3.Triple Glass Low - E

- Triple glazing provides *higher thermal* insulation compared to single or double glazing.
- Dashed orange rays = sunlight blocked by the horizontal louvres.
- Low-E coating reduces infrared heat transfer, lowering solar heat gain while still allowing visible daylight.
- In hot–humid tropical climates, this reduces indoor cooling loads and enhances comfort.

Solar Control + Louvres + Low-E glass = Minimize heat penetration from sunlight.
Daylighting = Glazing allows natural light to enter, reducing artificial lighting demand.
Thermal Comfort = Triple glass with Low-E and thermal break mullions cut heat transfer, improving indoor comfort.
Rain Protection = Louvres add a secondary shield against direct rain impact.

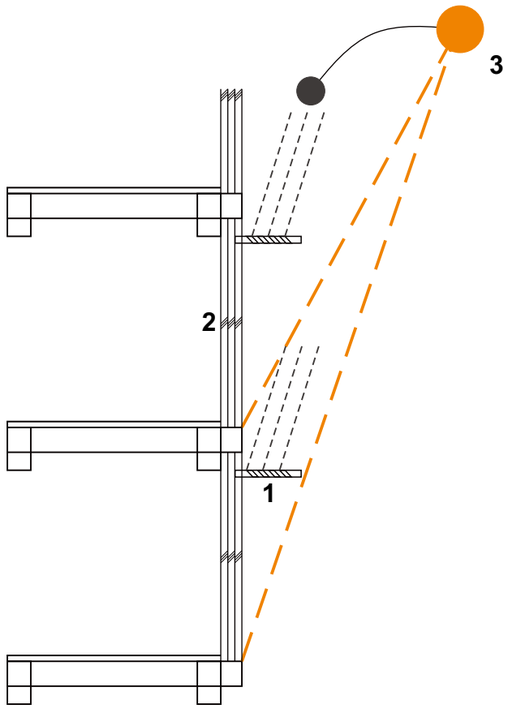


Figure 3.6.1.2 Scheme of Sun Shading with Horizontal louvre
Source: *Author,2025*

The sectional diagram illustrates the role of horizontal louvres in a curtain wall system with triple glass Low-E. Positioned externally, the louvres intercept solar radiation at high sun angles, thereby reducing heat gain and glare while still allowing diffused daylight into the interior. This climate-responsive facade strategy enhances thermal and visual comfort while lowering cooling energy demand in tropical environments.

1. Horizontal Louvres

- Installed as external shading devices.
- To block direct sunlight before it strikes the glass surface.
- By intercepting solar rays, they reduce solar heat gain, glare, and cooling load.

2. Triple Glass Low-E coating

- Low-E (low-emissivity) coating reduces the transmission of infrared radiation, keeping interiors cooler.

3.Sun Path and Radiation (orange circle & dashed rays)

- The diagram shows the sun angle (high sun at midday).
- Dashed orange rays = sunlight blocked by the horizontal louvres.
- Diffused daylight passes through to the interior, creating comfortable lighting without excess heat.

Facade as Climate Skin = Louvres act as *sunshades*, blocking heat before it enters.
Energy Efficient = Reduces reliance on mechanical cooling (air conditioning).
Comfort = Enhances visual comfort by avoiding glare, while still admitting daylight.
Adaptation to Climate = Especially effective in hot-humid tropic.

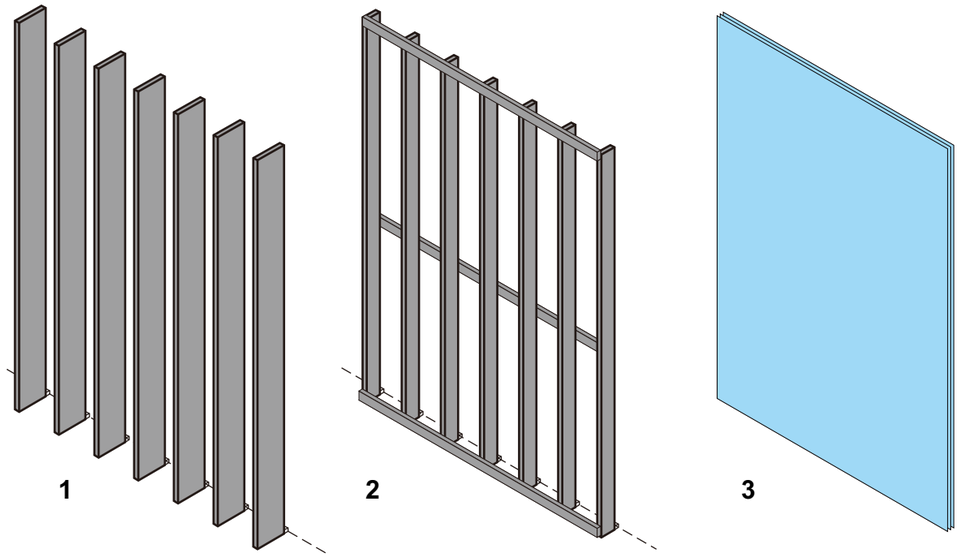


Figure 3.6.1.3 Scheme of Vertical Louvre
Source: *Author,2025*

This facade skin integrates a curtain wall system with triple glass Low-E and aluminium mullions, complemented by vertical louvres as external shading. The Low-E glazing reduces solar heat gain and enhances indoor comfort, while the vertical louvres block low-angle sunlight from the east and west, which is common in tropical climates. By mitigating glare and reducing heat penetration during morning and afternoon hours, the system ensures thermal efficiency, controlled daylighting, and lowers dependence on mechanical cooling. This combination demonstrates how facade skin can adaptively respond to solar orientation and local climate conditions.

1. Vertical Louvres

- Installed as external shading devices in front of the glass.
- Block low-angle solar radiation (especially at high sun angles) before it strikes the glass surface.
- Reduce glare and excessive heat gain, during morning and afternoon sun, while still allowing diffuse daylight and outward views.
- In tropical rainy climates, vertical louvres also provide shading without fully obstruction natural ventilation and can be oriented to optimize daylight penetration.

2. Aluminium Mullions
- Act as the main structural frame supporting the glass.
- Transfer loads (glass weight, wind pressure) to the building's primary structure.
- Often designed with thermal breaks to prevent heat conduction through aluminium.
- Integration slots for louvres and drainage channels.

3.Triple Glass Low - E
- Triple glazing provides *higher thermal* insulation compared to single or double glazing.
- Dashed orange rays = sunlight blocked by the horizontal louvres.
- Low-E coating reduces infrared heat transfer, lowering solar heat gain while still allowing visible daylight.
- In hot–humid tropical climates, this reduces indoor cooling loads and enhances comfort.

Solar Control + Louvres
+ Low-E glass = Minimize heat penetration from sunlight.
Daylighting = Glazing allows natural light to enter, reducing artificial lighting demand.
Thermal Comfort = Triple glass with Low-E and thermal break mullions cut heat transfer, improving indoor comfort.
Rain Protection = Louvres add a secondary shield against direct rain impact.

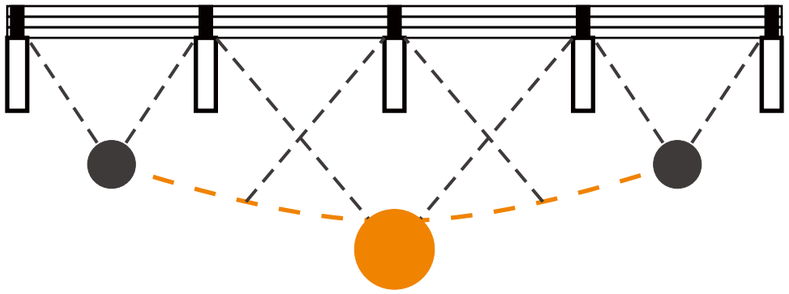


Figure 3.6.1.4 Scheme of Sun Shading with Vertical louvre
Source: *Author,2025*

The sectional diagram illustrates the role of vertical louvres in a curtain wall system with triple glass Low-E. Positioned externally, the louvres intercept solar radiation at high sun angles, thereby reducing heat gain and glare while still allowing diffused daylight into the interior. This climate-responsive facade strategy enhances thermal and visual comfort while lowering cooling energy demand in tropical environments.

1. Vertical Louvres
- Installed as external shading devices.
- To block direct sunlight before it strikes the glass surface.
- By intercepting solar rays, they reduce solar heat gain, glare, and cooling load.

2. Triple Glass Low-E coating
- Low-E (low-emissivity) coating reduces the transmission of infrared radiation, keeping interiors cooler.

3.Sun Path and Radiation (orange circle & dashed rays)
- The diagram shows the sun angle (high sun at midday).
- Dashed orange rays = sunlight blocked by the horizontal louvres.
- Diffused daylight passes through to the interior, creating comfortable lighting without excess heat.

Facade as Climate Skin = Louvres act as *sunshades*, blocking heat before it enters.
Energy Efficient = Reduces reliance on mechanical cooling (air conditioning).
Comfort = Enhances visual comfort by avoiding glare, while still admitting daylight.
Adaptation to Climate = Especially effective in hot-humid tropical regions where solar radiation is strong throughout the year.

3.6.2 The concept of Facade Skin according to Material

Facade skin plays a fundamental role not only as the aesthetic envelope of a building, but also as a mediator between interior and exterior environments. The choice of material determines its thermal performance, daylight control, acoustic insulation, structural durability, and architectural expression. Thus, selecting façade materials should be approached holistically, considering both performance criteria and design intent.

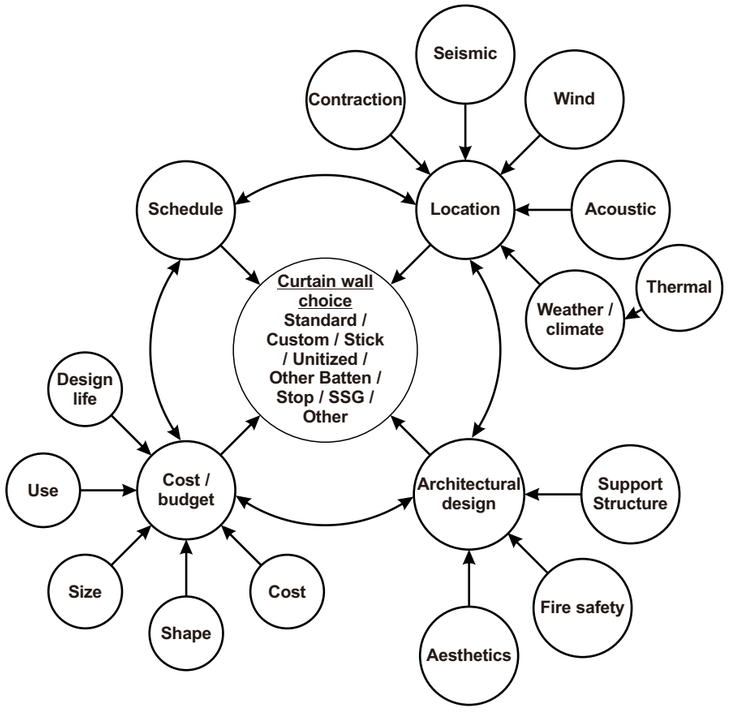


Figure 3.6.2.1 Factors Influencing Curtain Wall System Selection
Source: *Author, 2025*

The bubble diagram illustrates the various factors that influence the selection of a curtain wall system. At the center is the curtain wall choice, which may include standard, custom, stick, unitized, batten, stop, SSG, or other systems. Surrounding this core are key considerations such as location, which is affected by seismic activity, wind, contraction, acoustics, and thermal performance, as well as broader weather and climate conditions. Another major factor is architectural design, which incorporates aesthetics, fire safety, and the support structure of the building. Cost and budget also play a crucial role, determined by design life, usage requirements, size, shape, and direct cost implications. Additionally, the schedule of the project is interconnected with these factors, influencing feasibility and implementation. Together, these elements form an interconnected framework that ensures the chosen curtain wall system balances performance, safety, aesthetics, budget, and environmental conditions.

Facade as Climate Skin = Louvres act as *sunshades*, blocking heat before it enters.
Energy Efficient = Reduces reliance on mechanical cooling (air conditioning).
Comfort = Enhances visual comfort by avoiding glare, while still admitting daylight.
Adaptation to Climate = Especially effective in hot-humid tropical regions where solar radiation is strong throughout the year.

3.6.2 The concept of Facade Skin according to Material

Facade skin plays a fundamental role not only as the aesthetic envelope of a building, but also as a mediator between interior and exterior environments. The choice of material determines its thermal performance, daylight control, acoustic insulation, structural durability, and architectural expression. Thus, selecting façade materials should be approached holistically, considering both performance criteria and design intent.

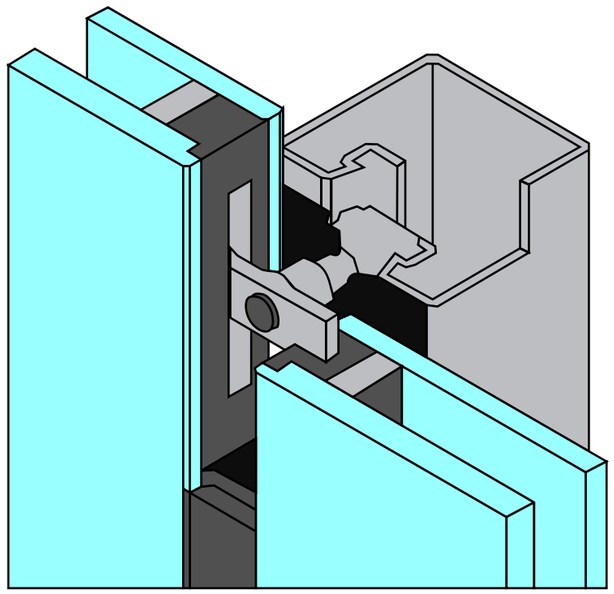
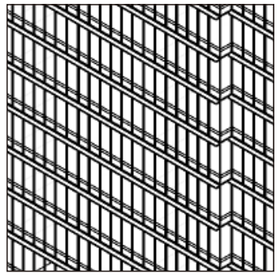


Figure 3.6.2.2 Building envelope scheme
Source: *Author,2025*

1. **Glass Panels (Light Blue)** Represent the vision glass or spandrel glass panels of the curtain wall.Usually made of tempered, laminated, or insulated glass units (IGUs).Positioned on both sides of the mullion to form the transparent building envelope.
2. **Aluminum Mullion (Gray, Backside Profile)** The vertical structural frame (mullion) that carries the dead load and wind load of the glass.Made from extruded aluminum for strength, durability, and corrosion resistance.Attached back to the building's primary structure (floor slab/beam).
3. **Transom Connector / Bracket (Gray, Middle)** The mechanical connector (shown in the middle) is used to fix the glazing support to the mullion.Typically secured with bolts or screws.Ensures stability of the glazing system while allowing for structural movement (thermal expansion, wind sway, and seismic tolerance).
4. **Pressure Plate / Glass Retainer (Dark Gray)** Runs vertically behind the glass.Serves as the clamp that holds the glass panel in place.Often paired with a gasket system to ensure airtightness and watertightness.
5. **Cover Cap / Mullion Cap** Typically snapped onto the pressure plate (not drawn here).Provides aesthetic finish (flat, rounded, or custom profiles).Conceals bolts and fasteners.

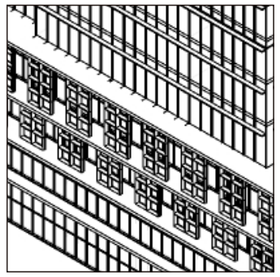
HORIZONTAL LOUVER



Material: Typically aluminum or other lightweight, durable metals.

Function: Controls solar heat gain by blocking direct sunlight, especially effective on east–west orientations. It allows daylight penetration while reducing glare, improving indoor comfort and lowering cooling loads.

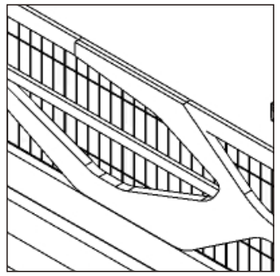
ALUMINIUM PERFORATED PANEL



Material: Perforated aluminum sheets.

Function: Works as a breathable skin that reduces solar radiation while still allowing airflow and filtered natural light. The perforation pattern can be designed for aesthetics as well as performance, giving a dynamic appearance to the facade.

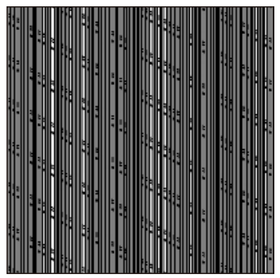
ACP - (Aluminium Composite Panel)



Material: Composite of aluminum sheets with a polyethylene or mineral-filled core.

Function: Provides a sleek, modern finish with durability and weather resistance. It serves as a protective cladding layer, enhancing insulation while reducing maintenance. Its lightweight property makes it versatile for complex facade geometries.

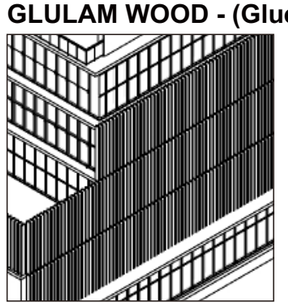
VERTICAL LOUVER



Material: Aluminum or steel, sometimes combined with other materials.

Function: Primarily effective for north–south orientations, where controlling low-angle sunlight is critical. It also adds vertical rhythm and texture to the facade, contributing both to shading performance and architectural identity.

GLULAM WOOD - (Glued Laminated Timber)



Material: Engineered timber created by laminating layers of wood.

Function: Introduces warmth and natural texture into the facade. Beyond aesthetics, it is a sustainable material with good structural performance and thermal properties. It softens the rigidity of metal and glass facades, creating balance and biophilic qualities.

Chapter 04

Design Result & Proof

4.1 Project Description

This chapter will focus on the development of the design technical drawing, Building on the concept of Envelope and Energy Efficient. This chapter explores the project's strategies across two main scales: miso (building level) and micro (unit and space level). While the macros scale addressing the high used of energy on Building has been discussed earlier, the focus here shift to the smaller, more immediate layer of the energy efficient that directly affect energy consumption's, Thermal and visual discomfort, and negative environmental impact (CO2). The design includes of the architectural and system solution within the building. This chapters also outlines technical measures, spatial configurations, and infrastructure system that together form an efficient network, ensuring the building operates efficient and effectively as both residence and sustainable.



