DESIGN OF FLATHOUSE IN TERBAN, YOGYAKARTA

WITH BIOCLIMATIC CONCEPT

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ARCHITECTURE UNDERGRADUATE STUDY PROGRAM

UNIVERSITAS ISLAM INDONESIA

DEPARTMENT of ARCHITECTURE

한국건축학교육인증원 Korea Architectural Accrediting Board

CANBERRA ACCORD

Final Architectural Design Studio
Department of Architecture
2020/2021

Design of Flat House in Terban, Yogyakarta
with Bioclimatic Concept

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Design of Flat House in Terban, Yogyakarta
with Bioclimatic Concept

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Students Identification : 17512020

FADS Project Title : Design of Flat House in Terban, Yogyakarta with Bioclimatic Concept

Design Report Quality : **Average, Good, Excellent** *

Therefore **Recommended / Not Recommended** * to become Final Architectural Design Studio product precedent.

Yogyakarta, July 28th 2021
Supervisor

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STATEMENT OF AUTHENTICITY

I, Adelia Bunayya Anugralita Suwarno, stated that all parts of this project is my own work except for those works that has been mentioned as references and there was no additional help from other party whether it is all or only several part of the making process. I also stated that there are no intellectual ownership conflict of this work and will handing it over Department of Architecture Universitas Islam Indonesia to be used as education and publication purposes.

Yogyakarta, July 28th 2021

Adelia Bunayya Anugralita Suwarno

FOREWORD

Bismillahirrahmanirrahim. First of all, I would like to Thank God for making me strong enough to finish this project. Thank you for always slipped good thoughts while working on this project and because of that I have been able to finish my Final Architectural Design Studio Project called 'Design of Flat House in Terban, Yogyakarta with Bioclimatic Concept' as a requirement to finish my undergraduate study and to be able to receive Bachelor Degree of Architecture.

Hence, during the process of making this project, I had received so many helps and supports from many parties. In this occasion, I would like to thank:

1. Both of my parents, for always unconditionally supporting me, giving me the right to decide my own life and eventually became my biggest motivation to finish this project.
2. Dr. Yulianto P. Prihatmaji as my supervisor, for always pushing me beyond my limit by giving numerous inputs and critics during the making process. Thank you for the time and your willingness to not taking it easy for me so that I can finish the project well.
3. Prof. Noor Cholis Idham and Bu Putu Ayu P. Agustiananda as my jury, for the inputs which gave me newer perspectives of how I should see my design during seminar.
4. Latifa Azizzah, Abraham Risyad, Mode Jutta, Berlian Inda, Kirana Nandang, Kemala Fitri, Salma Yoani, Avinsa Haykal, Rasyid Dewangga, and Nela Dwianti, for being the best university mate that always cheers me up, help me get the answer of my design problem when I am stuck, and always validate my feeling when I am low, I wish you all a wonderful journey ahead.
5. Galih Indraswari, Bhanu Arsyi, and Ahnaf Mumtaza, for being my classmate during this FADS journey. Thank you for not leaving each other behind, always share information and even help each other to get through the hardest times. Because of that, we are now able to graduate together and continue to open a new chapter of life.
6. NCT, for being my greatest source of entertainment when I need a quick runaway from working phase. Not only from your music or performances, but your existence itself shows me that you are all also hardworkers and it motivates me to keep going.

Last but not least, I am surely wishing that this project can bring benefits for those who study this project and hopefully it can sparks so much more design inspiration in the future. For anyone who read this book, thank you in advance.

Yogyakarta, July 28th 2021

Adelia Bunayya Anugralita Suwarno

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ABSTRACT

Yogyakarta is one of the most visited cities in Indonesia. Many visitors came for tourism purpose, livelihood, or even for educational purpose. Badan Pusat Statistik in DI Yogyakarta have recorded that the population density in Yogyakarta City itself has reached 13,413.42 person/ km^2 in 2020 with only 32.5 km^2 land area. This result as an issue related with spatial availability, especially in several locations at the center of the city like Terban. Many housing in Yogyakarta have not yet implement the sustainable principles, especially in lighting and thermal elements. For instance, instead of having a design that may control unwanted heat, house owners prefer to use air conditioner. This is important enough knowing how rapid technology development nowadays and how it affected the world in a large scale. Compared to 8-10 years ago, the average temperature is increasing up to 1 degree celcius per year. Of course, external factor such as the carbon footprint from vehicles also affects the climate.

In order to solve the current spatial issue, effective spatial design can maximize the functional spaces and increase the user capacity. The idea is to create residential building which will focus on enhancing the space vertically. It will be multi-storey building, but not necessarily a one mass building like an apartment, so that the house quality of each unit can be enhanced as well. The flat house will be designed through bioclimatic approach which allows us to design based on the response towards the existing climate that wil be focusing on the thermal and lighting aspect of housing design. The performance-based design method will be used in order to be able to analyze whether the housing quality aspect already reach the design goals or not.

The flat house complex consists of multi-mass buildings in which each mass consists of four storeys that will be used collective for small-scale families. The house plotting will be divided based on the spatial function and lighting priority resulting in the existence of inner courtyard as gap between each mass. The housing unit has been simulated in terms of daylighting and several thermal aspect as well as energy usage calculation and has accomplished the project aim of housing quality enhancement.

Keywords: *Flat House; Indoor Housing Quality; Bioclimatic Design: Urban Context*

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CHAPTER ONE
INTRODUCTION

DESIGN BACKGROUND
PROBLEM STATEMENT
DESIGN METHODS
FRAMEWORK OF THINKING
ORIGINALITY AND NOVELTY

1.1. DESIGN BACKGROUND

1.1.1. Urban Dynamics Theory

According to the dynamics of growth in cities in recent decades, the world is heading for an unavoidable process of increasing urbanization, implying population concentration centralized in the densest cities and wide spread to rural spaces. Therefore, it can be stated that urban development characteristic have a tight connection with the initial phases of industrialization (Docampo, 2014).
Preston (1975) argues economical aspect takes great part of urban development. Capitalism affect the hierarchy of settlements at different locations which centered on large urban centres, such as capital cities. Towns are widely known for having various influences, such as social and economic life, to smaller urban nuclei.

In terms of urban settlement, there are four aspects of spatial dynamics which is the side effect of urban development. Those four are increasement in settlement area, residential housing compression, tendency of housing segregation, and the growth of slum area (Yunus, 2008).

1.1.2. Housing In Urban Area

Housing typology in Yogyakarta vary from a house consists of one-three storeys until an apartment. In some rural areas like in Bantul and Sleman District, the land is often wide enough for the house owner to create green open area. In urban area, land availability is very limited which eventually caused extreme land price increasement throughout the years. According to a news article from Tribun Jogja, Andi Wijayanto, Ketua DPD Real Estate Indonesia, said that the land price reached one million rupiah per square meter in several areas including Sleman, Bantul, and Yogyakarta City. While the other area that is considered far from the urban area, the land price is only around 250,000 rupiah per square meter. This shows that the housing density in Yogyakarta is not yet spread equally. One of the current solutions to provide more space is by building high-rise building like apartments or flats which we can found in many strategic urban areas in Yogyakarta.

However, most of the existing housing design in Indonesia have not yet implement effective spatial layout design. Putri and Prianto (2016) argues that in terms of spatial availability aspect, conventional housing do not consider the existence of dining room as well as guest room in average. Based on their observation, the user tend to enjoy their meal and welcome their guest in living room. Other than that, the existence of other functional room arrangement without any consideration of its arrangement and its comfort shows that conventional housing not yet fulfill the effective spatial layout design.

Furthermore, hot climate increase energy usage for artificial cooling system. Building cooling system exists due to building inability to create thermal comfort for its user (Sibyan and Asnawi, 2018). In urban apartments, every unit use minimum one unit of AC average which almost always turned on all day long. This condition exists because of the building envelope facing the sun radiation directly which cause indoor temperature increase (Mufidah, 2004). Based on research conducted by Santoso (2012), indoor temperature decrease can be achieved by creating shading devices or placing vegetation. But those in general have not yet be able to provide effective thermal comfort since it can only lower indoor temperature for 1.5 until 2 degree Celcius.

1.1.3. CO Pollution and Energy Usage in Indonesia

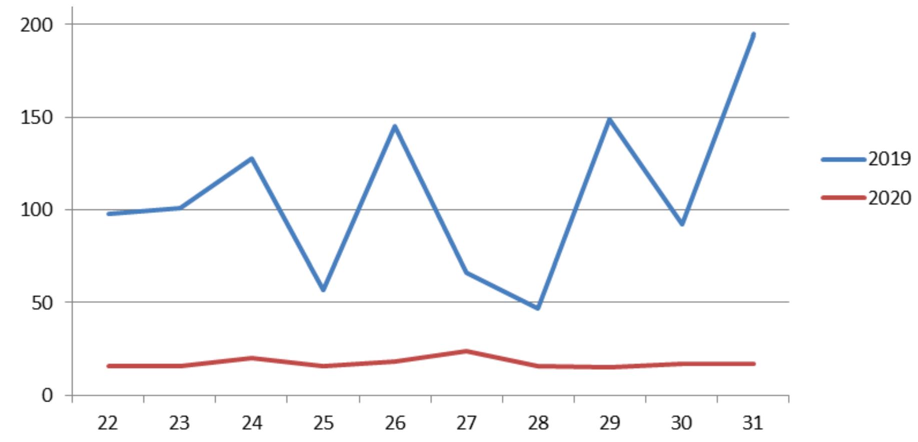

Figure 1.1. Daily Pollutant Index (CO) Yogyakarta
Source: https://lingkunganhidup.jogjakota.go.id/

The data above is example of daily pollutant index (CO) in Yogyakarta. As we can see, in last few days of 2019 the CO index is either considered as moderate (51-100) or unhealthy (100-199), while in last few days of 2020 the CO index is considered good (0-50). Hypothetically, this may be affected by the quarantine and stay-at-home appeal that has been applied since COVID-19 happening in Indonesia which means that the carbon footprint from vehicles usage has been reduced a lot. However, the carbon footprint within a house is still exists although it is not as massive as carbon footprint from vehicle usage.

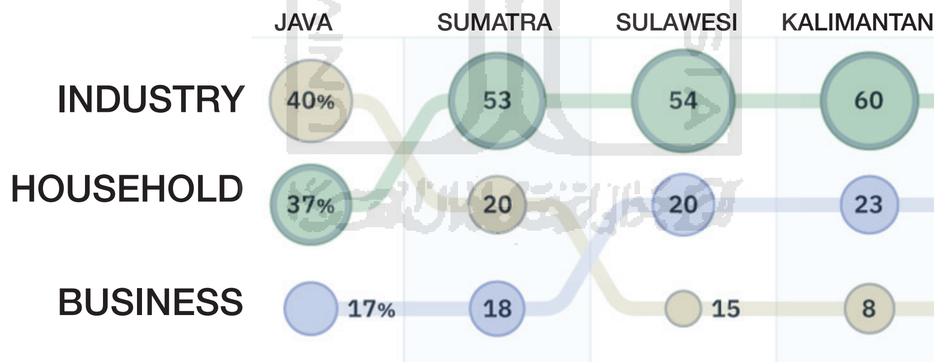

Figure 1.2. National Electricity Consumption
Source: https://lokadata.id/

Aside from pollution issue, there is another issue related with energy usage within a household especially considering the COVID-19 situation whereas most of the activity is being done in a house. Generally, the electricity consumption in national scale did not affected by the current situation. National electricity consumption in 2019 reached 234,617 Giga Watt Hour (GWh). In national scale, the biggest consumption amount came from household which is approximately 42 percents or 97,832 GWh. While industry consumption reached 33 percents or 76,946 GWh. According to Lokadata, if every household can save electricity consumption for about 30 percents, then it can save national electricity consumption until approximately 5,679 GW which means it can save cost estimate of Rp83,3 trillion.

1.2. PROBLEM STATEMENT

1.2.1. General Problem Formulation

How to reduce artificial energy usage, minimize pollution production, and provide sufficient space for housing design?

1.2.2. Specific Problem Formulation

1. How to provide sufficient space without eliminating the sense of living in a village neighborhood?
2. How to maximize the use of natural lighting for housing design?
3. How to control the heat inside a room, especially during the day?
4. How to apply the principles of bioclimatic architecture in housing design?

1.2.3. Design Limitation

1. Architect
   - Designing structural construction of the vertical village.
   - Units are designed based on bioclimatic approach to improve the quality of thermal and visual comfort aspect of housing.
   - Circulation between each unit and each block will be connected in a way that it will not affect the boundary between public and private area.
2. Client

   Local developer company who has been working on many innovative residential property project and has vision to provide high quality residential property in strategic urban area of Yogyakarta. The project should be designed not only for providing the best housing quality but also concerning the commercial value.
3. User

   Small family consists of 3-4 person who has concern with housing quality and looking for a place for living in urban area. The ground floor of each unit will be used for public space to provide efficient spatial arrangement. The users can own the housing units as well as the communal area.
4. Legislator

   The vertical village design will be based on Local Regulation by the government of Kota Yogyakarta.

1.3. DESIGN METHODS

1.3.1. Design Problem Solving

Performance-Based Design will be used as the design method since this project will be based on building performance simulation, it is important to calculate and analyze the design as well.

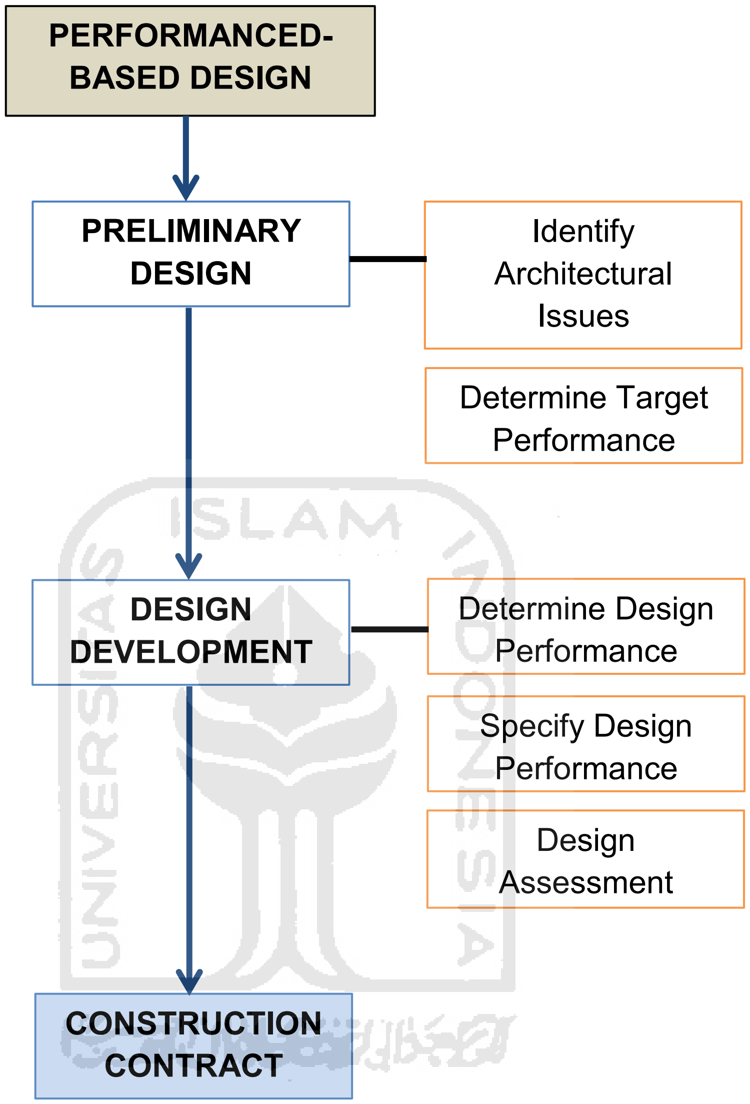

Figure 1.3. Performance-Based Design Framework
Source: Author

Preliminary design will be based on literature study by collecting secondary data from scientific journals related with urban housing and bioclimatic design as well as observe the existing site condition, and read through government archives of collective quantitative data as well as building regulations, etc.
Design development will be focusing on visual and thermal enhancement which goals already set up. Design process will be based on physical condition and journal references which later will be simulated through softwares and calculations.

1.3.2. Design Simulation

This project simulation will be based on software simulation and model analysis. The software that will be used for lighting simulation is Velux Daylight Visualizer. While for the thermal analysis, it will be using OTTV sheet calculation.

1.4. FRAMEWORK OF THINKING

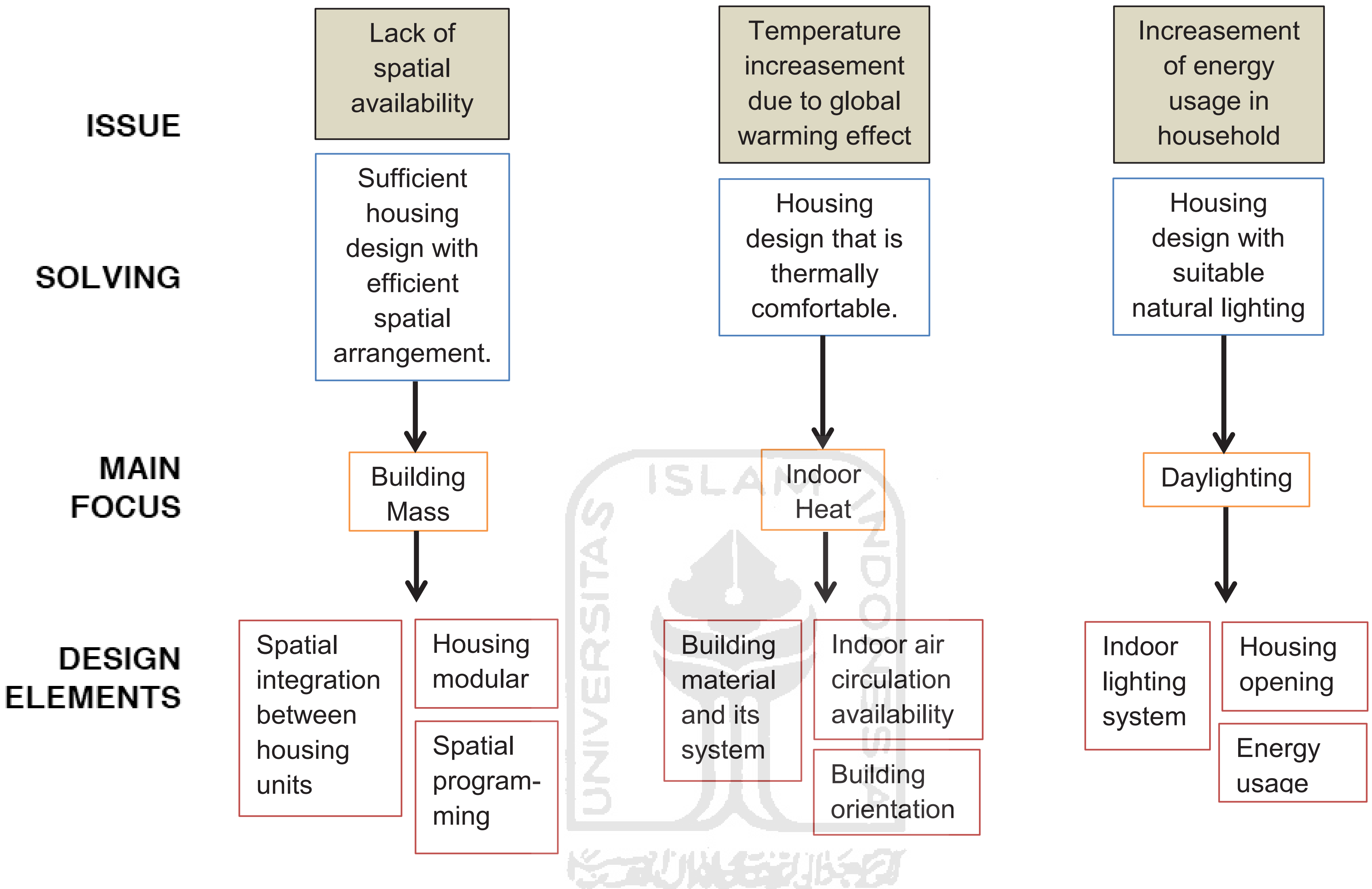

Figure 1.4. Design Hypothesis
Source: Author

1.5. ORIGINALITY AND NOVELTY

Hereby five similar cases related with this project to ensure its authenticity of the project:

1. Title : Resort in Pantai Srandakan, Bantul with Bioclimatic Design Application
   Author : Mulyadi, Syamsudin Sidik
   Differences : Although it use the same approach as my project, but this project is focused on designing beach resort.

2. Title : Vertical Village at Sosrodipuran, Yogyakarta based on Community Approach
   Author : Imas Nurrahmah
   Differences : This project use community as the approach method which is not related with building technology.

3. Title : High-Rise Apartment in Maguwoharjo with Green Building Concept of Water Conservation and Energy Efficiency
   Author : Dwi Mairani M
   Differences : This project has similar urban context and energy efficien cy concern as my project, however this project focus on the water conservation of a high-rise apartment.

4. Title : Low-Cost Apartment in Code Riverbank, Cokrodiningratan, Jetis, Yogyakarta with Green Building Concept of Passive Cooling
   Author : Al Majid Ari Putra
   Differences : Green building concept of passive cooling is actually quite similar with my project, but the design product is different. This project focused on designing low-cost apartment and the context is near the riverbank.

5. Title : Biophilic Healthy Vertical Village in Slums Area in Pingit Yogyakarta with Biophilic Approach
   Author : Priescilia Berliana Uaes Murtanto Putri
   Differences : Similar with my project, this one also about vertical village but it focus more on providing healthy aspect in slum area in Yogyakarta rather than building technology.

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CHAPTER TWO
DESIGN PROBLEM STUDY

SITE AND CONTEXT STUDY
DESIGN THEME STUDY
BUILDING TYPOLOGY STUDY
BUILDING PRECEDENT STUDY
DESIGN PROBLEM MIND MAP

2.1. SITE AND CONTEXT STUDY

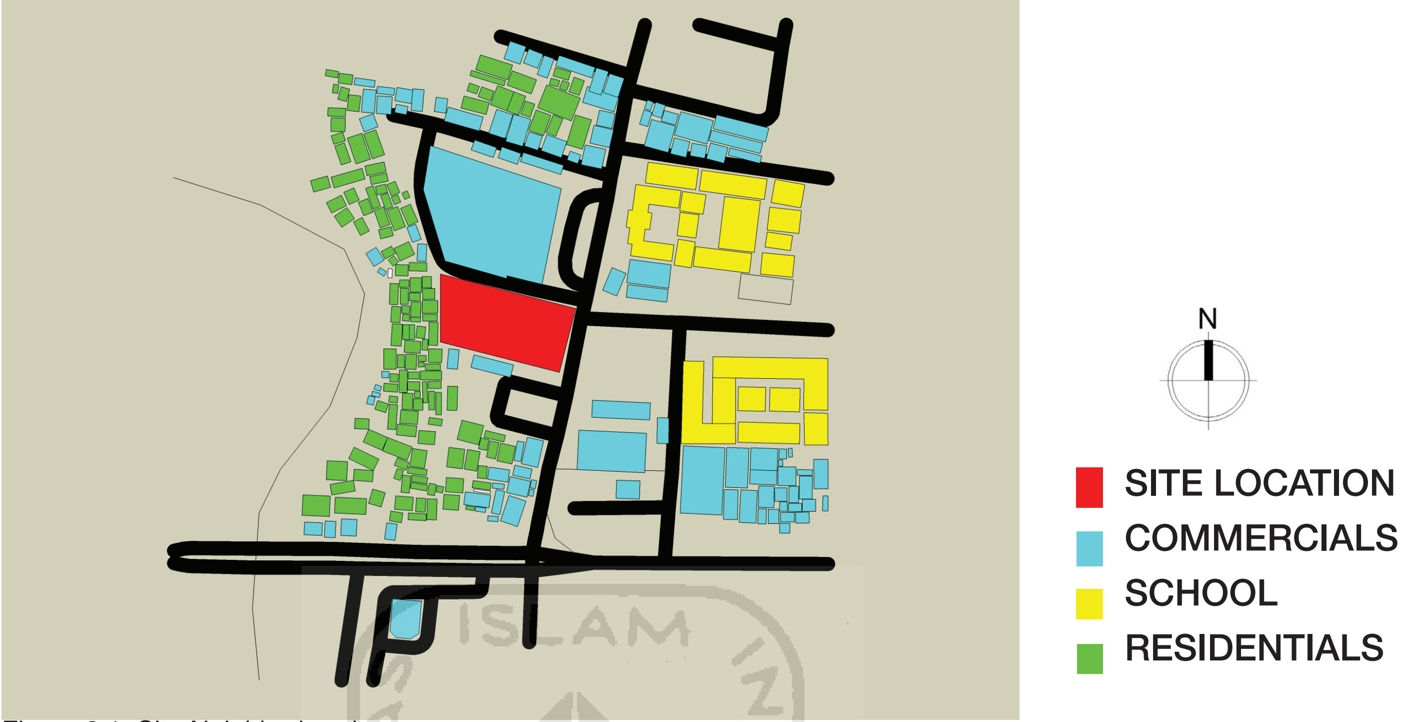


Figure 2.1. Site Neighborhood
Source: Author

2.1.1. Site Location

Located in Jl. C. Simanjuntak, Terban, Kec. Gondokusuman, Kota Yogyakarta, Daerah Istimewa Yogyakarta, Terban is one of the most strategic road in Yogyakarta since it is located near many commercial buildings as well as schools, such as SMA N 6 Yogyakarta, SMP N 8 Yogyakarta, SMA N 9 Yogyakarta, SMA Stella Duce, etc. Similar with Kaliurang Street, Palagan Street and Magelang Street, most of the people stay in these areas are newcomers that come for educational and livelihood purpose. Therefore, we can see so many housing complexes and apartments located in those areas.

2.1.2. Site Neighborhood

Figure 2.2. Site Surrounding; (i) Terban Traditional Market; (ii) SMA N 6 Yogyakarta; (iii) Existing Site East Vista
Source: https://google.com/maps

The site surrounded by mostly commercials since it is located near main street. The northside neighborhood is Terban Traditional Market which actively use to sell farm products as well as chicken. The southside neighborhood is Terban Gas Station which consists not only gas station but also minimarket, ATM, and few small cafe as their side facilities. The eastside neighborhood, which is across Jl. C. Simanjutak, is SMA Negeri 6 Yogyakarta. The westside, however, full of slum residential since it is also located near the Riverbank of Code. Most of the houses there are landed house which is used by low-middle income citizen of Yogyakarta.

2.1.3. Site Regulation

This site was functioned as Terban Bus Terminal and owned by goverment. According to Tribun News, the site is now abandoned and is being planned to be build for a new function. Based on Land Use Map of Kota Yogyakarta Year 2015-2035, the site is considered as commercial area.

Based on Local Regulation of Walikota Yogyakarta No. 64 Year 2012, the BCR (Building Coverage Ratio) planning for Development Area approximately around 30% until 90%. FAR (Floor Area Ratio) planning for Development Area approximately 0,3 until 4,8. BH planning in building block until 32 meters and enforced open view regulation (sky line) with 45º from the road space across.

Based on Local Regulation of Walikota Yogyakarta No. 6 Year 2010, site with more than 500 sqm area are obligated to plant minimum 3 shade trees, shrubs, and enough ground cover/grass. Every residential areas are also obligated to provide green open area which is suitable with the siteplan that has been designed.

2.1.4. Site Area

Total Area	: 2835 sqm
Building Coverage Ratio	: 850 - 2550 sqm
Floor Area Ratio	: 850 - 13,600 sqm

2.1.5. Client and Users

The client in this project is a local developer company. Since the site is owned by the government, there will be investment operation cooperation to proceed the project. It is recommended to proceed through BOOT (Buy, Own, Operate, and Transfer) method.

The user will be newcomers who need housing in urban area of Yogyakarta. It is targeted for small family consists of 3-4 person who has concern with housing quality and will be using rent-payment system.

2.1.6. Sun Path Analysis

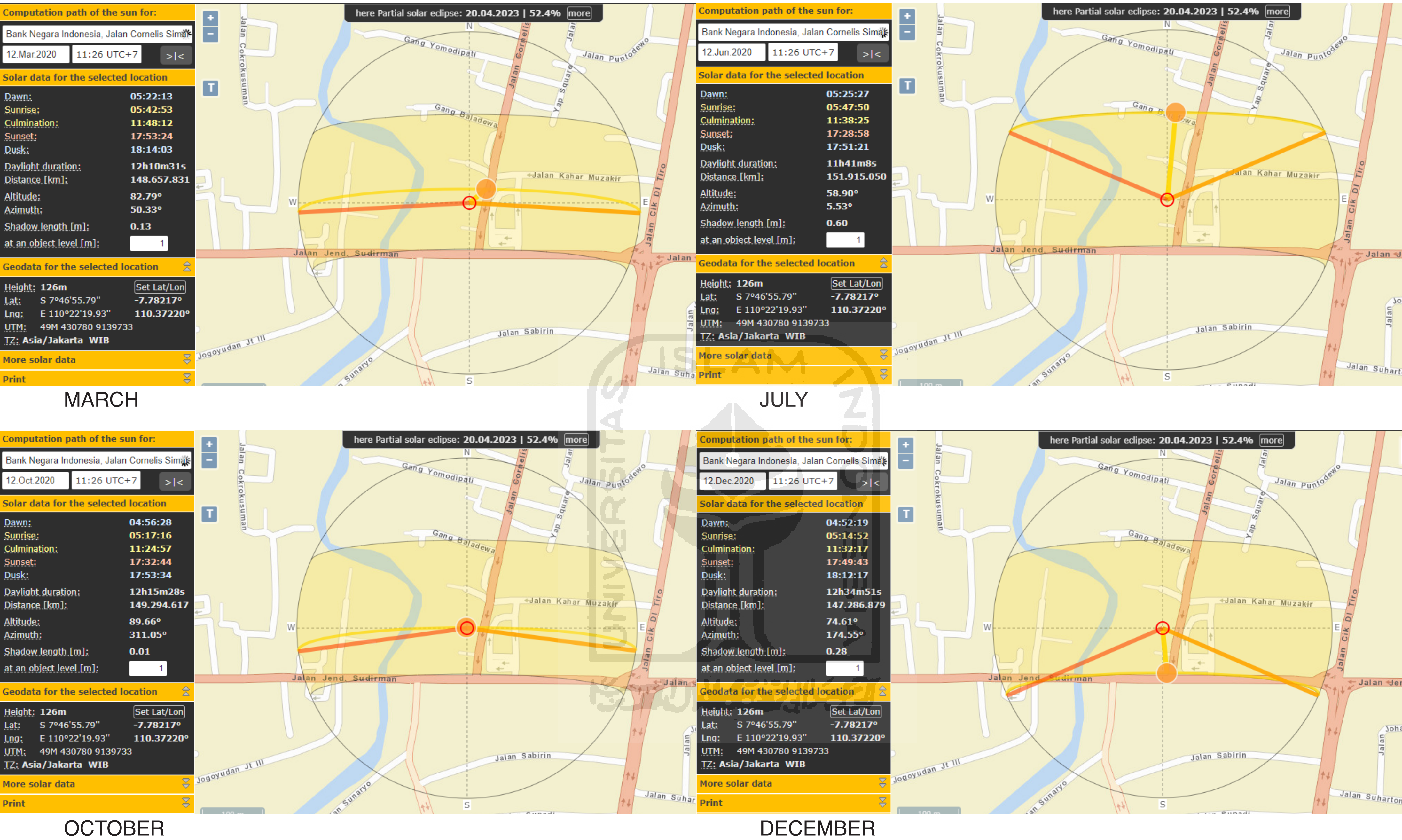


Figure 2.3. Sun Path
Source: https://www.suncalc.org/

The sun direction during March until June tend to inclined towards southern area. The sun direction in mid-year are tend to inclined towards northern area. The sun direction during July until October are still tend to inclined towards northern area. The sun direction in late year are tend to inclined towards southern area.

