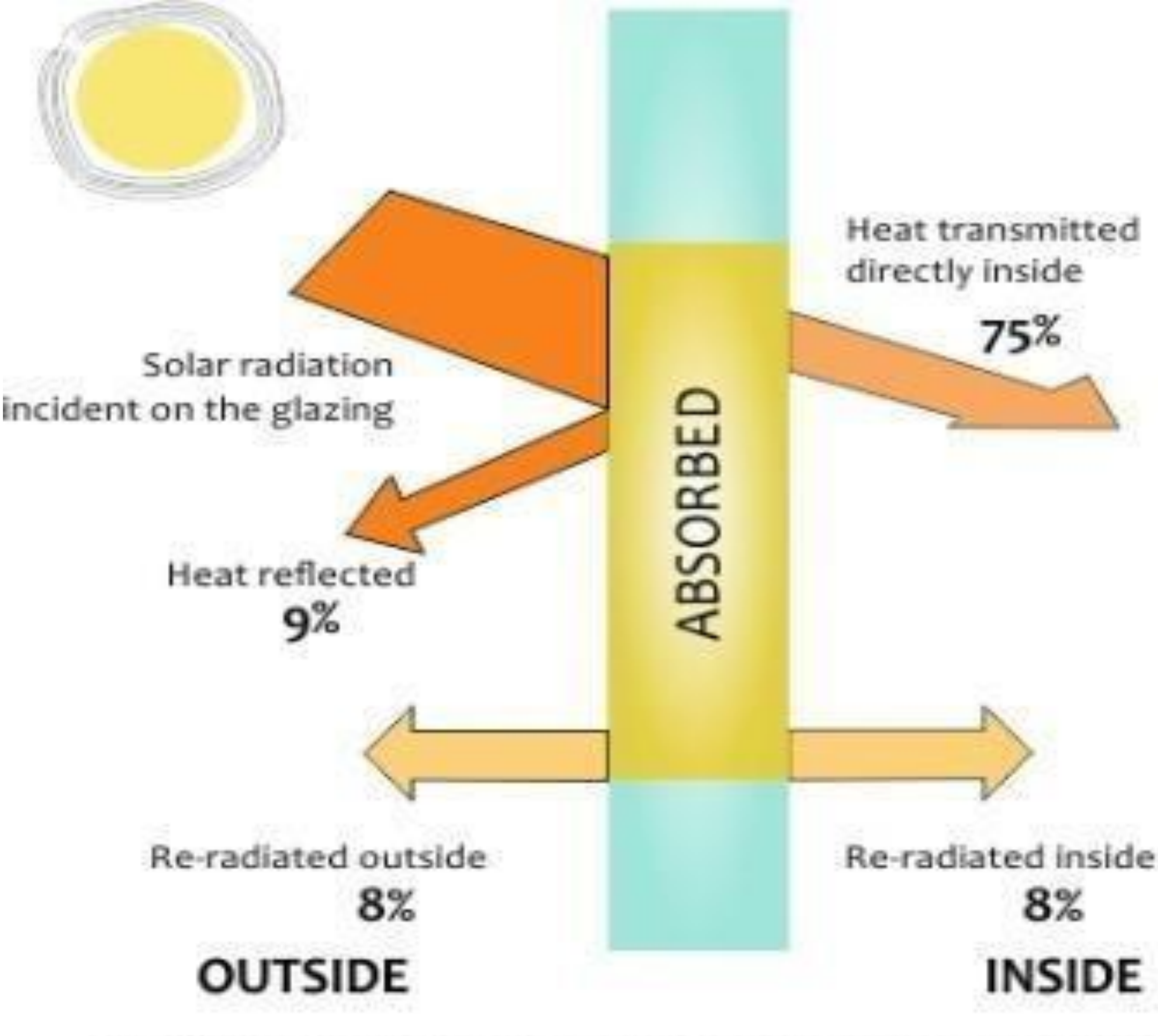
• Consequently, shading of south-facing openings must allow sunlight to pass through forheat gain in winter, but block it in summer. According to the USAID Net-Zero

Energybuildings, shading is only appropriate for north-facing openings to block high solar gainin summer.

➢ **Cool roofs.** Just as light-collored clothing can help keep a person cool on a sunny day, cool roofs usesolar-reflective surfaces to keep temperatures down on the roof. Highly reflective andlight colored roofs are now an integral part of a building's energy efficiencymeasure(USAID, Net Zero Energy Buildings).. Traditional dark roofs reach temperatures of 660C (150oF) or higher in the summer san,while a cool roof could remain more than 280C (50" F) cooler under the same conditions(USAID, Net Zero Energy Buildings).



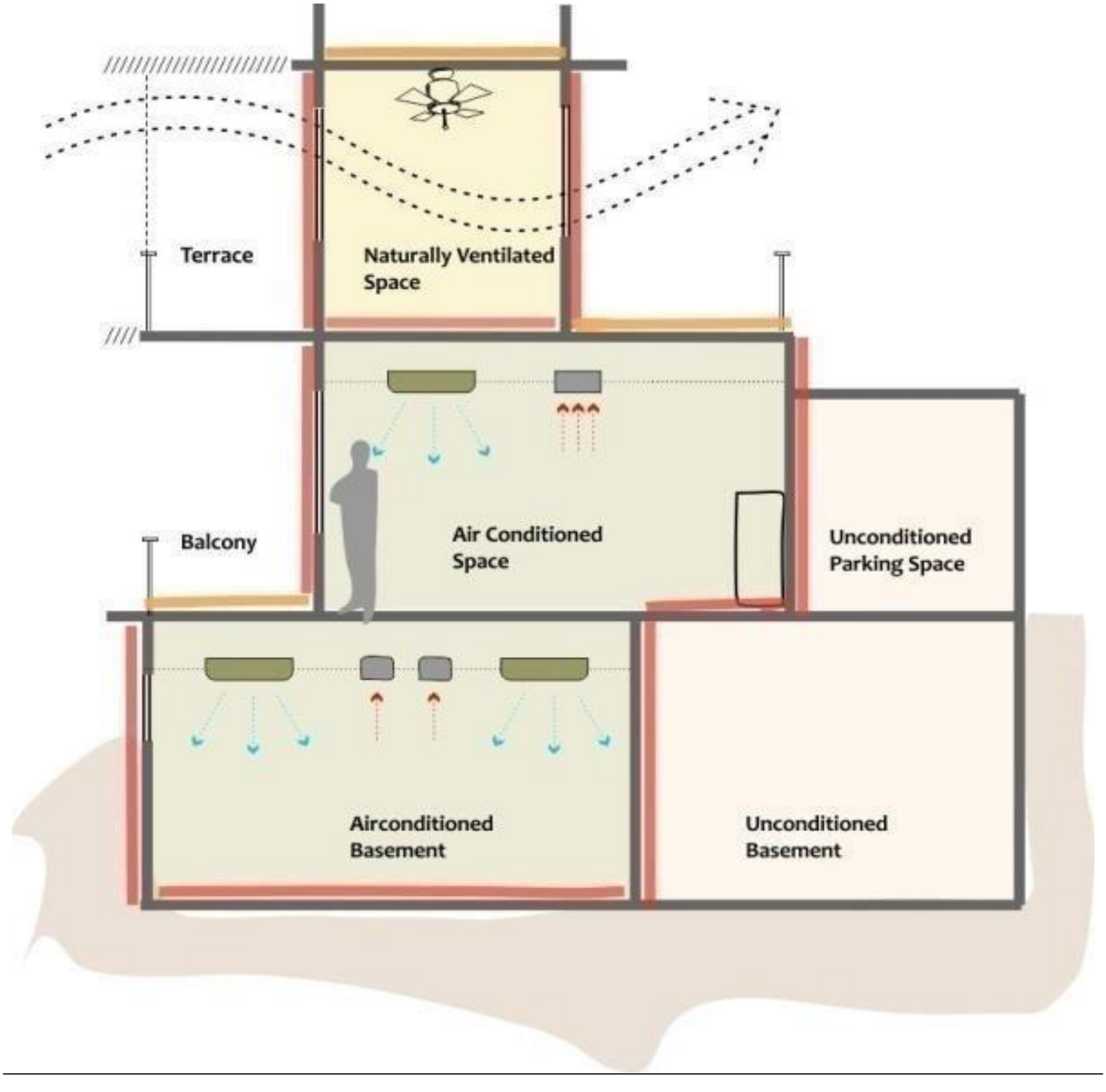
- When required, fenestrations (windows, skylights, and other openings in a building, etc.) allow sunshine and the prevailing wind within the building.
- Fenestrations often influence the capacity for daylight harvesting by minimizing lighting charges without compromising the visual and thermal comfort of occupants of buildings.
- Windows position, width and glazing can be used wisely to reduce the cooling load and, as a result, smaller cooling systems for buildings.
- In terms of both quantity and duration, solar radiation intensity is minimal on openings or walls facing north, followed by façades facing south. The openings (or walls) facing east and west receive a large amount of solar radiation all year round (USAID, Net zero energy buildings).



Heat transmission in a single glazing clear glass

➢ Insulation :-

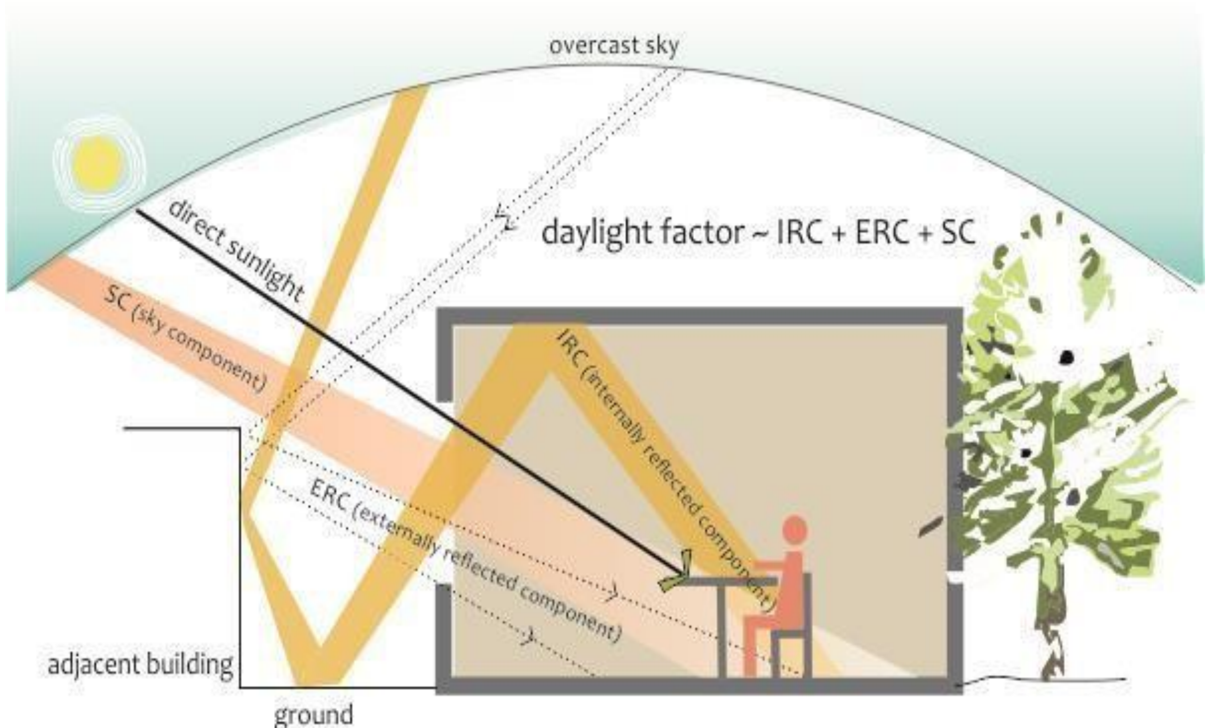
- In walls and roofs, thermal insulation reduces heat transfer from inside to outside and helps to maintain comfortable indoor temperatures. This creates a healthier environment, improves noise safety, and reduces electricity bills most significantly. Insulation helps keep indoor space cooler in summer months and warm during winters.
- Various materials can be selected including fiber glass, mineral wool, rock wool, expanded or extruded polystyrene, cellulose, urethane or phenolic foam boards and cotton.
- Higher R-values mean better insulation and turn into more energy savings, much needed to meet the development goals of the energy efficient buildings (USAID, Net zero energy building).



- **Daylighting :-**

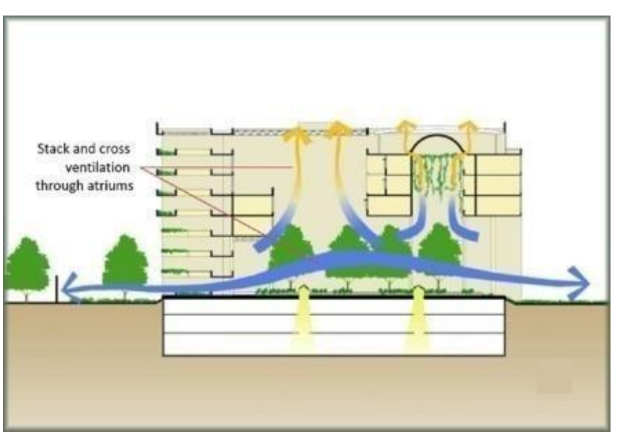
Daylighting is a technique for building design to use daylight. The presence of natural light in an occupied space provides a sense of well-being, raises awareness of one's surroundings and also increases energy saving potential with reduced reliance on artificial light.

- Appropriate use of windows, skylights, clerestories, and other building apertures provides means for daylight harvesting(USAID, Net zero energy buildings).



➢ **Natural Ventilation**

- Fresh air in a building provides health benefits to its residents and increased levels of comfort. The supply of fresh air is considered an effective and safer solution because it eliminates the need for mechanical ventilation of a house.



Thermal Mass:-

- Thermal mass helps to retain heat and moderate variations in the indoor temperature within the building structure. The building material heat storage capacity helps by providing time delay in achieving thermal comfort for occupants.
- Building material mass and density influence the ability for heat storage in buildings. High density materials like concrete, bricks and stone have highthermal mass, whereas materials like wood or plastics have low thermal mass.The effectiveness of direct sun irradiation depends on the placements of these components(USAID, net zero energy buildings).

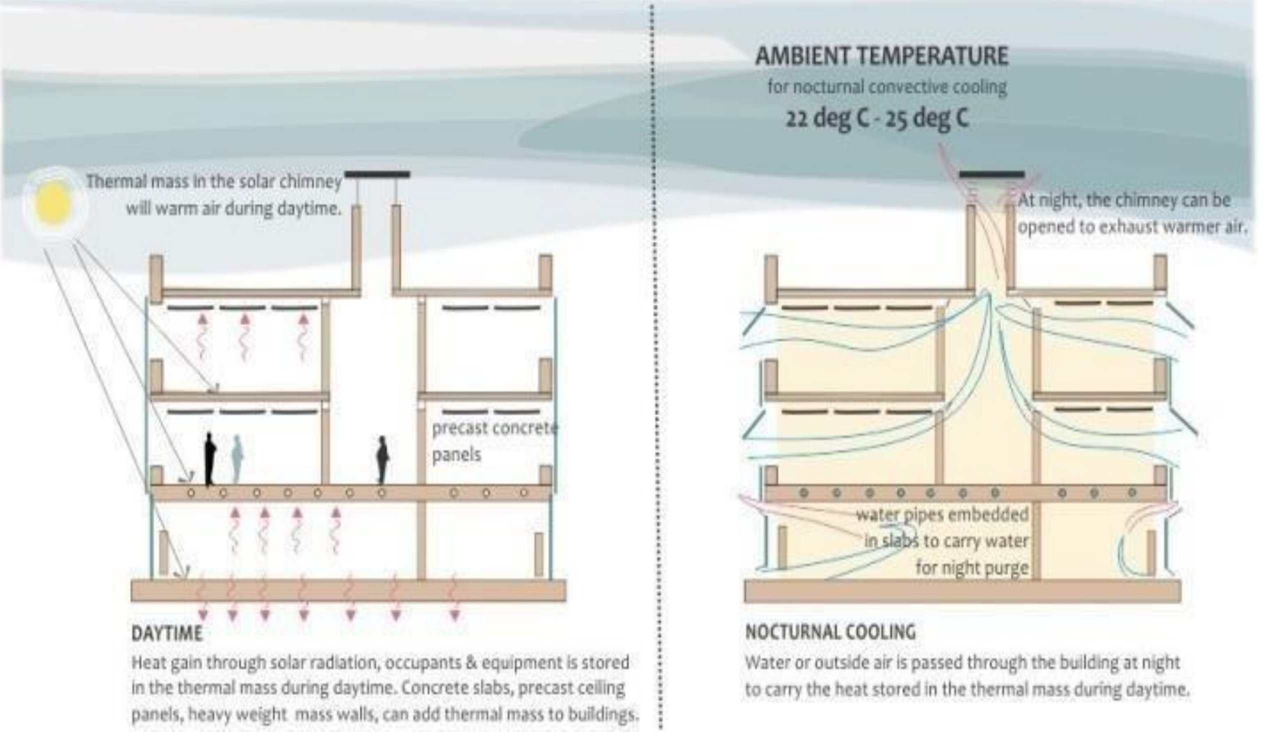


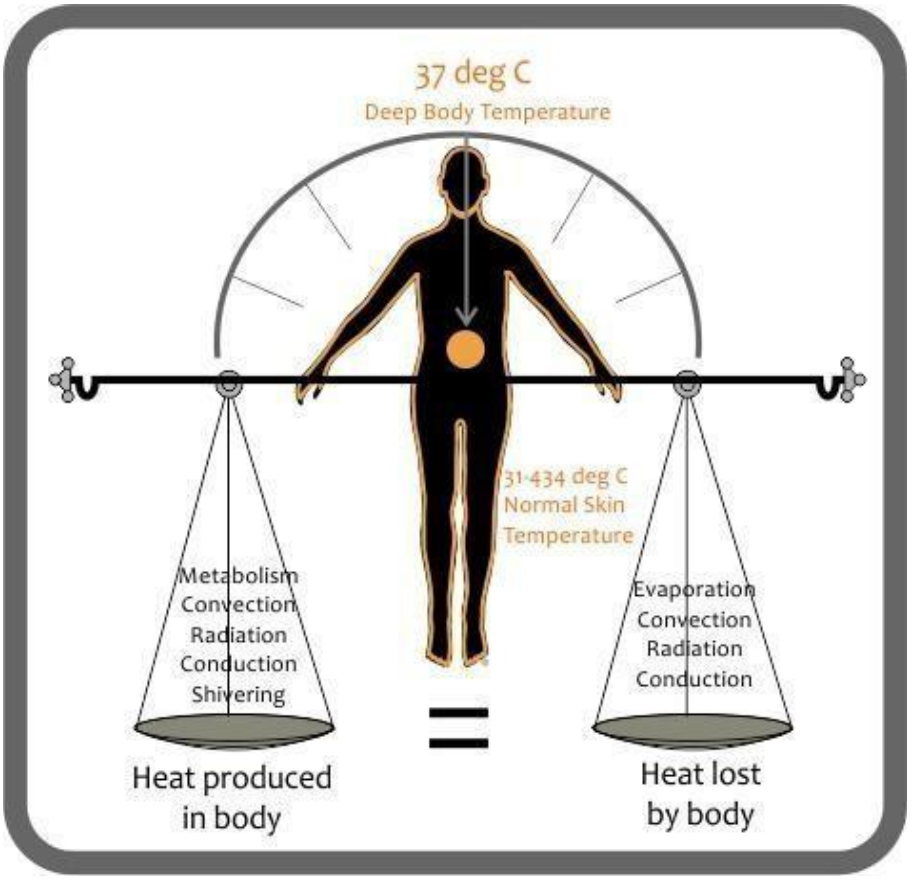
Figure 2.7: Thermal mass

➢ **Evaporative cooling**

- Over the years, traditional wisdom has supported the idea of a water body like pond, lake or fountain to give the surrounding environment a cooling effect. This effect reduces the temperature of indoor air-an evaporative cooling phenomenon

  that is widely known.This phenomenon is witnessed in most Indian households in systems such as desert coolers.
- Evaporative cooling reduces the temperature of the indoor air, thereby reducing the cost of power in building air conditioning. Reduced energy load leads to achieving the goals of efficient design(USAID, Net zero energy buildings).

- **Thermal Comfort**
- Ultimately, buildings are designed to provide shelter and comfortable habitats. Significant amounts of energy are expended as buildings are cooled or heated by mechanical equipment to maintain the optimal thermal comfort conditions It is important to understand what thermal comfort is and how, with the least amount of energy expended, it can be accomplished.
- Thermal comfort is an evaluation of the environment's thermal condition. ISO 7730 states that thermal comfort is described as "a condition of mind expressing satisfaction with the thermal environment"(USAID, Net zero energy buildings).



Human body needs to maintain its core temperature at 37 ºC. In order to do so, it must constantly exchange heat with the surroundings. People feel comfortable when this process is sufficiently supported by the surrounding thermal environment of a building(USAID, Net zero energy buildings).

- **<u>Vegetation :-</u>**

- Different air circulation patterns are produced by trees and shrubs, providing shade and keeping the surrounding area warmer. Vegetation can be used in buildings to conserve energy in the following ways:
  - ❑ Shading of buildings and open spaces through landscaping.
  - ❑ Roof gardens (or green roofs).
  - ❑ Shading of vertical and horizontal surfaces (green walls).
  - ❑ Buffer against cold and hot winds.

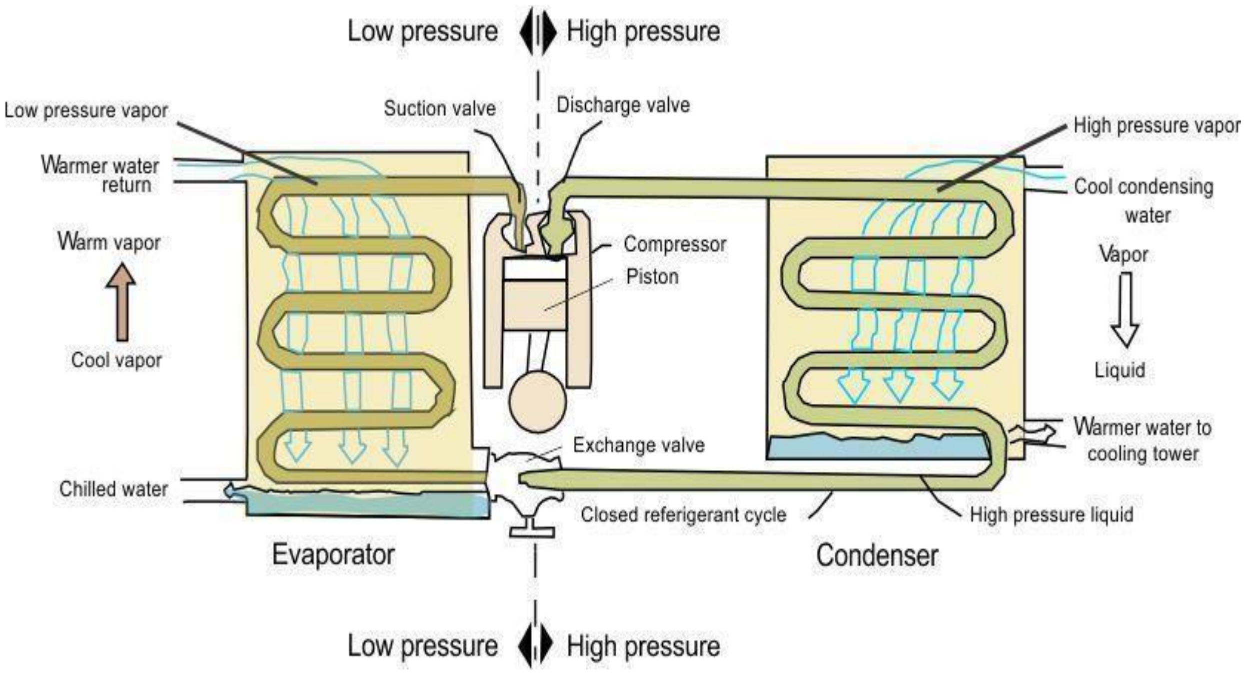
❑ Changing direction of wind.

- Vegetation is a dynamic control system for the penetration of solar and wind into buildings. This prevents direct sun from hitting and heating building surfaces and decreases the outside air temperature which in turn affects the heat transfer from outside to the exterior and interior of the building.
- Green roofs or roof gardens can also be used to help lower heat loads in a building. Extra thermal insulation is given by the additional thickness of the growing medium(USAID, Net zero energy buildings).

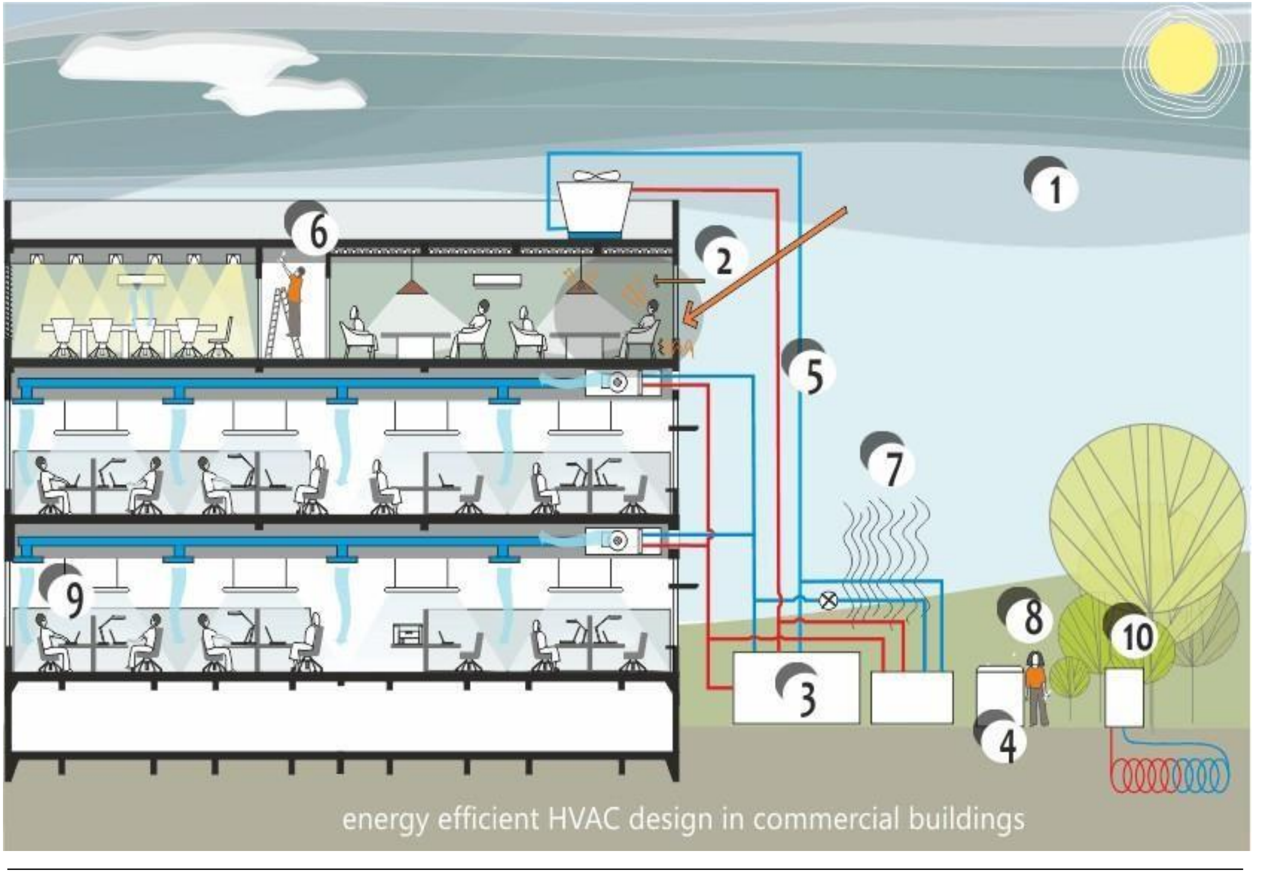
<u>Active Design Strategies</u>

➢ **HVAC**

- Comfort systems contribute almost 40% of the energy used in India by commercial buildings. There are many types of comfort systems on the market that range from low-energy comfort systems to conventional systems.
- Reducing heating / cooling loads through passive design strategies and enhancing HVAC systems efficiency are essential steps for any energy efficiency building policy.
- The system type are broadly categorized into two types:
  - ❑ Centralized system: central cooled water system (air-cooled and water-cooled system
  - ❑ Distributed system (DX system): VRF, duct-capable system, separated air-conditioners, unit systems.

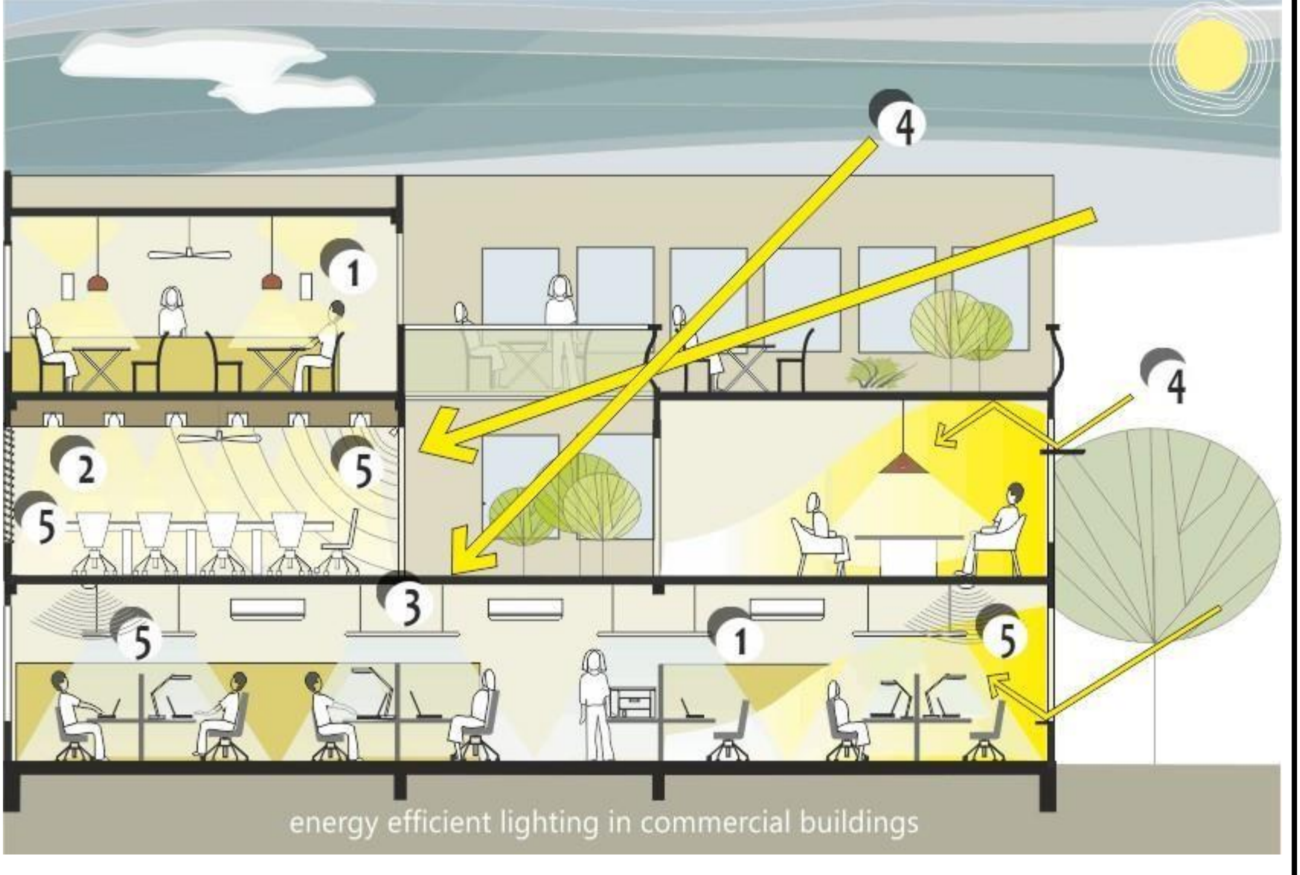


HVAC design and equipment selection majorly depends oncBuilding fumetional use, type, and operational sehedule. Variation in operational schedule and potential of system conlirols System complexity Commissioning - pre occupancy and post occupancyDesign(USAID, Net zero energy buildings).