Design Of

PAX Tower Apartment

An Approach to Energy-Efficient Through Facade

Supervisor
Prof. Ar. Noor Cholis Idham, S.T., M.Arch., Ph.D.,IAI

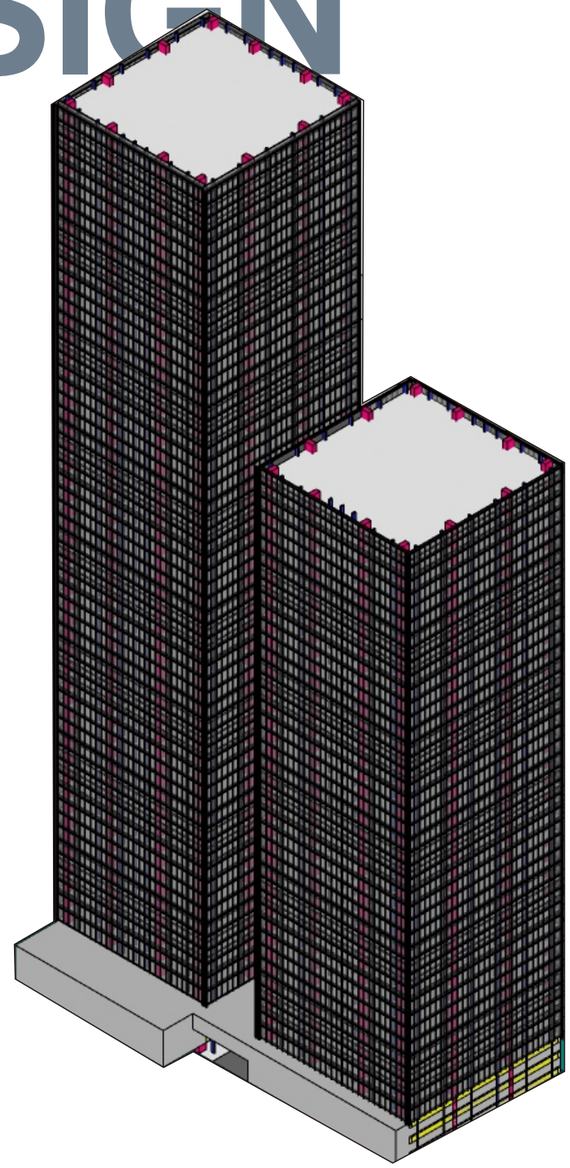
Student
Farhad Hammam Mughni
18512090

BUILDING PERFORMANCE & TECHNOLOGY LABORATORY

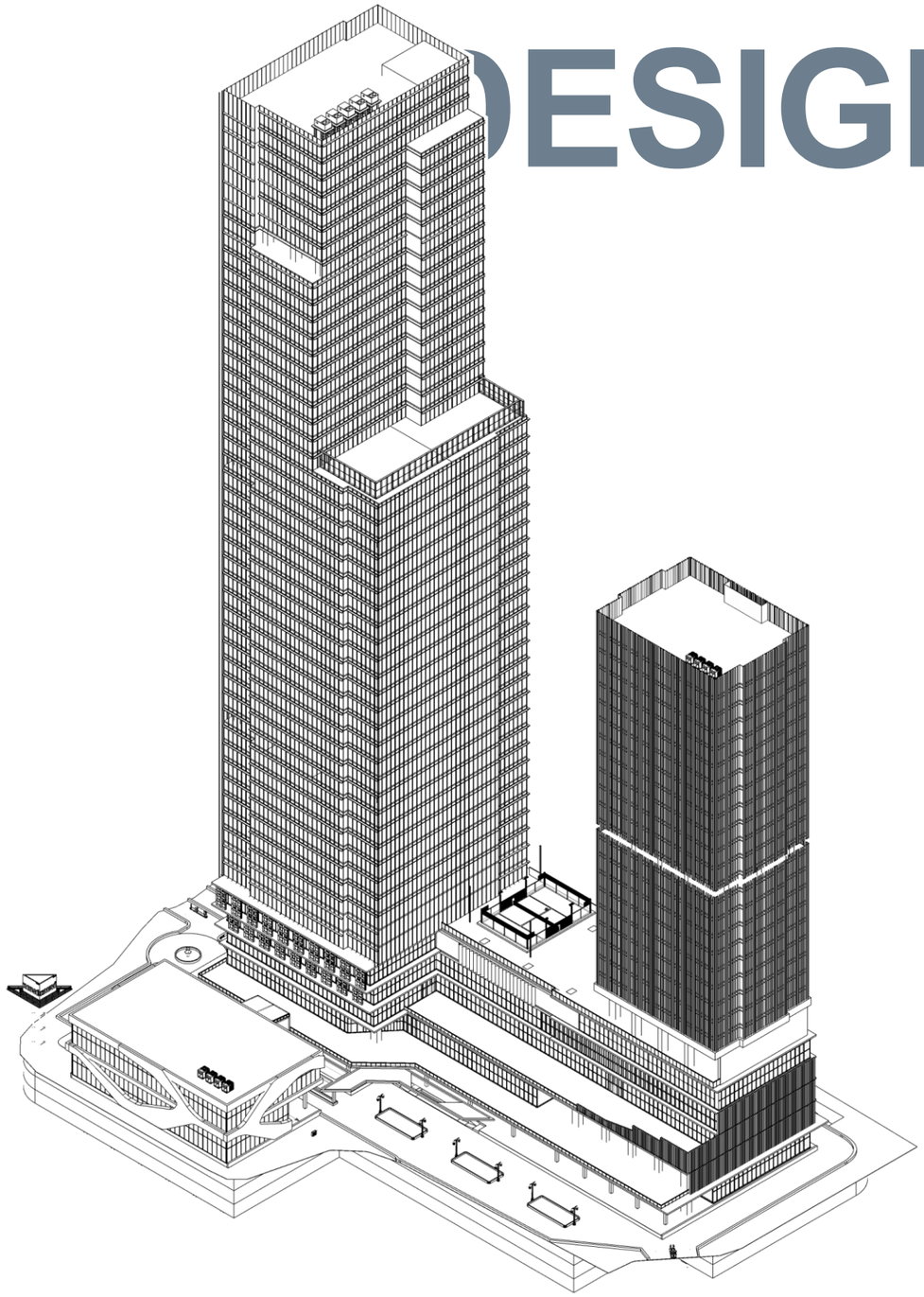
ARCHITECTURE UNIVERSITAS ISLAM INDONESIA | UNGGUL | KAAB 한국건축학교육인증원 Korea Architectural Accrediting Board | BOARD OF ARCHITECTS MALAYSIA LEMBAGA ARKITEK MALAYSIA



PREVIOUS DESIGN



NEW DESIGN



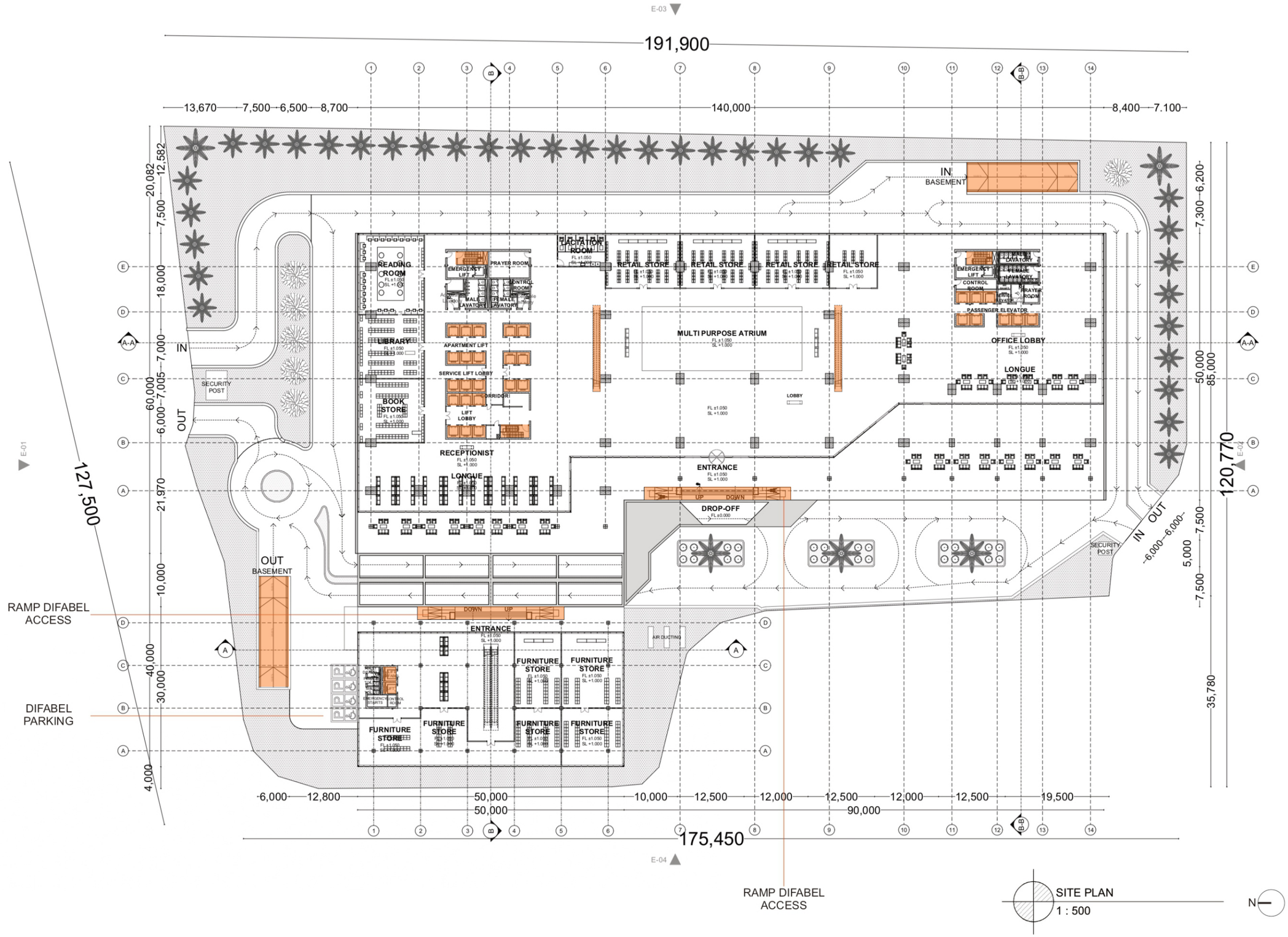


on the selected site, the surrounding buildings are tall buildings, namely:

1 = PAX APARTMENT TOWER (250m)
2 = GRAND INDONESIA (230m)
3 = LE PARC RESIDENCE
4 = AUTOGRAPH TOWER (382,9m)
5 = OUB PLAZA (194,3m)
6 = BLU TOWER
7 = BCA TOWER (230m)
8 = THAMRIN RESIDENCE (150m)
9 = MANDARIN ORIENTAL JAKARTA (107m)
10 = BUNDARAN HI
11 = DEUTSCHE BANK BUILDING

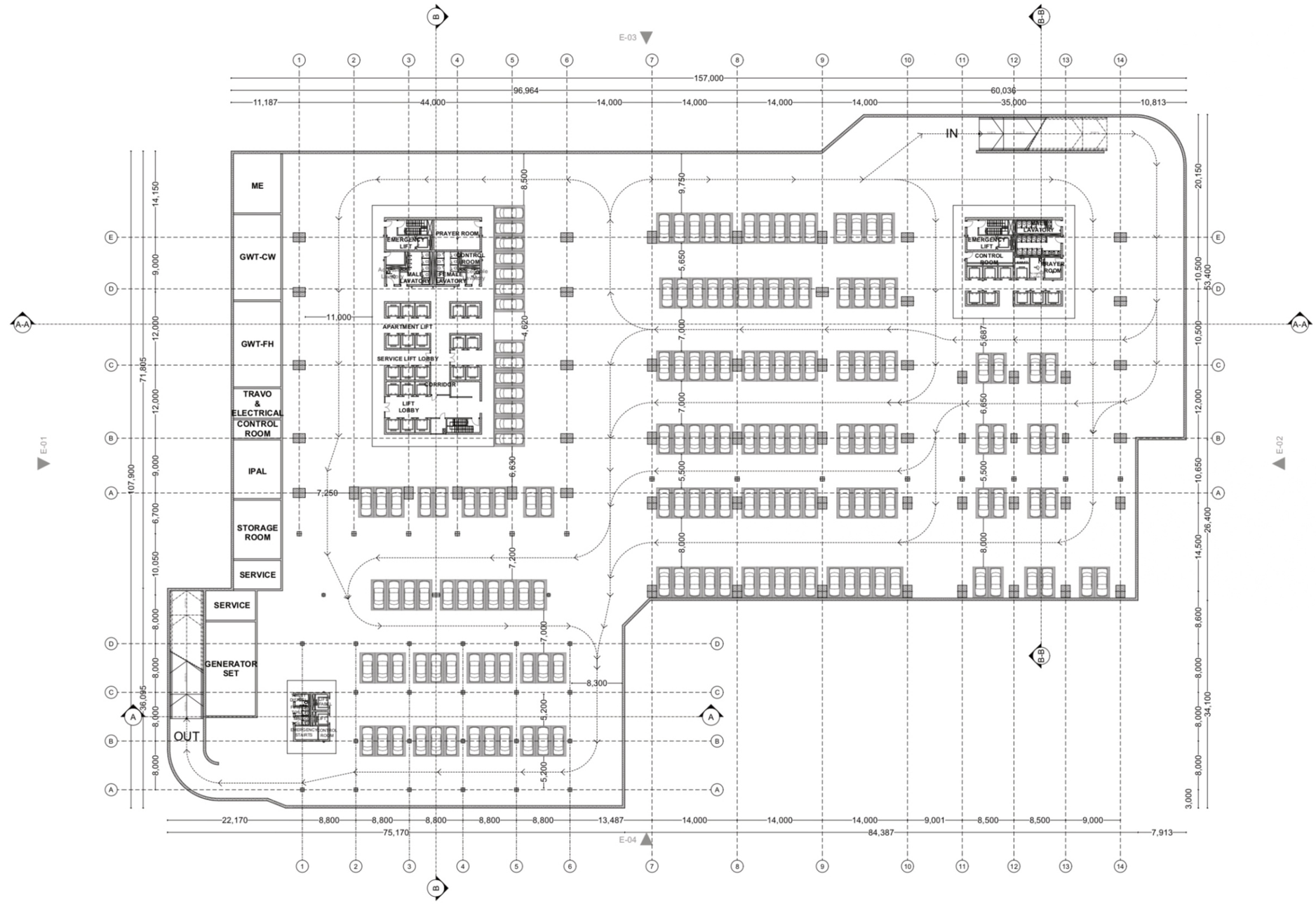
SITUATION PLAN
1 : 3000

N



SITE PLAN
1 : 500

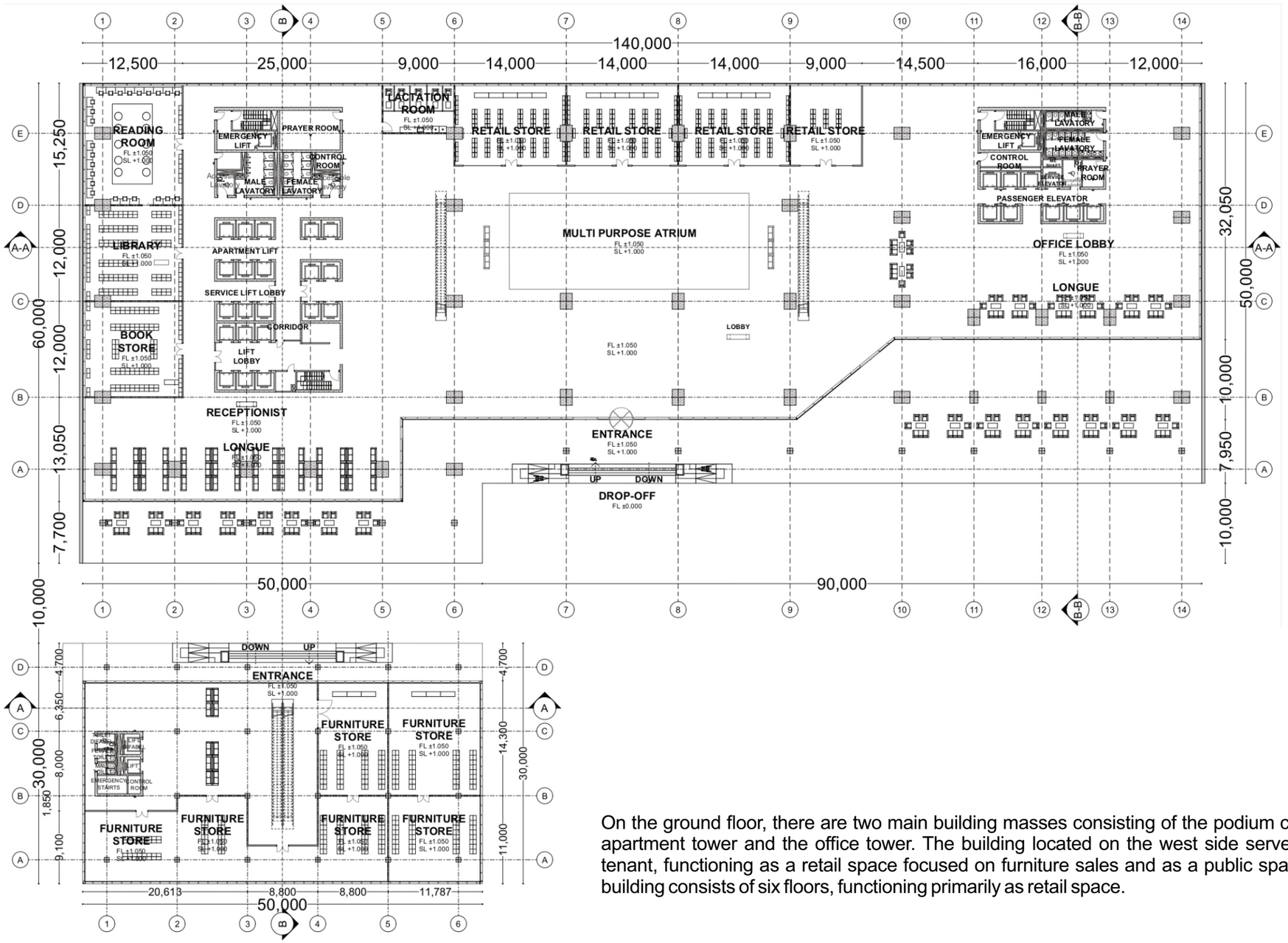
The site plan integrates commercial, public, and office functions within a single complex through an efficient circulation system and inclusive accessibility, supported by a strategic drop-off area and disabled-friendly facilities. The spatial zoning is clearly organized, with retail functions placed on the south side, a public multipurpose atrium at the center, office spaces on the east, and educational facilities such as a library and bookstore on the west. Green open spaces surrounding the site act as buffers and provide shading, while the front plaza serves as a welcoming transition area. This composition creates a development that is not only functional for business but also inclusive, environmentally responsive, and supportive of community interaction.



The basement plan is designed as the main parking area as well as the building's service zone, featuring an efficient vehicle circulation system. With a capacity of 162 vehicles per floor, the entrance is positioned on the northeast side and the exit on the southwest side, forming a one-way loop pattern that ensures smoother vehicle movement without traffic conflicts. The parking area dominates the central to the right portion of the plan, while service and utility rooms such as the generator set, wastewater treatment plant (IPAL), electrical control room, transformer, water tanks, and mechanical–electrical rooms are located on the west side for easy maintenance access without disrupting parking functions.

BASEMENT FLOOR PLAN
1 : 500

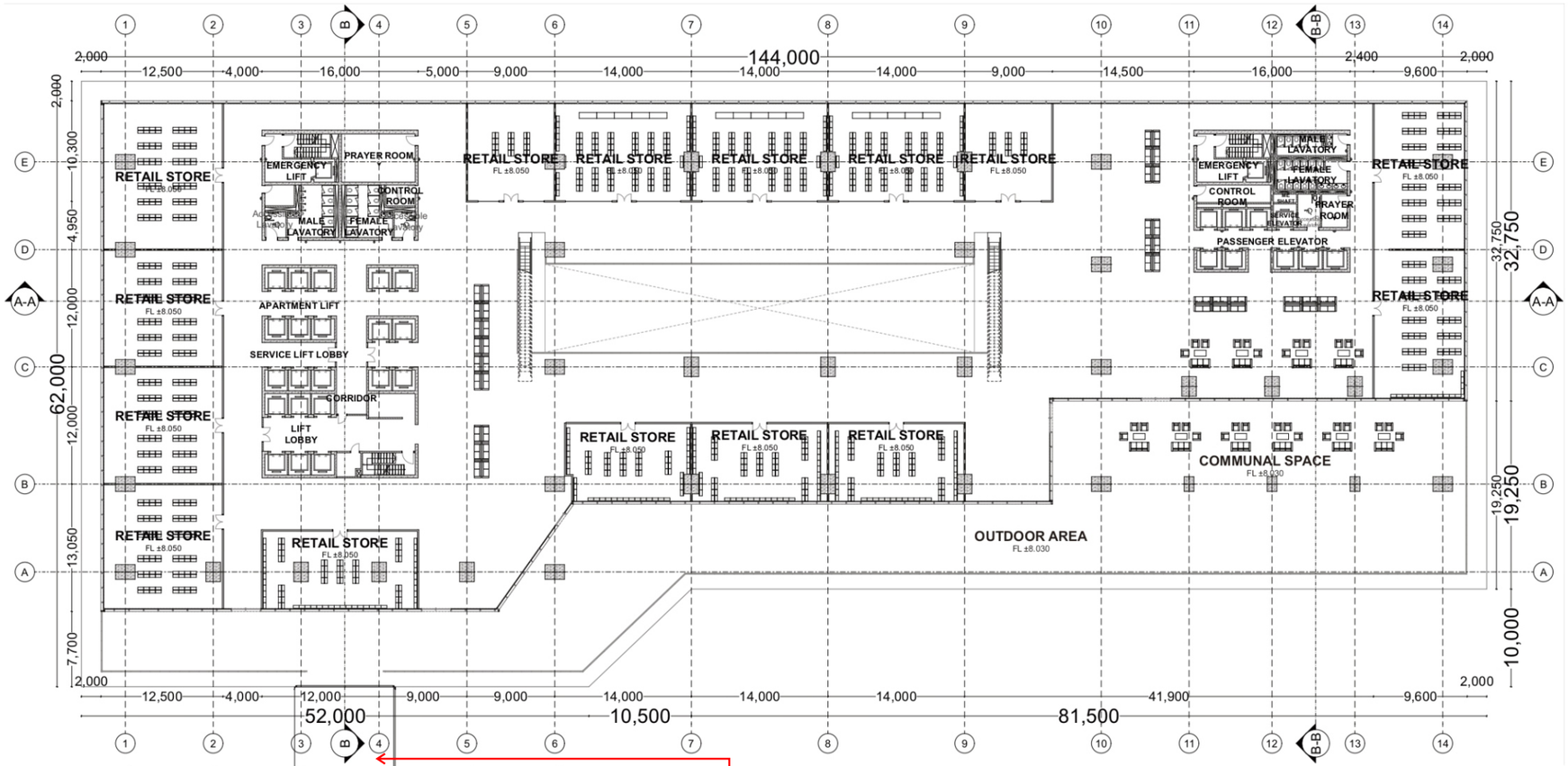
N

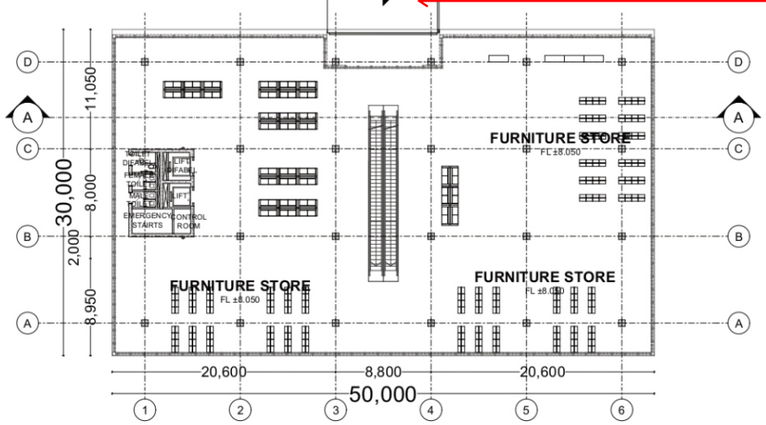


On the ground floor, there are two main building masses consisting of the podium connected to the apartment tower and the office tower. The building located on the west side serves as an anchor tenant, functioning as a retail space focused on furniture sales and as a public space. The podium building consists of six floors, functioning primarily as retail space.