The length of the day in Yogyakarta does not vary substantially over the course of the year, staying within 34 minutes of 12 hours throughout. In 2021, the shortest day is June 21, with 11 hours, 40 minutes of daylight; the longest day is December 21, with 12 hours, 35 minutes of daylight.

2.1.7. Climate Analysis

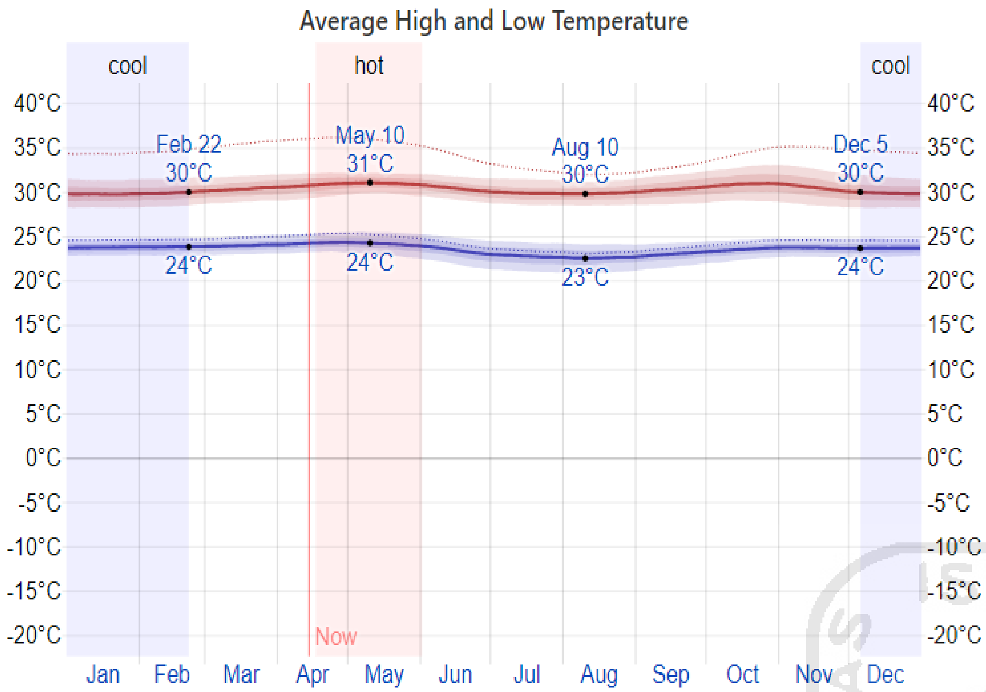
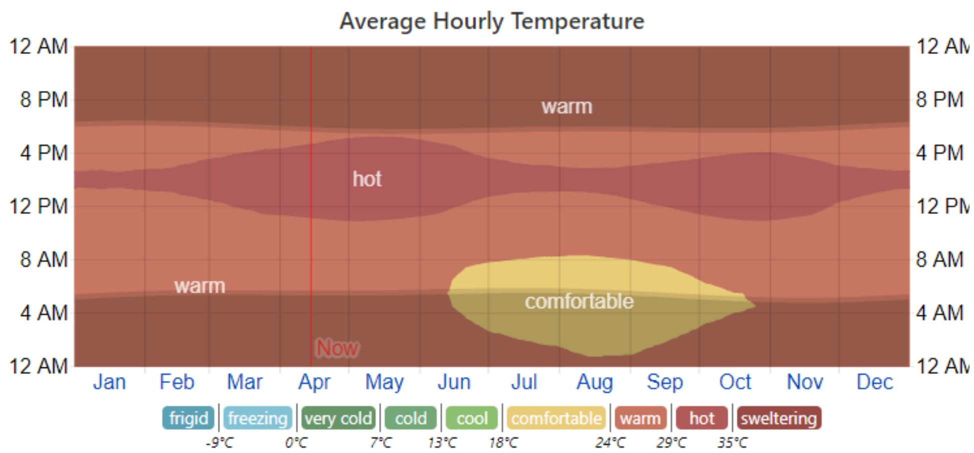


Figure 2.4. Temperature Chart
Source: https://weatherspark.com/



The hot season lasts for 1.5 months, from April 17 to June 1. The hottest day of the year is May 10, with an average high of 31°C and low of 24°C. The cool season lasts for 2.6 months, from December 5 to February 22. The coldest day of the year is August 10, with an average low of 23°C and high of 30°C.

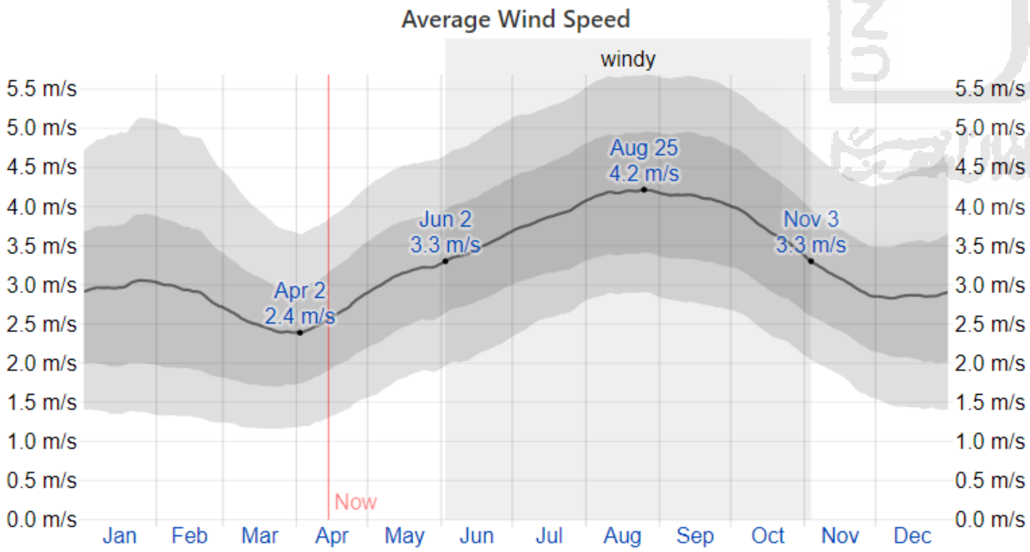
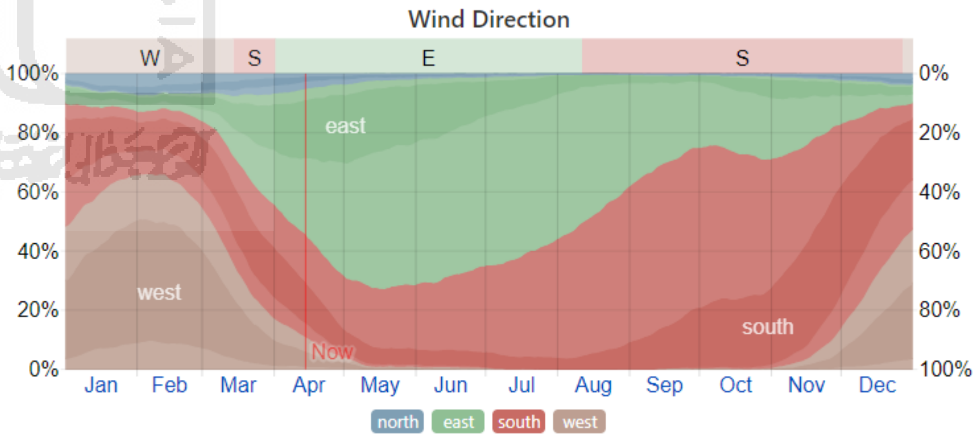


Figure 2.4. Wind Chart
Source: https://weatherspark.com/



The wind is most often from the south for 2.6 weeks, from March 14 to April 1. The wind is most often from the east for 4.3 months, from April 1 to August 11, The wind is most often from the west for 2.6 months, from December 27 to March 14.

2.2. DESIGN THEME STUDY

2.2.1. Bioclimatic Approach as Sustainable Design

In Merriam-Webster Dictionary, Bioclimatic is defined as “of or relating to the relations of climate and living matter”. This means that bioclimatic approach involves the existing natural elements and responds with the design. Vernacular architecture is one of the implementation of bioclimatic architecture. Vernacular architecture rely on the existing resources only as in the past there were no sophisticated technology that can enhance buildings like nowadays. For instance, in Pagoda, there is a courtyard located in the middle of the building which allows the air circulation flow through the building.

Overbay (1999) stated that bioclimatic design method is developed through ‘ecological footprint analysis’ of human behavior and their daily consumption on biophysical environment, which later determine the impact of various human populations. He also stated that the basic of bioclimatic design is to measure human activities including material and energy consumption as well as its waste production which related with the continuity of the available area of land and water. Several factors that affect the ecological footprint in the size of a household are types of construction materials, physical occupancy of the land, CO production and the amount of land for streets and highways.

Several components of bioclimatic design are including adaptive thermal comfort, climate types and microclimate (sun path, wind, rain), design elements (passive and active system), and assessment tools (Price and Myers, 2005). Bioclimatic design can become a way of achieving sustainable design. For instance during the construction process, several alternatives to maintain sustainability are enhancing passive design system rather than relying on mechanical equipment to save energy, or develop a certain area from a vehicle-based transport system into a multi-mobility transport. In terms of settlement, the final parameter is the life cycle of the building and the infrastructure and also to maintain user comfort and their well-being (Hyde, 2008).

2.2.2. Thermal Comfort in Tropical Building

Thermal comfort can be defined as a state of mind that express satisfaction towards thermal environment (Nugroho, 2006). Personal factor and indoor environment affect thermal environment condition which is commonly acceptable for 80% or more people from the majority of the users. However, it will never reach the exact standard measurement since research community in general agreed on thermal comfort that is acceptable for the user has tight connection with user satisfaction.

Santoso (2012) argues that thermal comfort in humid tropical climate for indoor areas with natural ventilation are most likely hard to reach the international comfort standard ASHRAE 55-92 because the average air temperature and the current humidity are relatively high, so the neutral temperature in these areas do not fulfill in the required comfort zone, which in between 23 ºC until 26 ºC. From several researches that have been done by Nugroho (2011), Roonak et al. (2009), Henry and Nyuk (2004), Sulaiman et al. (2011), Iftikhar et al. (2001) and Alison (2003) in humid tropical climate area with various type of building shows neutral temperature between 26.1ºC to 29.8 ºC. Based on those researches, the difficulty to reach neutral temperature based on thermal comfort zone affected by several factors including the building design that cause high amount of sun radiation (Nugroho, 2011), the air circulation which caused by low air velocity (Roonak et al., 2009), and the humidity caused by the current climate (humid tropical climate). In all climates to obtain thermal comfort using the passive method is to reduce the existing control equipment. In hot climates of massive buildings, good evaporation, and shade cooling can be used to improve comfort (Wang et al., 2015).

2.2.3. Daylighting and Indoor Visual Comfort

Thuillier (2017) stated that visual comfort usually defined through a set of criteria based on the level of light in a room, the balance of contrasts, the colour 'temperature' and the absence or presence of glare. The parameters and maximum light intensity vary based on multiple elements: time of exposition; composition of the light, as well as the colour and age of the eye of the individual using the space. Other elements of visual comfort are even more subjective, such as temperature of colour and views. With colour temperature for example, preferences are often cultural (Liu et al, 2013). So it is impossible to recommend an ideal colour temperature as people will have different feelings and interpretations of it.

While there is a lot of subjectivity in visual comfort, there are recommended levels of light in a building depending on the task performed and on the type of building. The National Optical Astronomy Observatory (NOAO) stated that the outdoor light level is approximately 10,000 lux on a clear day. In the building, in the area closest to windows, the light level may be reduced to approximately 1,000 lux. In the middle area its may be as low as 25 - 50 lux. Nowadays, light level is more common in the range 500 - 1000 lux - depending on activity. The table below is a guide for recommended light level in different workspaces:

Table 2.1. Indoor Light Level

Activity	**Illumination** ***(lux, lumen/m²)***
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750

2.2.4. Opening Design as Part of Building Envelope

Basthian (2016) conclude in his research that several opening design factors related with energy efficiency are the location, the area, and the construction system. The chart below shows each performance related with opening design aspect:

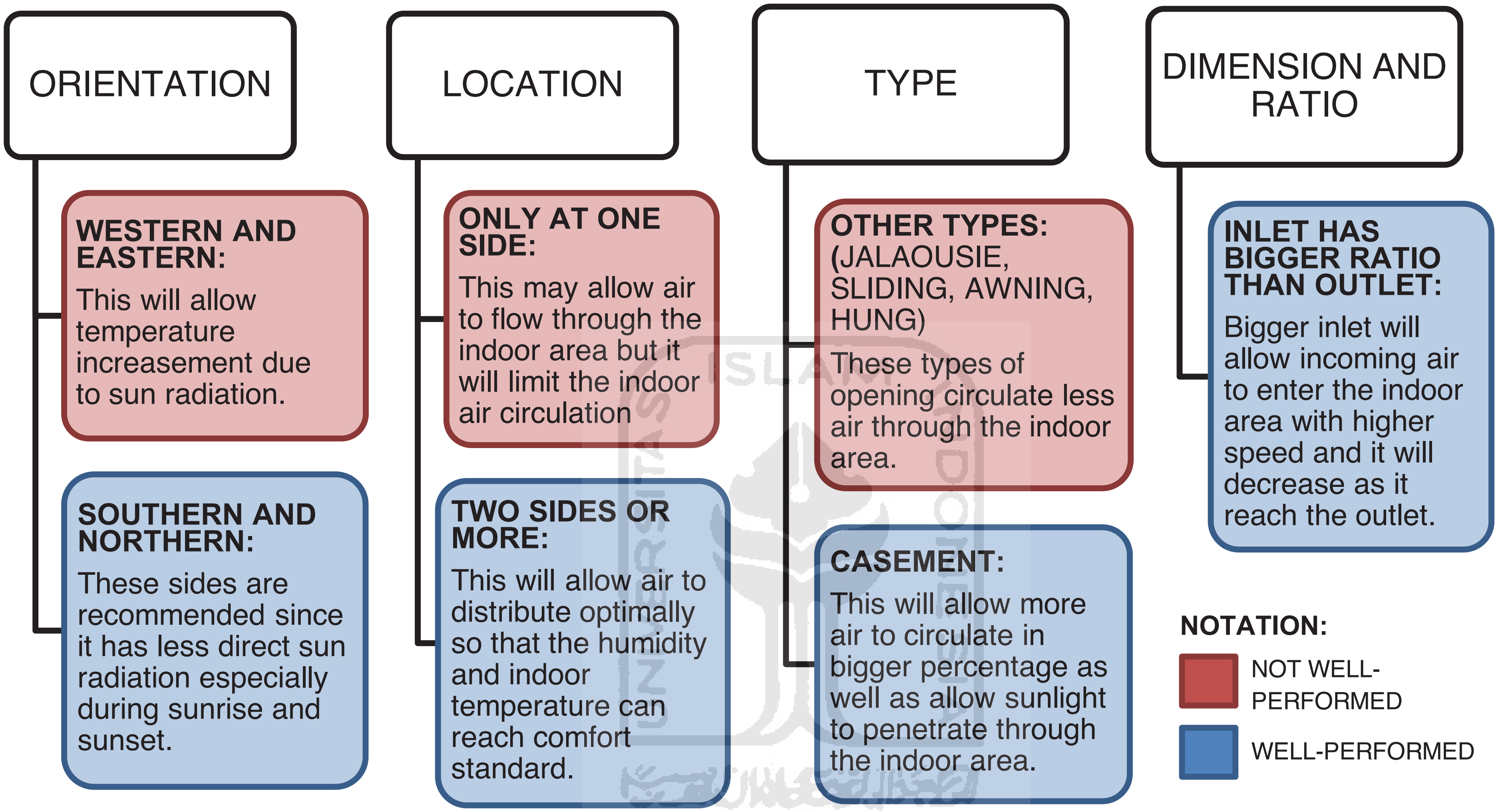


Figure 2.5. Building Opening Performance
Source: Author

Designing opening orientation towards the western and eastern area means that the building will get more sun exposure during the day which eventually cause indoor temperature increase. However, the current climate in Indonesia can be considered relatively hotter the international standard during the day. Therefore, other option related with air circulation needs to be considered, such as providing effective air circulation by providing more opening on two sides of the building, use certain type of window framing that allow more air to flow through the indoor area as well as considering the size of opening itself.

2.3. BUILDING TYPOLOGY STUDY

2.3.1. Residential Building Typology

Based in the building type, housing can be divided into single-family home and multi-family home. Single-family home is a regular landed house that are detached between each unit and usually have ground open area that can be function as garden or parking area. On the other side, multi-family home is a house or a building that is occupied by more than one family. Usually multi-family home are focusing in vertical aspect. Multi-family home means that each unit are occupied by different person or family. (Suh, 2020)

Single-family home is an ideal housing type in terms of providing quality. However, with the rapid development in urban area, another issue related with land availability rise up which results in vertical housing as a way to compromise the situation. Suh (2020) stated that apartment, condominium, and townhouse are several example of multi-family home. Apartment and condominium has similar construction type which is a high-rise building consists of several units in every floor. The major difference between apartment and condominium is the ownership. Apartment units usually rented, while condominium units are owned by its users. The other type of multi-family home is townhouse. It appearance looks like single-family home but it is built very close together and often connected to each other making it look like one building mass. In Indonesia, the term townhouse often compared with cluster housing and defined as single-landed house located in urban area with exclusive facilities owned by a person. Nonetheless, townhouse in other region such as Europe and America can have individual ownership such as conventional landed housing or operate the ownership like condominium.

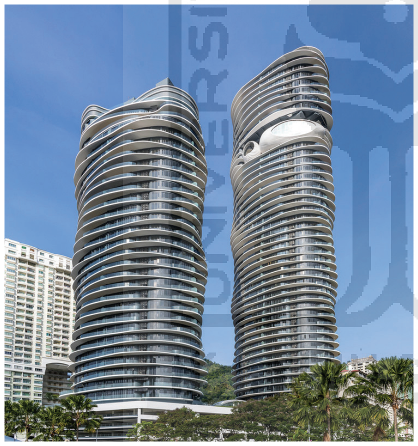




Figure 2.6. Residential Housing (Landed House, Apartment, Townhouse)
Source: https://www.pinterest.com/

In Indonesia, conventional vertical housing usually focused on providing sufficient space for as many potential users as possible which is why apartment or flathouse typology are often used. However, the existence of high-rise residential buildings may cause another issues related with the housing quality itself. Therefore, there is another flat house typology that is not necessarily high-rise building, it is called maisonette or duplex. Maisonette has various meaning depends on its location. In United Kingdom and America, maisonette means a self-contained flat within a larger building, with its own staircase and entrance or a split level flat. In Scotland, maisonette is one of a group of duplex flats, positioned on top of each other as part of a housing block, accessed via a communal entrance. (Miles, 2020)

2.3.4. Occupant Affordability

The existing maisonette typology as briefly discussed before have not yet been used in Indonesia. However, the rent-payment system is similar with existing apartment nearby. Therefore, there will be two study cases listed below. First is the housing cost based on the room type and the other is based on the unit area.

Table 2.2. Apartment Monthly Cost Based on Room Type

Apartment Type: 2BR / Full Furnished

NO	APARTMENT NAME	UNIT AREA (m^2)	RENT PRICE/MONTH
1	Malioboro City	40	5,500,000
2	Taman Melati	36	8,500,000
3	Uttara The Icon	42	4,500,000
		AVERAGE RENT PRICE	6,100,000

Table 2.3.Apartment Monthly Cost Based on Unit Area

Apartment Type: Studio / Full Furnished

NO	APARTMENT NAME	UNIT AREA (m^2)	RENT PRICE/MONTH
1	Student Castle	21	3,300,000
2	Malioboro City	23	2,500,000
3	Taman Melati	22	3,400,000
		AVERAGE RENT PRICE	3,000,000

Based on the list above, the cost estimation for this flathouse project if it is based on the similar room type, two bedrooms and one bathroom, will be six million in average. However, in this project, the cost can be cut half of the ordinary price due to the spatial efficient design of this flathouse. Occupants only have to pay at the same amount as the studio type of typical apartment but will be getting two bedrooms and a bathroom as well as complementary facilities such as communal space and green open area.

Elizabeth Warren in her book of “All Your Worth: The Ultimate Lifetime Money Plan” argues that in order to manage living cost, we have to split the outcome percentage into 50-30-20. 50% is meant for the primary needs, 30% for the secondary needs, and 20% for the tertiary needs. Housing is included in the primary needs alongside clothes and foods. However, in terms of renting a house which there will be long-term payment necessary, means that the amount of money that will be spent must came from stable income money. Therefore, in this case, it is saver to prioritize rent house as 30% outcome type or as secondary needs.

Survey of Living Cost Survey in Yogyakarta conducted by Central Statistic Organization stated that the group that are able to spend 30% of their income to rent a house are the one that has nine million above per month. Thus, there will be 32.19% of citizen in Yogyakarta that will be able to rent this type of house.

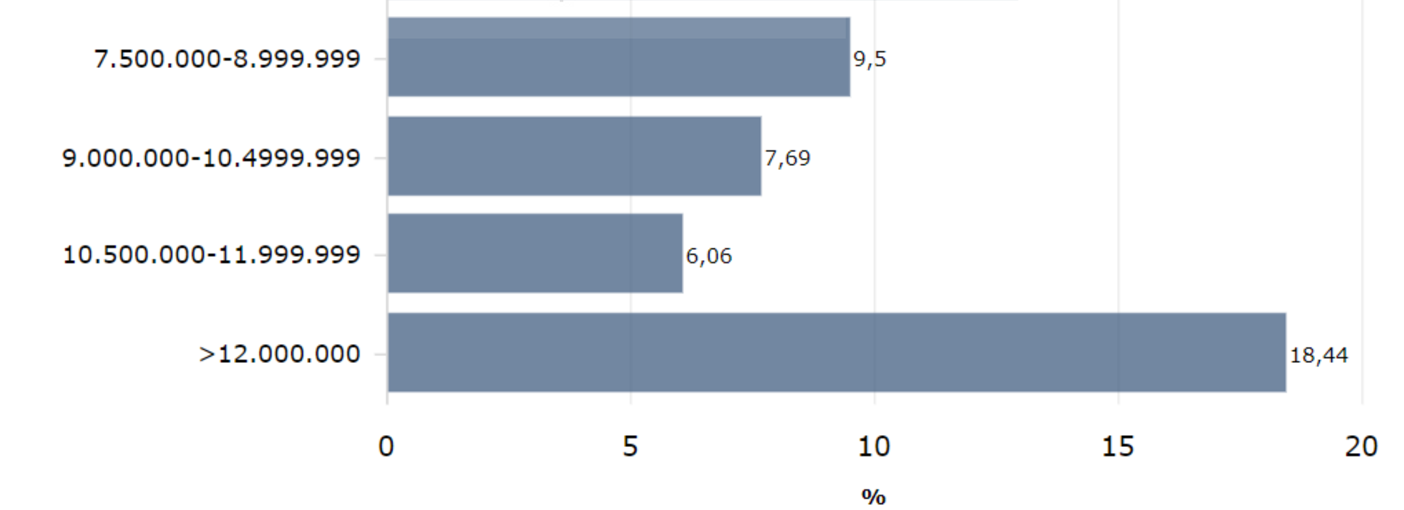


Figure 2.7. Household Income Distribution Group Per Month (2018)
Source: https://databoks.katadata.co.id/

2.4. BUILDING PRECEDENT STUDY

2.4.1. Uma Bulug Guest House, Indonesia

Figure 2.8. Uma Bulug Guest House
Source: https://www.archdaily.com/

Location : Bali, Indonesia
Architect : Biombo Architects

This guest house which located at one of the main destination for tourism in Indonesia has very natural and local vibe from its building material. Similar with this project, the guest house has the same function with flat house, which is for residential purpose. The main attractiveness from this guest house is the stacked red brick on its facade that allows sunlight to pass and it gives certain light pattern for the interior which not only use for aesthetical purpose but also to reduce artificial light during the day.

Passive Cooling System in Tropical Climate
The ground floor of the guest house is an semi-open area. This house provide enough private space without having to build rigid wall to cover all area. This is interesting because the air could flow throughout the entire interior of the ground floor area. Considering the current climate condition in Indonesia, this might be a good precedent of efficient lighting and thermal comfort in housing design. However, the privacy aspect of this area is still provided by creating the outer gate around the ground floor so that the user can have private space within the ground floor although there is no wall in the interior area.

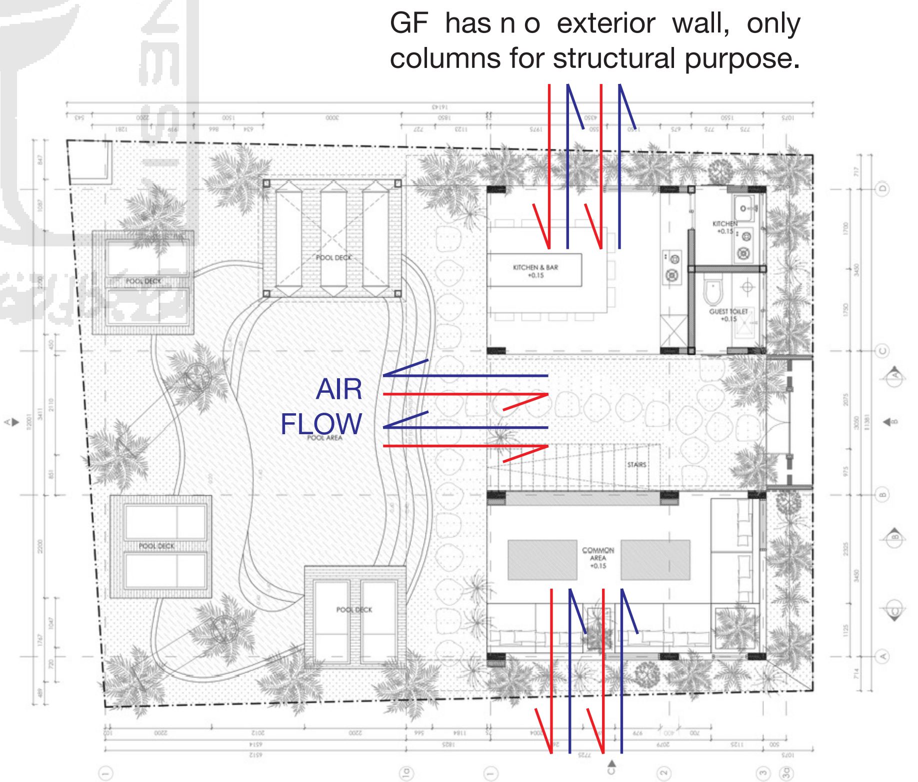


Figure 2.9. Uma Bulug Guest House GF Plan
Source: https://www.archdaily.com/

2.4.2. R Micro Housing, Indonesia

Figure 2.10. R Micro Housing
Source: https://www.archdaily.com/

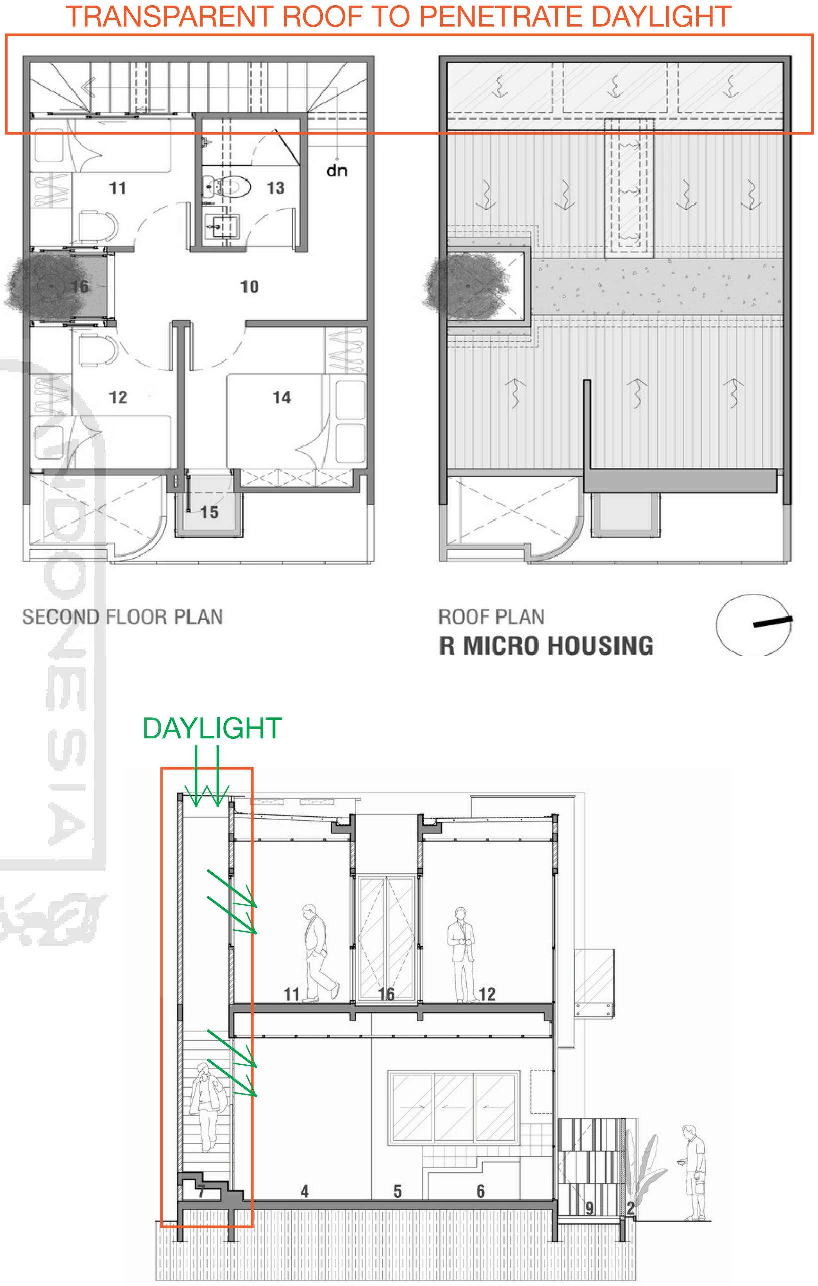


Figure 2.11. R Micro Housing Plans
Source: https://www.archdaily.com/

Location : Surabaya, Indonesia
Architect : Simple Project Architecture

The project is a small housing complex located in dense urban area. With similar concern of land availability, the project focused on providing ideal house with enhancement in spatial and lighting elements. Not only providing sufficient space for housing, the architect even provide small green open area for the housing user desipite how limited the ground area is. The design is very simple and compact yet it looks sophisticated, quite contrast with the neighborhood.

