paghábi

A MUTLTI-FAMILY DWELLING

About the Project

In response to the demand for urban residential spaces, cities have been revising land uses toward increasing residential densities. This project aims to design a multifamily housing project that will respond to the challenges of residential comfort and urban density.

Its objectives include: (1) adapting into the design the application of passive cooling, natural daylighting, and other climate-appropriate features; (2) Integrating conceptual structural, electrical, plumbing, mechanical, and waste disposal systems into the design: (3) providing safety, security, and privacy for all the users.

Design Concept

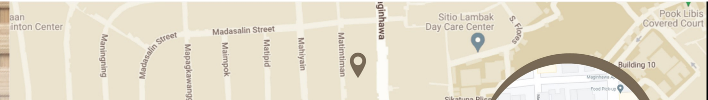
Pagháb i is a multi-family dwelling that is essentially inspired by the Filipino woven basket. It is wrapped around by several solar shading devices that emulate the form of a bayong. The crisscrossing vertical and horizontal patterns are deconstructed to form separate groups of louvers perpendicular and parallel to the ground. This building skin serves as the focal point of its entire exterior.

Pagháb i aims to provide a space for dwelling for people of various demographics, **interweaving** concepts of **sustainability, tropical architecture, and communalism.**

Figure 1. Bayong weaving patterns.

tropical
sustainable
communal

JEAN EDSEL GONZALBO ARCH 32&55



About the Site

The Site is surrounded by a residential neighborhood and scattered food hubs. Parallel to Matimtiman Street from the east side is the famous food trip and gastronomical destination, the **Maginhawa Street**. Several cafes and food parks are situated around the vicinity, this gives the site a **walkability score: of 98%.**

In a closer look, one can notice that the site is located along a street that is comprised of more residential units than commercial ones.

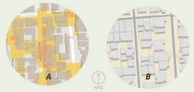
Figure 2. The Neighborhood Context.

Micro-climatic Considerations on Site

Topography & Water

The site is relatively flat. It is gently sloping down towards the street.

Figure 3. Site Topography.



A. This Project NOAH map shows how the site has **MEDIUM** hazard for flooding, and little to no hazard for storm surge and landslide.

B. Geoportal PH also shows how the site is relatively flat. No major contour line passes through the lot.

On WATER: no existing body of water that can affect the microclimate of the site.

Figure 4. Site Topography via Online Mapping utilities

Surrounding Structures

Left side of the site. Right side of the site.

The directly adjacent house to the left has 2 storeys, and is built through light-frame construction and only the first floor is made of concrete. The directly adjacent house to the right has 1 floor and is made completely of concrete.

Figure 5. Photo showing the Street Layout and **Density of Development.**

Site Vegetation

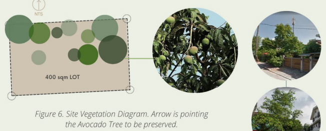
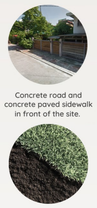


Figure 6. Site Vegetation Diagram. Arrow is pointing the Avocado Tree to be preserved.

There is present vegetation on site featuring several trees, and an avocado tree that has to be preserved at the rear of the property situated approximately at the centerline.

Photos of the exterior of the site, via Google Maps

Ground Surfaces on Site



Concrete road and concrete paved sidewalk in front of the site.

Unpaved soil that allows for site vegetation inside the lot.

Soil Bearing Capacities in Quezon City

Figure 7. Photo of Guadalupe Volcanic Tuff

The surface geology of Quezon City is reported as tuff, it can be generalized that the city is mostly made up of rocks. It is in this premise that the estimated soil bearing capacities in the different areas in Quezon city are relatively high.

High-rise buildings can be easily built in the area without many struggles in the foundation design. Because of this, settlement in the said area can be considered minimal, thus, structures can be built confidently to resist such phenomena (Dungca, 2020).

