

MIXED-USE SKYSCRAPER

A THESIS

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Architecture degree

By

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DEPARTMENT OF ARCHITECTURE
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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
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NOVEMBER 2021



DEPARTMENT OF ARCHITECTURE

BONAFIDE CERTIFICATE

This is to certify that this Thesis Report is the bonafide work of Senthilvel.U (37210032) who carried out the Thesis entitled "Mixed-Use Skyscraper" under our supervision from July 2021 to November 2021.

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DECLARATION

I, **Senthilvel.U** hereby declare that the Thesis Report entitled “**Mixed-Use Skyscraper**” done by me under the guidance of **Ar.Yusuf Chiniwala** (Internal Guide), **Ar. Vijendranath.R**(Internal Review Member) and **Ar.Sarath C Kanth** (External Guide) Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Architecture Degree.

DATE: 06/12/2021

PLACE: Chennai

A photograph of a handwritten signature in black ink on a light-colored surface. The signature reads 'Senthilvel.U' with a horizontal line under 'Senthilvel' and a small 'U' at the end. There are also two dots below the 'U'.

SIGNATURE OF THECANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **Sathyabama Institute of Science and Technology** for their kind encouragement in doing this Thesis and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. DevyaniGangopadhyay**, Dean and Head of the Department, School of Building and Environment, Our Design Chair **Dr. Suresh Kuppuswamy**, Thesis Coordinator**Ar.SuryaRajkumar** for providing me necessary support and details at the right time during the progressive reviews.

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THESIS SYNOPSIS

The community of integrated use by the neighbours, like any other on the street, turns vertically into the sky. It is an idea that has been around since the first towers were built in the late 1880s but now it is already gaining traction in the construction community.

Urban migration, when people move to urban areas in search of work, leaves short cities with affordable housing, transportation links and can lead to urban sprawl or urban prosperity. The high development of mixed use provides answers to both of these problems by increasing the number of people who can live and work in a small, limited area of available land.

Modern architecture has begun to study the systems for mixing with a single tower, but they have changed slightly to keep the economy as high as possible. But the problem of separation requires a magnificent approach, the floors of one dressing are broken and are freely accessible from each other. In this way, additional spatial intelligence can be explored in the hope that there are new ideas to improve on what has already been developed.

This concept looks at design issues and aims at maximizing high utilization of mixed applications. The design and planning of high-performance mixed-use development involves the consideration of all existing conditions and is often guided by local bidding rules. provision for future growth is one of the key elements to be included in the construction.

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1. CHAPTER ONE – INTRODUCTION

Man has always built monumental structures for the gods, including temples, pyramids, and cathedrals that pointed to the sky which symbolize power, richness, prestige, and glory.

SKYSCRAPER:

A skyscraper is a long, durable structure with many floors. Modern sources currently describe the builders of buildings as a minimum of 100 meters or 150 meters high, although no definition is universally accepted. Historically, the term first referred to buildings between 10 and 20 stories when these types of buildings were first built in the 1880s. Larger buildings can hold offices, hotels, residences, and shopping malls.

Various organizations from the United States and Europe describe building builders as buildings at least 150 meters high or high, with "high" buildings of more than 300 meters (984 ft) and "mega tall" buildings for those over 600 meters (1,969 ft).



Figure 1- Skyline of Dubai

MIXED-USE DEVELOPMENT:

Mixed-use development is a form of urban development, town planning, and / or design that incorporates the use of residential, commercial, cultural, institutional, or recreational uses in one place, where those activities are integrated to some degree physically and professionally, and provide pedestrian communication.

Mixed-use development can be applied to new building projects in the city or on the outskirts of the city or may apply to a single building, existing or new location, or to a city-wide or other political allotment policy.

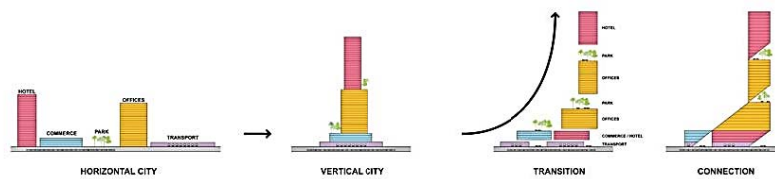


Figure 2- Mixed-Use Development

FEATURES OF VERTICAL MIXED-USE DEVELOPMENTS

- Combines different functions in one building.
- Provides additional public space on the ground floor such as shopping malls, restaurants, and shopping malls.
- Encourage economic investment.
- Increase revenue.
- Reduce car dependence, road travel, air pollution and reduce carbon emissions.
- Easy-to-reach, cycling areas, increased access to transport, both leading to reduced travel costs.
- Reduction between distances, workplaces, retail business, and other items and facilities.
- More integrated development.
- A strong neighbour's character with a sense of place.

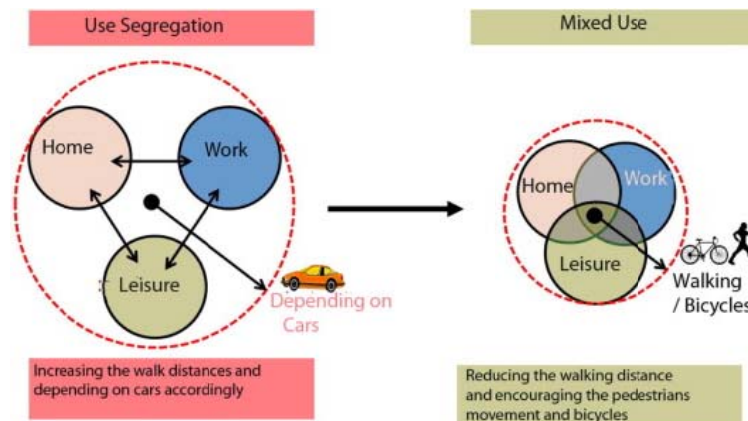


Figure 3- Influence of mixed-use on the daily life

AIM:

This project is to develop a symbolic mixed-use skyscraper and also help in shaping the future skyline of the city by being an inspiration for buildings to come.

OBJECTIVES:

- To study the contribution of architecture in mixed-use development.
- To study the built forms, structures, services, and spaces used in skyscraper buildings worldwide.
- To integrate structure and services with the architectural form.
- To use sustainable material and functional requirements in design and integrating it into services also.
- To design spaces that enhance physical and visual interaction and reduce isolation by transparency, openness, fluidity of space and also bring closer to nature and harmony.

NEED OF THE PROJECT:

Design a Mixed-use skyscraper that will provide Residential, Commercial, hotels, offices, and other recreational facilities to the people.

METHODOLOGY:

The method chart describes the first step, in terms of reading the general details of the higher order. It includes components for advanced editing, high-definition descriptions, and its sophisticated services. The next step is to study advanced planning from a variety of disciplines. Thereafter the classification of problems in various ways was done from the findings. Subsequent detailed research was performed on each aspect with various case studies. Finally, the design concept has changed and evolved into design development.

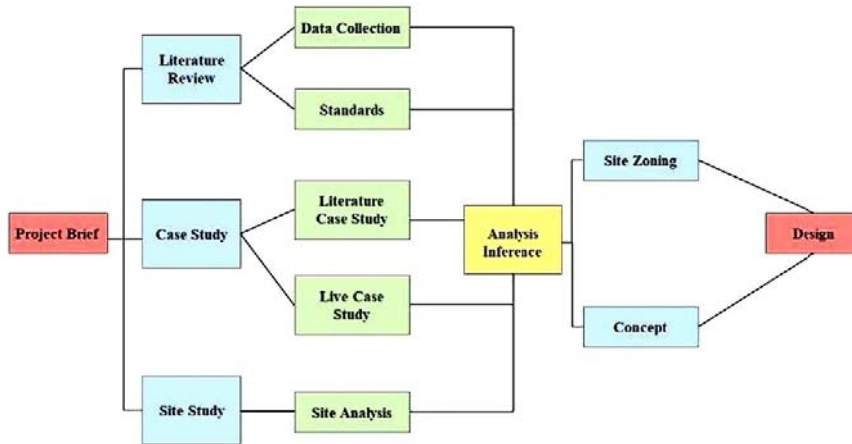


Figure 4- Design Methodology

LIMITATIONS:

Work is limited to the core urban development projects and does not take into consideration low-income groups residing on the campus, although the employment of these people is generated in the project.

2. CHAPTER TWO – DATA COLLECTION AND STANDARDS

CLASSIFICATION OF TALL BUILDING STRUCTURAL SYSTEM:

- It is classified according to the structure used as concrete or metal.
- Tall buildings can also be divided into two broad categories
 - o Interior Buildings
 - o Exterior structures
- The subdivision depends on the distribution of parts of the initial load resistance system over the structure.
- The system is divided into an internal structure where most of the side load system is located inside the building.
- Similarly, if a key component of a sloping load system is located around a building, the system is classified as an external structure.

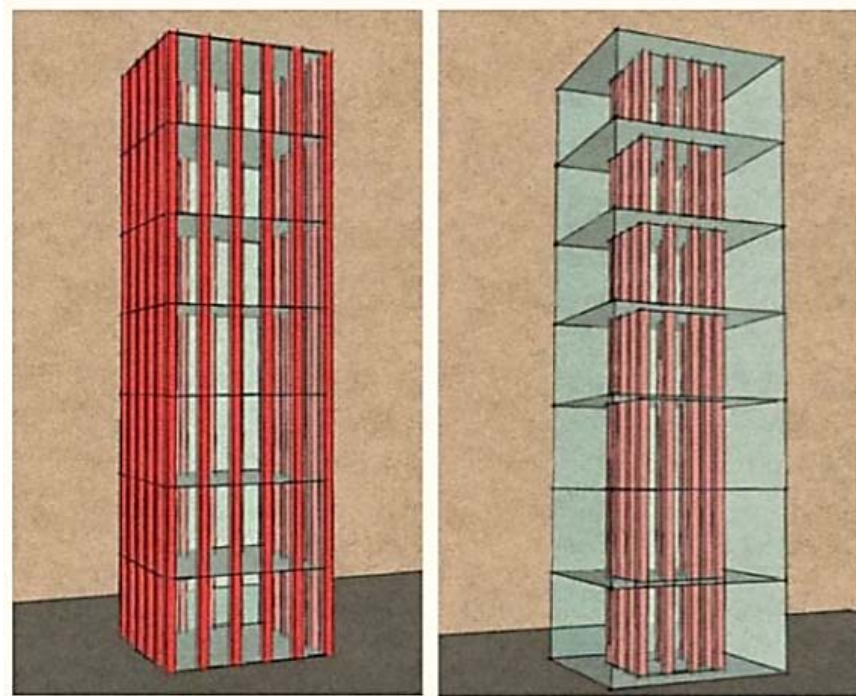


Figure 5- Exterior and Interior Structures

INTERIOR STRUCTURES:

- **SHEAR FRAMES:**

- o **RIGID FRAME STRUCTURE:**

A solid structure in structural engineering with load-resistant bones composed of straight or curved joints connected by a strong anti-motion connector caused by the limb joints. Its members can take a moment to bend, trim, and axial loads. Contains columns and girders attached to instant-resistant connections. It can build up to twenty-five floors.

- o **SHEAR WALL STRUCTURE:**

Permanent concrete or stone walls can serve both structural and structural components to carry gravity and subsequent loading. The high altitude and power of the planes make them ideal for tall buildings. It is usually constructed as the structure of the structure. It can build up to 35 floors.

- o **OUTRIGGER STRUCTURES:**

The backbone may be located between the exit costs on both sides or in some cases may be located on one side of the building and the exit on the side pillars on the other side. Outriggers are usually in the form of giant (1 or 2 deep stories) in steel structures, or in concrete walls, which work effectively as strong articles that attract couples to pressure on the outer columns. Belt trusses are often provided to distribute this strength and pressure to a large number of columns of the outer frame. Construction up to 150 floors.

EXTERIOR STRUCTURES:

- **TUBE SYSTEM:**

The concept of a tube system is based on the idea that a building can be built to withstand rear loads by designing it as a bare cantilever that is grounded. In the simplest detection case of the tube, the outer perimeter consists of closely spaced columns connected together with deep spandrel beams with a second connection. This combination of columns and beams forms a solid frame that becomes a dense and solid wall of the building on the outside of the building.

The different tubular systems are:

- o Framed tube
 - o Braced tube
 - o Bundled tube
 - o Tube in tube

- **DIAGRID SYSTEMS:**

With the efficient operation of the structure as a variant version of the tubular systems, diagrid structures have always emerged as a new form of beauty for tall buildings in this era of plural styles. Early designs of tall buildings recognized the function of diagonal bracing elements in resisting lateral forces. Most of the systems built on the previous tall buildings were metal frames with integrated inserts of various modifications such as X, K, and chevron. However, while the importance of the design of the diagonals was well recognized, their aesthetic power was not appreciated because they were considered a distraction from the outside view. It is well resistant to lateral shoving by axial forces on diagonal joints but with complex joints.

- **SPACE TRUSS:**

Space truss structures are converted into tubes tied with diagonals connecting the outside and the inside. According to the standard tube structure, all diagonals, which connect the chord members - columns in the corner are generally wider, are located on the plane along the front pillars. However, in space communities, some diagonals fit inside a building.

- **EXOSKELETON STRUCTURE:**

In exoskeleton buildings, lateral load resistance systems are placed outside the construction line away from their front garments. Due to the structural features of the system, it serves as a key architectural indicator - one of the major roles of horizontal construction in normal contexts. The fire prevention of the system is not a major problem because it is located outside the building line.

- **SUPERFRAME STRUCTURES:**

Superframe buildings can build ultra-high-rise buildings up to 160 feet below. Superframe or Mega frames take the form of a given portal outside the building. Frames are resistant to all wind forces as an external tubular structure. The portal frame of the superframe is made up of vertical legs in each corner of the building connected by straight objects on almost every 12 to 14 floors. Since direct objects are concentrated in the structural components, high efficiency is obtained to withstand wind strength.

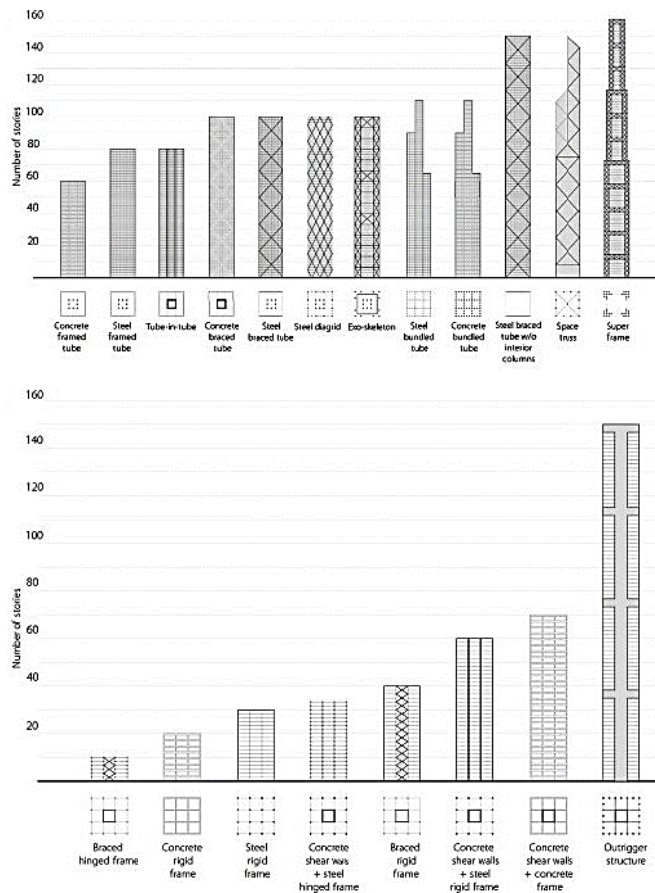


Figure 6- Types of Structural Systems for Tall Buildings

STRUCTURAL CONCERNS:

The skeletal bones of a tall structure can be seen as the upper cantilever and the base of the canopy. The building must carry vertical gravity loads and side air loads and earthquake loads. Gravity loads are caused by dead and living loads. Rear loads often tear down a building or tear it down. The building must therefore have adequate shear strength and resistance to bending and must not lose its direct load capacity.

FIGHTING GRAVITY:

- The weight of the building is supported by a group of vertical columns.
- Each floor is supported by horizontal steel belts running between vertical columns.
- A curtain wall made of steel and concrete adheres to the outside.

WIND RESISTANCE:

- Buildings longer than 10 stories can often require additional metal for lateral system.
- The basic method of controlling horizontal force is simply to strengthen the structure. When the horizontal girder attaches to the vertical column, bolts the construction workers and burns them up and down and side to side. This allows the complete metal structure to fit together as a single unit, like a pole, in contrast to the flexible bone.
- For very tall buildings, strong connections do not create a strategy to keep these buildings very stable, engineers should build strong cores in the middle of the building.
- Wind effects can also be reduced by the aerodynamic construction of the building. The air tunnel test looks for the appropriate loading of the overall lateral system design and wear design and predicts the sensitivity of movement and pedestrian level results.
- Use damping systems as the structure becomes larger and the structure is possible due to the lateral forces being more sensitive than the greater demand for brackets and columns forming a solid lateral load-bearing system.

STRUCTURAL LOAD:

Structural loads are forces, deformations, or accelerations applied to a structure or its components.

TYPES OF LOADS:

• DEAD LOAD:

Loads that are relatively constant over time. It is also known as permanent or static loads.

• LIVE LOAD:

- o Dynamic or impose or moving loads, temporary of short duration.
- o Considerations: impact, momentum, vibration, slosh dynamics of the fluid.

- **ENVIRONMENTAL LOADS:**

These are loading that act as a result of weather, topography, and other natural phenomena. These are:

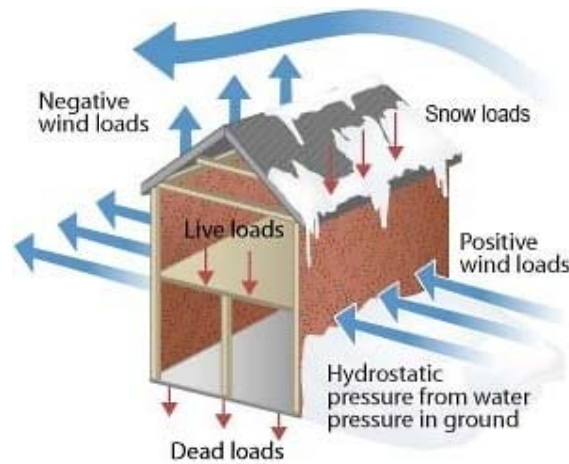


Figure 7- Types of loads on a building

SEISMIC LOAD:

- Buildings undergo dynamic motion during the earthquake.
- The building is subjected to inertia forces that act in the opposite direction to the acceleration of earthquake excitations.
- These inertia forces called seismically loads are usually dealt with by assuming forces external to the building.

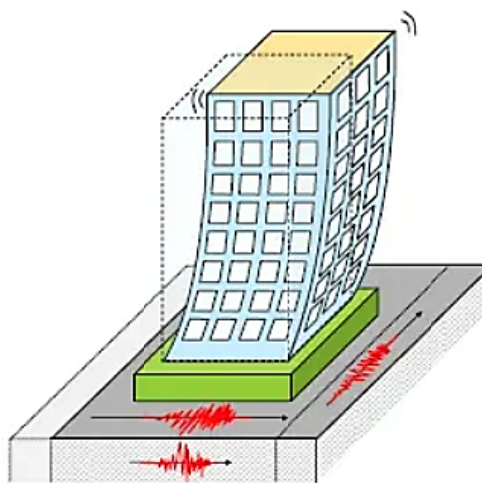


Figure 8- Seismic Load

WIND LOADS:

- Thermal loads (temperature changes leading to thermal expansion).
- The lateral pressure of soil, groundwater, or bulk materials.
- Wind load can bring a building to sway.
- Wind velocity increases with the increase in height.

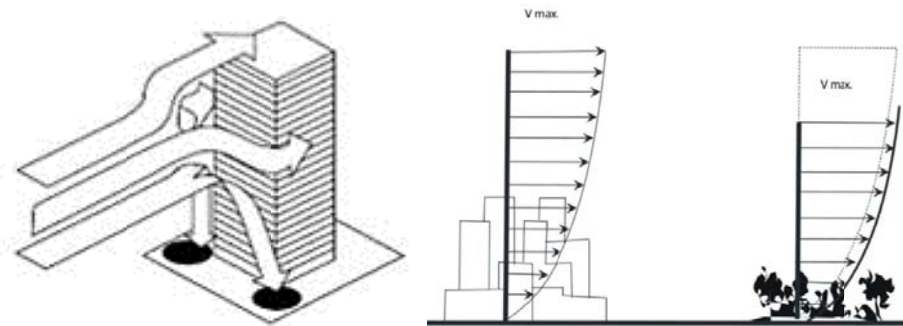


Figure 9- Wind Load

WIND TURBULENCE:

- When any moving air mass meets an obstruction, such as a building, it responds like any fluids by moving to each side, then rejoining the major airflow.
- The Venturi effect is one type of turbulent wind action. Turbulence develops as the moving air mass is funneled through the narrow space between two tall buildings. The corresponding wind velocity in this space exceeds the wind velocity of the major airflow.

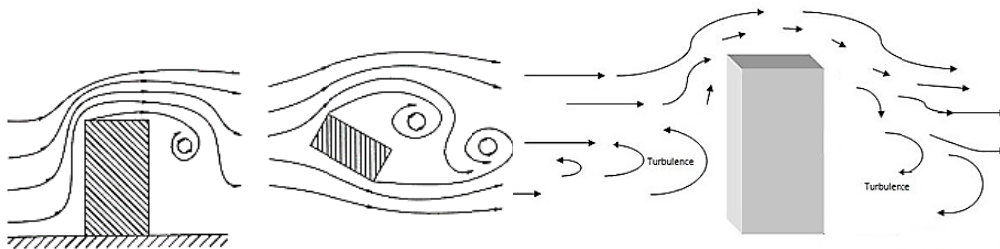


Figure 10- Wind Turbulence

LOAD DISTRIBUTION SYSTEM:

All types of loads can be considered as Vertical load & Lateral load.

- **VERTICAL LOADS TRANSFER THROUGH:**

- o Bearing wall.
- o Column.
- o Core.
- o Diagonal frame.

- **LATERAL LOADS TRANSFER THROUGH:**

- o Shear wall.
- o Slab Core.
- o Beam Core Column.
- o Diagonal Frame.

CORE:

- The core is one of the most important structural and functional elements of the high-rise building.
- The core of a building is the area reserved for elevators' stairs, mechanical equipment, and the vertical shafts that are necessary for ducts, pipes, and wires.
- Its wall is also the most common location for vertical wind bracing.
- The placement of the service core stems from four generic types which are:
 - o Central core.
 - o Split-core.
 - o End core.
 - o Atrium core.

FOUNDATIONS DESIGN FOR EARTHQUAKE:

Deep foundations often show better earthquake resistance than shallow foundations. Floating foundations can be useful in soft soils, as they can better reduce the action of sound. The risk of shrinkage is much greater with floating foundations than with deep foundations. "Base splitting is a ground-breaking construction method that uses the principle of minimizing vibration. This structure is further away from the ground floor by tightening elements to the base ring or base plate. the earth can also cause tremors.