➢ Lighting

- Lighting is designed based on user activity and usable space requirements. To meet the goal, choose possible lamps available on the market.
- Lighting is one of building design's most complex parts. A variety of issues regarding lamp engineering and luminaires, lighting design philosophy, energy efficiency, and aesthetics have to be juggled by the lighting designer.
- Designer should target an LPD reduction of at least 50% of the value stated in ECBC for an energy-efficient design(USAID, Net zero energy buildings).



Efficient appliances :-

Solar and off grid appliances

- Renewable energy-based devices will go a long way towards saving customer money by decreasing energy bills and increasing reliance on the electricity grid.
- For controlling external lighting, small photovoltaic modules can be used.

Solar Water heaters use energy firom the rays of the sun for domestic and commercial purposes to heat water. There are two types of closed loop and open loop solar water heaters.

Standards and Labelling

Energy Efficiency Standards & Labelling (S&L) systems in many countries have been active in increasing the supply and performance of energy-eflicient goods.In India, the S&L appliance system was launched by the Bureau of Energy Efficiency (BEE) in 2006

Refrigerator

In particular in residential buildings, refrigerators account for a significant fraction of the annual energy usage. There are two main types of refrigerators in the market, Direct Cool and Frost Free, based on the process of circulating cooling and defrosting.

Room Air Couditioners

Air Conditioners are designed to offer comfort to humans by reducing room temperature and bamidity. While air conditioners consume large amounts ofeleetricity, their popularity is incereasing among the general public. Two types offair conditioners are present in the market

- Window Type
- Split Type

Distribution Trausformer

This type of transformer is the fine all slep in the electrical distribution system's voltage transformation. This reduces the voltage obtained from the distributionlines to a rate that is expected by the end consumer. The standard ratings coveredby the program are 16, 25, 63, 100, 160 and 200kVa and 16 to 200kVa non-slandard ratings.

Tubular Fluorescent Lamps (TFL)

TFLs are typicallly lww-pressure mercury vapor gas discharge lamps that peoduce light by using fluorescence. The labeling scheme for BEE Star covers 4-foot TFLswith up to 40W waltages.

Ceiling Fans

For 1200 mm sweep and a total air supply of 210 cu. m/ min, the BEE star labeling system for ceiling fans is applicable

Electric Geysers

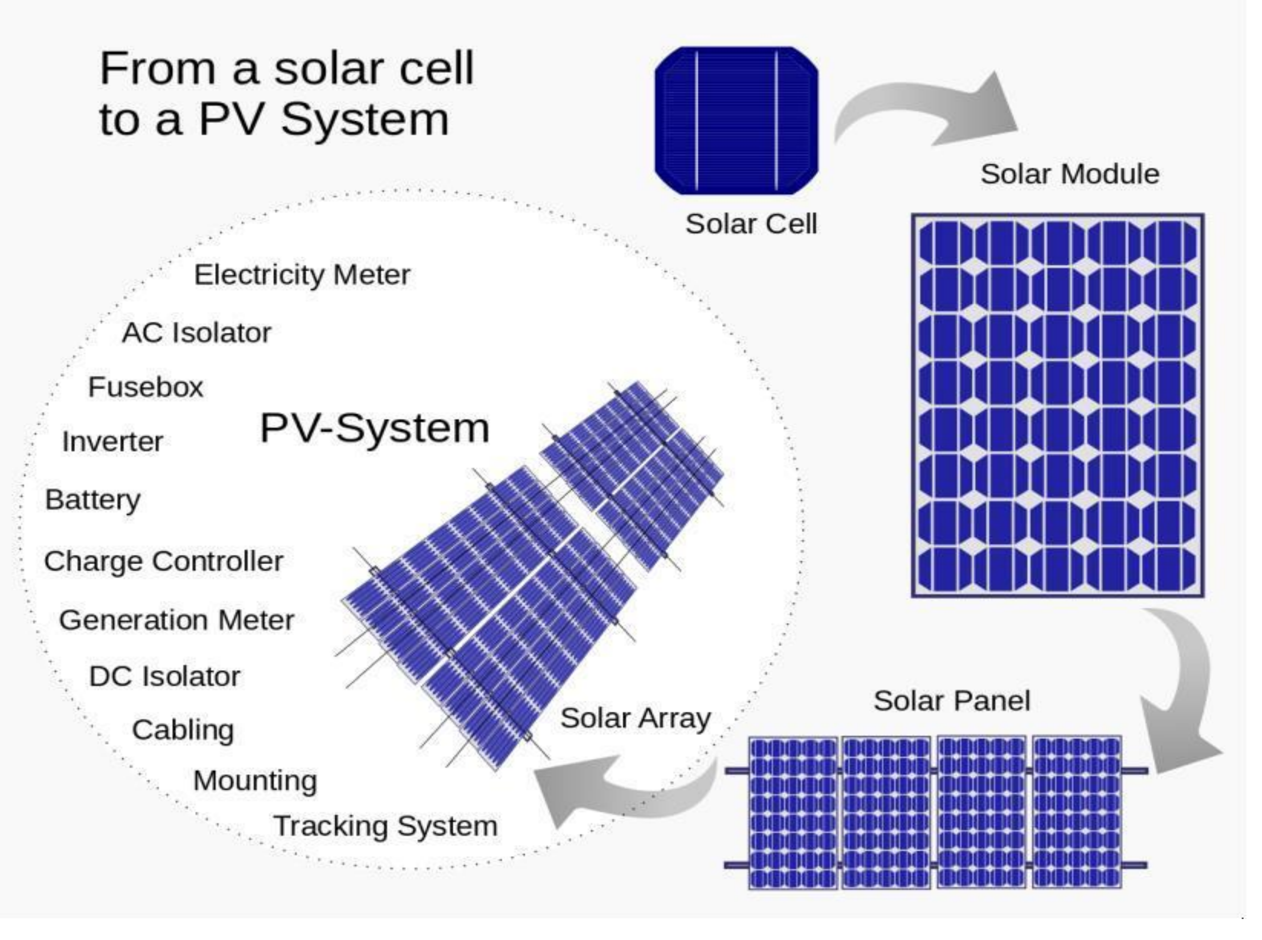
Efficient computer system(USAID, Net zero energy builldings).Renewable Energy> Solar Photovoltaic

Renewable Energy :-

- Solar Photovoltaic

Solar photo voltaics are a combination of panels that contain a number of solar cells that transform the solar energy incident into usable electricity.

- These panels can be mounted anywhere they receive plenty of sunlight. Solar cells consist of semiconductor materials such as crystalline silicon, which includes monocrystalline silicon, polycrystalline silicon, ribbon silicon, and mono-like multi-silicon, and thin films like cadmium telluride, copper indiumgallium selenide, silicon thin film, and thin film gallium arsenide.
- **Factors affecting generation of electricity:**
- Location, tilt, and orientation
- Over shading
- Temperature
- Panel efficiency (USAID, Net zero energy buildings)



➢ Wind Energy :-

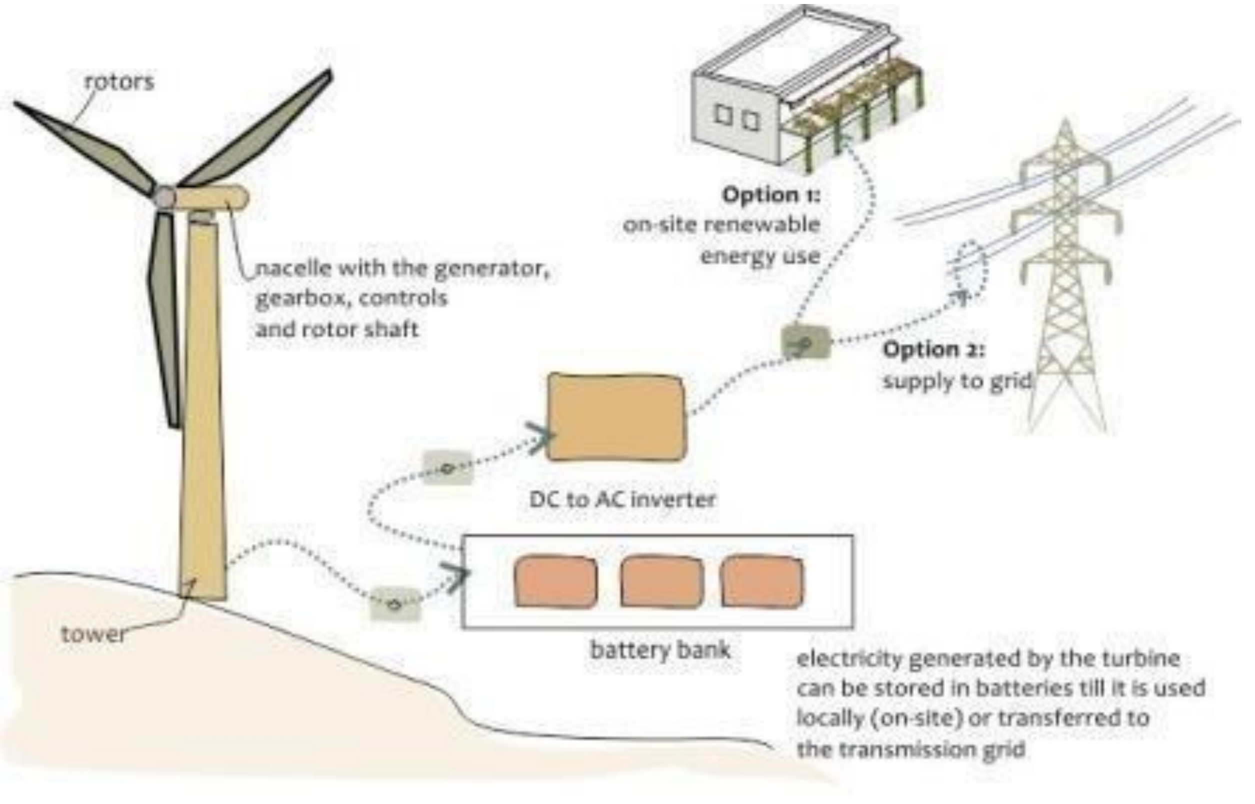
- By using wind turbines to harness the wind's kinetic energy, wind power is generated. Wind blowing across a wind turbine's rotors causes it to spin.
- Rotator spinning transforms a part of the wind's kinetic energy into mechanical energy. The mechanical power is further transformed into electricity by a generator(USAID, Net zero energy buildings).

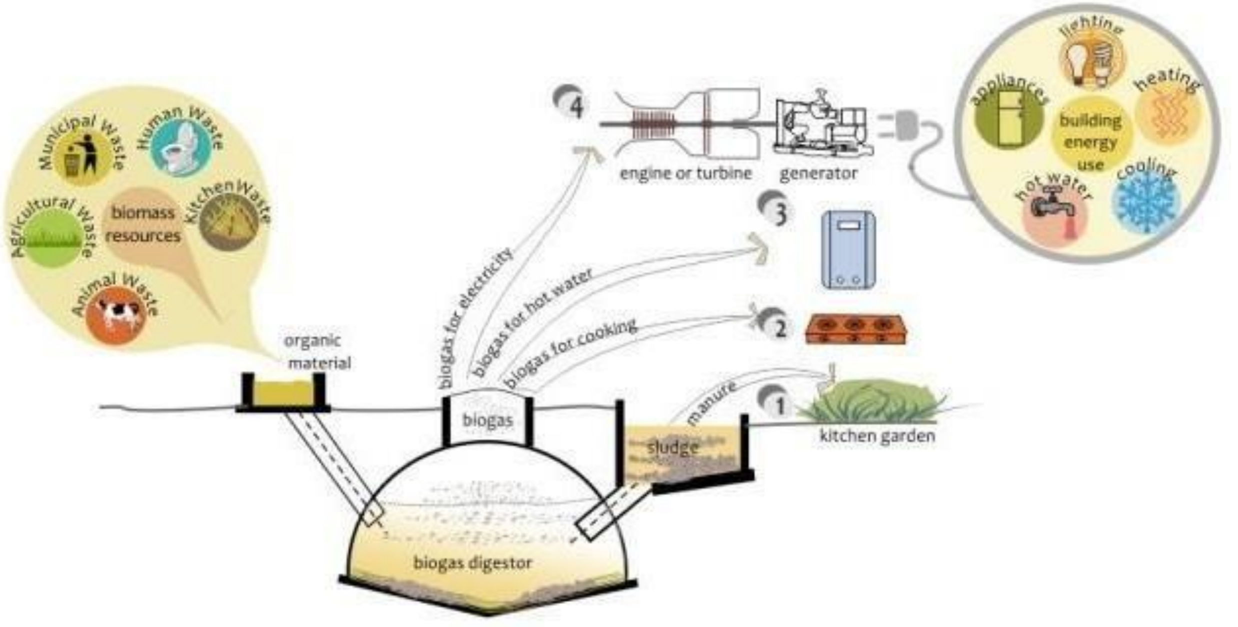
➢ Biomass

- Biomass fuel is the energy from plants or products derived from plants. Woodis the most widely used source of energy from biomass. Certain biomass sources include: land and aquatic plants, agricultural waste, industrial waste, sewage sludge, animal and municipal waste.

  To transform biomass into useful energy, three main technologies are used:

- ❑ Bio Gastification
- ❑ Biogas
- ❑ Biofuels(USAID, Net zero energy buildings)





- **Hydro**
- Hydro energy is power generated from running or falling water energy on an energy conversion (turbine or wheel) equipment.
- These energy conversion devices transform the kinetic energy into mechanical energy, which is further converted to electrical energy through a generator(USAID, Net zero energy buildings)

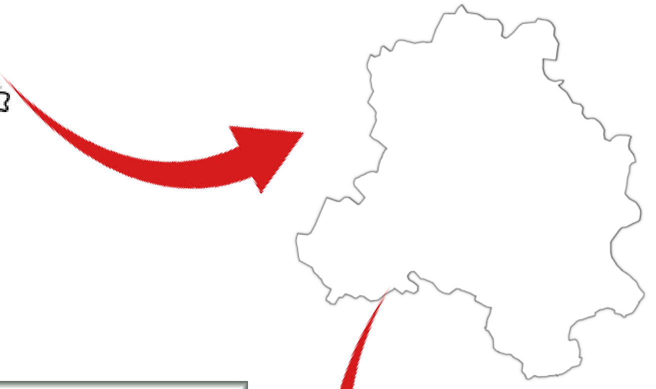
Author's	**Design Variables**	**Analysis Target**	**Simulation tool/method**	**Country**	**Main Finding**
(Su & Zhang, 2009)	WWR,orientation, glass type (e.g.,single , hollow)	Environm ental impact	Life cycle environm ental analysis	China	WWR is the most important factor in the environmental impact of the life cycle.
(Ma, Wang, & Guo, 2015)	WWR(i.e., 10~100% withinterva l 10%), U-value	Recom me nded WWR	Mathemat ical model	USA	The optimum WWR is determined not only by the amplitude of the temperature but alsoby the U value of the building envelope.
(G. Zenginis & Kontoleon 2017)	WWR Building aspect ratio (i.e. lenth and width dimensions) .	Heat gain and loss	Mathematical model	Greek	The orientation of the facade And the design aspect ratio with WWR. have a huge impact on heat fluxes through the building
(Wen, Hiyama , & Koganei, 2017)	WWR(i.e., 10~70%, interval:10 %), orientation	Total CO2 emission, recomm en ded WWR	EnergyPl us	Japan	This research proposed the optimum WWR of all Japanese regions by taking into account the environment and window properties

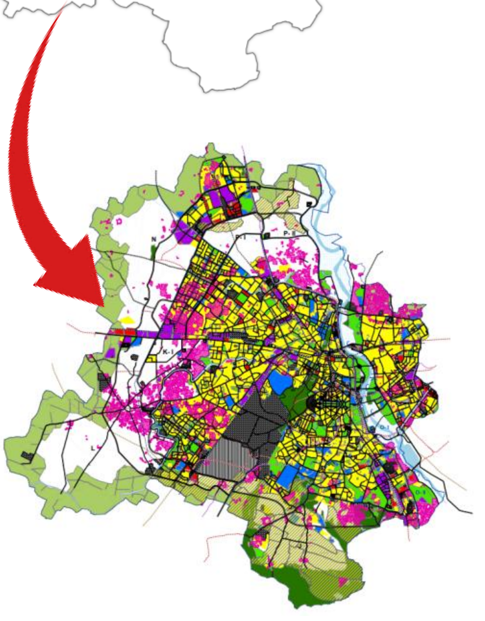
CASE STUDY : 1

INDIRA PARYAVARN BHAWAN

INDIRA PARYAVARN BHAWAN:-

- Geographic coordinates: 28°N, 77°E;
- Location: New Delhi;
- typology: new construction;
- climate type: composite;
- project area: 9565 m2;
- nnection; EPI43.75 kWh/m2/year; Type of use: office (MoEF);





INDIRA PARYAVARAN BHAN

Background :-

Indira Paryavaran Bhawan, the new Ministry of Environment and Forests (MoEF) building, is the first major building in the country to receive the Net Zero and Energy Positive marks, and the first government building to do so.The building is located in Aliganj on JorBagh Road in South Delhi and includes the minister's office and various administrative areas of the ministry.This project was undertaken at all levels by the Central Public Works Department (CPWD) and Dependra Prashad, Dependra Prashad, Architects and Planners (DPAP) Sustainable Design Consultants to design a building that is not only energy efficient, but also capable of generating more energy on site than it consumes over the course of a functional year (Prashad & Chetia, 2014).

DEVELOPING INDIRA PARYAVARAN BHAWAN

Indira Paryawaran Bhawan Plan

The design of the building went through various iterations with a twin North- South facing blocks with a large open space court in the middle being the final design.

To keep the building height in tune with the surroundings, the maximum permitted ground coverage was used.

Permission to cut 46 trees was granted, the design and measures proposed helped to reduce chopping to just 19 trees.

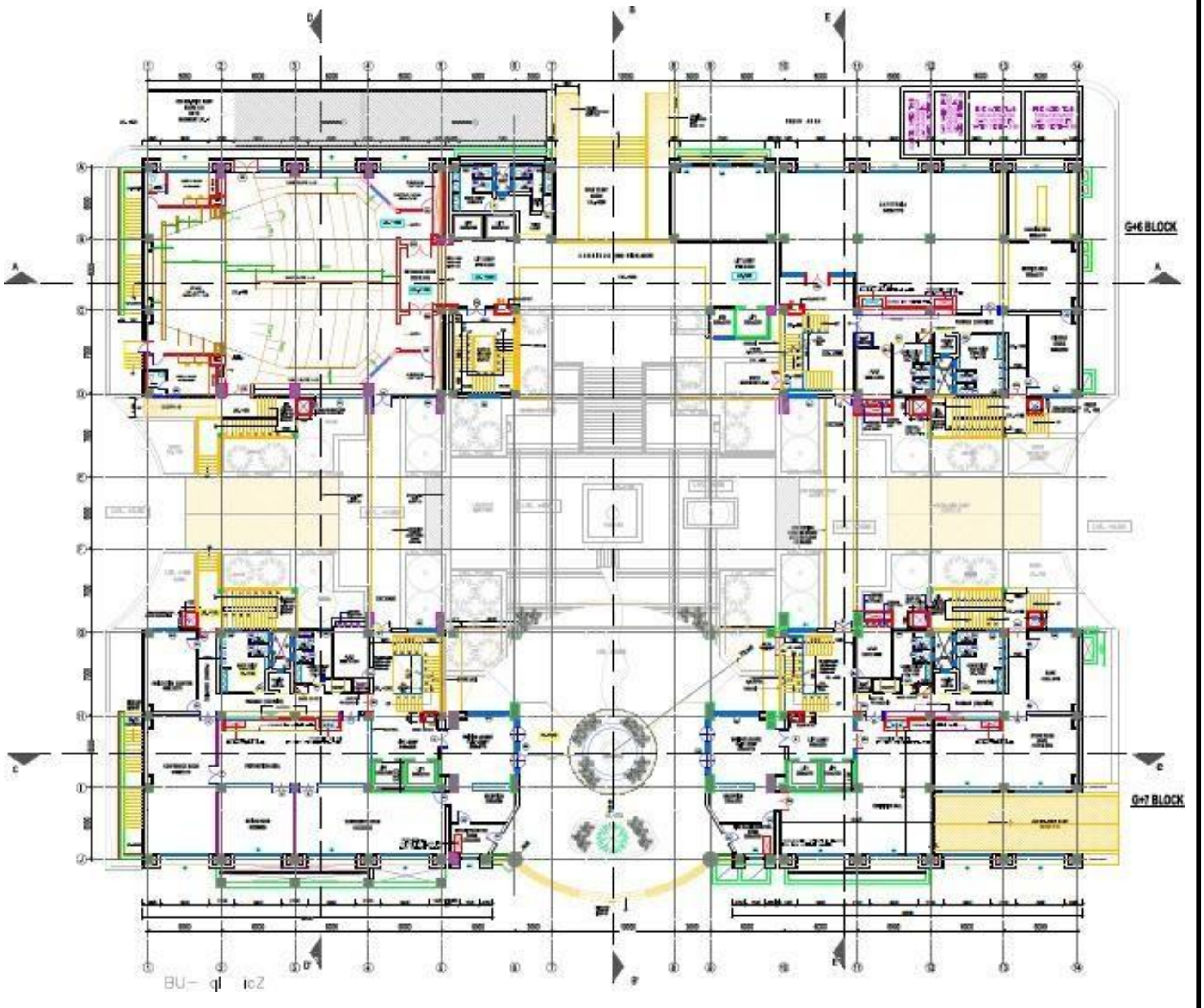
The landscaping project was planned not only to serve as a climate change agent, but also to highlight the country's plant diversity (Prashad & Chetia, 2014).

Introduction

The new office building of the Ministry of Environment and Forests (MoEF), Indira Paryavaran Bhawan, represents a fundamental departure from conventional construction methods.

The project team paid special attention to strategies to reduce energy demand by providing adequate natural light, shade, landscaping to reduce ambient temperatures, and energy-efficient, effective building systems. - Several energy conservation measures were taken to reduce the building's electricity loads, and the remaining demand was met by generating energy from on-site high-efficiency solar panels to meet net-zero requirements. By reclaiming wastewater from the site, the proposal incorporated sustainable building principles such as water optimization and conservation. The Indira Paryavaran Bhawan is now India's top-rated green building. The project received a GRIHA 5-star rating and LEED Platinum.

<u>*FLOOR PLAN OF INDIRA PARYAVARAN BHAWAN :-*</u>



Passive Design Strategies

- **Orientation**

The building is oriented north-south, with separate blocks connected by corridors and a huge central courtyard. Orientation reduces heat intake. Optimal ratio between window and wall.

- **Landscaping :-**

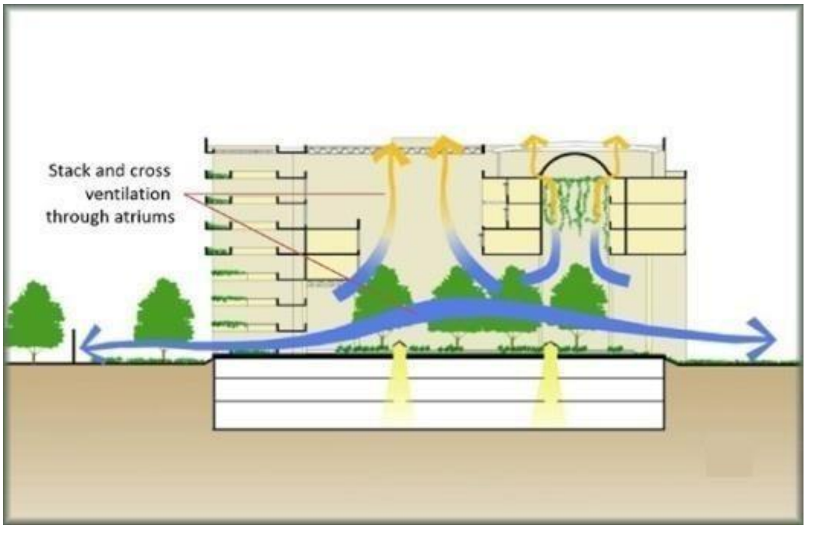
About 50% of the land outside the building is coverd by the forest. circulation, roads and paths are paved softly to allow drainage of groundwater.

Daylighting

75% of the building floor space is daylight, reducing reliance on artificial lighting sources. The courtyard inside serves as a bright light.

Ventilation :-

As natural ventilation occurs due to the stack effect, the central courtyard aids in the air movement. Cross ventilation is supported by windows and jaalis.



Building Envelope and Fenestration :-

Optimized building envelope -window installation (U-value 0.049 W/m2K), VLT Double-glazed, hermetically sealed windows made of UPVC with low thermal transmittance glass Insulation made of rock wool High-efficiency glass

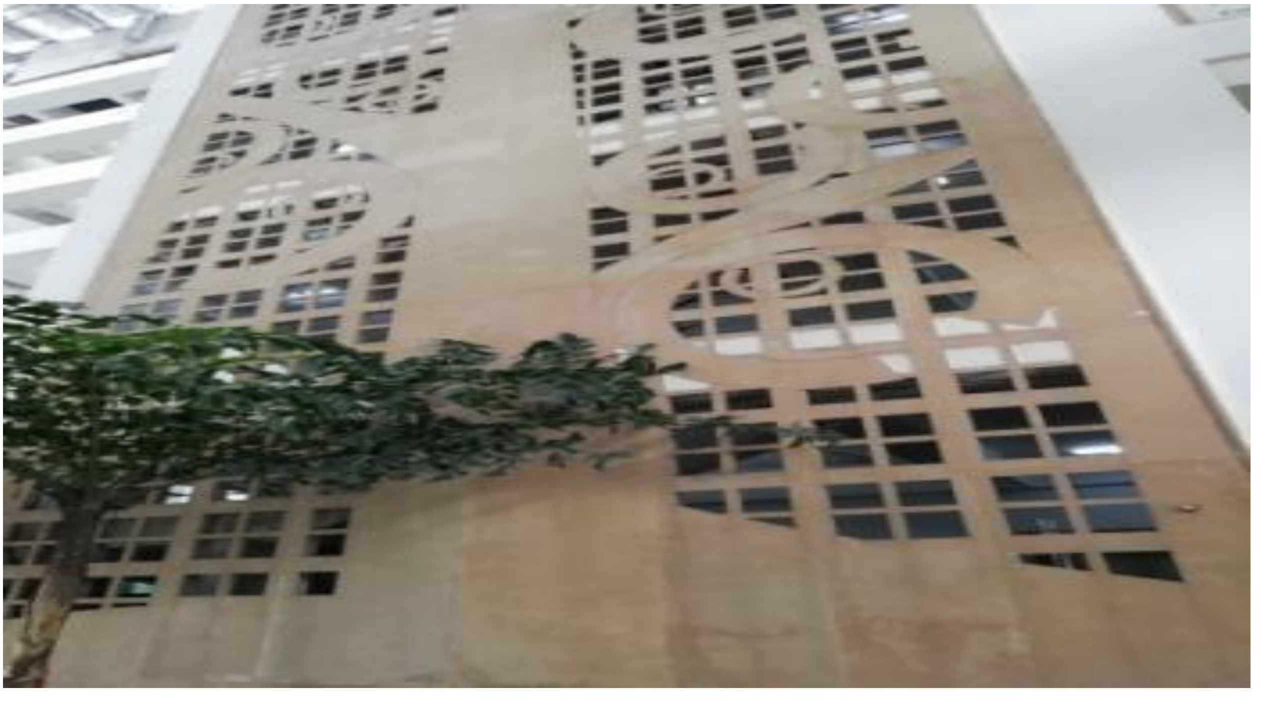
Cool roofs: use of highly reflective terrace slabs for heat absorption, high resistance, durable

The building envelope of Indira Paryavaran Bhawan is designed for energy efficiency and uses heavy weight construction with high insulation. The roof consists of a 2 cm thick clay tile, 6 cm cement mortar, 4 cm PUF insulation, 6 cm brick bat coba, 6 cm cement mortar, and 10 cm concrete. The walls are constructed using 30 cm thick AAC block, 7 cm mineral wool insulation, 12 cm air gap, and 12 cm "Fal-G" block brick. The building also utilizes uPVC windows with sealed double glazing and high-efficiency glass.

Materials and construction techniques :-

- AAC blocks with fly ash.
- Plaster and mortar based on fly ash.
- Jaalis made of stone and ferrocement.
- Floor coverings made of local stone.
- Doors, frames and flooring made of bamboo-jute composite material.
- High-efficiency glass, high VLT, low SHGC and low U-value, optimized by appropriate shading.

Light Shelves for difused Sunlight :-



Active Design Strategies:-

Lighting Design

- An energy-efficient lighting system (LPD = 5 W/m2) reduces energy consumption even furthei because it is over 50% more efficient than the requirements of the Energy Conservation Building Code 2007 (LPD = 11 W/m2).
- Building integrated photovoltaic (BIPV) supplies the remaining lighting load.
- Using T5 bulbs and other energy-efficient lighting fixtures.
- Making use of the lux-level sensor to enharce the performance of artificial lighting.