GROUND FLOOR PLAN
1 : 400

N

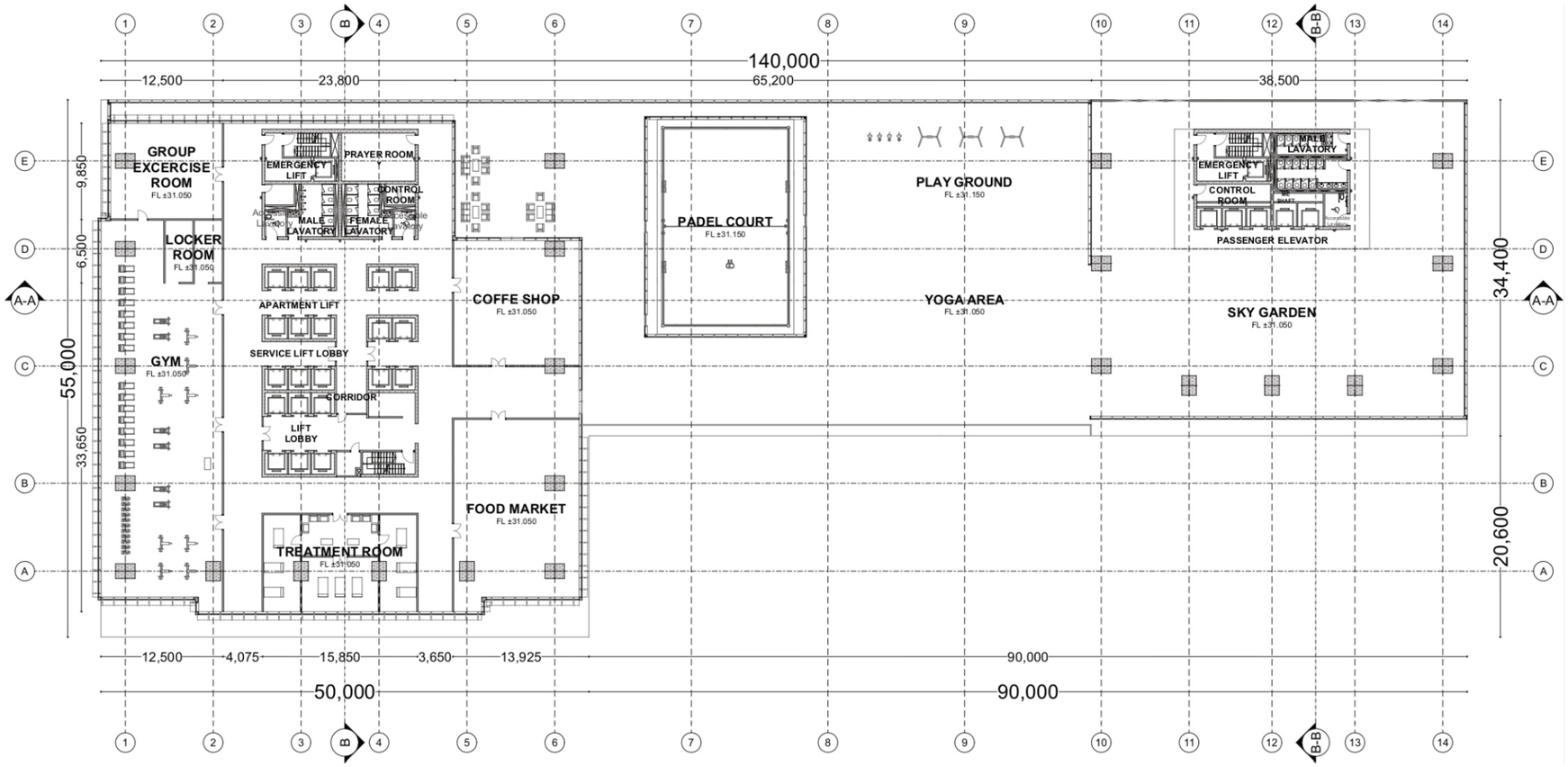




Above the ground floor, the second level features a connecting bridge that links the podium to the anchor tenant. This bridge functions as an effective access point, allowing users to move more efficiently between the two building masses.

1ST STORY PLAN
1 : 400

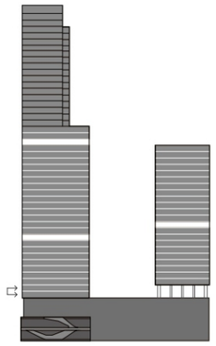
N

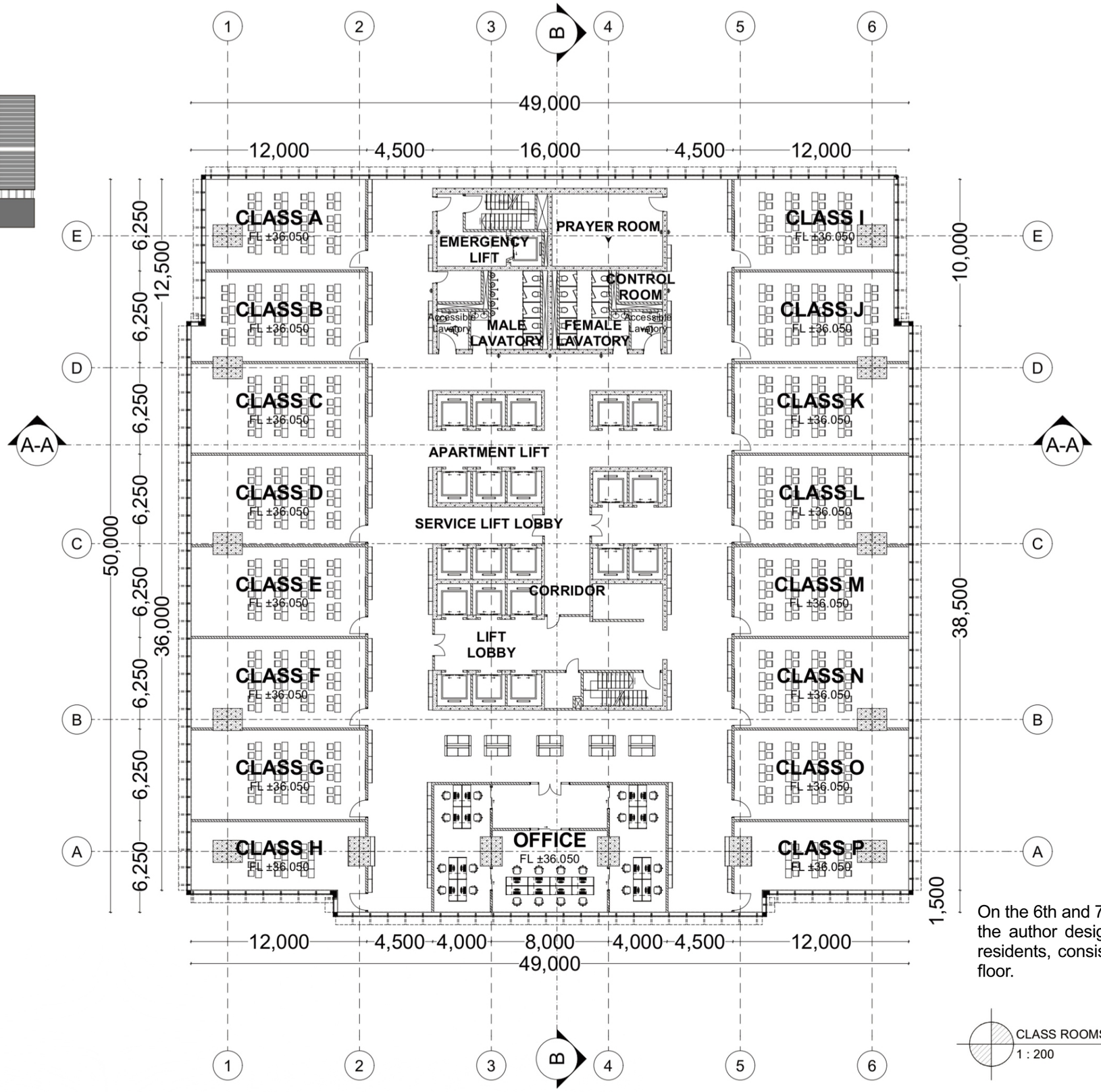


On the fifth floor, which serves as the podium rooftop, functions as an amenities area primarily dedicated to the apartment residents. This level accommodates various productive activities such as a gym, padel court, spa, playground, yoga space, and a sky garden.

5TH STORY PLAN
1 : 400

N

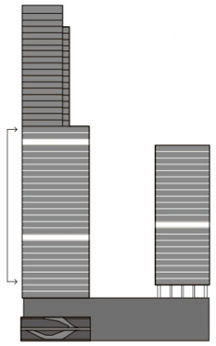


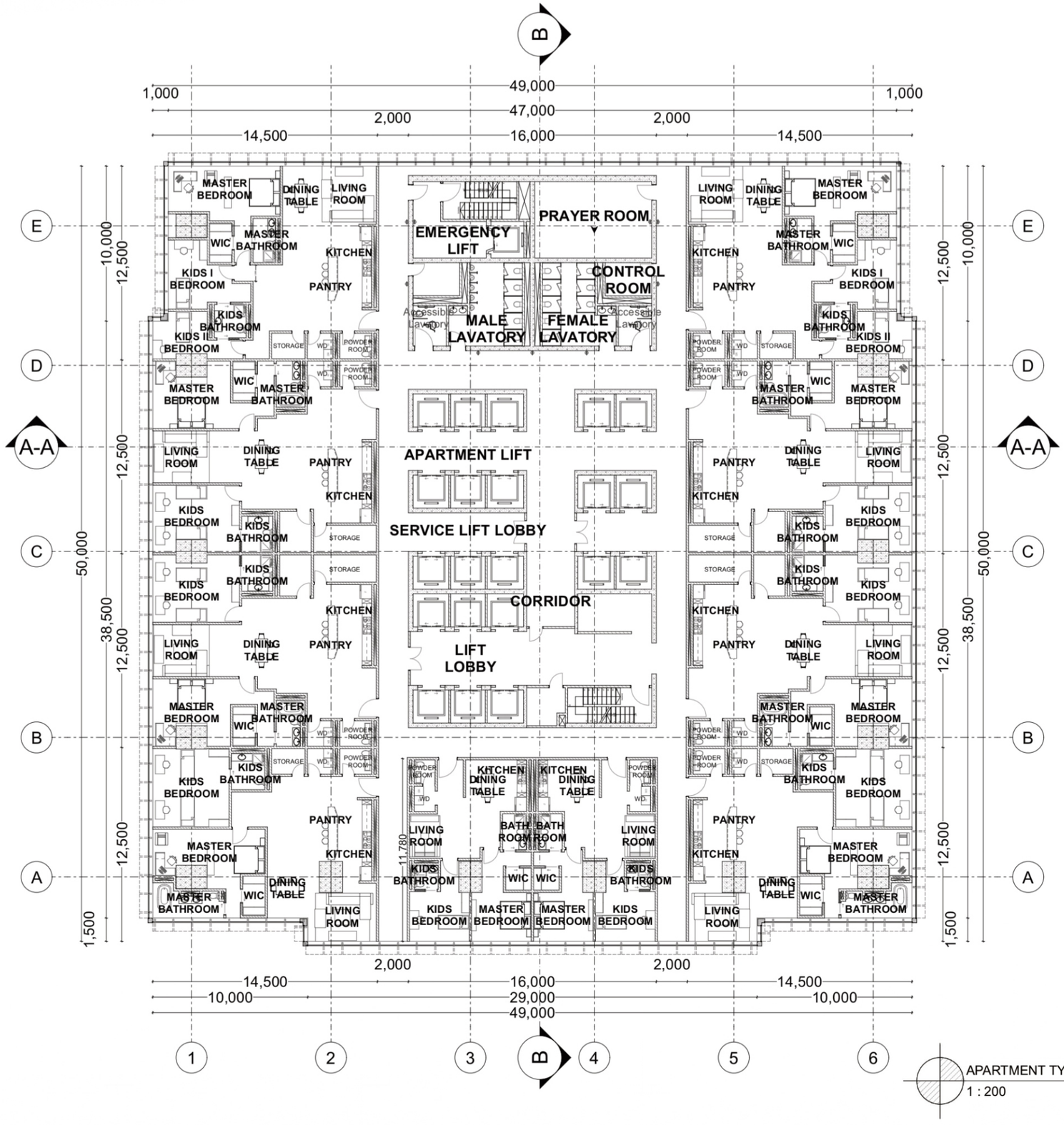


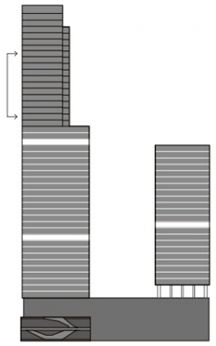
On the 6th and 7th floors of the apartment tower, the author designed a school dedicated to the residents, consisting of 16 classrooms on each floor.

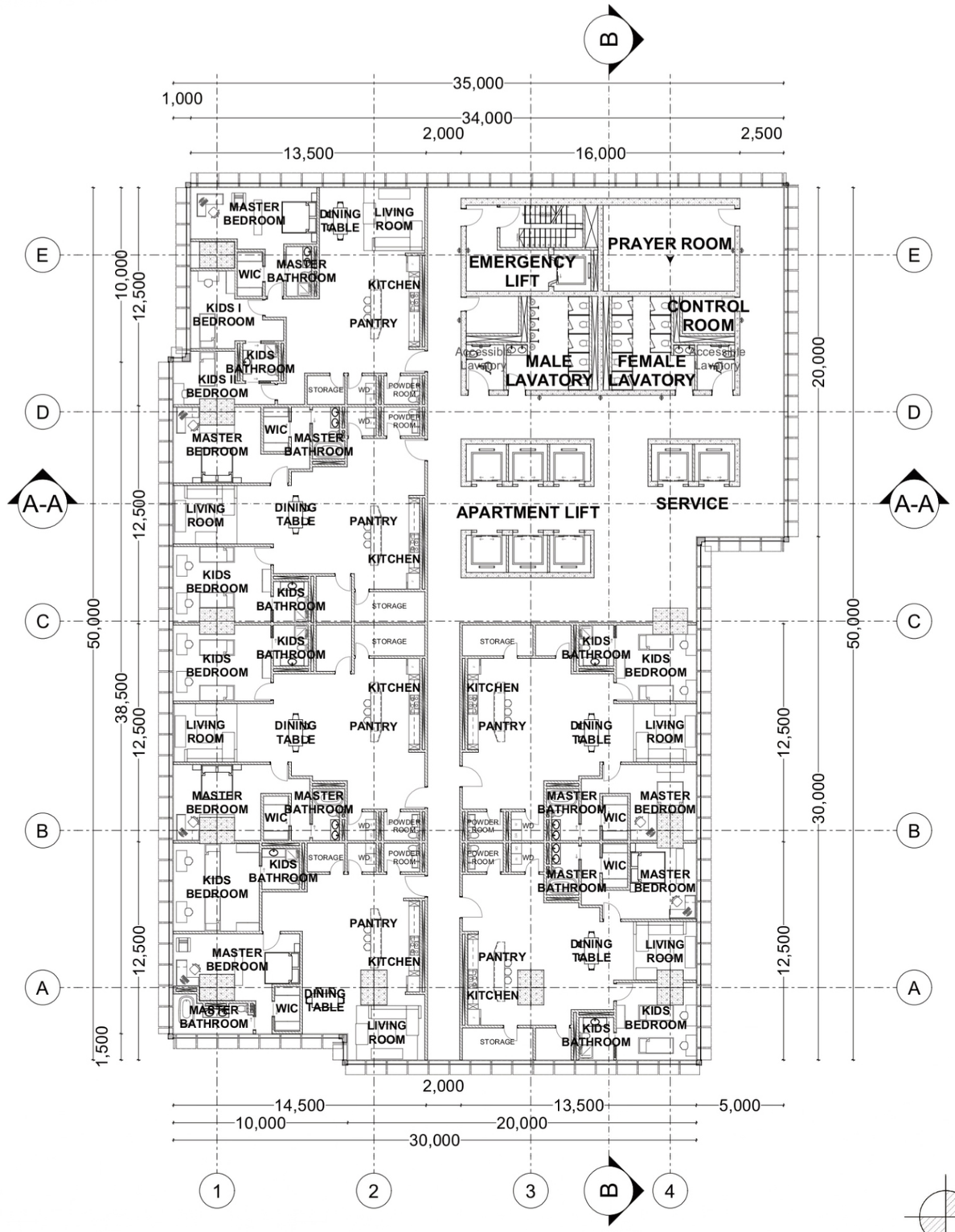
CLASS ROOMS PLAN
1 : 200

N




B
49,000
1,000
47,000
1,000
2,000
2,000
14,500
16,000
14,500
E
D
A-A
C
B
A
10,000
12,500
12,500
12,500
50,000
38,500
12,500
12,500
10,000
1,500
MASTER BEDROOM
DINING TABLE
LIVING ROOM
WIC
MASTER BATHROOM
KITCHEN
PANTRY
KIDS I BEDROOM
KIDS BATHROOM
KIDS II BEDROOM
STORAGE
WD
POWDER ROOM
PRAYER ROOM
EMERGENCY LIFT
CONTROL ROOM
Accessible Lavatory
MALE LAVATORY
FEMALE LAVATORY
APARTMENT LIFT
SERVICE LIFT LOBBY
CORRIDOR
LIFT LOBBY
KIDS BEDROOM
BATH ROOM
MASTER BEDROOM
11,780
2,000
2,000
14,500
16,000
14,500
10,000
29,000
10,000
49,000
1
2
3
B
4
5
6
APARTMENT TYPICAL FLOOR PLAN
1 : 200
N