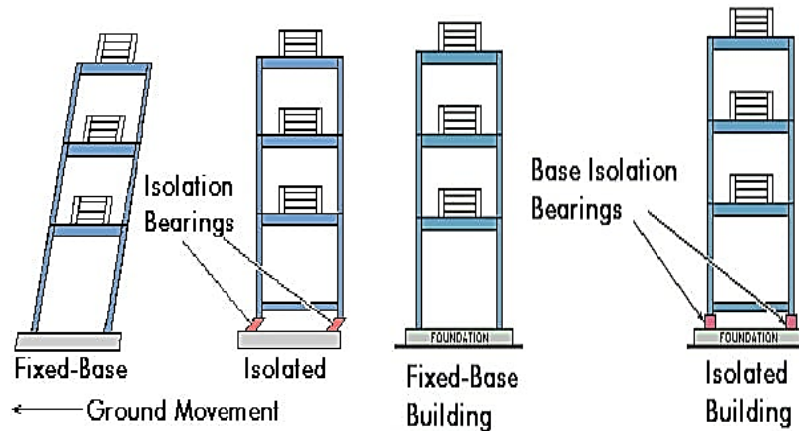


Figure 11- Base during Earthquake

HEIGHT OF THE BUILDING:

High-rise buildings are at greater risk of damage from solid earthquakes farther away than nearby weak earthquakes. They usually have a low resonant frequency and lower emissions than lower structures. Parts of the wave-wave oscillation in earthquakes are accelerated rapidly, while parts of long waves (usually [<1 Hz]) can still be heard at a distance of several hundred kilometers, especially in the form of overhead waves.

ENERGY AND WATER SUPPLY:

Unlike the case of conventional multi-storey buildings, the technical service components in high-rise buildings must meet special requirements only if due to the height, because the supply of required energy, water, air and air pollution is relatively large. These resources should also be taken to the last floor in sufficient quantity, under sufficient pressure, and sometimes completely different temperatures. The planning effort required on the part of the service engineers responsible for the delivery and disposal of services in high-rise buildings is therefore much greater than for small and medium-sized project projects. The pressure load on each item is reduced by dividing it into several pressure levels by technical service centers in the basement or floor, floor and middle of the roof.

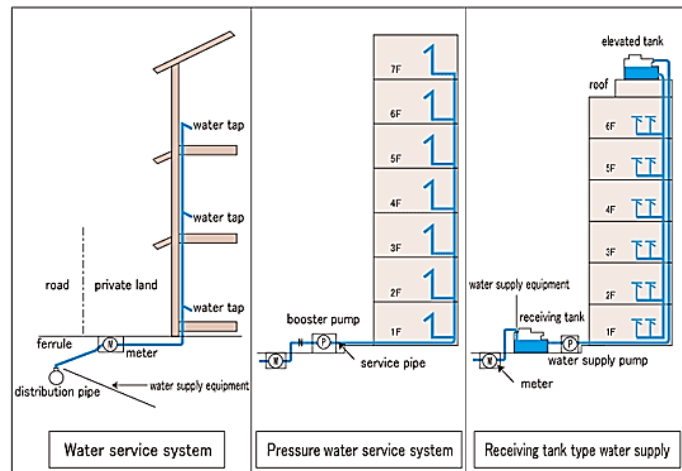


Figure 12- Water Supply System

VENTILATION AND AIR-CONDITIONING:

Systems should be designed in such a way as to ensure flexible segregation (large rooms, individual rooms) so that their use can be changed without major modifications. A variety of ventilation and ventilation systems can be installed, depending on the purpose for which the building is used. Deutsche Bank's high-rise headquarters in Frankfurt am Main, for example, is provided with a high-pressure two-channel system where the air is blown up and out through the same exhaust air windows. The second, independent system of two high-pressure channels adds air to the rooms from the false floors.

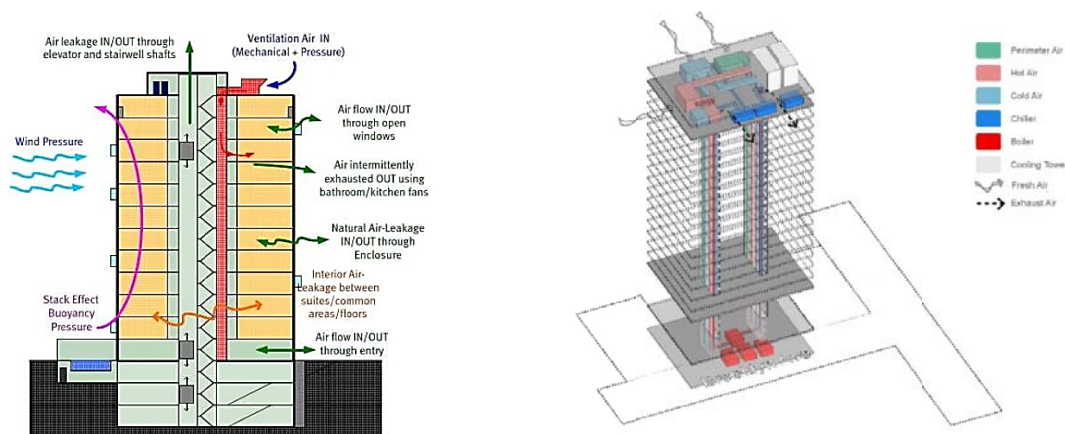


Figure 13- Ventilation and Air-Conditioning System

In fact, all air conditioning and ventilation systems must meet the same basic requirements:

- The air in the room should be continuously refreshed (when three to six air exchanges are required per hour).
- External airflow should be ensured with a minimum air flow of 30 to 60 m³ / h per person.
- The risk of downtime should be reduced and there should be no disturbance due to the removed audio transmission.
- There should be closure of individual plant parts where the same parts of the structure can be used.

SANITATION:

Pressure measures are also required in the field, so it allows the use of smaller pumps. Sanitary facilities should not be separated from the building for noise-protection purposes. Internal heating loads (e.g., hot air, exhaust heat from refrigeration systems) collected in high-rise buildings are used to heat water with the help of heat pumps or heat recovery systems. Studies have shown that elevation has no effect on flow rate and collapse levels, as the issue of finance and pollution does not automatically descend to the ground under gravity, but to less or less air flowing down the walls of the pipes.

CONTROL SYSTEMS:

Today's sophisticated, modern control systems are primarily based on intelligent digital controllers. This technology allows direct communication between DDC (direct digital control) channels and resources and centralized controls that also take over power management functions, such as:

- Effective use of reducing night and weekend temperatures.
- Coordinating service water heating and re-cooling refrigeration system, external blind performance.

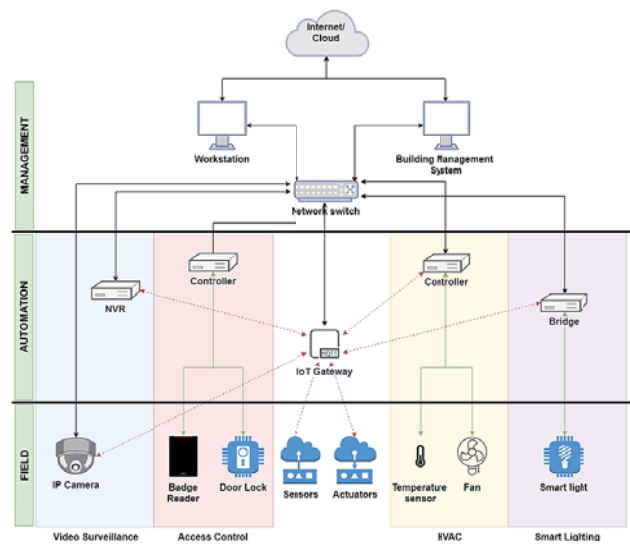


Figure 14- Control System

FIRE FIGHTING:

Fire is one of the major hazards in all buildings especially high-rise buildings. Thanks to the magnificent photographs and film sequences that have been shown to the media, major fires have been going on - and will continue to make headlines not only during construction but above all during the occupation.

FIREFIGHTER ACCESSIBILITY:

It is important that emergency personnel (e.g., firefighters, paramedics, police) have access to a building as soon as possible in the event of an emergency. In addition, this person cannot be expected to climb every stairs. This requirement returns to cash plans. The tower has auxiliary elevators running above the elevators for local passengers. One of these app launchers runs over the tower. This is very fast and has been set up to override local elevators to allow for quick and easy transfers. The elevators themselves are fire-resistant to these materials, making access to the building a painless process.

OCCUPANT EVACUATION:

Existing public transportation is a concern of any building: however, it poses a special challenge given the height of the tallest buildings. With the increase, passengers will need information on the situation, mechanical assistance to speed up the process, and stairs and safe places in the event of

equipment failure. It is important to note that many of the problems a building will face will not require the full exit of the building. However, when lives are at stake, it is still important to ensure that it is possible.

AREAS OF REFUGE:

The design of the tower includes well-placed shelters that allow for better controlled exit. A typical shelter will have fire extinguishing stairs closed with doors to prevent the spread of smoke. Construction workers will be trained to guide and direct survivors. Also, the shelters are designed to connect to various stairs.

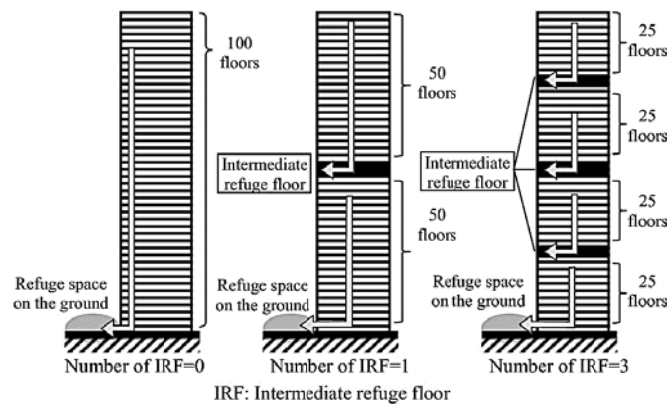


Figure 15- Refuge Area

SKY LOBBY:

- In tallest buildings, the efficiency of the elevator can be increased through a system that includes sound and local lifts. Descriptive elevators stand on stilts called sky lobbies.
- There, passengers can transfer to local elevators that will take them to their desired destination. By dividing the structure into levels used by reflective elevators, local elevators can be placed to sit on the same shaft. That way, each location can be served simultaneously by its local cash bank.
- In tallest buildings, the efficiency of the elevator can be increased through a system that includes sound and local lifts. Descriptive elevators stand on stilts called sky lobbies.
- There, passengers can transfer to local elevators that will take them to their desired destination. By dividing the structure into levels used by reflective elevators, local elevators can be placed to sit on the same shaft.
- Thus, each location can be served simultaneously by its local elevator bank.

DOUBLE SKIN:

- DTI studies on commercial buildings have shown that double skin structures can reduce:
 - o 65% power consumption
 - o Running costs by 65%
 - o 50% CO2 emissions
- In normal cold climates, compared to a single developed skin structure. The cost of exercise has shown that buildings that use double skin can cost up to 2.5% based on the full interior.

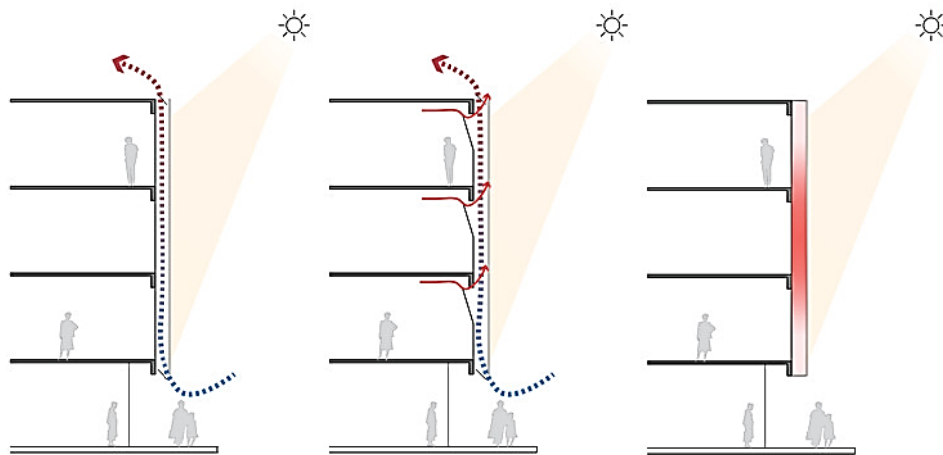


Figure 16- Double Skin Facade

3.CHAPTER THREE - CASE STUDIES

1.BURJ KHALIFA

Burj Khalifa or "Burj Dubai" is a high-rise building located in Dubai, United Arab Emirates, and is the tallest building in the world at 828m (2717 ft). This building has 162 floors. Construction of the tower began in 2004. The building was officially opened on January 4, 2010. The building is 300 meters (980 ft) higher than the Taipei 101. Taipei 101 was the tallest building until 2010 before the Burj Khalifa was built.



Figure 17- Burj Khalifa, Dubai

Adrian Smith designed the tower. He worked with Skidmore, Owings, and Merrill (SOM) until 2006. Developed by Samsung Engineering & Construction, Besix, and Arabtec. Its status is based on symbols from Islamic Architecture. Contains a basic layout plan. It has 57 elevators with 12-14 human power per room and 8 escalators.

AREA AND HEIGHT:

- Official Name: Burj Khalifa bin Zayed
- Status: Complete
- Type: Mixed-Use
- Height: 829 m
- No. of Floors: 206
- Elevators: 57, speed: 10m/sec
- Total Area: 4,000,000 m²
- Cost: 15 billion USD
- Designed by: Skidmore Owings and Merrill
- Structural Engineer: William F. Baker
- Main Contractor: Samsung C&T
- Developer: Emaar Properties

CONCEPT:

Burj Khalifa is designed to be a state-of-the-art facility, with mixed use development involving 30,000 homes, nine hotels (including Dubai city center address), 3 hectares (7.4 hectares) of the park, and at least 19 residential towers, Dubai Mall , and 12 hectares (30 hectares), man-made Burj Khalifa Lake. According to the architect of the building, Bill Baker of SOM, the construction of the building incorporates cultural and historical elements especially in the region such as the spiral minaret. It winds the minaret and it grows thinner as it rises. The buildings have a three-page, three-page structure, named after a desert flower named Hymenocallis. The tower is made of three elements arranged in the center.



Figure 18- Concept of Burj Khalifa

RELEVANCE OF CASE STUDY:

- It is the world's constructed tallest building as well as a mixed-use skyscraper.
- Structural marvel and exceptional example of building engineering.
- Innovative use of modern construction technology as well as maintenance.

SELECTION CRITERIA:

- Height: 829 m height housing 206 floors.
- Services To study the building services of a skyscraper which is of almost a kilometer height.
- Structure: Bundled Tube system for better structural stability.

SITE PLAN OF BURJ KHALIFA:

The Burj Khalifa project is a mixed-use development tower with a total floor area of 4,60,000 sqm that includes residential, hotel, commercial, office, entertainment, shopping, leisure, and parking facilities.

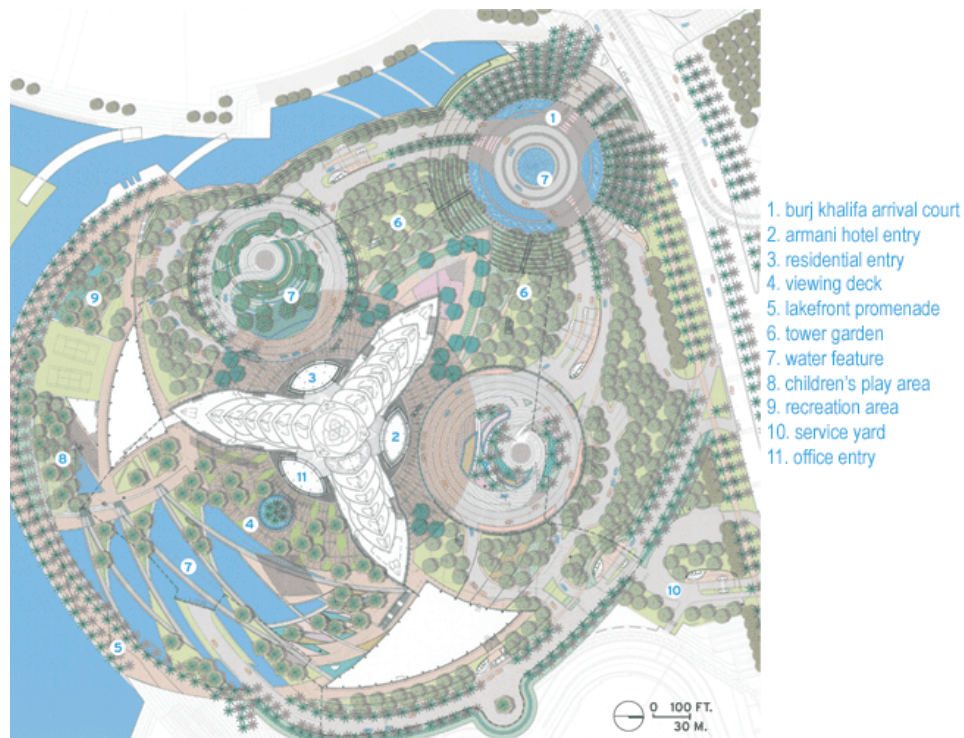


Figure 19- Site plan of Burj Khalifa

VERTICAL ZONING:

- The Right-Wing:
 - Spire: Over 200m long and house communications equipment
 - Level 156 to 159: Broadcast and telecom companies
 - Level 125 to 135: The corporate suites Level 112 to 121: The corporate suites
 - Level 77 to 108: Private Residences
 - Level 76: Sky Lobby (fitness facilities Jacuzzi Swimming pools & recreational room)
 - Level 38 to 39 Armani Hotel Dubai
 - Level 19 to 37: The Residence
 - Level 9 to 16: Armani Residence
- Concourse, ground to level 8: Armani Hotel, Dubai
- The Left Wing:
 - Level 139 to 154: The corporate suites
 - Level 124: At the top observation deck
 - Level 123: Sky Lobby (business lounge and Library)
 - Level 122: Atmosphere restaurant
 - Level 44 to 72: The residence
 - Level 43: Sky Lobby (fitness facilities, Jacuzzi, Swimming pools & recreational room)
- Podium: Provides a base (150m wide, six levels) anchoring the tower to the ground. Provides separate entries for the corporate suites, residence, and Armani Hotel.
- Foundation.

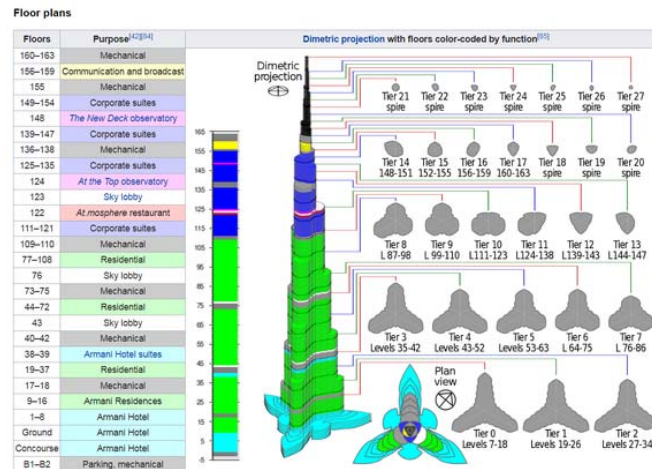


Figure 20- Vertical Zoning of Burj Khalifa

STRUCTURAL DESIGN CONSIDERATIONS:

- FOUNDATION:**

The main structure is supported by a large reinforced concrete mat, which is also supported by a large number of reinforced concrete. The design was based on many geotechnical studies and earthquakes. The floor is 3.7 m thick and is composed of four separate stones approximately 12,500 cubic meters of concrete. High-quality concrete, low-grade concrete has been used on the foundations, and a cathodic protection system under cat, to reduce any adverse effects from destructive chemicals in groundwater.

- PODIUM:**

The platform provides a base that strengthens the tower floor, allowing access to the distance from three different sides to three different levels of the building. Burj Khalifa accommodation on the ground floor and the Armani hotel on the 1st floor.

- EXTERIOR CLADDING:**

The outer cover consists of a transparent glitter with aluminum and stainless steel spandrel panels as well as straight stainless steel tubular wings. Approximately 26,000 glass panels, each cut by hand, are used in Burj Khalifa outerwear. The dressing system is designed to withstand the extreme summer heat in Dubai and to further ensure its reliability, the engine of the Second World War aircraft was used to test air and energy. The curtain wall in Burj Khalifa is equivalent to 17 football fields or 25 American football stadiums.

- STRUCTURAL SYSTEM:**

A building plan can be described as a 'molded edge' and consists of the construction of a well-functioning concrete wall. This central console provides air resistance to the structure, similar to a closed axis pipe. Under the equipment, additional walls are provided connecting the parameter columns to the internal wall system, allowing the perimeter columns to play a role in resisting lateral load. therefore, all dry concrete is used to support gravity and side loads. The result is an extremely strong tower in the past. Perimeter columns and flat plate construction complete the program.

SERVICES:

- **ELEVATORS:**

Burj Khalifa has 57 elevators and 8 escalators a fire extinguisher with a capacity of 5500 kg and will be the longest elevator in the world. Burj Khalifa is the first major elevator where some elevators will be installed to allow people to evacuate with certain fire or security events. Burj Khalifa viewing elevators are double-story rooms with a capacity of 12-14 people per cabin. Walking 10 meters, they have the longest distance in the world from the lowest point to the highest point.

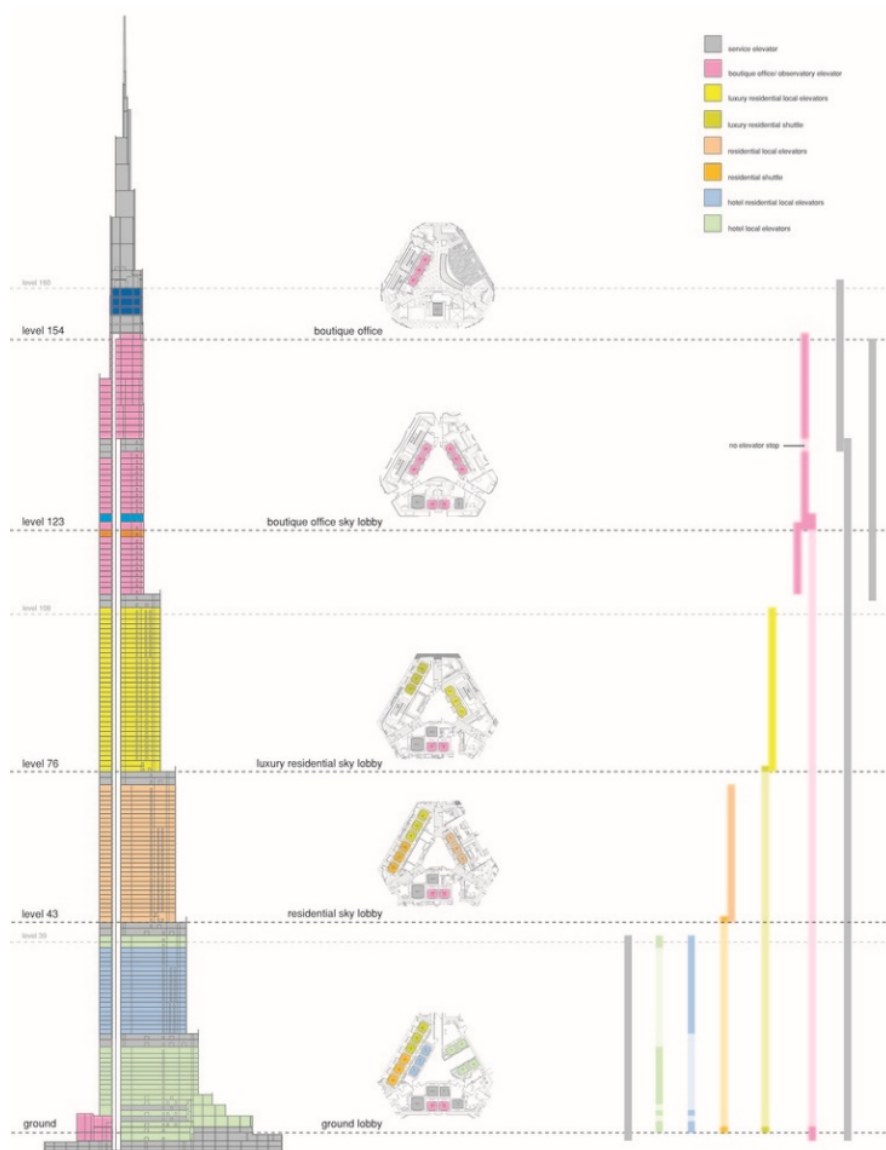


Figure 21- Vertical Transportation in Burj Khalifa

- **MECHANICAL FLOOR:**

The seven storeys floors that are the lowest floor make up the house that brings Burj Khalifa. Distributed in almost every 30 stories, the ground floor of the machine is equipped with power stations, water tanks, pumps, air conditioning units, etc., which are essential for the operation of the tower and the comfort of its occupants.