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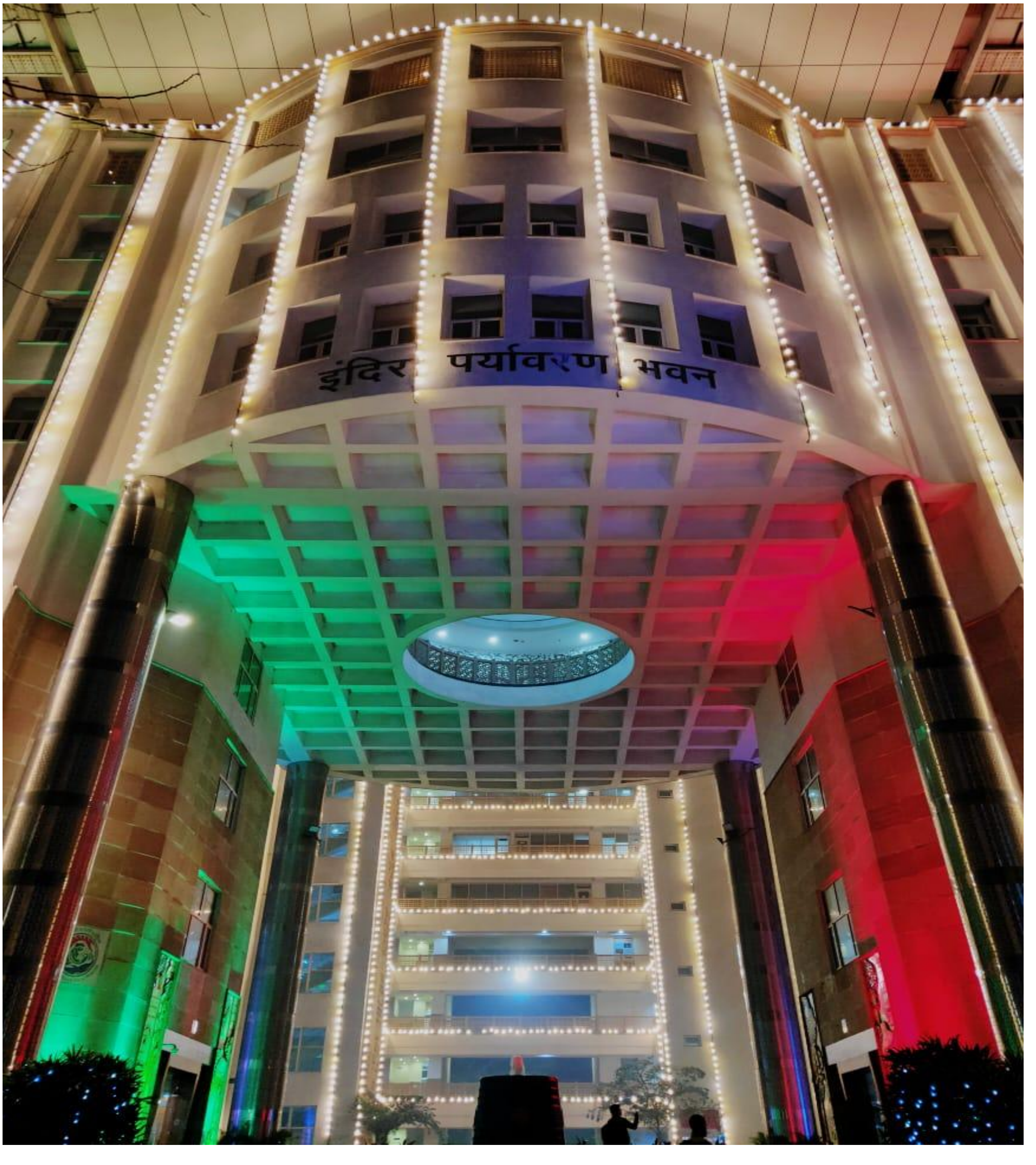
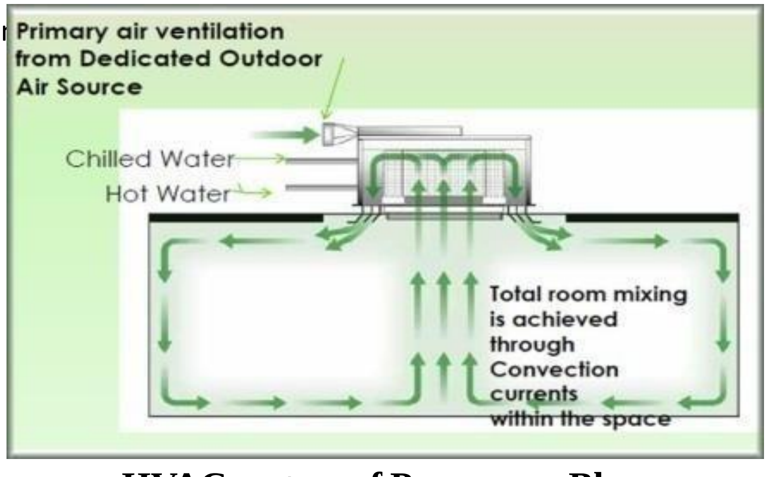


- ## Optimized Energy Systems / HVAC system

Chilled beam system/ VFD/ Screw Chillers

- A chilled beam system handles 160 TR of the building's air conditioning load. From the second to the sixth floor, a chilled beam is used. Compared to a conventional system, this system uses 50% less energy.
- The HVAC load for the building is 40 m2/ TR, which is about 50% more efficient than the ECBC requirements (20 m2/ TR). Chilled water is supplied at 16C and returned at 20°C.
- The chilled beams are equipped with drain pans to remove water droplets caused by condensation during the monsoon.
- Dual-skin air handling units, chillers, and chilled beams with variable frequency drives (VFDs) that reduce fan power consumption by 50 kW each.
- VFDs on AHUs, cooling tower fans and chilled water pumps.
- Using a sensible and latent heat recovery wheel to pre-cool fresh supply air with toilet exhaust air.
- Control of all systems and HVAC equipment via a comprehensive building management system.
- Use of functional zoning to reduce air conditioning demand. The space is maintained at

36 C plus or mi



HVAC system of Paryavarn Bhawan

<u>Chiller Beams</u>

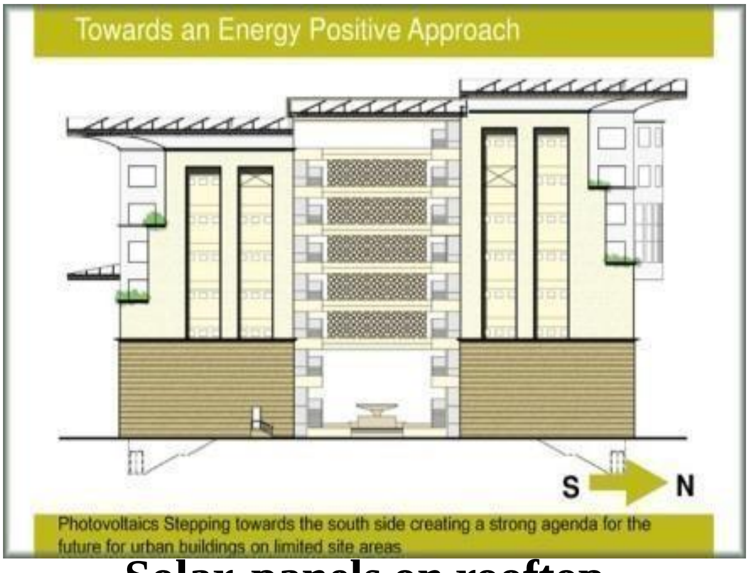
➢ **Geothermal heat exchange system**

- There are 180 vertical boreholes with a depth of 80 meters on the entire site of the building. A minimum distance of 3 meters must be maintained between two boreholes.
- Each borehole is equipped with a U-loop HIPE pipe (32 mm outer diameter) and a bentonite mud grout. Each U-Loop is connected to the condensate water piping system in the central air conditioning room.

One U-Loop has a heat rejection capacity of 0.9 TR. Without the use of a cooling tower, a heat release of 160 TR is achieved (USAID, Net zero energy building).

Renewable Energy

. pV solar plant with a power of 930 kW, 6000 m2 total area, 4650 m2 panel area and a total of 2844 panels.
. 14.3 lakh energy units are generated annually
. Actual production on site as of January 25, 2014
. Achieved power generation: 300 kWh per day - power injection to the grid started on November 19, 2013



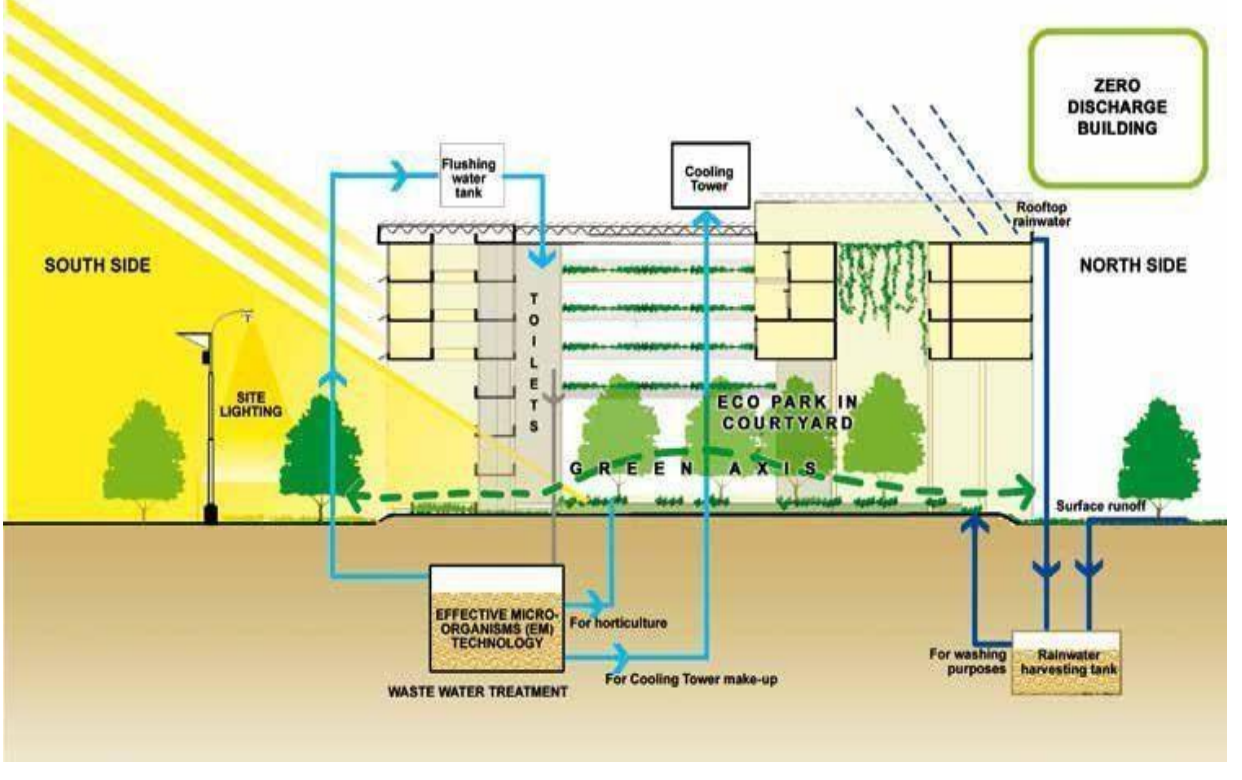
Solar panels on rooftop

Solar panels

Terrace Covered with Solar panels

Water Efficiency :-

- A water-efficient site also benefits from landscaping and site management, which can reduce water use for landscaping by up to 50% through the use of native plants and effective irrigation systems.
- The building's water use has been reduced through the use of water-efficient fixtures, recycling, reuse of wastewater from the building, and rainwater harvesting.
  The focus in this case is not only on water efficiency, but also on effective water management on the site and zero runoff, meaning that no water is discharged into the city's stormwater or wastewater systems.
- The excavation had to be extensively dewatered due to the high water table of 9 m; the
  extracted water is reinjected into the ground 250 m from the site.
- The New Delhi Municipal Corporation (NDMC) receives regular, free supplies of this extracted water to supplement the city's vater supply (Prashad & Chetia, 2014).



Efficient water use and reuse in cycle in Paryavarnbhawan

Major Design Interventions :-

- Another important design intervention planned by the planning team was zero
- tolerance for surface parking.
- A state-of-the-art, three-story parking garage with preferred parking for CNG/electric
- vehicles and carpools during office hours is planned to handle peak traffic.
- The building is also designed to have a direct, preferred entrance at the front, creating a 'pedestrian priority." vehicles enter the basement from the side and must back up.
- Instead of the usual concrete lawn grids, a large number of polymer plastic grids are installed, making the surface completely soft, resulting in less surface runoff and better infiltration of water.
- A lower contribution of the building to the Urban Heat Island (UHI) effect is another tangible benefit of the lower paved area. The UHI effect leads to an overall increase in temperature in highly urbanized/paved areas due to the absorption and re-radiation of solar heat on hard surfaces (Prashad & Chetia, 2014).

Some of the other significant design measures include:

- Window shading design is appropriate for the entire building, and reducing the window-to-wall ratio helps reduce heat gain and necessitates the use of high-efficiency glass.

- Window shading and patio openings are designed to reduce heat gain in the summer while allowing winter sun to pass through. Most of the windows an living areas are located on the outer periphery, allowing good daylighting and views of the scenic surroundings from most office spaces.

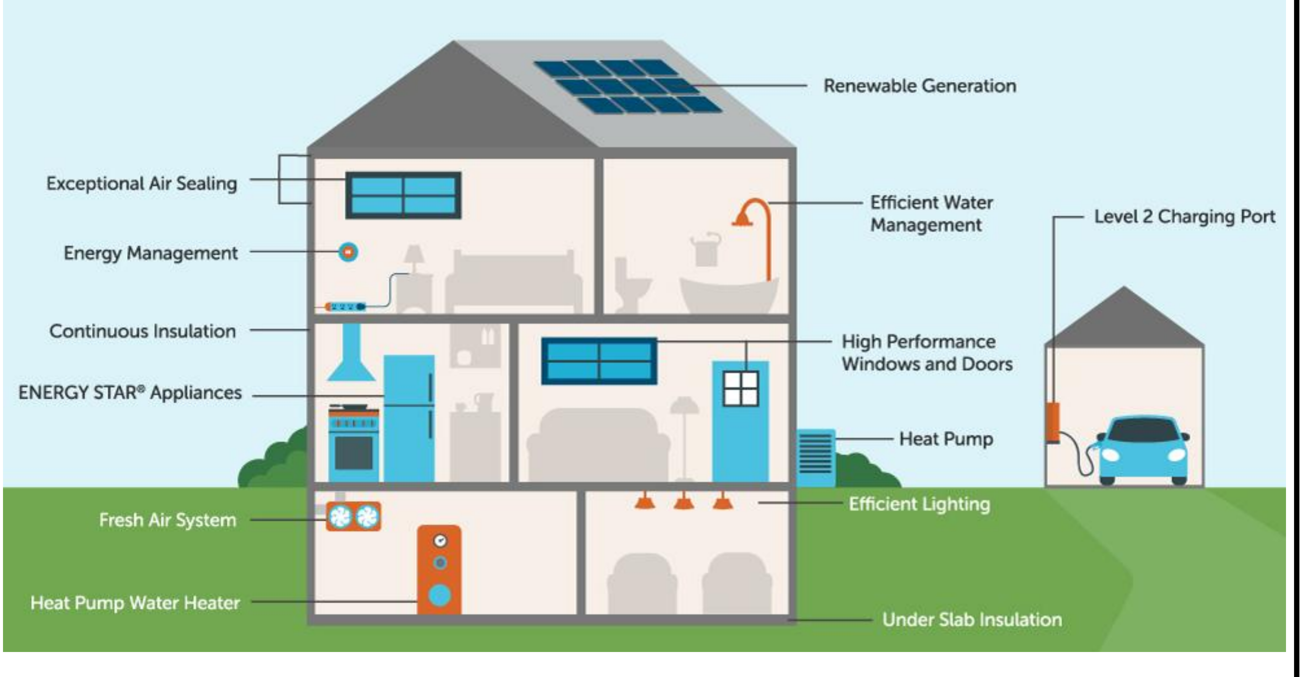
- A large number of spaces, including passages and lobbies, have been developed as non-air-conditioned spaces provided by stone jalis for natural cooling and shading (Prashad & Chetia, 2014)

The shaded and vegetated passages in one of the upper floor plans

Other measures promoting energy-efficient systems include:

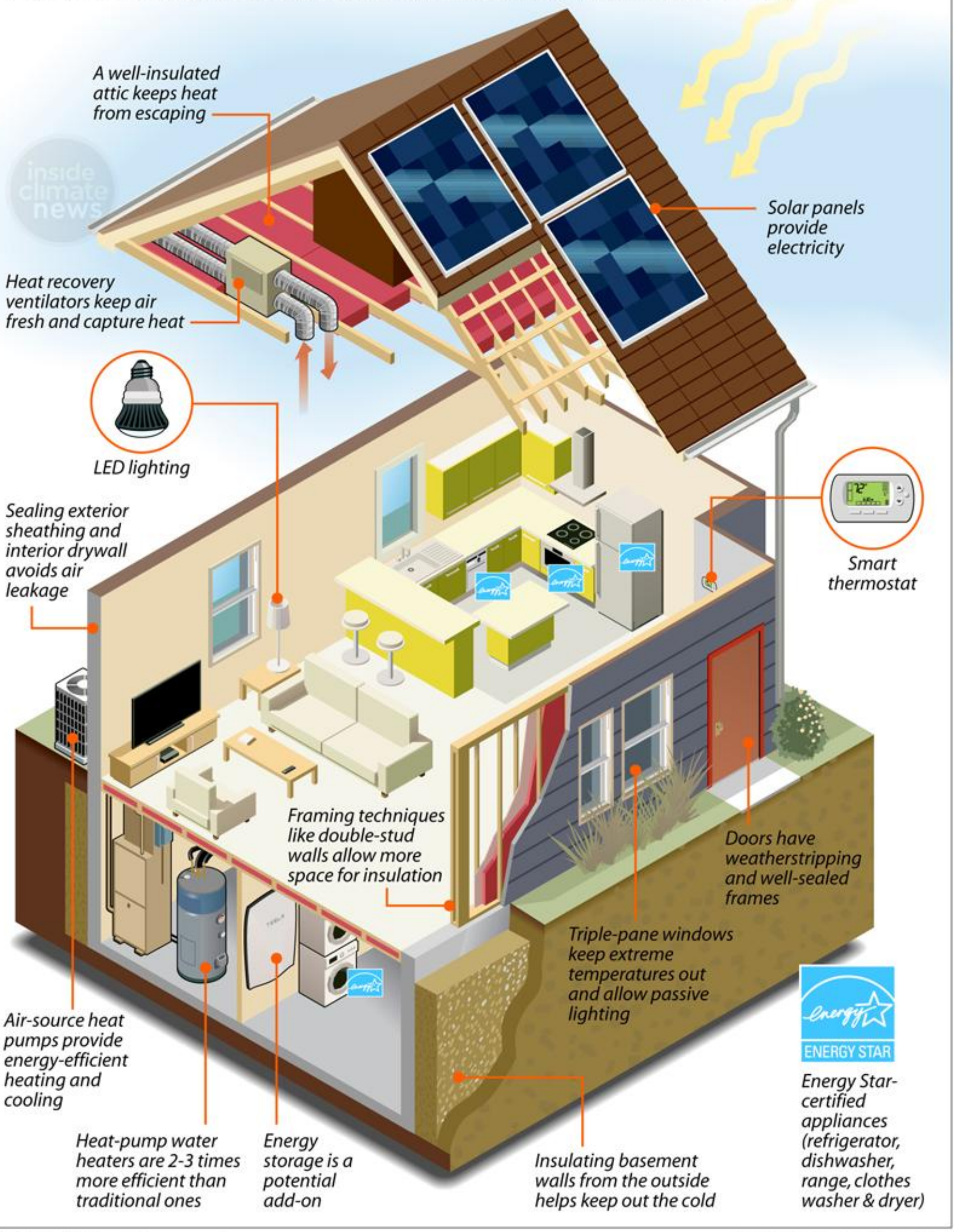
- To improve the process of artificial lighting, use the Lux level sensor.
- Integrated Building Management System (IBMS) designed to manage energy consumption, monitor performance, etc.


LED Lighting
Solar Panels
Electric Car Charger
Nucleus Appliances
Water Heater
Water Filtering


Renewable Generation
Exceptional Air Sealing
Energy Management
Continuous Insulation
ENERGY STAR® Appliances
Fresh Air System
Heat Pump Water Heater
Efficient Water Management
Level 2 Charging Port
High Performance Windows and Doors
Heat Pump
Efficient Lighting
Under Slab Insulation

What Goes Into a Net-Zero Home?

Houses can be built with such energy efficiency that their electricity needs are offset by a few rooftop solar panels. Here are some of the ways builders make homes net-zero energy.



SOURCE: InsideClimate News research

PAUL HORN / InsideClimate News

CASE STUDY : 2

CII SOHRABJI GODREJ GREEN BUSINESS CENTRE HYDRABAD

4.1 INTRODUCTION

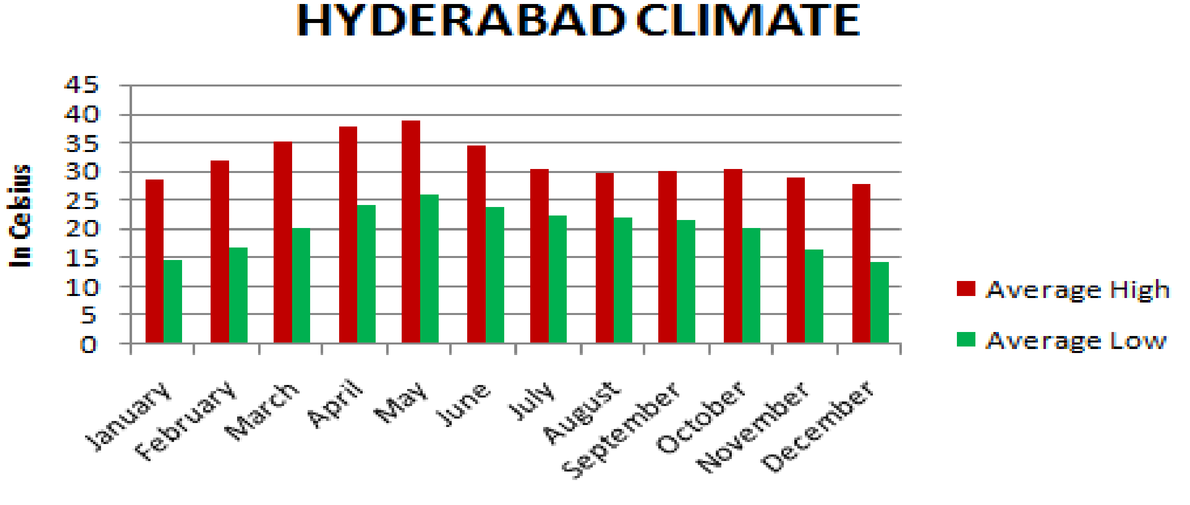
Hyderabad is the capital of the state Andhra Pradesh and is one of the fastest growing economic state in India. The city is situated at an elevation of 544 M the average temperature during the months of summer is anywhere around 40 degree celsius, in the month of winters the average temperature is about 16 degree celsius. Best time to visit Hyderabad is during the months of
September to March.

Summers: (Chart 1)
Average maximum temperature – 40 Degree Celsius
Average minimum temperature – 25 Degree Celsius

Winters: (Chart 1)
Average maximum temperature – 28 Degree Celsius
Average minimum temperature – 13 Degree Celsius

Average Rainfall – 79 cm (approximately)

CII Sohrabji Godrej Green Business Centre (CII-Godrej GBC) was established in the year 2004, as CII's Developmental Institute on Green Practices and Businesses, aimed at offering world class advisory services on conservation of natural resources. The climate of Hyderabad an arid climate. The days are hot and dry, usually going up to extreme highs 40 degree celsius, while nights are cool and breezy.



Godrej The First LEED Platinum Rated Building in India –

It offers advisory services to the Industry in the areas of:

- Green buildings Energy Efficiency
- Water Management
- Environmental management
- Renewable energy
- Green business incubation
- Climate change activities CII Godrej GBC

An attempt to make a positive change in design by Reducing the negative impact on the environment in terms of:

- Use of materials
- Energy Efficiency
- Natural Ventilation Ecological footprint
- Socio Cultural Response etc.
- Water Management
- Sustainability
- Reuse and Recycle
- Renewable Energy Effective Land Use
- Carbon Footprint

Green Architecture is about Expanding and complementing the classical Expanding and complementing the classical building design in building design in matters of economy, utility, durability, and comfort. Designing to reduce the overall impact of the built-up environment on human health and the natural environment by:

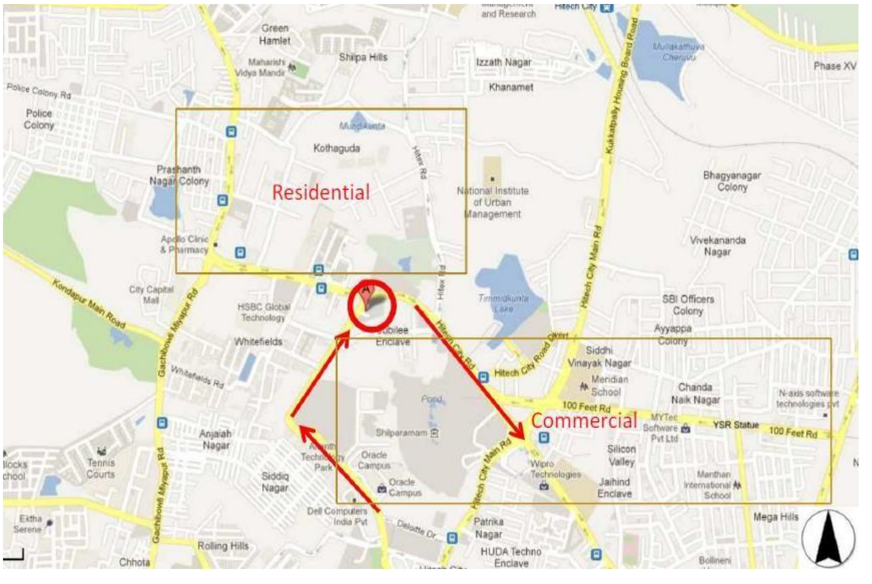
1. Efficiently using energy, water, and other resources
2. Protecting occupants' health and improving productivity
3. Reducing waste, pollution and environmental degradation
4. Ensuring sustainability
5. Natural building - use of natural materials available locally.

(Green Business Centre)

The First LEED Platinum Rated Building in India – CII Godrej GBC

- It offers advisory services to the Industry in the areas of :
- Green buildings
- Energy Efficiency
- Water Management
- Environmental management
- Renewable energy
- Green business incubation
- Climate change activities

LOCATION



DESIGN EVOLUTION

- Site Area : 5 acre
- Built up area : 20000 sq ft
- Building footprint : Only 9.2% of the site
- Minimum disturbance to the existing site feature
- Large area for landscape to enhance micro climate and for visual delight

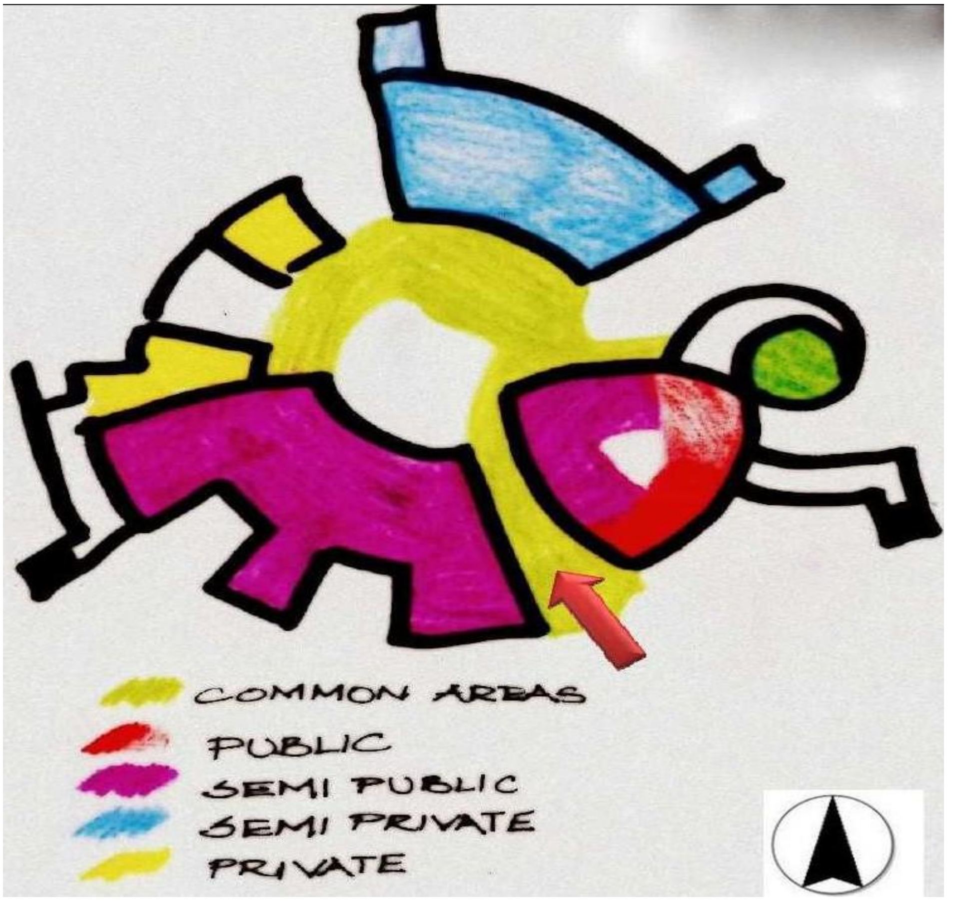
The Main gate opens to a long driveway with a lush greenery on both side creating emphasis to the entrance.

The Main building has direct access from the main road, but the entrance to it is form the inside to insure privacy and security.

ZONING

Zoning done by HIERARCHY in terms of PRIVACY

- PUBLIC - Reception, Library
- SEMI PUBLIC - Administration, Office for employees
- SEMI PRIVATE - Seminar hall
- PRIVATE - Conference rooms, Cabins for Senior Executives
- COMMON AREAS - for circulation and gathering



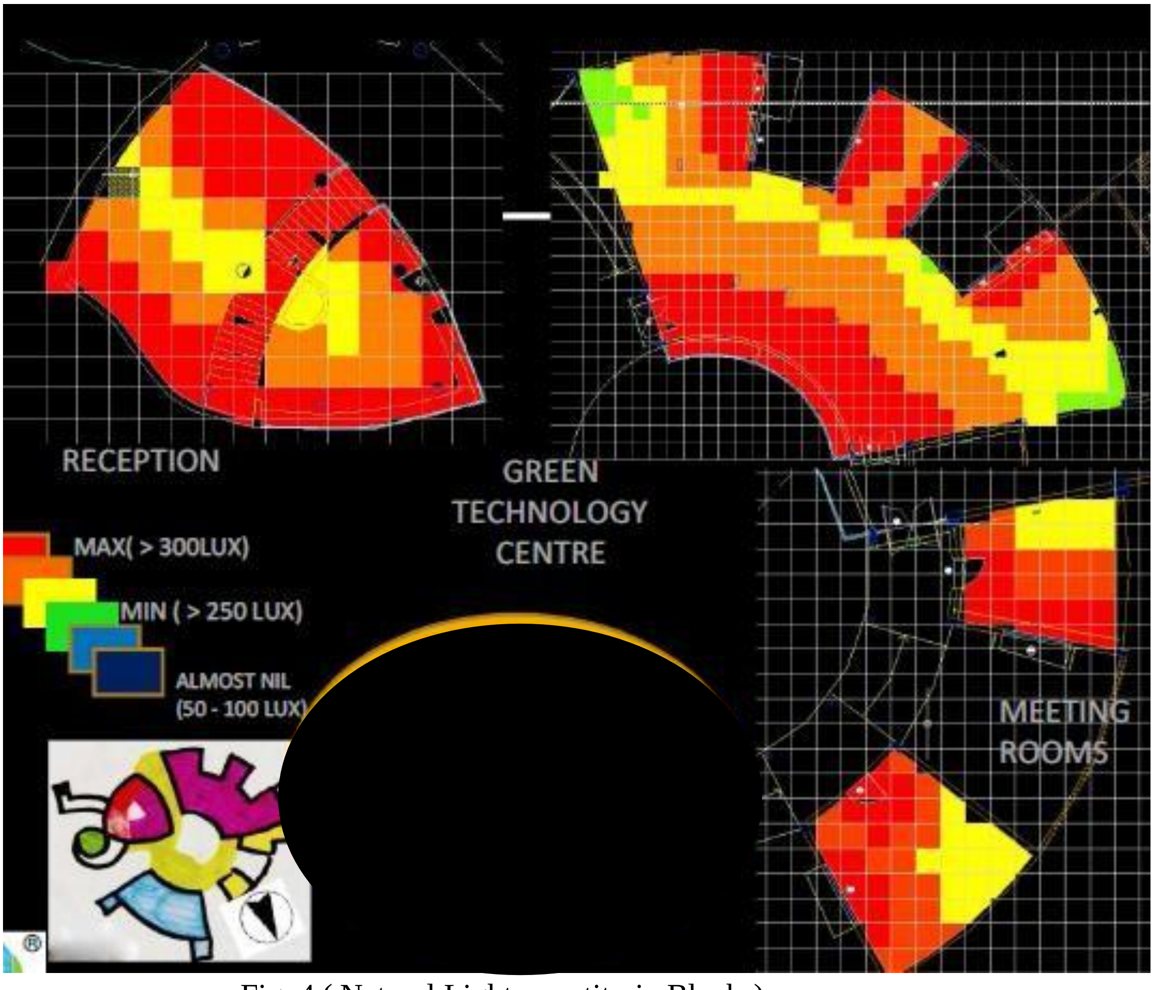


Fig. 4 (Natural Light quantity in Blocks)

The office block on the first floor receives sufficient natural light (Fig. 4) within even on dull days by the presence of internal courtyard and glass windows along all exterior walls

Since the seminar hall is generally air conditioned and lit mechanically,
only optimum level of natural light has been ensured.