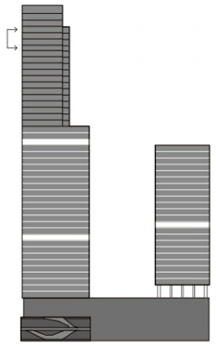


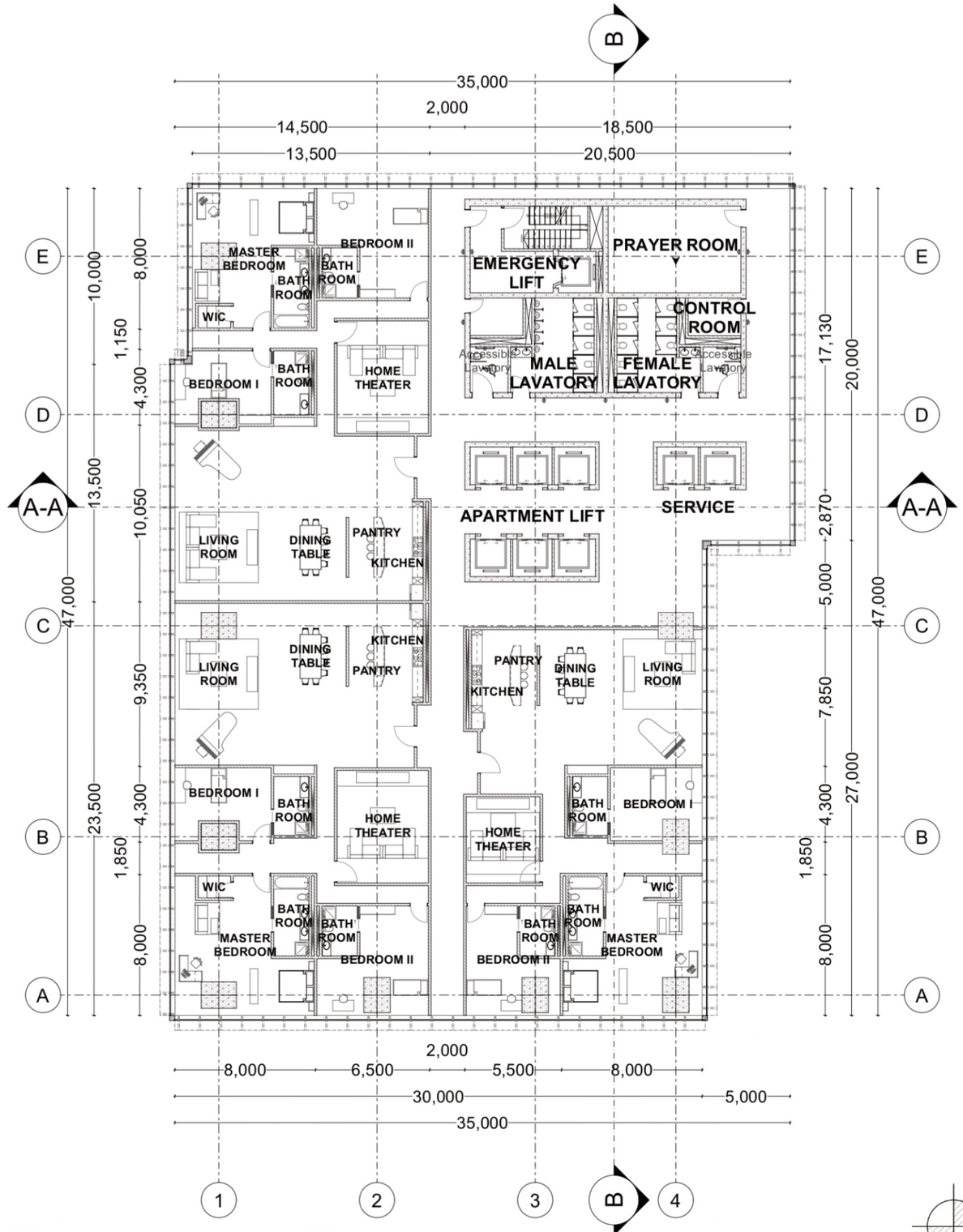


APARTMENT TYPICAL FLOOR PLAN

1 : 200

N

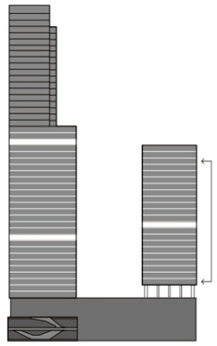


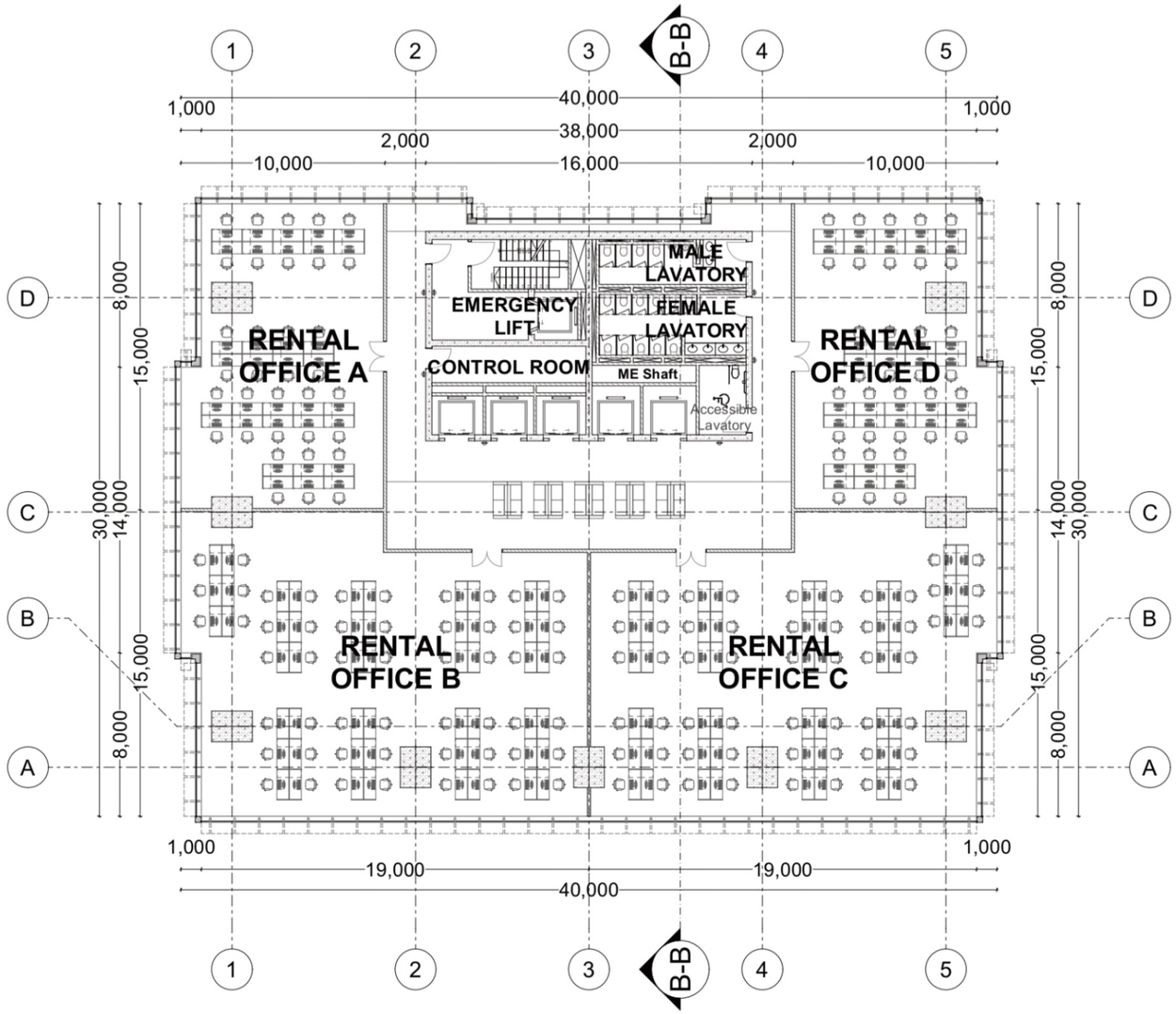


APARTMENT TYPICAL FLOOR PLAN

1 : 200

N





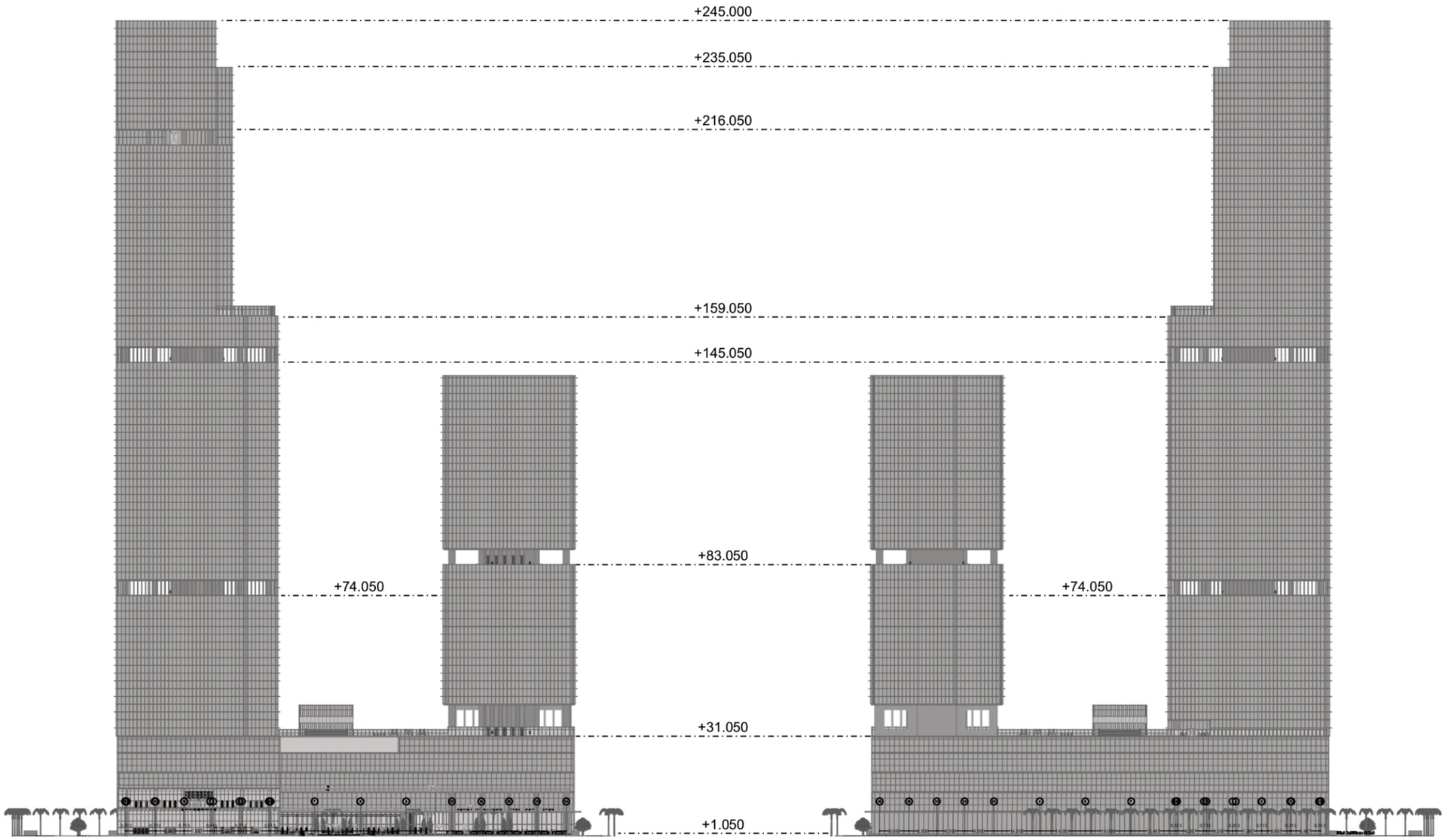
OFFICE TYPICAL FLOOR PLAN
1 : 200

N

WIND ORIENTATION

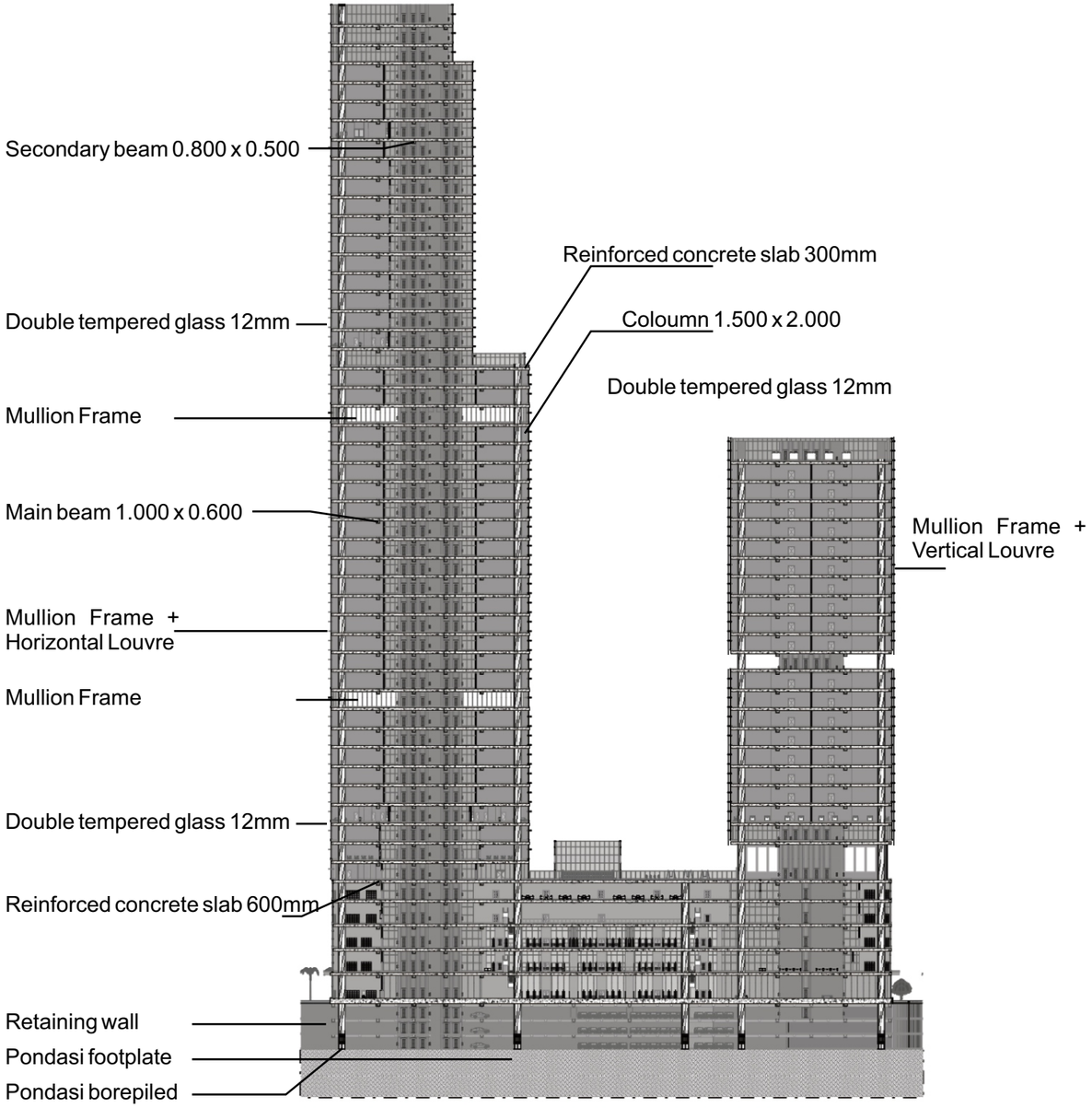
EFFICIENT LIGHTING

HIGH PERFORMANCE ENVELOPE

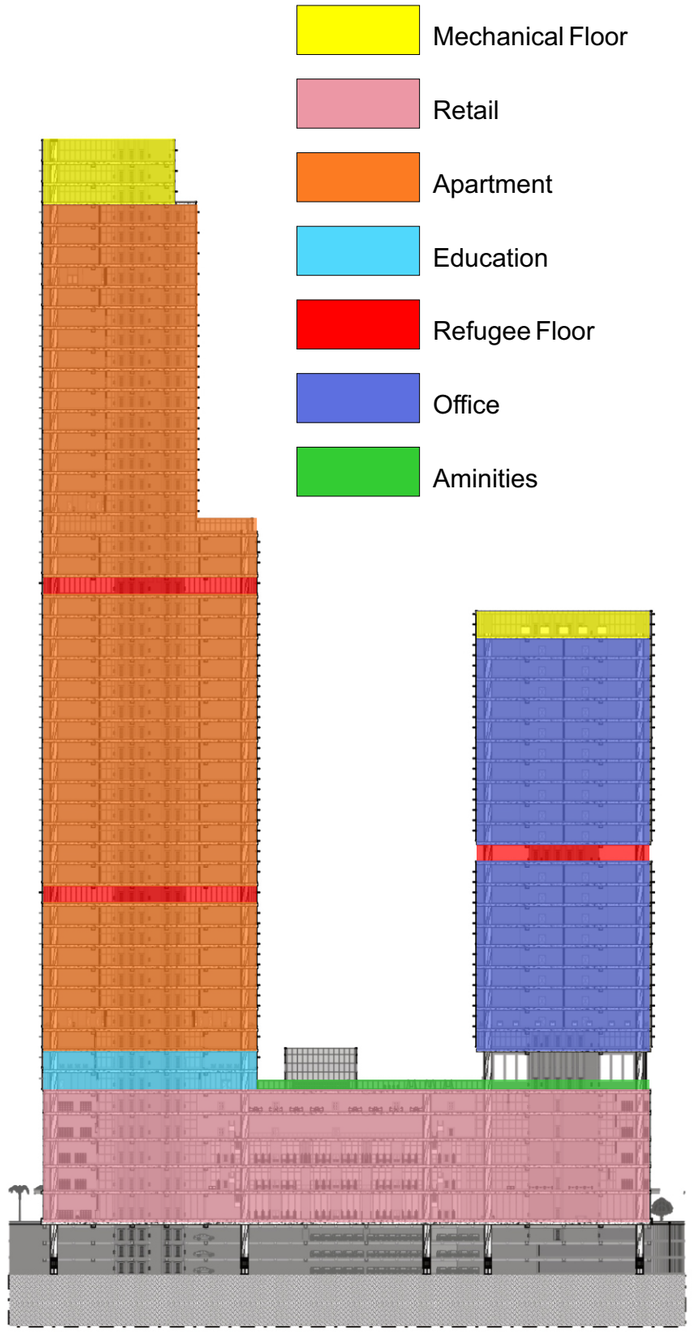


WEST ELEVATION
1 : 1000

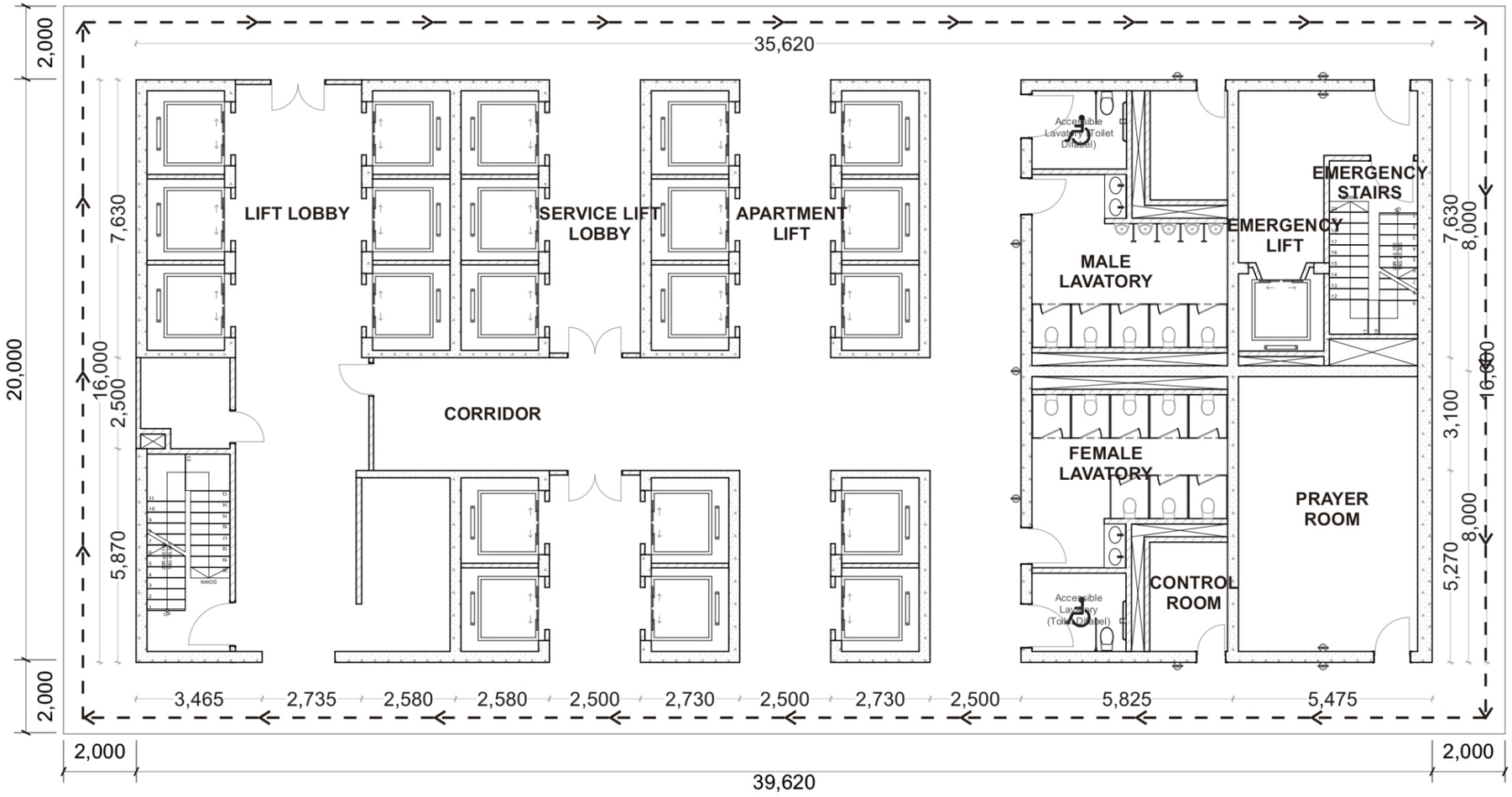
EAST ELEVATION
1 : 1000



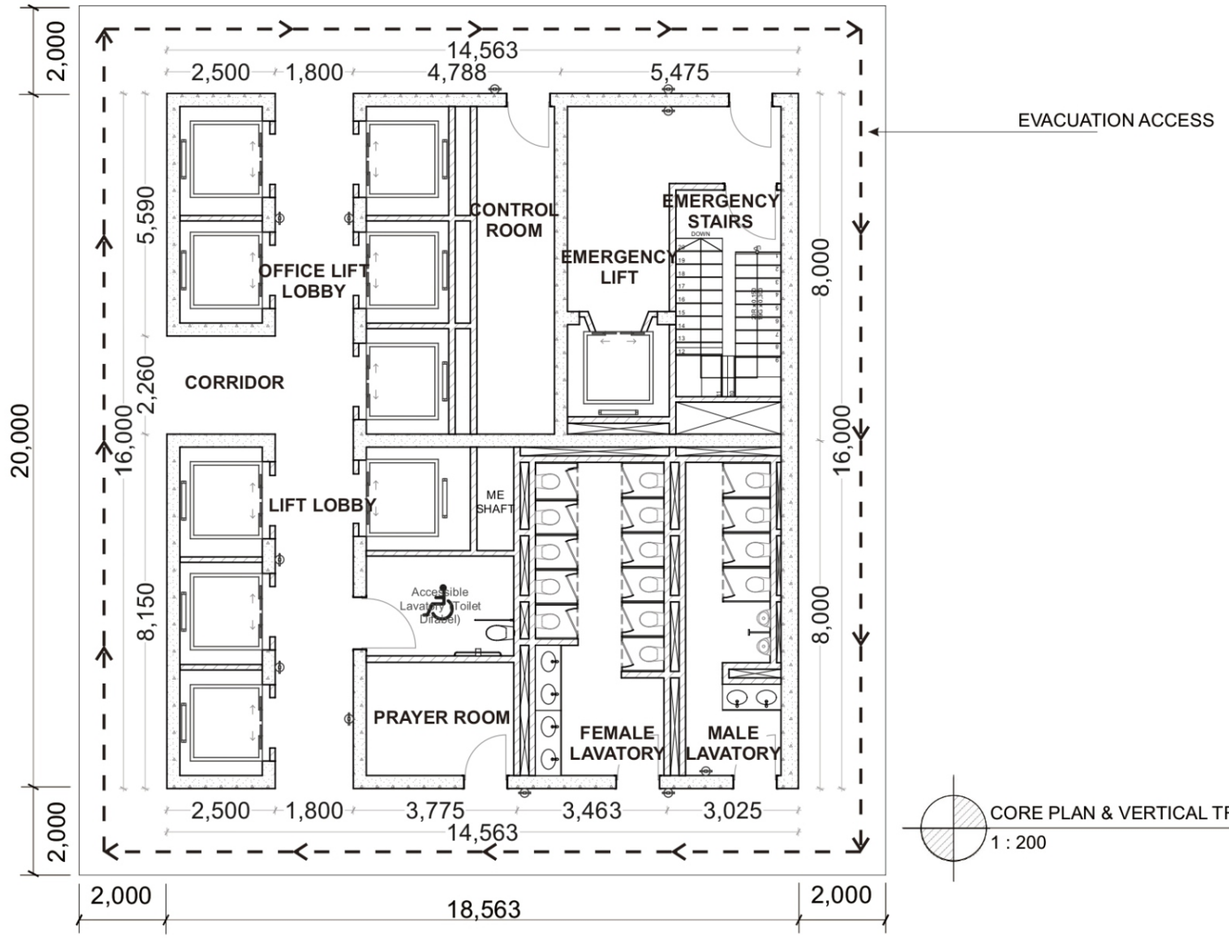
SECTION A-A
1 : 1000



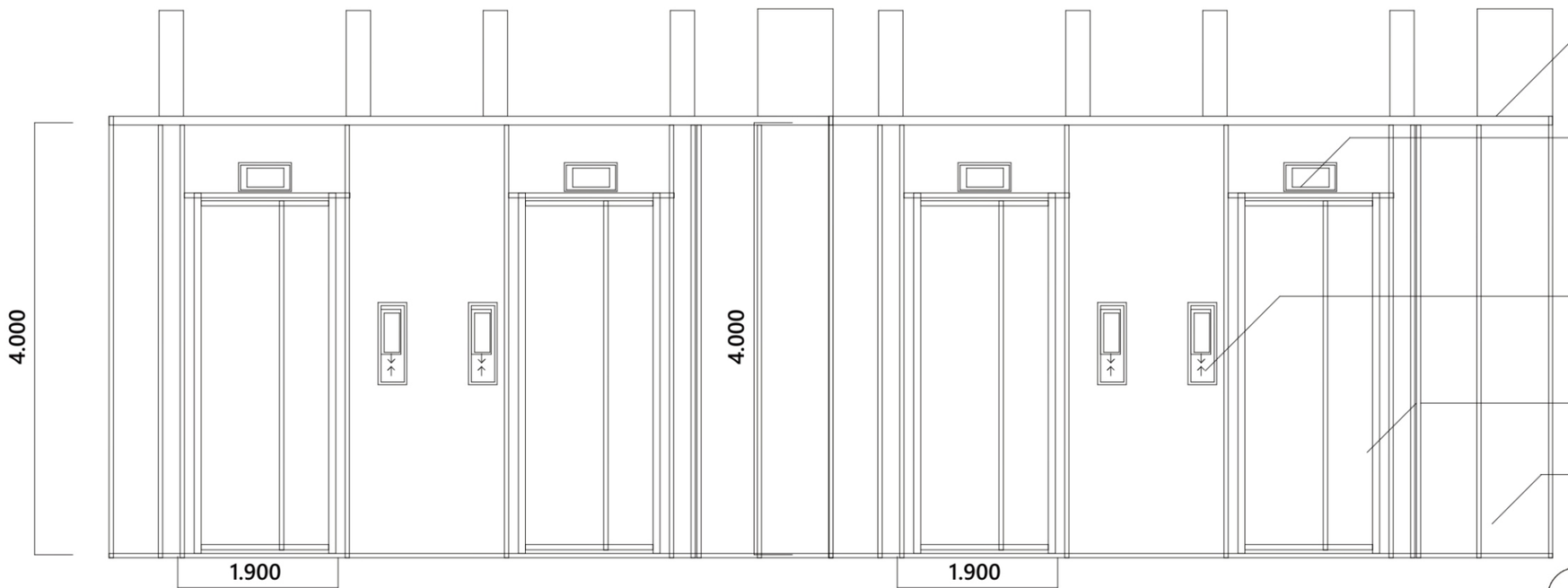
SECTION A-A
1 : 1000



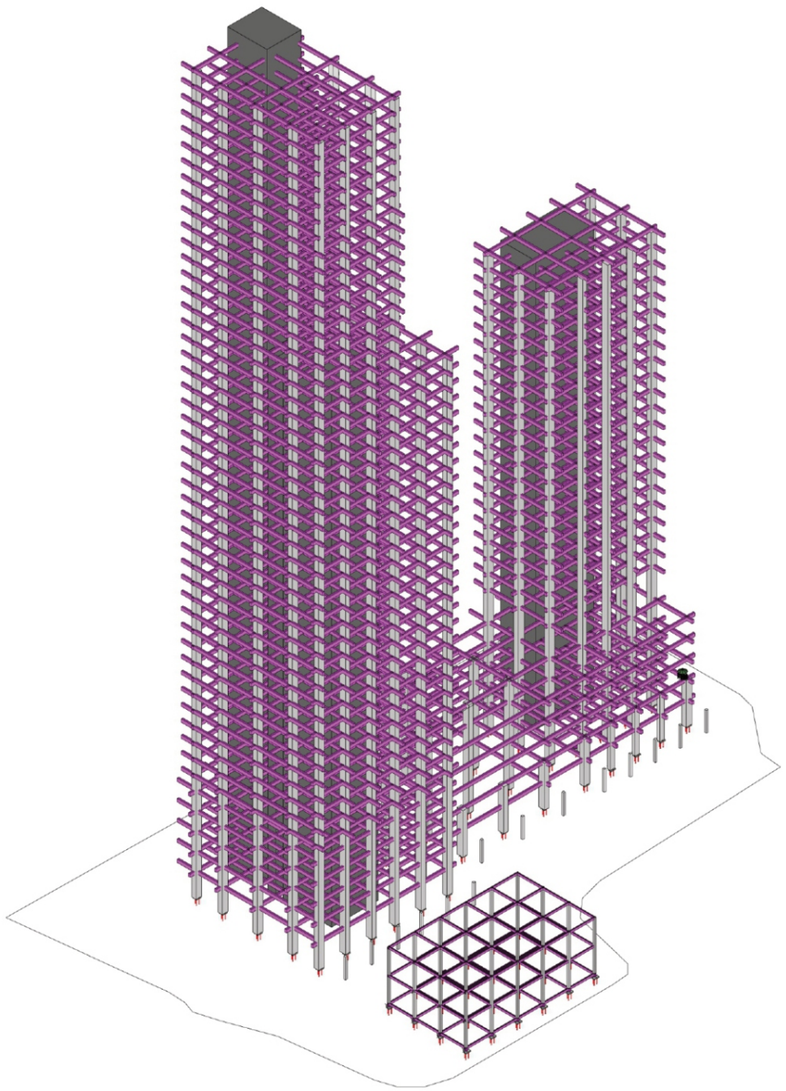
CORE PLAN & VERTICAL TRANSPORTATION
1 : 200

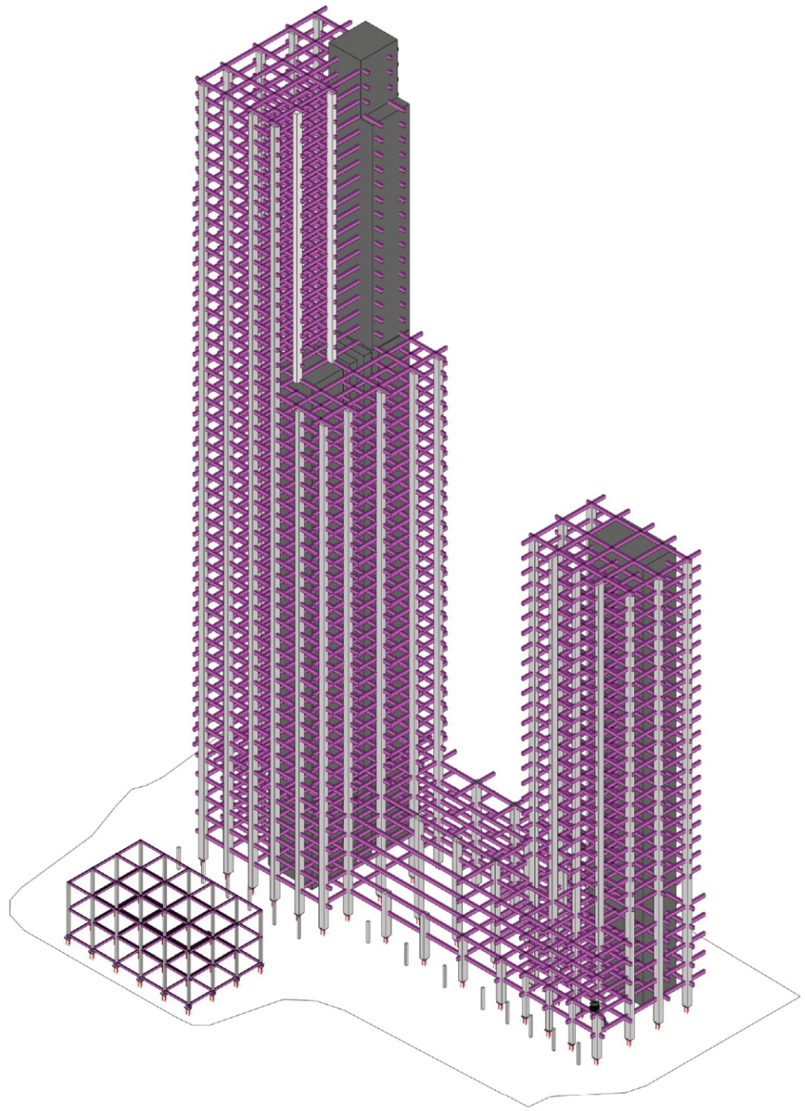


CORE PLAN & VERTICAL TRANSPORTATION
1 : 200



ELEVATION & DETAIL
PASSENGER ELEVATOR
1 : 200





K1 : MAIN CONCRETE COLOUMN