Daylighting Enhancement In Limited Housing Space
The house tries to incorporate as much daylight as possible by providing sizable openings which also functioned as cross ventilation as well as integrating the inner courtyard located on the second floor as a part of the housing design. Not only that, above the staircase area is covered by transparent roof material which allow daylight to penetrate not only to the area within the second floor but also the first floor.

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2.4.3. Group of Yard House Maxiang, China

Figure 2.12. Group of Yard House Maxiang
Source: https://www.archdaily.com/

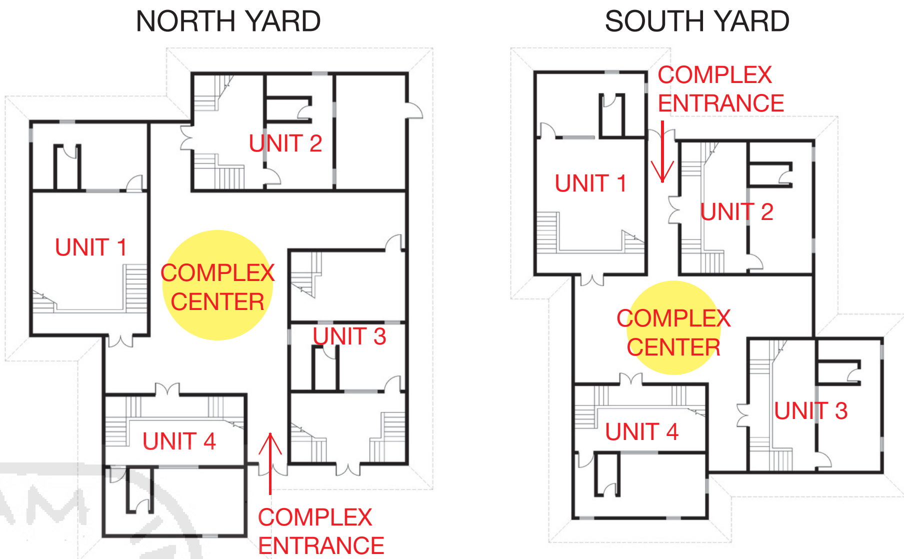

Figure 2.13. Group of Yard House Maxiang Site Plan
Source: https://www.archdaily.com/

Location : Dongxiang Autonomous County, Gansu Province of China
Architect : CU Office

This complex located in a dry climate area where the UV radiation is considered quite extreme due to the duration of daylight. However, the building able to show extreme shadow line throughout many spots during the day because of that particular reason. Thus, that is why the whole exterior has no ornament and painted in white color.

Spatial Integration Between Units

This vertical village located in 800 sqm consists of two masses, the north and the south. The architect has similar concern of how low social interaction between housing users nowadays which become the foundation of their fluid circulation design. Instead of creating rigid modular mass throughout the space, this project split outdoor and indoor area in a way that will allow the user to have interaction when they are not inside the house. They also created multiple leveling to connect each houses into a united vertical village.

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2.4.4. Zero Cottage, San Fransisco

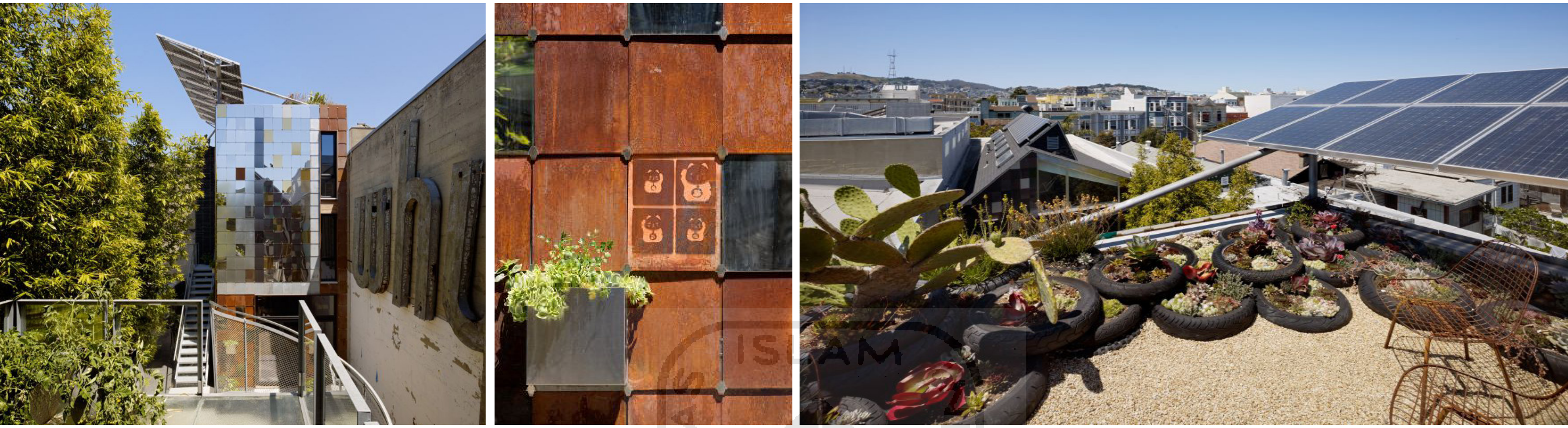


Figure 2.14. Zero Cottage
Source: https://www.dbarchitect.com/

Location : San Francisco, CA, United States.
Architect : David Baker Architects

Zero Cottage is an active mixed-use complex combining cultural, commercial and residential uses located in California that is certified LEED for Homes Platinum. It is the first Passive House-certified home in San Francisco, and achieved Net Zero Certification. This project consists of 66-square-meter loft townhouse set over a 40-square-meter workshop.

Building Technology Application as Performance-Based Design
Since the concept of the building is to be able to become sustainable building that can self-produce their own energy as well as reduce the energy used, the rooftop of the building is covered by green roof as well as solar panel located next to the rooftop to provide energy that will be used to power the building.

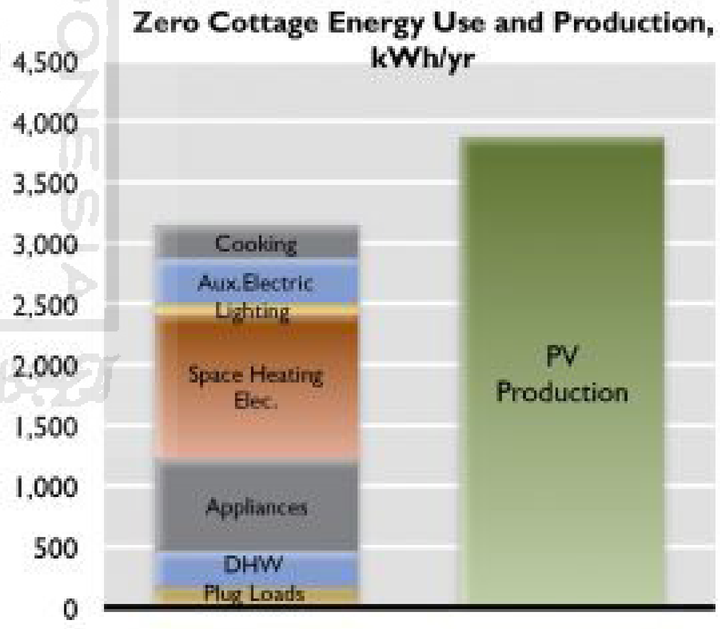


Figure 2.15. Zero Cottage Energy Use and Production
Source: https://www.dbarchitect.com/

ANNUAL ENERGY USE
Actual : 2,897 kWh/yr
Simulated/Design : 3,012 kWh/yr

ANNUAL ENERGY PRODUCTION
Actual : 5,533 kWh/yr
Simulated/Design : 4,517 kWh/yr

2.5. DESIGN PROBLEM MIND MAP

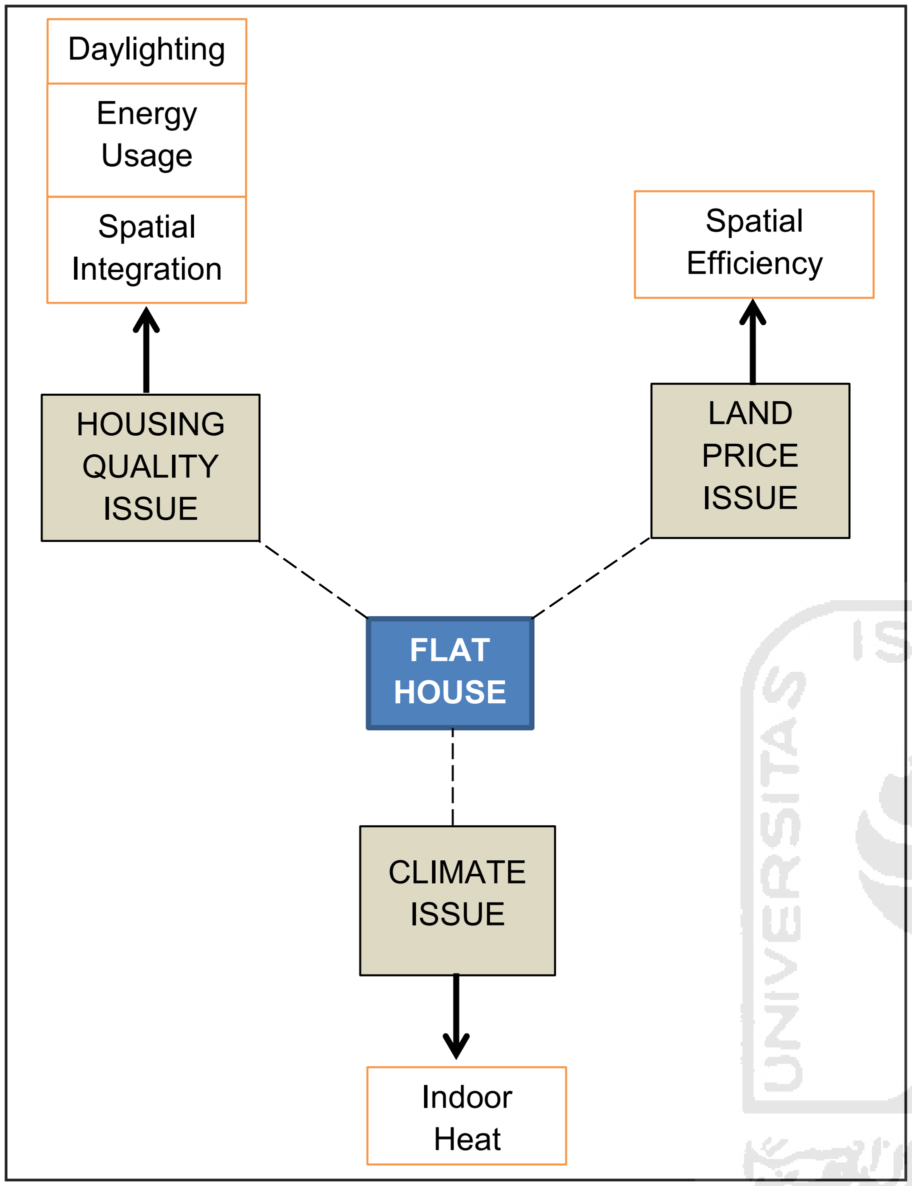


Figure 2.16. Design Problem Mind Map
Source: Author

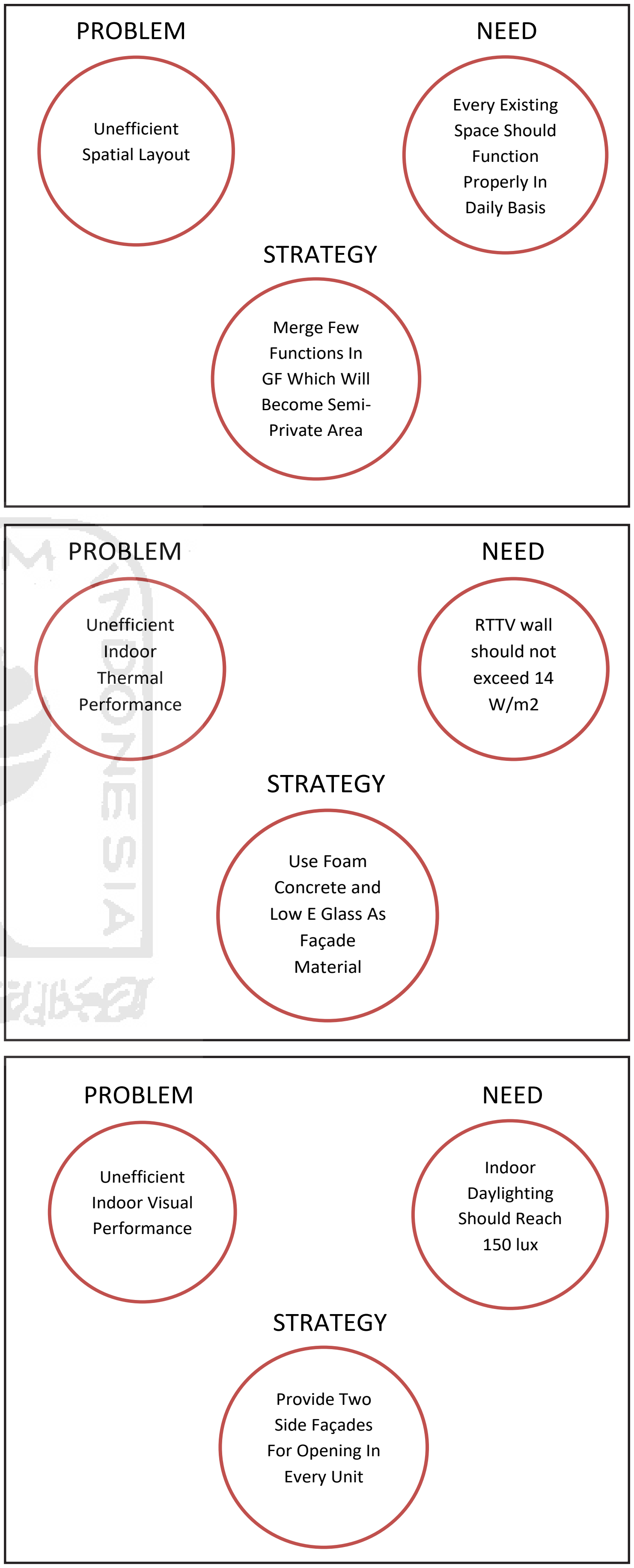


Figure 2.17. Design Strategy Mind Map
Source: Author

3

CHAPTER THREE
DESIGN RESULT AND PROOF

SITE CONTEXT EXPLORATION
DESIGN THEME EXPLORATION
BUILDING FUNCTION EXPLORATION
DESIGN SIMULATION

3.1. SITE CONTEXT EXPLORATION

3.1.1. Wind Flow

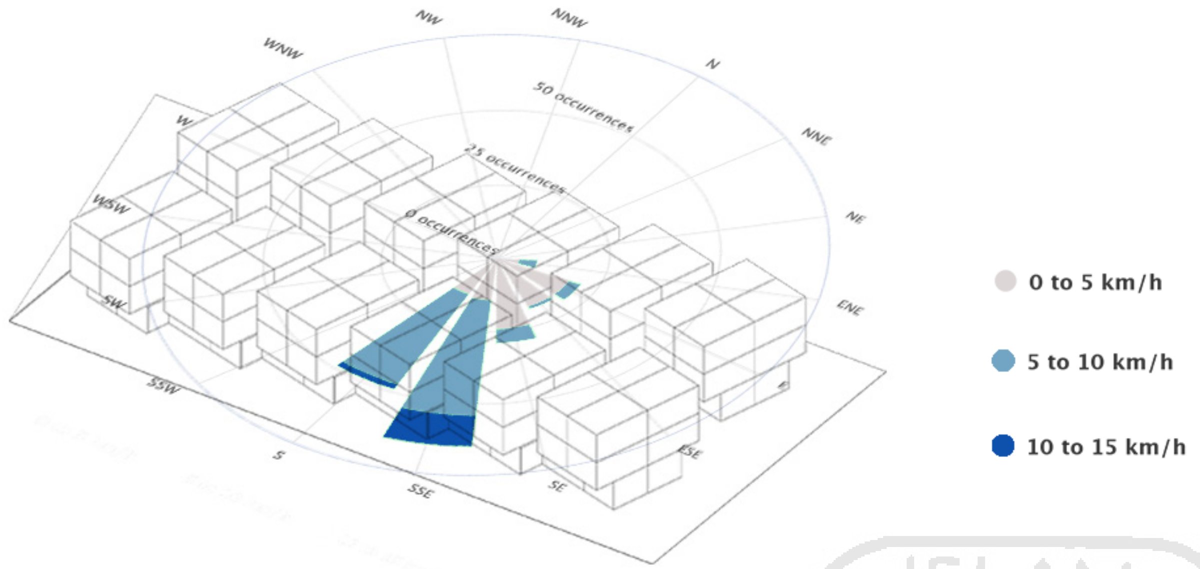


Figure 3.1. Site Wind Direction
Source: Author

Based on the analysis, the wind flow mostly from the south and east and both directions provide wind flow throughout the year. Thus, each unit should have facade that allows wind from either east or south to flow through. Since each unit will have two facades, front and side facade, the facade option should be either north-south or west-east. However if the building mass orientation is tilted, although there are still only two facades exist, but it will allow the air flow from at least three-directions.

3.1.2. Sun Radiation

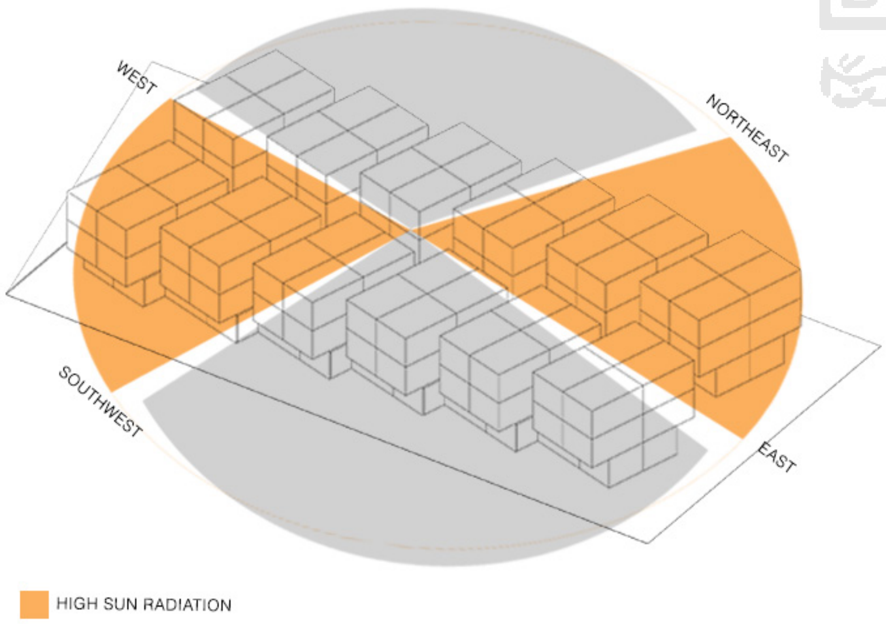


Figure 3.2. Site Sun Radiation Direction
Source: Author

Baharuddin (2013) stated that sun radiation towards vertical surface varied throughout the year and is affected by the time and orientation. The biggest radiation comes from the surface that has east, northeast, west, and southwest orientation. While the least radiated comes from the south orientation. Based on that, it is better to avoid exposing building orientation towards east, northeast, west and southwest direction. However, due to spatial layout limitation, it is impossible to create all unit without those directions. Therefore, the building mass will be tilted in a way so that the building that has northeast and southwest orientation is the side that has less facade area.

3.1.3. Sun Shading Impact on Site Plan

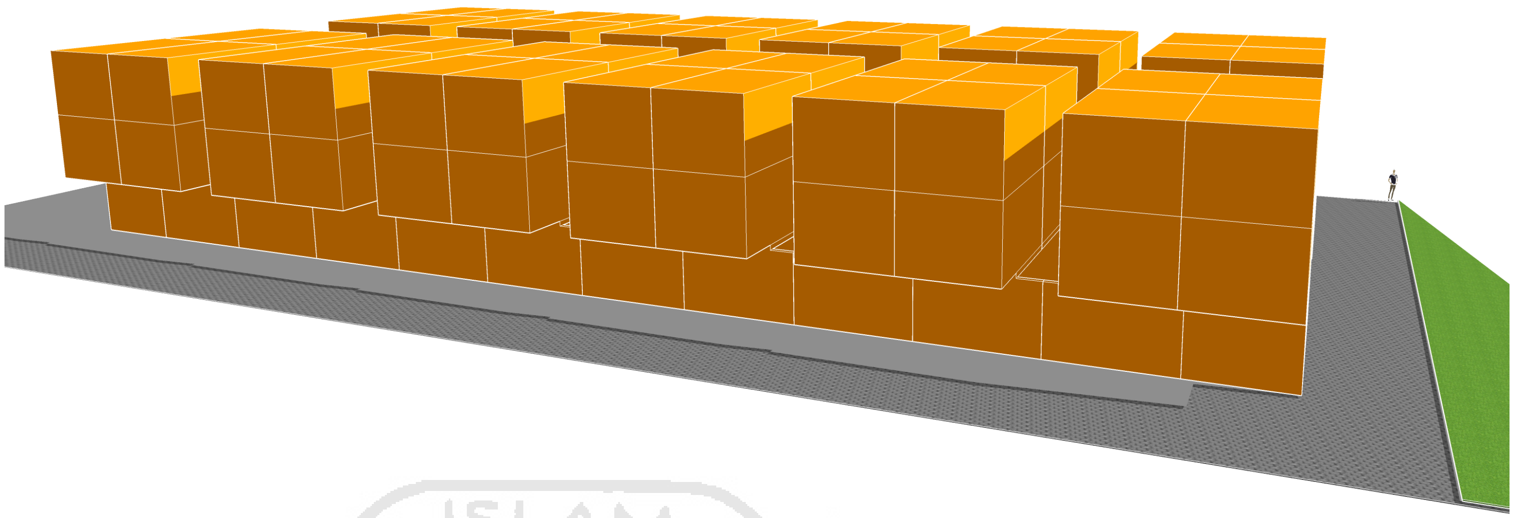


Figure 3.3. Site Plan Daytime Shading
Source: Author

During the daytime, the ground floor and the first floor tend to get shaded by the mass beside it. This will help decrease the heat transfer especially during sunrise from the eastside and sunset from the westside. However, this does not apply to the highest floor, second floor, and the mass located on the outer part of the housing complex. This various shade affects the thermal performance in each mass. The unit located at the higher floor tend to have higher heat transfer than the unit located at the lower floor. Therefore, those unit that have less shaded area from the neighborhood mass will be provided with secondary skin to ensure the thermal performance between each unit will most likely be similar.

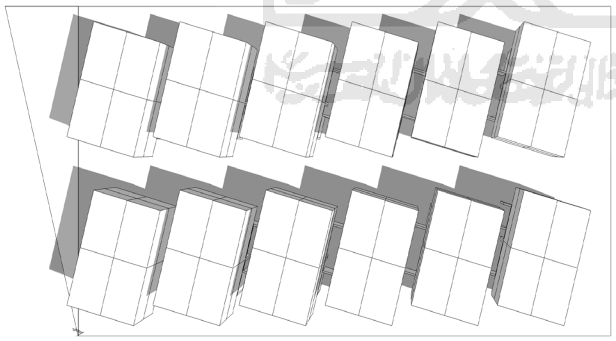


Figure 3.4. Site Plan Morning Shade
Source: Author

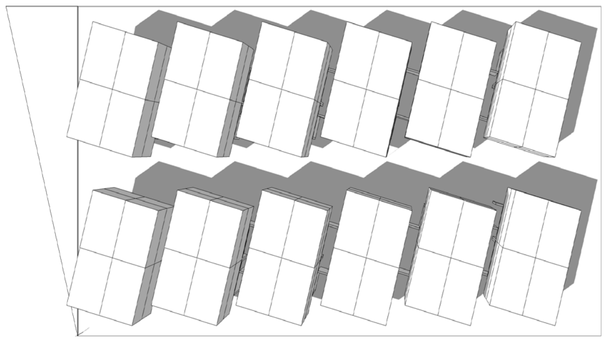


Figure 3.5. Site Plan Afternoon Shade
Source: Author

3.1.4. Site Circulation

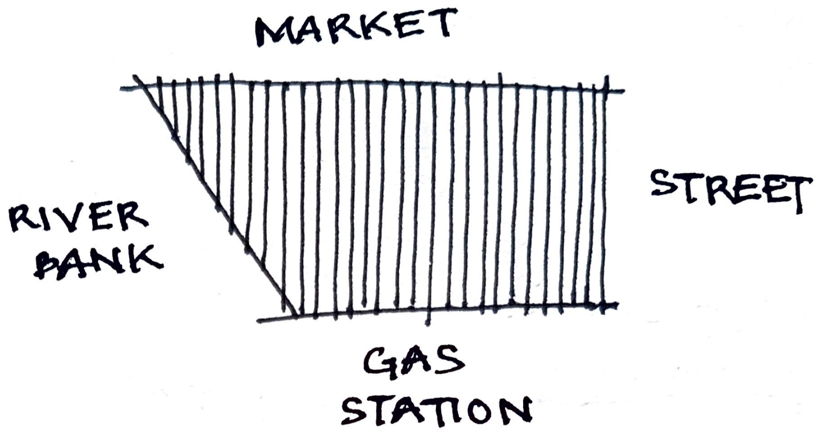
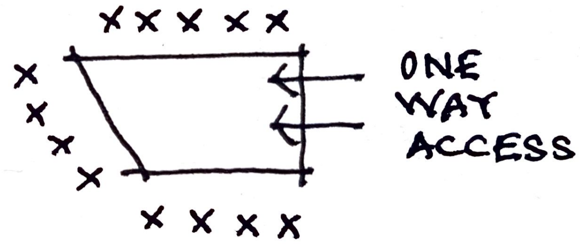


Figure 3.6. Site Barrier Scheme
Source: Author

SITE ACCESS

There is only one side that have direct access to the main street which will be used as main access to the site. The rest of the site are adjacent to another buildings.



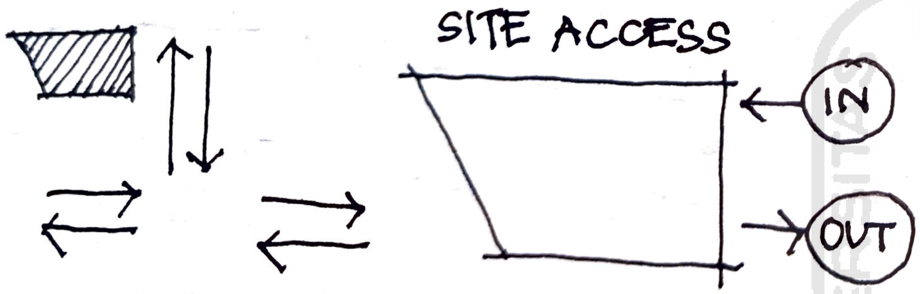


Figure 3.7. Site Circulation Scheme
Source: Author

SITE ENTRANCE

Since the site located near traffic lamp intersection, it is possible that the circulation to the site will cause traffic jam. Therefore, the entrance will be located on the furthest side of the site, which is the northeast, to decrease the possibility of traffic jam.