Micro-climatic Elements on Site

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16a)	(16b)
MONTH	RAINFALL		TEMPERATURE						VAPOR PRESS. (mbs)	RH (%)	MSLP (mbs)	WIND		CLOUD AMT. (okta)	NO. OF DAYS W/	
	AMOUNT (mm)	NO. OF RD	MAX (°C)	MIN (°C)	MEAN (°C)	DRY BULB (°C)	WET BULB (°C)	DEW POINT (°C)				DIR (16pt)	SPD (mps)		TSTM	LTNG
JAN	27.1	4	30.6	21.4	26.0	25.5	22.4	21.1	24.9	77	1012.6	N	1	5	2	1
FEB	24.4	3	31.5	21.5	26.5	26.1	22.4	20.9	24.6	73	1012.5	NE	1	5	1	0
MAR	32.9	4	32.9	22.6	27.8	27.5	23.1	21.4	25.3	70	1011.6	SE	1	4	2	1
APR	41.7	5	34.6	24.1	29.4	29.1	24.3	22.5	27.1	68	1010.1	SE	1	4	4	2
MAY	211.9	12	34.4	25.1	29.8	29.4	25.3	23.9	29.6	73	1008.9	SE	1	5	14	7
JUN	322.7	17	33.1	25.0	29.1	28.6	25.5	24.5	30.5	79	1008.5	SW	1	6	15	9
JUL	516.6	21	31.8	24.5	28.2	27.6	25.2	24.4	30.5	83	1007.9	SW	1	6	17	8
AUG	568.5	21	31.2	24.6	27.9	27.4	25.3	24.5	30.7	85	1007.8	SW	1	7	16	7
SEP	500.3	21	31.5	24.4	27.9	27.4	25.2	24.4	30.5	84	1018.0	SW	1	6	17	8
OCT	283.6	15	31.7	23.9	27.8	27.2	24.7	23.9	29.5	82	1009.1	N	1	6	10	5
NOV	141.4	12	31.6	23.2	27.4	26.8	24.1	23.1	28.3	81	1010.4	N	1	5	6	2
DEC	114.5	8	30.7	22.4	26.6	26.0	23.2	22.1	26.6	80	1011.4	N	1	5	2	1
ANNUAL	2,785.6	143	32.1	23.6	27.8	27.4	24.2	23.1	28.2	78	1010.7	N	1	5	106	51

In order to understand the microclimatic elements of the site, there is a need for the **climatological normals** of its location. These are the **data** from the nearest weather station (PAGASA Science Garden) of the site, from **1991 - 2020.**

Table 1. Climatological normals of the site.

Air Temperature

- Hottest in **MAY**: with **29.8 °C** Mean Temperature and **29.4 °C** Dry Bulb Temperature
- Annual Mean Temperature is **27.8 °C**
- Annual Dry Bulb Temperature is **27.4 °C**

Atmospheric Humidity

- Relative Humidity - **78% (ANNUAL)** - it is the ratio of the amount of water vapor actually in the air to the maximum amount the air can hold at that temperature
- Highest Relative Humidity in **AUGUST** with **85% RH**

Precipitation

- Highest number of rainy days during the months of JULY, AUGUST, and SEPTEMBER: **21 rainy days.** These are during the monsoon season.
- Lowest number of rainy days during the month of **FEBRUARY.**
- Annual number of rainy days is **143 days.**

Sun Path

This shows the daily and seasonal arc-like path that the Sun appears to follow across the sky as the Earth rotates and orbits the Sun. The rear side of the site faces the East will receive the early morning sun. The afternoon sun will hit the front side of the site facing the South and West.

Prevailing Wind Direction

The Southwest prevailing winds are observed during the monsoon season, with a speed of 1 m/s. Southeast winds are more frequently observed from March to May. In an annual scale, Northern winds are the most frequently observed direction, with a speed of **1 m/s** as well.

These data also tell us that the **average monthly and annual wind speed** in this location is **1 m/s.**

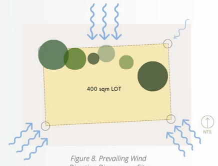


Figure 8. Prevailing Wind Direction Diagram on Site

Average monthly hours of sunshine in Quezon City

On average, **April** is the most sunny month with **261 hours of sunshine.** September has on average the lowest amount of sunshine with **132 hours.**

The average annual amount of sun hours is: **2110 hours.**

Figure 9. Sun Path on Site.