K2 : SECONDARY CONCRETE COLOUMN
B1 : MAIN CONCRETE BEAM
B2 : SECONDARY CONCRETE BEAM

FLOOR SLAB : 150mm thick
BORED PILE FOUNDATION
CORE STRUCTURE 400mm thick

STRUCTURAL PLAN
A2 NTS SCALE PERSPECTIVE



ELECTRCAL ROUTING

- PLN HIGH VOLTAGE
- MVDMDP
- TRAFOMATOR
- LVMDP
- PKG (Panel Kontrol Genset)
- GENSET

PLUMBING SANITATION

- SITE DRAINAGE CHANNEL GUTTER GALVANIS STEEL GRATING
- DRAINAGE INFILTRATION WELL

BUILDING SAFETY

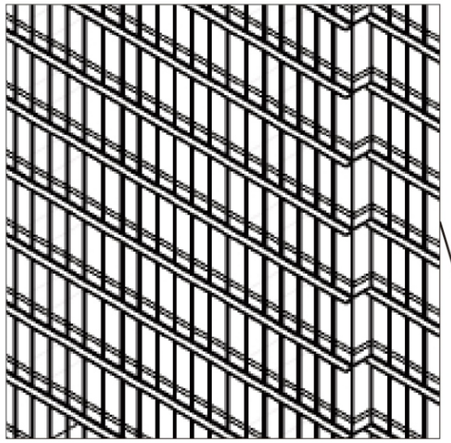
- ASSEMBLY POINT
- VERTICAL TRANSPORTATION BARIER FREE
  - RAMP DIFABEL
  - RAMP TRANSPORTATION
  - ELEVATOR & ESCALATOR

INTEGRATION SCHEME SITE PLAN

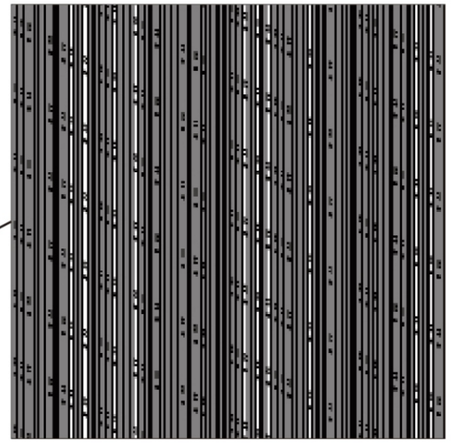
1 : 500

N

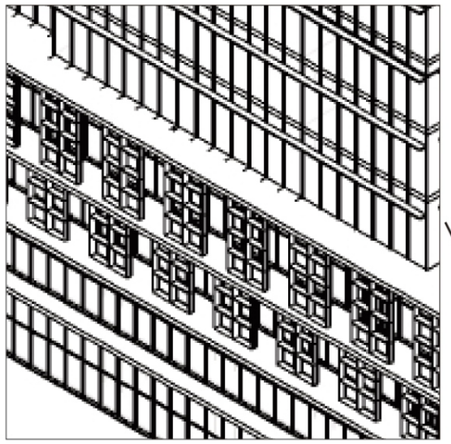
HORIZONTAL LOUVER



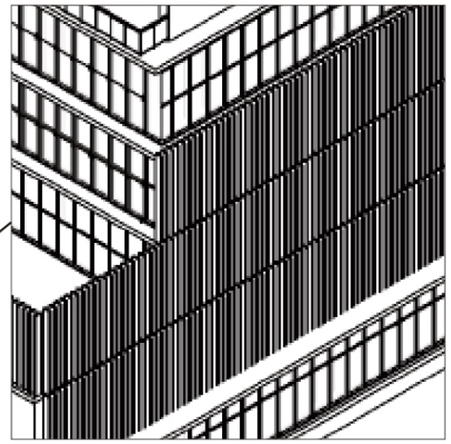
VERTICAL LOUVER

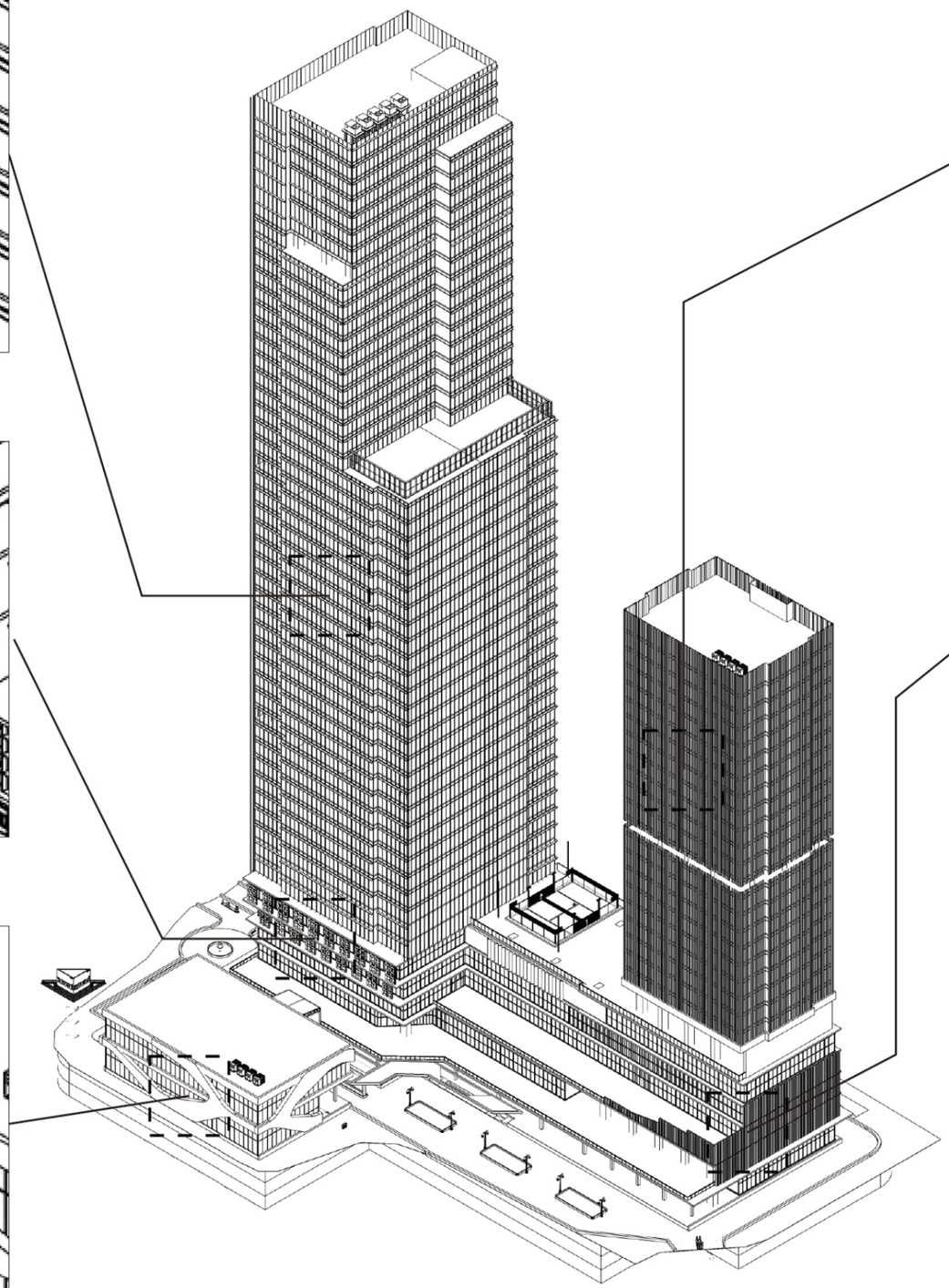


ALUMINIUM PERFORATED PANEL

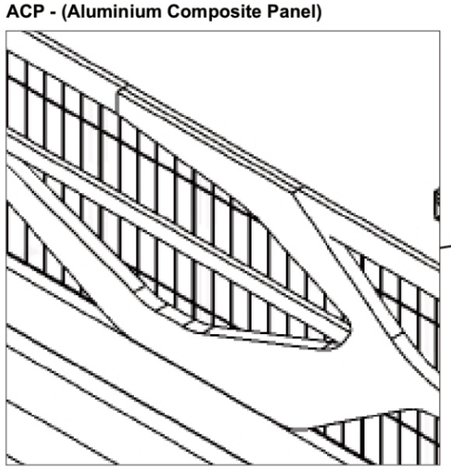


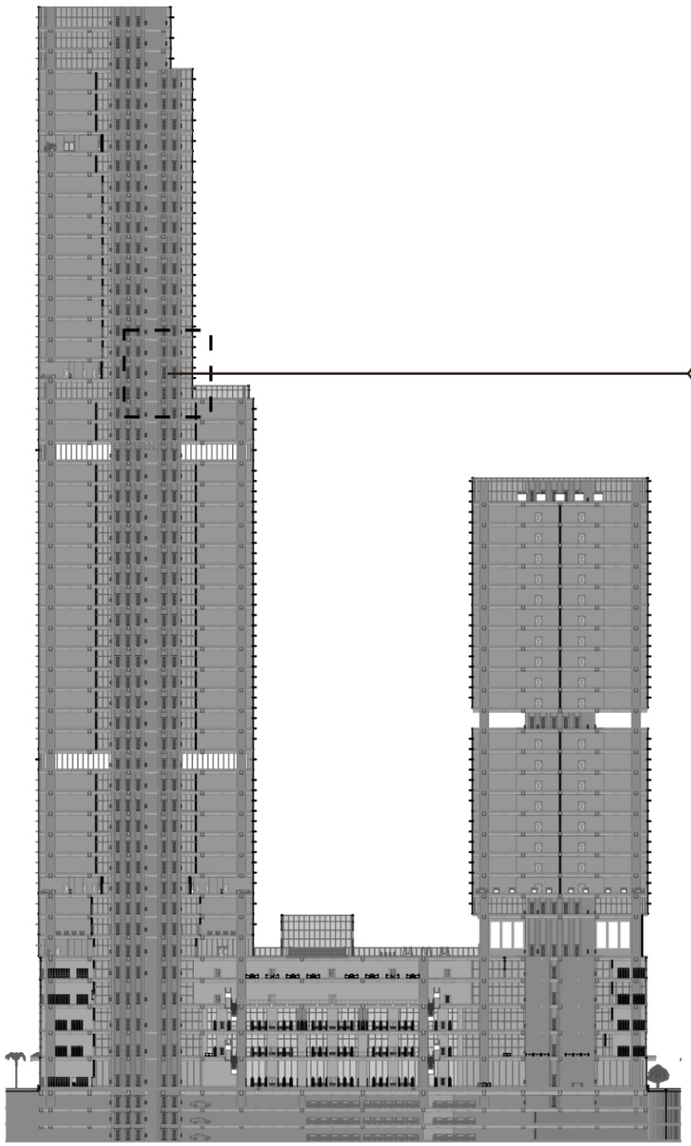
GLULAM WOOD - (Glued Laminated Timber)