SITE CIRCULATION CONCEPT DEVELOPMENT

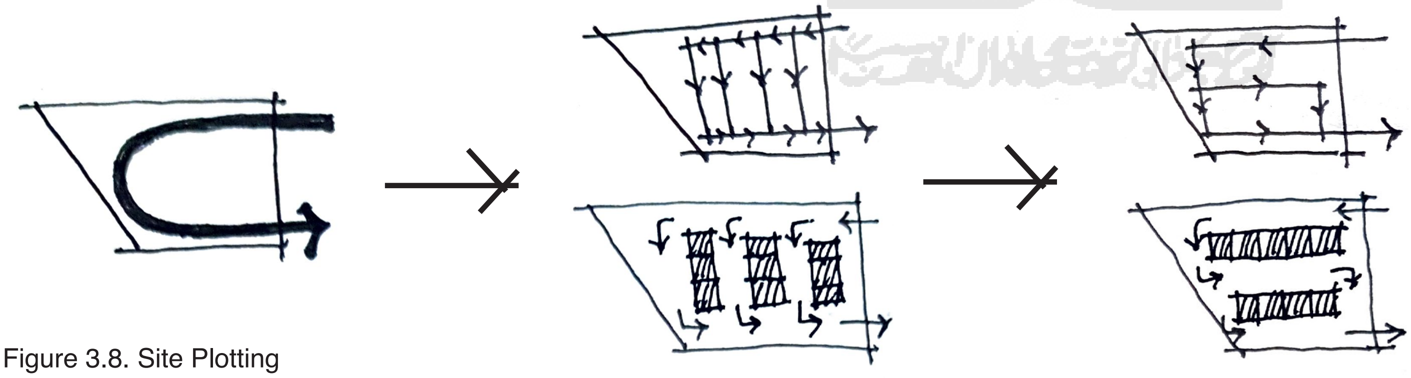


Figure 3.8. Site Plotting
Source: Author

The idea is to circulate the house complex from northeast to the southeast as seen on the figure above.

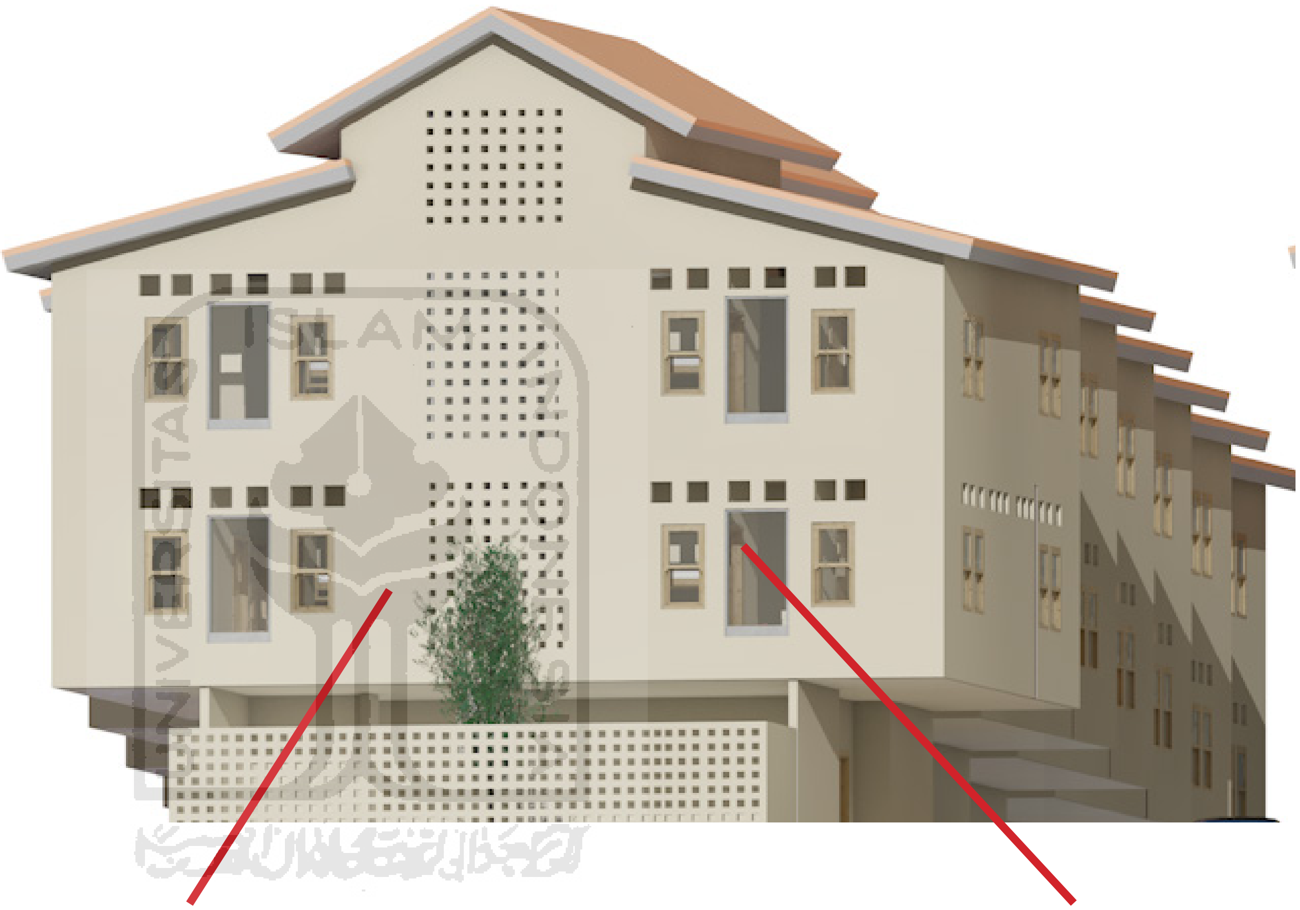
Initially, the access will be split into multiple alley arranged horizontally as seen above. However, it takes too much space and eventually decrease the possible amount of building mass in order to create these type of linear circulation.

To maximize the available spaces and provides more masses, the circulation arranged as seen above. Instead of creating many alleys, there will only be three one-way alleys.

3.2. DESIGN THEME EXPLORATION

3.2.1. Thermal Performance

In terms of providing thermal quality, exposing the interior without proper heat filter could lead to temperature increase which may cause overheat and user uncomfort. According to research conducted by Brunner et al. (2015), foam concrete is one of building material that can become wall construction alternative due to its capability of insulate heat. As for initial concept, the glass facade wil be using coated glass such as Low Emissivity Glass and the wall will be using AAC Block instead of ordinary red brick. For facade near the stairs, it will be covered by alumunium panel in order to let the air circulate freely to the indoor area and even through the housing unit area.



One of the option to improve indoor thermal comfort is by having proper envelope design since building envelope will transfer the heat. Thus, to filter the unwanted heat, AAC Block is choosen due to its capability of filtering heat radiation.

Related with building visual performance or daylighting performance, it is necessary to have proper opening that allows light to penetrate throughout the interior. However, opening design increase the amount of heat transfer as well. Therefore, Low E Glass is choosen due to its capability of insulating heat.

Figure 3.9. Building Thermal Envelope Scheme
Source: Author

WINDOW MATERIALS

Low Emissivity Glass
(Low E Glass)

Figure 3.10. Low E Glass
Source: https://www.pinterest.com

Table 3.1. Clear Glass and Low E Glass Comparison

CLEAR FLOATED GLASS	LOW E GLASS
Offers no additional performance benefits in terms of insulation or reduction in solar heat gain.	Provides improved insulation properties and is a good choice in all climate situations.
Visually colourless and distortion free glass providing high light transmission (daylight) and clarity.	Has a thin metallic coating on the glass that reflects the thermal radiation rather than absorbing it, improving insulation.

Low Emissivity Glass or known as Low E Glass is a type of glass that have transparent coating which allows heat transfer to be reduced in both sides, exterior and interior, without minimizing the amount of daylighting that enters the building.

WALL MATERIALS

Autoclaved Aerated Concrete Block
(AAC Block)

Figure 3.11. Foam Concrete
Source: https://www.pinterest.com

Table 3.2. Red Brick and Foam Concrete Comparison

RED BRICK	FOAM CONCRETE (AAC BLOCK)
Tend to absorb heat and release it at night.	Able to prevent heat radiation but not absorb heat.
Dead load on the structure is low which reduces the consumption of cement, steel, and water.	Heavy dead load on the structure.
Emit less heat in the atmosphere due to less use of cement, steel, and concrete.	Emits high heat to the atmosphere.

Autoclaved Aerated Concrete Block also known as Foam Concrete is a type of brick that is light-weight, precast, that are also known as environmental-friendly material which do not require curing and plastering in the construction method.

3.2.2. Visual Performance

In order to provide sufficient daylighting that could save electricity usage, every housing unit will have two side facades. The opening will not only allow light to penetrate through the unit interior but also allow air to circulate well, Based on the literature study, overall residential daylighting light level should reach 150 lux. However, that level is not enough if the users are working in the unit. For instance, there might be users who need to study during the day. For these purpose, the light level neccessity increase up to 500 lux.

HOUSING UNIT ROOM

Room	User and Possible Activities	Room Needs
BEDROOM 1	User: Parents (Adults) Possible Activities: - Rest, Sleep - Work (Through book or gadgets) - Read, Write, Watch Knowledges/Entertainment	Room Needs: The priority need of lighting is when the room is used for working which light level is 500 lux.
BEDROOM 2	User: Children, Teenagers Possible Activities: - Rest, Sleep - Study (Through book or gadgets) - Play Games - Hobby Development (Sewing, Drawing, Play Music Instrument, etc.)	Room Needs: The priority need of lighting is when the room is used for studying which light level is also 500 lux.
LIVING SPACE	User: Adults, Children Possible Activities: - Family Interaction (Conversation) - Play Games - Eat and Drink	Room Needs: Since no certain work that needs high light level, light level requires here is 150 lux.
BATHROOM	User: Adults, Children Possible Activities: - Shower - Pee - Wash	Room Needs: Since no certain work that needs high light level, light level requires here is 150 lux.

Figure 3.12. User Activity and Room Daylighting Needs
Source: Author

FACADE CONCEPT

Two fulfill the housing quality requirement, each unit will consists of two facades. Therefore, there will be two side of the building taht will get direct daylighting

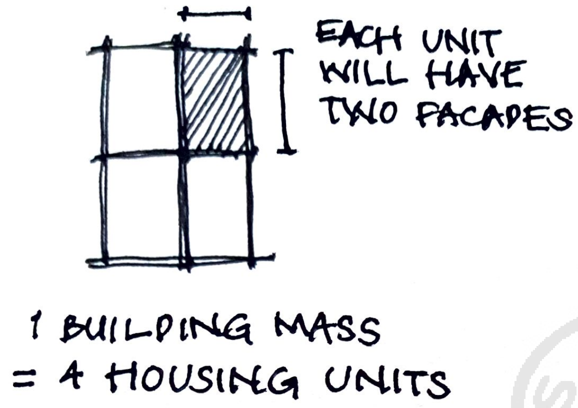


Figure 3.13. Housing Unit Plotting
Source: Author

SPATIAL LAYOUT PRIORITY

Based on the user activity analysis, there are two rooms that need to be prioritized in order for these function to be able to perform well. These prioritized room will be located near the daylighting source.

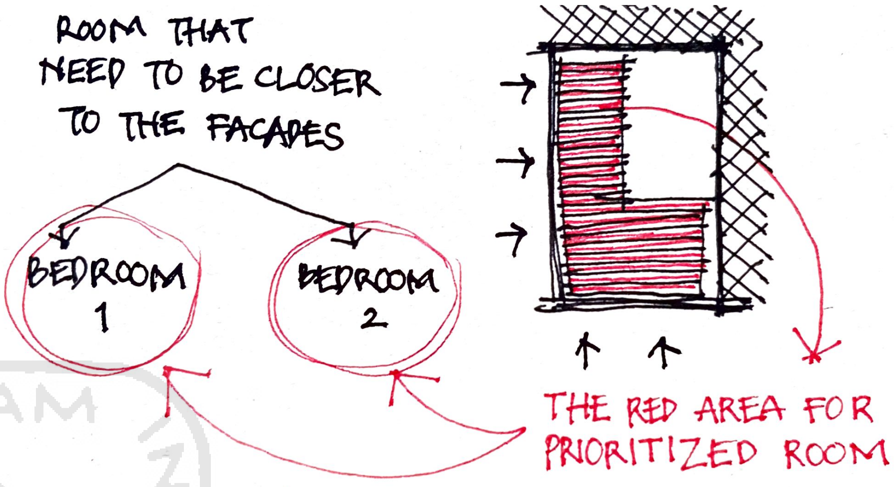


Figure 3.14. Room Daylight Priority
Source: Author

ROOM PLOTTING CONCEPT DEVELOPMENT

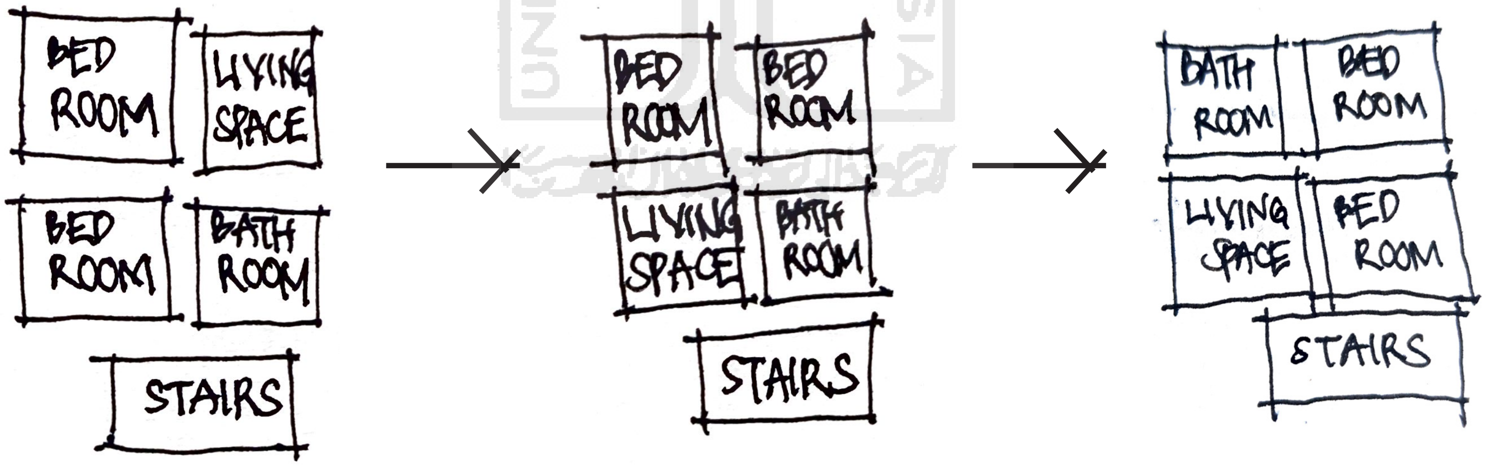


Figure 3.15. Room Plotting
Source: Author

The bedroom located next to facade as both bedrooms are included as prioritized room. However, the access to enter the housing unit will be disturbed.

The other bedroom is exchanged position with the living space. The unit circulation is now perform well. However, the room might have better view to the inner courtyard rather than the street.

The position of the bathroom is now exhanged with the bedroom. The bedroom will gain daylighting as well as have great view to the inner courtyard.

3.3. BUILDING FUNCTION EXPLORATION

3.3.1. User Activity

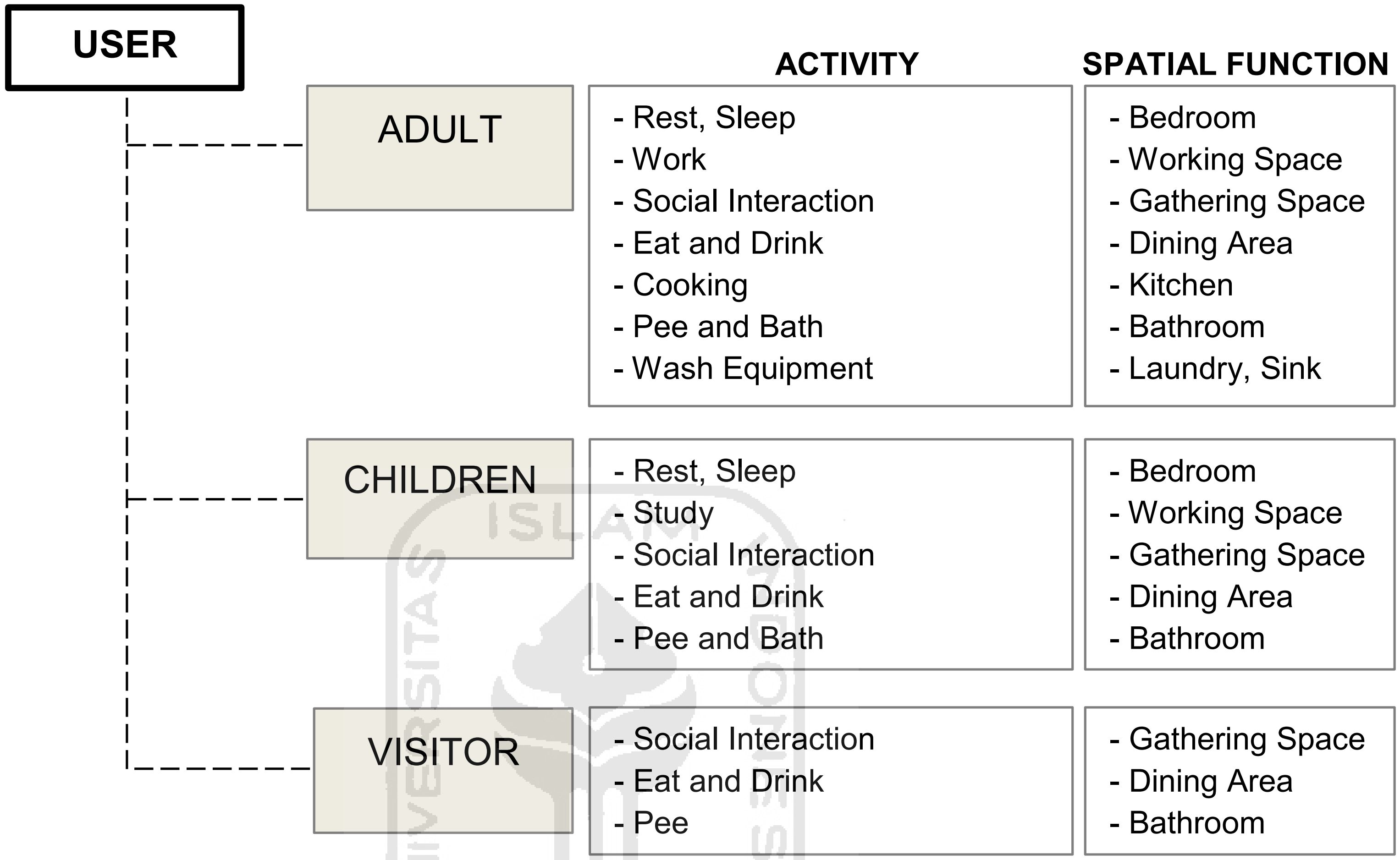


Figure 3.16. User Activity Data
Source: Author

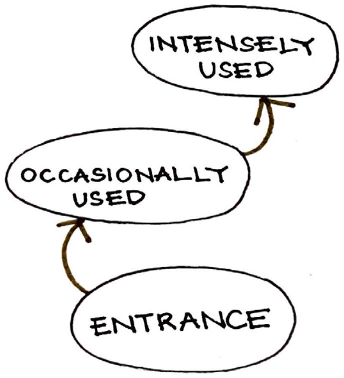


Figure 3.17. Function Hierarchy
Source: Author

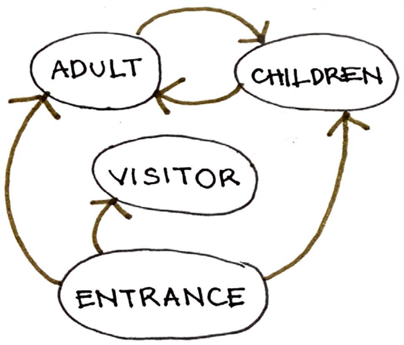


Figure 3.18. User Hierarchy
Source: Author

From the data above, there are several function that is used by all the users including gathering space, dining area, and bathroom. But the intensity of these spatial function may be different. For instance, the kind of social interaction for the regular users, adult and children, with the kind of social interaction for visitor with the user wil be different. Therefore, the gathering space for that will be split into two spatial type based on the functional hierarchy. The access will also affect the room plotting. So, the user hierarchy will be divided by visitor and regular user, adult and children.

3.3.2. Spatial Function Efficiency

Lang (1987) argues that human needs these several aspects available in residential building: physiological, safety, affiliation, esteem, actualization, and cognitive or aesthetic. Based on those aspects, it can be concluded that several functions in housing layout listed as follows:

Table 3.3. Residential Room Function

	CONVENTIONAL LANDED HOUSE	CONVENTIONAL APARTMENT	TERBAN FLAT HOUSE
GUEST ROOM	•		
LIVING ROOM	•	•	•
BEDROOM	•	•	•
KITCHEN	•	•	
DINING ROOM	•	•	
BATHROOM	•	•	•

Based on research conducted by Putri and Prianto (2016), average conventional housing do not consider the existence of dining room. The users tend to eat somewhere else, such as in living room or any other gathering space that is not specifically dining room. This also goes the same for guest room considering the user did not welcome guest every day, guest room become less functional. Therefore, certain activities in residential area actually can be merged in one functional area in order to increase the spatial layout effectiveness.

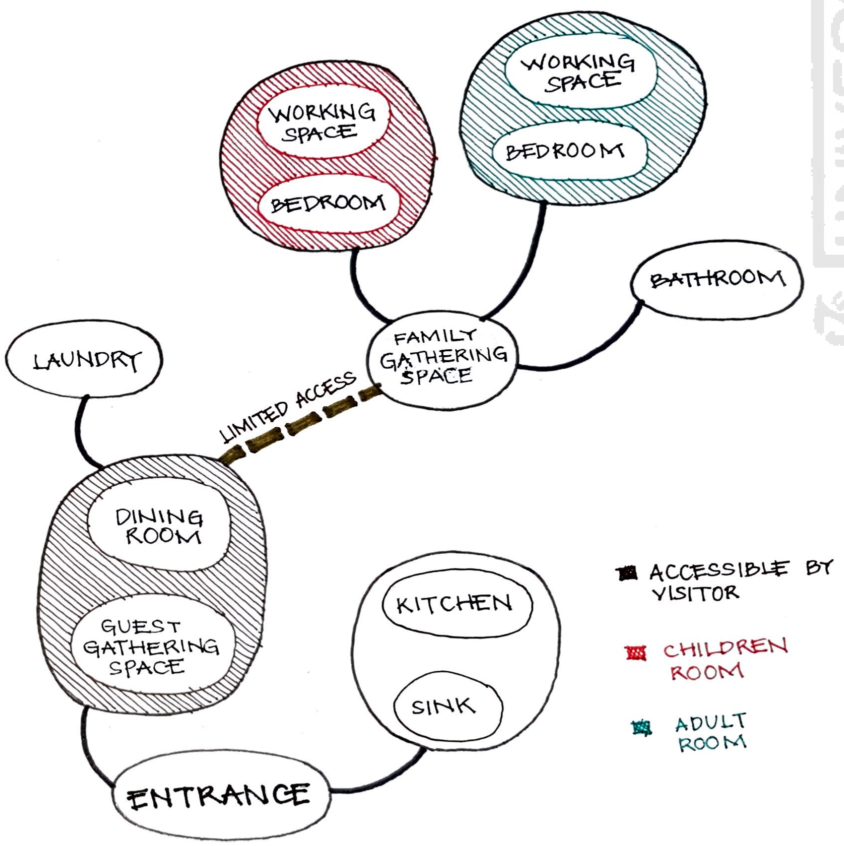


Figure 3.19. Bubble Diagram
Source: Author

In conventional apartment, small studios often shrink the kitchen into kitchenette which usually has refrigerator, microwave, and sink only. Kitchen itself is indeed one of the most important elements in housing design. However, the essence of kitchen needs nowadays can be replaced by ordering food through delivery service or take away dishes from restaurants nearby. Especially in urban area where restaurants are usually only one block away. Thus, kitchen in average urban area housing is either removed or shrinked.

In Terban Flat House, rather than removing dining room, guest room, and kitchen which may be important for certain occasion, those three elements will be merged as one communal space which can be accessed collectively by several users from different units and it will become semi-private space. While the unit will consist of other functions that are effectively used in daily, such as bedroom, bathroom, and living room for family-scale gathering space.

3.4. DESIGN SIMULATION

3.4.1. Daylighting Simulation

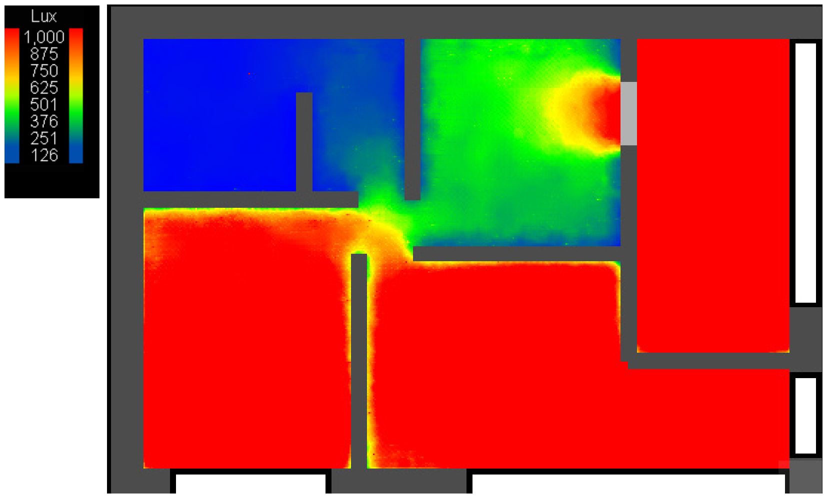


Figure 3.20. Initial Unit Layout
Daylighting Simulation
Source: Author

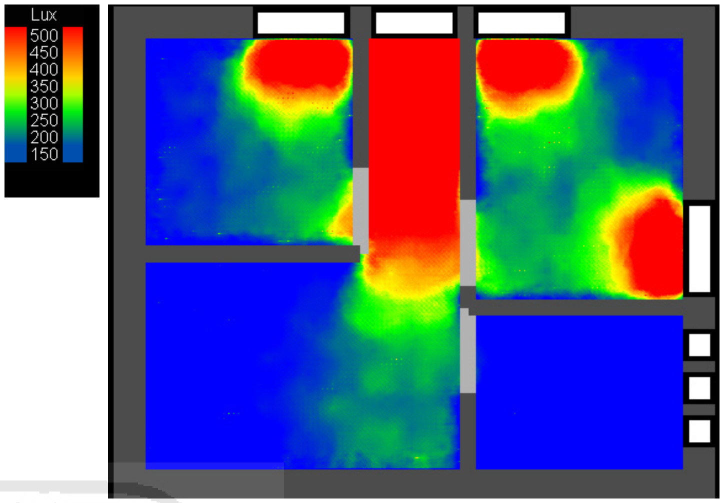


Figure 3.21. Final Unit Layout
Daylighting Simulation
Source: Author

Most area of the floor plan are coloured red which means that the illuminance level in those areas reach approximately 1000 lux which considered too bright for residential purpose. Furthermore, these type of layout and opening will allow more heat to penetrate throughout the interior area which theoretically will cause another thermal issue.

Most area of the floor plan are coloured blue which means that the illuminance level are up to 150 lux which considered good for overall residential purpose. The area that has red colour located in the bedroom which will be used as working space. Therefore, the 500 lux requirement of the working area can be achieved through this type of layout and opening.

3.4.2. Wind Flow Simulation

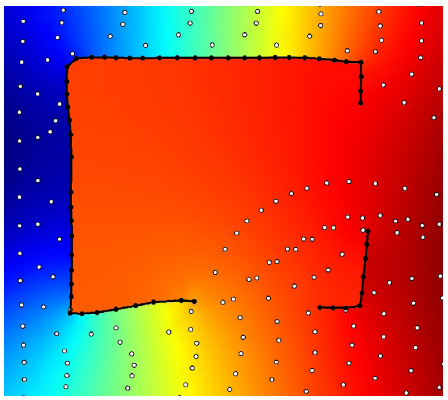


Figure 3.22. Straight Mass Orientation
Mesh Flow Simulation
Source: Author

Based on the climate analysis, majority of the wind flow from the south, east, and west. This unit only has east and north facade and the simulation shows the air flow from the south. This type of orientation will eventually bring disadvantages for the building performance since there are no opening facing to the wind direction throughout the year.

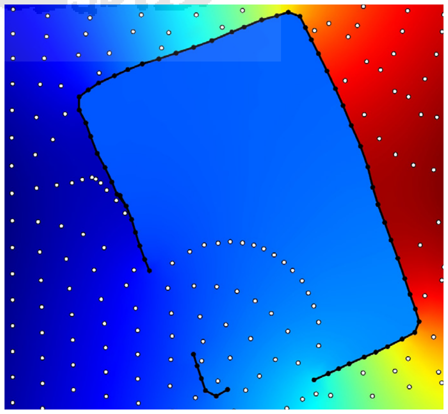


Figure 3.23. Tilted Mass Orientation
Mesh Flow Simulation
Source: Author

On the other hand, if the mass is tilted, there will be air flow from the south that can enter the unit indoor area and circulate well as shown on the graphic. This orientation will allow more unit air circulation performance to be enhanced rather than having the orientation not being tilted.

3.4.3. Envelope Material Calculation

Based on SNI 6389:2011 related with Envelope Energy Conservation in Building, the allowable OTTV value in Indonesia is 35 W/sqm. However, the implementation of OTTV in Indonesia are usually for the large-scale building such as high-rise building which make the current OTTV less applicable for residential buildings. Therefore, in residential scale, Hongkong Government issued a practice note namely Design and Construction Requirements for Energy Efficiency of Residential Buildings. To enhance energy efficiency of residential buildings, the RTTV of wall should not exceed 14 W/sqm. This standard is the one that is used for the OTTV parameter in this project.