- **FIRE SAFETY:**

Fire safety and speed of evacuation were key factors in the construction of the Burj Khalifa. Concrete around all stairs and the construction service and fire extinguisher have a capacity of 5500 kg and is the longest in the world. Since people are not expected to walk down 160 feet, there are pressurized, air-conditioned areas located on almost every 25 floors.

- **POWER SUPPLY SYSTEM:**

The maximum amount of electrical energy required by the tower is 50 million volt-amp.

- **AIR SUPPLY SYSTEM:**

The Air supply system is divided into 6 mechanical zones and the Major plant rooms are located at 7 levels.

- **WATER SUPPLY SYSTEM:**

Production capacity: 9.46,000 items

INFERENCES AND CONCLUSIONS

- Burj Khalifa is the tallest wall of 829 m, with 206 beds.
- The three-Y-shaped block building provides better stability in the structure as the triangular shape is the most efficient form of the opposing side air loads.
- The composite cone form provides a broad base in the structure, which continues to decrease in length in order to build back and reduce building delays over time.
- The foundation system uses the CRPF, namely, the Composite Raft and Pile Foundation system with a 3.7 m thick cement used in Taipei 101 to transfer better load and structure to the ground.
- A total of 57 elevators and 8 escalators in the Vertical Transportation building. The fire extinguisher has a capacity of 5500 kgs and is the longest elevator in the world.
- A space receiver for better and faster direct movement with a raised lift to stop the fixed position.
- Seven-storeys two-story floors are still distributed on almost every 30 floors.
- The use of two-story elevators to reduce waiting time and crowd control.
- The Water Supply System uses PRVS-gravitational gravity, namely, Pressure Assist Relative to maintain pressure in the pipe and taps.

2.KOHINOOR SQUARE

Kohinoor square is a 52-story 203-meter (666 ft) semi-twin, a mixed-use skyscraper located on the land previously owned by Kohinoor Mills in Shivaji Park, Mumbai, India



Figure 22- Kohinoor Square, Mumbai

It is one of the first skyscrapers in India to achieve a LEED (Leadership in Energy and Environmental Design) gold rating for environmental sustainability. The Kohinoor Square complex comprises a main skyscraper and a residential skyscraper which are for mixed-use. Houses, Hotels, Residences, and a High-end Shopping Mall are being constructed by Kohinoor CTNL Infrastructure Corporation.

AREA AND HEIGHT:

- Official Name: Kohinoor Square
- Status: Under Construction (exp 2020)
- Type: Mixed-Use
- Height: 203 m (Main building)
- 142 m (Residential building)
- Floors:
 - o 52 (Main building)
 - o 32 (Residential building)
 - o 8 (Residential building)
- Elevators: 40 (Main building)
- Total Area: 2,55,000 m²
- Cost: 21 billion INR (290M USD)
- Designed by: SSA Architects, Mumbai
- Client: The Kohinoor Group

INTENT:

- To study the relationships between the various institutions that serve as sectors related to integrated work in an integrated manner.
- General services provided for information, distribution - sizes, types, and spatial design.
- Study the environment created within a building through a variety of building materials, facade treatments, building materials, and weather-induced sky gardens.
- Character analysis of building construction, distribution of motor and pedestrian services, zoning, and parking.
- Finally, learn how a building takes steps to reduce its impact on the environment.

SITE PLAN:

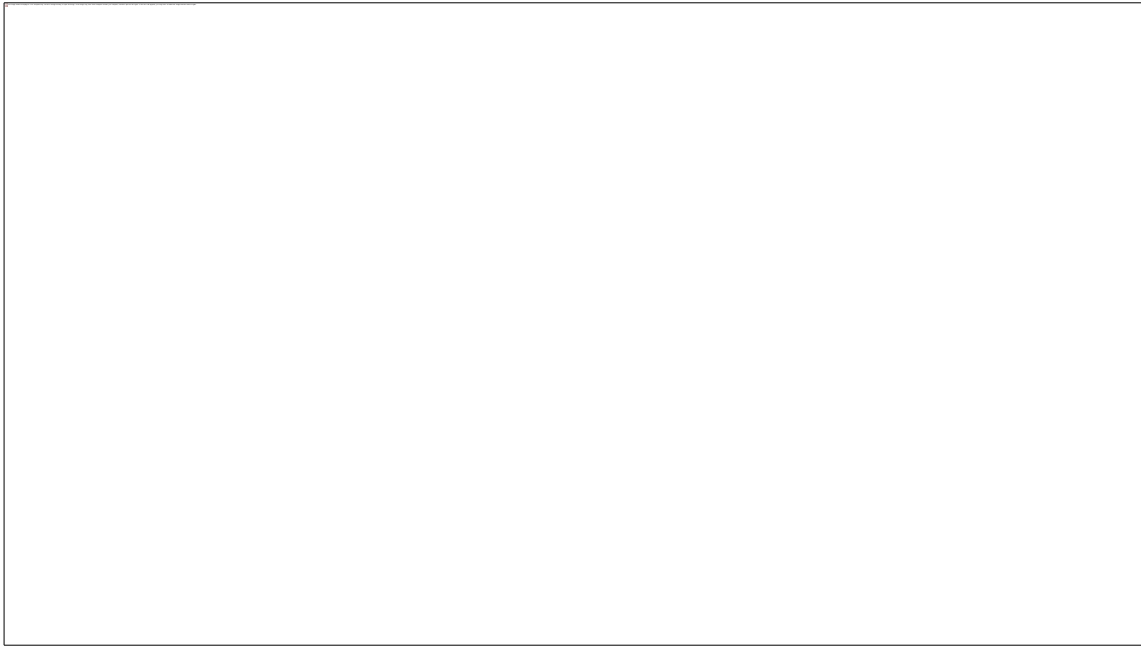


Figure 23- Site Plan of Kohinoor Square

SITE CIRCULATION:

ENTRANCE:

- Gate 1- Vehicular Entrance from the ND Kelkar Road leads straight to a drop-off zone from where one can return. Otherwise, the path leads straight to the basement. Used both by office staff as well as public
- Gate 2- Vehicular Circulation entrance from Padmabai Thakkar Road leads to the basement. Majorly used by office staff.
- Gate 3-Service entry for goods vehicles and fire tenders.
- Gate 4-For the residents who live in Tower 2 of the complex, entry will be from this gate straight to the 13-floor multi-level parking block. Entry will be made from JKSawant Road.

VEHICULAR CIRCULATION:

- The environment is traffic-free although they will have specifically appointed traffic coordinators to monitor the flow.
- The periphery has no space for parking and is only meant for vehicle and pedestrian flow.
- Peripheral Road direct vehicles into the basement.

PEDESTRIAN CIRCULATION:

- Pedestrian Scale Campus.
- Pedestrian movement is through a paved pathway next to the periphery road linking the beautiful landscape courts.

FLOOR AREA DISTRIBUTION:

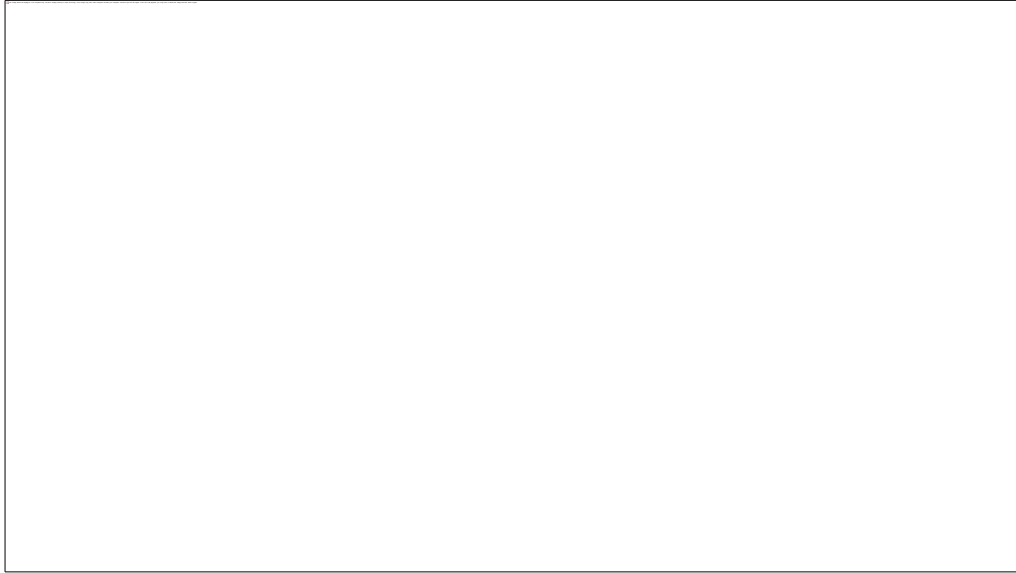


Figure 24- Floor Distribution of Kohinoor Square

West Tower	3 Basement + Ground to 2nd floor for retail and 3rd service and 4th and 5th floors for Commercial Offices.
Central Tower	3 Basement + Ground to 2nd for retail, 3rd 27th and 28th floors for services, 4th to 43rd floors for commercial offices, and 45th to 47th floors for hotel rooms (42 rooms), 48th-floor Hotel lobby and Restaurant + Helipad.
East Tower	3 Basements + Ground to 13th upper floors for public parking +14th floors for service and 15th to 32nd upper floor's residential purpose. No. of flats: 68.
Energy Center	2 Basement + Ground + 1st to 3rd floor, 5th 8th, and 11th floor.

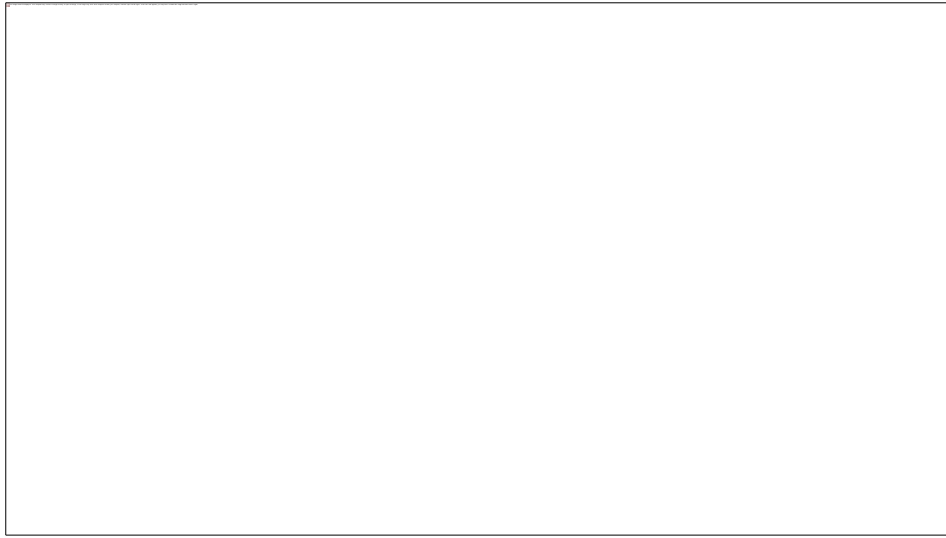
SERVICES:

Figure 25- Service Core of Kohinoor Square

FOUNDATION:

An integrated stockpile system is used. It is a geotechnical composite construction that incorporates the effect of carrying both basic and positive elements. The pile raft foundation system has recently been widely used in many buildings, especially in high-rise buildings.

VERTICAL TRANSPORTATION:

Commercial Tower in Kohinoor Square has 47 elevators with different cash banks at different levels below, which ensures a short waiting time. The system is called the Compass Navigation System, which separates traffic between different elevators, to ensure a waiting time of not more than 29 seconds

FACADE:

Encouraged by Kohinoor Diamond, the artistic rendering is reflected in the beautiful sides where the exterior shape of the other creates a compelling combination of "glittering" diamonds and the intricately crafted spandrel accentuates the diamond frames at night. The 24-meter-high West Tower atrium is made of special fabric glass and serves as a reminder to the hardworking mill workers on this piece of land, the original projects, the use of low-performance demonstrations, double glass units, reduces thermal gains by 10% -15% and led to low temperature manifestations. It is one of the first projects built in India with an unprecedented design of uninterrupted LED lighting.

PARKING:

- Providing parking for 2000 cars was a huge challenge. The construction was also halted due to FSI issues due to the high demand for parking but that issue has been resolved and the construction is going as planned.
- The parking job was made easy by placing the parking lot on 3 basement floors that run underneath the complex.
- Also, special parking has been provided in the form of 13 stories multilevel for the residential as well as the office staff only.
- TFA 200,000 sqm.
- According to Norms- ECS for the commercial area is 1.05 per 100 sqm equivalent to parking for approximately 2000 which is adequate.

RAMPS:

- System of ramps marked which separate entries and exits ensure proper circulation hence help safe circulation.
- One-way ramps have been provided with a slope of 1:10.

SUSTAINABLE FACTORS:



Figure 26- Sustainable Factors of Kohinoor Square

INFERENCES:

- The design of different jobs is done in such a way that each employee gets a different business and the person who comes in will know where to go.
- Consecutive high weather gardens will allow for winter indoors and will allow for the winter sun indoors, and will be responsible for creating a level of luxury, which will keep them alive in the afternoons.
- Positioning the center with controlled access to your destination will be useful for safety and monitoring purposes.
- The use of bioclimatic walls will help improve indoor air quality.
- Providing residents, office workers, and the community with free parking spaces without errors will make it easier.
- A general food court provided by the public and the office will promote its use and improve knowledge.

3. WORLD ONE

The 'WORLD' project is one of the most recommended projects in India, as it will be the longest residential building in India. It is 1450 meters long for the Load World One Mumbai Residential Skyscraper. It is currently the tallest building in India under construction and is a residential building with a proposed height of 442 meters and 117 floors. According to some claims, this small building in Mumbai World will be the tallest building in the world when completed! Because the largest Pentonium building in Dubai, which was to be the tallest tower in the world at 516m and 122 meters high, is currently under construction.



Figure 27- World One, Mumbai

World One was built at a cost of more than US \$ 321 million. Construction began in 2011, expected to be 442 m (1,450 ft) in height. As the engineer failed to get approval from the Airports Authority of India for this length, the project was suspended for a few years. Following the hiatus, the project was reorganized to the current length and completed. World One is now 280.2 m (919 ft) and is still the tallest building in India.

The Mumbai World One building will have about 300 luxury homes, including three living quarters and four bedrooms, living quarters and private pools, and a limited number of luxury living quarters.

AREA AND HEIGHT:

- Official Name: World One
- Status: Complete
- Type: Residential
- Height: 442m
- No. of Floors: 117
- Elevators: 25: 8m/sec
- Total Area: 75,00,000 m²
- Cost: 321Million USD
- Designed by: Pei Cobb Freed & Partners
- Structural Engineer: Leslie E. Robertson Associates
- Main Contractor: Arabian Construction Co. & Simplex and Muscovite Group
- Developer: Lodha Developers

FLOOR AREA DISTRIBUTION:

- 1st to 40th having 3 BHK residences having an area of 2800 sqft and 4 BHK residences having an area of 3400 sqft.
- 41st to 80th floors are having world villas with private pools having an area of 7000 sqft.
- Floor 81st & above is Duplex World Mansions.
- 6 podium levels for parking



Figure 28- Floor Distribution of World One

SITE PLAN:



Figure 29- Site Plan of World One

STRUCTURAL FEATURES:

Reinforced concrete is used for columns and slabs as well as steel and glass facade. The theme is separated throughout the system and has a clear-double clearance.

The tower structure, supported by reinforced concrete slabs and piles. The building was built as a 'mega building' for architectural design - the first time this technology was used in India.

SERVICES:

- 18 elevators go up to 8 meters / sec (over 25 ft / sec, over two floors / second).
- World One is designed to manage the impact of air traffic and earthquakes. High-strength concrete forms the structure of the tower.
- Special measures have been taken to ensure the highest standards of fire safety, including fire detection systems and automatic spraying, pressing fire ladders, and fire speed elevators.

SUSTAINABILITY:

- World one is counted as a gold certified building built by the green building council.
- It will be one of only 100+ news outlets in the world to receive this coveted certificate, which reflects the highest level of environmental protection in its construction and operation.
- Key aspects of environmental sustainability include:
 - 100% recycling of water and rainwater harvesting - reduces water consumption by up to 50% above normal building.
 - Use of vry air-conditioning and solar energy in normal local light and water temperature - reduces electricity consumption by up to 40% for waste disposal and recycling.

4.TAIPEI 101

Taipei 101, formerly known as the Taipei World Financial Center, is a prominent flag-selling building in the Xinyi District of Taipei, Taiwan. The building was officially classified as the tallest in the world in 2004 and remained so until the Burj Khalifa opened in Dubai in 2010. In July 2011, the building was awarded the LEED Platinum Certification, the highest award in terms of Leadership in Energy and Environmental Design (LEED) rating system, and became the world's greenest building. Taipei 101 is designed for C. Lee and Partners and is composed primarily by KTRT Joint Venture. Construction began in 1999 and was completed in 2004. The tower has served as a symbol of modern Taiwan since its opening.



Figure 30- Taipei 101, Taiwan

Taipei 101 has 101 floors above ground level and five floors below. The building is masterfully crafted as a symbol of the emergence of Asian technology and culture. Its approach to postmodernist style incorporates traditional building materials and provides them with modern treatment. The tower is designed to withstand storms and earthquakes. The multicultural shopping mall that meets the tower has many shops, restaurants and clubs.

AREA AND HEIGHT:

- Site Area: 30,277 m²
- Floor Area: 3,73,831 m²
- Height: 508 m
- No. of Floors: 101
- Main Tower: 101, Podium: 6, Basement: 5
- Type: Office Building
- Location: Taipei 101, No. 7, Section 5, Xinyi Road, Taipei City, Taiwan 110.

CONCEPT:

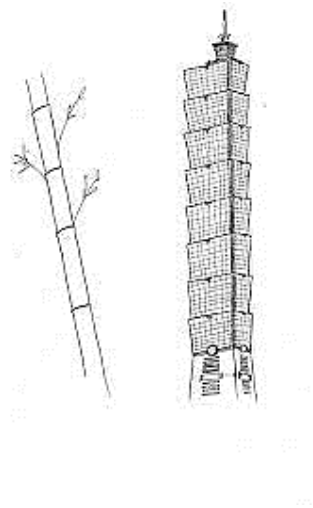


Figure 31- Concept of Taipei 101

Taipei 101 was designed by C.Y. Lee and Partners and constructed by Samsung C&T and KTRT joint ventures. The building is designed to resemble growing bamboo, a symbol of everlasting strength in Chinese culture.

RELEVANCE OF CASE STUDY:

- It was the world's tallest building with a height of 508m and remained such until the opening of Burj Khalifa in 2010.
- A symbol of the evolution of technology and Asian tradition.
- Location in the earthquake-prone region of Taiwan and magnificently withstand the seismic load as well as wind load through its innovative design.

- **SELECTION CRITERIA:**

- It helps in understanding various technical aspects of a skyscraper.
- Studying Taipei 101 gives an idea about designing high-rise structures in earthquake-prone regions of Asian countries.
- Only a Skyscraper in the world uses a Mass Tuned Damper to resist the lateral sway of the building during an earthquake and high-speed wind.
- It will help in understanding structural systems that can be used in high riser buildings about 100-floor levels.
- It gives an idea about various building services (spaces) requirements and the interlinking of different types of uses and user activity.

SITE PLAN:

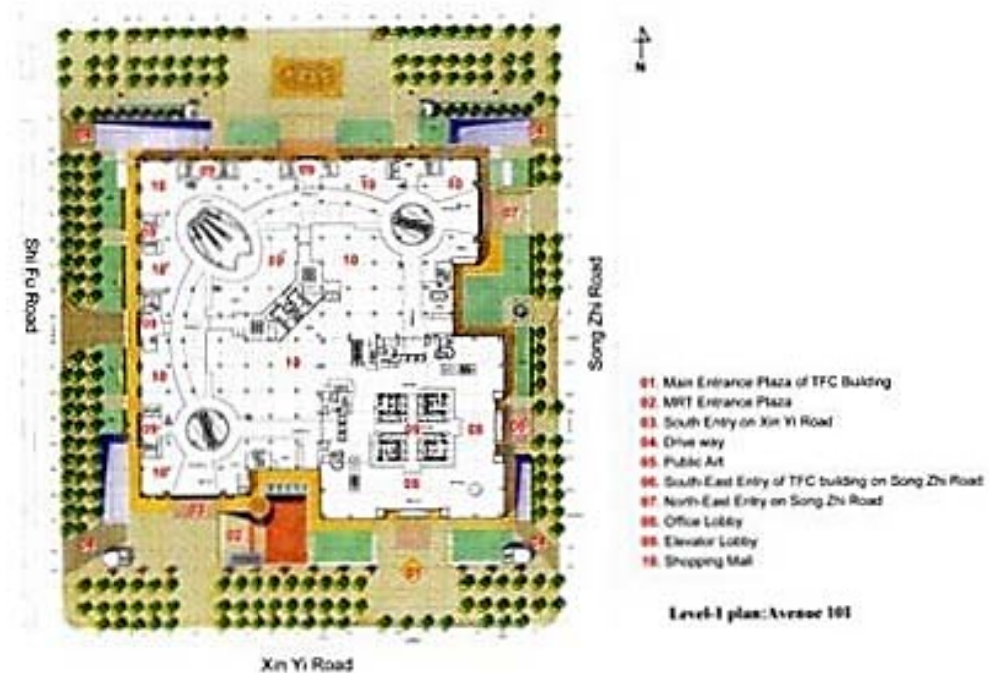


Figure 32- Site Plan of Taipei 101

VERTICAL ZONING:

- Floor 101-Summit 101 (Private VIP Club)
- Floor 92-100- Communication
- Floor 91-Outside observatory deck
- Floor 88-89- Indoor Observatory deck
- Floor 85-86- High Zone Office
- Floor 59 60- Sky Lobbies
- Floor 35-58- Mid Zone Office
- Floor 36- Taipei 101 Conference Centre
- Floor 35- Amenities
- Floor 9-34-Low Zone Office
- Basement 1-Floor 5-Taipei 101 Mall
- Basement 5-B 2-Parking Levels

STRUCTURAL DESIGN CONSIDERATIONS:

• FOUNDATION:

Soft rock comes from less than 40 to 60m of clay and solid soil for mixing. Five major elements have been used to create two different basic systems:

Each column of the platform carries one pier 2m (6.5 ft.) Wide. Sockets 5 to 28m (16 to 92 ft) in the base line resist the net lift from the pressure drop of pressure.

One pier design allowed for low-rise construction: an apartment was thrown to reinforce the perimeter walls, and the excavation material continued under it.