Where natural light un available- washrooms sensor lights have been used to save power

Main campus –
Located on the flattest zone on site- least
interference to site features during construction
Easy access from Main Road
Centrally located on site
Scope to create buffers surrounding the building for effective design according to site climate
Less prone to pollution

Water Body –
Located at the lowest region of the site for maximum accumulation using existing site drainage pattern

4.3 Views / Plans

- Bicycle riders are treated preferentially - convenient parking, lockers, shower cleaning
- 30 % of employee transportation: carpools, bicycles, and LPG cars
- Use of battery operated vehicles encouraged – Charging stations available
- The documented reduction of harmful emissions achieved is 62 %
- Encourage building occupants to minimize their reliance on fossil fuel-based transportation.

Fig. 5 (Parking Area)

Fig. 6 (Approach from road)

PEDESTRIAN CIRCULATION

Emphasis of the entrance by a large projected overhang/portico
Separation of pedestrian and vehicular movement for easy circulation

THE TRADITIONAL CENTRAL COURTYARD

The spatial and formal elements around a courtyard create introverted blueprint.
Courtyard space was not rigidly fixed but could be adaptable depending on the time of day, season
Its mood changed with varying degrees of light and shade, and with them the ambience
Centrally located, serves as visual anchor.. It was the spatial, social, and environment control center of the home.
Brought in an additional usable space within the living space.
Court yard acts as the energy centre, also the communication centre
Courtyard functions as a convective thermostat and gives protection from extremes of weather.
The total number of courtyards in one residence could sometimes be five to six.

RECEPTION AND LIBRARY


Fig. 8 (Reception and Library area)

Like most olden system of construction , structures are kept ground hugging ensuring natural modulation of microclimate and creating more interaction with nature. Give a sense of being close to nature.

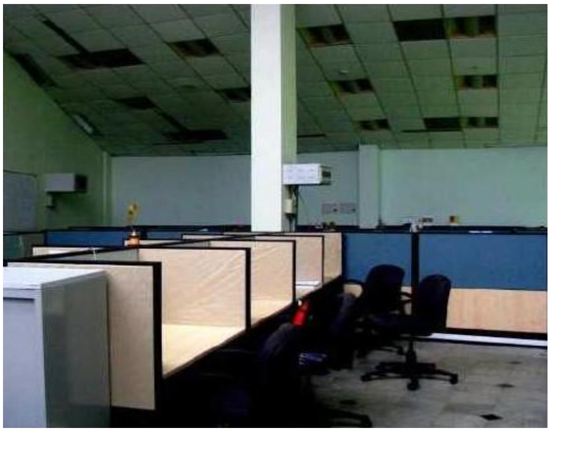



Fig. 9 (Office desks)

Grid like arrangement of desk spaces. Sufficient diffused daylight for all areas through recessed courtyards and North light glazing.

<u>First Floor Office :-</u>

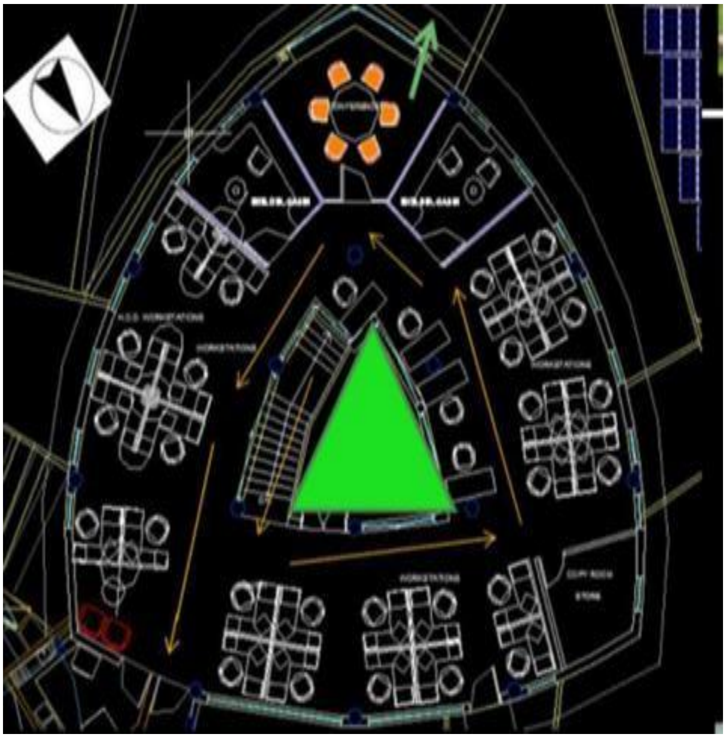


Fig. 10 (Floor Plan)

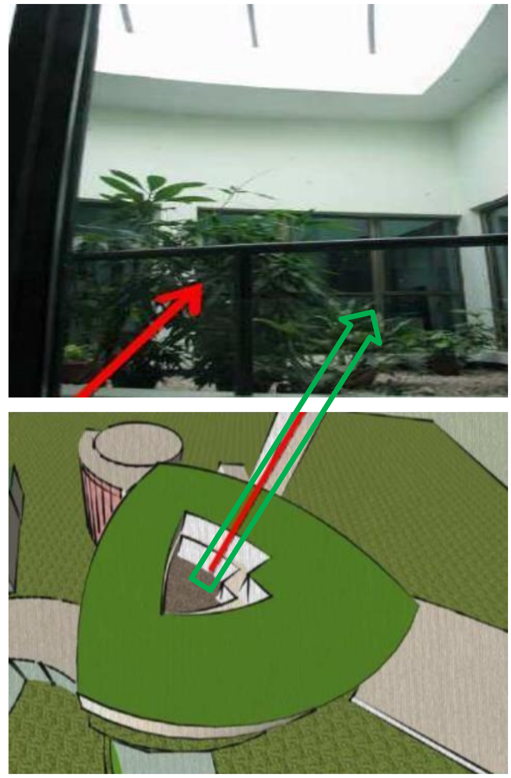
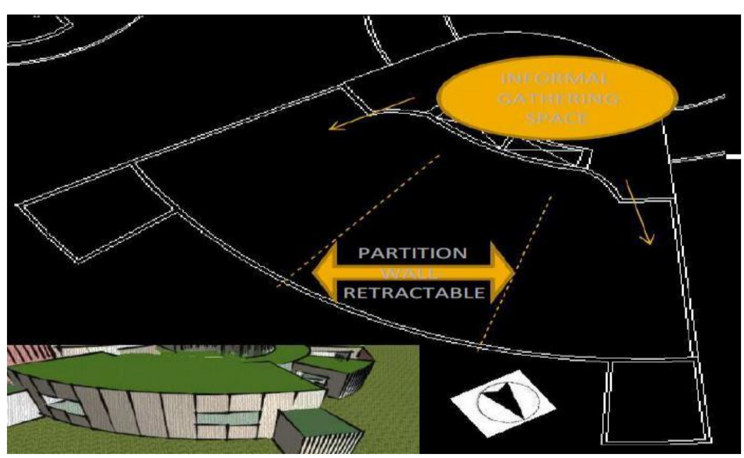


Fig. 11 (Courtyard shown thus)

Fig. 12 (Work space)

All workstations organized around a central court. Naturally lit throughout the day

SEMINAR HALL



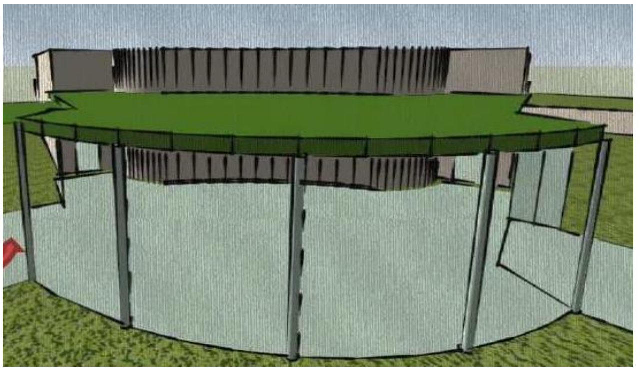


Fig.14 Gathering space outside for interactive discussions before and after seminars may also be used as dining space

Fig.15 Can be divided using partition walls to create smaller meeting rooms, flexibility of spaces

Fenestration : Light and Ventilation

Building layout ensures that 90% of spaces have daylight access and views to the outside.
North facades are glazed for efficient diffused light
Low heat transmitting glass used
Double glass to further reduce heat gain
Natural lighting - no lights are used until late in the evening
Minimum lux levels for all work stations have been ensured
Light captured from as many sides possible - the use of courtyards

Fig. 17 Natural light ensured in dark corners by the use of full length slits for maximum light

Fig. 18 Fully glazed windows help to light the entire technology centre

Fig. 20 North light roof used to naturally light the entire green technology center

Fig. 19 All work stations have ample natural light

Fig. 21 Light may been filtered in meeting rooms and offices by the use of shutter curtain panels

CASE STUDY -3

VISITORS CENTRE AUROVILLE

INTRODUCTION

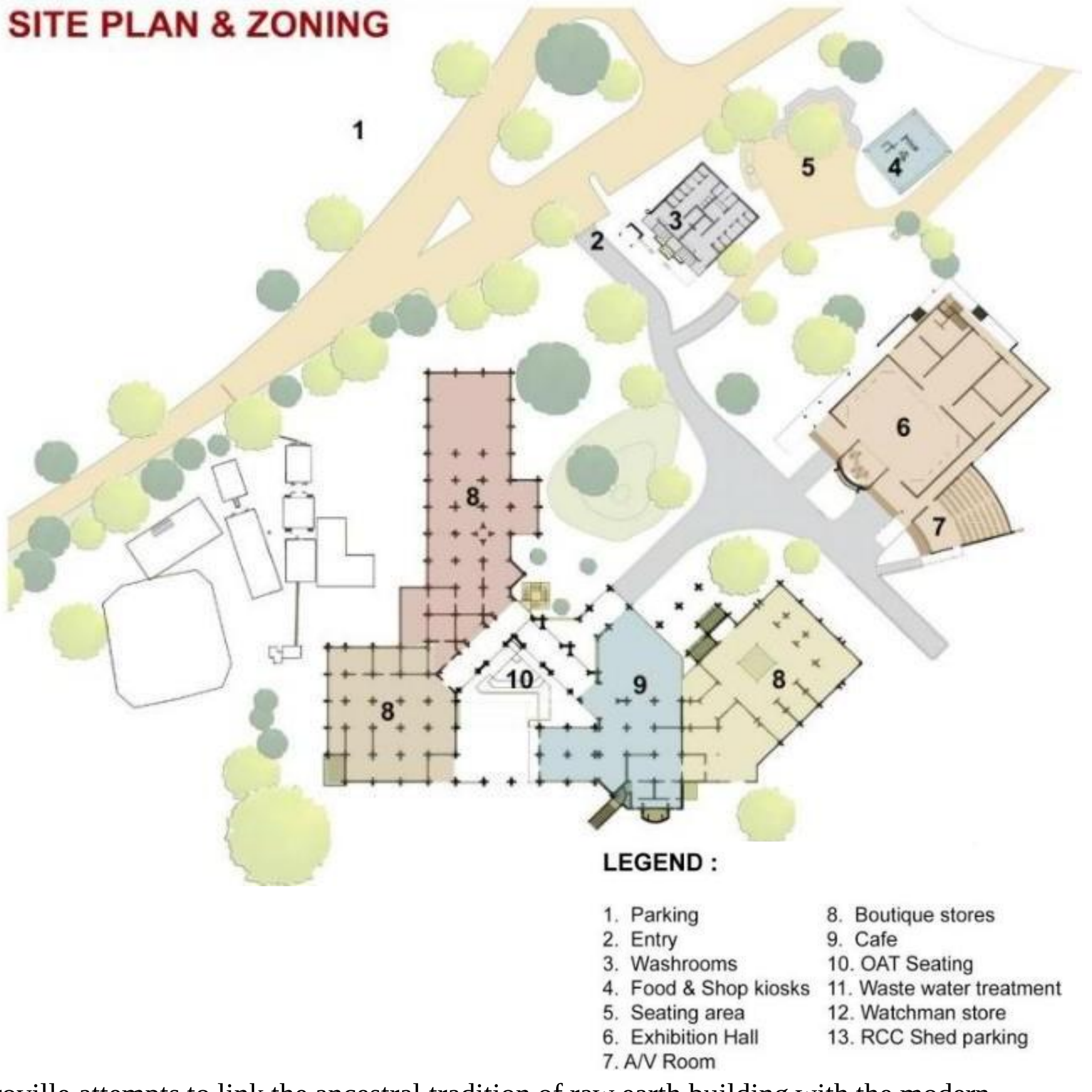
The Auroville Visitors and Reception Centre is a popular and pleasant placefor the visitors and Aurovilians alike.

Type of building use : Institutional building for visitors of Auroville
Architect: Suhasini Iyer
Construction Started: 1988
Built-up Area: 5000 sqm
Plot area: 3 acres
Location: Auroville International Zone, Auroville
Climate : Hot humid coastal

The Visitors Centre, which welcomes large numbers of visitors every day, has been conceived as a demonstration site for **alternative sustainable technology, renewable energy, alternative building techniques and integrated waste water management**. The aim is to demonstrate the possibility to successfully run such acentre in a pleasant set up with low or no environmental impact and pollution

4.2 DESIGN EVOLUTION

The concept of the visitor centre had been initially designed by Suhasini Iyer, but she had absolutely no knowledge about Earth Architecture and site management. Satprem Maini joined Auroville to design fully and build this centre, and at the same time createthe former Auroville Building Centre/Earth Unit. He trained Suhasini, gave a technical design to the concept and mostly managed the construction site.



Auroville attempts to link the ancestral tradition of raw earth building with the modern technologies of stabilised earth.
Earth as a building material, can be used for creating a modern, progressive and eco- friendly habitat.

SALIENT FEATURES

- Integrated site planning for effective management of surface and roof run-off to recharge the aquifer.
- Landscaping with indigenous "tropical deciduous evergreen forest" – reduced water needs Decentralised recycling of all waste water including black
- Urban agriculture to grow fruits
- Solid waste management with segregation / recycling / composting
- Wind mill for Water pumping
- Use of appropriate building materials and technology like CSEB / Ferro cement / rammed earth / light roofing / natural stone floors / minimum wood use
- Solar passive design; natural ventilation / lighting / solar chimneys
- Energy efficient fixtures for lighting and appliances
- Reclamation and afforestation

- It is a popular and pleasant complex specifically designed for visitors from all over the world, with the local climate, materials and building skills influencing the design.
- Special emphasis has been placed on natural lighting and ventilation in the building, as renewable energy sources were to be used.
- From the outset, the plan for the building was to limit the use of concrete and steel.
- Prefabricated Ferro cement elements were used for all doors and overhangs, thereby doing away with the use of wood.
- A 4m grid using load-bearing pillars and arched or corbelled openings was made with stabilised compressed earth blocks to reduce costs.
- Stabilised earth blocks for domes and prefabricated Ferro cement channels were considered as the best solution for roofing.

PLANS

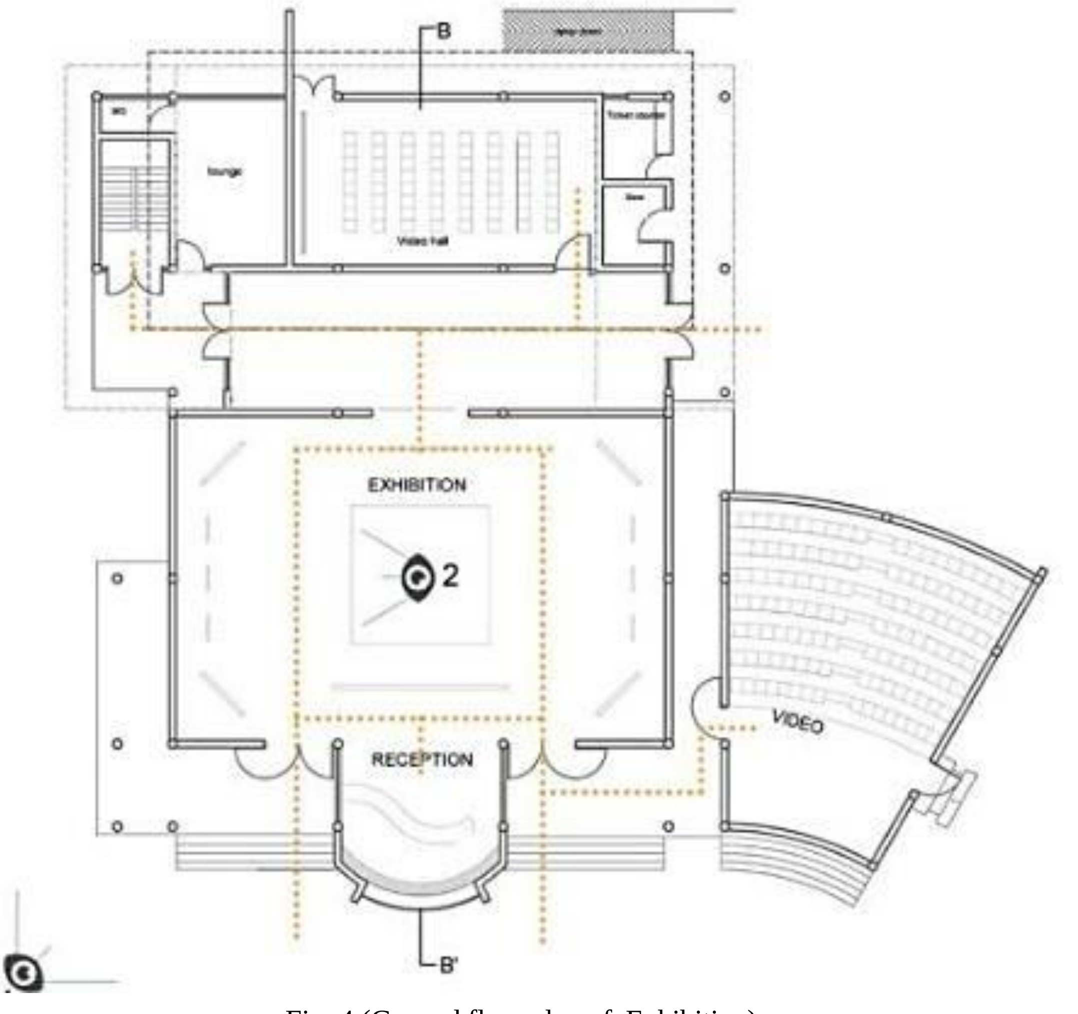


Fig. 4 (Ground floor plan of Exhibition)

SECTION DETAIL OF EXHIBITION

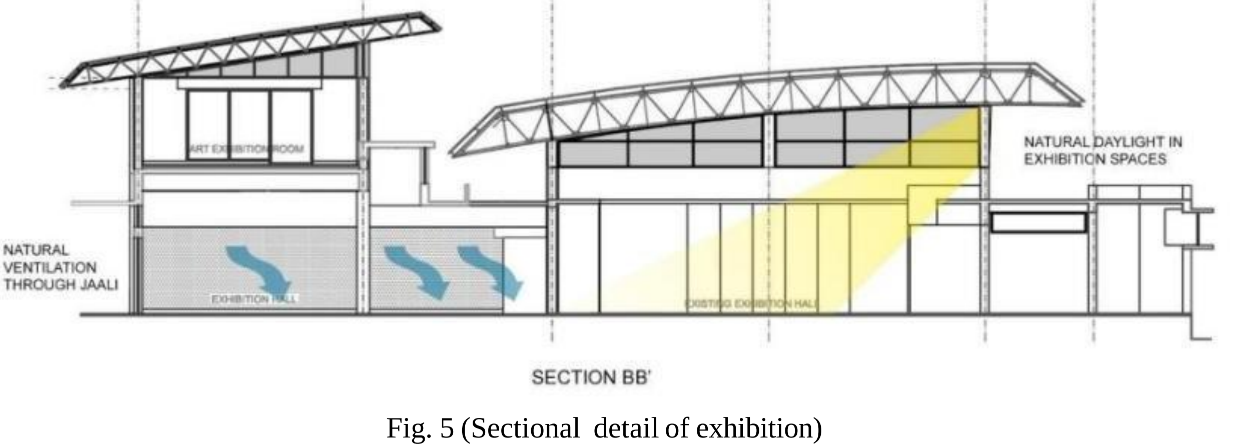


Fig. 5 (Sectional detail of exhibition)

4.6 GROUND FLOOR PLAN OF BANQUET HALL

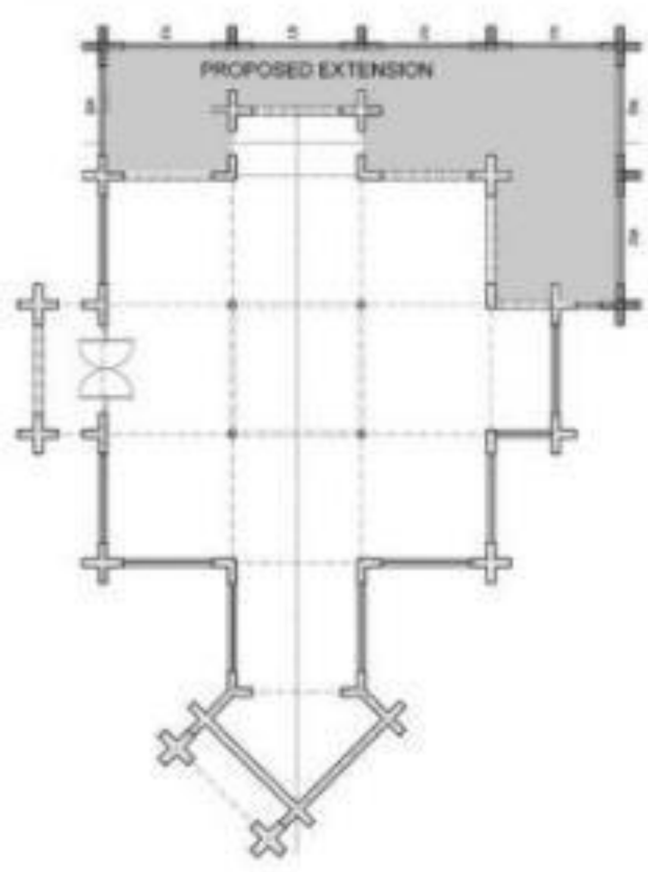


Fig. 6 (Ground floor plan of Banquet Hall)

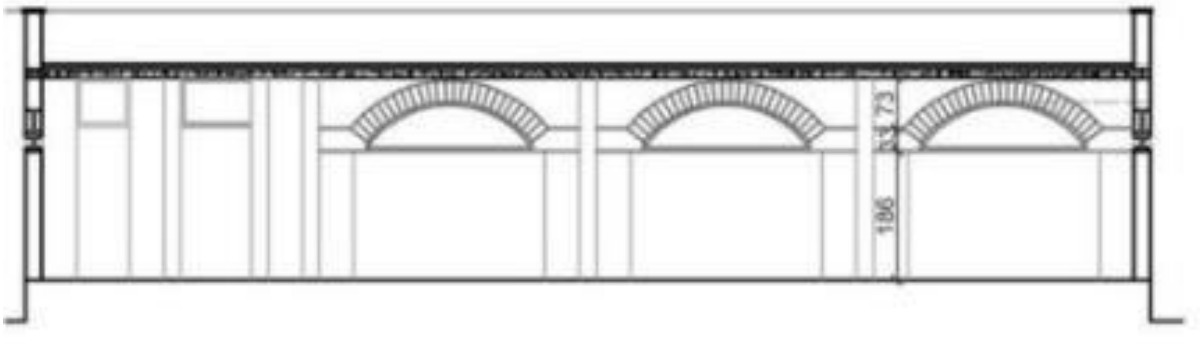


Fig. 7 (Sectional detail of Banquet hall)

SITE STUDY :

Profile :
The North East facing site has Parallelogram profile. Site is almost flat with irregular shape. Site is almost 6 acre in area.

Connection :
The connectivity to the site is from the ring road which ROW is 300'.

Service Lines :
Service line of water supply,sewer,Electrical,telephone run Parallel to the site and also High tension line run through south west corner of the site .

Trees and Plantation :
There is no more vegetation and plantation on the site.

Adjoining area :
Adjacent features of site ....
1. A non operating railway track at their north direction.
2. Ring road at East direction.
3.Railway track running towards south to west direction.
4.GPT. Infrapjojects limited kolkata based factory.

Context :
IP depo is situated from 500 mt. away at north direction. Indraprastha Metro station is also in the same direction from 600 mt. away. Pragati thermal Power plant is 400 mt. away from the site at its east direction. Pragati Maidan is 150 mt. away from the site at its south direction.

Views :
The site will be visible from ring road.

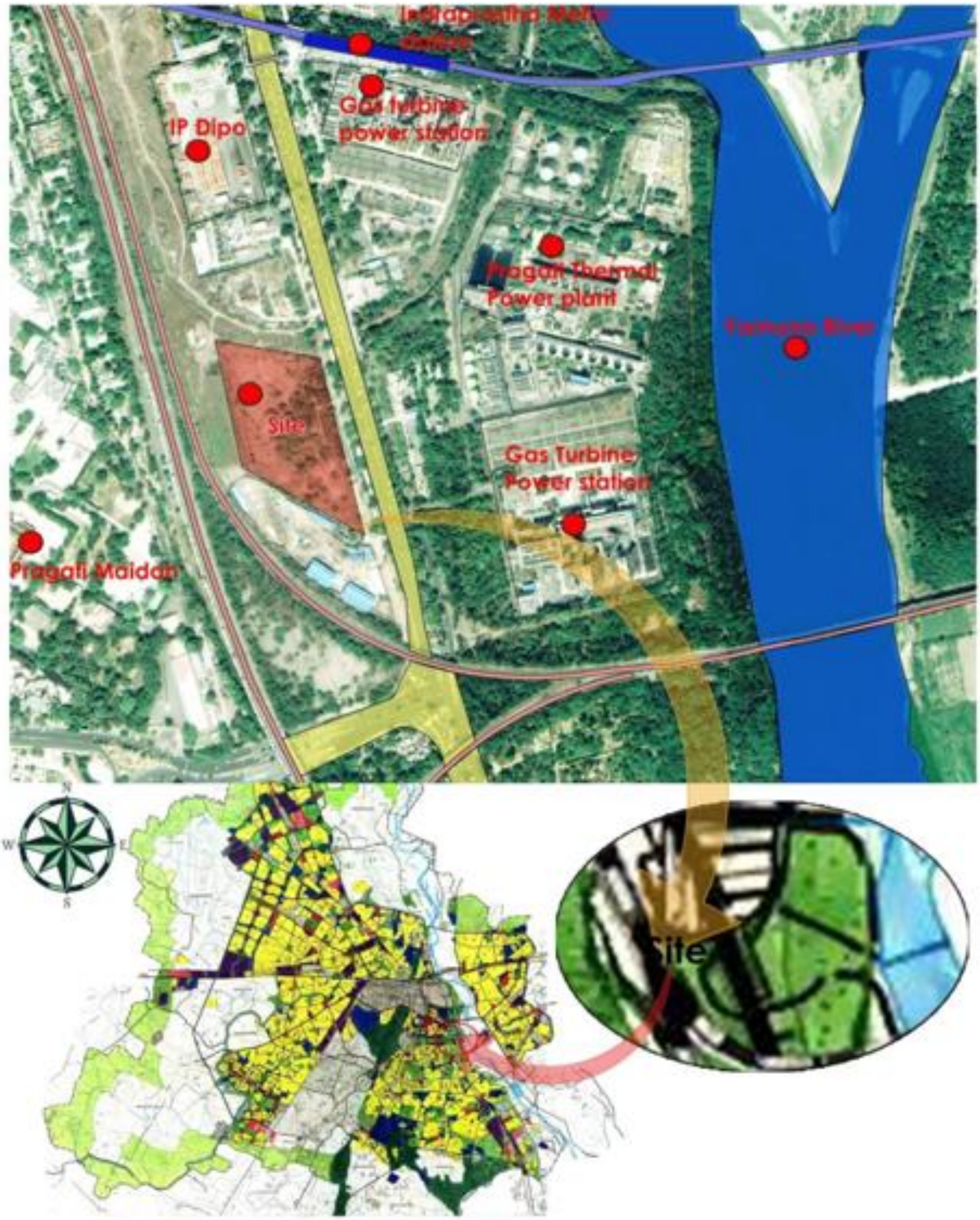
Soil :
The soil in Delhi is basically alluvial in nature and hence the site has alluvial soil. Since the site is situated near the awater body and the Yamuna river hence, moisture is there in the soil.

Drainage,water and Power supply :
The drainage is through pipelinesf exposed)near the site and the water needs is also catered through the lines near the site.

Power supply is through poles near the roads and across the Noida toll bridge we have the high tension wires running.

Site location :

Site located in Delhi near indraprastha metro station adjajcent to ring road.Yamuna river is 500 mt.away at east direction and Pragati maidan is 150 mt.away at west direction.



Total site area - 18499 sqft.
FAR-2.6
Ground Coverage-53%
permissible ground coverage-60%

Thesis Statement:

- This thesis explores the architectural design of a net-zero energy mixed-use building in a dense urban context, integrating passive and active energy strategies, urban form considerations, and multifunctional spaces to create a resilient, low-carbon prototype for future development.

Objectives:

1. To develop a design strategy that balances commercial, residential, and public space functions within a net-zero energy framework.

2. To investigate the challenges and opportunities of integrating renewable energy systems in dense urban environments.

3. To demonstrate how mixed-use development can support energy efficiency through shared resources and community synergy.

4. To promote compact, walkable, and sustainable urban living.

Scope:

- Medium to high-rise building (5–15 floors).
- Located in a metropolitan area (you can choose a specific city for context).
- Includes residential units, retail space, co-working areas, and communal amenities.
- Incorporates site-specific climate response.

Design Strategies:

1. Passive Design:

- Building orientation and massing for daylight and wind flow.
- Solar shading, thermal insulation, and natural ventilation.
- Courtyards, green roofs, and vertical gardens.

2. Active Systems:

- Solar PV panels integrated into facades and roofs.
- Smart HVAC systems with energy recovery.
- Real-time energy monitoring systems.

3. Sustainable Urban Integration:

Transit-oriented design (proximity to public transport).

Shared infrastructure: district energy, water reuse systems.

Public plaza or street activation for social sustainability.

Research Methods:

Case studies of successful net-zero mixed-use developments (e.g., The Edge in Amsterdam, Bosco Verticale in Milan).

Climate data analysis and site study.

Simulation and modeling (energy modeling using software like EnergyPlus, daylight analysis with Ladybug).

User studies for programmatic needs.

Expected Outcome:

A detailed architectural proposal demonstrating a scalable and realistic net-zero mixed-use building, serving as a model for sustainable urban growth.

Site Surroundings :

Important Features of Site :

1. A non operating railway track at their north direction.
2. Ring road at East direction.
3.Railway track running towards south to west direction.
4.GPT. Infrapjojects limited kolkata based factory.
5 National science museum at west.
6.Indraprastha metro station is also situated at north direction of the site.