These data and observations reflect the tropical characteristics of the site's climate and micro-climate. These figures suggest that there is a need for tropical design strategies or interventions.

Strengths, Weaknesses, Opportunities, and Threats Found in Site

Strengths

- The lot is generally flat, suitable for building construction.
- Water flows outwards the lot
- Good shading from present trees
- Wind coming from all sides of the site depending on season.

Weaknesses

- Has medium hazard for flooding
- Has symptoms of Soil Erosion

Opportunities

- Proximity to different amenities in the neighborhood, may complement this by providing services that are not yet available in the vicinity.

Threats

- Density of development: concrete houses next to each other may affect the ambient temperature of the site.
- Has only one (1) drainage outside the site.
- Noise from the road and from the neighborhood.

Site Utilities and Circulation

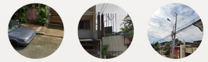


Figure 10. Actual photos of the drainage and electrical posts surrounding the site.

The positioning of the drainage is in line with the slope characteristic of the site. The water flow goes directly to the street drainage. However, just one drainage outside the site does not seem to be enough because there are traces of flooding outside.

Pedestrian & Vehicular Access

The site has direct access for pedestrians from the street it is facing in the west side, Matimtiman Street. There are no public transportation routes like for jeepneys that pass along Matimtiman Street, except for the barangay toda. Private vehicles are mostly seen along this street.

Sewage

Barangay Teacher's Village is tapped to the East Avenue Sewage Treatment Plant.

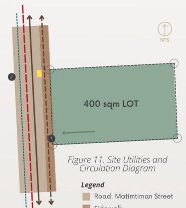


Figure 11. Site Utilities and Circulation Diagram

Sensory Analysis

Visual

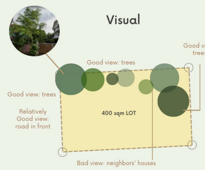


Figure 12. Sensory Diagram for Good and Bad Views

Majority of the **good views** are seen on the north side, north-west side, and north-east side of the site where the greenery is located.

Auditory and Olfactory

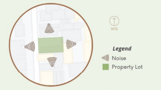


Figure 13. Sensory Diagram for Smell

Noise
North, South, and East sides are prone to noise because of its proximity to neighboring houses. West side would experience noise form the road.

Smells can also originate from the same directions of these noises: the neighborhood from the north, south, and east sides, and pollution from the road on the west side.

Demographics

Student users at college level, under a parent or legal guardian, who have a monthly allowance of Php 18000.00 (De La Salle University, n.d).

Needs:

- Study spaces that are conducive for flexible learning setups.
- Dwelling spaces that can accommodate the lifestyles of university students.

Middle class single users in Quezon City who have an average monthly income of Php 54,100.00 (Salary Explorer, n.d).

Needs:

- Spaces that are conducive for flexible working setups.
- Dwelling spaces that can accommodate the lifestyles of a middle class individual living in solitude.

A **middle class family unit** that earns Php 60,248.50 monthly (Adrian, 2021).

Needs:

- Spaces that are conducive for both flexible working and learning setups.
- Dwelling spaces that can accommodate the lifestyles of a middle class family living as a single unit.

Legal Codes Size and Zoning

Size

- 16m by 25m
- 400 square meters

Zoning Classification

- Medium Density Residential Zone (R-2)

Road Right-of-Way (RROW)

- Matimtiman Street, Teacher's Village, Quezon City
- 7.8 meters + 2 meters (both sidewalks)

Setbacks

- 3 meters in width along the entire length of its property line adjoining an R1 and R-1A district.

Building Height Limit (BHL)

- Not exceed twenty one (15) meters or five (5) storeys

Allowable PSO

- 60% without Firewall at 240 sq. m.
- 70% with Firewall at 280 sq. m.