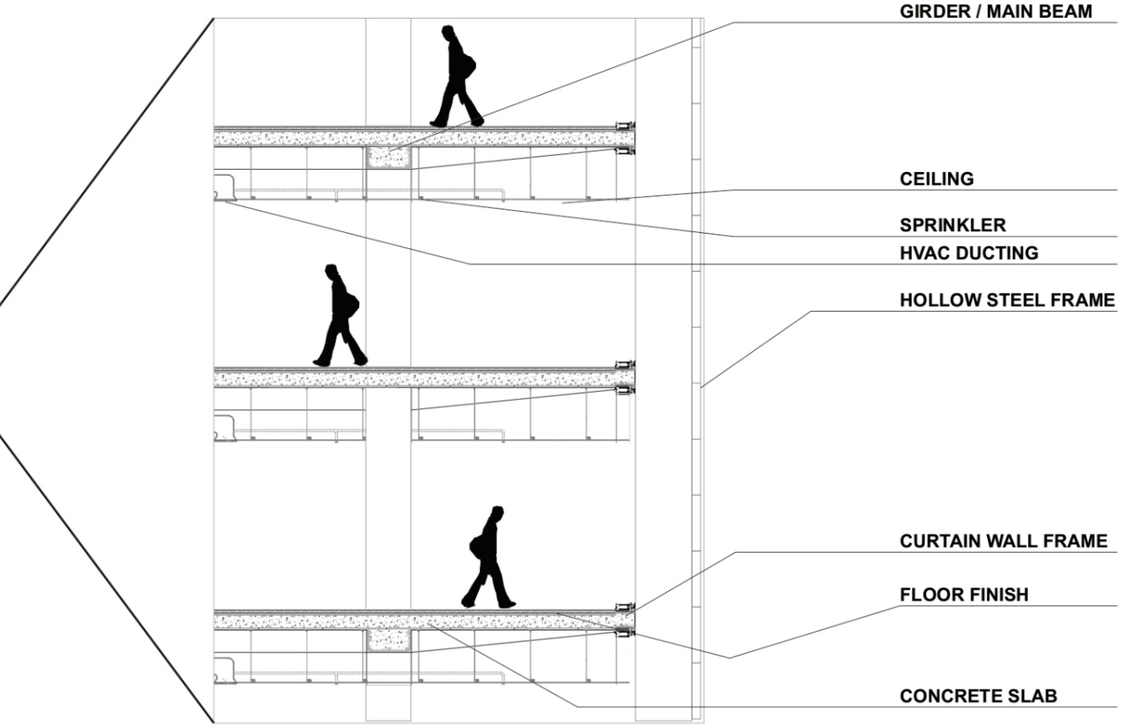


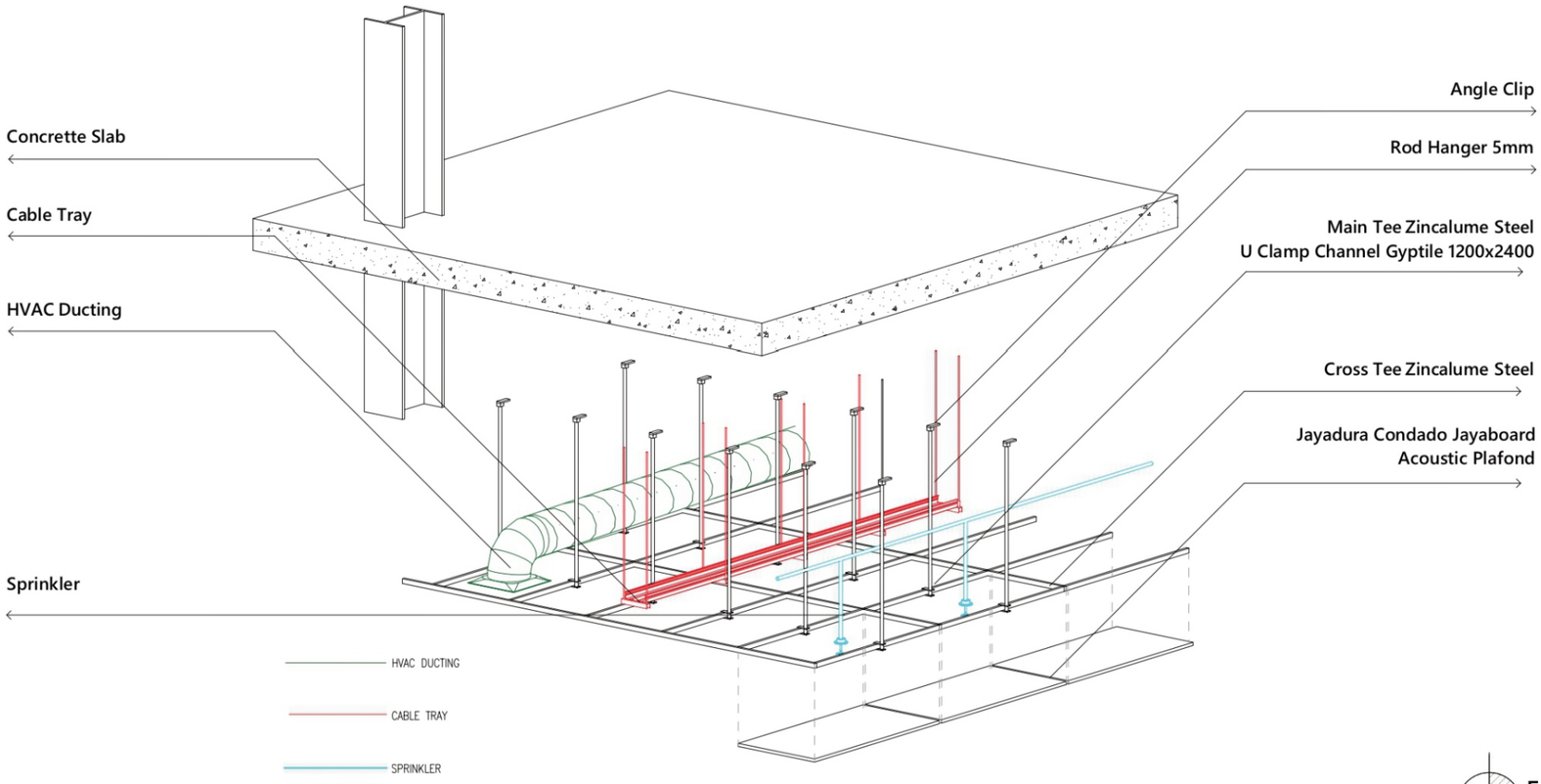


ACP - (Aluminium Composite Panel)