Table 3.4. Red Brick Wall OTTV Calculation

No	Side	Conduction Through Wall	Conduction Through Opening	Radiation Through Opening	Total	Façade Area Total	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D = A + B + C	E	D / E
1	NORTH	373.47	-	-	373.47	15.00	24.90
2	NORTHEAST	-	-	-	-	-	-
3	EAST	448.16	-	-	448.16	18.00	24.90
4	SOUTHEAST	-	-	-	-	-	-
5	SOUTH	373.47	-	-	373.47	15.00	24.90
6	SOUTHWEST	-	-	-	-	-	-
7	WEST	373.47	-	-	373.47	15.00	24.90
8	NORTHWEST	-	-	-	-	-	-
		1,568.56	**-**	**-**	**1,568.56**	**63.00**	**24.90**
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL

Do not fullfil the requirement.

Table 3.5. Foam Concrete Wall OTTV Calculation

No	Side	Conduction Through Wall	Conduction Through Opening	Radiation Through Opening	Total	Façade Area Total	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D = A + B + C	E	D / E
1	NORTH	121.69	-	-	121.69	15.00	8.11
2	NORTHEAST	-	-	-	-	-	-
3	EAST	146.03	-	-	146.03	18.00	8.11
4	SOUTHEAST	-	-	-	-	-	-
5	SOUTH	121.69	-	-	121.69	15.00	8.11
6	SOUTHWEST	-	-	-	-	-	-
7	WEST	121.69	-	-	121.69	15.00	8.11
8	NORTHWEST	-	-	-	-	-	-
		511.09	**-**	**-**	**511.09**	**63.00**	**8.11**
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL

Has already fullfil the requirement.

3.4.3. Energy Usage Calculation

The daylighting and thermal enhancement within the housing unit allows the energy usage inside a household to be reduced, especially inside the housing unit itself. The two of the main energy source that we focused on is the artificial lighting fixture and the active cooling fixture which is the lamps and the air conditioner. Therefore, it is measured through calculation below of how the design will be able to minimize the usage of those fixtures mentioned before.

Table 3.6. Housing Unit Energy Usage Calculation

AMOUNT	POWER NEEDS	USAGE PER DAY (HOUR)	TOTAL POWER (WATT)	TOTAL POWER PER DAY
Normal Usage				
4	LED Lamps	16	8.5	544
2	Air Conditioner	16	750	24,000
			TOTAL	24,544
Efficient Usage				
4	LED Lamps	5	8.5	170
0	Air Conditioner	-	-	-
			TOTAL	170

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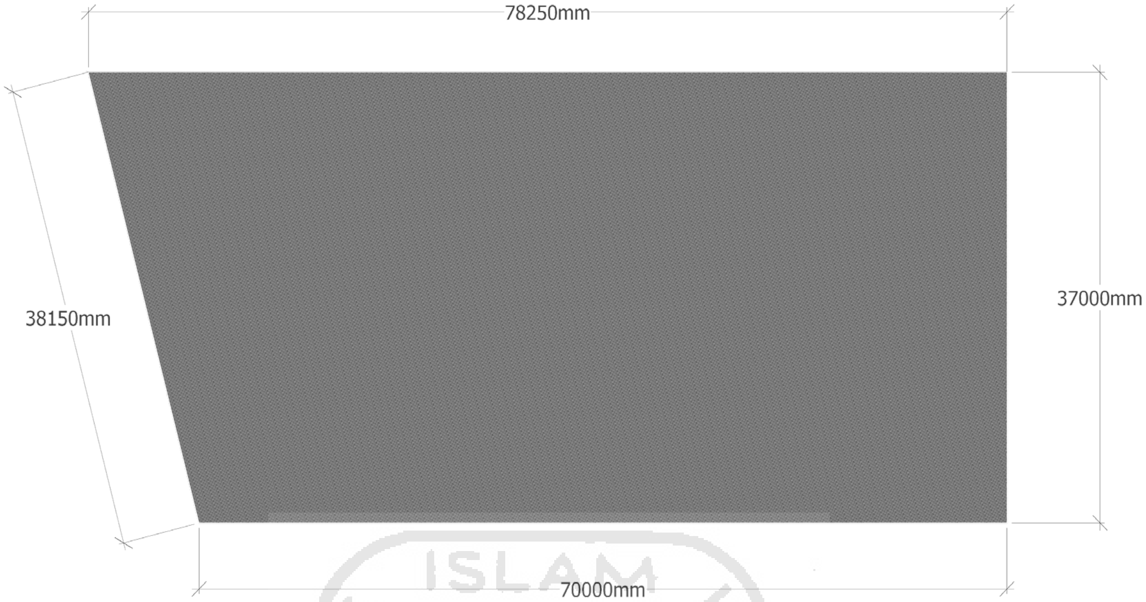
CHAPTER FOUR
DESIGN RESULT DESCRIPTION

Property Size and Room Programming
Site Development
Housing Mass Layout
Building Envelope Design
Structure and Infrastructure
Building Safety
Barrier-Free Design

4.1. PROPERTY SIZE AND ROOM PROGRAMMING

4.1.1. Property Size



Total area of the site is 2835 sqm which based on the local government regulation, 30% until 90% area of the site can be build. The site has trapezoid shape following the existing contour of Code Riverside.

Figure 4.1. Site Plan Measurement
Source: Author

SITE AREA	**2835 SQM**
BUILDING COVERAGE RATIO	1,509 SQM

Based on the local regulation, the BCR percentage should be around 30 - 90% of the total site area.
Local Regulation : 850 - 2550 sqm

The total ground floor area is 768 sqm with the addition of vehicle circulation of 741 sqm, meaning that the total building coverage area that will be used is approximately 1,509 sqm.

FLOOR AREA RATIO	3,456 SQM

Based on the local regulation, the FAR coefficient should be around 0,3 - 4,8 of the total site area.
Local Regulation : 850 - 13,600 sqm

Every building consists of 4 storeys. The ground floor has 64 sqm, the first and second floor has total of 192 sqm, and the rooftop has 32 sqm. Every mass has total of 288 sqm area and there will be total of 12 building masses.

BUILDING HEIGHT	4 STOREYS (12 METERS)

The local regulation allows building to have height up to 32 meters. Thus, in this project the tallest building height will be 12 meters which equals to 4 storeys building.

4.1.2. Spatial Zoning and Plotting

VERTICAL ZONING AND PLOTTING

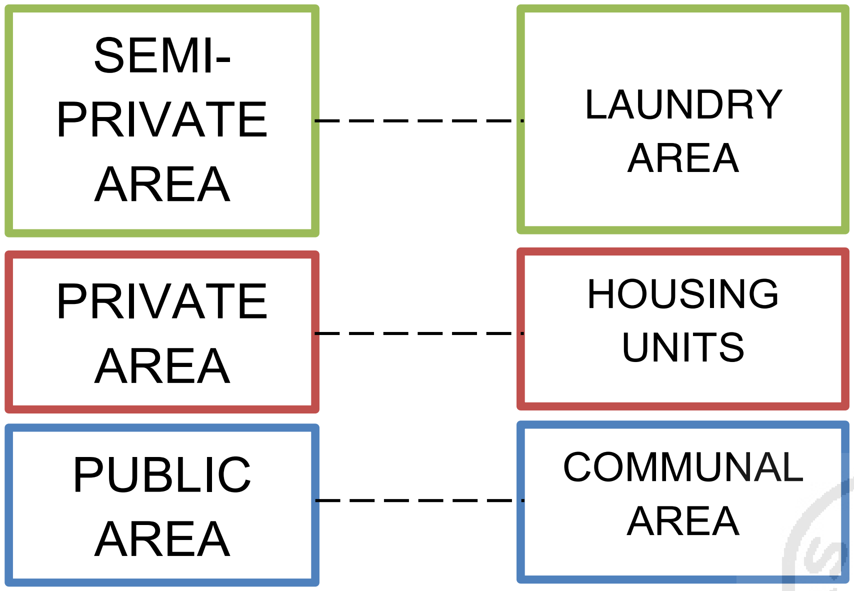


Figure 4.2. Vertical Mass Zoning
Source: Author

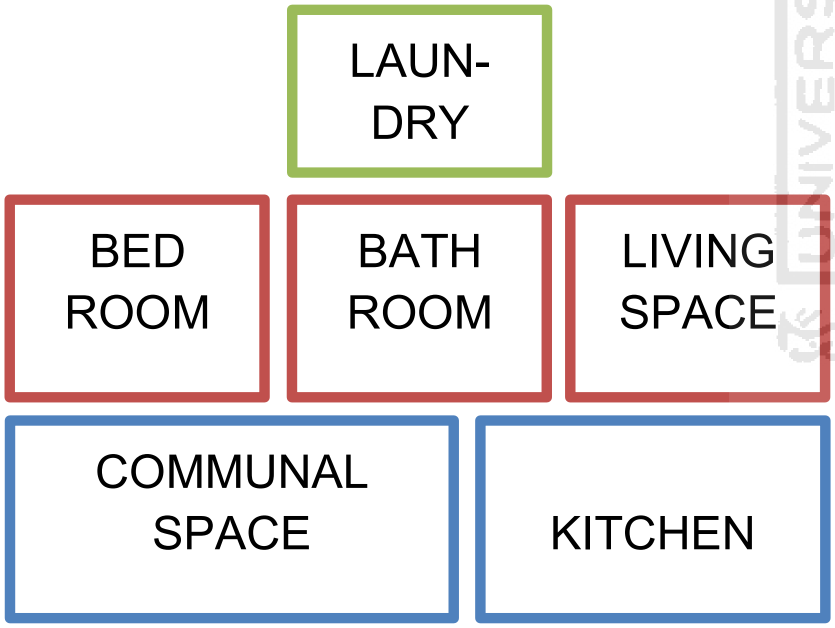


Figure 4.3. Vertical Mass Plotting
Source: Author

Based on the user analysis and spatial efficiency analysis, it is concluded that every mass will be divided vertically based on the privacy priority. The public area will be located on the ground floor which is accessible for visitor. Then, the upper floor will be used for the housing units which can only be accessed by the house owner. On the rooftop, there will be semi-private area which can be accessed by the occupants collectively.

Maisonette in general consists of two-storeys which in every floor owned by different users. This idea of splitting floors into units in one building mass become the zoning background of Terban Flat House as well. In every building mass of Terban Flat House will consists of four storeys with two storeys for housing units. Unlike maisonette in Scotland, the ground floor will not be used for housing unit, only for public area which will be used collectively by the user.

HORIZONTAL ZONING AND PLOTTING

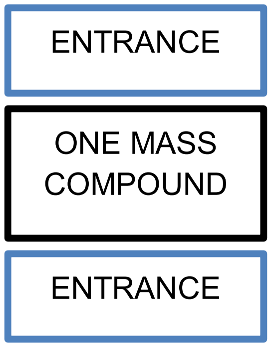


Figure 4.4. Horizontal Mass Zoning
Source: Author

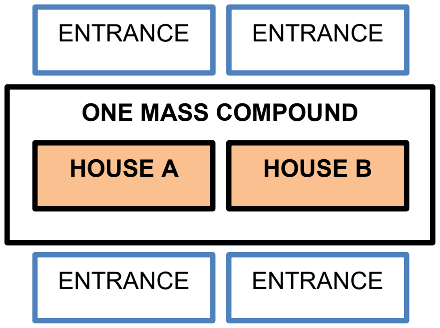


Figure 4.5. Ground Floor Zoning
Source: Author

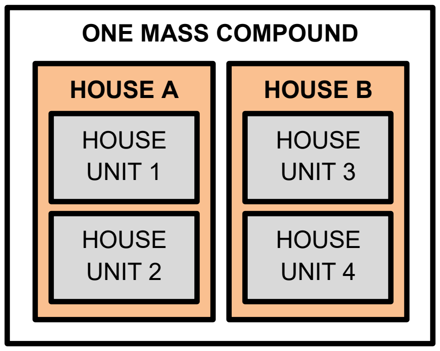


Figure 4.6. Typical Floor Zoning
Source: Author

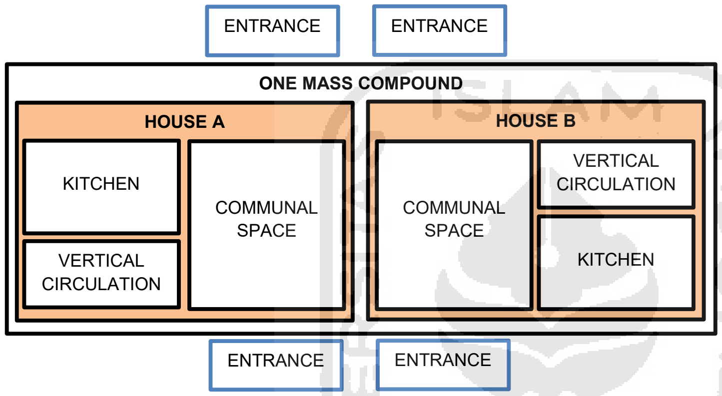


Figure 4.7. Ground Floor Plotting
Source: Author

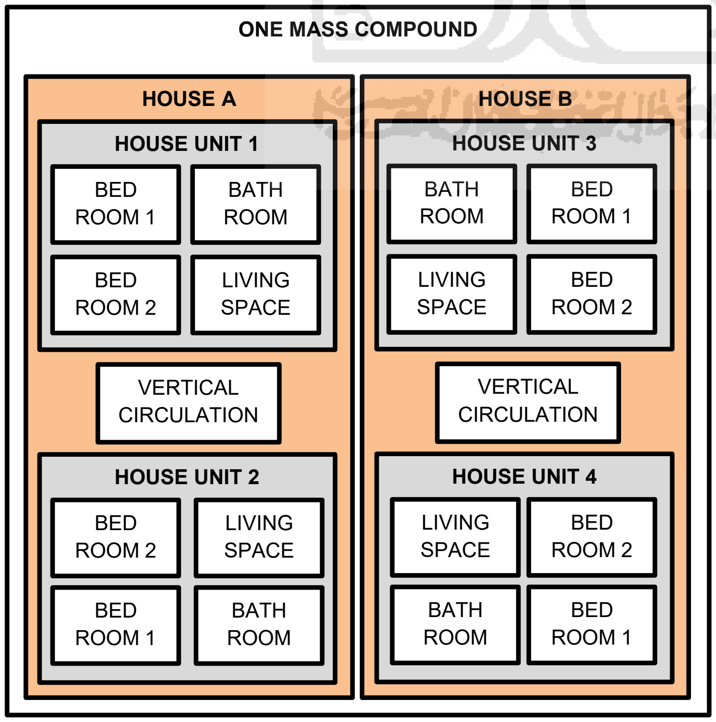


Figure 4.8. Typical Floor Plotting
Source: Author

Since a building mass will be used collectively by several occupants, the access will be split into two entrance because every building mass will have two street circulation. Occupants can enter and exit through the closest access considering there might be occupants who bring vehicles and park near the house.

In every building mass (mass compound), the housing unit will again be split into two area considering each mass will be separated by inner courtyard. The limited access will increase the security of each housing unit without affecting the inner courtyard existence.

The horizontal plotting of each floor are made based on spatial efficiency study and user analysis. Altough the entrance split into two accesses, there only one vertical access to the housing unit to enhance spatial effiency. So the vertical access will be located in between housing unit. In terms of housing unit, the living space located near the unit entrance and is located on the area farthest from the facade due to daylighting priority analysis which has been conducted as well.

4.1.3. Modular Design and Building Capacity

The building mass module wil be designed based on the housing unit module which located on the first and second floor. Based on the occupant affordability study in previous chapter, the unit module that will be used will have area of approximately 20 sqm or similar as typical studio apartment in Yogyakarta but it will consists of two bedrooms, a bathroom and a living space or family gathering space in each housing unit.

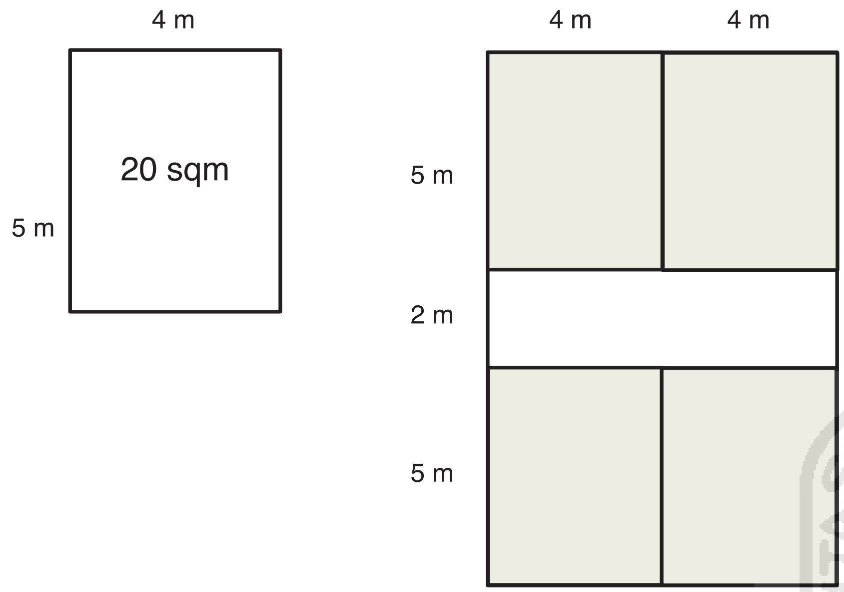


Figure 4.9. Housing Unit Floor Area
Source: Author

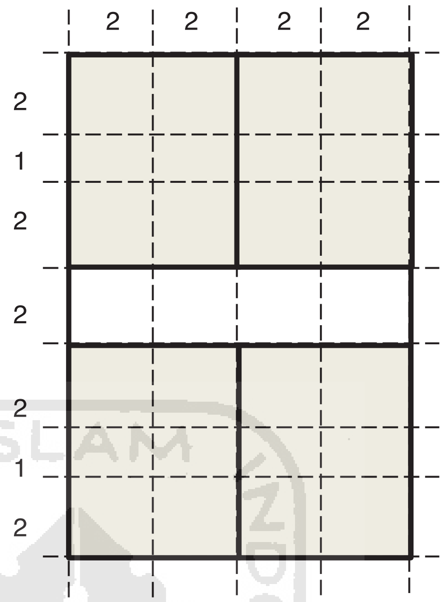


Figure 4.10. Typical Floor Grid
Source: Author

Each typical floor will consists of four housing units of 4 x 5 m which means that the area of each floor will be approximately 80 sqm with the additional area for vertical circulation 2 x 4 m. The total area of each floor should be 96 sqm which will be applied in typical rectangular form to ease the structural grid system as well as enhance the spatial efficiency of each buiding mass.

Based on the room plotting and the unit area proposed, the architectural program of each building mass can be seen down below. Since the area needed for communal area and laundry area are not as big as housing unit area, so the floor area at the ground floor and rooftop can be reduced but still based on the same grid as housing unit area or typical floor grid.

Table 4.1. Architectural Programming

NO	ROOM NAME	CAPACITY	AREA (m^2)
1	Guest Gathering Space (Communal Space)	8	6 x 5
2	Kitchen + Sink	2	2,5 x 2
3	Laundry	1	4 x 4
4	Family Gathering Space (Living Space)	4	2 x 3
5	Adult Bedroom	2	2,5 x 2
6	Children Bedroom	2	2 x 2
7	Bathroom	1	1.5 x 2

The regular user of the flathouse can be calculated based on the housing unit capacity. Each housing unit will be used by 3-4 person and since there will be total of 96 housing units throughout the complex, it means that the total capacity of the flathouse will be approximately 384 person.

4.2. SITE DEVELOPMENT
4.2.1. Situation Overview

Figure 4.11. Site Situation
Source: Author

Terban Flat House located next to Code Riverside Village which most of the houses there are landed house and even considered as slum area. Not only the village, right next to the site, there is Terban Traditional Market that is still actively functions for years. Thus, creating a typical high-rise commercial residential building in that area will most likely be contradiction to the existing neighborhood. Therefore, the flathouse typology is choosen as a response of the neighborhood context. Though by choosing this typology will limit the building capability to add as many user capacity as possible, but there is still possible to at least double the capacity of housing to solve the limited land availability without compromising the neighborhood context.

4.2.2. Site Planning and Landscape

Figure 4.12. Site Plan
Source: Author

The maisonettes and the main access will be located side by side throughout the site. So, a maisonette mass will have two accesses, which is the front side and the back side of each maisonette, depending on how close the unit located from the access. Then, in order to solve housing quality issue, each maisonette mass will be separated by inner garden which will provide air circulation and daylighting for each unit.The vehicle circulation and the parking area will be differentiate by the material. Grass block is being used for the parking area while the pavement road is used for vehicle circulation.

4.2.3. Vehicle Circulation

Figure 4.13. Housing Complex Alley View
Source: Author

The site access will be divided into three ways, the site circulation illustrated as shown above. The user or visitors who own a vehicle and wants to park their vehicles can do paralel parking right beside their housing unit since there will be no collective parking area in a certain area.

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4.2.4. Inner Courtyard

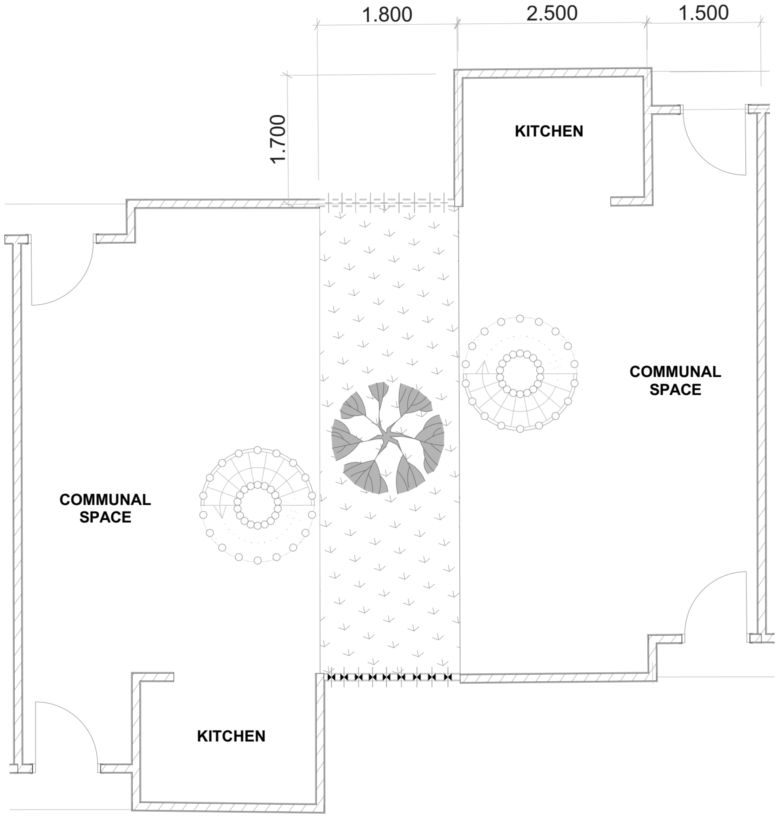

Figure 4.14. Inner Courtyard Plan
Source: Author

The inner courtyard initially will be function as a gap between each mass to provide enough daylighting and air circulation throughout each of the housing unit. The inner courtyard provide 1,8 meters distance between each mass which can be accessed from the closest communal space on the ground floor.

The design of inner courtyard will allow two housing unit to have direct connection which hopefully will allow interaction between the users or even the guests, but at the same time it will give space for privacy between each communal space area.

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Vegetation Specification

Madagascar Almond (*Terminalia Mantaly*)

Madagascar Almond or well-known as Pohon Ketapang Kencana in Indonesian is a plant that commonly use as shade tree that has unique shape as seen at Figure XX. This tree has many functions including pollution absorption, increase productivity focus, as well as provide shading area from the sun.

Figure 4.15. Madagascar Almond
Source: http://www.google.com/

Japanese Lawn Grass (*Zoysia Japonica*)

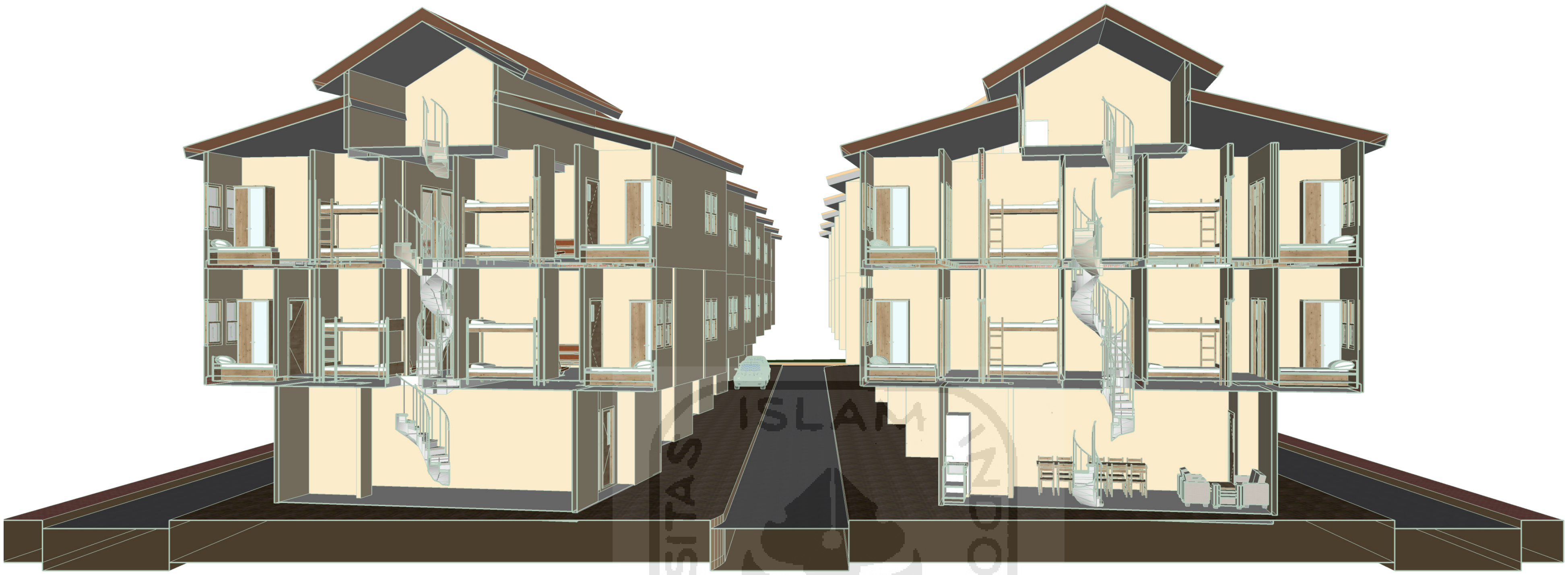
Japanese Lawn Grass is an easy-maintenance grass that is suitable for housing vegetation. This type of grass leaves are not too sharp, making it comfortable to sit and step on. With only watering this grass regularly will keep this grass alive and not easily withered.

Figure 4.16. Japanese Lawn Grass
Source: http://www.google.com/

4.3. HOUSING MASS LAYOUT

4.3.1. Flat House Typology As Spatial Issue Solving

Front Section (East)

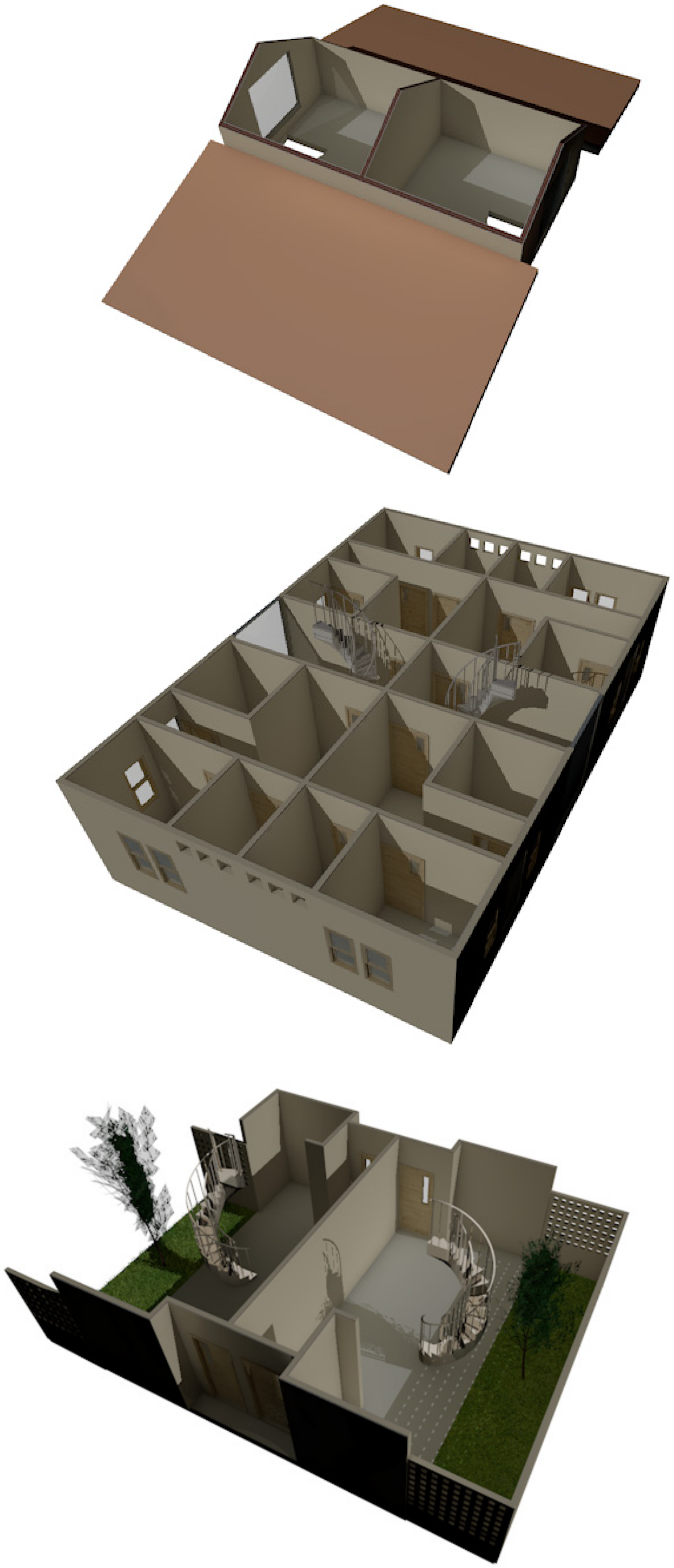


Side Section (South)

Figure 4.17. Site Section
Source: Author

The front section shows the vertical integration in each mass. The staircase located in between each housing unit and function as vertical circulation within the building. The typical floor located on the first and second storey between rooftop and ground floor. These floors have the highest privacy level compared to the others. The laundry area located at the rooftop which can be accesed collectively only by the users and not by visitors or guests. On the other hand, the ground floor can be accessed by the visitors as long as the entrance access is granted by any housing users. From the side section, it can also be seen that there is separation in the middle area of each mass which eventually limit the access in each housing unit while each mass still be able to access inner courtyard directly from the communal space.