Site Isometric Views

Development Cost

AREA/SPACE	SPACE FACTOR
Typical Floor (fully enclosed space)	1.00
Auditorium	1.50
Balcony	0.40
Canopy Entrance	0.45
Lobby and Lofty Space	1.50
Basement	1.00
On-stilt	0.55
Covered Areas (partially walled space)	0.60
Stairs	1.25
Toilets	2.00
Kitchen, Kitchenettes	1.25
Media-Agua	0.25
AHU Rooms, Electrical Rooms	0.70
Deck Terrace (with waterproofing)	0.35
Interstitial space less than 1.50 m	0.35
more than 1.50 m	0.70
Open Terrace (no roof)	0.30
Ramp	0.70
Parking Area	0.60
Elevator Shaft	0.50
Cistern	0.70
Light well	0.25

Table 2. Space factors to be used in estimating by area (UAP, n.d.).

To develop a budgetary estimate, this project will be using the **per square meter method with space factor.** In order to arrive at an accurate cost per square meter, a building's spaces and its appendages should be converted into their equivalent values in relation to the predominant enclosed space. Provided here is the **United Architects of the Philippines' space factor table** that should be used in computing for the costs.

For the purposes of this project, the estimated unit cost shall be **Php25 000, per square meter,** based on the conducted market analysis.

Dwelling Unit 1 – Family Dwelling

General Space	Area	Space Factor	Unit Cost Per Sqm (PHP)	Total (PHP)
Kitchen	20.95	1.25	25000	654,687.50
Dining Area	13.3	1.00	25000	332,500.00
Living Area	33.96	1.00	25000	849,000.00
Master's Bedroom	20.13	1.00	25000	503,250.00
Bedroom 1	16.03	1.00	25000	400,750.00
Bedroom 2	20.63	1.00	25000	515,750.00
Walk-in Closets	3.39	1.00	25000	84,750.00
Toilet & Bathrooms	5.51 3.07 4.92 4.26	2.00	25000	366,500.00
Laundry Area	3.07	1.00	25000	76,750.00
Balcony	6.39	0.40	25000	63,900.00
Stairs	6.55 x 3	1.25	25000	614,062.50
Garage	55.11	0.60	25000	826,650.00
			TOTAL	5,288,550.00

Dwelling Unit 2 – For Single Users

General Space	Area	Space Factor	Unit Cost Per Sqm (PHP)	Total (PHP)
Kitchen	15.68	1.25	25000	490,000.00
Dining & Living Area	31.8	1.00	25000	795,000.00
Master's Bedroom	16.45	1.00	25000	411,250.00
Office	32.48	1.00	25000	812,000.00
Bedroom 1	14.31	1.00	25000	357,750.00
Bedroom 2	13.85	1.00	25000	346,250.00
Walk-in Closets	3.2	1.00	25000	80,000.00
Toilet & Bathrooms	12.08	2.00	25000	604,000.00
Balcony	9.28	0.40	25000	92,800.00
Stairs	19.65	1.25	25000	614,062.50
Laundry Area	6.27	1.00	25000	156,750.00
			TOTAL	4,759,862.50

Dwelling Unit 3 – For Student Dormers

General Space	Area	Space Factor	Unit Cost Per Sqm (PHP)	Total (PHP)
Kitchen	16.22	1.25	25000	506,875.00
Dining & Living Area	36.53	1.00	25000	913,250.00
Office Space	29.24	1.00	25000	731,000.00
Bedroom A (3 units)	45.9	1.00	25000	1,147,500.00
Bedroom B (2 units)	44.01	1.00	25000	1,100,250.00
Student Lounge	30.56	1.00	25000	764,000.00
Toilet & Bathrooms	18.57	2.00	25000	928,500.00
Balcony	30.58	0.40	25000	305,800.00
Stairs	26.2	1.25	25000	818,750.00
			TOTAL	7,215,925.00

Table 3. Computations of budget estimate per area of each space allocated to each dwelling unit.