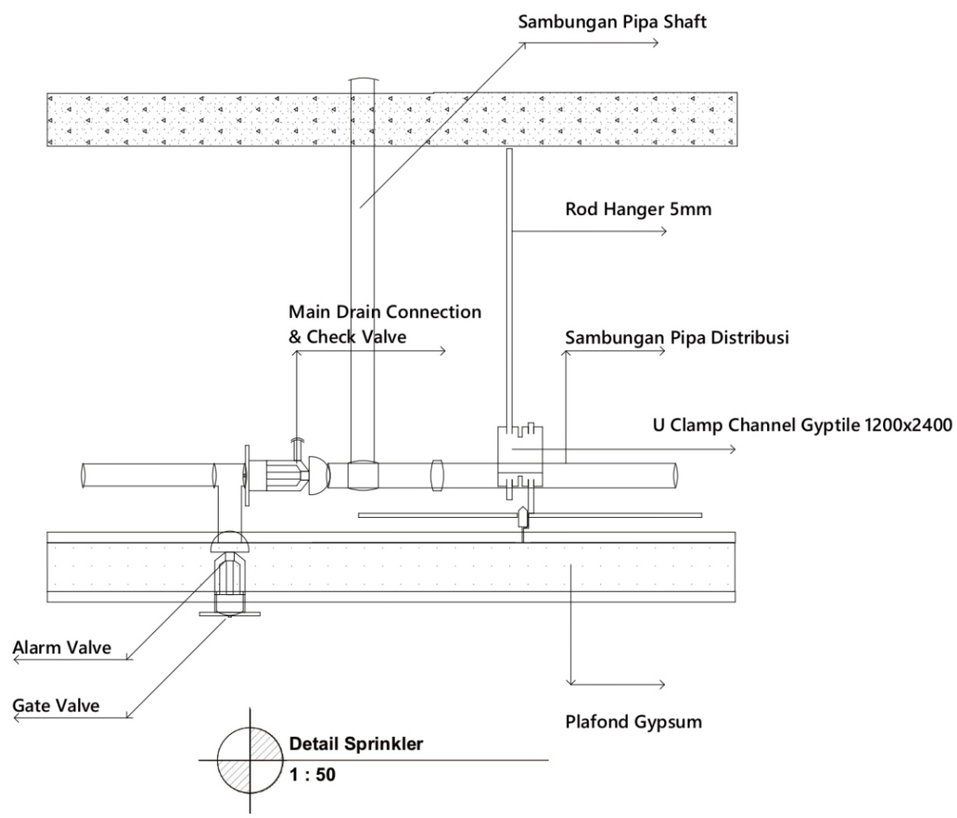




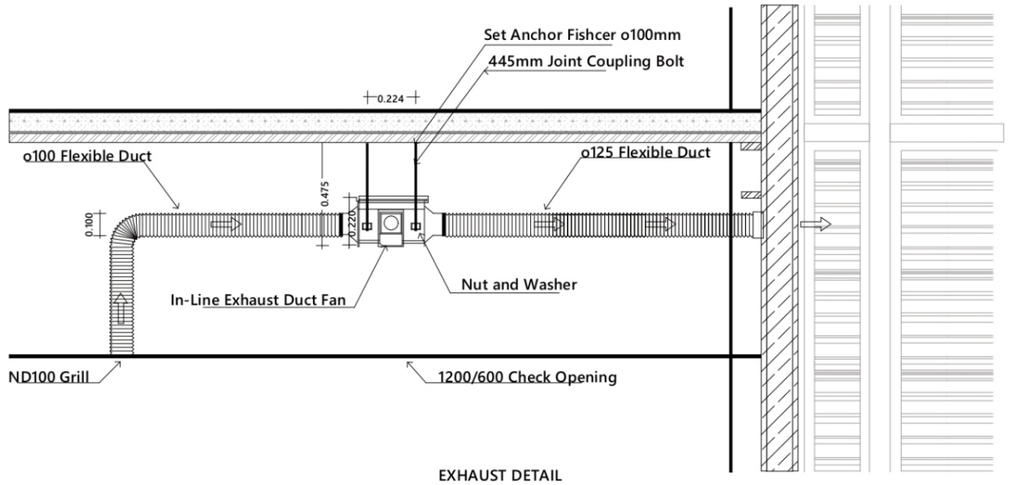

GIRDER / MAIN BEAM
CEILING
SPRINKLER
HVAC DUCTING
HOLLOW STEEL FRAME
CURTAIN WALL FRAME
FLOOR FINISH
CONCRETE SLAB



Exploded Axono Ceiling & MEP
1 : 50



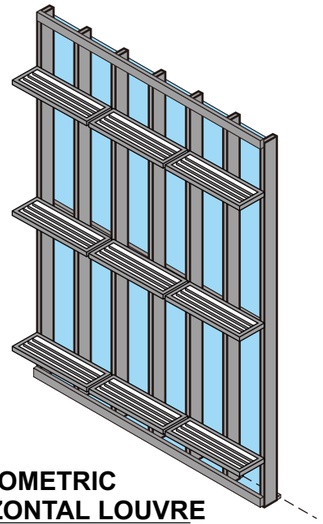
Detail Sprinkler
1 : 50



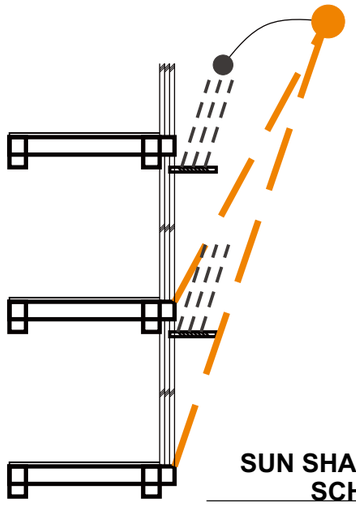
Detail Exhaust & Cassette AC
1 : 50

HORIZONTAL LOUVRE

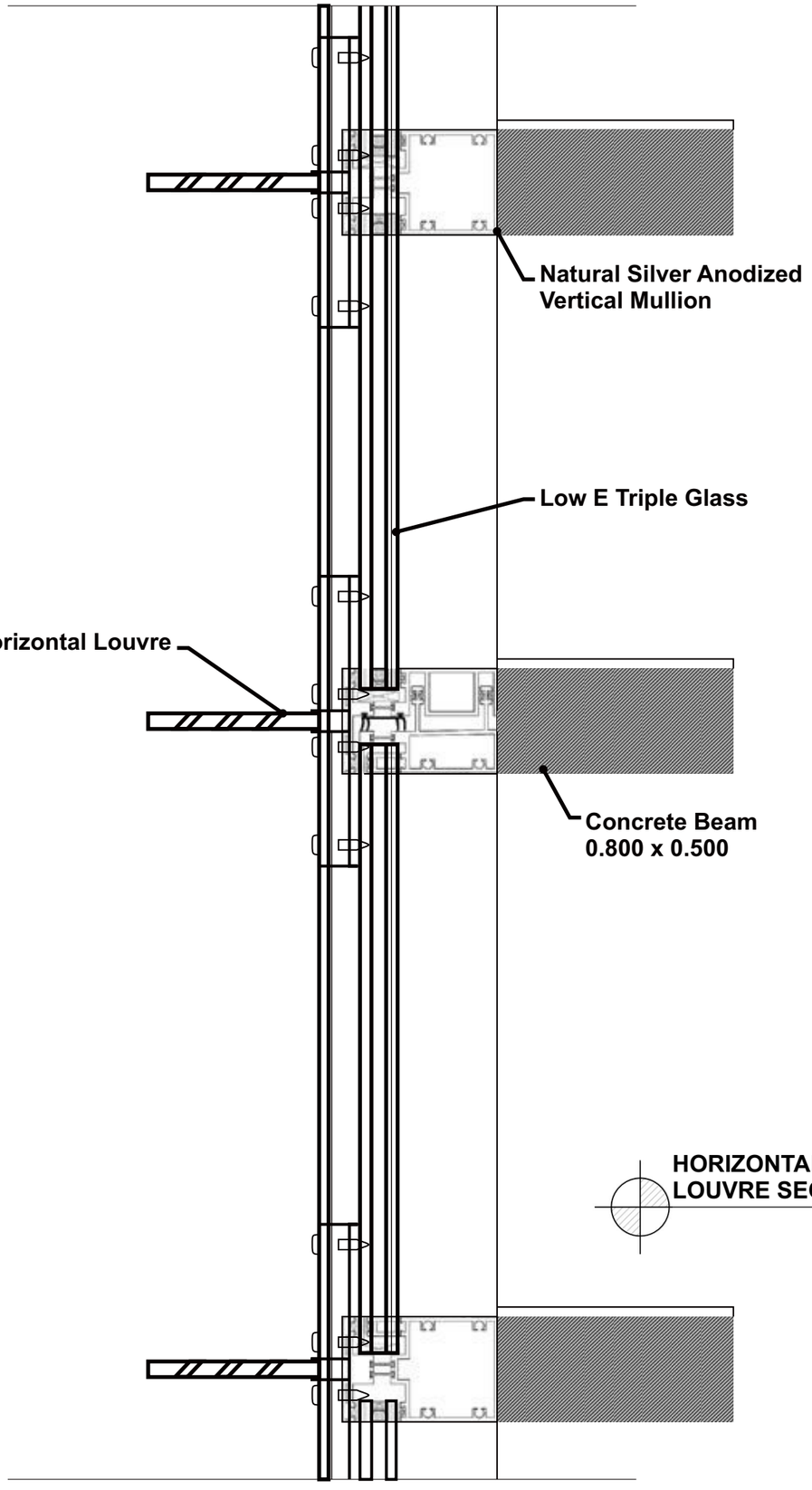




AXONOMETRIC
HORIZONTAL LOUVRE

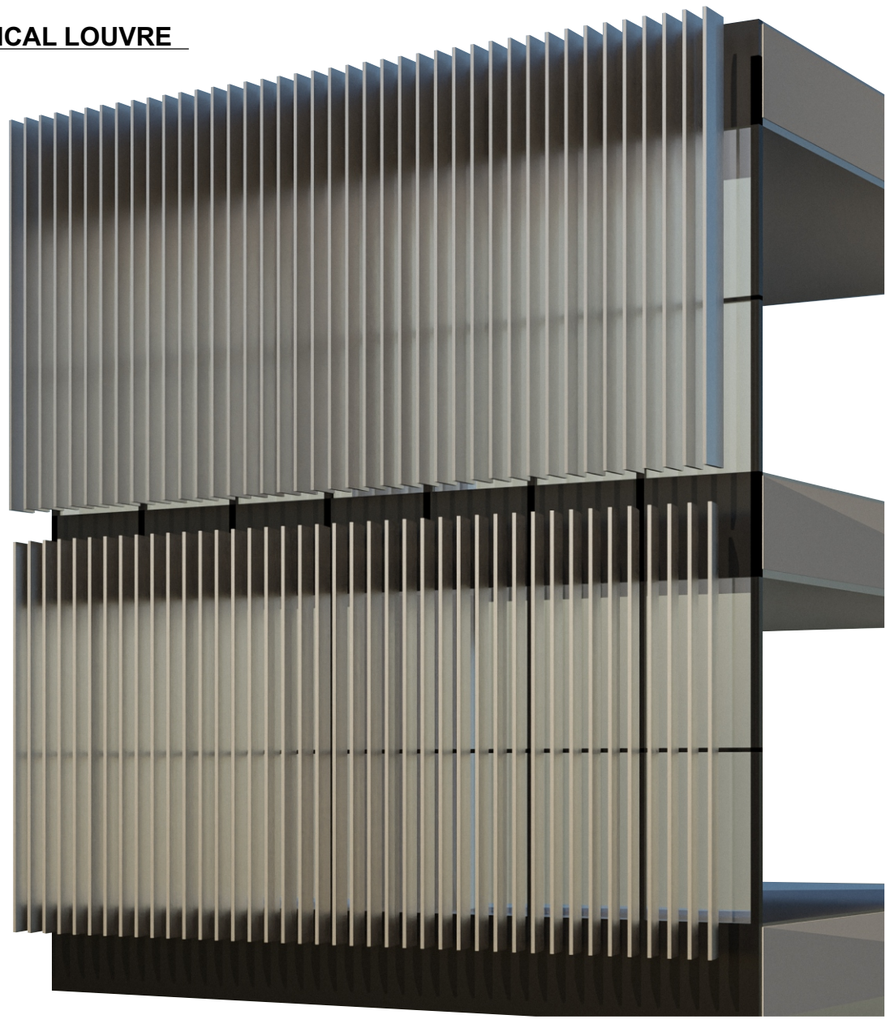


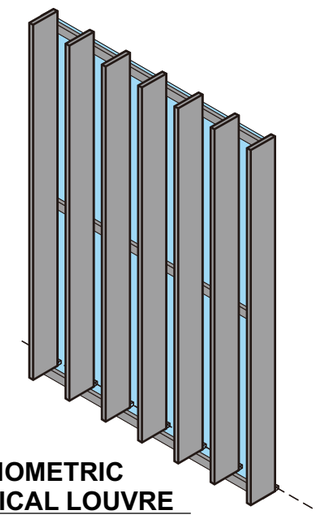
SUN SHADING
SCHEME



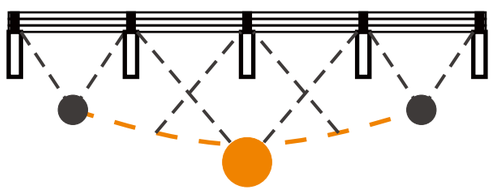
HORIZONTAL
LOUVRE SECTION

VERTICAL LOUVRE

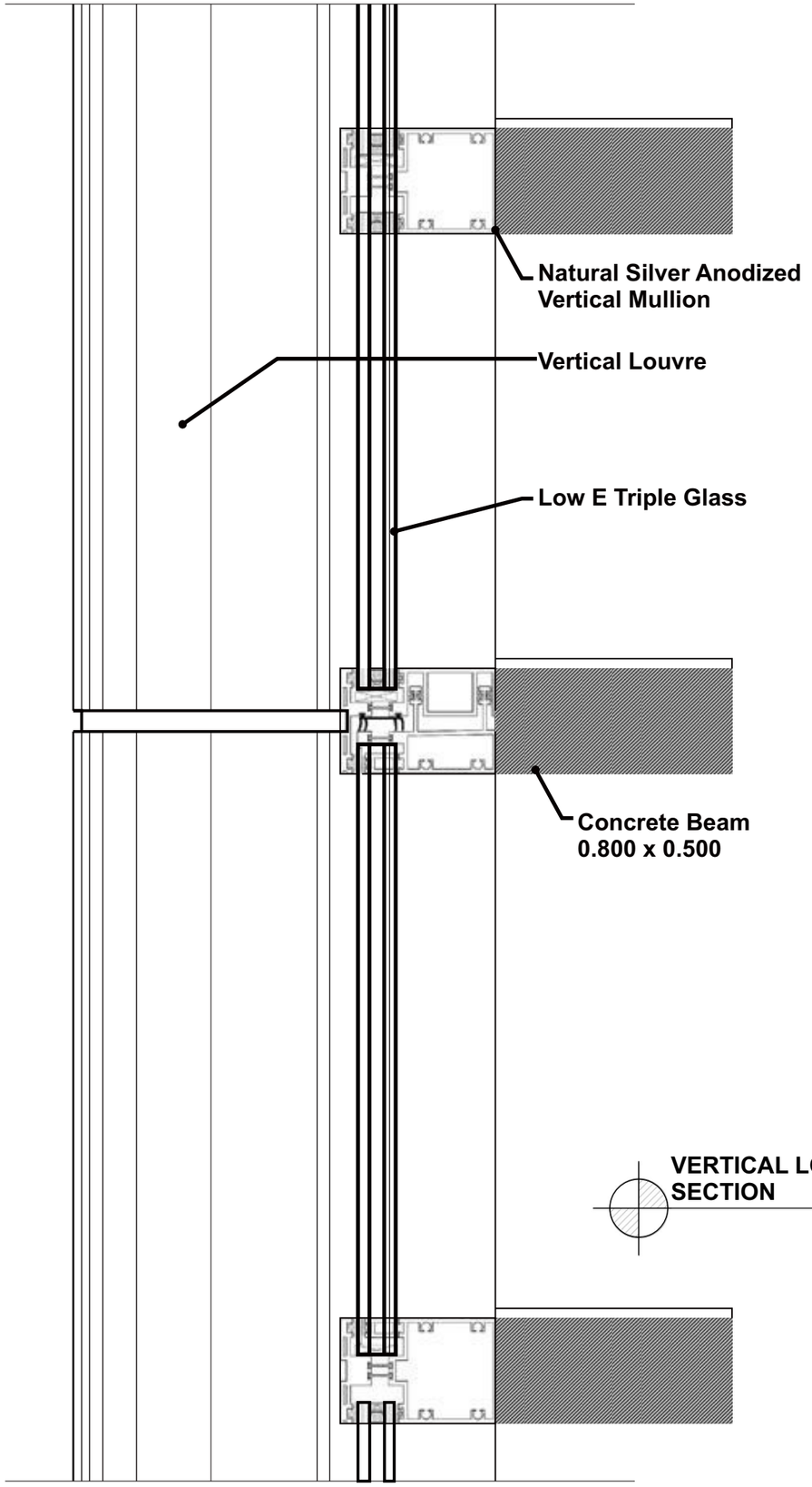




AXONOMETRIC
VERTICAL LOUVRE



SUN SHADING
SCHEME

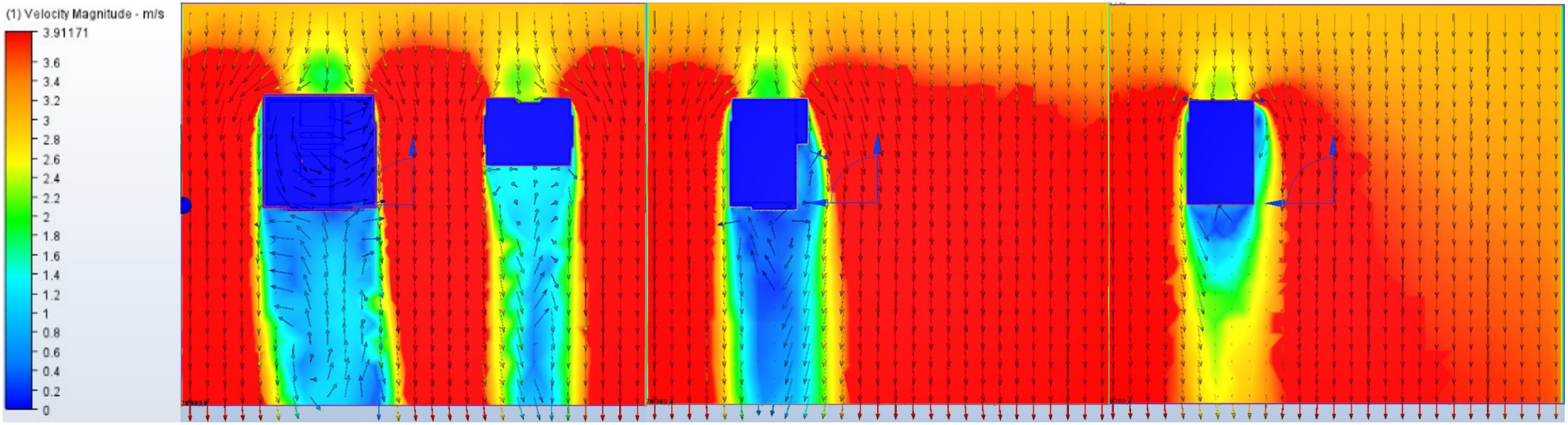


VERTICAL LOUVRE
SECTION

Chapter 05

Simulation Results

Simulation



The Computational Fluid Dynamics (CFD) simulation for PAX Tower Apartment was conducted to analyze airflow behavior around the building complex, which consists of a podium serving as a retail area, Tower 1 as a residential apartment, and Tower 2 as an office building. The primary objective of this analysis is to optimize the façade's performance as part of an energy efficiency strategy through the utilization of natural ventilation, heat control, and improved thermal comfort. The simulation results reveal variations in wind velocity illustrated through a color gradient. Dark blue zones (0–0.4 m/s) indicate areas with very low or nearly stagnant wind speeds, typically located behind the building masses due to the wind shadow effect. Green to yellow zones (1–2 m/s) represent moderate wind speeds, generally found along building sides or within gaps between the towers. Meanwhile, red zones (>3 m/s) indicate areas with high wind speeds, occurring in open spaces without obstructions or on building façades directly exposed to prevailing winds.

The findings from this analysis have direct implications for façade design and outdoor space planning. Façade openings can be optimized in areas with moderate wind speeds to maximize natural ventilation without creating excessive indoor air pressure. Façades in stagnation zones require additional shading or screening elements to reduce heat gain from solar radiation. Amenities such as the sky garden, gym, and padel court are positioned on the podium rooftop in areas with moderate airflow to ensure user comfort. Furthermore, the wind tunnel effect between the two towers can be mitigated through adjusted opening orientations or the addition of wind-breaking elements.

Overall, the CFD simulation demonstrates that the mass configuration of PAX Tower Apartment significantly influences wind speed distribution and airflow patterns across the site. Integrating these findings into the design supports the concept of An Approach to Energy Efficient Through Façade, aimed at reducing dependence on mechanical cooling, enhancing thermal comfort, and creating a healthy, energy-efficient, and user-friendly environment. Through this approach, PAX Tower Apartment serves not only as a visual landmark in the city but also as an example of sustainable façade design informed by scientific data.

Chapter 06

Design Reflection

Supervisor
Prof, Noor Cholis Idham, ST., M.Arch., Ph.D., IAI

Notes:
- *The proof for energy efficiency needs more elaboration and explorations.*

Examiner 01
Johanita Anggia Rini, S.T., M.T., Ph.D

Notes:
- *dilengkapi agar layak lulus.*

Examiner 02
Ir. Hanif Budiman, M.T., Ph.D

Notes:
- *The detail of facade techinally and systematically should be draw as a design approach for this case.*

OTTV CALCULATION

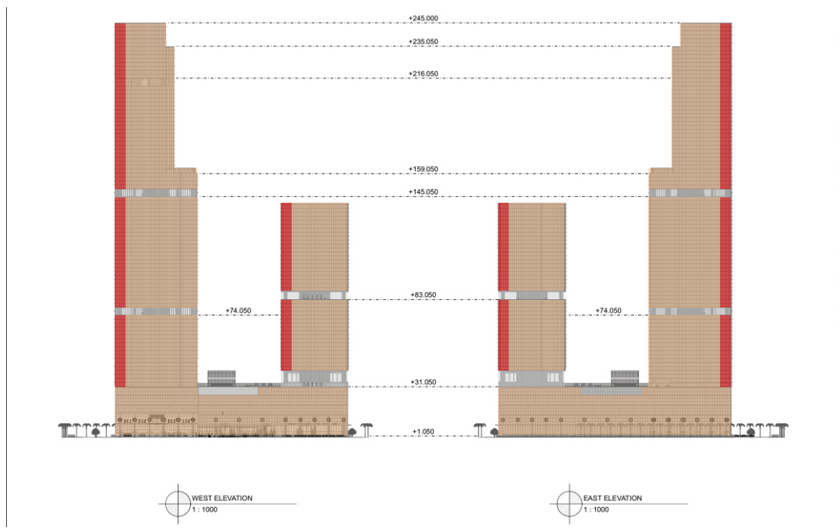
The proof for energy efficiency needs more elaboration and explorations.

Based on the feedback above, the author will provide further evidence that this building can achieve energy efficiency through the calculation of the Overall Thermal Transfer Value (OTTV). OTTV is a widely recognized method used to evaluate the thermal performance of building envelopes, particularly in tropical climates such as Jakarta. By analyzing the heat transfer that occurs through external walls, windows, and glazing systems, OTTV provides a quantitative measure of how effectively the façade design reduces heat gain and, consequently, lowers cooling loads. This calculation not only demonstrates the role of passive design strategies such as the use of high-performance glass and shading devices but also provides evidence that the building's façade contributes significantly to minimizing energy consumption. Therefore, the application of OTTV in this study serves as an objective tool to validate the building's energy-efficient performance and ensures that the design meets contemporary sustainability standards.

OTTV calculations were performed on apartment buildings because they utilize artificial ventilation, as required by OTTV regulations. The PAX Tower Apartment design utilizes a building envelope. Curtain walls made of double-glazed glass are found on each side of the building, and louvres connected to the curtain walls provide shading and protection from direct sunlight. Aluminum louvers are also used around the building to block direct sunlight. A section of the material used can be seen in the following image:

FASAD MASIF	ARRANGEMENT
ALUMINUM	OUTDOOR AIR SPACE ALUMINUM MESH INDOOR AIR SPACE
BRICKS	OUTDOOR AIR SPACE WHITE PLASTER BRICKS INDOOR AIR SPACE
CONCRETE	OUTDOOR AIR SPACE WHITE PLASTER BRICKS INDOOR AIR SPACE
TRANSPARENT FACADE	
DOUBLE GLAZING	Double Glazing Unit (DGU / IGU – Insulated Glass Unit) 6 mm (outer) + 12 mm spacer + 6 mm (inner)
TRIPLE GLAZING	Triple Glazing Unit (TGU) high-performance silver-blue glass cladding 6 mm + 12 mm + 6 mm + 12 mm + 6 mm

Table 6.1 OTTV Caltulation
Source: *Author,2025*



	REKAP NILAI OTTV			
JENIS KACA	GLASS CONDUCTION			
Double Glazing (West)	SC	WWR	SF	SC x (WWR) x SF
Double Glazing (North)	0,23	0,332725615	243	18,59603464
Triple Glazing (East)	0,23	1,176079734	130	33,6358804
Triple Glazing (East)	0,23	0,43817527	243	23,42484994
Double Glazing (South)	0,22	0,256007394	112	6,308022181

	REKAP NILAI OTTV			
JENIS KACA	GLASS RADIATION			
Double Glazing (West)	Uf	WWR	AT	Uf x (WWR) x AT
Double Glazing (North)	2,94	0,98	5	14,406
Triple Glazing (East)	1,046353458	0,03	5	0,156953019

Table 6.2 Calculation of glass conduction
Source: *Author,2025*

	REKAP NILAI OTTV		
BIDANG SISI	LUAS BIDANG	OTTV PARSIAL	LUAS BIDANG X OTTV PARSIAL
WEST SIDE (CURTAIN WALL)	1097	33,19437621	36414,23071
WEST SIDE (BRICKS)	833	16,50355526	13747,4593
WEST SIDE (ALUMINUM)	1149	19,03098976	21866,60723
SOUTH SIDE (CURTAIN WALL)	368	41,30963409	15201,94535
SOUTH SIDE (ALUMINUM)	858,6	46,23538919	39697,70516
EAST SIDE (BRICKS)	1082	25,83211885	27950,3526
NORTH SIDE (BRICKS)	953	43,83141079	41771,3349
EAST SIDE (CURTAIN WALL)	602	48,23422197	29037,00163
TOTAL	7707,6	314,530035	256560,7678
OTTV VALUE		33,2867258	

Table 6.3 OTTV calculation recap
Source: *Author,2025*

On the facade of the apartment tower, the author used a curtain wall mullion frame and triple glazing as a strategy to minimize the building's OTTV value. Previously, the OTTV value was 40 W/m2.
After using the curtain wall mullion frame and triple glazing, the building's OTTV value became 32.3 W/m2.

FASAD MASIF	ARRANGEMENT
ALUMINUM	OUTDOOR AIR SPACE ALUMINUM MESH INDOOR AIR SPACE
BRICKS	OUTDOOR AIR SPACE WHITE PLASTER BRICKS INDOOR AIR SPACE
CONCRETE	OUTDOOR AIR SPACE WHITE PLASTER BRICKS INDOOR AIR SPACE
TRANSPARENT FACADE	
DOUBLE GLAZING	Double Glazing Unit (DGU / IGU – Insulated Glass Unit) 6 mm (outer) + 12 mm spacer + 6 mm (inner)
TRIPLE GLAZING	Triple Glazing Unit (TGU) high-performance silver-blue glass cladding 6 mm + 12 mm + 6 mm + 12 mm + 6 mm

	REKAP NILAI OTTV			
JENIS KACA	GLASS CONDUCTION			
Double Glazing (West)	SC	WWR	SF	SC x (WWR) x SF
Double Glazing (North)	0,23	0,332725615	243	18,59603464
Triple Glazing (East)	0,23	1,176079734	130	33,6358804
Triple Glazing (East)	0,23	0,43817527	243	23,42484994
Double Glazing (South)	0,22	0,256007394	112	6,308022181

	REKAP NILAI OTTV			
JENIS KACA	GLASS RADIATION			
Double Glazing (West)	Uf	WWR	AT	Uf x (WWR) x AT
Double Glazing (North)	2,94	0,98	5	14,406
Triple Glazing (East)	1,046353458	0,03	5	0,156953019

	REKAP NILAI OTTV		
BIDANG SISI	LUAS BIDANG	OTTV PARSIAL	LUAS BIDANG X OTTV PARSIAL
WEST SIDE (CURTAIN WALL)	1097	33,19437621	36414,23071
WEST SIDE (BRICKS)	833	16,50355526	13747,4593
WEST SIDE (ALUMINUM)	1149	19,03098976	21866,60723
SOUTH SIDE (CURTAIN WALL)	368	41,30963409	15201,94535
SOUTH SIDE (ALUMINUM)	858,6	46,23538919	39697,70516
EAST SIDE (BRICKS)	1082	25,83211885	27950,3526
NORTH SIDE (BRICKS)	953	43,83141079	41771,3349
EAST SIDE (CURTAIN WALL)	602	48,23422197	29037,00163
TOTAL	7707,6	314,530035	256560,7678
OTTV VALUE		33,2867258	

Facade System and Details

The detail of facade techinally and systematically should be draw as a design approach for this case.

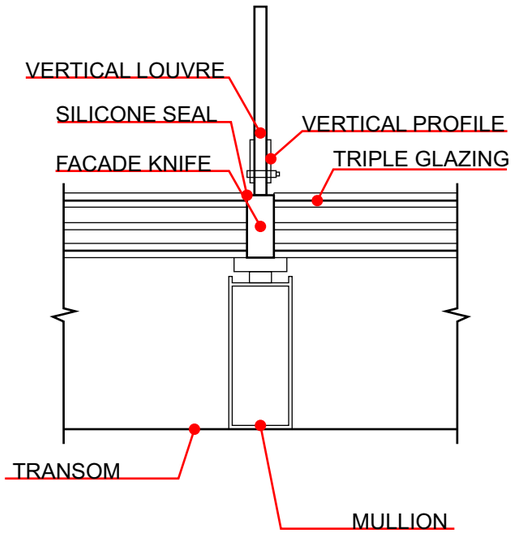


Figure 6.1.1 Building envelope section (1)
Source: *Author,2025*

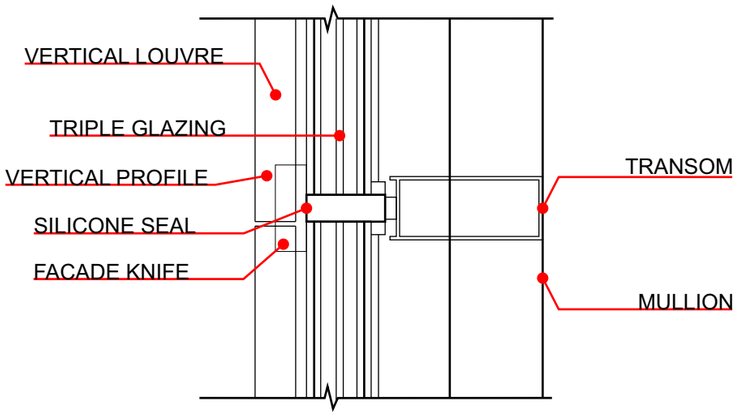


Figure 6.1.2 Building envelope section (2)
Source: *Author,2025*

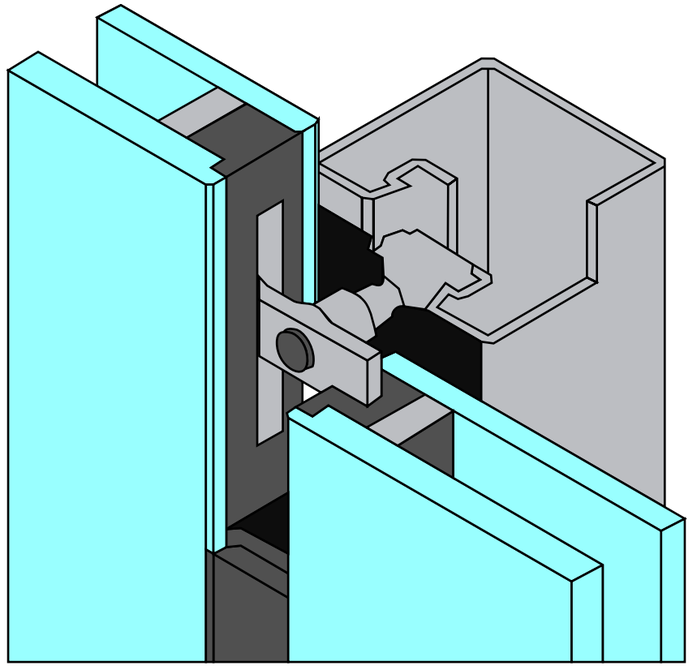


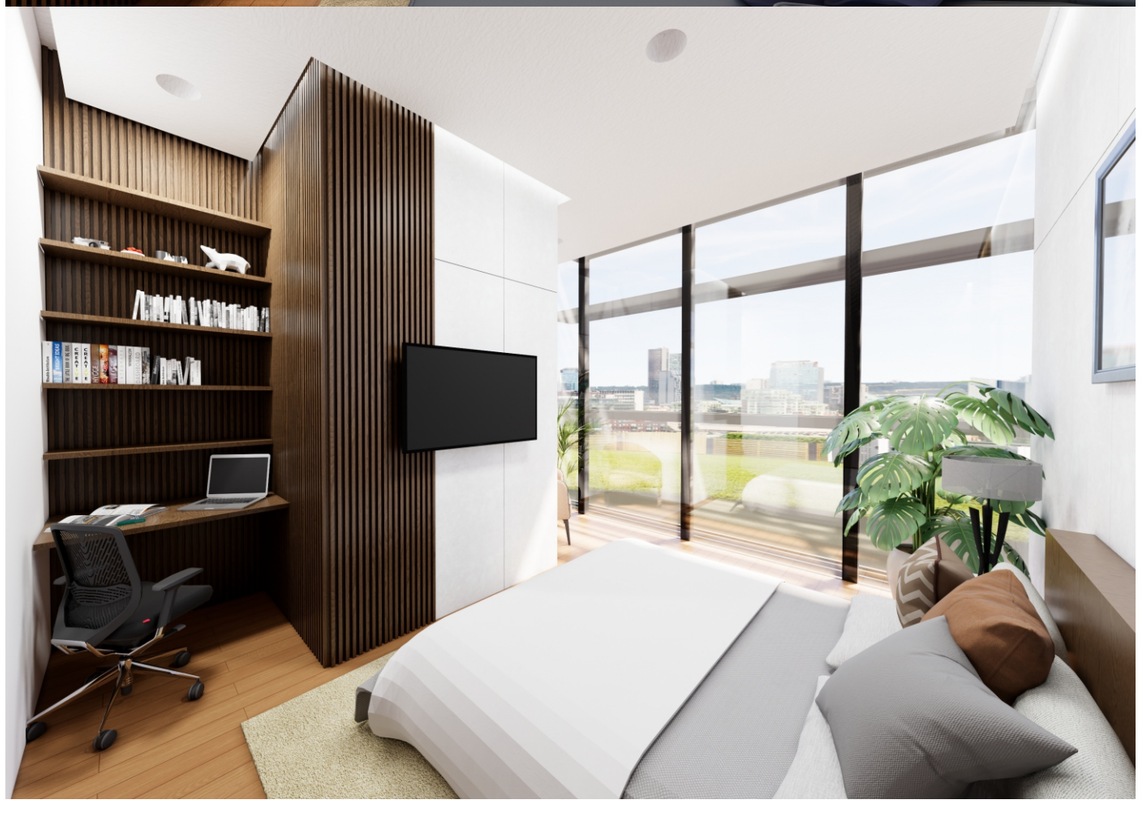
Figure 6.1.3 Building envelope scheme
Source: *Author,2025*

This detail illustrates a curtain wall system, specifically a stick or unitized curtain wall assembly that uses aluminum mullions and structural glazing. The glass panels, which may consist of tempered, laminated, or insulated glazing units, serve as the transparent envelope of the building. These panels are supported by vertical aluminum mullions that transfer both dead loads and wind loads to the main building structure, while also providing durability and resistance to corrosion. Mechanical brackets and connectors fix the glazing support to the mullions, ensuring stability while still allowing for structural movement due to thermal expansion, wind sway, or seismic forces. Pressure plates, combined with gaskets, securely hold the glass panels in place and provide airtight and watertight performance. Cover caps are often added to conceal fasteners and enhance the facade's appearance. The gasket and sealant layers contribute further to weatherproofing, thermal insulation, and acoustic control. Overall, this curtain wall system functions as a non-load-bearing façade that enhances transparency and daylight penetration while maintaining structural safety, environmental protection, and architectural aesthetics.