The construction of the main building was done simultaneously. As a result, the trading platform was opened about a year before the tower came out. The second mud wall, which encloses only the footprint of the tower, was supported by a steel cross-section where the excavation deepened. The walls were reinforced to accommodate the construction sequence. Frequent reinforced fluids up to 3 to 4.7m (10 to 15 ft) the maximum load transfer from the straight column and loading points on the wall of the shear in a distributed pattern of 380 molded pipes, 1.5m wide (5 ft .), Divided by 4m (13.12 ft.) In the center of the vertical lines to withstand gravity of between 10.7 and 14.2 mn (1500 and 2000 kips). It is used to enclose steel with a reduced construction weight, helping to reduce the cost of foundation compared to a straight shaft, if the building system includes perimeter columns.

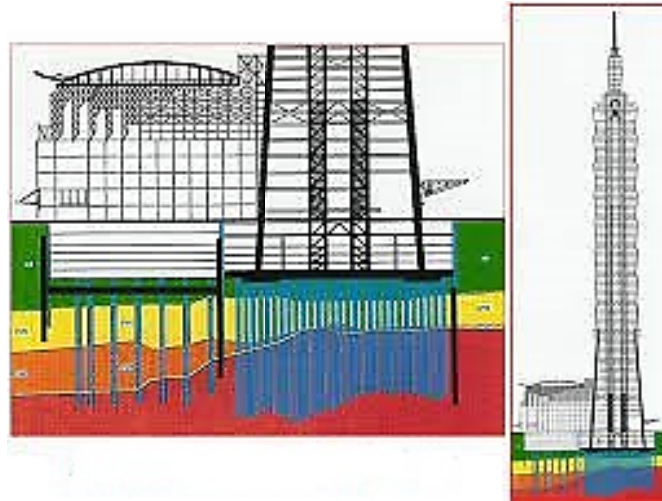


Figure 33- Foundation of Taipei 101

- **SEISMIC DESIGN:**

- o Central core
- o Trusses and Bracing
- o Truncated Pyramid Base
- o Flexible but Sturdy Materials: 10,000 psi concrete and 60 ksi steel.
- o Elevation
- o Mass Damper
- o Mini Dampers on Spire

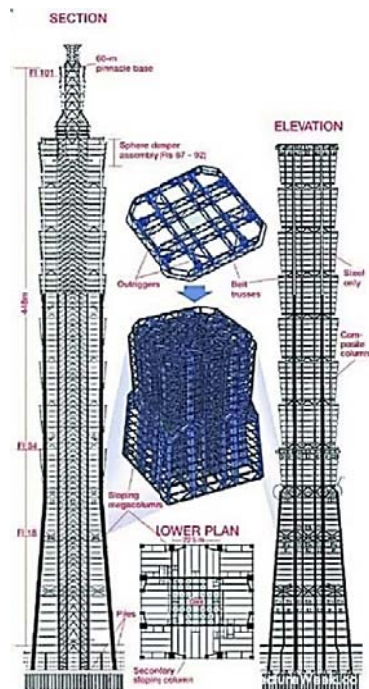


Figure 34- Structural Diagram of Taipei 101

SERVICES:

VERTICAL TRANSPORTATION:

- Viewing Elevators: 2 one deck, 1600 kg (24 people) per deck in 2004, Guinness Record is the world's fastest lifts with aerodynamic-powered boats, rising at 1010 m / min.
- Passenger Elevators: 10 Double-deck, 2040 kg (31 people) with individual shooting elevators per floor deck, 24-deck decks, 1350 kg (20 people) deck each access within six locations (4 per zone), three deck power).
- Utility Elevators: 3 one desk 2x 2040 kg 1x 4800 kg).
- Car Park Elevators: one deck, 1600 kg to lobby lobby.

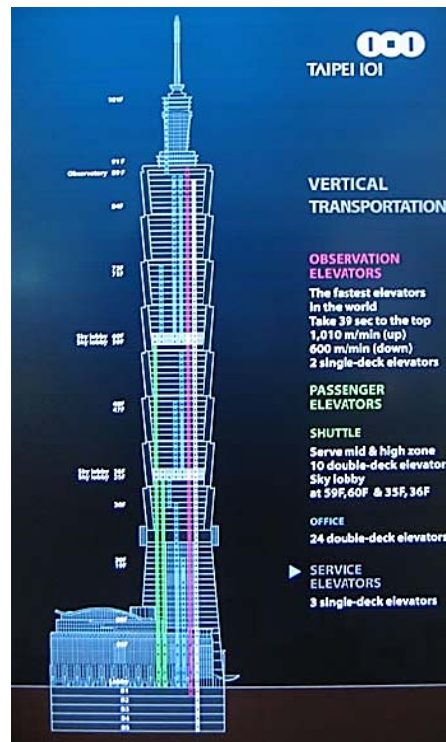


Figure 35- Vertical Transportation in Taipei 101

INFERENCES AND CONCLUSIONS:

- Taipei 101 is a historic building that has been the tallest building in the world since 2004-2010 overcoming the height of the Petronas Towers by 58m.
- Be a symbol of Taiwan's efficiency and expertise. The structure is flexible enough to withstand earthquakes and strong enough to withstand storm winds.
- The engineers and designers of the Taipei 101 have gone beyond the expectations and imagination of the human mind to create this great phenomenon.
- The construction and installation of Tuned Mass Dampers and super-columns resulted in earthquakes.
- The design of the modules and the step-by-step form of planning give you a quick edge, which is one of the most important methods of building large buildings.
- Taipei 101 is a building that can withstand high winds of 60 m / s (197 ft / s, 216 km / h or 134 mph) and the strongest earthquakes that can occur over a 2500-year cycle.
- A soft ground foundation requires metal foundations for bored piles and metal walls.
- This project outlines the major and minor construction and engineering decisions needed to complete the construction challenges.

5.ABENO HARUKAS

Abeno Harukas is a 60-story building with five floors below, located directly above the Abeno station. It has a total floor area (TFA) of about 306,000 square meters and consists of a university, a day nursery, high quality medical centers, and a small theater area, in addition to office space, department store, hotel, museum and viewing area. At an altitude of 300 meters, it is the tallest building in Japan and the first great nation building. A large part of the tower's tower, with a TFA of about 212,000 square meters, was considered an extension of a building that already has a TFA of about 94,000 square meters. This has enabled engineers to apply the "local law" with special measures regarding urban reconstruction profitably "



Figure 36- Abeno Harukas, Japan

The city of Supertall Compact City such as Abeno Harukas combines a variety of activities that are common in all major cities in a large building. With access to the railway network, these structures can have a sufficient impact on reorganizing not only the surrounding buildings but the entire urban region. The integrated, railway structures of such a city help to reduce energy consumption and carbon emissions and provide a variety of services and services in an integrated environment. The developers of Abeno Harukas believe that such cities will be able to promote psychological and economic activities, just as the population is declining.

AREA AND HEIGHT:

- Owner: Kintetsu Corporation
- Design and Supervision: Takenaka Corp Osaka, First Class Architects Office
- Construction: Takenaka Corp Okumura Corp, Obayashi Corp, Dai Nippon Construction Co Ltd, and the Zenitaka Corp. Joint Venture.
- Location: Osaka city
- Zoning: Commercial District, Fire Zone, Special Urban Renaissance District.
- Use Purposes: Department store, railroad station, office, hotel, Museum, and observatory
- Building Area: Tower Building: 6,110.00 m² (25,000 m² in total)
- Total Floor Area: Tower Building: 212.000 m² (306,000 m² in total)
- Floor Area Ratio: 1,163.73%
- Structural Scale: Steel (above-ground) SRC (under-ground)
- Five basement stories, 60 stories aboveground with one penthouse (legally approved number of stories: 6 basement stories, 62 stories, and 1 penthouse).
- Maximum Height: GL+ 300.00 m
- Building Depth: GL-30.47 m

VERTICAL ZONING:

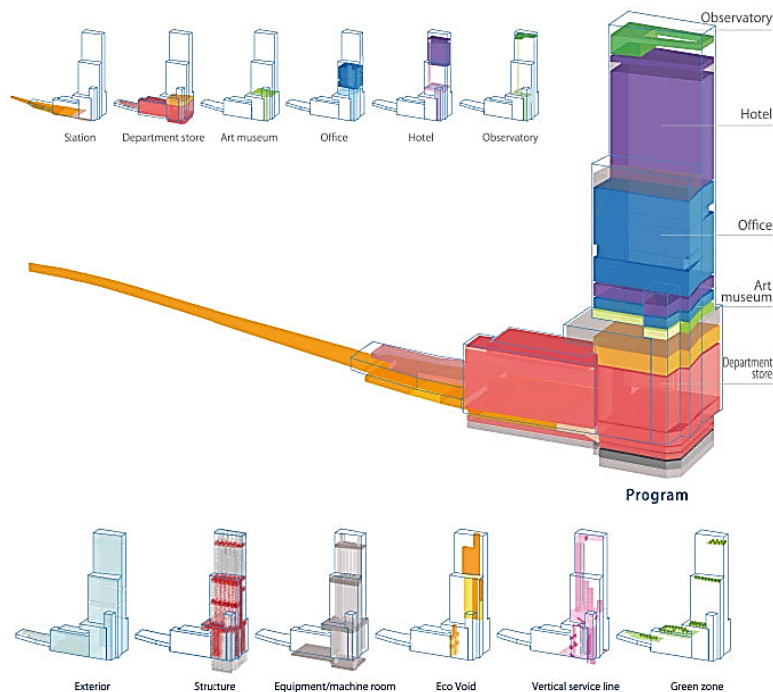


Figure 37- Zoning of Abeno Harukas

TRANSPARENT CORE:

In supertall construction, the center cores are usually fastened to increase durability and are often used as window-free state areas that block natural light. Instead, Abeno Harukas contains cores that transmit light and use them as connections between nature and the city. With this image in mind, the group left part of the spine as an external area (avoid), allowing the use of glass walls on stairs and elevator shafts that occupy space. This had many layers of clear spaces, each with a different character, which transmits natural light to the very inner parts of the office. The spaces are comfortable and help residents understand them. As a result, they promote meaningful association.

SERVICES:

- **FIRE SAFETY:**

In connecting areas between zones, truss floors are set up to prevent a fire from progressing. If a fire breaks out and spreads, these zones prevent it from spreading to other areas where there is no fire.

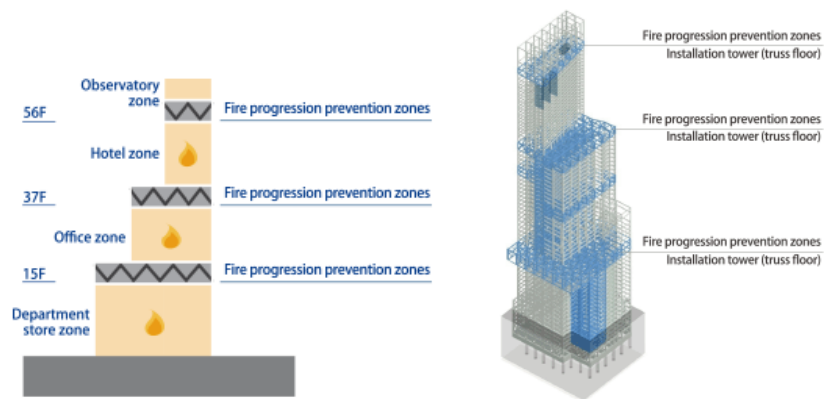


Figure 38- Fire Safety in Abeno Harukas

- **CENTRAL WAITING AREAS:**

When the entire building has to be evacuated, including areas where there is no fire, lobbies on the 16th and 38th floors, and the rooftop garden will be used as central waiting areas to prevent prolonged congestion on the emergency stairs.

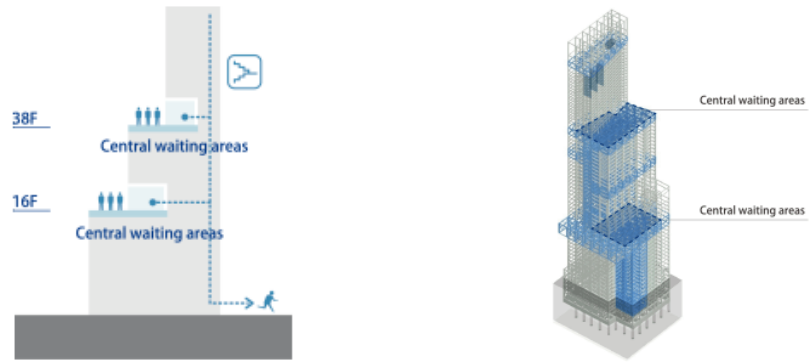


Figure 39- Waiting areas in Abeno Harukas

INFERENCES AND CONCLUSIONS:

- Once the entire building has to be evacuated, including non-fire areas, storage areas on the 16th and 38th floors, and the roof garden will be used as central waiting areas to prevent prolonged congestion on emergency stairs.
- Exemplar project Supertall Compact City prototype.
- The range of plans, the balance and variety of collection spaces, the clear design and functionality of the façade design, and the integration of the green type made with advanced technology work together, providing a truly tall building that will truly add to the city.

4. CHAPTER FOUR – SITE STUDY AND ANALYSIS

SITE SELECTION:

WHY CHENNAI?

Chennai was once home to the tallest building in India- the 15-storied LIC building in 1959. It was common to see people gawk at it in awe while trying to count the number of floors each time they passed by.



Figure 40- Skyline of Chennai City

“The identities of most modern cities have been their skyscrapers. One of the main reasons Indian cities are underdeveloped is the lack of high rises. With the relaxation of rules, developers can build structures that are a class apart in terms of technology, structure, and design.” says The Hindu.

There is an unprecedented growth rate of infrastructure across India. Cities like Mumbai are already known as Skyscraper City with the highest number of 12 architects in the world. Most of these buildings are residential. There is no doubt that the practice of living on heights has taken over the country.

The city now prefers to stay away from the world, with minimal pollution and increased privacy, and has no problem spending money on this lifestyle. Another important factor that has inspired development is that as international travel becomes more common, people expect the same places in the city. They would not want to open their window and see what was going on at their neighbour’s house. Aside from the benefits of space, less air, and viewing.

The main reason for this project in Chennai is because this will bring the city once again home to the tallest building in India.

SITE LOCATION:

Sardar Patel Rd, Venkta Puram, Saidapet, Chennai, Tamil Nadu 600015

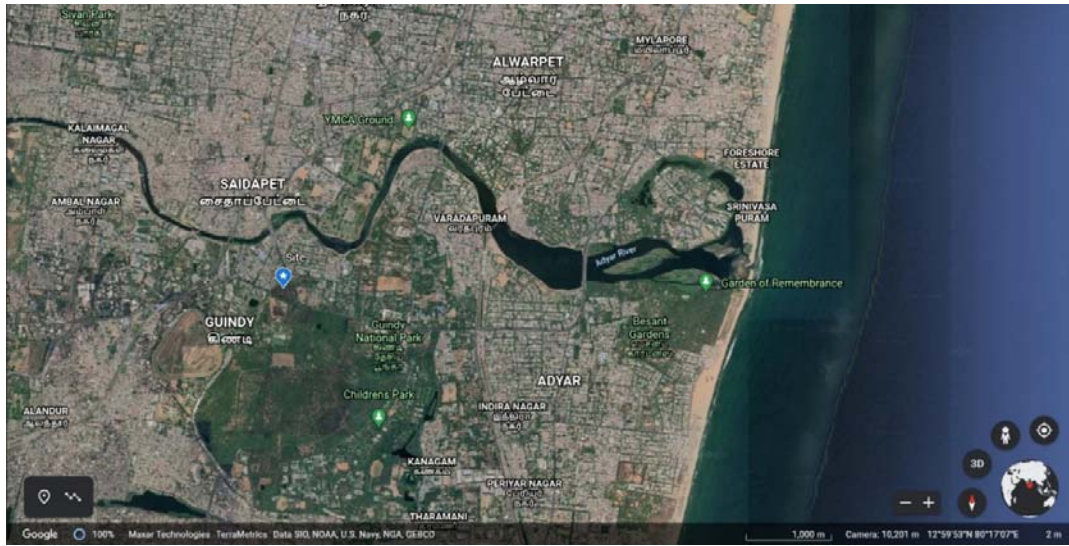


Figure 41- Map of South Chennai



Figure 42- Location of Proposed Site

SITE JUSTIFICATION:

The site is in the center of the city that shapes the skyline of the city and the future. It is surrounded by government buildings, institutional buildings, commercial buildings, and residential buildings. So, this site has the scope to attract people of all ages and groups. It also has a view towards the Adyar River, Beach, a picturesque landscape of Chennai's national park, and the whole city skyline of Chennai.

SITE ANALYSIS:

ACCESSIBILITY:

The site is accessible from 3 sides

- EAST: 25m ROAD
- SOUTH: 25m ROAD
- WEST: 9m ROAD

PLOT AREA:48562.2 sqm (12 acres)

PROXIMITY MAP:

Bus Stop	Taramani Bus Terminus (5.8km)
Metro Station	Little Mount Station (900m)
Airport	Chennai Airport (8km)

The site is next to Chennai-Trichy Highway

SITE SURROUNDINGS:

Saidapet is in a well-developed area which has all the main buildings of Chennai like:

- Raj Bhavan- Governor's Residence
- Metropolitan Magistrate Courts
- Anna University
- Guindy National Park
- Indian Institute of Technology Madras
- Adyar Cancer Institute
- University of Madras

SERVICES:

- WATER SUPPLY:Groundwater and Metro water.
- SEWAGE:Underground metro sewage system.
- ELECTRICITY:Transformers are located next to the site.

GEOLOGY:The site contains Sand and Sandstone.

VEGETATION:

It contains a lot of trees and shrubs in the northwest part of the site and around the site boundary.

TOPOGRAPHY:

Terrain slope varies from 1:5000 to 1:10,000. The terrain is very flat with contours ranging from 2 m to 10 m above mean sea level.



Figure 43- Slope of the Site

SEISMIC ZONE:

Chennai falls under **Seismic Zone – III**. The whole of the Chennai Metropolitan Area falls in this zone.

CLIMATIC ANALYSIS:

- SUN PATH:**

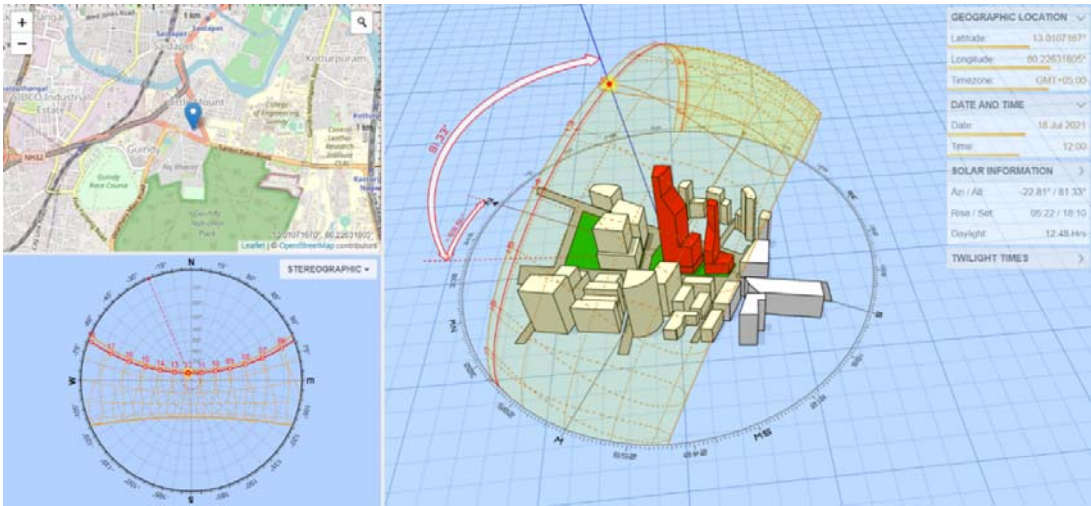


Figure 44- Sun Path Diagram of the Site

- TEMPERATURE:**

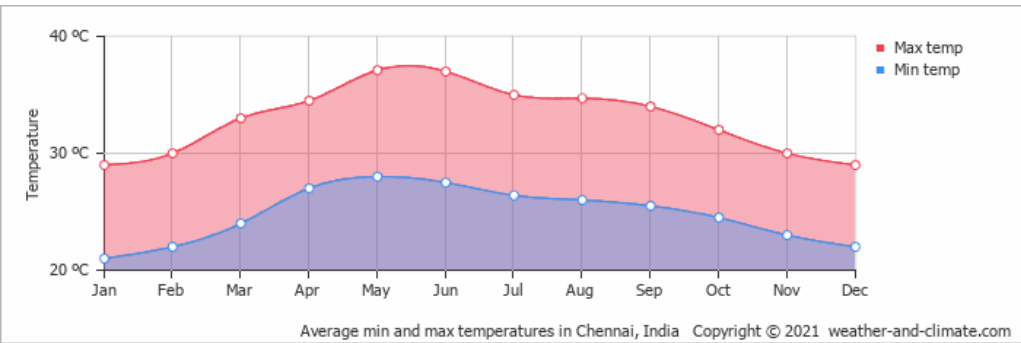


Figure 45- Annual Graph of Temperature of Chennai

- RAINFALL:**

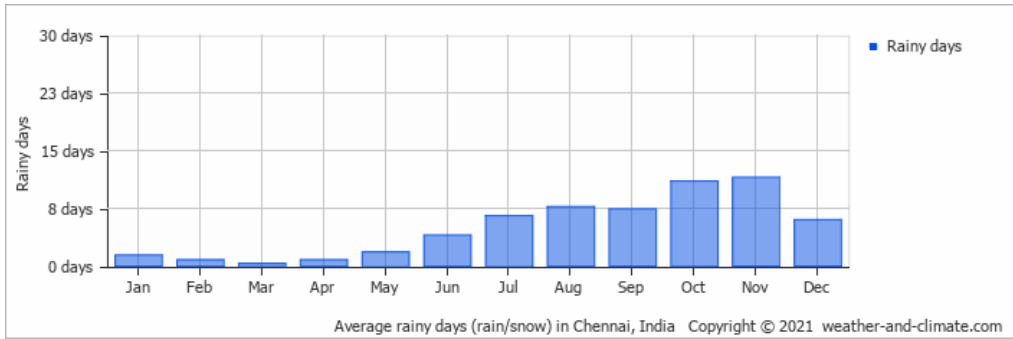


Figure 46- Annual Graph of Rainfall of Chennai

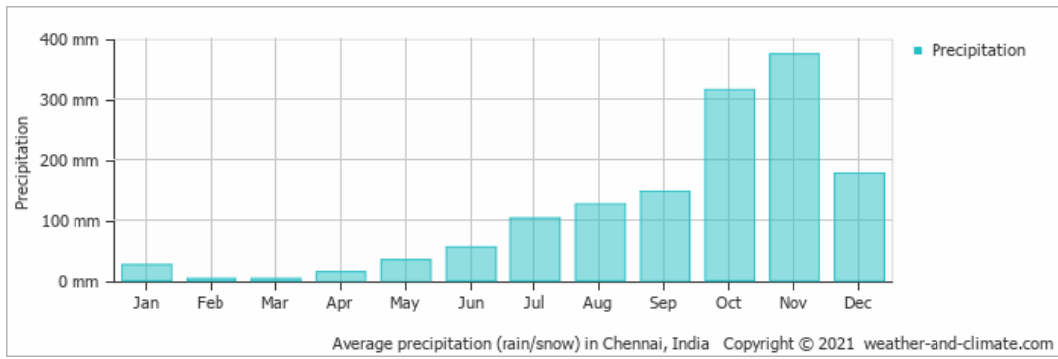


Figure 47- Annual Graph of Precipitation of Chennai

- HUMIDITY:**

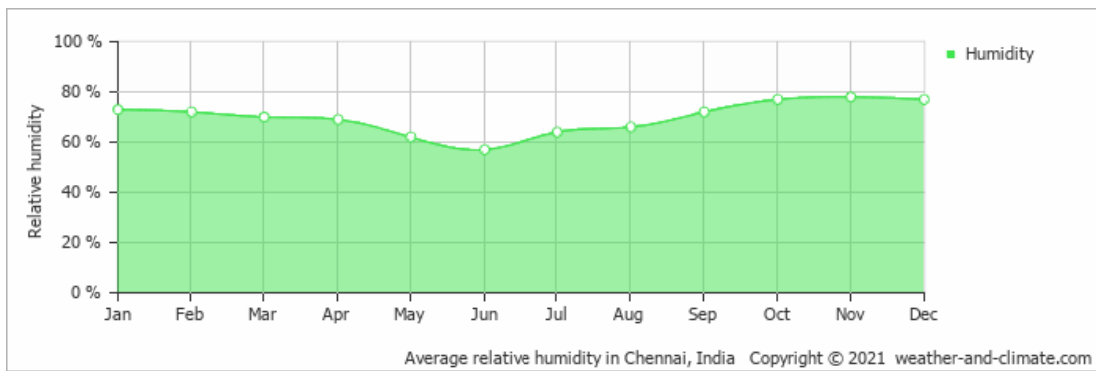


Figure 48- Annual Graph of Humidity of Chennai

- WIND-PATH:**

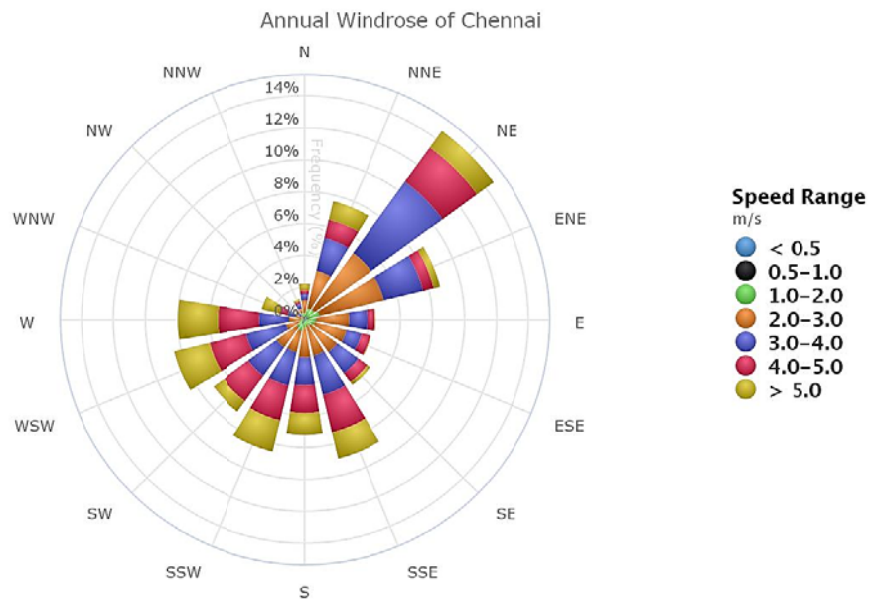
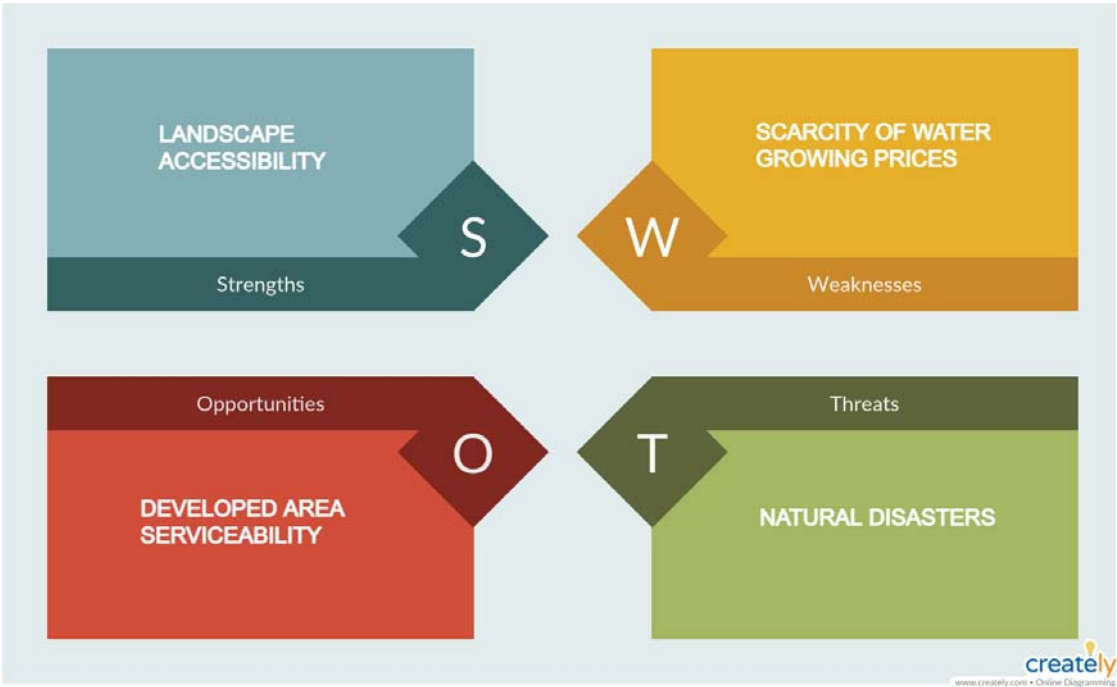


Figure 49- Wind-Path of Chennai

SWOT ANALYSIS:



5. CHAPTER FIVE - ARCHITECTURAL DESIGN

BUILDING NORMS:

- The minimum Road width for a building above 60m is 18m
- Maximum F.S.I.: 3.25
- OSR-10% of the plot extent
- Maximum plot coverage = 50%
- Maximum Height above ground level is 60m
- Further, every increase in height of 6m, the minimum extent of setback is 1m or a maximum of 20m
- Vehicular access within the site 7.2m
- Height of basement floor 1.2m minimum if above ground level
- The height of basements from floor to ceiling shall be maximum up to 4.5m
- There will be no restriction on the number of levels of the basement subject to mechanical ventilation as per provisions in National Building code-2005, waterproofing, and structural safety.
- Refuge Area: For all buildings exceeding 24m height, a refuge area of 15 sqm shall be provided as follows:
 - o The refuge area shall be provided on the periphery of the plot or preferably on a cantilever projection and open to the air on at least one side protected with suitable railings.
 - o The floors above 24m and up to 39m- one refuge area on the floor immediately above 24m.
 - o For floors above 39m - one refuge area on the floor immediately above 39m and so on after every 15mtrs.

BASIC PLANNING CONSIDERATIONS:

- Planning module
- Span
- Ceiling height
- Floor-to-floor height
- Depth of structural floor system
- Elevator system
- Core planning
- Parking

BASIC DESIGN CONSIDERATIONS:

The basic design considerations for a high-rise building include the following parameters:

- The cultural, political, and social aspects of the city where the building will be located.
- a strong relationship with the city.
- The master plan and an appropriate site selection
- Sustainability
- Safety and Security issues
- Learning about the possibilities and limitations of technology

When a high-rise building is designed the design team should also be aware of the codes, regulations, zoning requirements, and life safety issues.

MAXIMUM BUILT-UP AREA:1,57,827.15 sqm

NUMBER OF FLOORS:100 (500m)

TOTAL HEIGHT OF THE BUILDING:600m

HEIGHT OF EACH FLOOR:5m

TYPES OF USERS:

- Public
- Office staffs
- Residents
- Building management staffs

FLOORS OF THE BUILDING:

- Shopping complex
- Hotel
- Office
- Amenities
- Retail
- Apartments
- Mechanical floors

SPATIAL REQUIREMENTS:

- **SHOPPING COMPLEX:**

- o Shops - Large & Small - Range from 100 sq.m to 200 sq.m
- o Lobby
- o Atrium
- o Staff area-BMS room

- **OFFICE:**

- o Offices - Large & Small - 500 sq.m to 1500 sq.m
- o Lobby
- o Atrium
- o Staff area-BMS room
- o Service area

- **APARTMENTS:**

- o 2 Bedroom Unit: 105 sq.m.
 - Living: 30 sq.m.
 - Kitchen: 15 sq.m.
 - Dining: 15 sq.m.
 - Bedroom: 20 sq.m.
 - Bathroom & Closet: 5 sq.m.
- o 3 Bedroom Unit: 125 sq.m.
 - Living: 40 sq.m.
 - Kitchen: 20 sq.m.
 - Dining: 20 sq.m.
 - Bedroom: 20 sq.m.
 - Bathroom & Closet: 5 sq.m.
- o 4 Bedroom unit: 200 sq.m.
 - Living: 40 sq.m.
 - Kitchen: 20 sq.m.
 - Dining: 20 sq.m.
 - Bedroom: 20 sq.m.

- Bathroom & Closet: 8 sq.m.

- o Entrance Lobby
- o Swimming pool
- o Gym & Yoga

- **HOTEL:**

- o Rooms:50 sq.m.
- o Lounge
- o Restaurants
- o Bars
- o Conference halls
- o Health club
- o Swimming pool

- **NON-FSI AREAS:**

- o Staircase and lift rooms
- o Lift wells
- o Fire escape staircases
- o Cantilever fire escape passages
- o Stilt parking floor
- o Service ducts/ garbage shaft
- o Ahu rooms
- o Electrical room
- o Pump room
- o Generator room

- **PARKING DETAILS:**

- o Parking: 1 car space for every 50 sq.m. for shopping, 100 sq.m. for office, 75 sq.m. for flats, 50 sq.m. for hotels.
- o 1 Two-wheeler parking for every 50 sq.m. of shopping, for every 25 sq.m. of office space for every 75 sq.m. of flats, for every 50 sq.m. of hotels
- o Car stall size: 25 x 5.0m,two-wheeler 1.0m x 1.8m
- o Driveway 3.0m for one way, 7.0 m for two-way
- o Width of entry-exit gates 3m wide
- o Ramp: ramp gradients 1 in 8, turning radius 4.0

VERTICAL ZONING:

B1-B5	Parking
G-4	Shopping Mall
5-22	Office
23-24	Mechanical floor
25	Sky Lobby
26	Amenities
26-47	Hotel
48-49	Mechanical floor
50	Sky Lobby
51-72	Residential [3BHK & 4BHK]
73-74	Mechanical floor
75	Sky Lobby, Mechanical & Amenities
76-97	Residential [2BHK]
98-99	Mechanical floor
100	Sky Observatory

CONCEPT:

AEROHIVE:

Aero means objects or activities related to the wind or air movement and the nest means a place where people are busy. The concept is known after the structure of the building and therefore the science of Aerodynamics.

FORM DEVELOPMENT:

After performing the air flow analysis of the various types of structure, it has been observed that the triangle creates a larger number of vertical vortexes in relation to the square shape. Therefore, small cracks have been observed with a small number of standing points in the building area.

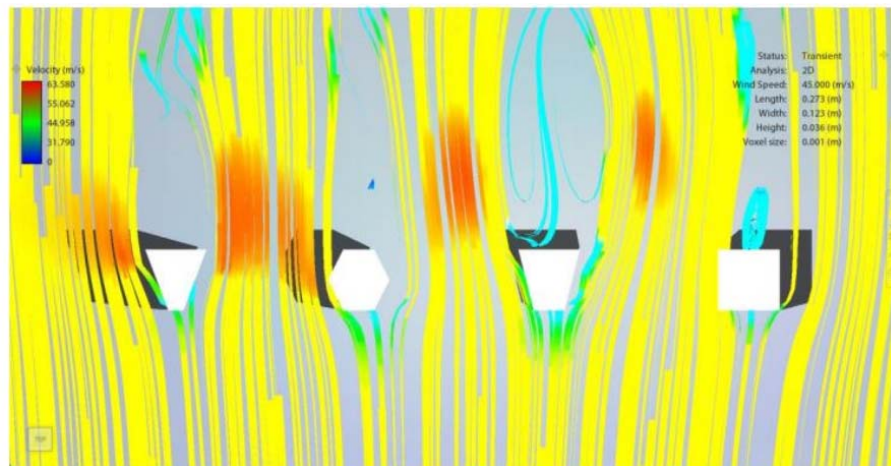


Figure 50- Wind Flow of Various Shapes

WHY TRIANGLE?

Tall modern buildings are extremely sensitive to air. Therefore, air load testing to design these structures is important. Reducing the equilibrium efficiency of drag aerodynamic transformation is done by integrated, rotated, and retractable angles as well as the performance of aerodynamic formations, set-back, taper, and 45-deg helical in a long triangular structure. Construction scales are considered $B = 1 / 6H$. Aerodynamic modification of rounded, tapered corners is able to create a decrease in the drag drag of the structure by 66% and 24%, respectively. In addition, the aerodynamic conversion process is approximately 74% more efficient to meet air effects than aerodynamic form techniques.

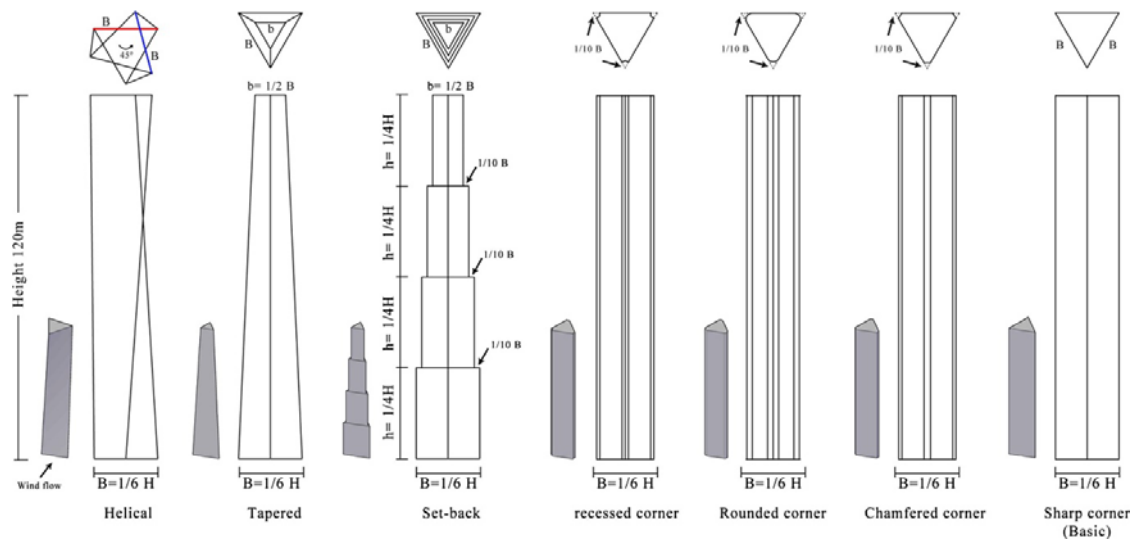


Figure 51- Wind Aerodynamic Characteristics Of Different Triangular-shaped Tall Buildings

THE CONCEPT OF AERODYNAMICS:

To reduce the impact of air load on the ground floor is considered under the 3-D exterior design which includes a vertical triangle at the base where the area is smaller at the top. The triangular surface in the cracks in the structure, the air load as it passes around the structure allows for much less gravity than when sharp edges were in progress.

THE ANALYSIS SUGGESTS THAT A CHAMFERED TRIANGLE BEHAVES SIMILAR TO A CIRCLE AND REDUCE THE WINDLOAD ON THE STRUCTURE.

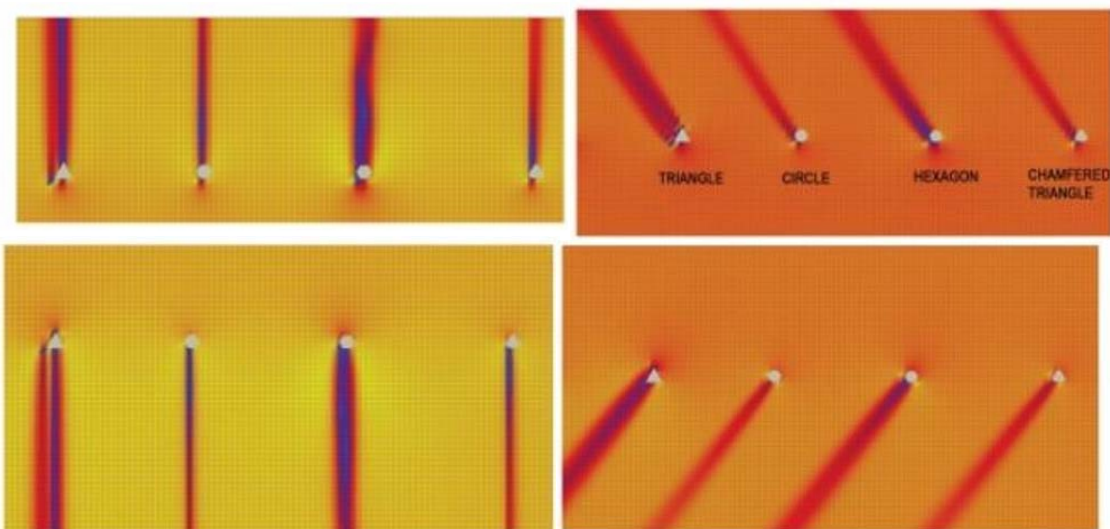
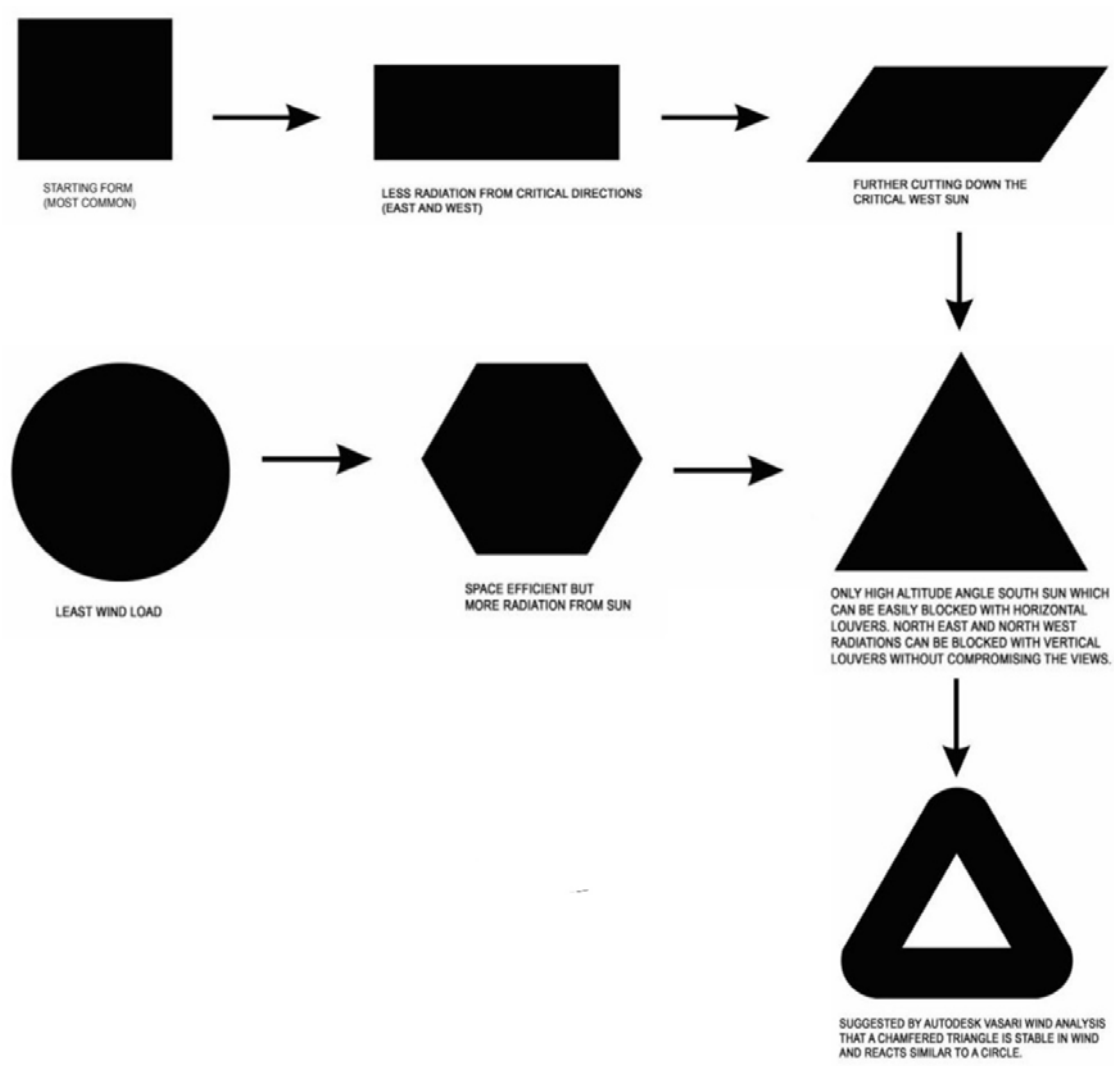


Figure 52- Wind Flow of Various Shapes

EVOLUTION OF FORM :



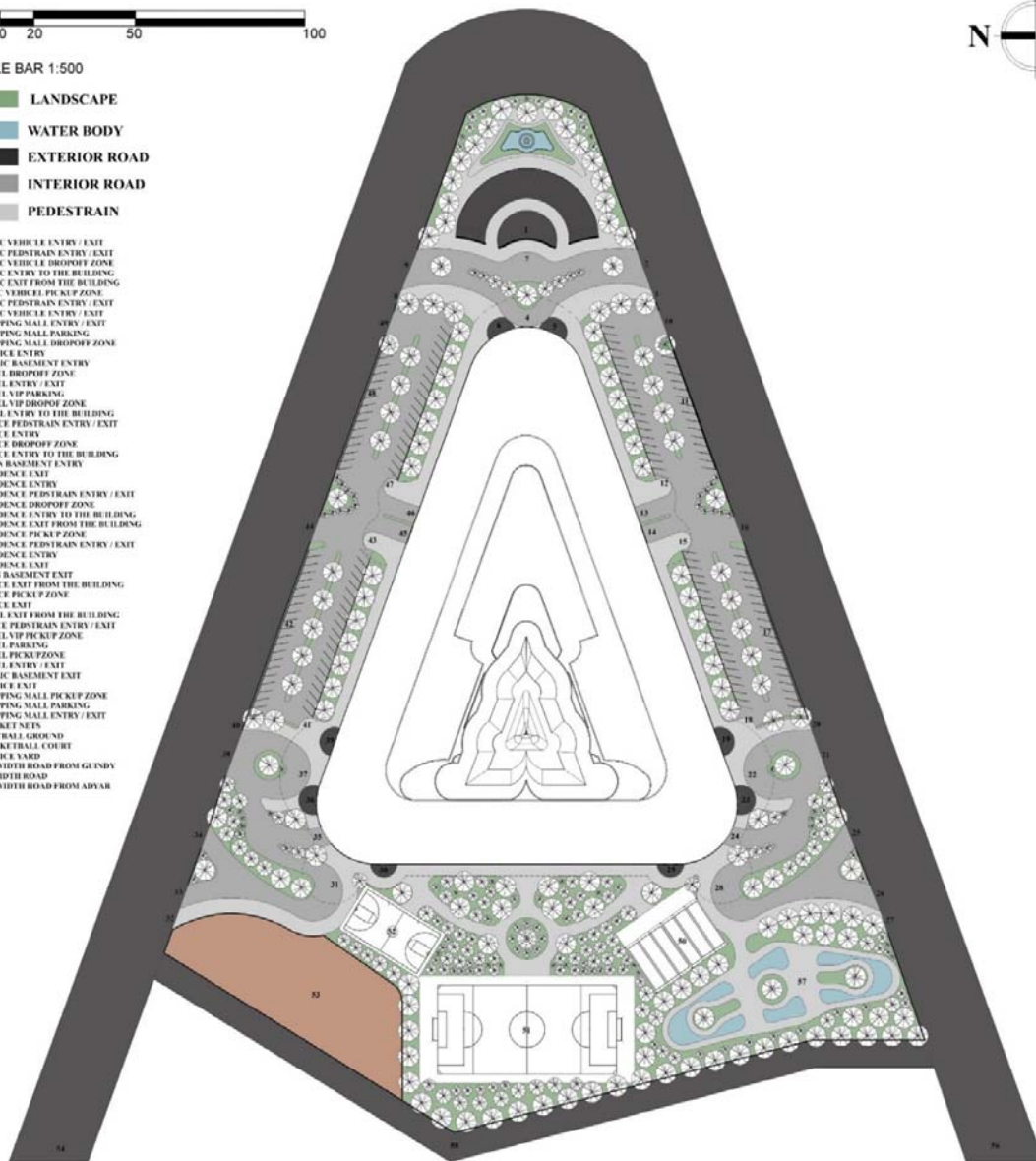
SITE PLAN:



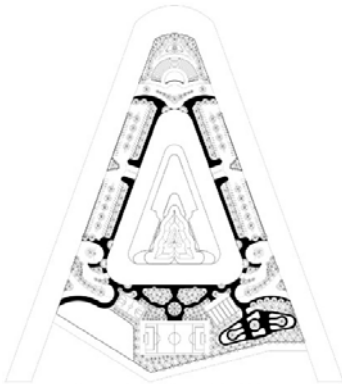
SCALE BAR 1:500

- LANDSCAPE
- WATER BODY
- EXTERIOR ROAD
- INTERIOR ROAD
- PEDESTRAIN

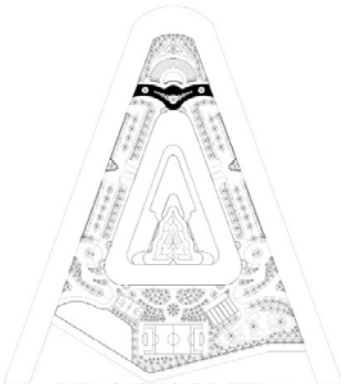
1. GATE
2. PUBLIC VEHICLE ENTRY / EXIT
3. PUBLIC PEDESTRAIN ENTRY / EXIT
4. PUBLIC VEHICLE DROPOFF ZONE
5. PUBLIC ENTRY TO THE BUILDING
6. PUBLIC EXIT FROM THE BUILDING
7. PUBLIC VEHICLE PICKUP ZONE
8. PUBLIC PEDESTRAIN ENTRY / EXIT
9. PUBLIC VEHICLE ENTRY / EXIT
10. SHOPPING MALL ENTRY / EXIT
11. SHOPPING MALL PARKING
12. SHOPPING MALL DROPOFF ZONE
13. SERVICE ENTRY
14. PUBLIC BASEMENT ENTRY
15. HOTEL DROPOFF ZONE
16. HOTEL ENTRY / EXIT
17. HOTEL VIP PARKING
18. HOTEL VIP DROPOFF ZONE
19. HOTEL ENTRY TO THE BUILDING
20. OFFICE PEDESTRAIN ENTRY / EXIT
21. OFFICE ENTRY
22. OFFICE DROPOFF ZONE
23. OFFICE ENTRY TO THE BUILDING
24. MAIN BASEMENT ENTRY
25. RESIDENCE EXIT
26. RESIDENCE ENTRY
27. RESIDENCE PEDESTRAIN ENTRY / EXIT
28. RESIDENCE DROPOFF ZONE
29. RESIDENCE ENTRY TO THE BUILDING
30. RESIDENCE EXIT FROM THE BUILDING
31. RESIDENCE PICKUP ZONE
32. RESIDENCE PEDESTRAIN ENTRY / EXIT
33. RESIDENCE ENTRY
34. RESIDENCE EXIT
35. MAIN BASEMENT EXIT
36. OFFICE EXIT FROM THE BUILDING
37. OFFICE PICKUP ZONE
38. OFFICE EXIT
39. HOTEL EXIT FROM THE BUILDING
40. OFFICE PEDESTRAIN ENTRY / EXIT
41. HOTEL VIP PICKUP ZONE
42. HOTEL PARKING
43. HOTEL PICKUP ZONE
44. HOTEL ENTRY / EXIT
45. PUBLIC BASEMENT EXIT
46. SERVICE EXIT
47. SHOPPING MALL PICKUP ZONE
48. SHOPPING MALL PARKING
49. SHOPPING MALL ENTRY / EXIT
50. 30 MET NETS
51. FOOTBALL GROUND
52. BASKETBALL COURT
53. SERVICE YARD
54. 25m WIDTH ROAD FROM GUNBY
55. 7m WIDTH ROAD
56. 25m WIDTH ROAD FROM ADVAR
57. OSR



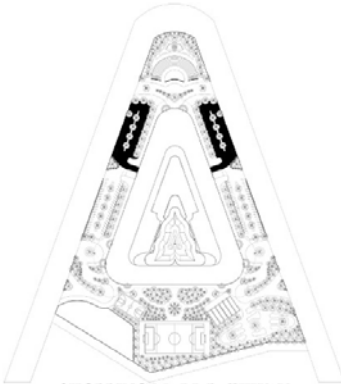
PATHWAYS FOR DIFFERENT TYPES OF USER GROUP:



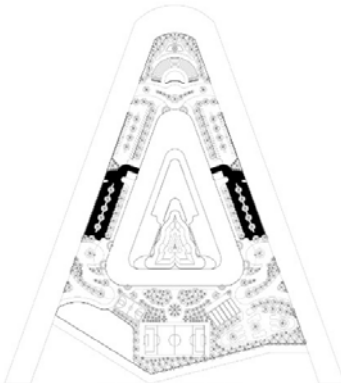
PEDSTRAIN PATHWAYS



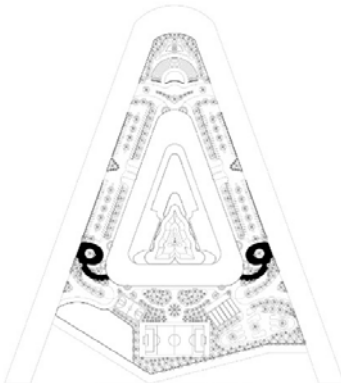
PUBLIC VEHICLE PATHWAY



SHOPPING MALL PATHWAY



HOTEL PATHWAY

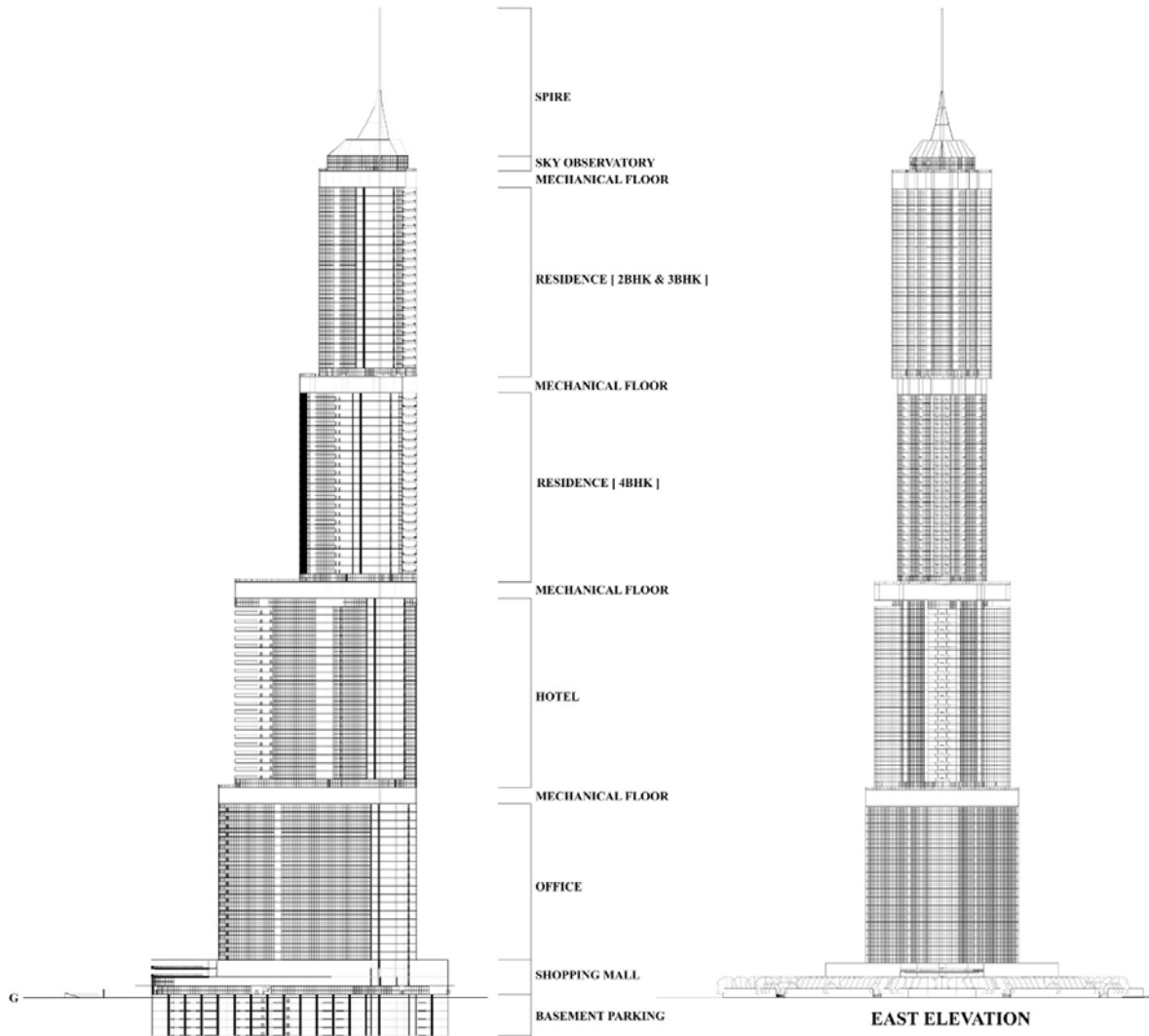


OFFICE PATHWAY



RESIDENCE PATHWAY

SECTION AND ELEVATION:

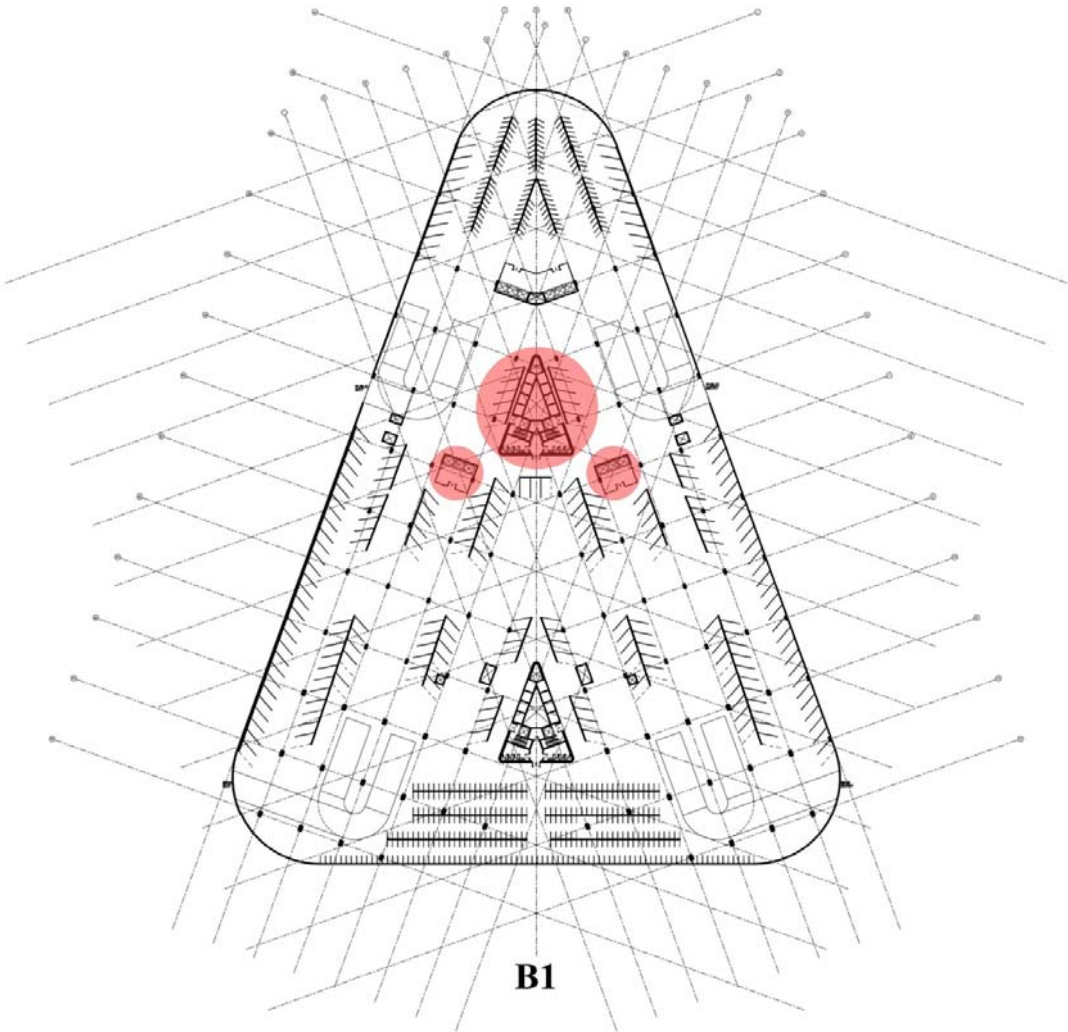


VERTICAL TRANSPORTATION:

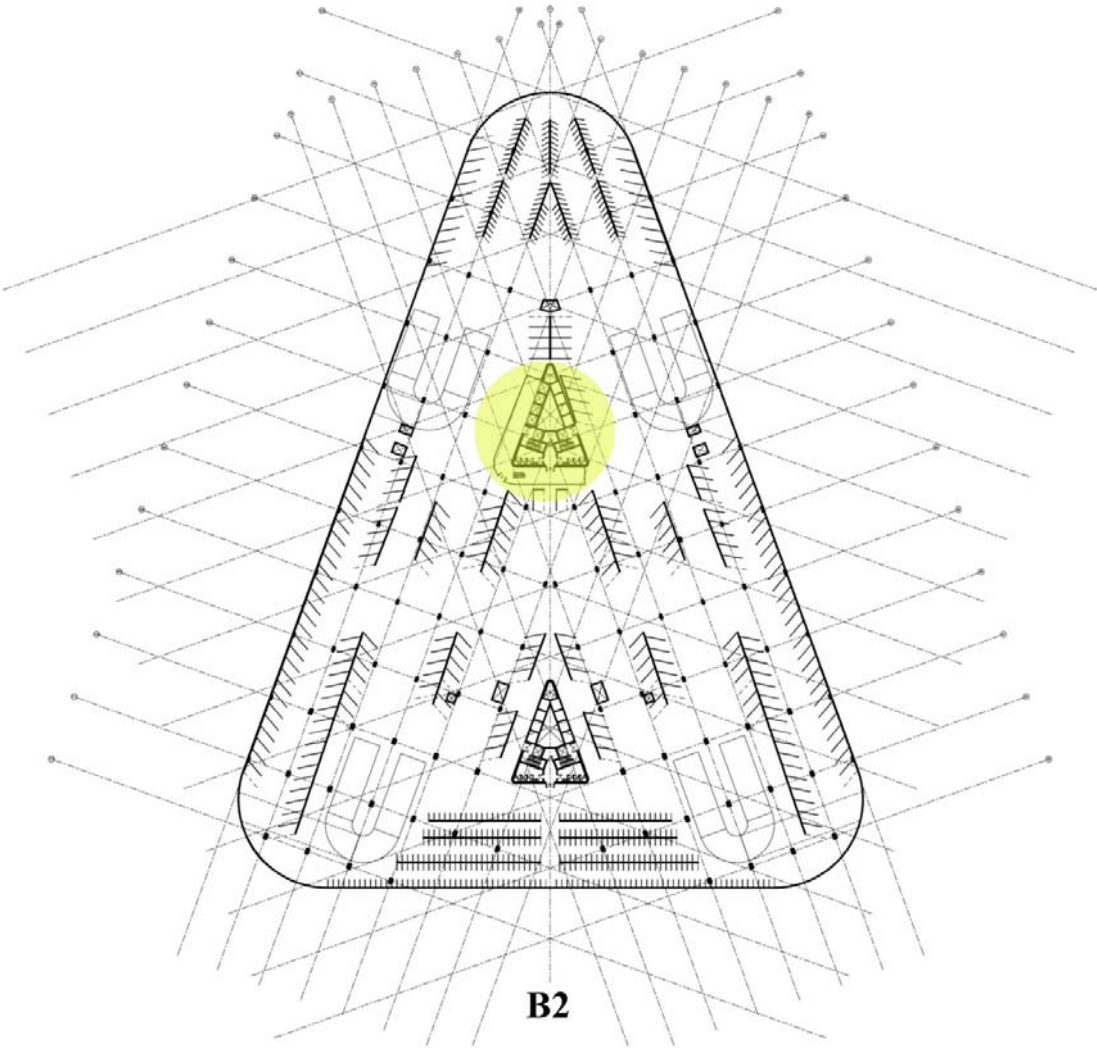


VERTICAL TRANSPORTATION

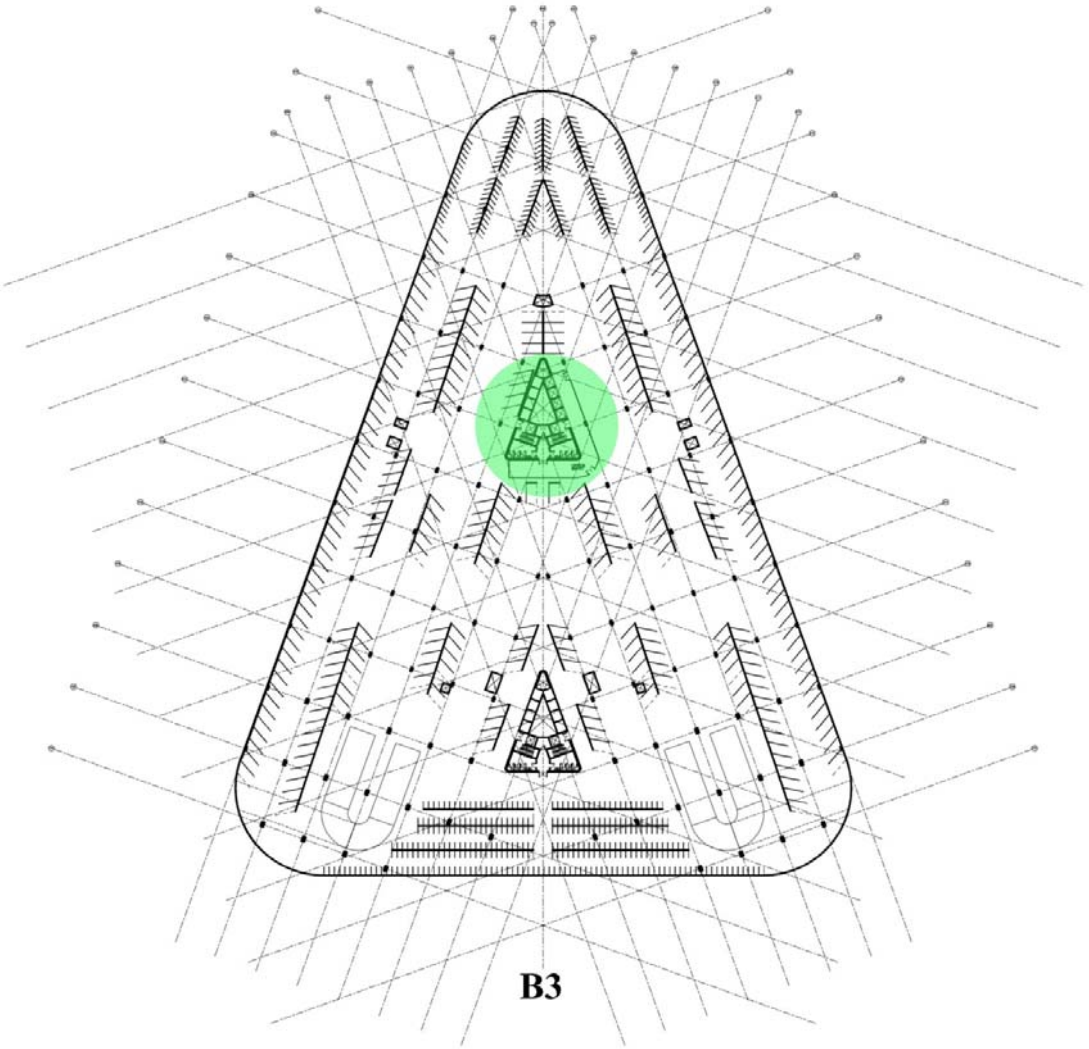
1ST BASEMENT FLOOR PLAN:



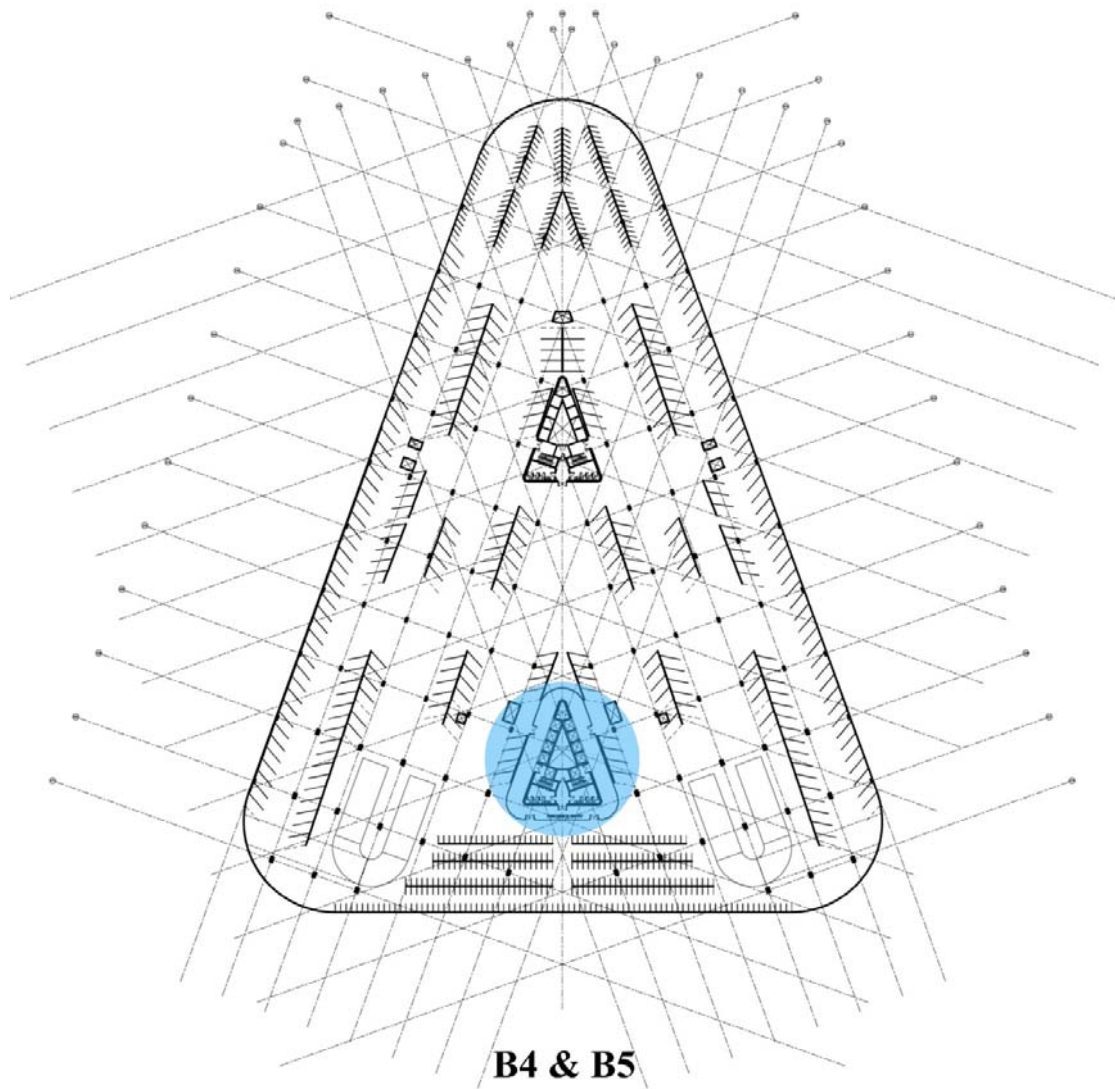
2ND BASEMENT FLOOR PLAN:



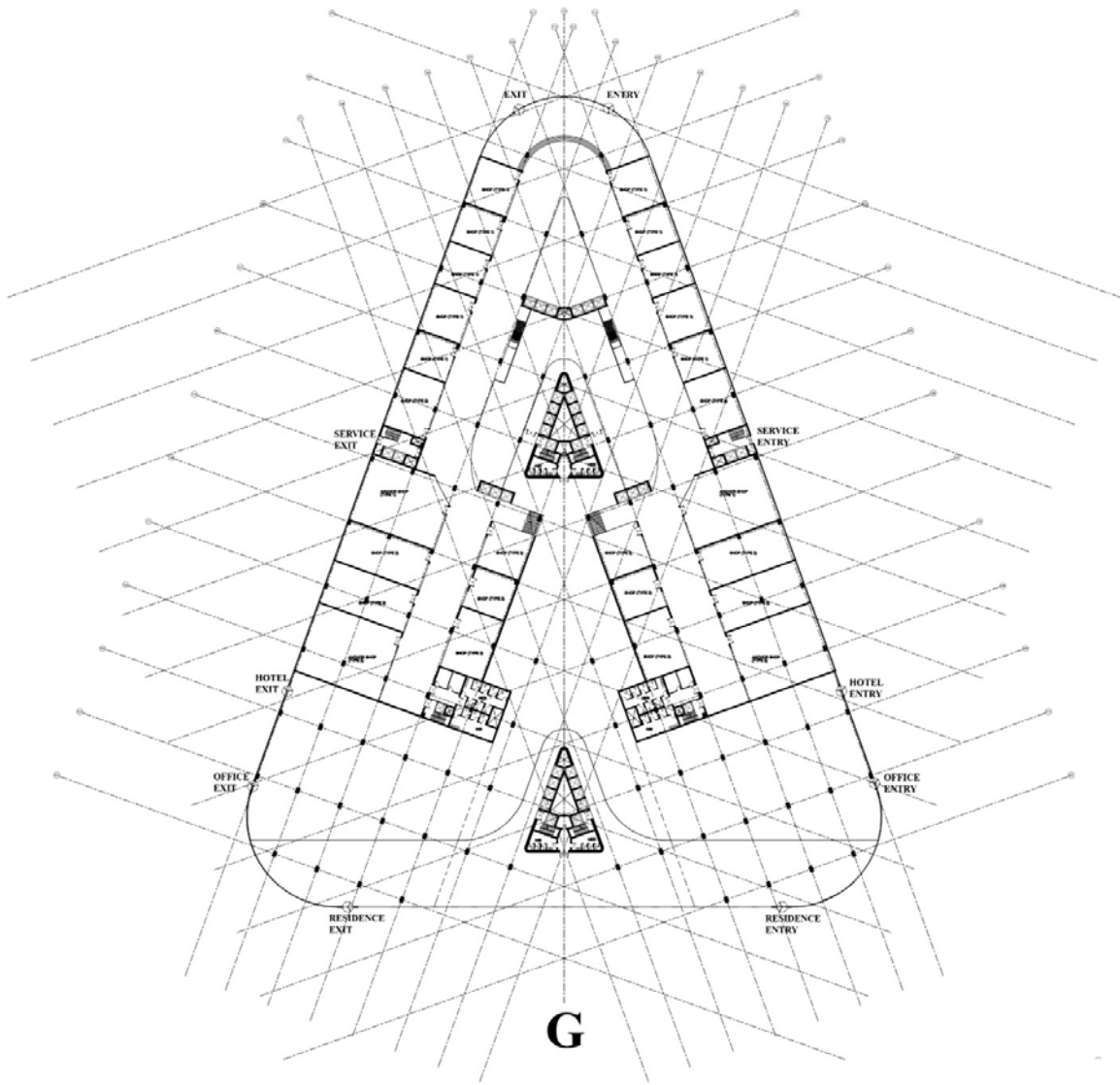
3RD BASEMENT FLOOR PLAN:



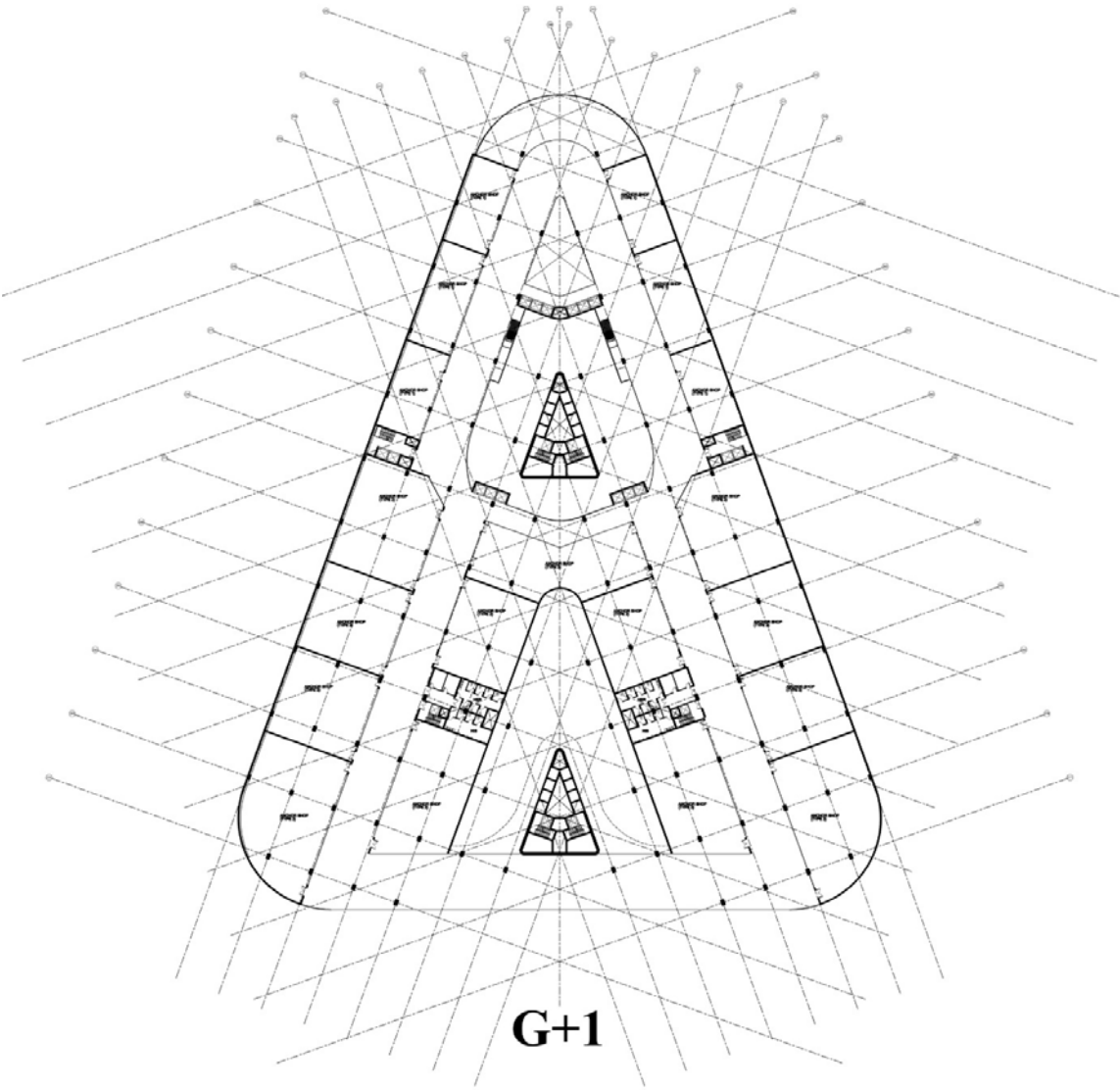
4TH& 5TH BASEMENT FLOOR PLAN:



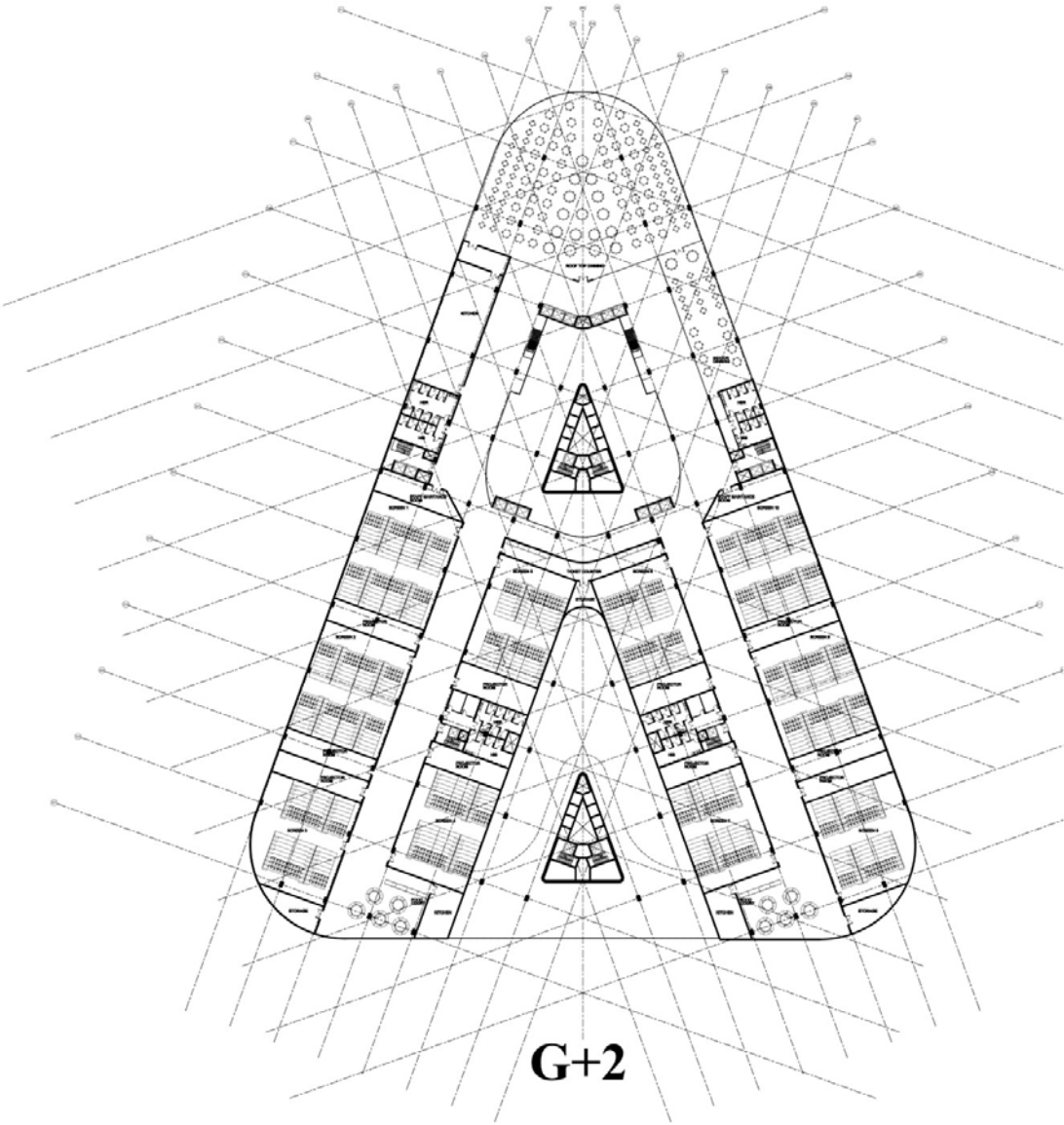
GROUND FLOOR PLAN – SHOPPING MALL:



1ST FLOOR PLAN – SHOPPING MALL:



2ND& 3RDFLOOR PLAN – SHOPPING MALL:



G+2

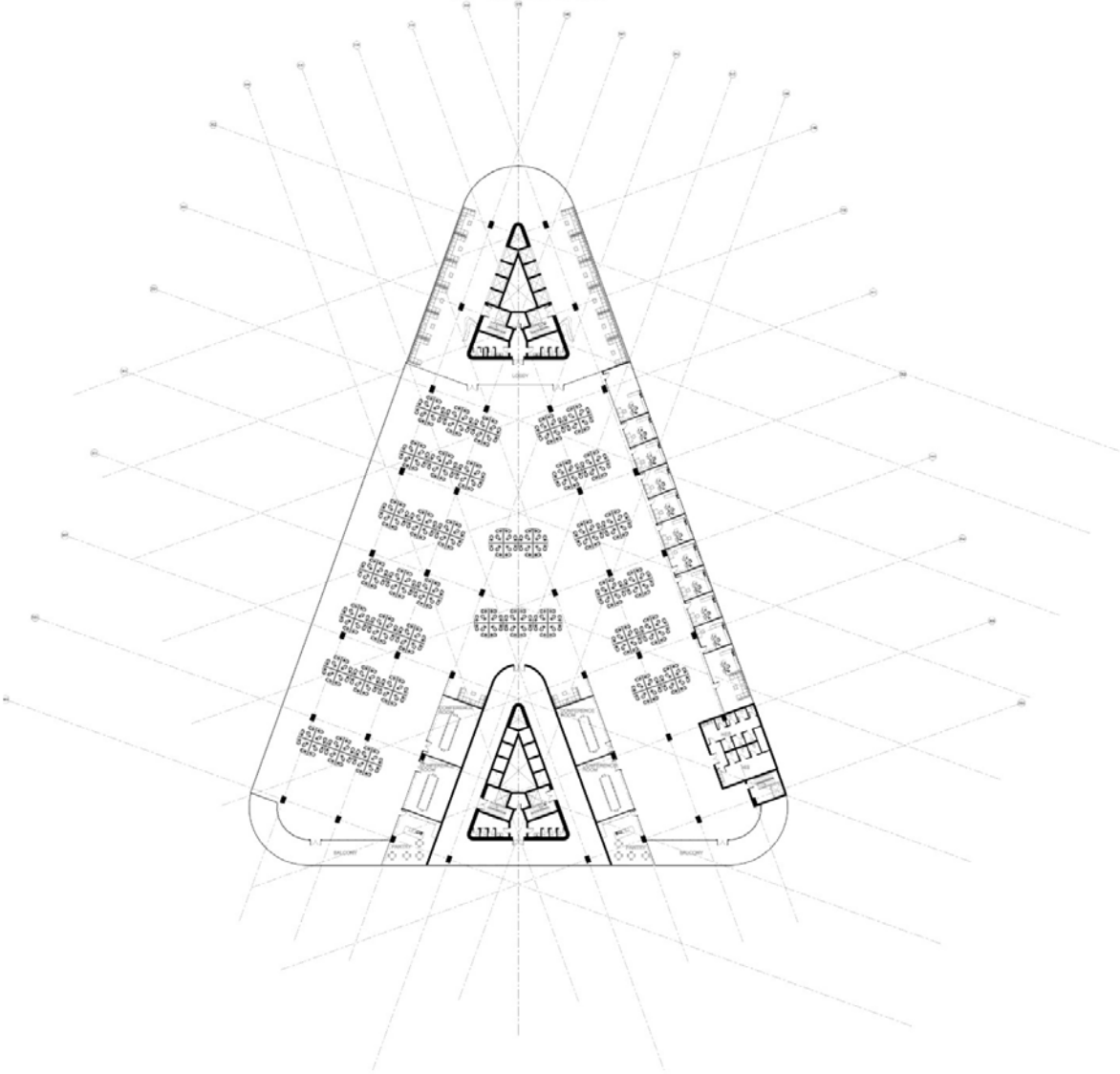
3-D VIEWS OF SHOPPING MALL FLOORS PLANS:



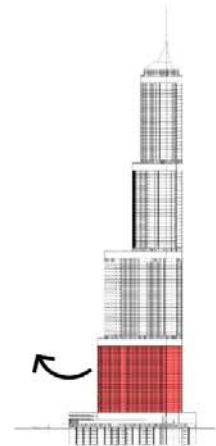
4TH-22NDFLOOR PLAN- OFFICE:



4th - 22nd FLOOR



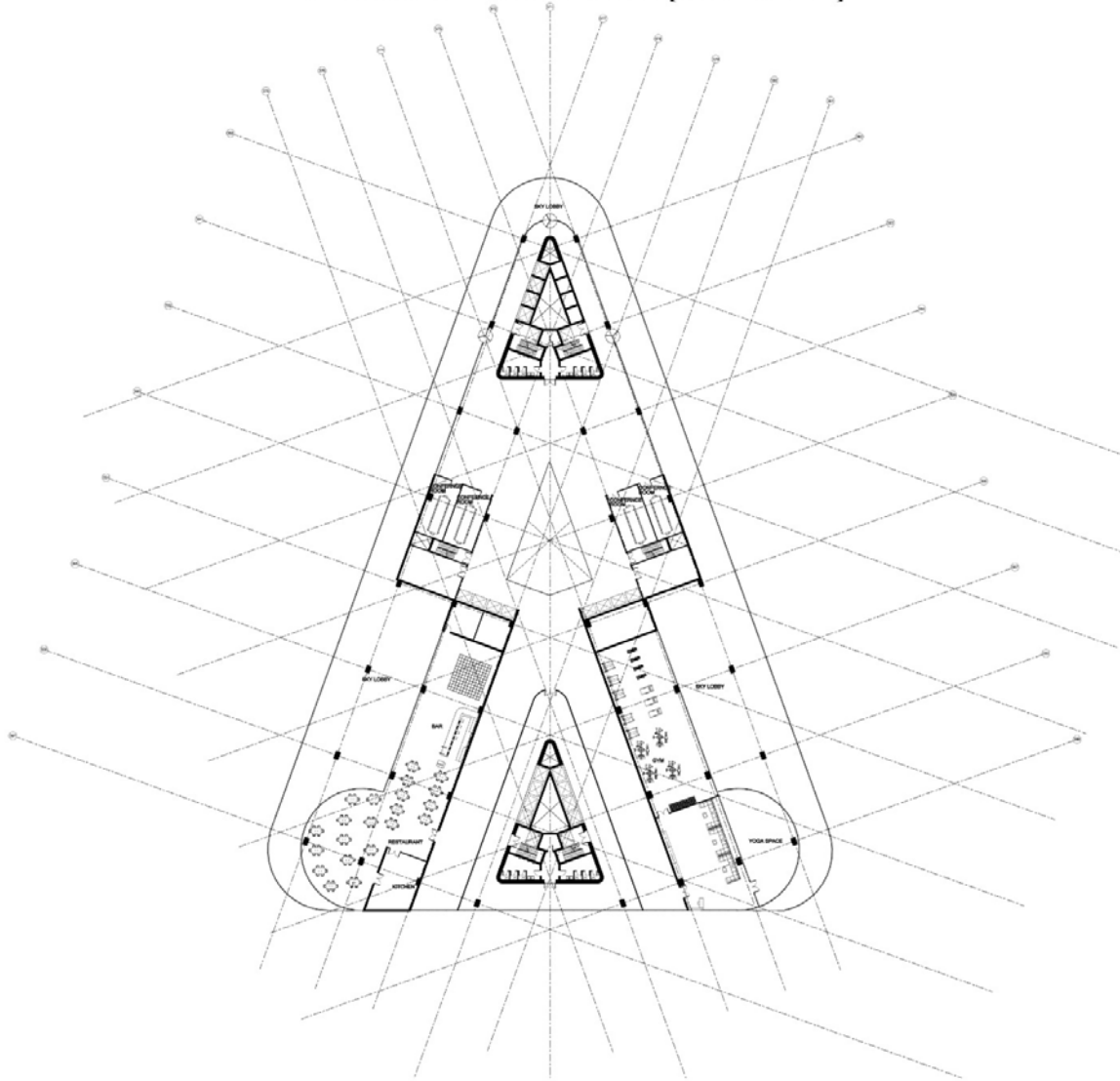
3-D VIEW OF OFFICE FLOORS PLANS :



25TH FLOOR PLAN – HOTEL AMMENITIES & SKY LOBBY :