The overall total estimated development cost for the entire project is

PHP 17 264 337.50

Sustainability Goals & Manifesto

WATER	WATER / GROUND	AIR / GROUND	AIR	AIR / ENERGY	ENERGY
Add rainwater harvesting system; Address signs of soil erosion		Redesign site vegetation	Design according to the new normal	Provide natural ventilation	Provide natural lighting; Use EDGE to cross-check the projected reduction in energy use

WATER · AIR · GROUND · ENERGY

This project is guided by several sustainability goals focusing on five main factors: WATER, AIR, ENERGY. GROUND, and HEALTH AND SAFETY. Every overlapping space means that a certain goal falls under those 2 categories. The accomplishment of these goals will be discussed as they appear in the

EDGE Sustainability Attainment

44.24% Meets EDGE Energy Standard

41.35% Meets EDGE Water Standard

40.23% Meets EDGE Material Standard

Paghabi, the multi-family dwelling meets significant EDGE standards for sustainability. This is a result of using certain materials and implementing specific building technologies for construction and design.

- High window-to-wall ratio to allow for natural ventilation in the building.
- Use of water-efficient faucets and showerheads, having a flow rate of 6L/min, equipped with aerators.
- Implementation of External Shading Devices that significantly lessen the solar heat gain.
- Use of water-efficient toilet bidets and water closets having flush rates of not more than 4L/flush.
- Use of easily sourced out materials like steel and concrete to lessen carbon footprint emission in construiction.
- Construction of windows that are primarily made of aluminum which is easily sourced out from the local market.
- Designing interiors that allow good natural ventilation. This project specifically prioritized cross-ventilation.
- Implementation of floor and wall insulation systems to effectively minimize heat gain and heat transfer.
- Use of EDGE-certified energy efficient appliances and electronic, and mechanical devices. (eg. ceiling fans and smart meters).
- Implementation of roof insulation with <100 mm insulating air gap.
- Construction of a rainwater harvesting system that will collect stormwater from the roofs.
- Use of reflective roofing material in order to minimize heat absorption of the roofs.

Design Morphology

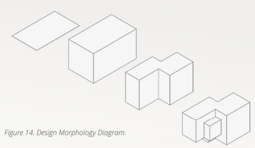


Figure 14. Design Morphology Diagram.

The form started as a rectangle covering the maximum buildable area on site. It is extruded upwards, even more maximizing the site's buildable space in three dimension. It is cut around to give space on the site's entrance in front, and the site's present vegetation at the back. Finally, it is molded into what seems like a combination of blocks forming a unique shape in itself.

Zoning and Distribution of Spaces

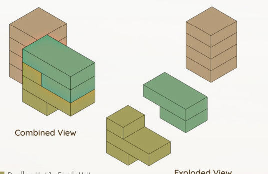


Figure 15. Zoning and Space Distribution Diagram.

This diagram shows the distribution of spaces in the building. The three dwelling units signify the 3 colors shown. It follows a LEGO configuration where in 2 units share the same floor, just separated by a wall..

Aerial Perspective

ARCHITECTURAL PLANS

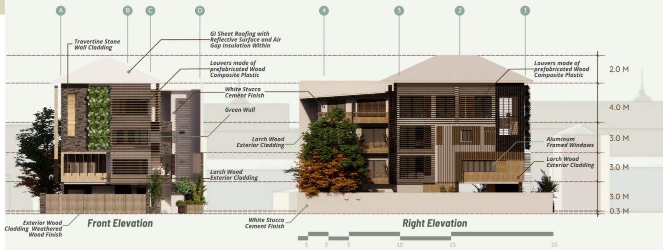
SITE DEVELOPMENT PLAN

Longitudinal Site Section NTS

The site section is not cut orthogonally to show the depth of space and provide more details of the cut interiors.

1. Master's Bedroom
2. Bedroom
3. Bedroom
4. Stairwell
5. Bedroom
6. Kitchen
7. Laundry Area
8. Living Room
9. Master's T&B
10. Master's Bedroom
11. Master's Balcony
12. Kitchen
13. Laundry Area
14. Powder Room
15. Bike Parking
16. Garage

1-7 Dwelling Unit 2; 8-16 Dwelling Unit 1



Front Elevation

Right Elevation

Rear Elevation

Left Elevation

Ground Floor Plan on Site

Second Floor Plan

Third Floor Plan

Fourth Floor Plan

Accurate window and door details were not shown well in these stylized plans. For better precision, see **Systems Integration.**

Tropical Design Strategies

Orientation, Programming of Spaces, and Ventilation Solution

Figure 16. Rendered Floor Plans with Wind Flow Diagrams..