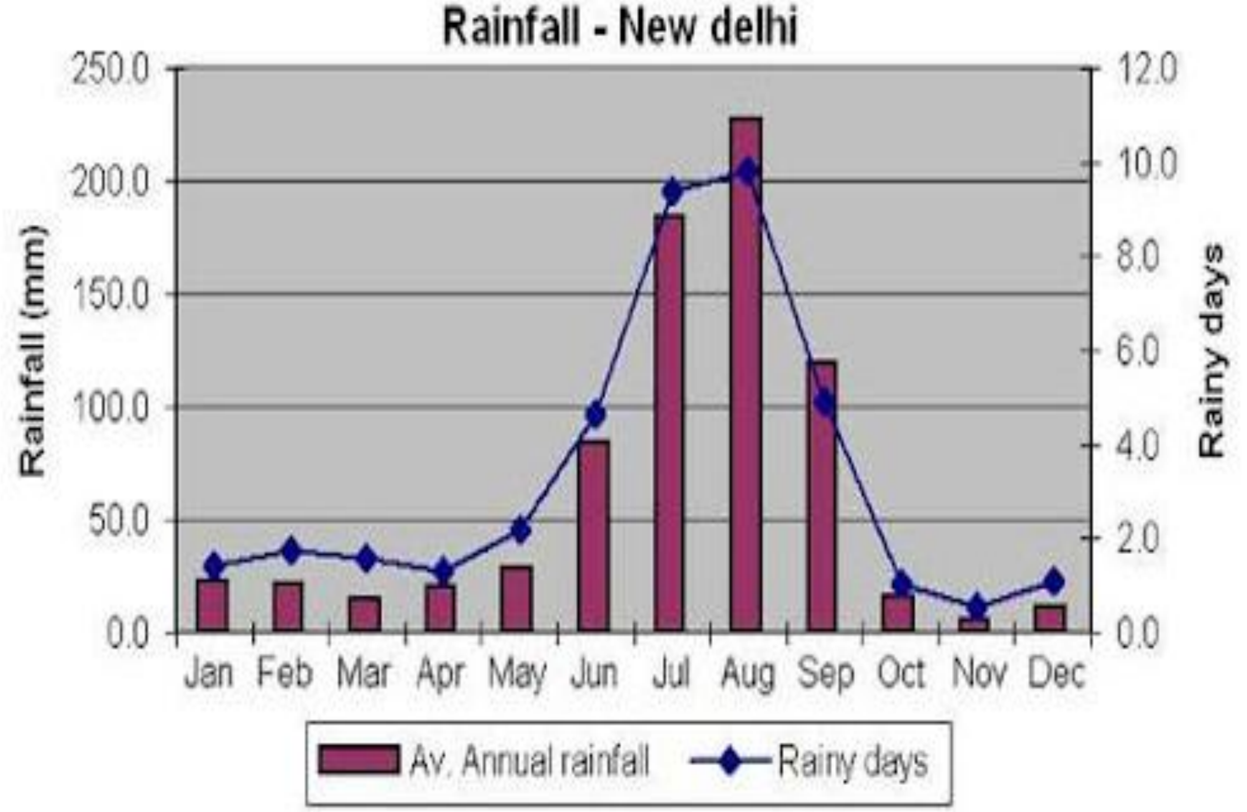
CLIMATIC CONDITIONS :-

Delhi's average annual rainfall is 774.4 mm. However, rainfall in Delhi can vary from year to year:

2024: As of September 14, 2024, Delhi's annual rainfall was 1063.6 mm, which is higher than the long-term
average.
2021: Delhi's annual rainfall was 1526.8 mm, making it the second-wettest year on record.
2022: Delhi's annual rainfall was 811.4 mm.

Delhi's monsoon season is from July to mid-September. The city receives most of its rainfall from the
Bay of Bengal branch.

Here are the average temperatures. Precipitation amounts to 760 millimeters (29.9 inches) per year:
so, it is at an intermediate level. It ranges from 4.9 mm (0.2 in) in the driest month (November) to
235 mm (9.3 in) in the wettest one (August). Here is the average precipitation.



SOIL CONDITION :-

Here's some information about the soil conditions in Narela, Delhi:

Soil type

The soil in Delhi is mostly light, with some medium texture soils. The light texture soils are sandy, loamy, sand and sany loam, while the medium texture soils are loam silty loam.

Drainage

The sub-city of Narela has a good natural drainage system. The area is divided into two drainage basins: the catchments of Bawana escape and the catchments of Drain No. 6.

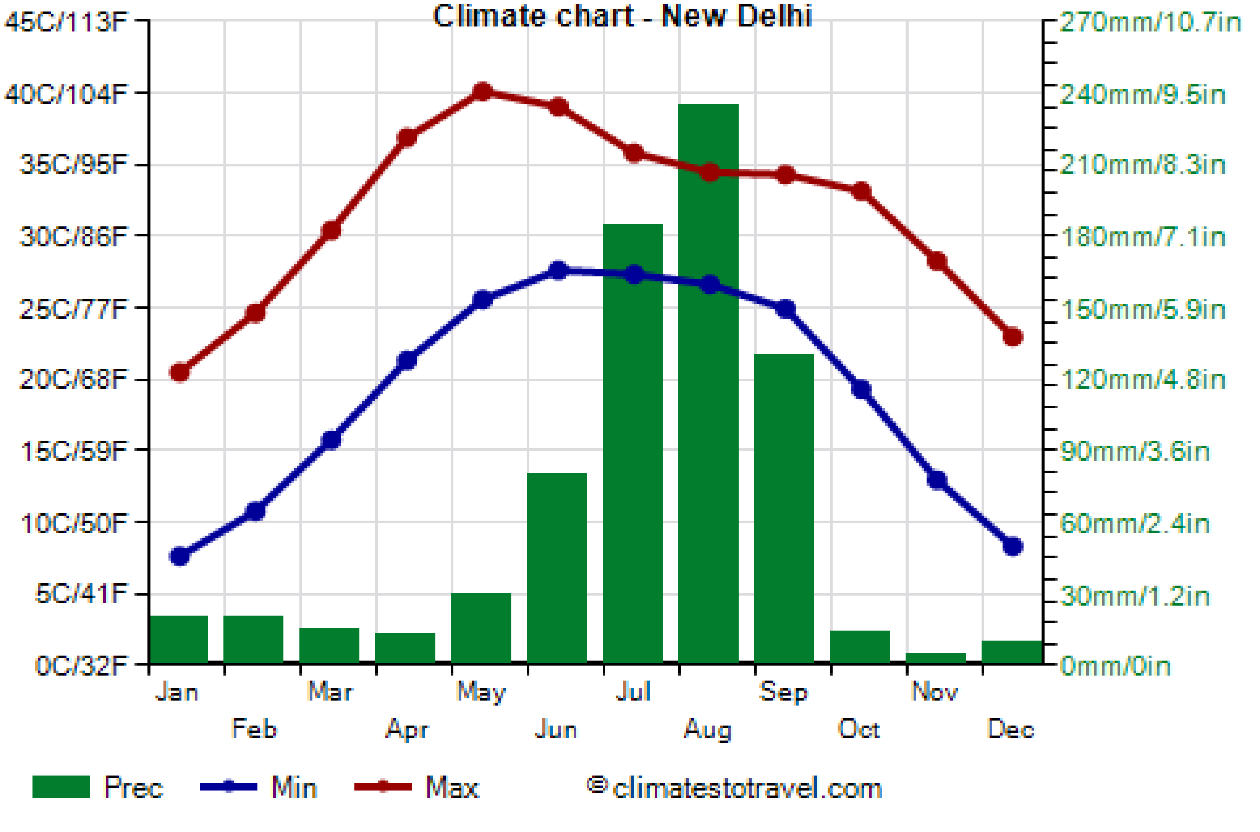
Land use

The zone P-I of Narela is well connected by major roads and highways and is ideal for urban development. The area has a large green tree coverage in the form of orchards, forest, and farmlands.

Groundwater

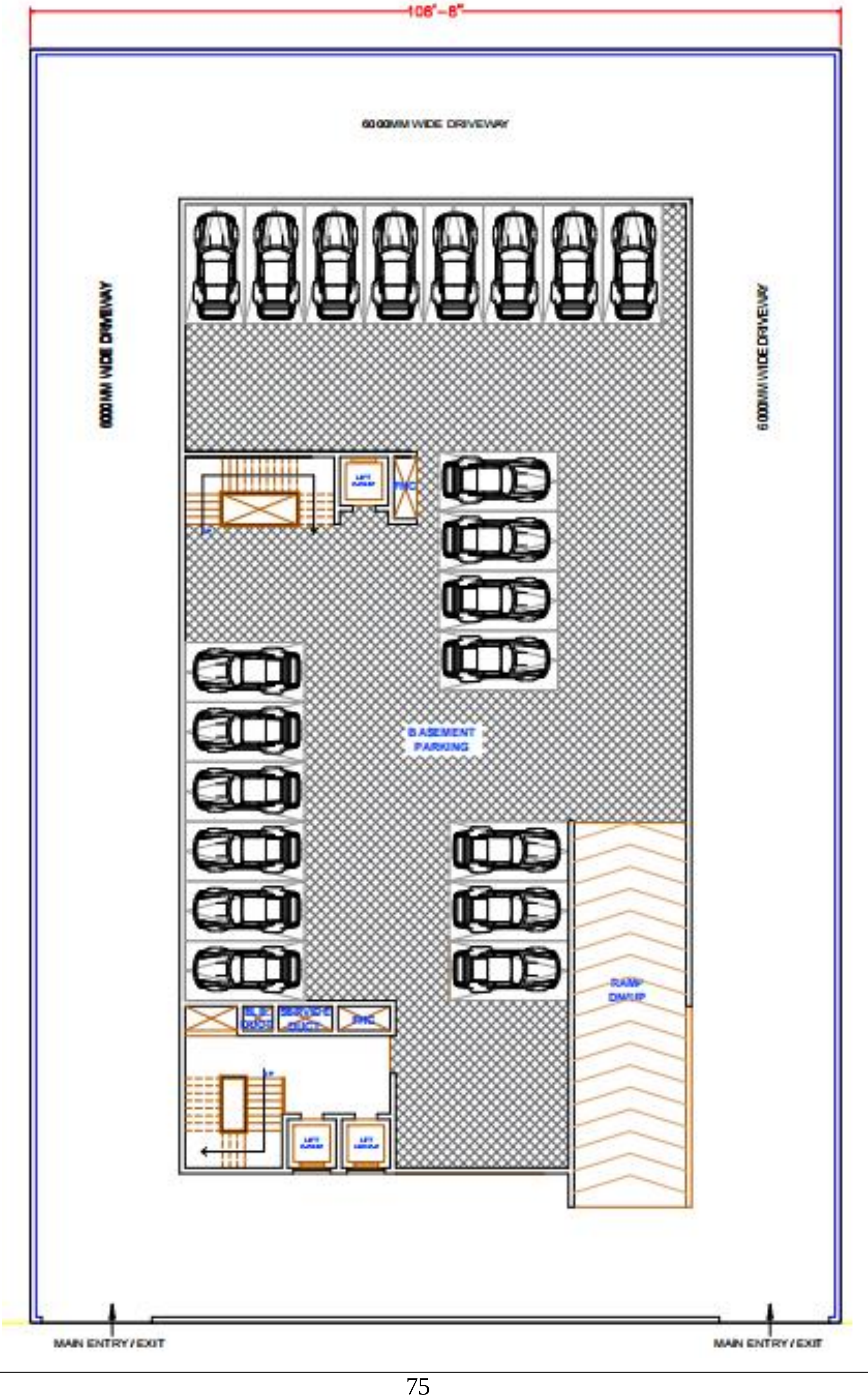
The indiscriminate pumping out of groundwater for agriculture and other needs has significantly exhausted the aquifers in Narela.

You can get your soil tested at a reliable soil testing laboratory in Narela, Delhi.



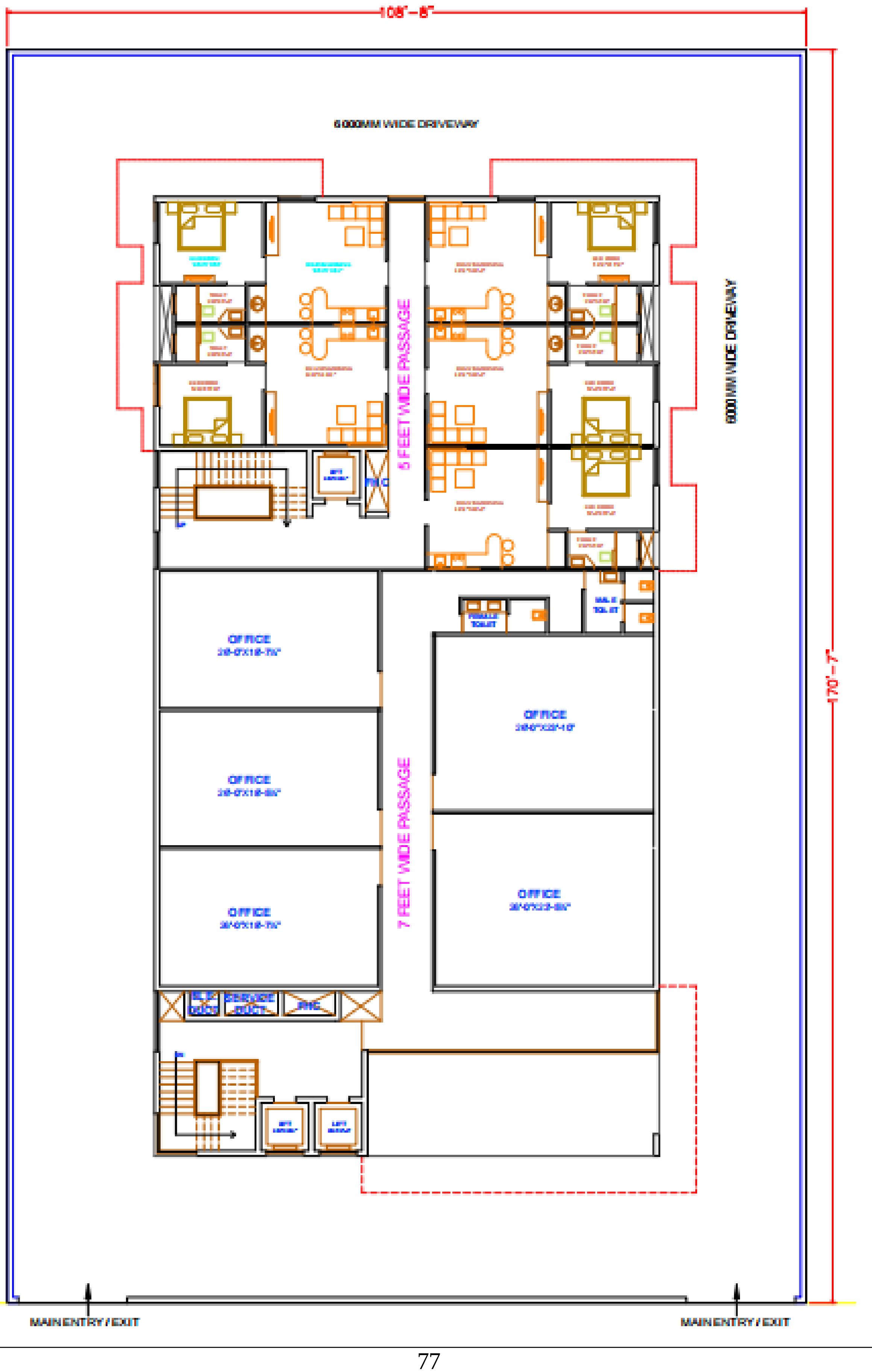
FLOOR PLANS :-

BASEMENT FLOOR PLAN :-

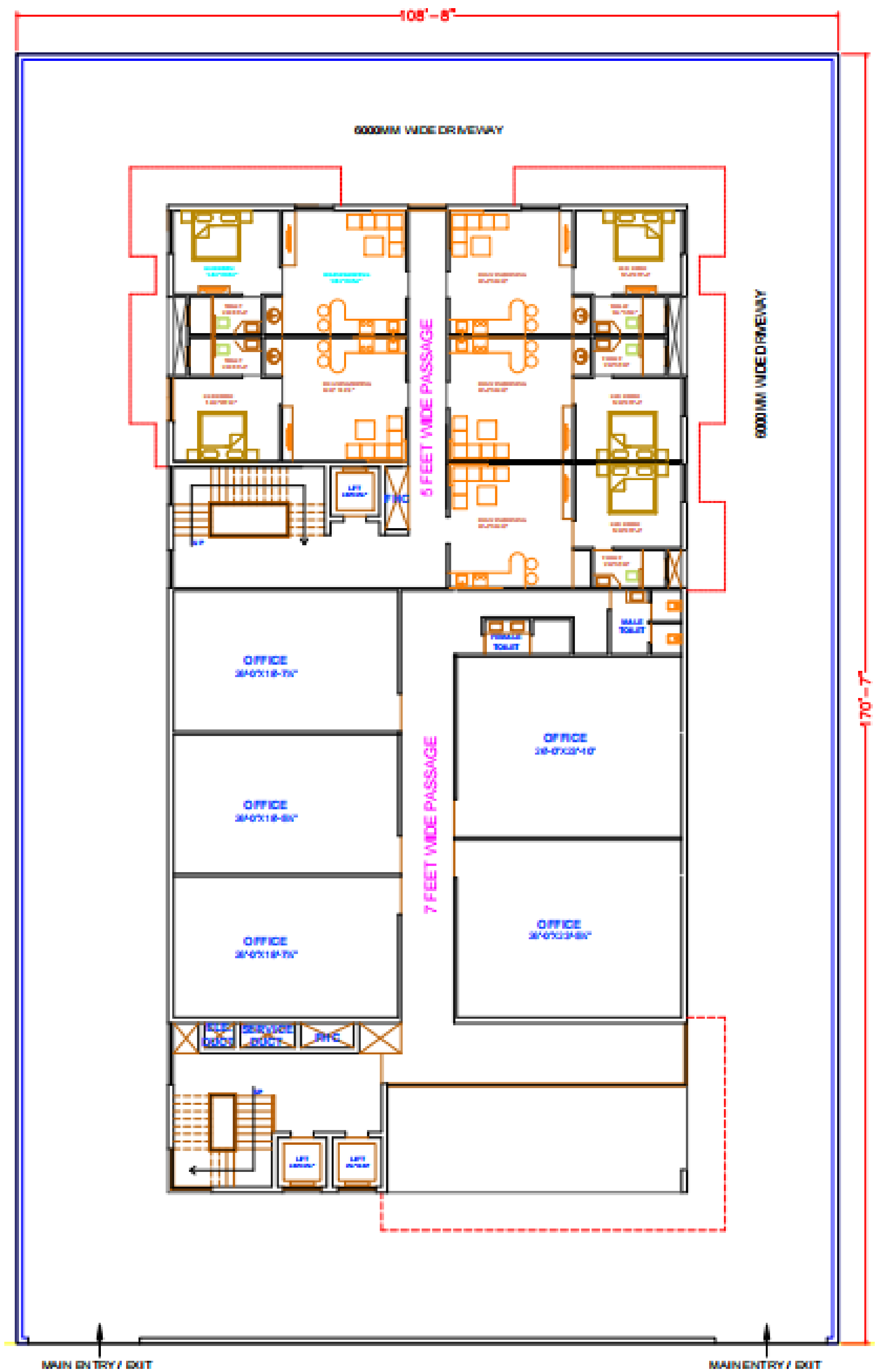


GROUND FLOOR PLAN :-

FIRST FLOOR PLAN

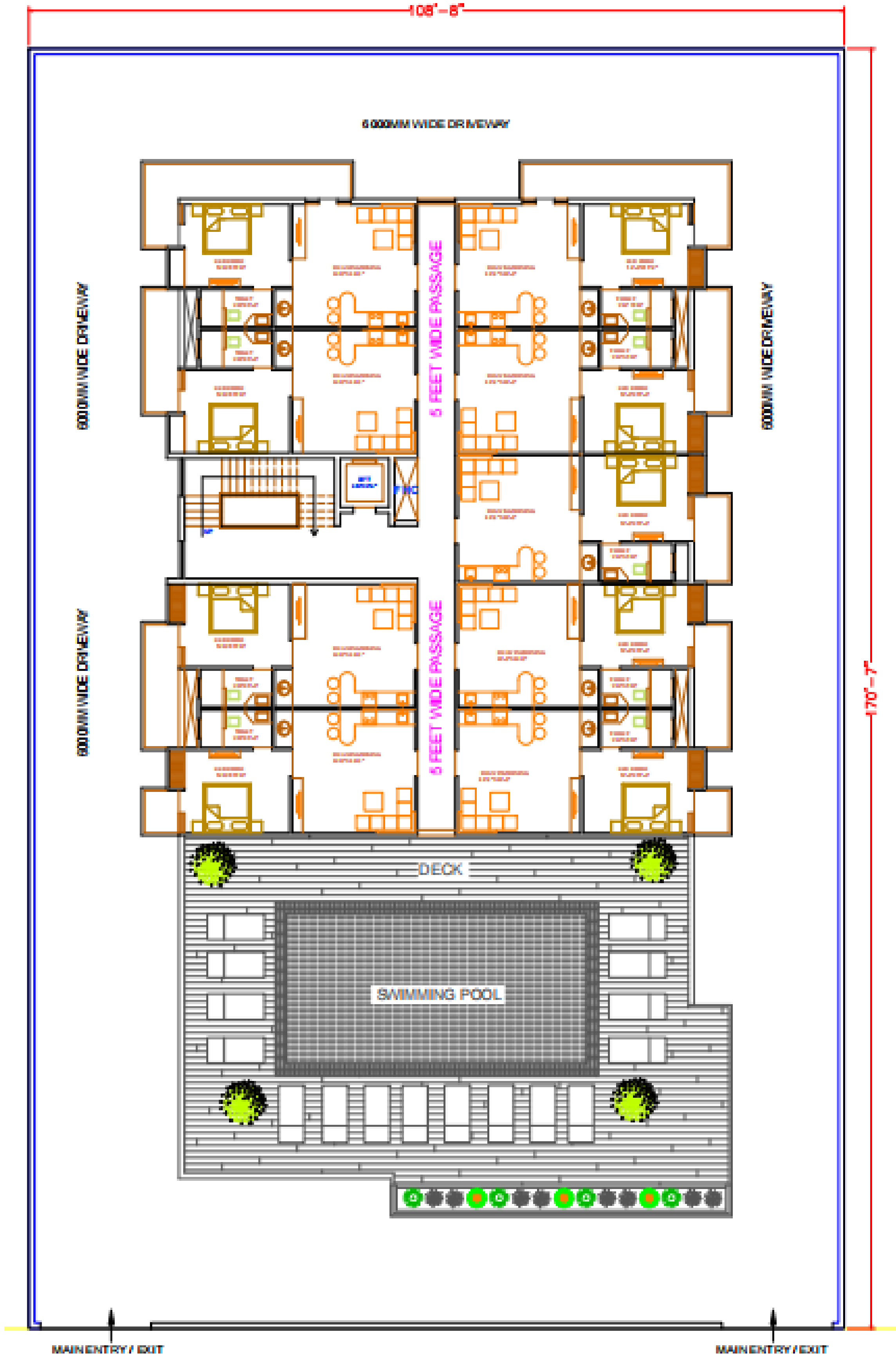


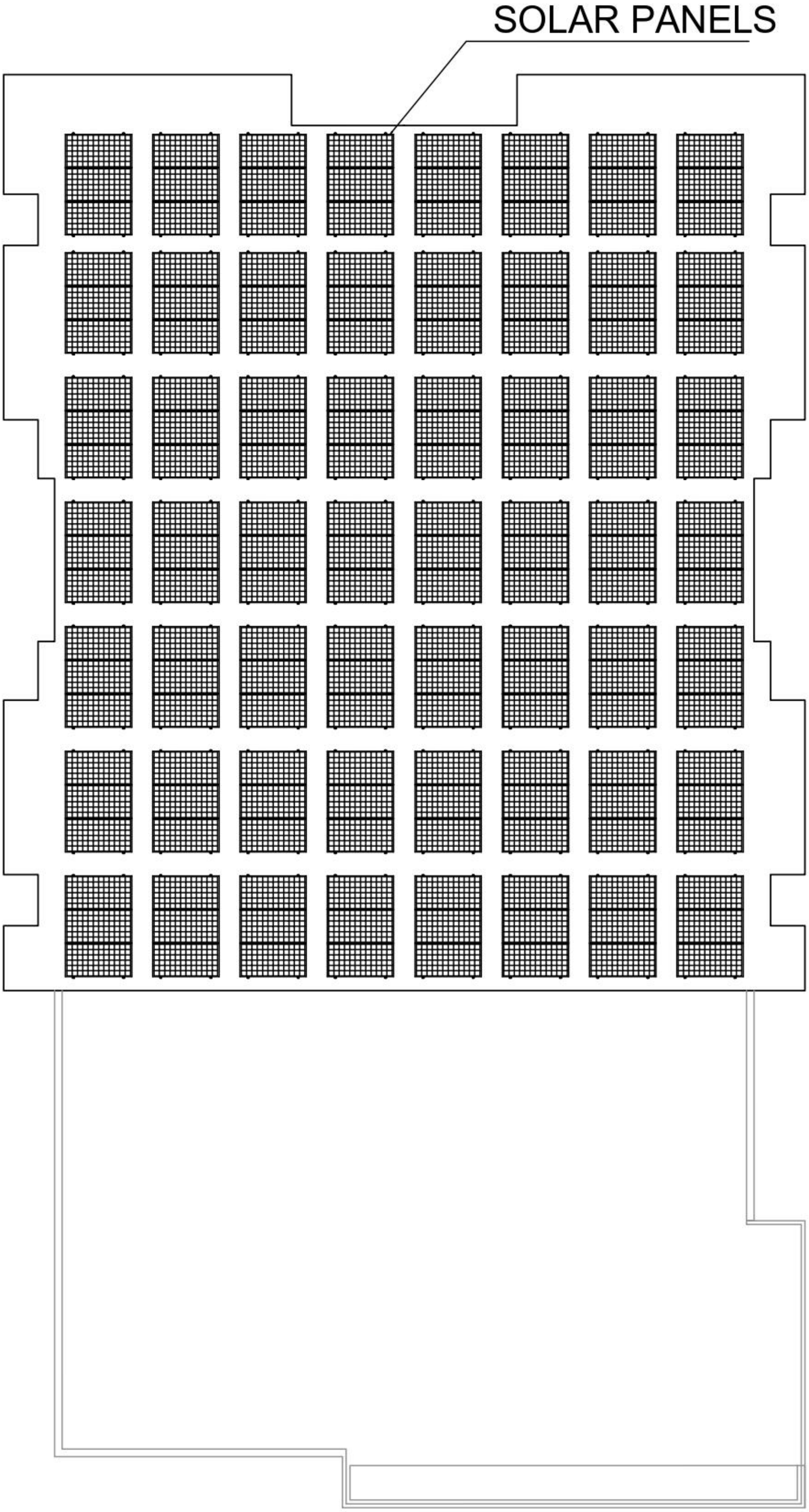
SECOND FLOOR PLAN



THIRD FLOOR PLAN

TYPICAL FLOOR PLAN :-




SOLAR PANELS

Typical Heat Gain Ranges in Buildings
These vary by climate and design. For a well-designed NZEB, total heat gain is minimized to achieve balance with renewable energy generation.

Source	Conventional Building	NZEB Target
Solar Gain (Windows)	40–60% of total heat	≤20%
Conduction (Walls/Roof)	20–30%	≤10–15%
Internal Loads	20–30%	Minimized via energy-efficient appliances
Infiltration	5–15%	≤5% (airtight envelope)

TOTAL NO. OF SOLAR PANELS -370
ELECTRICITY PRODUCED BY A PANEL- 300 WATT

Total System Capacity
370 panels x 300W/panel = 111,000W or 111 kW

Daily Energy Production
Assuming 5 peak sun hours per day, the daily energy production would be:
111 kW x 5 hours = 555 kWh/day

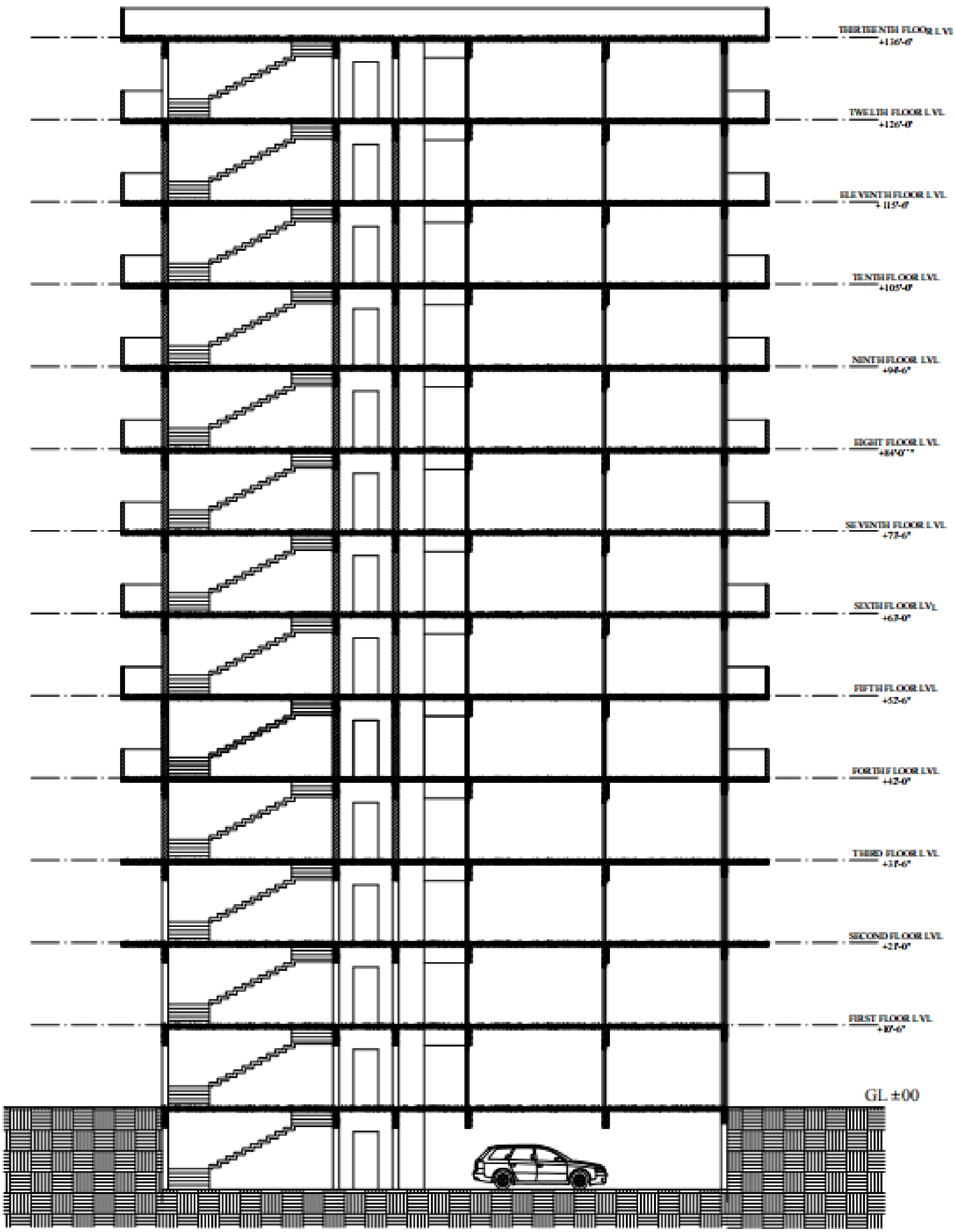
Monthly Energy Production
555 kWh/day x 30 days = 16,650 kWh/month