4.3.2. Flat House Storeys



Rooftop

The rooftop area will be used mainly for laundry activity. Just like the communal space area, the rooftop will be available for the user and can be used collectively as semi-public area.

Typical Floor (1st and 2nd Floor)

The housing units can be accessed by stairs located near the entrance. The stairs will be located in between two units of each floor. This layout applied in order to ensure that each housing unit will get at least two side facades so that the thermal and the visual quality of every housing unit can be enhanced as well as limit the access for each housing unit as offered by maisonette flat house typology. Each floor will consists of four housing unit which will be separated by two staircase access depends on the entrance unit.

Ground Floor

The ground floor can be accessed from two entrances which will lead to the staircase area to access housing units above. Each of communal space will be separated by an inner courtyard at one side and a wall at the other side. Although the ground floor is semi-open area, the access are limited only to the users that has access to the housing units above in order to ensure the housing privacy and building safety.

Figure 4.18. Housing Mass Axonometry
Source: Author

4.3.3. Private Area (Housing Unit)

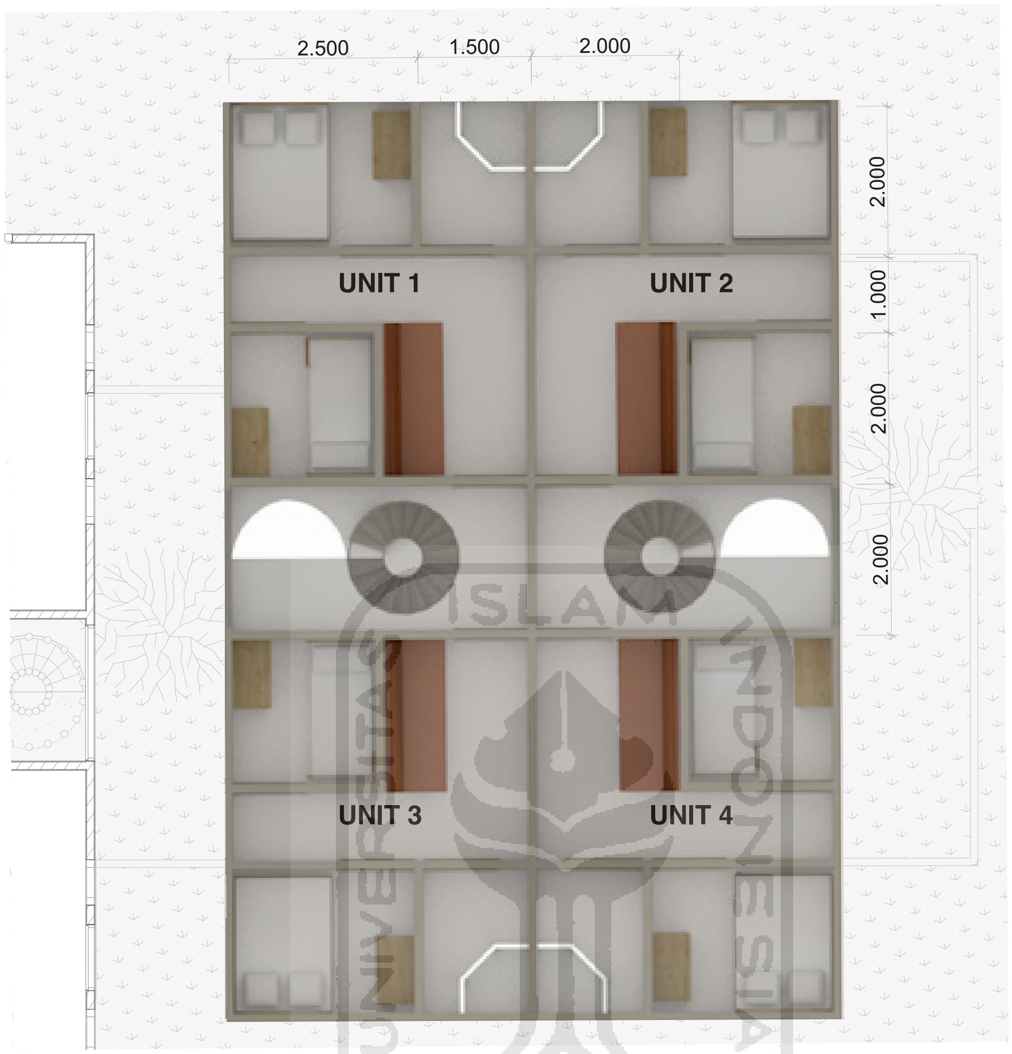


Figure 4.19. Housing Unit Plan
Source: Author

Inside a housing unit will consists of a living space for family gathering space, two bedrooms, and a bathrooms. Every room will have direct access to the opening which will allow daylighting to penetrate without any obstacle. The living space, however, will not have direct daylighting but will still be getting daylight from the window between the two bedrooms.

There will not be any major difference in terms of housing unit performance towards the location, neither the orientation nor the storey level. The performance of each housing unit will relatively be the same throughout the day. Therefore, there will not be any different type of design for each housing unit except for the room layout which has to respond the daylighting issue.

Figure 4.20. Housing Unit Living Space View
Source: Author

Figure 4.21. Housing Unit Bedroom View
Source: Author

4.3.4. Semi-Public Area

Communal Space Area

Figure 4.22. Ground Floor Interior View
Source: Author

The ground floor will be used as mainly as communal space both for the users and the visitors. The kind of activity that is included in this area will be gathering, dining, as well as cooking. Therefore, the ground floor will consists of kitchen, dining tables, and sofas that can be used collectively by the users while accessible for the visitors as well. The location of the communal space placed in the ground floor also highly related with the barrier-free design.

Laundry Area

Figure 4.23. Rooftop Interior View
Source: Author

In order to provide enough privacy for the users without eliminating the ability of the space to be used collectively, the laundry area is located on the rooftop. This will limit the visitors or the guest from accessing the area directly.

4.4. BUILDING ENVELOPE DESIGN

4.4.1. Facade Design As Response Towards Climate

Front Elevation (East)

Side Elevation (South)

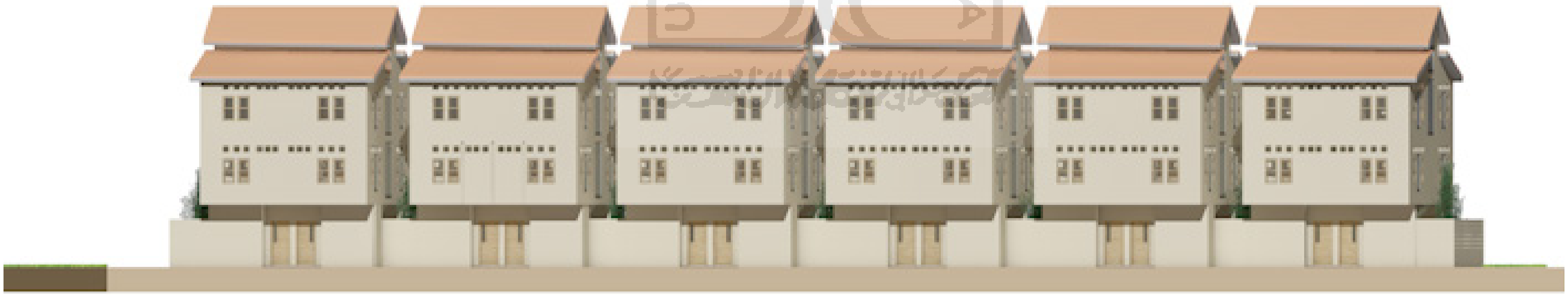


Figure 4.24. Site Elevation
Source: Author

From the east elevation, it can be seen that the building mass divided into two rows and each masses are 10 degree tilted to northeast. The open area next to the building mass can be used as parking area if necessary. While from the south elevation, it can be seen that each masses has inner courtyard as the gap which will be function as air flow circulation as well as daylighting enhancement. It can also be seen that each mass has two separated entrance to the housing unit inside.

4.4.2. Housing Unit Opening

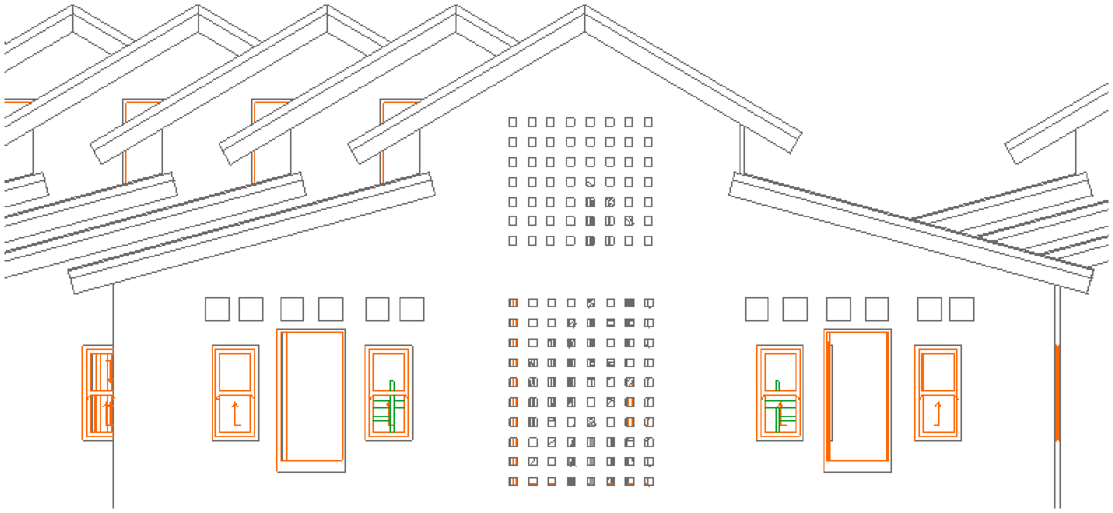


Figure 4.25. Housing Unit Opening
Source: Author

Based on the design simulation, the daylighting system within each housing unit performed well, or actually too many light penetrate through the interior. Therefore, in order to adjust with the possible thermal increase, the opening inside the housing unit will be made smaller, while the opening for the staircase area will maximized as it seen above.

Casement Window

This type of window will be used in the bedroom area and is able to be open to let the air circulate through the indoor area.

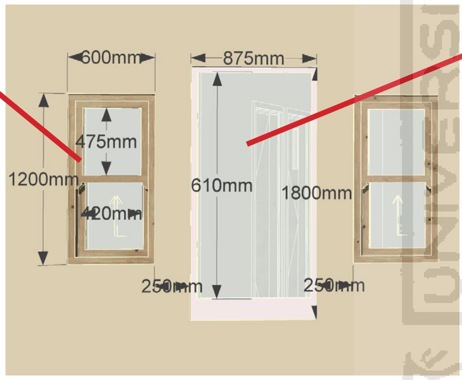


Figure 4.26. Opening Dimension
Source: Author

Storefront Window

This window is used in alleys, such as staircase area and alley between room inside a housing unit.

4.4.3. Communal Space Opening Area

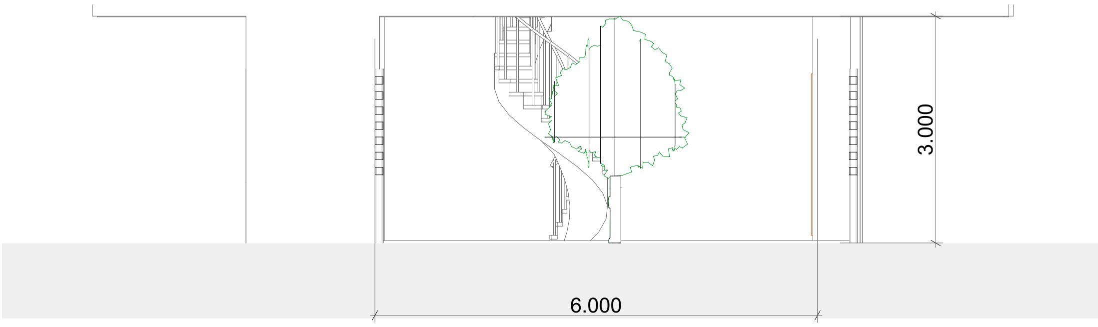


Figure 4.27. GF Opening Dimension
Source: Author

The communal space at the ground floor will have its one side open as seen above. The open side will allow air to circulate also to give direct view to the inner courtyard. Since its located on the lowest storey and is covered by the shade of the neighborhood building mass during the day, this semi-open area will become comfortable gathering space even during the day.

4.4.4. Bioclimatic House System

The project idea is to design a house that is able to respond the current weather and climate condition. By creating the ability of a house to respond the climate condition with passive system, the architectural issues such as energy usage and pollution production will automatically decrease due to the housing ability to adapt while provide comfort for the user.

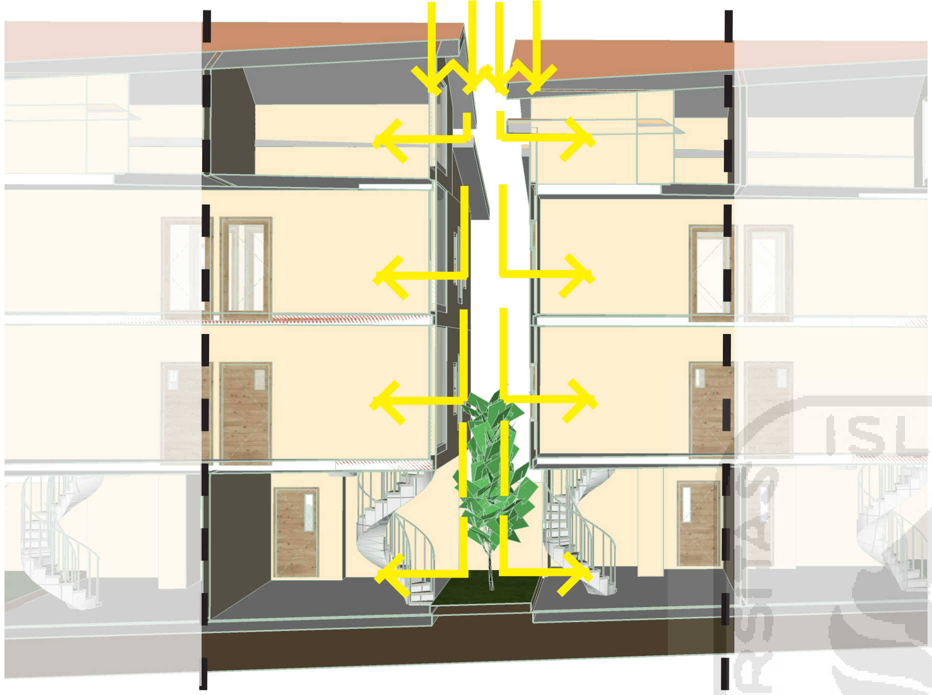


Figure 4.28. Bioclimatic Daylighting Concept Scheme
Source: Author

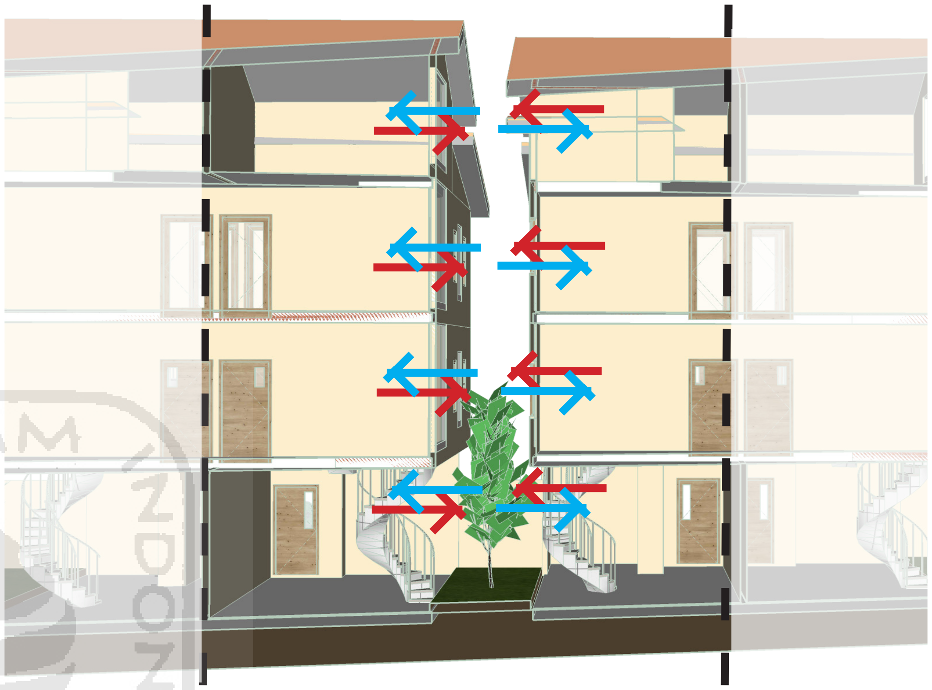


Figure 4.29. Bioclimatic Air Flow Concept Scheme
Source: Author

By creating the gap between each of housing mass, creating more opening to enhance daylighting within the interior area will be possible. The light that enter the building will possibly decrease the energy usage of artificial lighting within the interior area which will affect the housing energy usage especially during the daytime. Nonetheless, the communal space located on the ground floor has one side completely open. This will allow the ground floor area to have view to the inner courtyard as well as enhancement of the passive daylighting system within the area. The ground floor also has benefit of having more shaded area due to the building mass located next to it. The shade will decrease the incoming lighting and become filter which make it possible to create such open space for the ground floor area.

The opening located on the gap between each building mass will allow air flow to penetrate the housing interior area. Allowing air to circulate throughout the housing interior area will increase the interior thermal comfort. However, creating bigger opening may become unwise decision for the user thermal comfort considering the current tropical climate condition in Terban area. Therefore, it is necessary to create opening that allow air to circulate without the possibility to increase the house interior temperature by choosing building material that has better ability in absorbing and filtering the heat.

4.5. STRUCTURE AND INFRASTRUCTURE

4.5.1. Building Structural System

Each building mass consists of 4 storeys located above the ground and have no basement floor. The structural system will be using reinforced concrete as the main material of the columns, beams, slab, as well as the foundation structure. Hereby the column and beam initial calculation based on the structural chart:

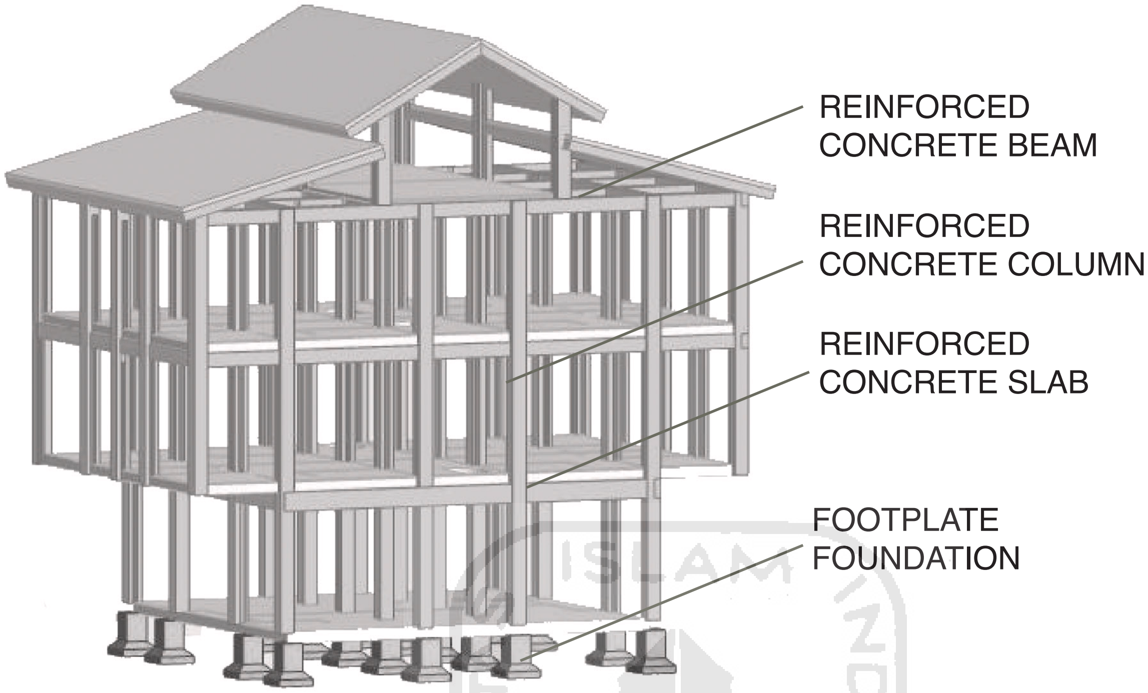


Figure 4.30. Structural Scheme Axonometry
Source: Author

Beam Calculation

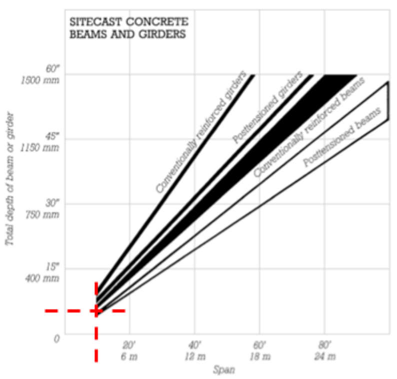
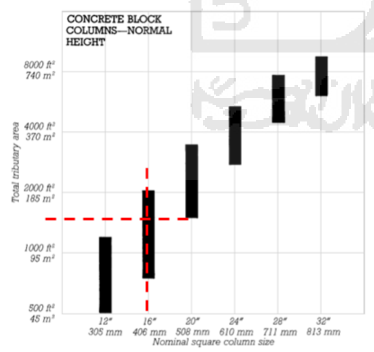


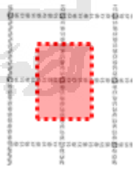
Figure 4.31. Concrete Beam Chart
Source: Author

DEPTH OF BEAM = SPAN/12
= 2000/12
= 166,7 mm

WIDTH OF BEAM = ½ DEPTH OF BEAM
= 83,3 mm

Column Calculation





COLUMN DIAMETER = 406 mm

Figure 4.32. Concrete Column Chart
Source: Author

TRIBUTARY AREA = 3 m x 2 m
= 6 m²

TOTAL COLUMN / FLOOR = 25 COLUMNS

TOTAL TRIBUTARY AREA = 150 m²

4.5.2. Electricity System

The electricity source will be from National Electricity Company (PLN) and will be distributed to every building mass by underground pipe. There will be separate electricity panel in every housing compound. So each panel will be functioned for one communal area and four housing units.

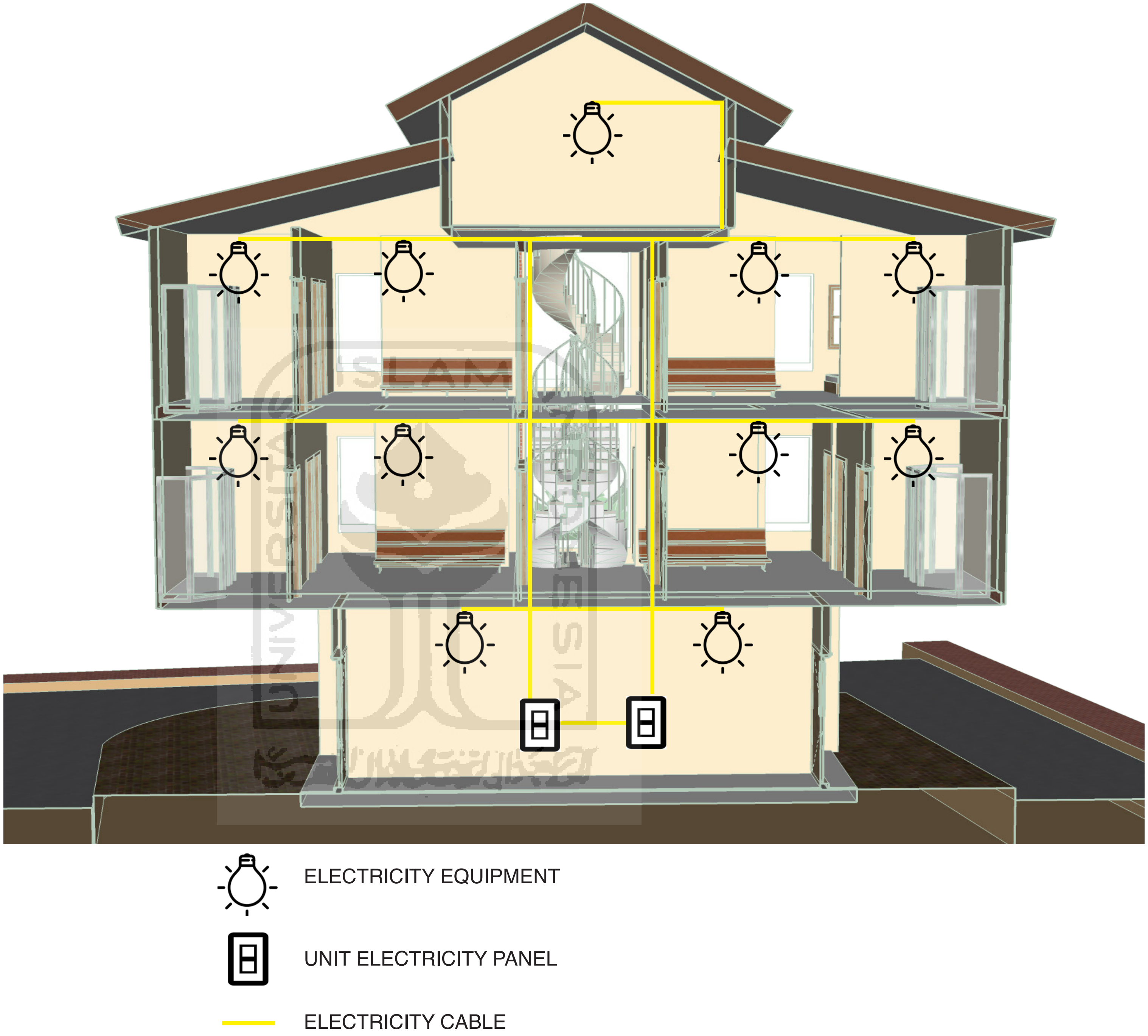


Figure 4.33. Electricity System Schematic Section
Source: Author

4.5.3. Water and Sewage System

The clean water source will be from Regional Water Company (PDAM) and will be distributed to every building mass equally. For the sewage, there will be communal septic tank located at the back of the site.