The spaces are designed primarily according to their orientation. 10 out of 11 bedrooms are placed facing the north side of the site to minimize extreme sun exposure. The other one was not oriented towards north but is still protected, nonetheless, by effective solar shading devices. The balconies of the students' dwelling are facing North and East, with the best vistas (the greenery of the communal garden), because connecting with nature positively impacts mental health, especially that the target users are university students. Kitchens, dining areas, and living rooms are designed with an open layout to lessen the construction of interior walls. This will help in better air circulation and will facilitate for cross ventilation.

The ventilation solution in this housing project is shown through its space programming and choices of wall openings. **Cross ventilation** is present in all main spaces like kitchen and dining areas, living rooms, master bedrooms, and communal spaces like the student lounge and office spaces. There are five different wall openings present in this building that will help allow good air flow.

1. **Accordion Louvered Doors** - Present in Dwelling 1 kitchen which opens directly to the garden at the rear side of the site; and Student Lounge area.
2. **Sliding Glass Doors for balconies**
3. **Sliding Glass Windows**
4. **Louvered windows** - Every space with a sliding glass window is paired with a louvered window.
5. **Balcony Louvered Single-Swing Windows** - Also used as a sun-shading device.11

All windows are operable and are designed to give the users a choice whether they will open the space for natural air flow or choose to use the HVAC at certain occasions.

Rainwater Solution

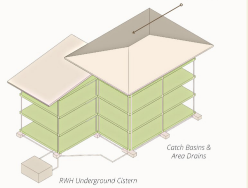


Figure 17. Rainwater harvesting System Diagram.

A rainwater harvesting system will be constructed in the multi-family dwelling project. Constructing a RWH system provides many benefits. As a tropical country with abundant rain, rainwater collection is a must; it will help in decreasing the consumption of mains water.

As per the Climatological Normals from PAGASA, there is an annual precipitation of 2785 mm in Metro Manila. With a 233 m^2 catchment area, this RWH system can potentially save an annual accumulative amount of 648905 liters of rainwater.

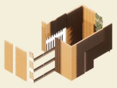
Roof Catchment Area (in m^2) x Annual Precipitation (in mm) = potential water collection (in litres)

Additionally, a rainwater harvesting system helps protect ground health. Having the storm water flow through a planned plumbing system lessens the surface runoff. This will address the **signs of soil erosion** found on site.

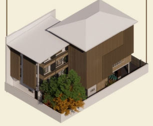
The diagram shows the drain pipes directing rainwater from the roof to a catch basin all going to the underground rainwater cistern. See the **Systems Integration** for the detailed plans.

The Skin

The Building Without the ***Skin***



The ***Skin***



Paghabi. *A building covered with Exterior Sun Shading Louvers and other Solar Shading Devices*

Sun Shading and Heat Gain Solution

The design concept of this project in terms of its form and exterior aesthetics focused mainly on its series of solar shading louvers, acting like the outermost skin of the building. In order to achieve the 100% solar ray coverage, multiple sun and shadow simulations were done. It arrived to having several patterns of **vertical and horizontal louvers around the exterior.**

Aside from louvers there are other shading devices used as well. Located at the balcony on the west side of site (front) is the **operable wooden windows** that can shield even the balcony itself from sun's heat [A]. On the same side of the building there is also a **vertical green wall** that can passively serve as a first layer protection from the sun's heat [B].

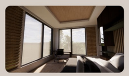
Lastly, the adjoining **corridor** from the west side serving as the means of egress of Dwelling Unit 2, will function as a concrete buffer zone of the unit from direct sunlight and heat gain [C].

The fixed louvers will not act as a load bearing exterior, and will be constructed like a brise soleil system, attached to the RC exterior load bearing walls. It will make use of prefabricated wood composite plastic, a lightweight and weatherproof material that can imitate wood finishes.