Annual Energy Production
555 kWh/day x 365 days = 202,575 kWh/year

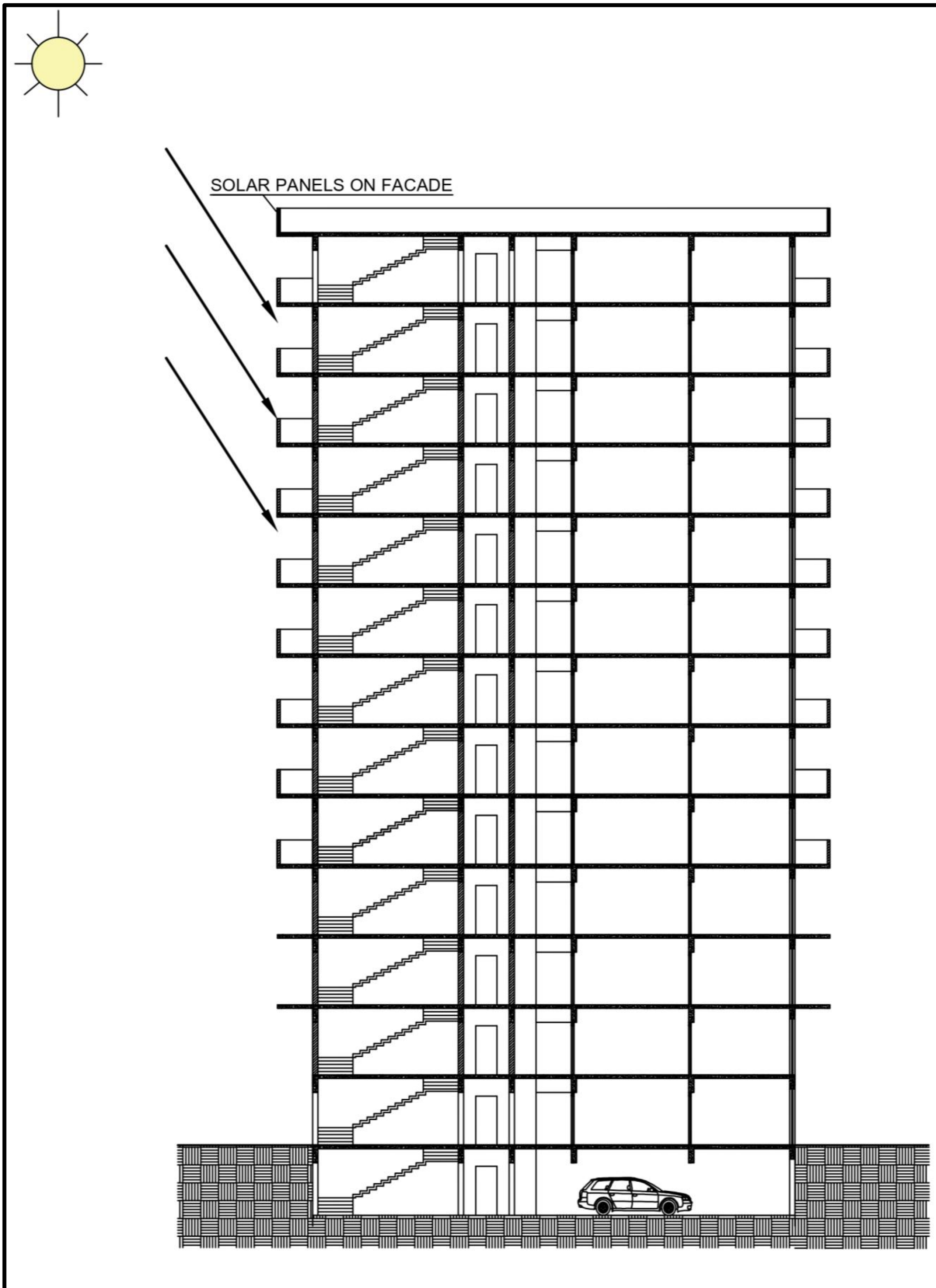
Keep in mind that actual energy production may vary due to factors like:
- Panel efficiency
- Sunlight intensity
- Temperature
- Shading
- System losses

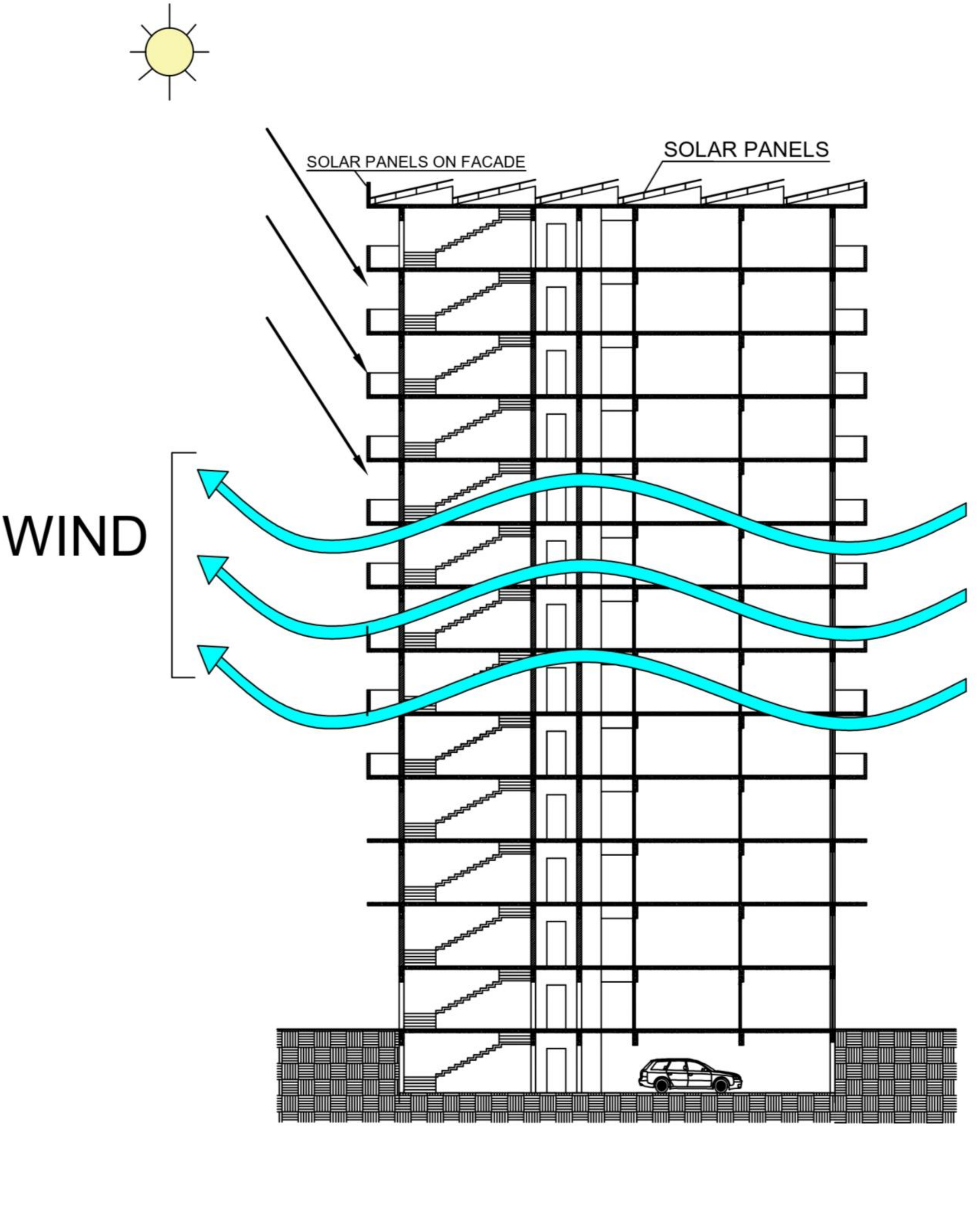
This calculation provides an estimate of the potential electricity generation from 370 solar panels

SECTION X-X'



THIRTEENTH FLOOR L.VL
+136'-6"
TWELTH FLOOR L.VL.
+126'-0"
ELEVENTH FLOOR L.VL.
+115'-6"
TENTH FLOOR LVL.
+105'-0"
NINTH FLOOR LVL.
+94'-6"
EIGHT FLOOR L.VL.
+84'-0"
SEVENTH FLOOR L.VL.
+73'-6"
SIXTH FLOOR LVL.
+63'-0"
FIFTH FLOOR LVL.
+52'-6"
FORTH FLOOR LVL.
+42'-0"
THIRD FLOOR L.VL.
+31'-6"
SECOND FLOOR LVL.
+21'-0"
FIRST FLOOR L.VL.
+10'-6"
GL ±00


SOLAR PANELS ON FACADE


SOLAR PANELS ON FACADE
SOLAR PANELS
WIND

SITE VIEWS :-

SITE VIEWS :-

9. REFERENCES

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MIXED USE

AREA CALCULATION:-

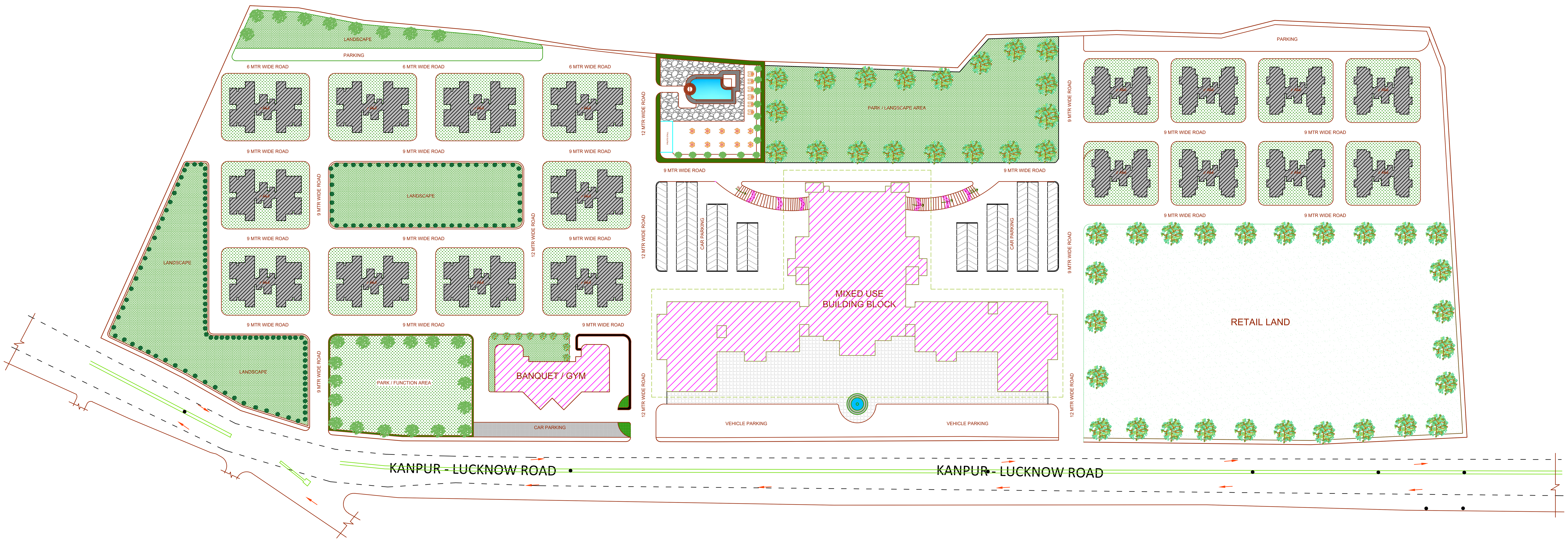
TOTAL PLOT AREA- 29 ACRES (1,17,358.84 sqm.)
GROUND COVERAGE - 35%
F.A.R. - 2
TOTAL BUILTUP AREA = 2,34,717.68 SQM.
TOTAL GR. COVERAGE = 41075.59 SQM.

TOTAL AREA OF 1BHK - 108192 sqm
TOTAL AREA OF 2BHK - 45360 sqm

TOTAL AREA OF SHOPPING MALL, HOTEL AND OFFICE - 72797 sqm

TOTAL AREA OF BANQUET - 5815.00 sqm

TOTAL BUILTUP AREA ACHIEVED = 232164.00 SQM.
(F.A.R. ACHIEVED = 1.978)
TOTAL GR. COVERAGE ACHIEVED = 16,297.40 SQM. (13.88%)



SITE PLAN
AREA -29 ACRE

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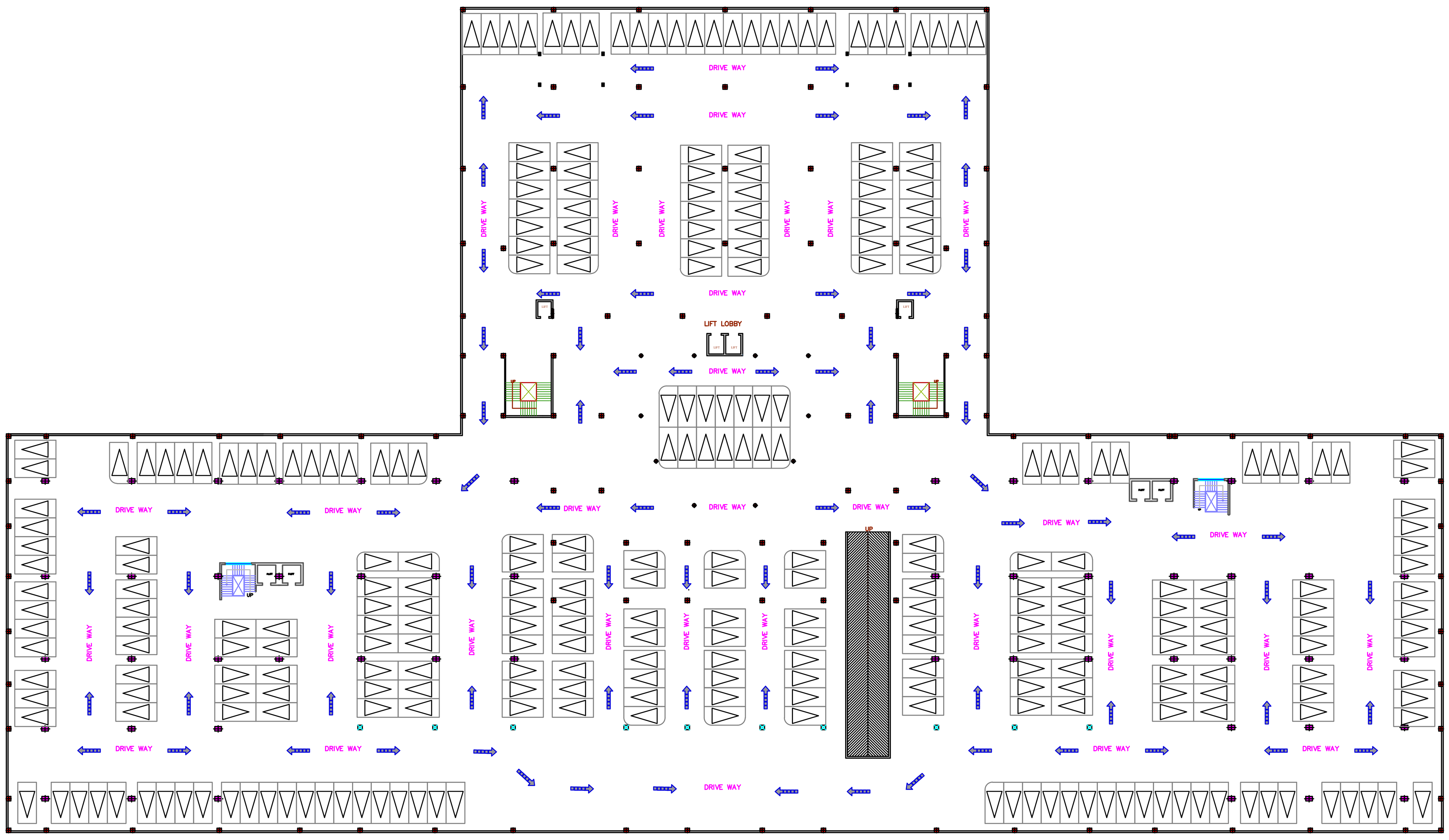
SHEET NO:
SCALE :1/1000

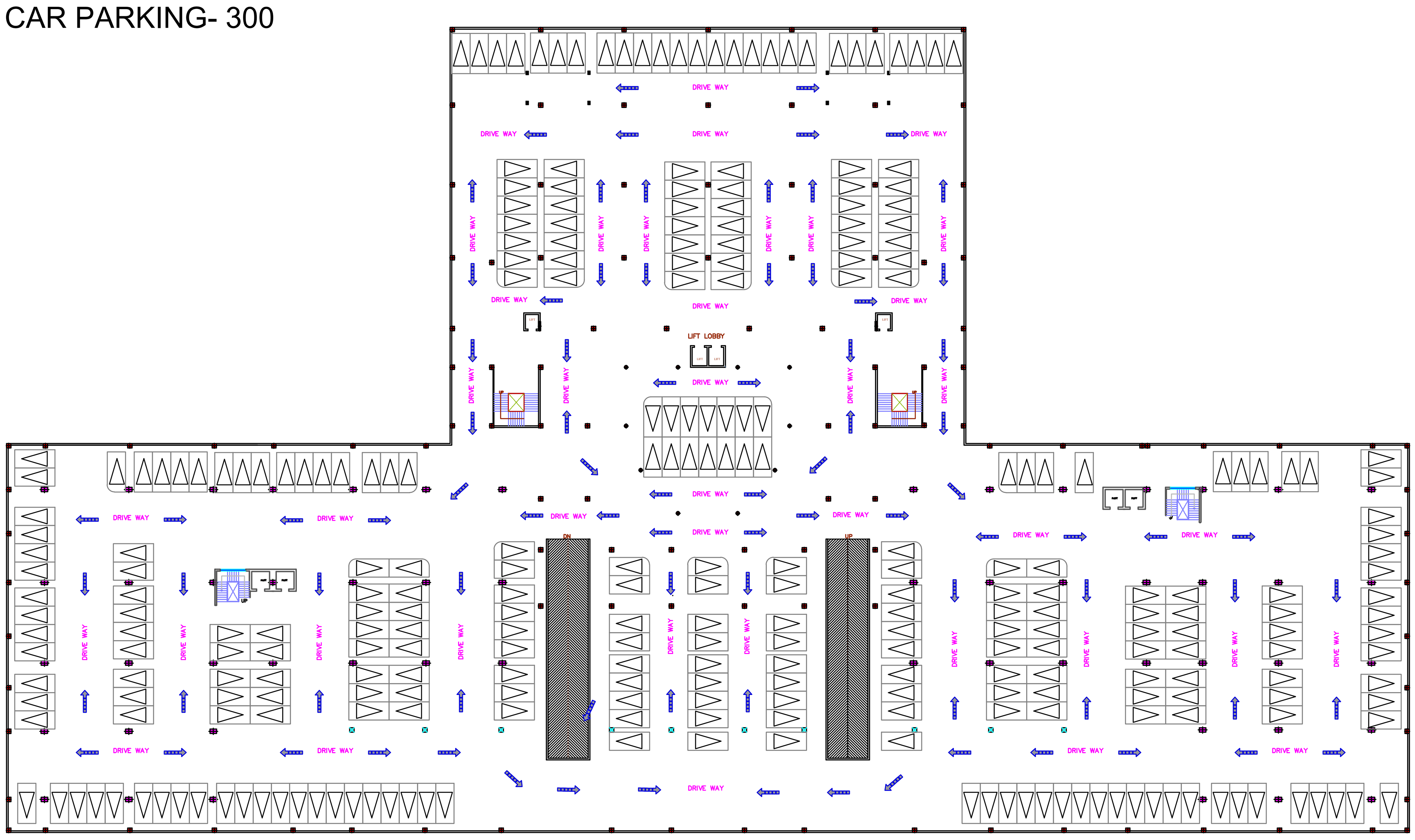
SESSION:
ROLL NO.-

SUBMITTED BY :
JATIN KHANNA

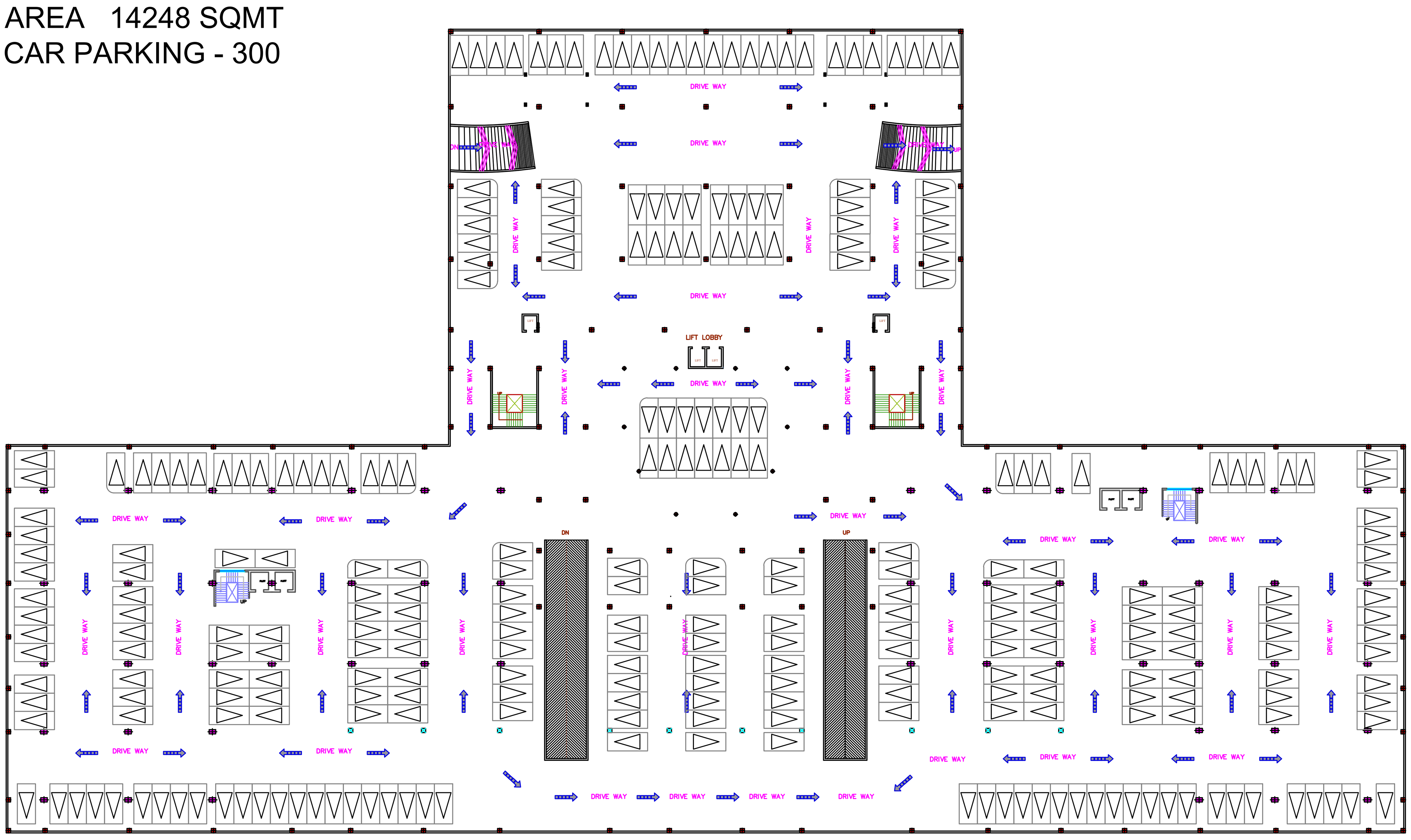
MIXED USE



SECOND FLOOR BASEMENT PLAN
AREA- 14248 SQMT
CAR PARKING- 300



FIRST FLOOR BASEMENT PLAN
AREA   14248 SQMT
CAR PARKING - 300



BASEMENT PLAN
AREA   14248 SQMT
CAR PARKING - 300

SUBMITTED TO :

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SESSION:
SCALE :1/500
ROLL NO.-

SUBMITTED BY :
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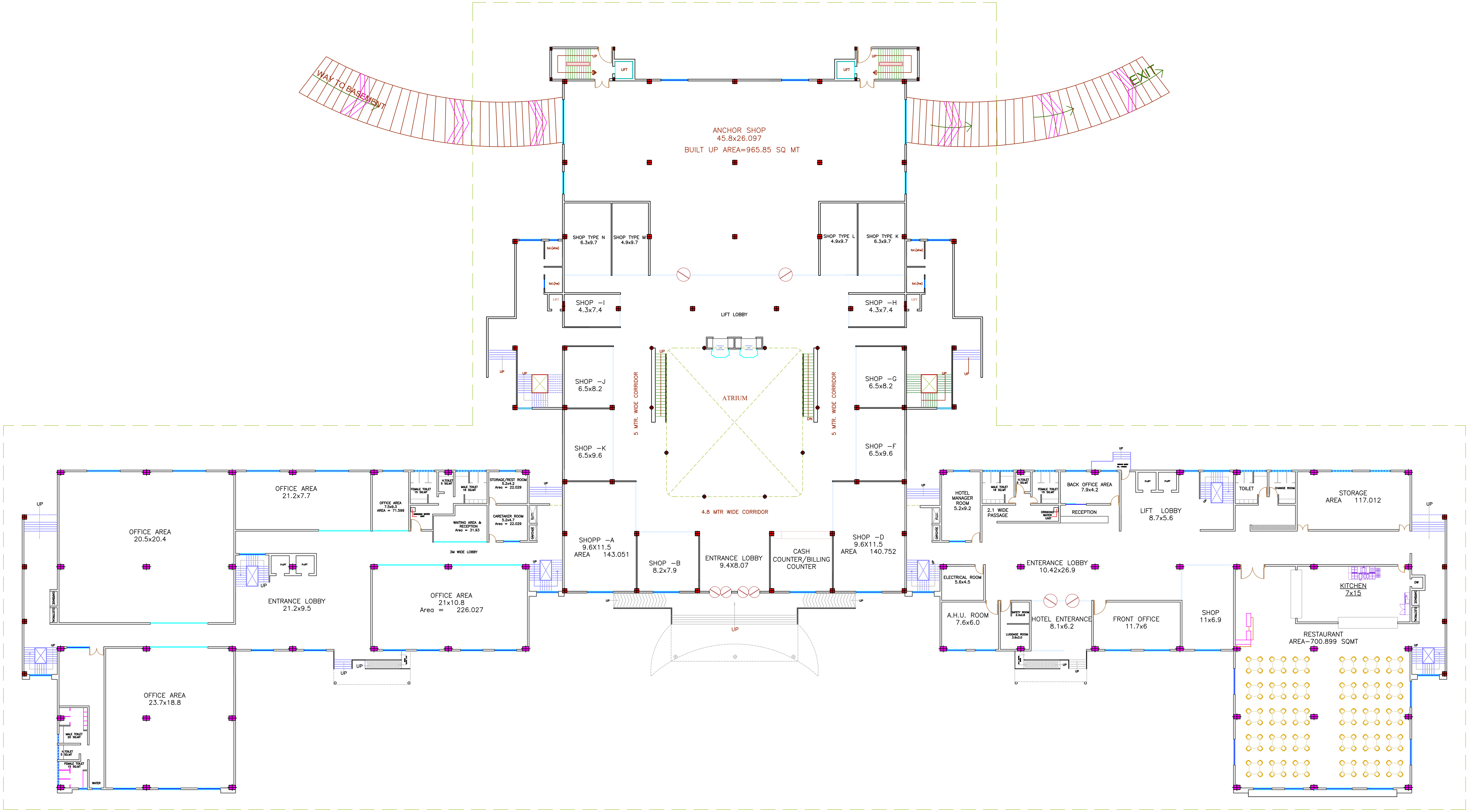
MIXED -USE DEVELOPMENT



GROUND FLOOR PLAN

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SCALE :1/200

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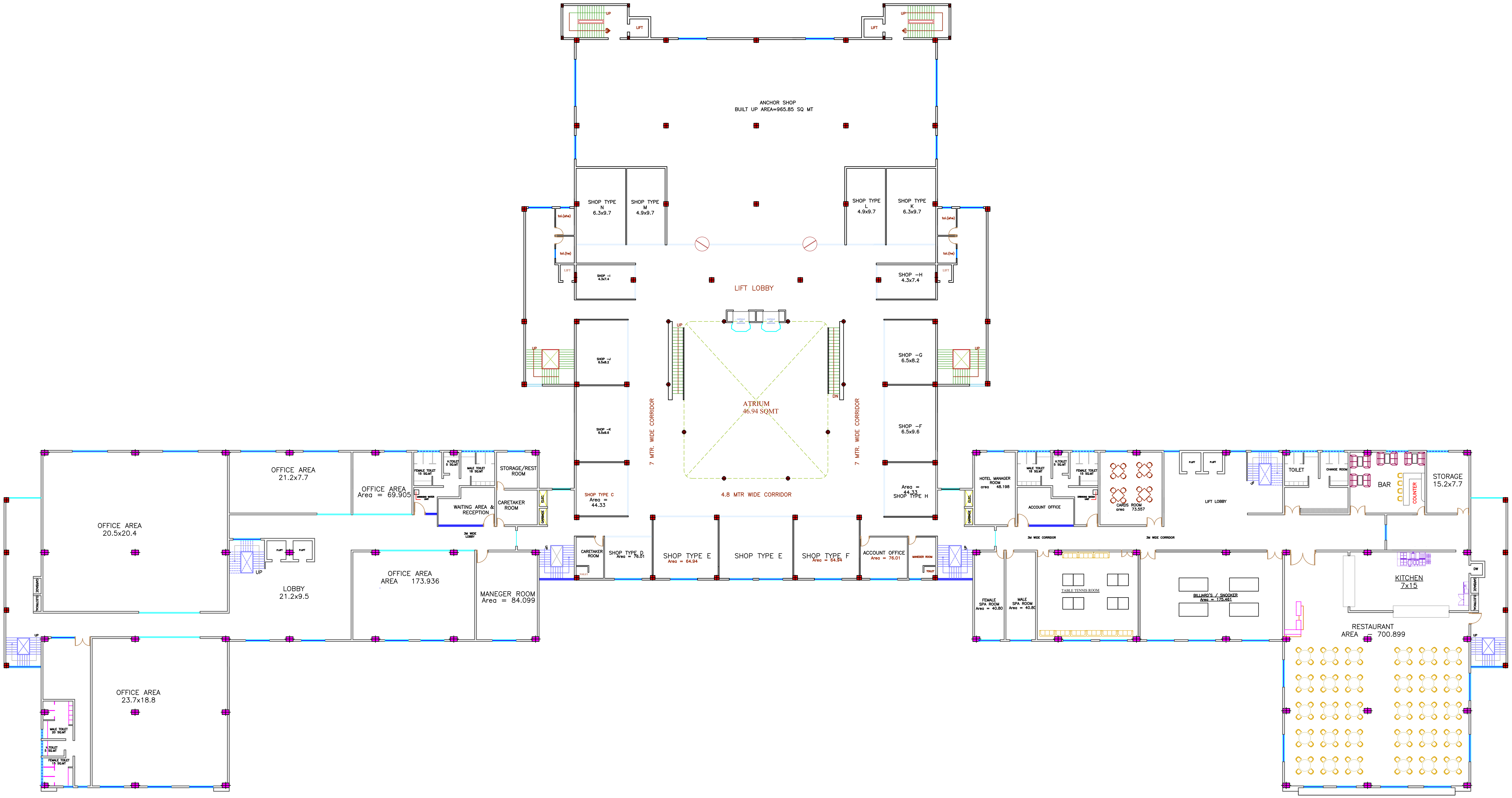
ROLL NO.-

SUBMITTED BY :