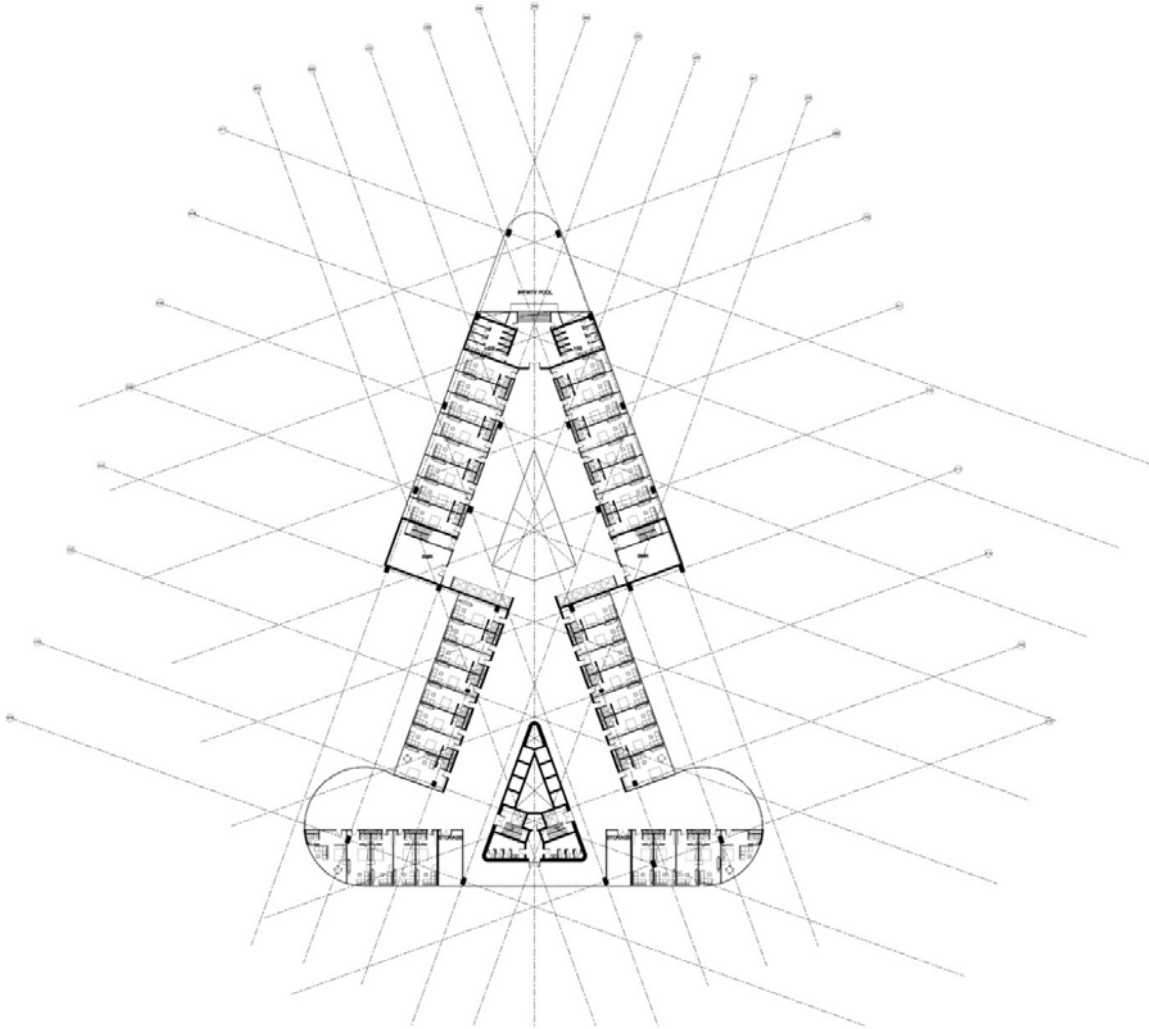
SKY LOBBY + AMMENITIES [25th FLOOR]



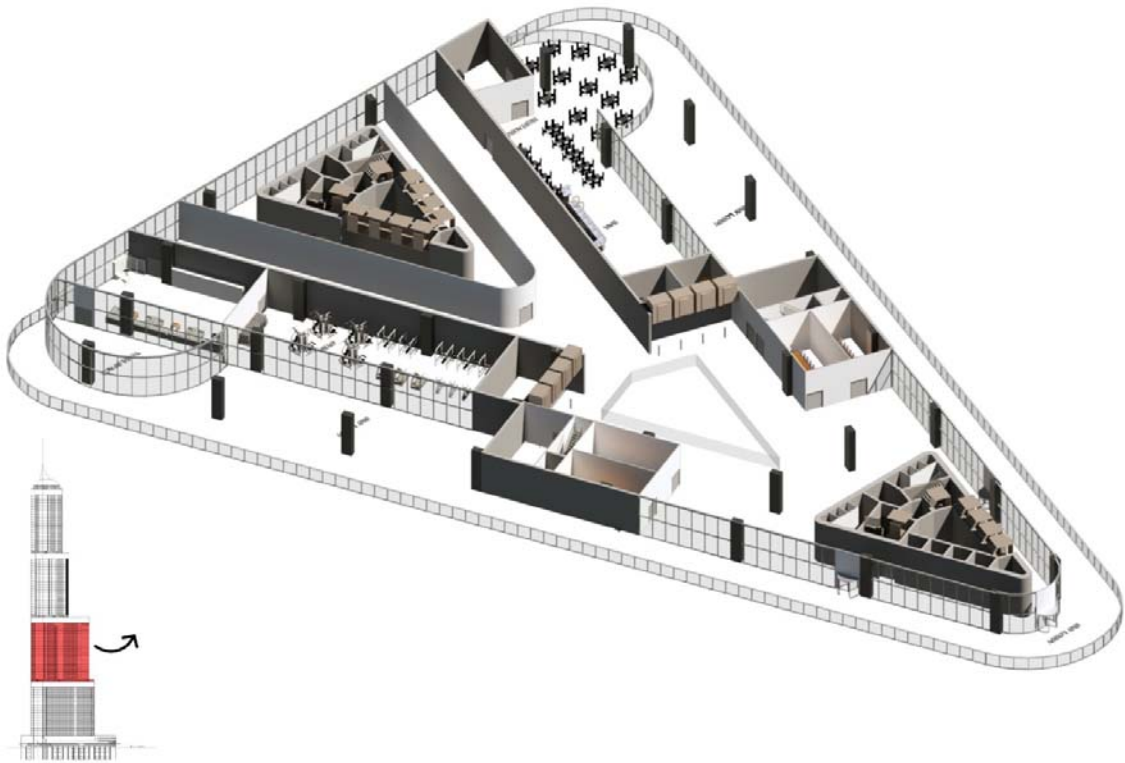
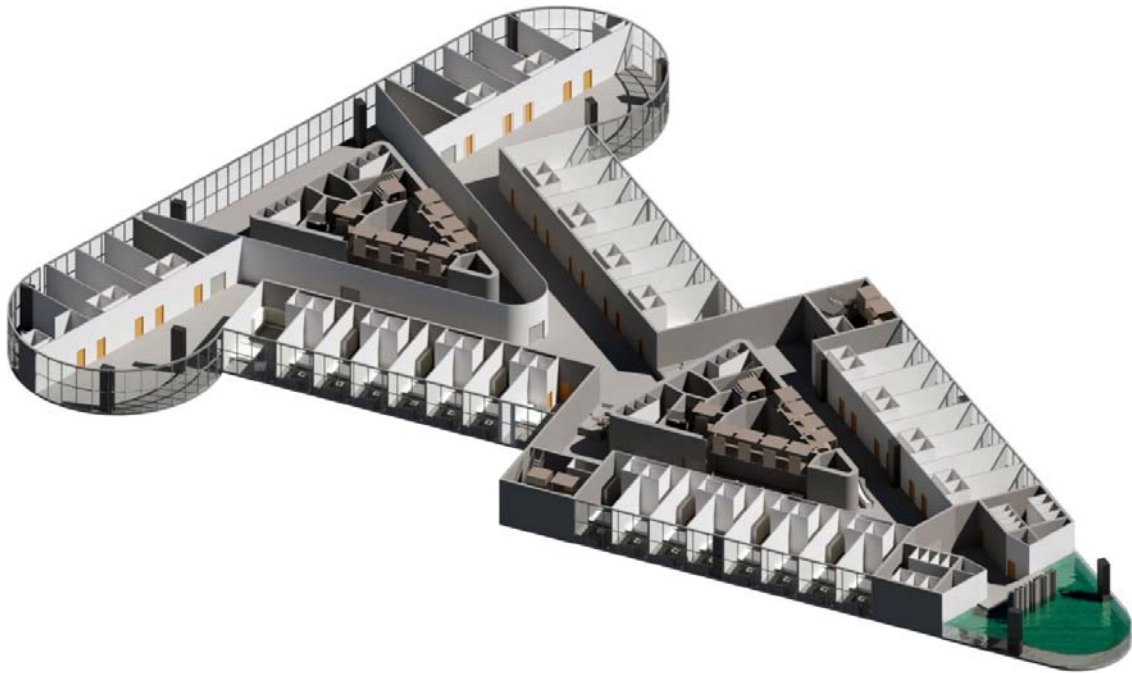
26TH – 46TH FLOOR PLAN – HOTEL :



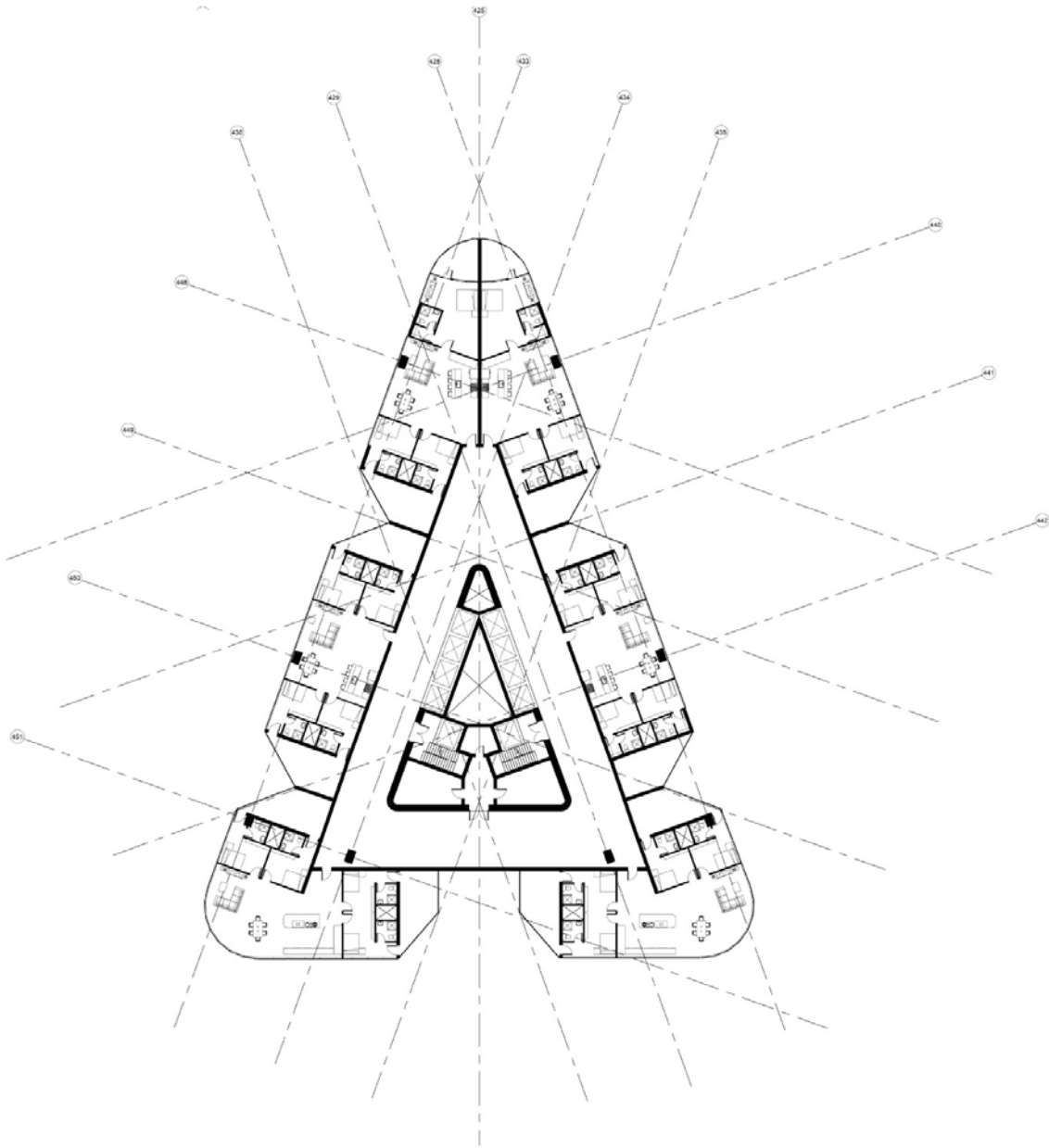
26th - 46th FLOOR



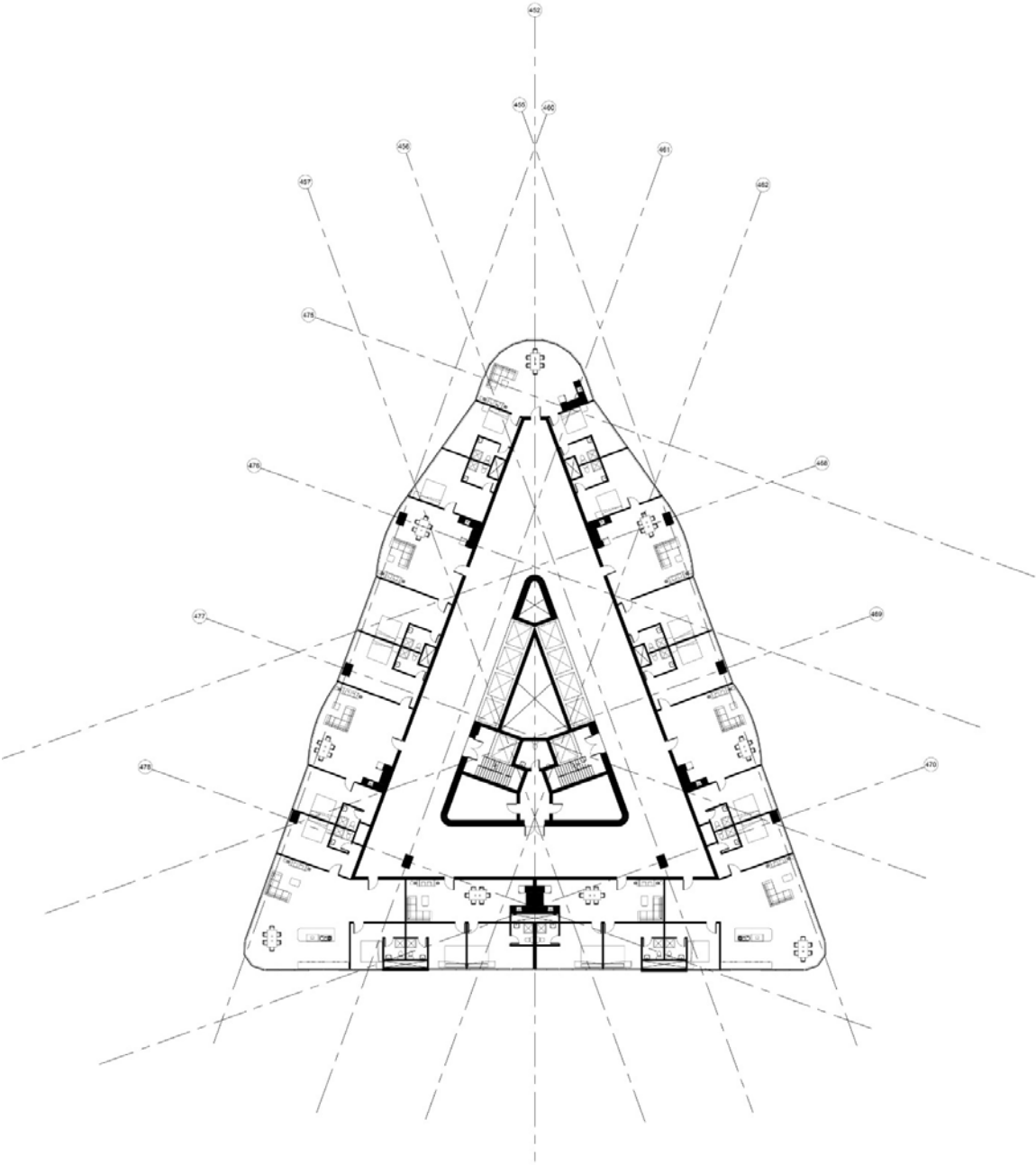
3-D VIEWS OF HOTEL FLOOR PLANS :



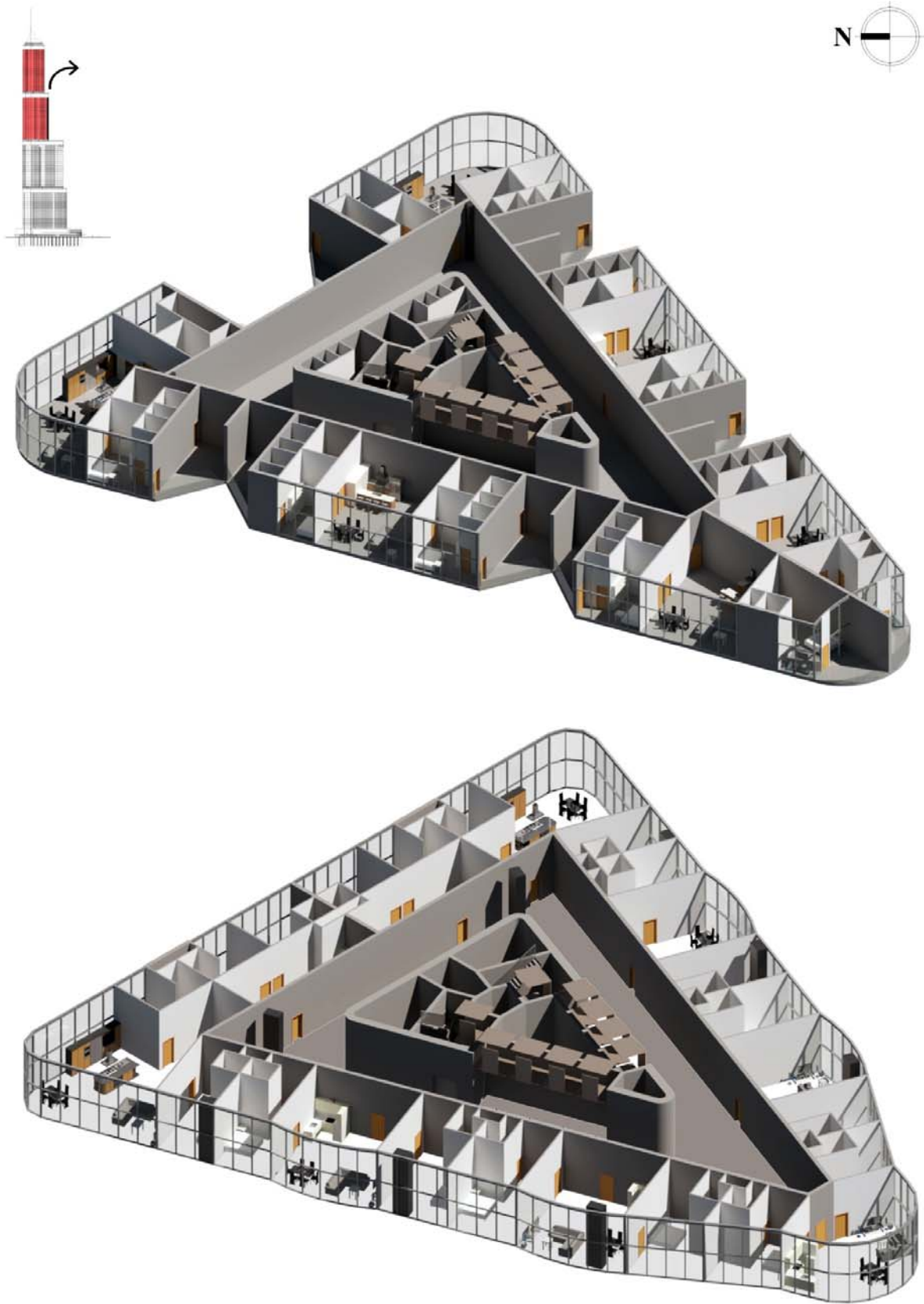
51ST – 73RD FLOOR PLAN – 3[BHK] & 4[BHK] :



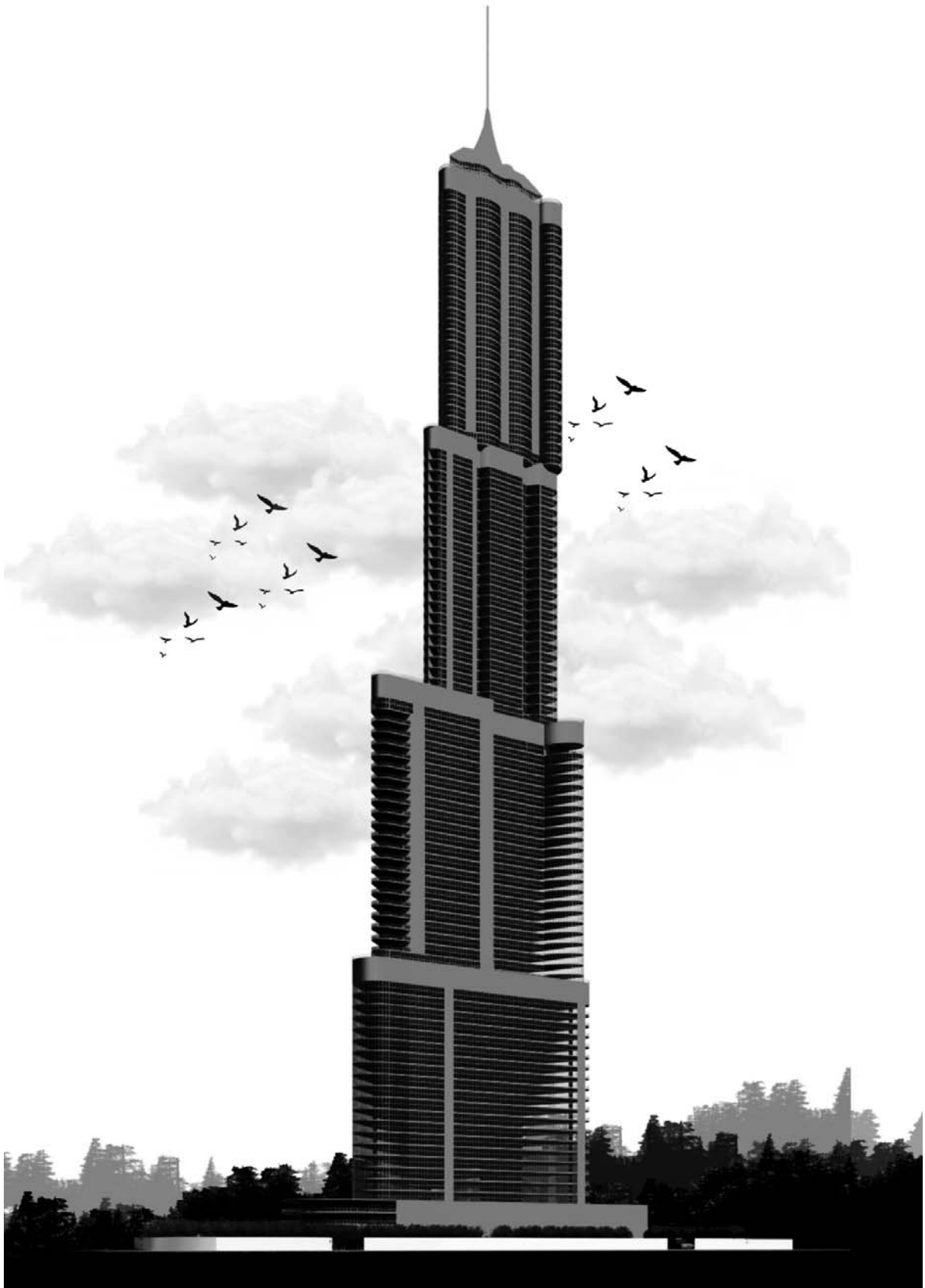
76TH – 97TH FLOOR PLAN – 2[BHK] :



3-D VIEWS OF RESIDENCE FLOOR PLANS :



3-D VIEW OF THE SKYSCRAPER :



6. REFERENCES

<https://en.wikipedia.org/wiki/Skyscraper>

https://en.wikipedia.org/wiki/Mixed-use_development

<https://shuchimishra.wordpress.com/2015/05/16/connecting-the-public-realm-to-contemporary-mixed-use-development/>

<https://concretecivil.com/classification-of-high-rise-building/>

https://en.wikipedia.org/wiki/Burj_Khalifa

<https://salaamsaudi.com/history-of-burj-khalifa/>

<https://www.slideshare.net/shobhita4/burj-khalifa-250282395>

<https://www.burjkhalifa.ae/en/the-tower/structures/>

<https://www.slideshare.net/TabaTapu/case-study-kohinoor-square-mumbai>

https://en.wikipedia.org/wiki/World_One

https://en.wikipedia.org/wiki/Taipei_101

https://en.wikipedia.org/wiki/Abenobashi_Terminal_Building