IMPORTANT NOTE:
The horizontal louvers are not perfectly parallel to the ground and are **slightly sloping** and angled away from the building. This is to prevent water ponding on its top surfaces.

Sun and Shadow Simulations

MASTER'S BEDROOM DWELLING UNIT 2
THIRD FLOOR. FACING BOTH NORTH AND EAST.



If the same space is simulated **without** the solar shading exterior louvers, direct sunlight will enter the interior. Photo shows March 22 at 8 AM. This proves the effectiveness of the solar shading device.

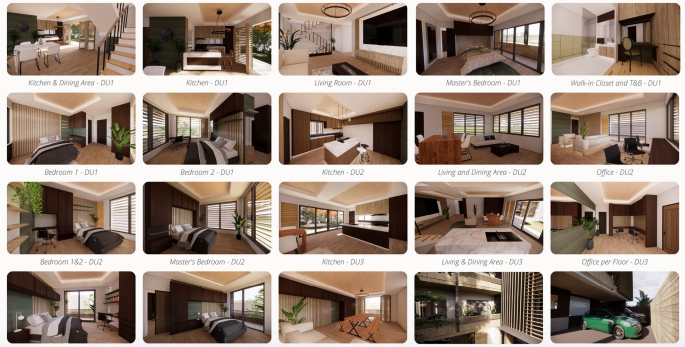
BEDROOM DWELLING UNIT 1
SECOND FLOOR. FACING BOTH SOUTH AND WEST.

As stated, this is the only bedroom in the whole building that is not oriented towards the north, however, with an effective sun shading device in place, it is protected from the harsh afternoon sun. Photo on the left shows December 22 at 4pm, the sun with the lowest angle. **Without** the louvers, it clearly shows that the sunlight fills the room completely.

LIVING ROOM DWELLING UNIT 1
SEOCND FLOOR. FACING BOTH NORTH AND EAST.

Interior & Exterior Perspectives

DU - Dwelling Unit



Kitchen & Dining Area - DU1 · *Kitchen - DU1* · *Living Room - DU1* · *Master's Bedroom - DU1* · *Walk-in Closet and T&B - DU1*
Bedroom 1 - DU1 · *Bedroom 2 - DU1* · *Kitchen - DU2* · *Living and Dining Area - DU2* · *Office - DU2*
Bedroom 1&2 - DU2 · *Master's Bedroom - DU2* · *Kitchen - DU3* · *Living & Dining Area - DU3* · *Office per Floor - DU3*
Bedroom 1&3 - DU3 · *Bedroom 2&4&5 - DU3* · *Student Lounge - DU3* · *Balcony - DU3* · *Garage*

Materials for Interiors

- Composite Wood for Cabinetry with Walnut Veneer Finish
- Synthetic Basalt Stone for Accent Walls
- Laminate Wood Flooring with Light Colored Wood
- White Stucco Cement Plaster Finish
- Larch Wood for Wall Vertical Aesthetics

SYSTEMS INTEGRATION

Structural Plan

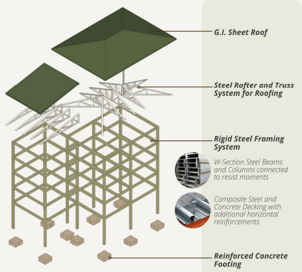


Figure 18. Structural Plan Isometric Diagram.

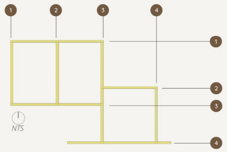
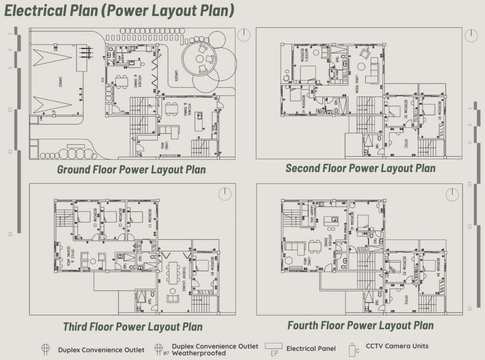


Figure 19. Plan showing the beam connections, intersecting at columns.