JATIN KHANNA

MIXED -USE DEVELOPMENT



FIRST FLOOR PLAN

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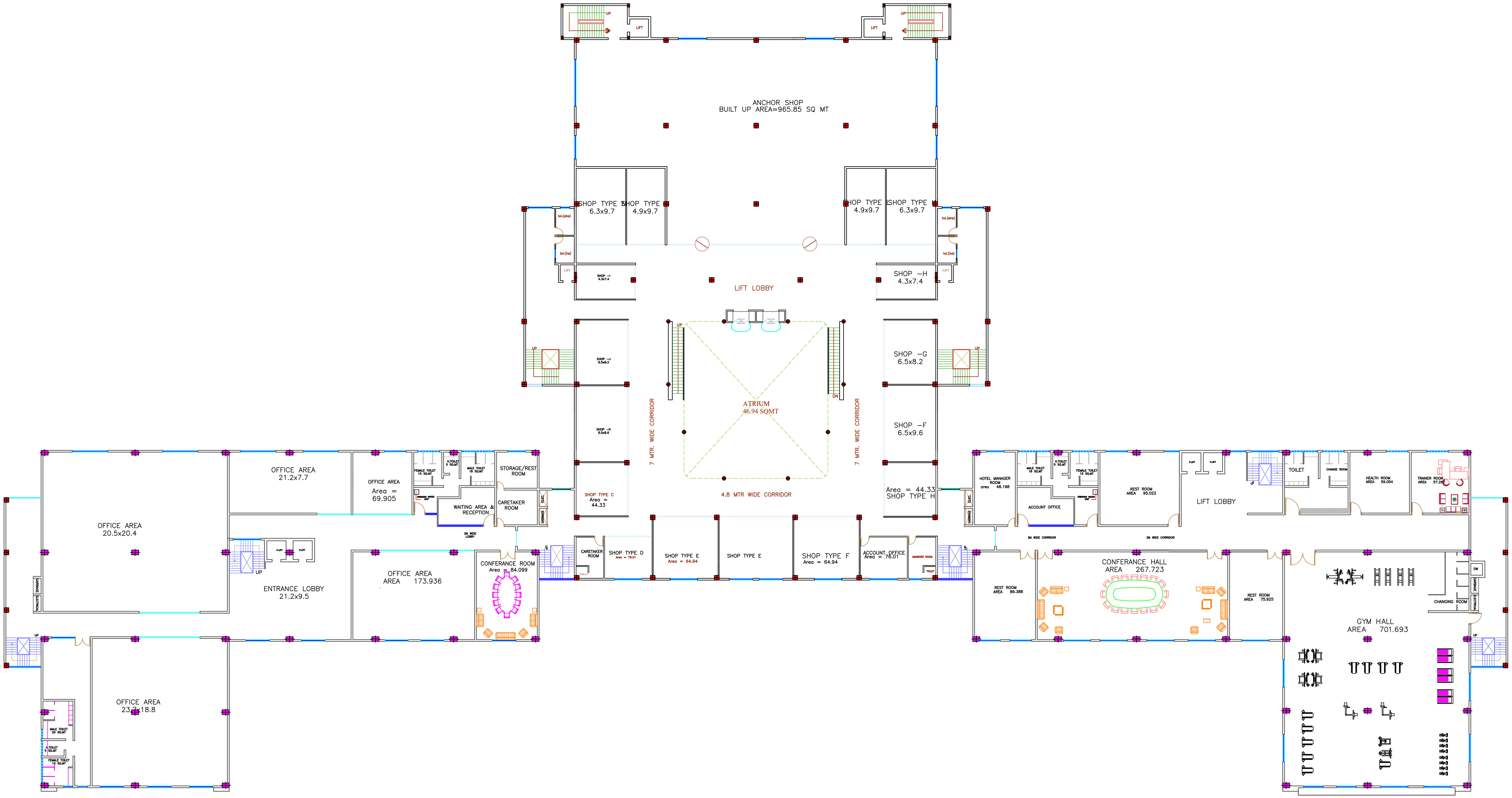

SECOND FLOOR PLAN

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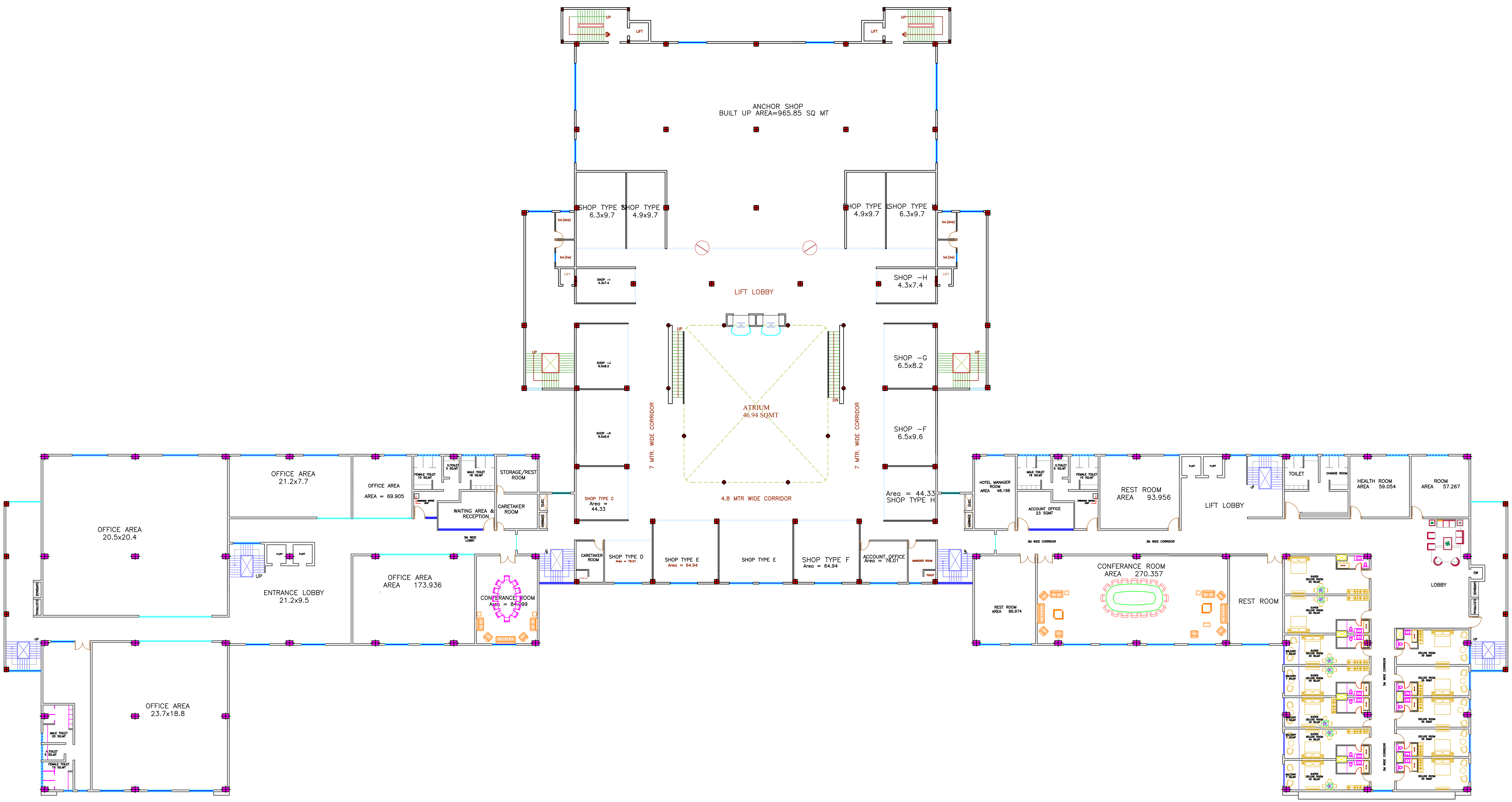
MIXED -USE DEVELOPMENT



THIRD FLOOR PLAN

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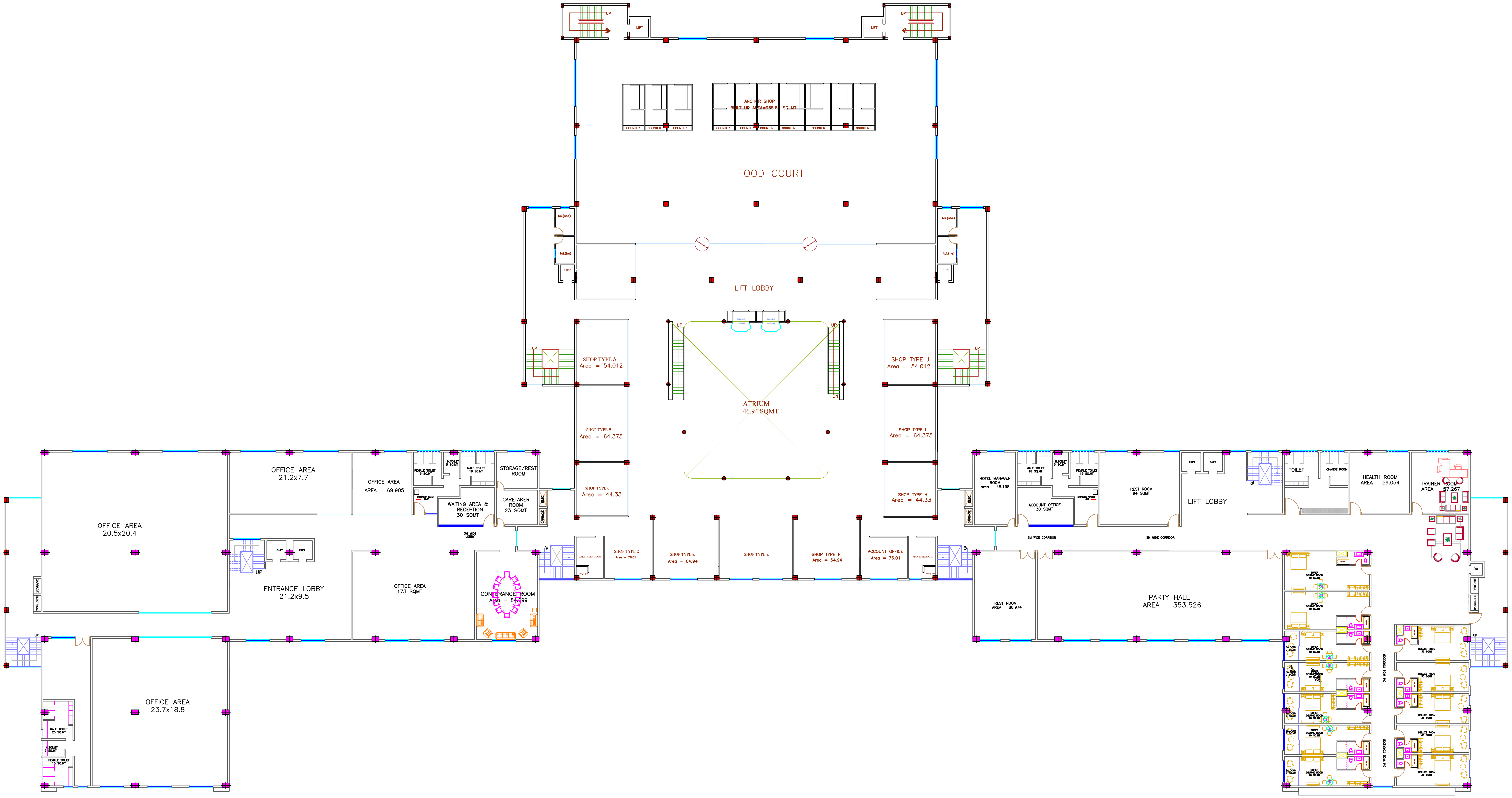
SUBMITTED BY :

JATIN KHANNA

MIXED -USE DEVELOPMENT



4TH FLOOR PLAN

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SCALE :1/200

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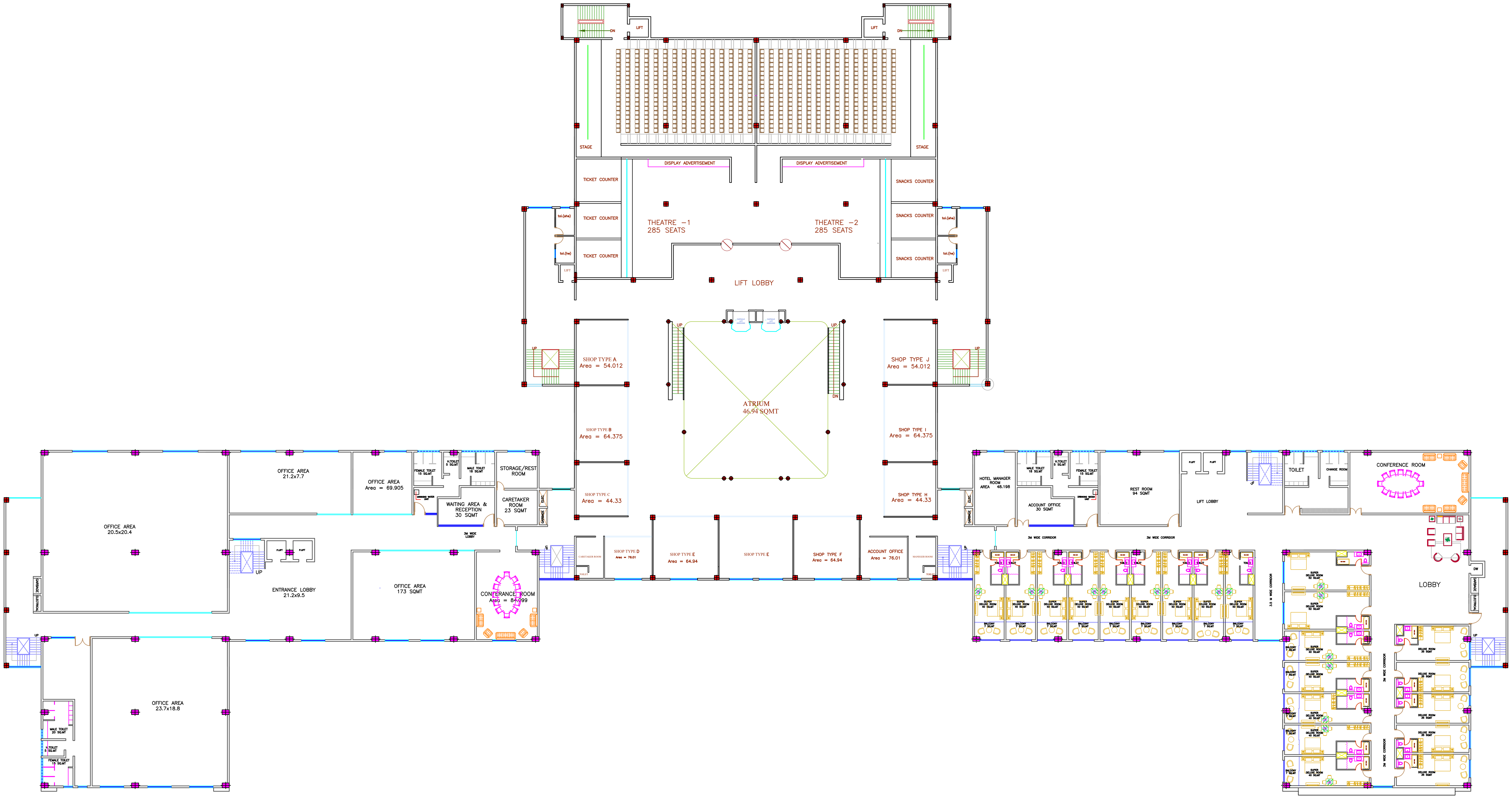

5TH,6TH FLOOR PLAN

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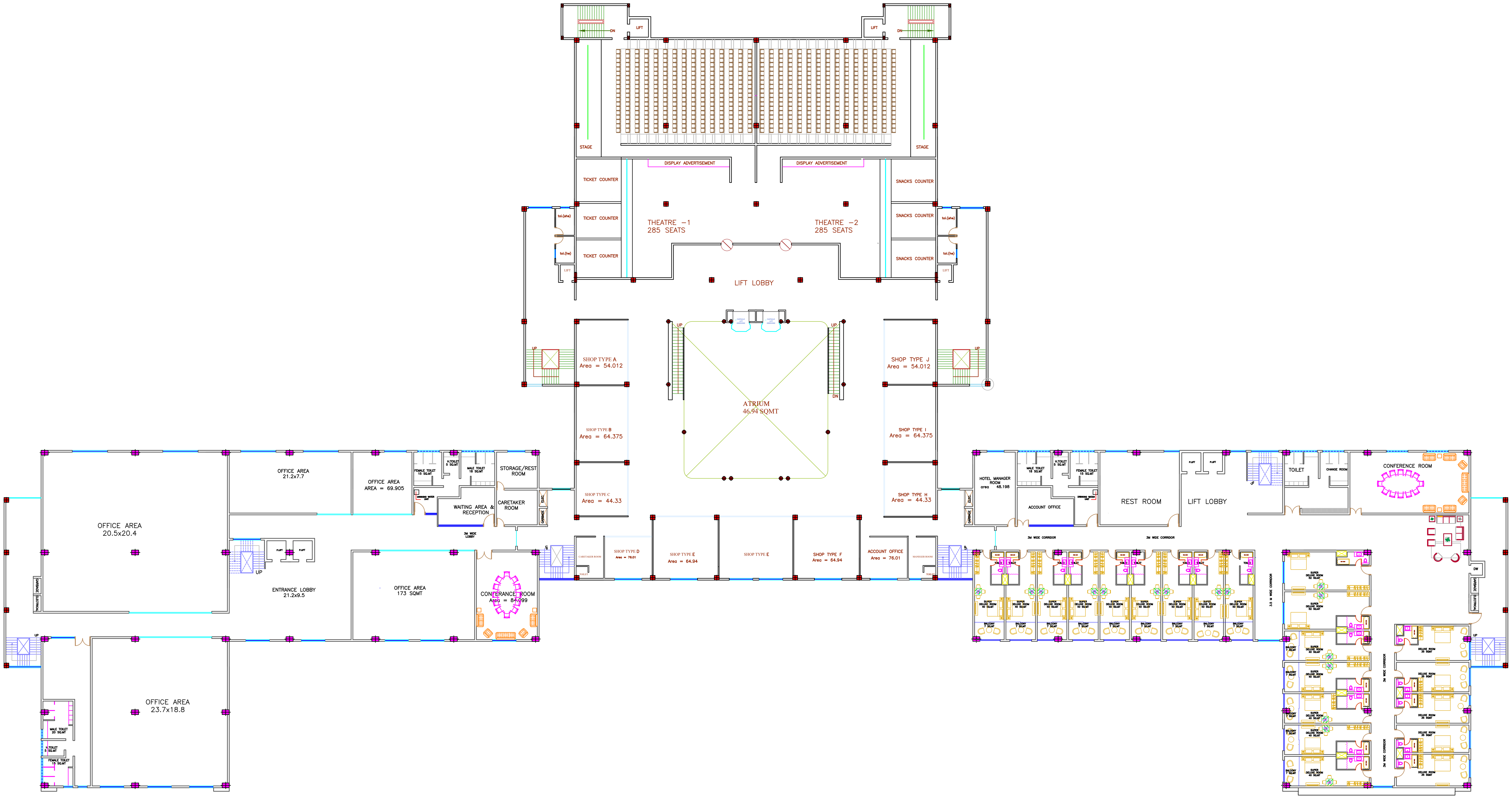

7TH FLOOR PLAN

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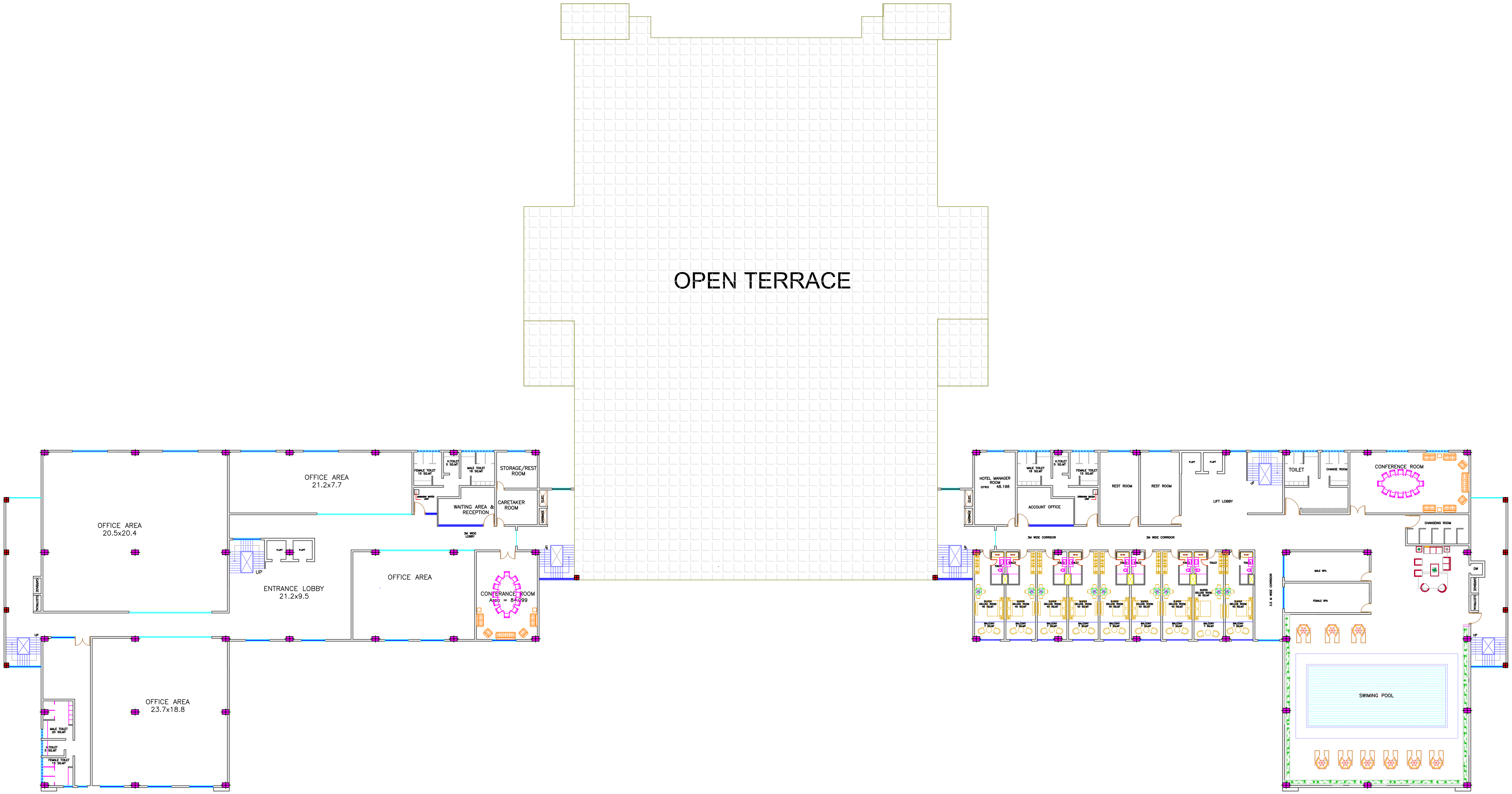
MIXED -USE DEVELOPMENT



18TH FLOOR PLAN

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SCALE :1/200

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ROLL NO.-

SUBMITTED BY :

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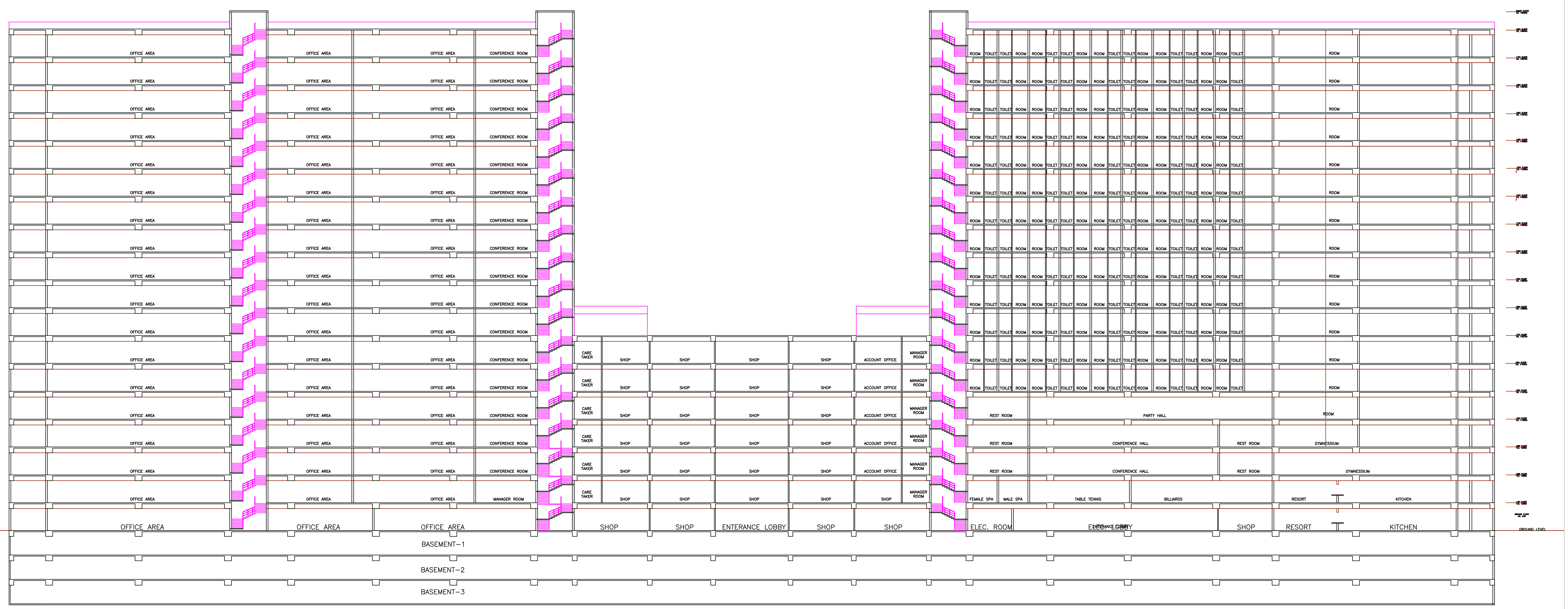
PRODUCED BY AN AUTODESK STUDENT VERSION

MIXED -USE DEVELOPMENT



SECTION AT A-A'

SUBMITTED TO :

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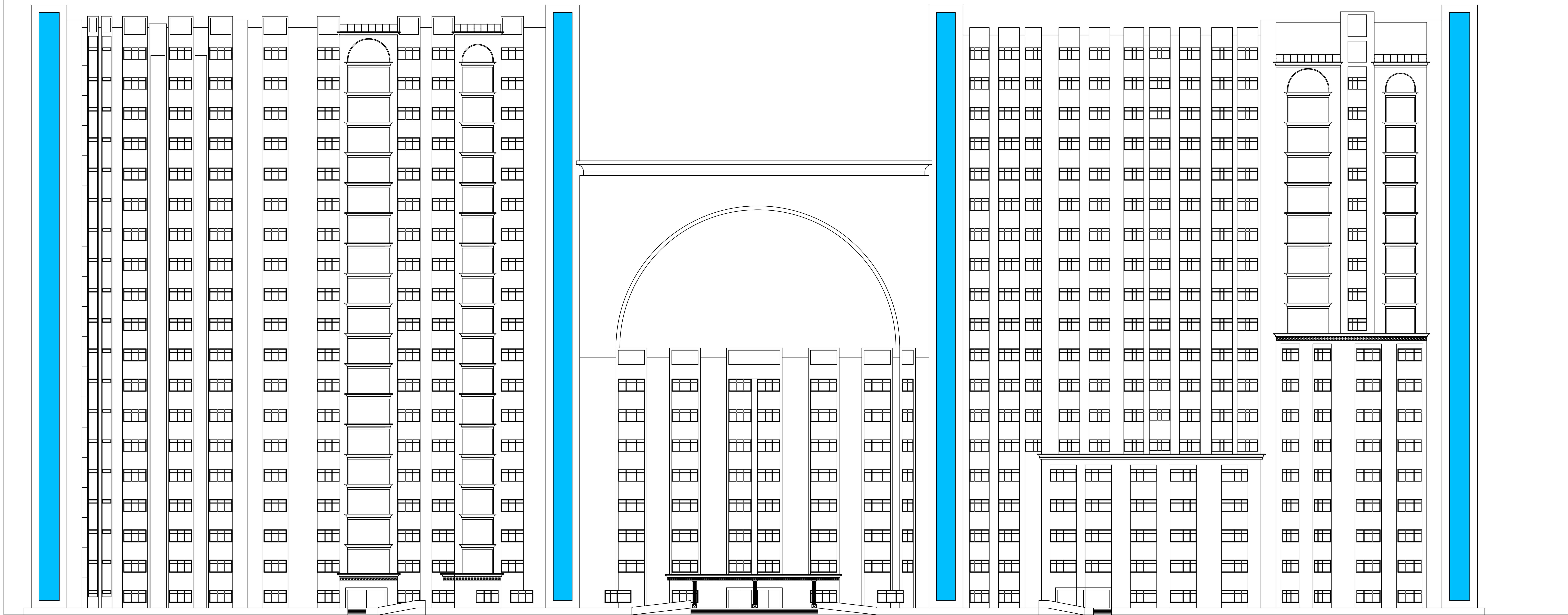
SUBMITTED BY :

PRODUCED BY AN AUTODESK STUDENT VERSION

MIXED -USE DEVELOPMENT



FRONT ELEVATION

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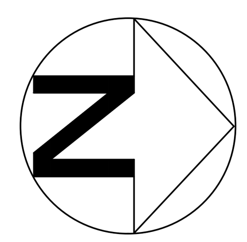
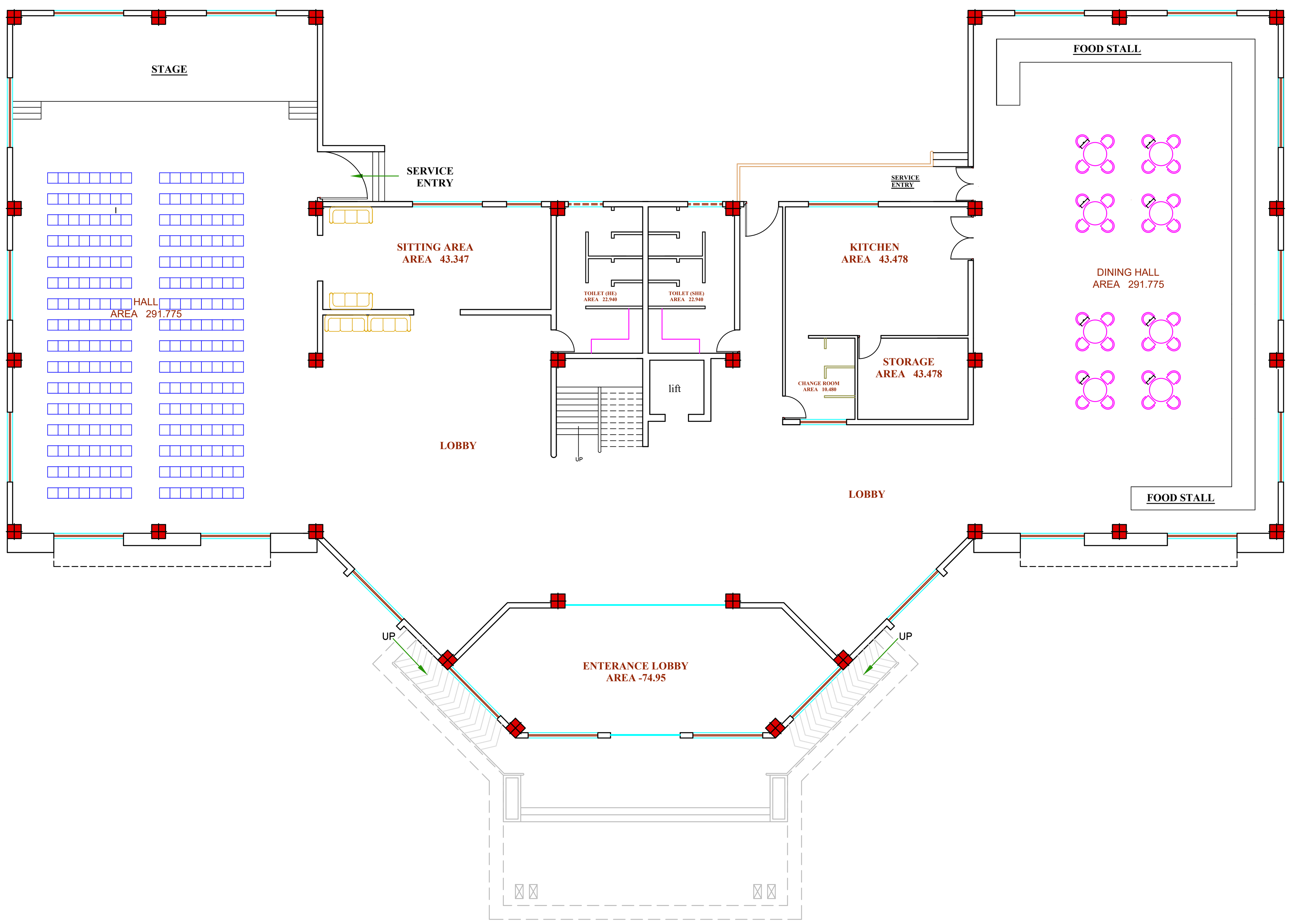