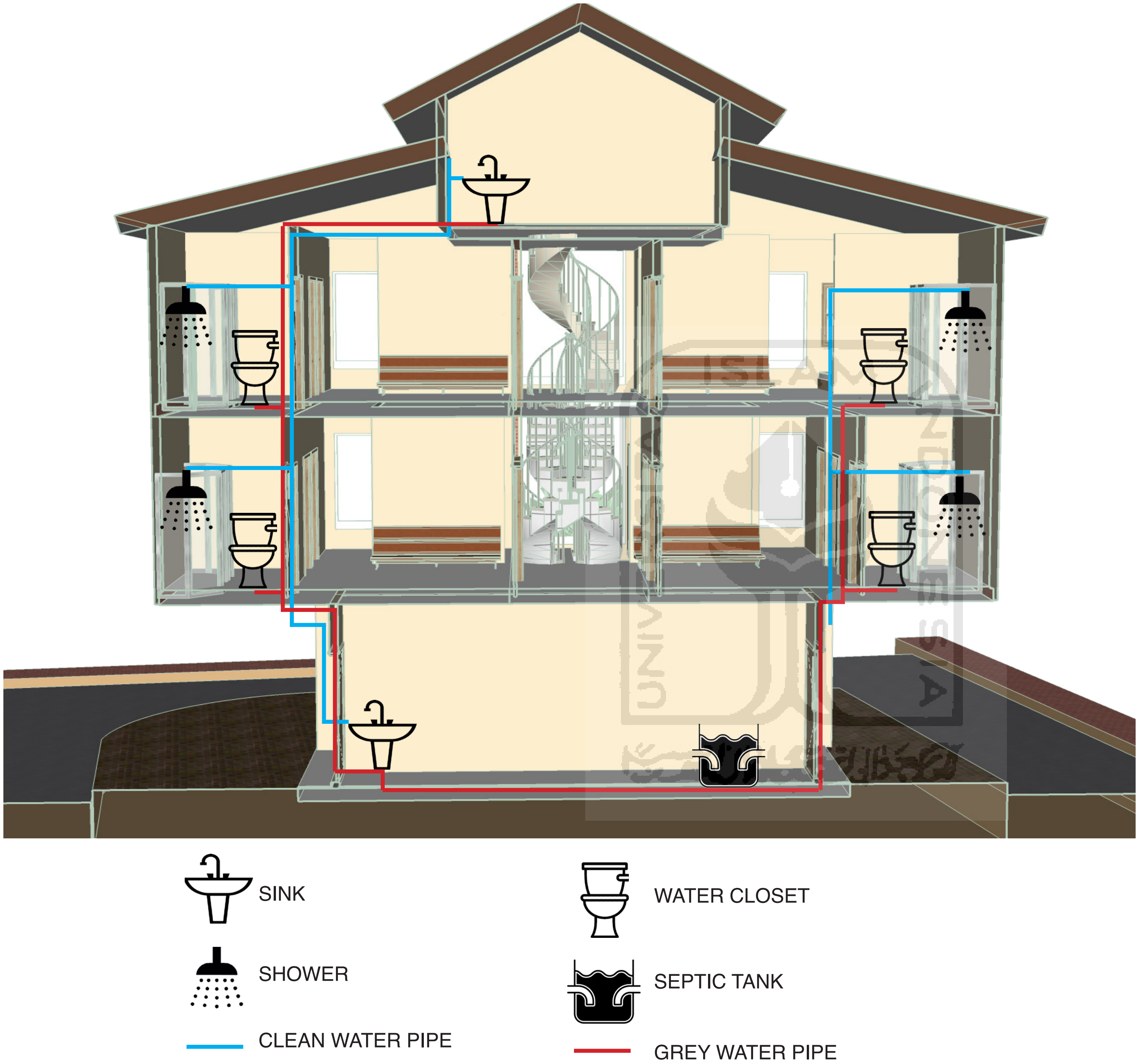


Figure 4.34. Water System Schematic Section
Source: Author

4.6. BUILDING SAFETY

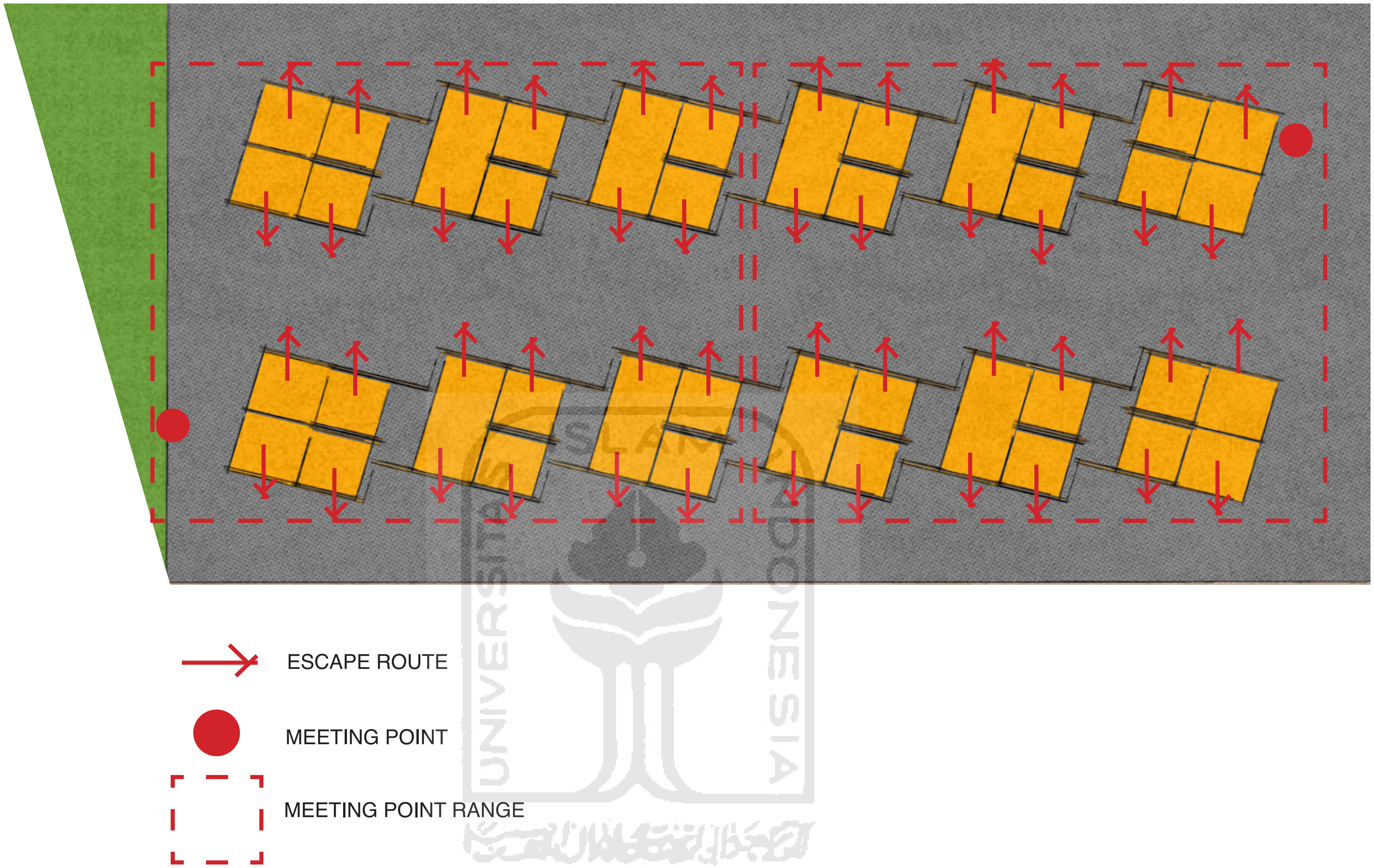


Figure 4.35. Safety Route Schematic Plan
Source: Author

In every communal space there will be fire estinguisher since the potential fire source which is the kitchen located on the ground floor. To escape from the building, the user may use the stairs to escape from housing unit then walk out through entrance of each mass. There will be two meeting points located as seen above which will be split based the distance between housing unit with the meeting point.

4.7. BARRIER-FREE DESIGN

4.7.1. Ground Floor Area for Communal Space

The communal space located at the ground floor to ease the access for visitors or user’s guest. That includes being accessible for the disabled. The gap between indoor and outdoor floor level are less than twenty centimeters which means that the ramp will take less space. The ramp will be located at indoor area with consideration to maximize the outdoor function as vehicles parking area.

Figure 4.36. Communal Space Design View
Source: Author

4.7.2. Entrance Door Ramp

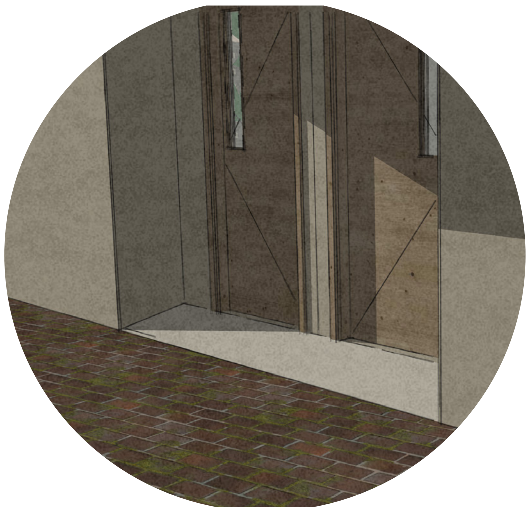


Figure 4.37. Building Entrance Ramp
Source: Author

Beside having the communal space located on the ground floor, the entrance to the area should be accessible by everyone. Therefore, in front of the entrance door will be placed ramp with calculation as follows.

Ramp Slope Distance Required (d)

To overcome a height of 15 centimeters, we will use a slope of 20%, which results in a 15 meter horizontal length.

20 = (0.15m / d) x 100
d = 0.15m / 0.2
d = 75 centimeters

5

CHAPTER FIVE
DESIGN EVALUATION

Summary of Evaluative Review

5.1. SUMMARY OF EVALUATIVE REVIEW

1. Regarding the ventilation issue, the ventilation has been added in every room. It has 300x300 mm dimension and located on the top of room window so that it could provide better interior air flow. The detailed drawing of the ventilation can be seen in Typical Floor HVAC Plan located in DED Product, page 41-42.

2. The consideration to ue spiral staircase is due to the spatial limitation. The ordinary staircase, although it is safer, but it actually takes more space. The spiral staircase itself has radius of 1.5 meters so it is not too narrow.

3. The kitchen originally located on the ground floor where one side facing that is facing the inner courtyard is completely open. Therefore, it is possible to not create additional opening in order to provide sufficient air flow throughout the kitchen area.

4. The cantilever has distance of two meters each from the nearest column and it is still considered safe in terms of structural system. The consideration to provide cantilever is because the ground floor area can be used as vehicle parking area. If there is column below, it will decrease the spatial function itself.

5. Since this project has budget consideration, the Low-E Glass in the staircase area has been replaced with other alternative like using roster wall which not only filter heat from using Foam Concrete as building material but also create ventilation without blocking the whole daylighting. However, the smaller Low-E Glass window is still being used inside housing unit due to privacy enhancement purpose, to block noises.

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LIST OF ATTACHMENTS

1. DETAILED ENGINEERING DRAWING

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1.2. Site Plan
1.3. Ground Floor Plan
1.4. Typical Floor Plan
1.5. Site Elevations
1.6. Site Sections
1.7. Interior Plans and Sections
1.8. Detailed Facade Opening
1.9. Structural Plan
1.10. Plumbing and Drainage Plan
1.11. Electrical Plan
1.12. HVAC Plans
1.13. Lamp Armature Plan
1.14. Safety Route Plans
1.15. Building Perspectives

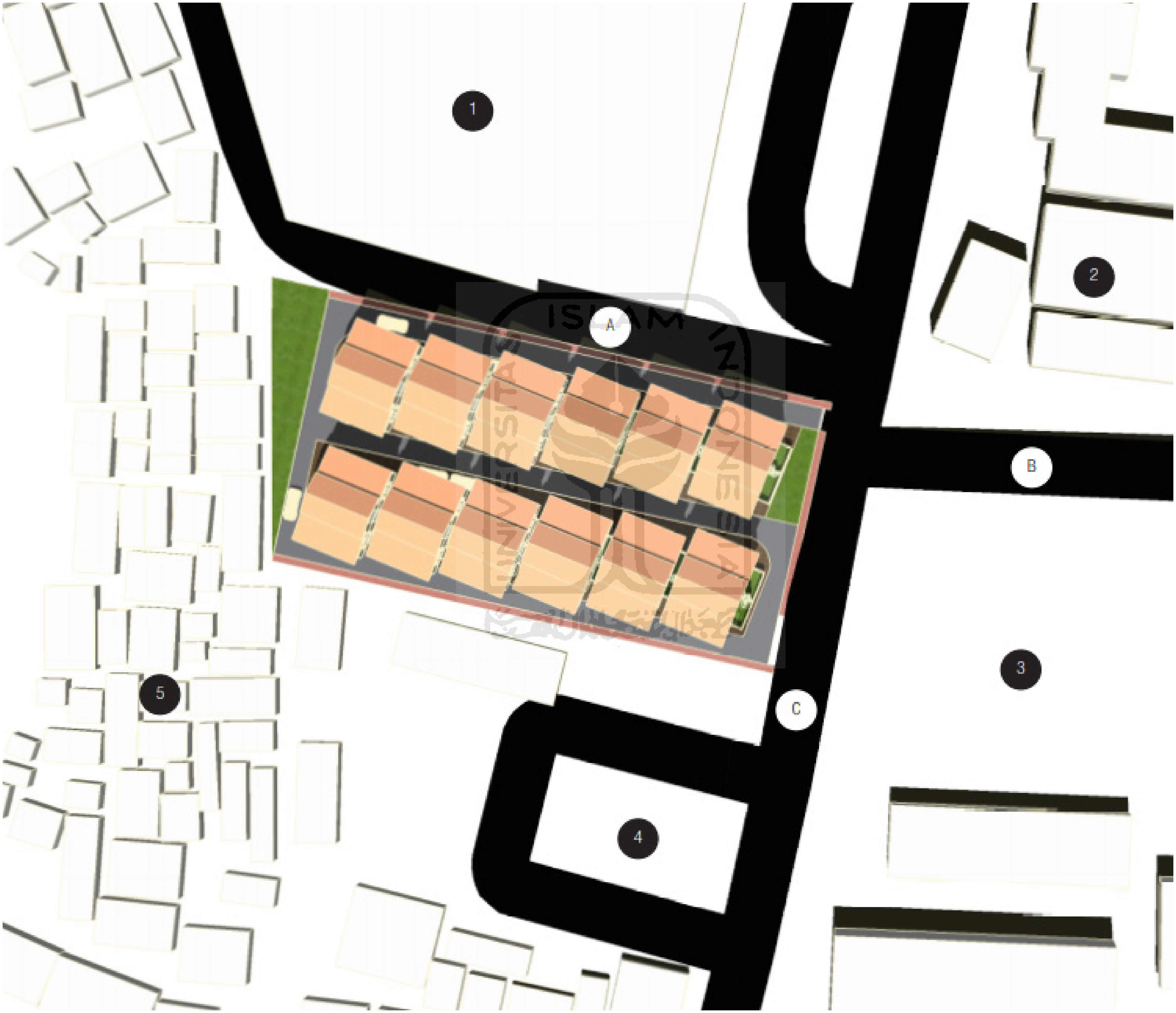
2. ARCHITECTURAL PRESENTATION BOARD

3. QR CODE / WEB LINK

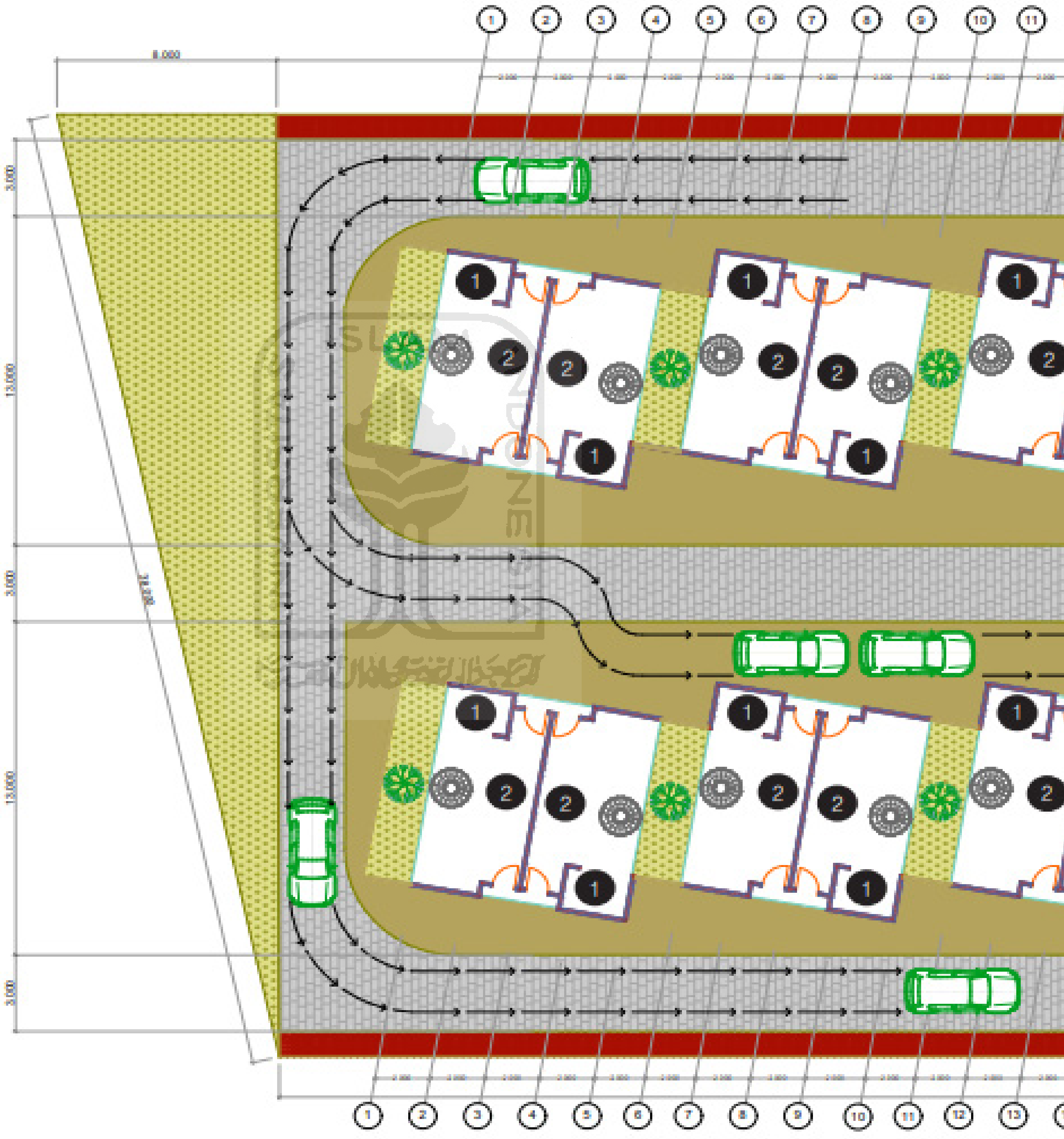
3.1. Presentation Video
3.2. 3D Modelling Video
3.3. DED Book (in original A2 size)
3.4. APREB (in original A1 size)

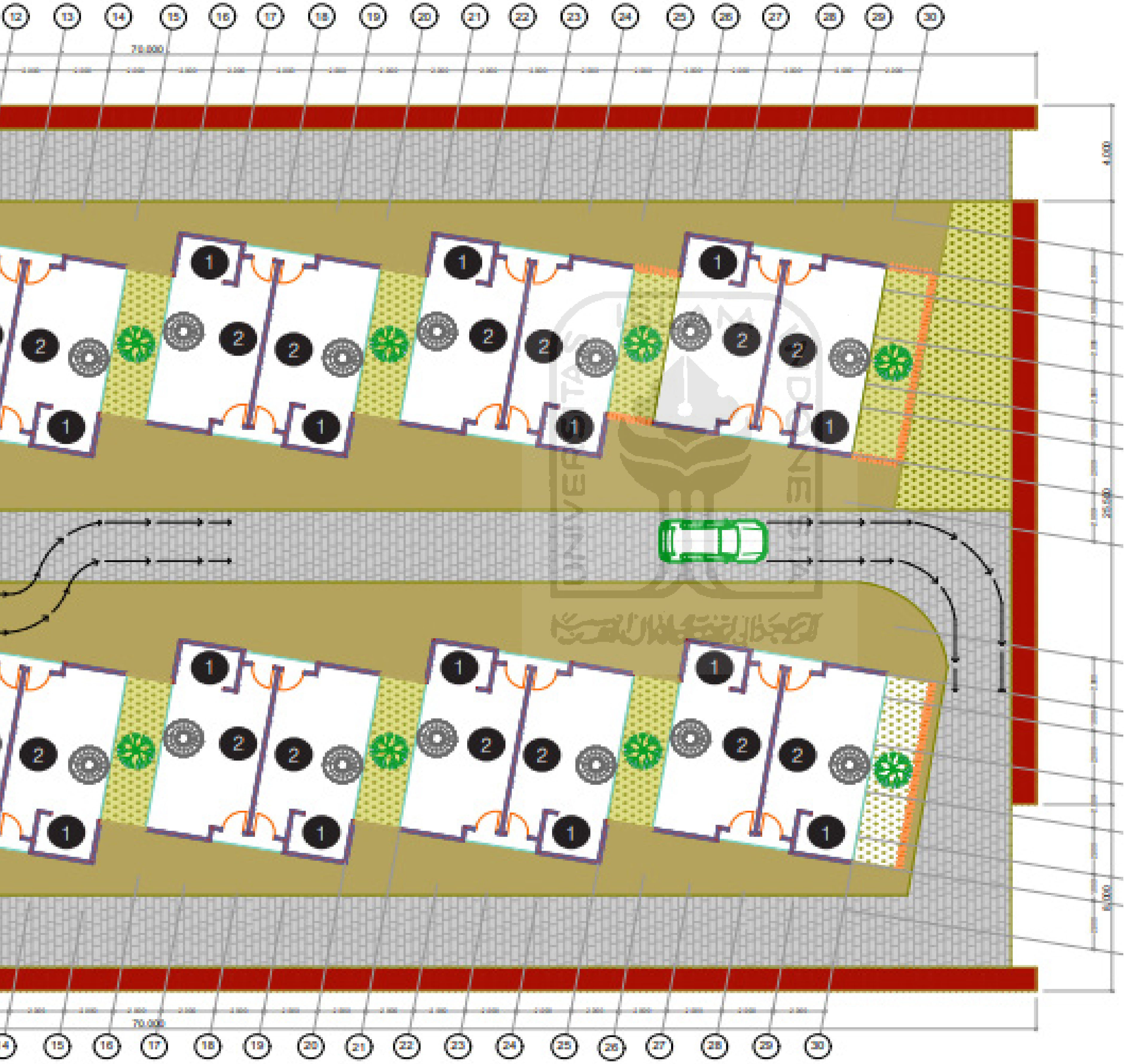
1. DETAILED ENGINEERING DRAWING

1.1. Situation Plan



1.2. Site Plan

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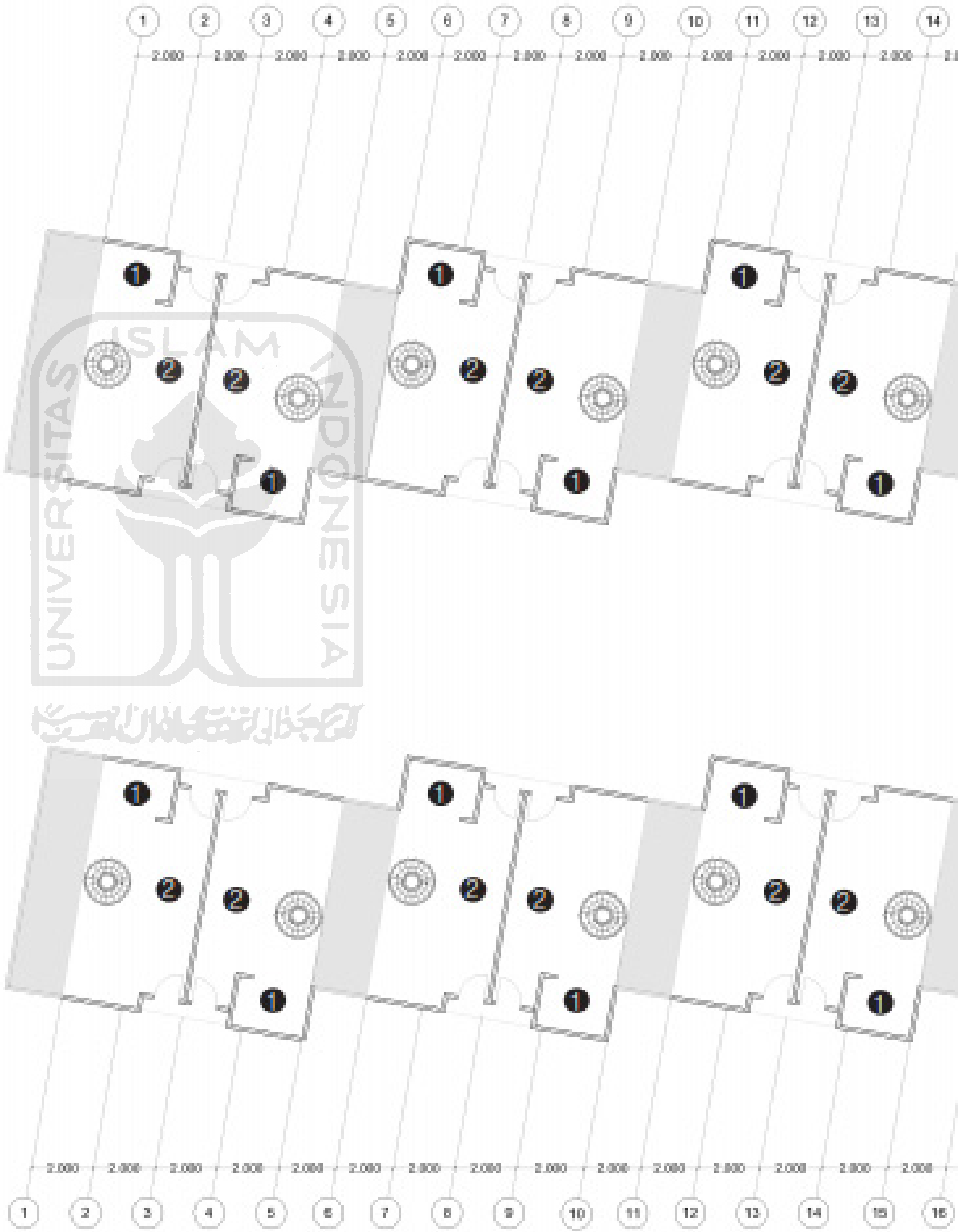
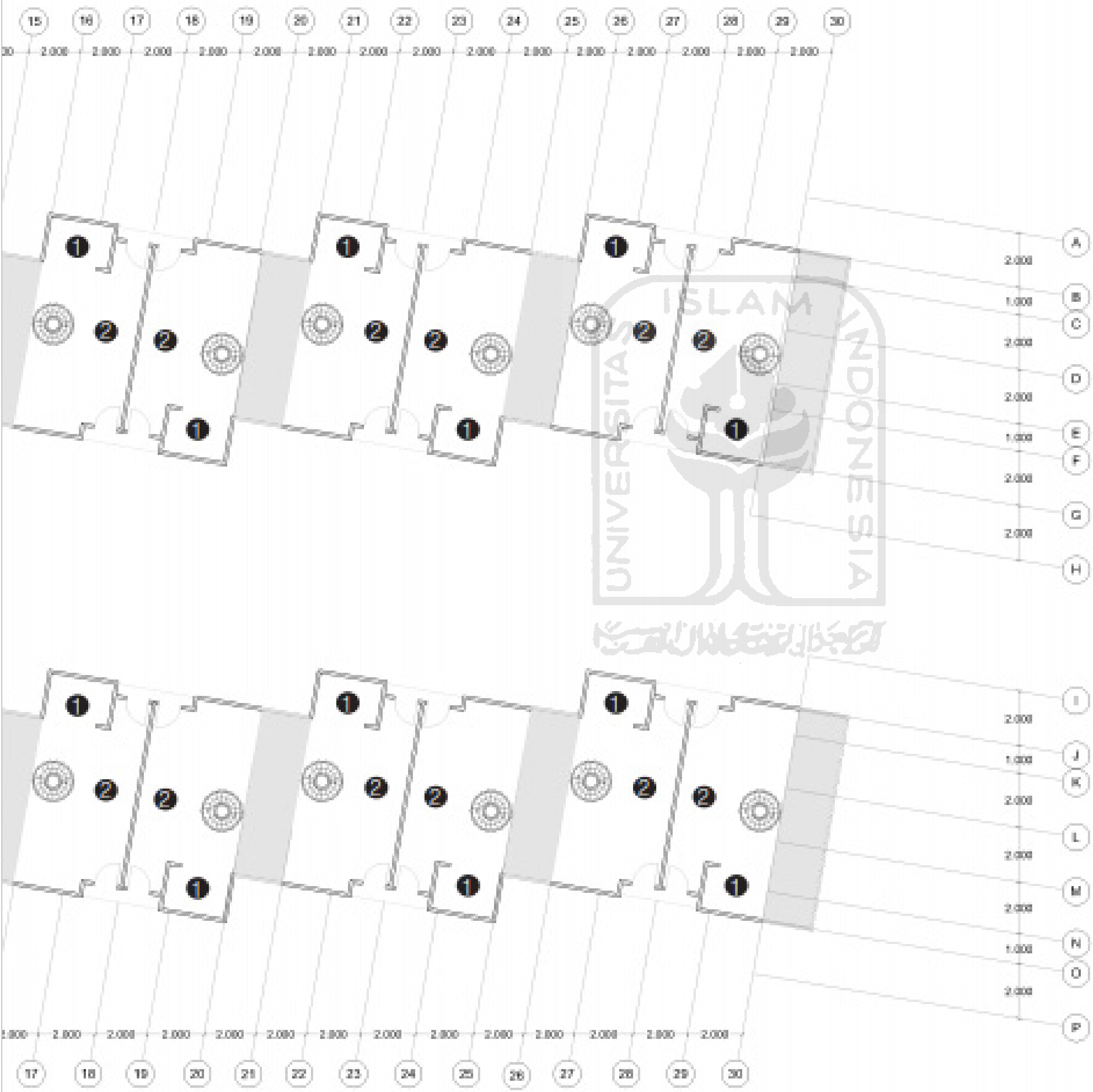
1.3. Ground Floor Plan