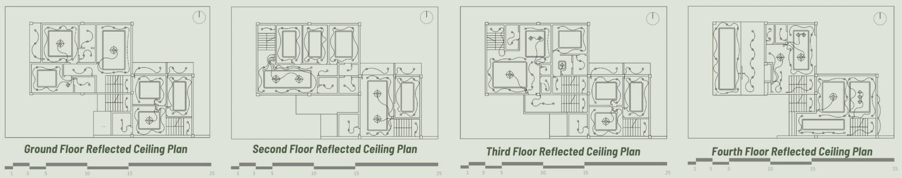
A typical beam layout plan will be used across all four (4) floors of the building.

Electrical Plan (Power Layout Plan)

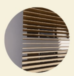


Electrical Plan (Reflected Ceiling Layout)

- Compact Mounted Light Bulb
- Pendant Lighting
- Chandelier
- LED Cove Lighting Strip
- Single Gang Switch
- Double Gang Switch
- Triple Gang Switch

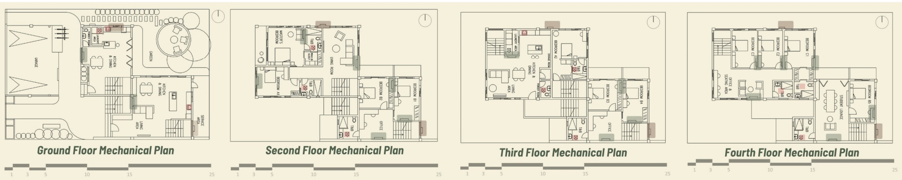


Mechanical Plan



Outdoor units of the split-type aircon will be concealed by the exterior sun shading louvers.

SPLIT-TYPE HVAC SYSTEM
- Indoor Units
- Outdoor Units
- Exhaust Fans and Range Hoods



Fire Protection Plan

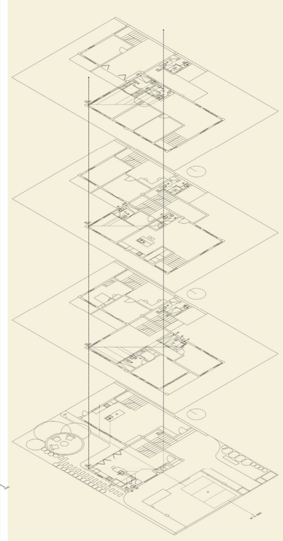
Fire extinguishers are generally placed in close proximity with kitchens, inside the cabinets. Fire alarm bells are placed near exits. Exits are provided with their own emergency lighting fixtures in case of an emergency.

- Fire Extinguishers
- Emergency Lighting
- Fire Alarm Bells
- Exits

Water Line Isometric Plan

This plan shows two sources of water: (1) commercially distributed mains water and (2) harvested rainwater.

The surface-mounted water tank will require at least 500-gallon capacity to supply the whole building.



Sanitary Line Isometric Plan

The septic tank designed here will be placed 15 meters away from the underground rainwater harvesting cistern. It will have a capacity of 2500 liters.

The plan shows two soil stacks that effectively vent out straight to the roof.

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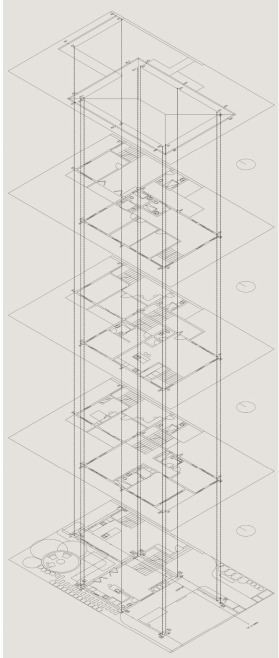

Storm Drain Layout Isometric Plan

This plan shows the drain pipes from the roof leading to the catch basins and towards the rainwater harvesting cistern. The cistern will store all the rainwater collected from the catchment area (roof), and will have a route that is tapped to the storm sewer in case of an overflow.