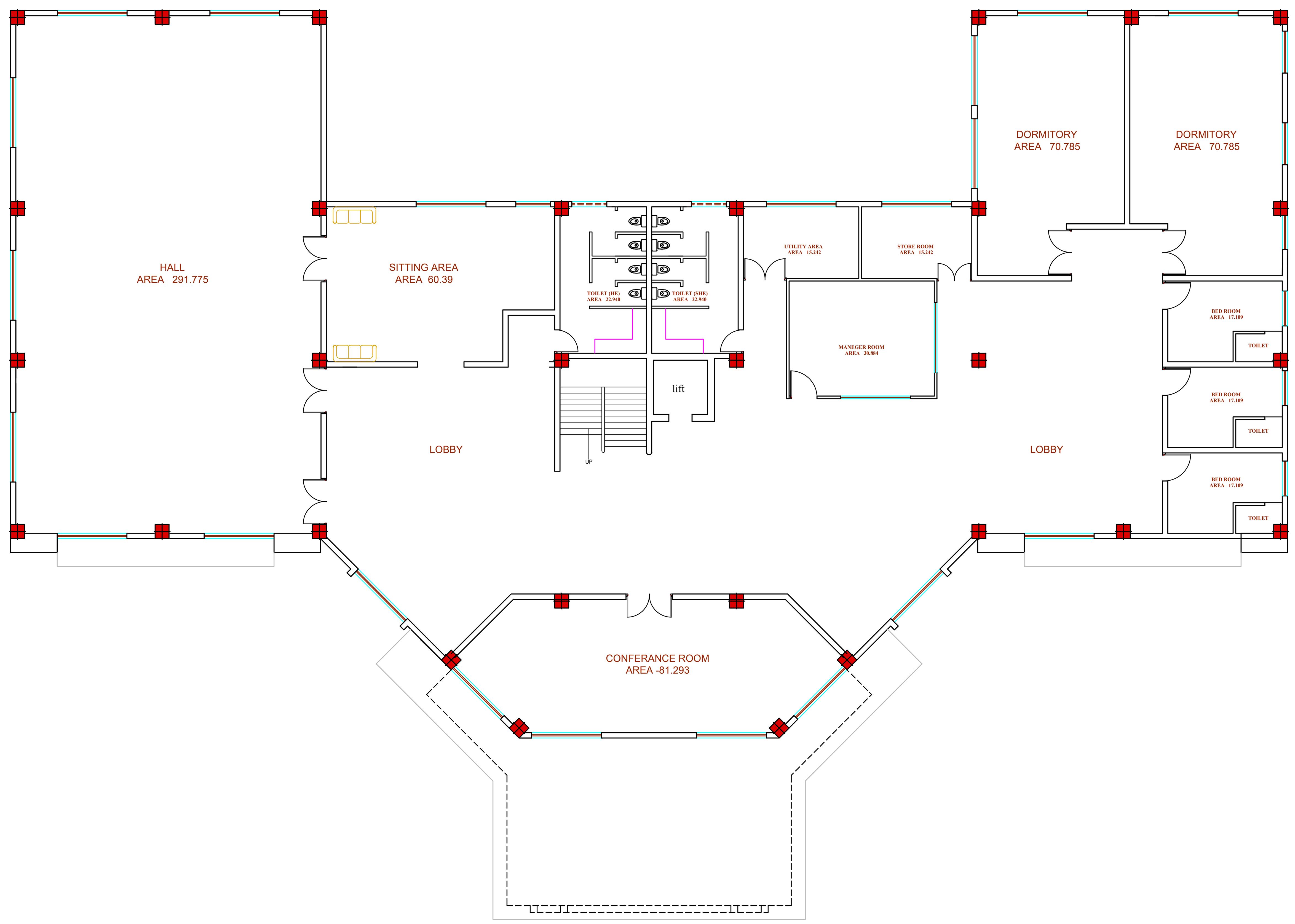
SUBMITTED BY :

JATIN KHANNA

BANQUET CUM CLUB HOUSE



GROUND FLOOR BANQUET PLAN



FIRST FLOOR BANQUET PLAN

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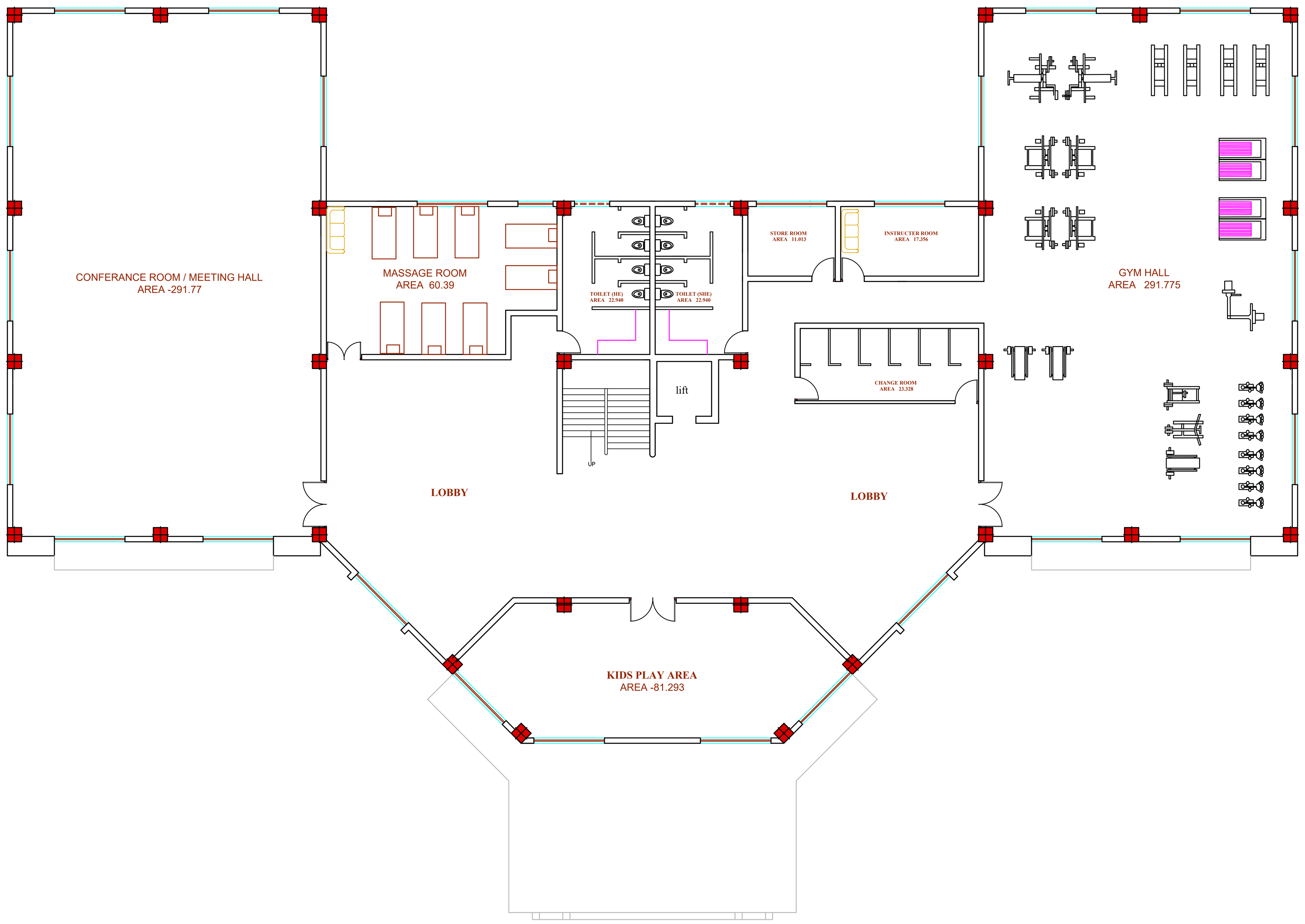
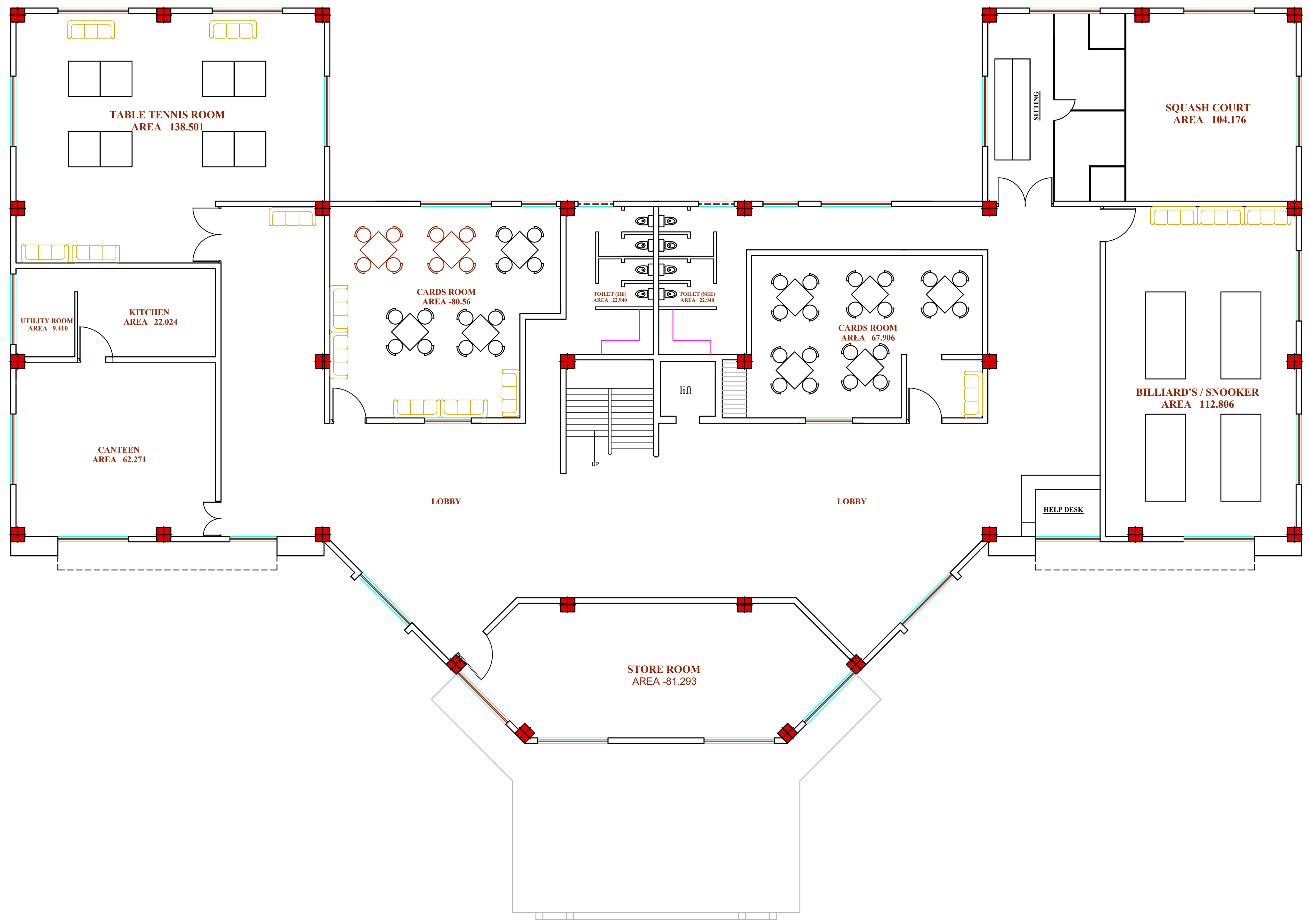
SUBMITTED BY :

JATIN KHANNA

BANQUET CUM CLUB HOUSE



SECOND FLOOR GYM PLAN



THIRD FLOOR CLUB PLAN

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ROLL NO.-

SUBMITTED BY :

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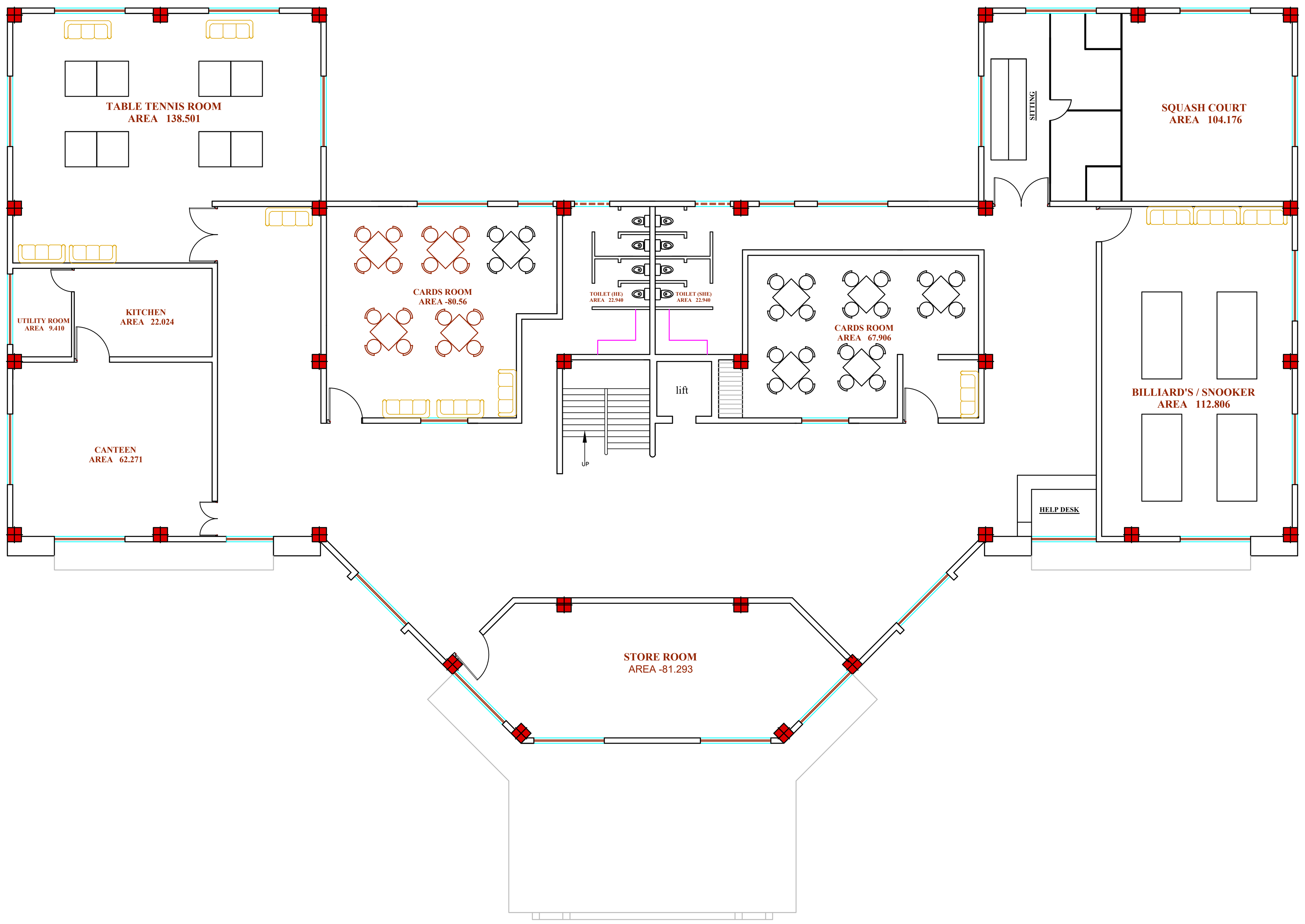
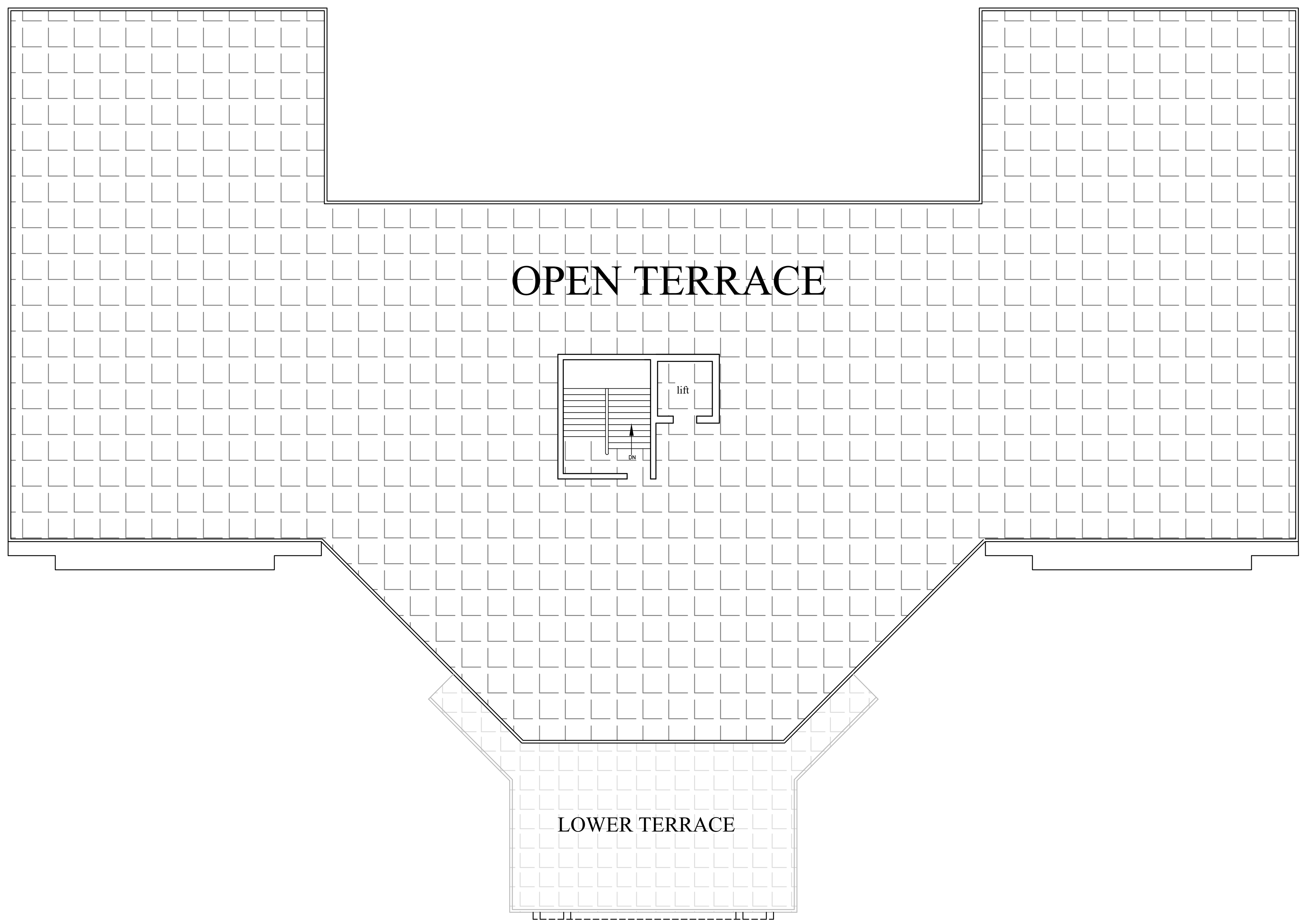
BANQUET CUM CLUB HOUSE



FOURTH FLOOR CLUB PLAN



TERRACE PLAN

SUBMITTED TO :

SHEET NO:

SCALE :1/200

SESSION:

ROLL NO.-

SUBMITTED BY :

JATIN KHANNA

PRODUCED BY AN AUTODESK STUDENT VERSION
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BANQUET CUM CLUB HOUSE

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FRONT ELEVATION

SUBMITTED TO :

SHEET NO:

SCALE :1/100

SESSION:

ROLL NO.-

N

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JATIN KHANNA

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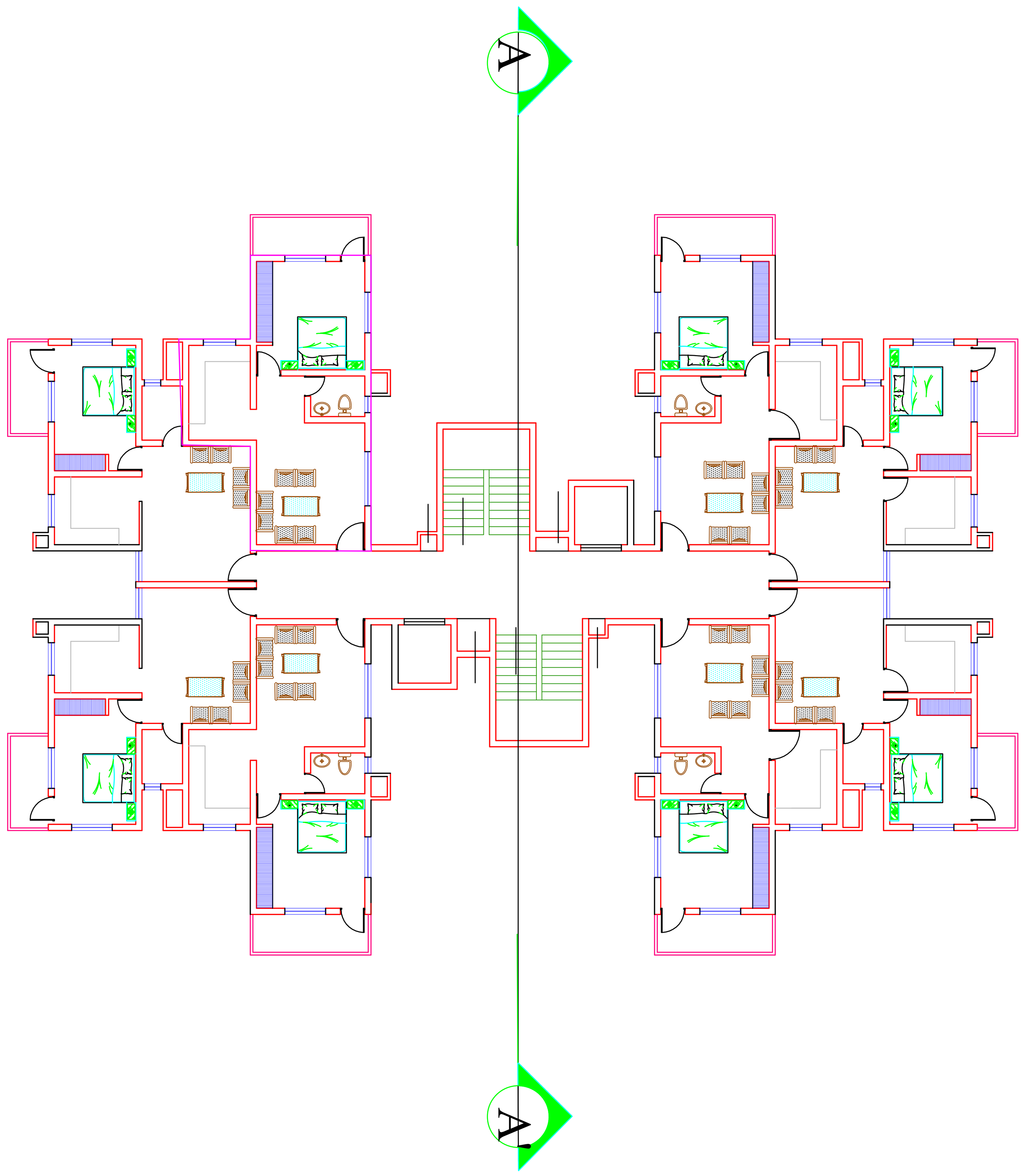
1 BHK HOUSING CLUSTER



TYPICAL FLOOR PLAN (G+15)

FRONT ELEVATION

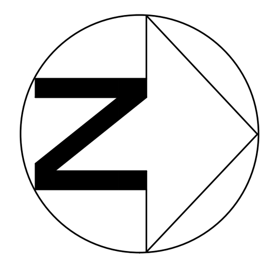
SUBMITTED TO :

SHEET NO:

SCALE :1/200

SESSION:

ROLL NO.-



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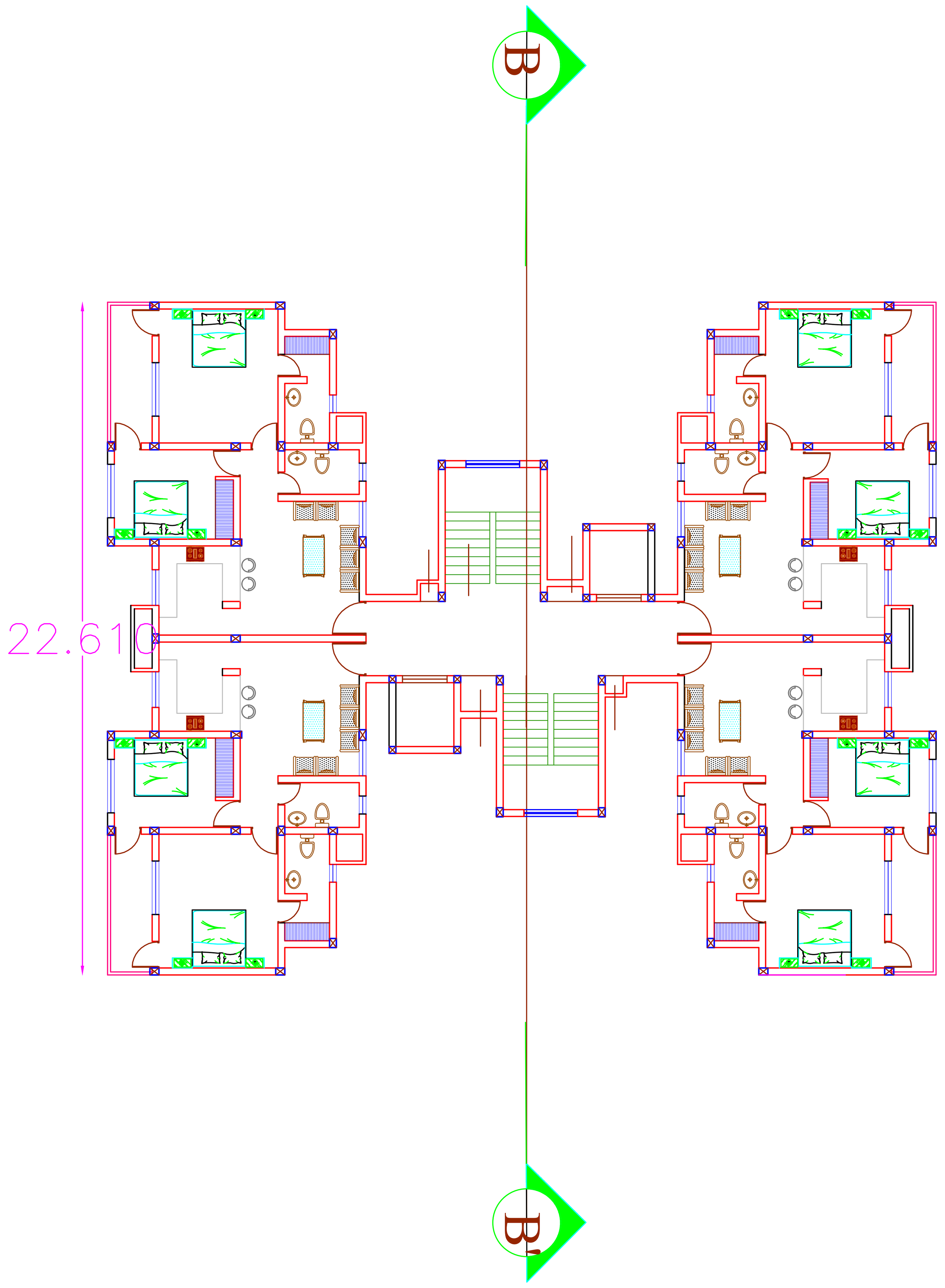
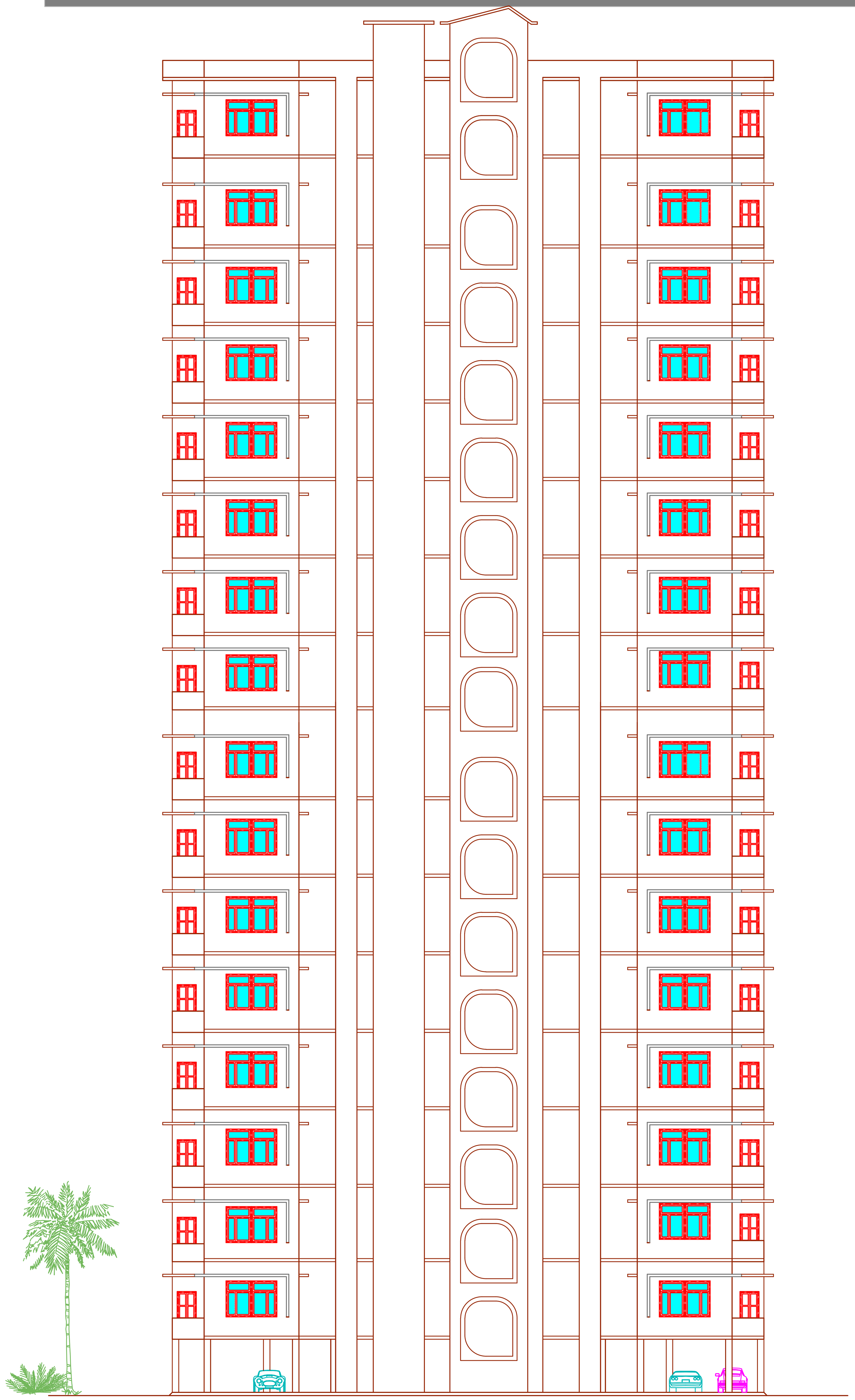
2 BHK HOUSING CLUSTER



TYPICAL FLOOR PLAN (G+15)



ELEVATION

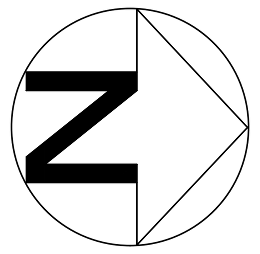
SUBMITTED TO :

SHEET NO:

SCALE :1/200

SESSION:

ROLL NO.-



SUBMITTED BY :

JATIN KHANNA