VISUALIZATON









VISUALIZATON





VISUALIZATON



PAX TOWER APARTMENT

AN APPROACH TO ENERGY EFFICIENT THROUGH FACADE

PAX comes from the Latin word for “peace” or “serenity”. In Roman history, Pax was the goddess of peace a symbol of an era of stability and prosperity (Pax Romana). This philosophy serves as the main inspiration for the design of PAX Tower Apartment bringing tranquility into daily life amidst the vibrant energy of Jakarta. Its architecture radiates harmony, with two towers standing side by side like twin pillars of peace, supporting a modern lifestyle that values quality of life, privacy, and calmness. PAX Tower Apartment emerges as a new symbol of Jakarta seamlessly blending modern lifestyles with sustainable design innovation. Adopting the concept of An Approach to Energy Efficient Through Facade, every detail of the façade is designed not only to enhance aesthetics but also to perform controlling sunlight, optimizing airflow, and reducing energy loads, ensuring the building operates efficiently while maintaining maximum comfort for its occupants.

“Live in Peace, Live in PAX.”



BACKGROUND

The energy mostly used by a building, and most of building with the high capacity energy is building in city, and building in city using energy is high-rise building. The population in Jakarta increase by 5% each year. PAX Tower Apartment is a high-rise commercial residential design concept that focuses on energy efficiency through facade design. This project aims to reduce energy consumption while improving the performance of high-rise buildings in dense urban environments.

Indonesia has experienced rapid economic growth over the past five decades, ranking among the top economies in Asia. This growth has led to increased energy consumption, particularly in the industry, transport, and building sectors, which has significantly contributed to CO_2 emissions. In fact, Indonesia is the ninth-largest emitter of CO_2 from fuel combustion globally.
The energy demand in Indonesia is projected to change dramatically by 2060. Fossil fuel dependency, which accounted for around 70% of total energy demand in 2021, is expected to decline to about 50% by 2060 as the country transitions toward renewable energy. The use of natural gas, bioenergy, and electricity is predicted to rise substantially, particularly in the transport and buildings sectors, as energy efficiency measures and decarbonization policies take effect.

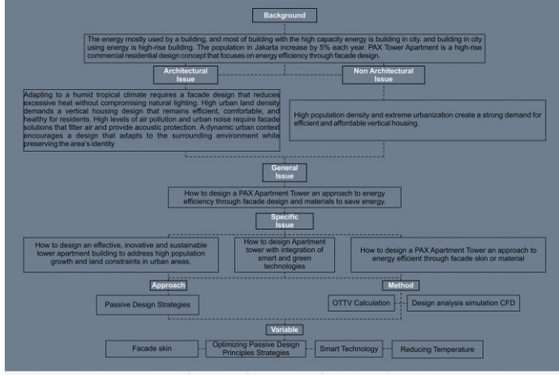
Economic growth in Indonesia is expected to remain strong, with total GDP projected to rise significantly by 2060, reaching levels comparable to advanced economies by mid-century. This growth, however, will require substantial efforts to balance energy demand and sustainability. To meet climate targets, energy efficiency measures and the adoption of low-carbon energy sources, such as renewables and hydrogen-based fuels, are essential.
eventually, Indonesia's future energy landscape will be shaped by its ability to implement sustainable policies, improve efficiency, and reduce dependence on fossil fuels while maintaining economic growth and urban development. With the facts and background above, the author chose the topic of designing the facade of a high-rise building in order to make the building more energy efficient.

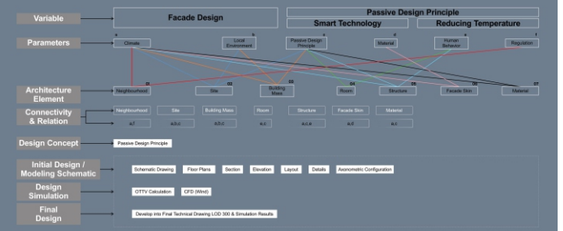
SITE LOCATION

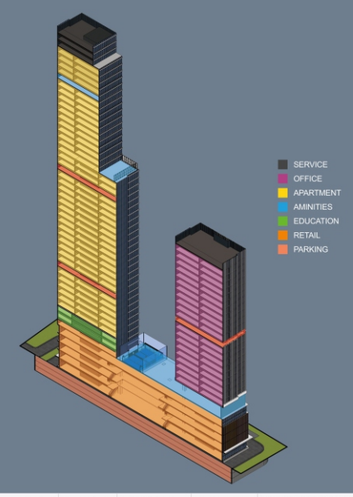
Jakarta is the capital city of Indonesia, experiencing rapid growth and development across various fields and sectors. Central Jakarta holds a strategic role as the center of government, economy, and transportation within both DKI Jakarta and Indonesia as a whole. This area is home to several important national institutions such as the Presidential Palace, the National Monument (Monas), and various government ministry offices, making it the administrative and political heart of the country. In addition, Central Jakarta is part of the Golden Triangle area, which serves as a hub for elite business and office centers, with numerous high-rise buildings, banks, and multinational company offices located along the Thamrin–Sudirman corridor. With excellent accessibility through public transportation such as KRL (commuter rail), MRT, and TransJakarta, the area functions as a major mobility node in the capital. Due to its highly strategic location and limited land availability, Central Jakarta has also experienced rapid vertical housing development to meet the growing demand for residences, especially among the urban workforce. This has led to a continuous influx of people from other regions seeking job opportunities in Jakarta, resulting in a steadily increasing population each year. Seeing this, the business potential for vertical housing such as apartments has become increasingly promising. The number of apartments in Jakarta is estimated to approach 200,000 units a figure that is still relatively small compared to Jakarta's population, which is nearing 25 million people.



DESIGN FRAMEWORK



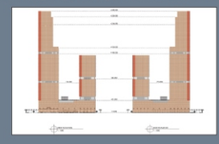


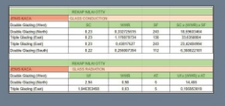


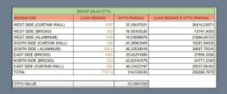
SIMUALTION - (OTTV CALCULATION)

On the facade of the apartment tower, the author used a curtain wall mullion frame and triple glazing as a strategy to minimize the building's OTTV value. Previously, the OTTV value was 40 W/m2. After using the curtain wall mullion frame and triple glazing, the building's OTTV value became 32.3 W/m2.

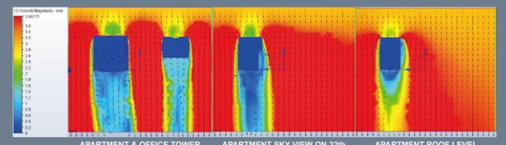








SIMULATION - (CFD)



APARTMENT & OFFICE TOWER LEVEL | APARTMENT SKY VIEW ON 32th Floors | APARTMENT ROOF LEVEL

The Computational Fluid Dynamics (CFD) simulation for PAX Tower Apartment was conducted to analyze airflow behavior around the building complex, which consists of a podium serving as a retail area. Tower 1 as a residential apartment, and Tower 2 as an office building. The primary objective of this analysis is to optimize the façade's performance as part of an energy efficiency strategy through the utilization of natural ventilation, heat control, and improved thermal comfort. The simulation results reveal variations in wind velocity illustrated through a color gradient. Dark blue zones (0–0.4 m/s) indicate areas with very low or nearly stagnant wind speeds, typically located behind the building masses due to the wind shadow effect. Green to yellow zones (1–2 m/s) represent moderate wind speeds, generally found along building sides or within gaps between the towers. Meanwhile, red zones (>3 m/s) indicate areas with high wind speeds, occurring in open spaces without obstructions or on building façades directly exposed to prevailing winds.

The findings from this analysis have direct implications for façade design and outdoor space planning. Façade openings can be optimized in areas with moderate wind speeds to maximize natural ventilation without creating excessive indoor air pressure. Façades in stagnation zones require additional shading or screening elements to reduce heat gain from solar radiation. Amenities such as the sky garden, gym, and padel court are positioned on the podium rooftop in areas with moderate airflow to ensure user comfort. Furthermore, the wind tunnel effect between the two towers can be mitigated through adjusted opening orientations or the addition of wind-breaking elements.

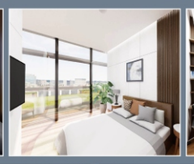
Overall, the CFD simulation demonstrates that the mass configuration of PAX Tower Apartment significantly influences wind speed distribution and airflow patterns across the site. Integrating these findings into the design supports the concept of An Approach to Energy Efficient Through Façade, aimed at reducing dependence on mechanical cooling, enhancing thermal comfort, and creating a healthy, energy-efficient, and user-friendly environment. Through this approach, PAX Tower Apartment serves not only as a visual landmark in the city but also as an example of sustainable façade design informed by scientific data.

PLANNING CONCLUSION - PAX Tower Apartment

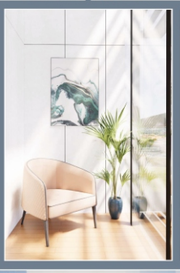
The PAX Tower Apartment project successfully integrates the concept of An Approach to Energy Efficiency Through Facade by applying facade design strategies responsive to the tropical climate of Jakarta. The use of elements such as horizontal louvers, vertical louvers, perforated panels, and durable materials has proven effective in reducing solar heat gain, maximizing natural daylight, and improving indoor air circulation.Facade performance simulations indicate a significant potential for energy savings, particularly in cooling and lighting systems, without compromising occupant comfort or the building's aesthetic value. This approach also strengthens the modern architectural identity while aligning with sustainability principles.Looking ahead, this concept can serve as a model for the development of vertical residential projects in hot-humid urban environments. Future development will focus on optimizing facade design through Computational Fluid Dynamics (CFD) analysis and integrating smart building technologies to further enhance long-term energy performance.

VISUALIZATION

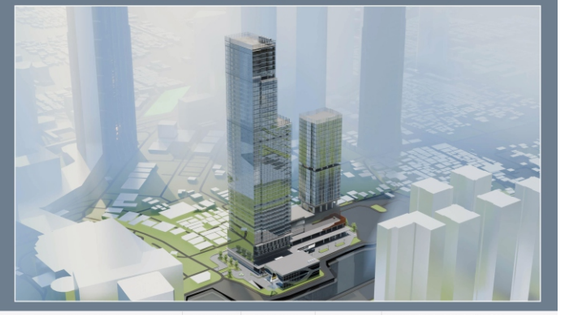






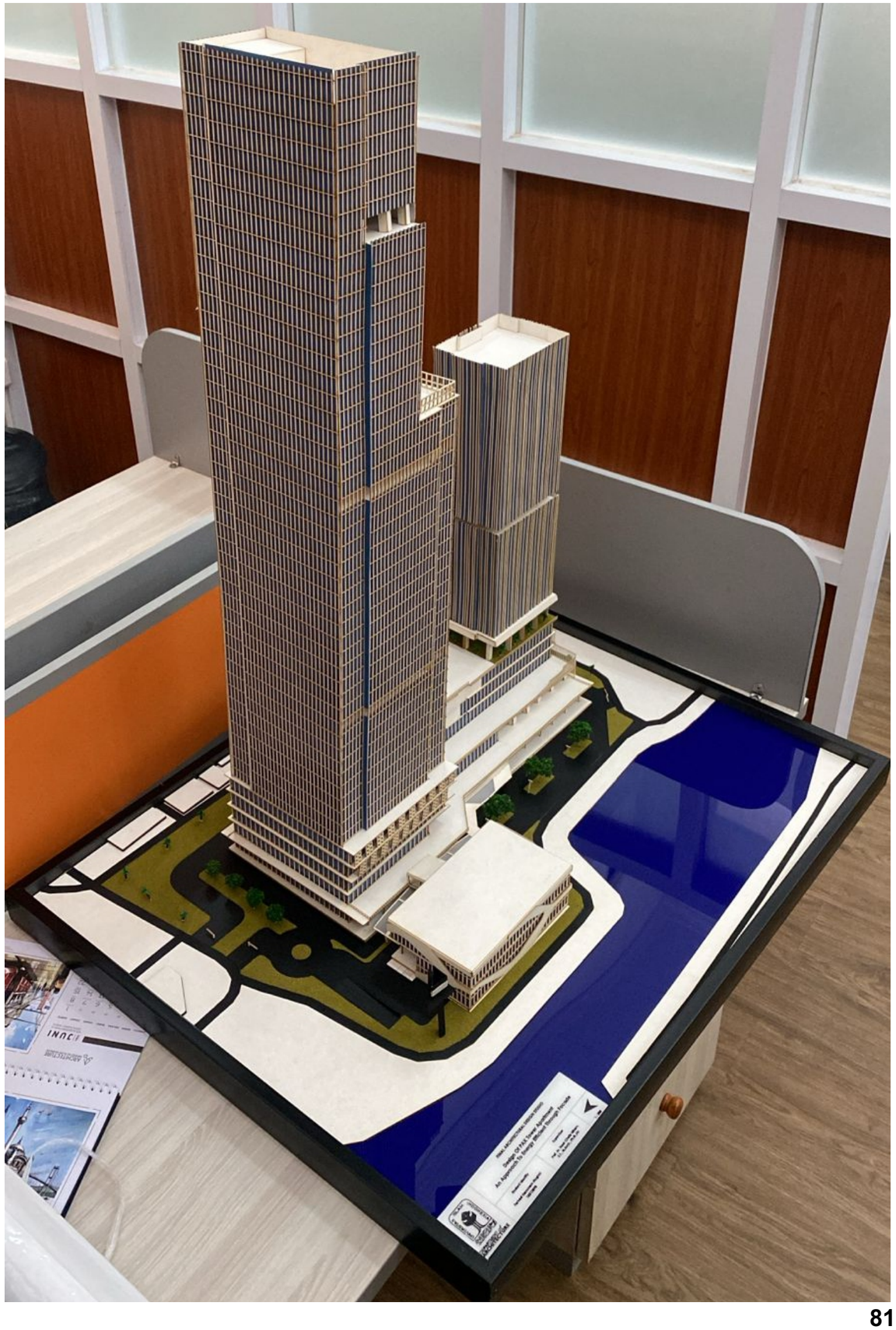






MAQUETTE





Direktorat Perpustakaan Universitas Islam Indonesia
Gedung Moh. Hatta
Jl. Kaliurang Km 14,5 Yogyakarta 55584
T. (0274) 898444 ext.2301
F. (0274) 898444 psw.2091
E. perpustakaan@uii.ac.id
W. library.uii.ac.id

SURAT KETERANGAN HASIL CEK PLAGIASI
Nomor: 2734633245/Perpus./10/Dir.Perpus/VII/2025

Bismillaahirrahmaanirrahiim

Assalamualaikum Wr. Wb.

Dengan ini, menerangkan Bahwa:

Nama	: Farhad Hammam Mughni
Nomor Mahasiswa	: 18512090
Pembimbing	: Prof, Noor Cholis Idham, ST., M.Arch., Ph.D., IAI
Fakultas / Prodi	: Teknik Sipil dan Perencanaan/ Arsitektur
Judul Karya Ilmiah	: PAX Apartemen Tower Dengan Pendekatan Efisiensi Energi Melalui Fasad

Karya ilmiah yang bersangkutan di atas telah melalui proses cek plagiasi menggunakan **Turnitin** dengan hasil kemiripan (*similarity*) sebesar **4 (Empat) %.**

Demikian Surat Keterangan ini dibuat untuk dapat dipergunakan sebagaimana mestinya.

Wassalamualaikum Wr. Wb.

Yogyakarta, 8/25/2025
Direktur

UNIVERSITAS ISLAM INDONESIA
DIREKTORAT PERPUSTAKAAN
YOGYAKARTA

Muhammad Jamil, SIP.

Reference

Hendrawan, A. S., Nugroho, S., & Firmandhani, S. W. (2020). Apartemen di Jakarta Selatan dengan desain berbasis green building. Jurnal Arsitektur Berkelanjutan, 12(2), 45-56. Jurnal Poster Pirata Syandana.

Ihara, T., Gustavsen, A., & Jelle, B. P. (2015). Effect of facade components on energy efficiency in office buildings. Applied Energy, 158, 422-432.

Archilogue 2021 : Skyscraper (Anila Pramesti - Thamrin Nine).
https://www.youtube.com/watch?v=0v4JnRsVFrw.

Autograph and Luminary Towers Waldorf Astoria Jakarta at Thamrin Nine.
https://www.kpf.com/project/thamrin-nine.

Transforming Cities, Shaping the Future.
https://meinhardtgroup.com/.

When you are redefining possibilities and pushing the limits on what is feasible, you need to work with the best. Supertall buildings require creative solutions to complicated wind, environmental, and design challenges.
https://rwdi.com/en_ca/.

This Building Saves Energy with a Pioneering Triple-Layer Glass Facade.
https://www.archdaily.com/869374/this-building-saves-energy-with-a-pioneering-triple-layer-glass-facade/58b2ccf1e58ece4cd100042d-this-building-saves-energy-with-a-pioneering-triple-layer-glass-facade-photo?next_project=no.

Yeang, Ken. (1999). The Green SkyCraper: The Basic for Sustainable Intensive Buildings. Munich: Prestel.

Chiara, J. (1986). Time Saver Standards for Building Types. New York: McGraw Hill.

Crosbie, Michael. (1981). Green Architecture: A Guideto Sustainable Design. Rockport Massachusetts: Rockport Publisher.

Karyono, Tri Harso. (2010). Green Architecture: Pengantar Pemahaman Arsitektur Hijau di Indonesia. Jakarta: Djambatan.

International Energy Agency (IEA). (2022). An Energy Sector Roadmap to Net Zero Emissions in Indonesia. IEA.
https://www.iea.org/reports/an-energy-sector-roadmap-to-net-zero-emissions-in-indonesia

Pressman, Andrew. (2012). *Designing Architecture: The Element of Process*. Routledge, New York.

https://archello.com/project/sequis-tower

Ministry of Energy and Mineral Resources. (2022)

Moussavi, F., & Kubo, M. (2006). The function of ornament. Barcelona: Actar.

Knaack, U., Klein, T., Bilow, M., & Auer, T. (2007). Principles of construction: Facades. Basel: Birkhäuser.

American Society of Civil Engineers. (2013). Guidelines for condition assessment of the building envelope (ASCE Standard 30-14). Reston, VA: American Society of Civil Engineers.

Spectus Windows. (n.d.). Triple glazing. Spectus Window Systems. Retrieved August 21, 2025, from https://www.spectus.co.uk/trade/products/triple-glazing/.

Brookes, A. J., & Grech, C. (1992). The building envelope: Applications of new technology cladding. Oxford: Butterworth-Architecture.

McLeod, V. (2007). Detail in contemporary glass architecture. London: Laurence King Publishing.

Schittich, C. (Ed.). (2006). Building skins: Concepts, layers, materials. New enlarged edition. Basel: Birkhäuser – Publishers for Architecture.

Watts, A. (2019). Modern construction envelopes: System for architectural design and prototyping (3rd ed.). Basel: Birkhäuser.

Herzog, T., Krippner, R., & Lang, W. (2004). Facade construction manual. Basel: Birkhäuser – Edition DETAIL.

Sidi, I. D., Budiono, B., & Haez, E. K. (2019). Development of risk-based performance-based design for super tall building in Indonesia. Proceedings of the International Conference on Civil Engineering and Disaster Management (ICCEDM 2019). Bandung: Institut Teknologi Bandung (CIBE).