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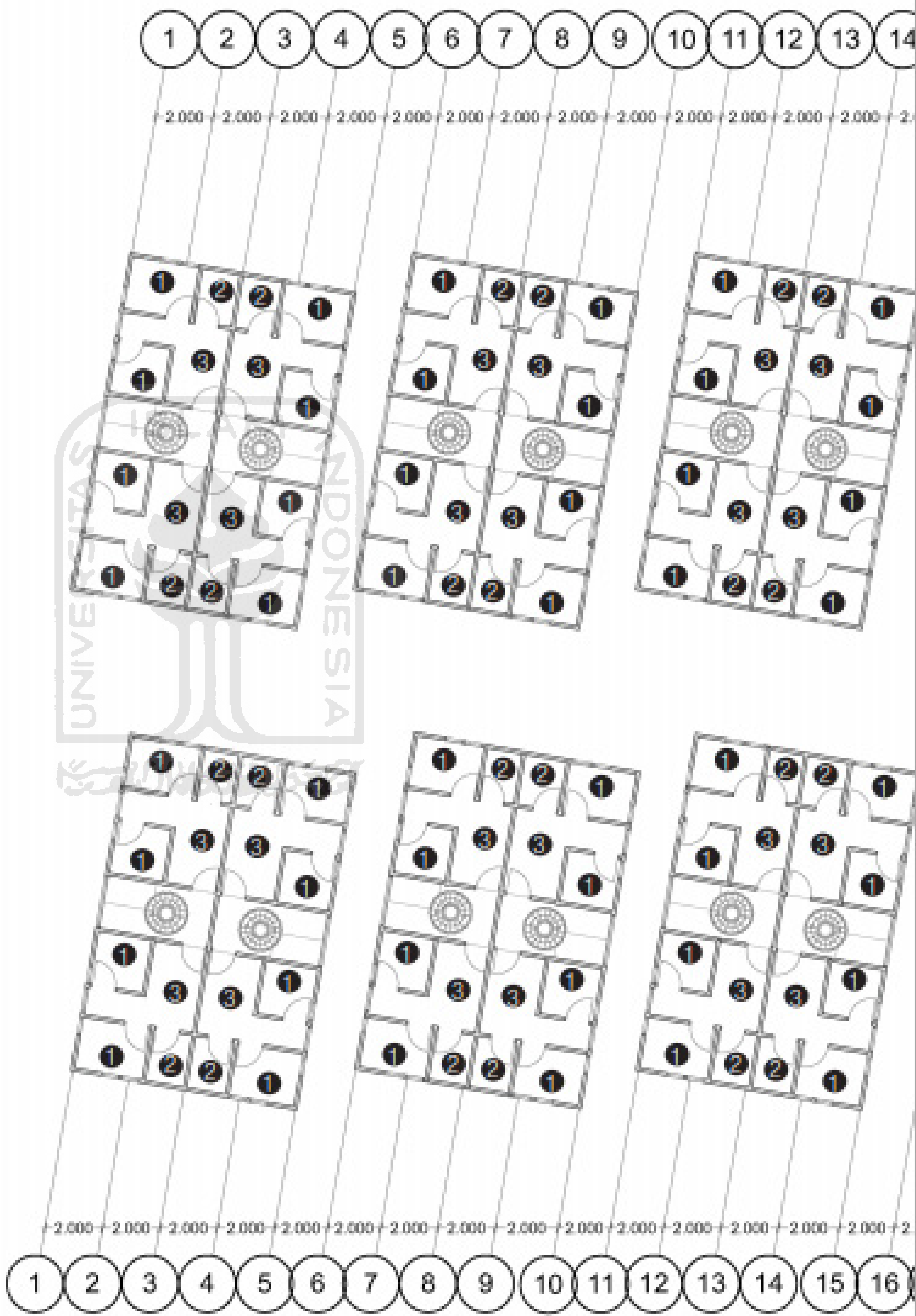
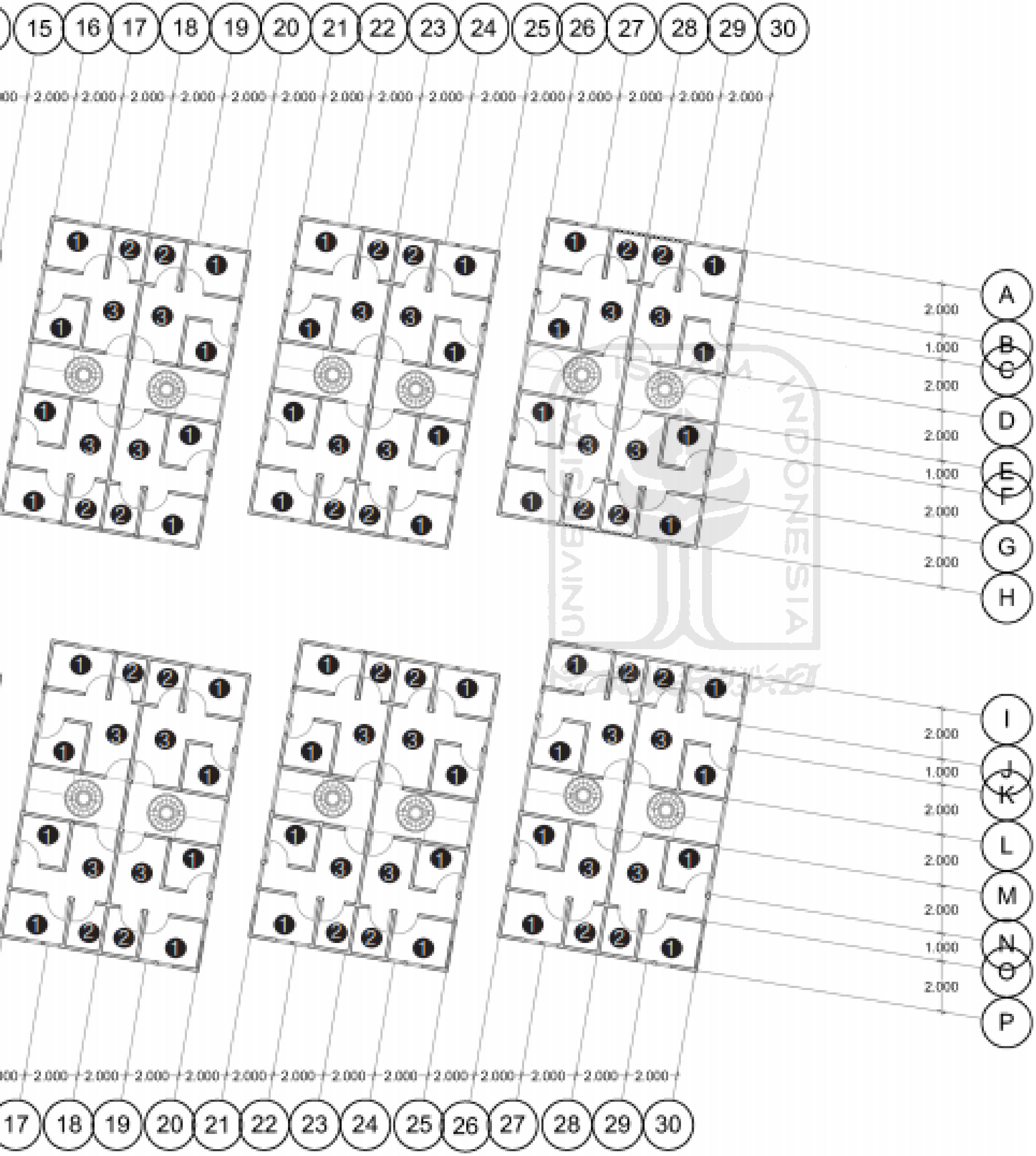
1.4. Typical Floor Plan





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1.5. Site Elevations

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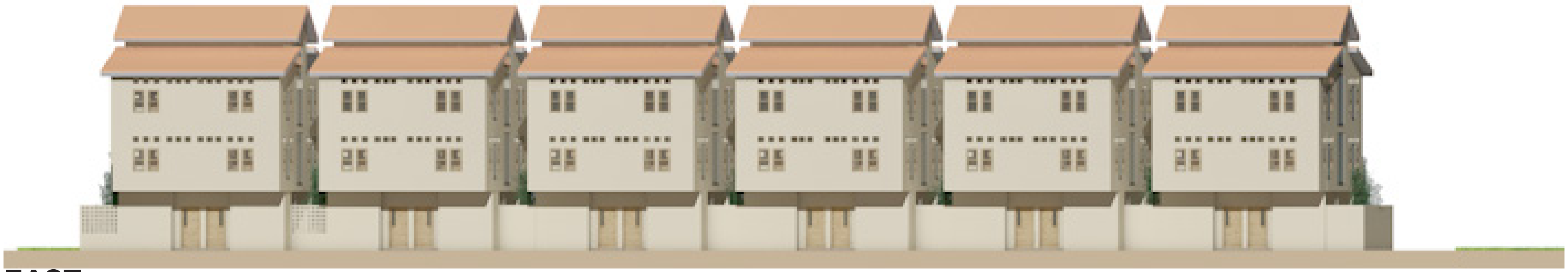

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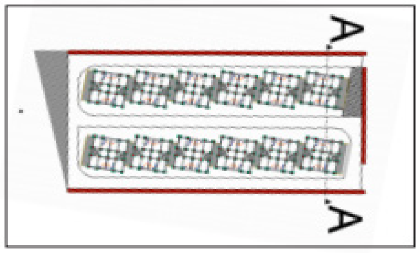
1.6. Site Sections



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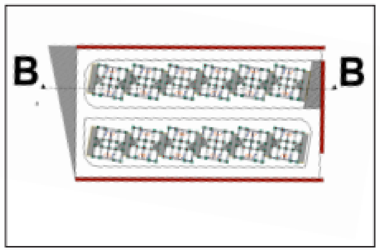

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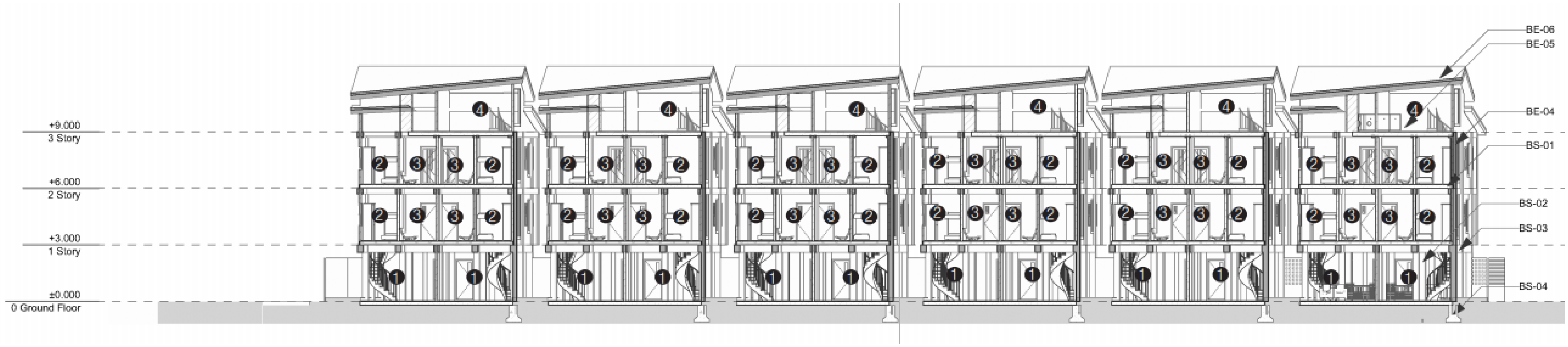
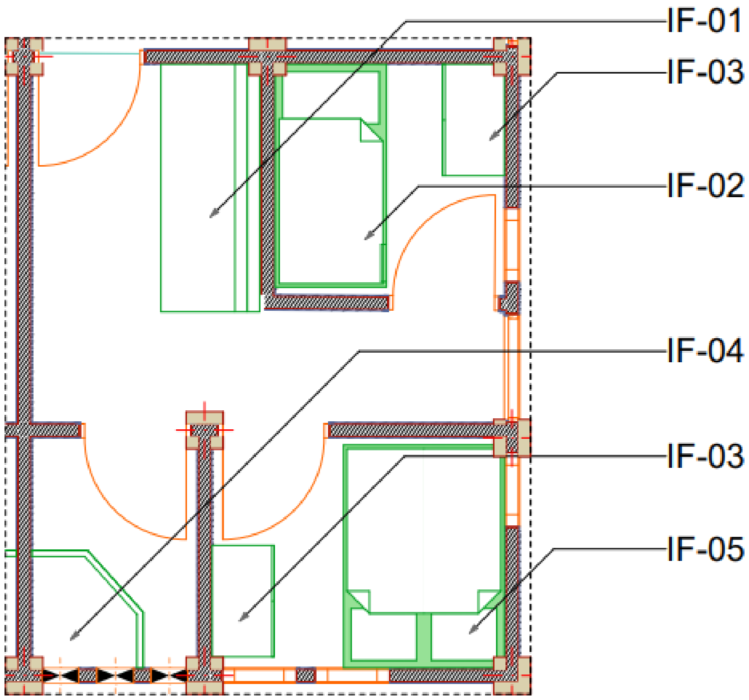
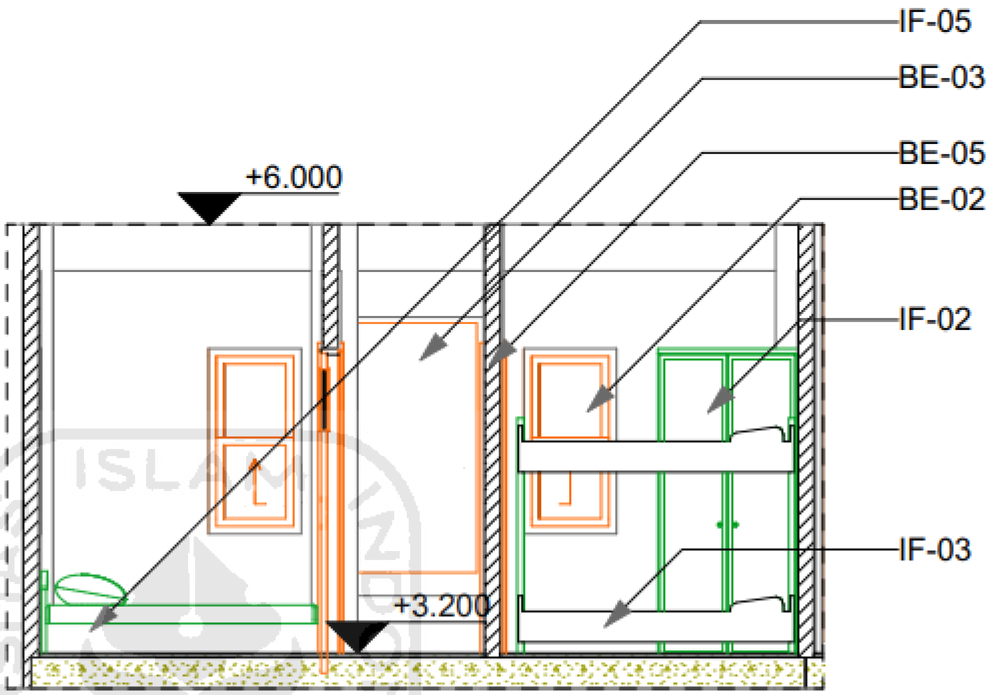


1.7. Interior Plans and Sections

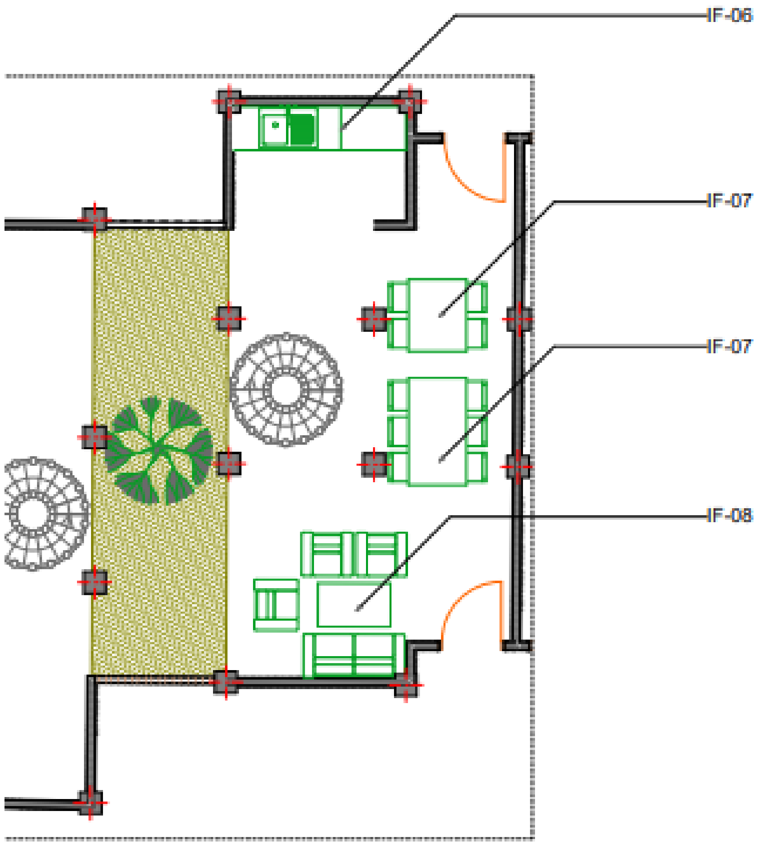
HOUSING UNIT PLAN



HOUSING UNIT SECTION



COMMUNAL AREA PLAN



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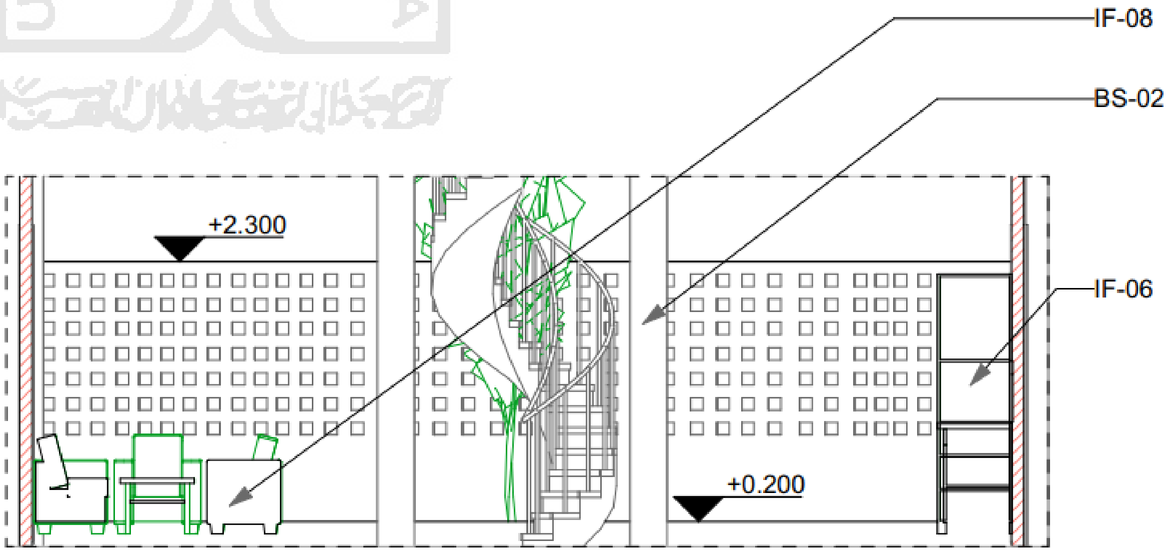
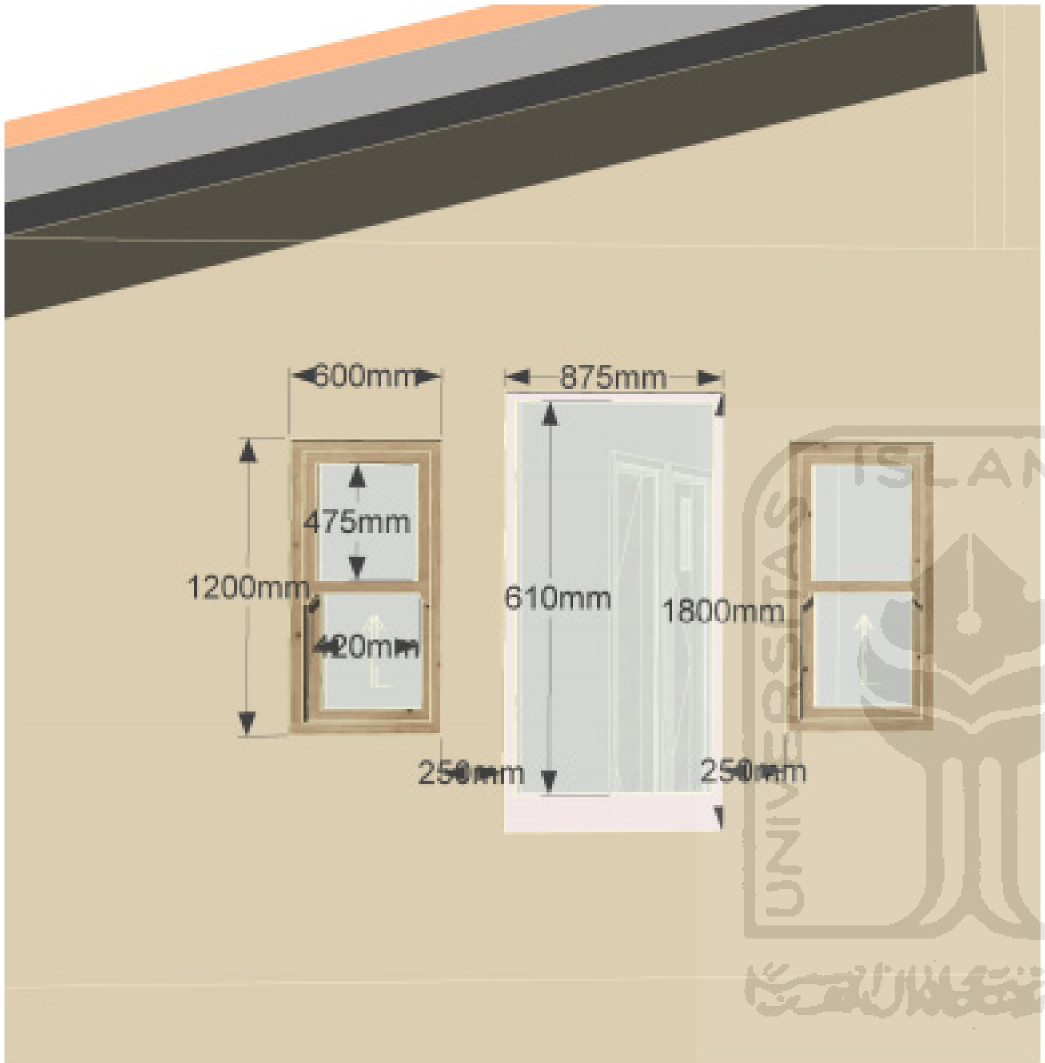
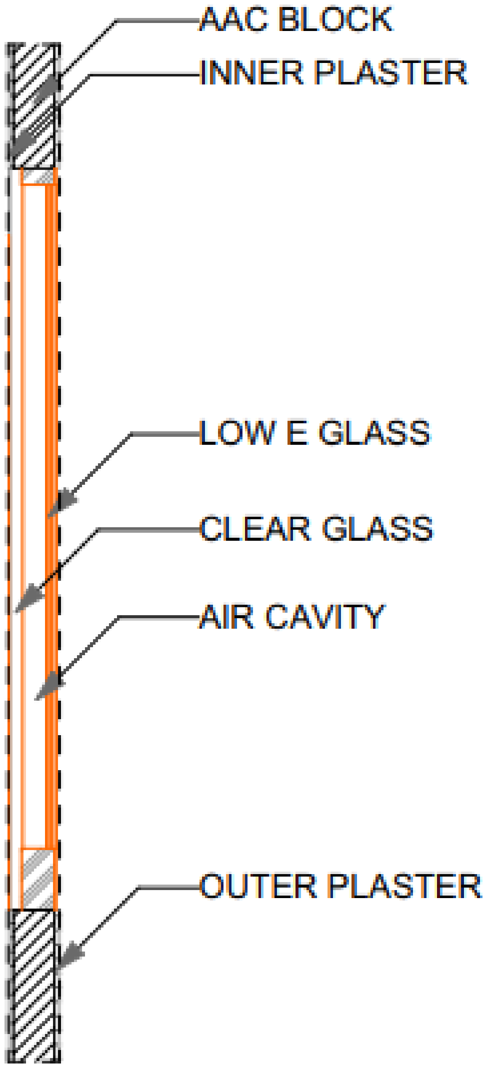
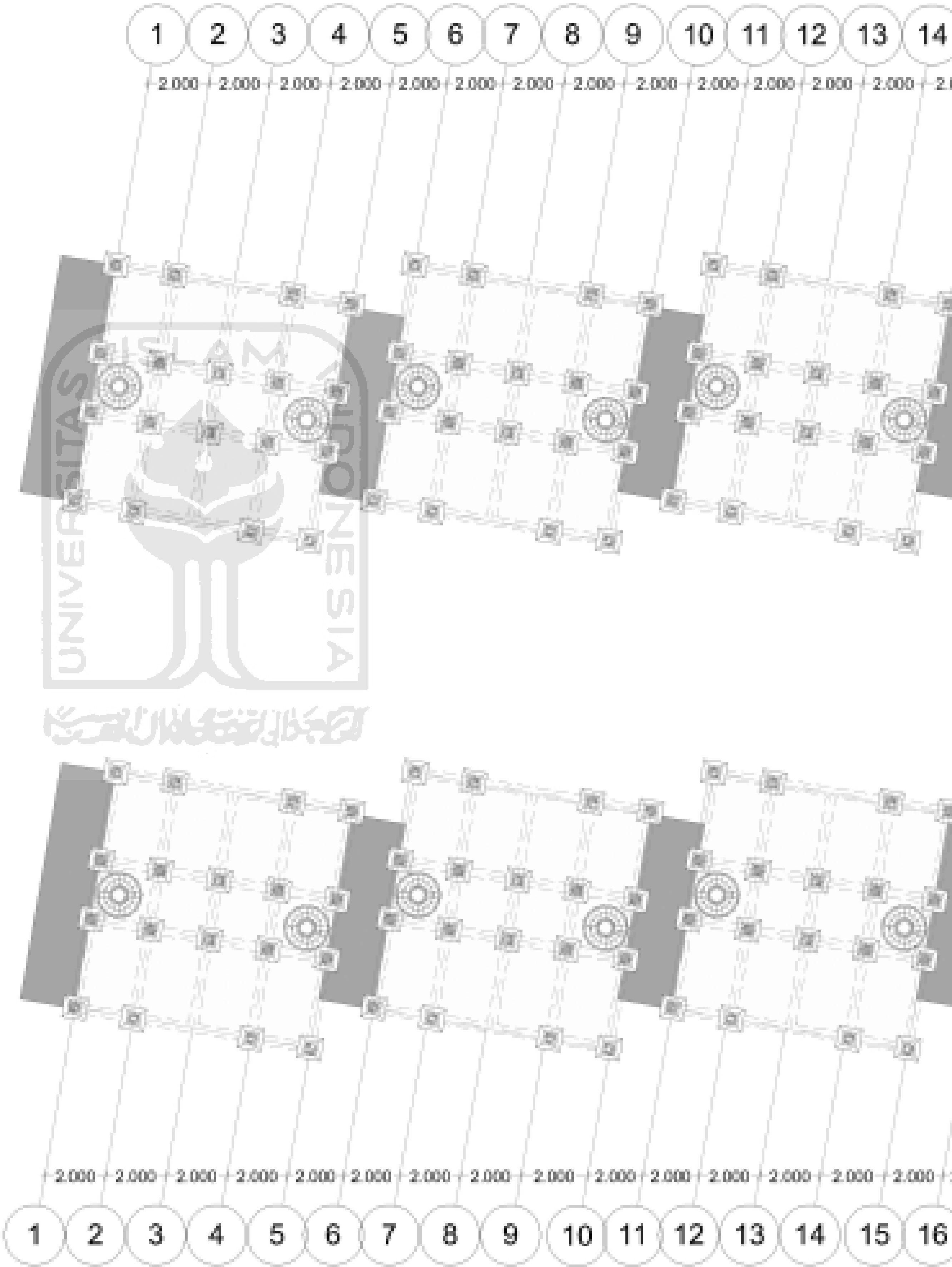


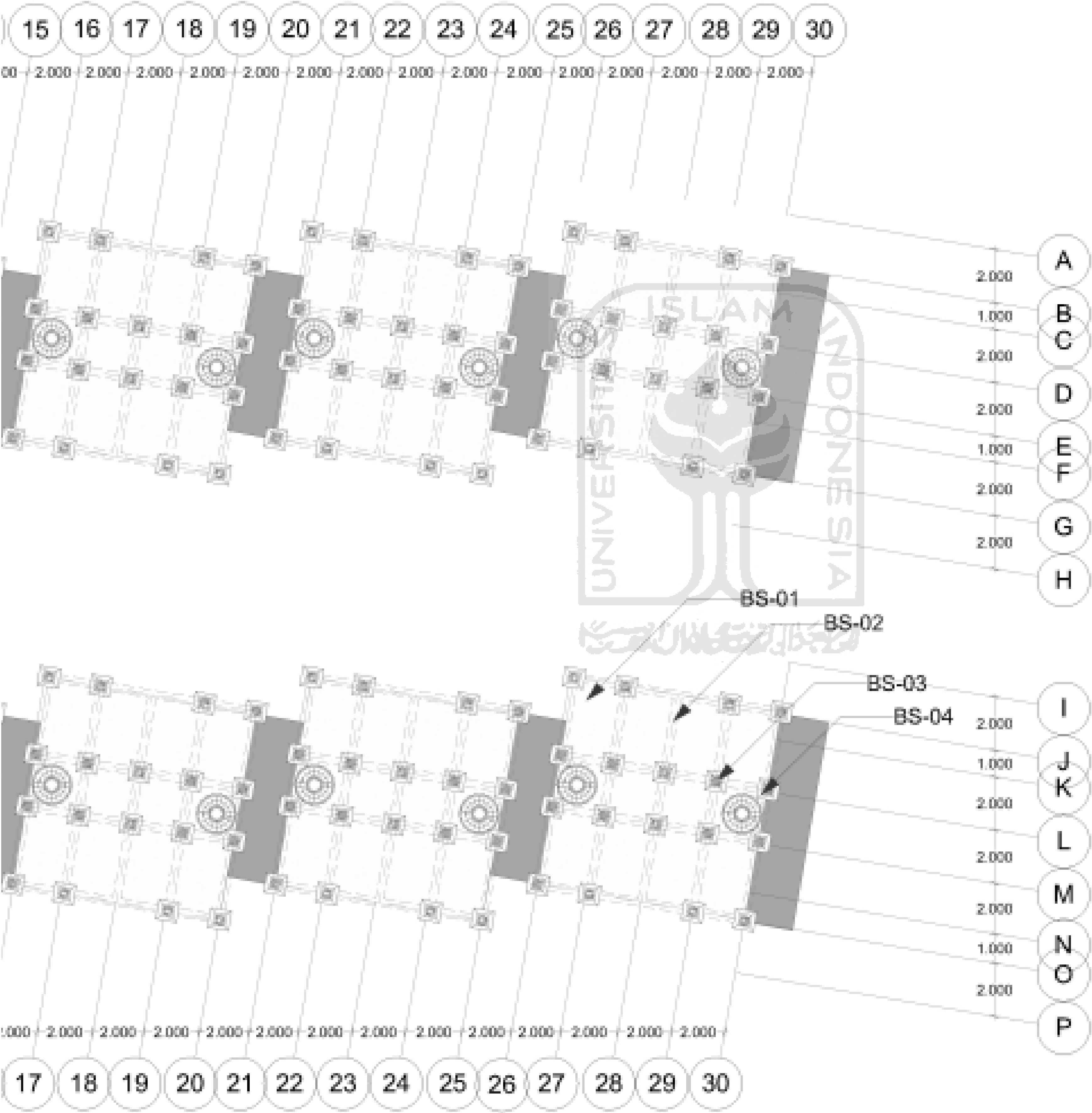
1.8. Detailed Facade Opening





1.9. Structural Plan

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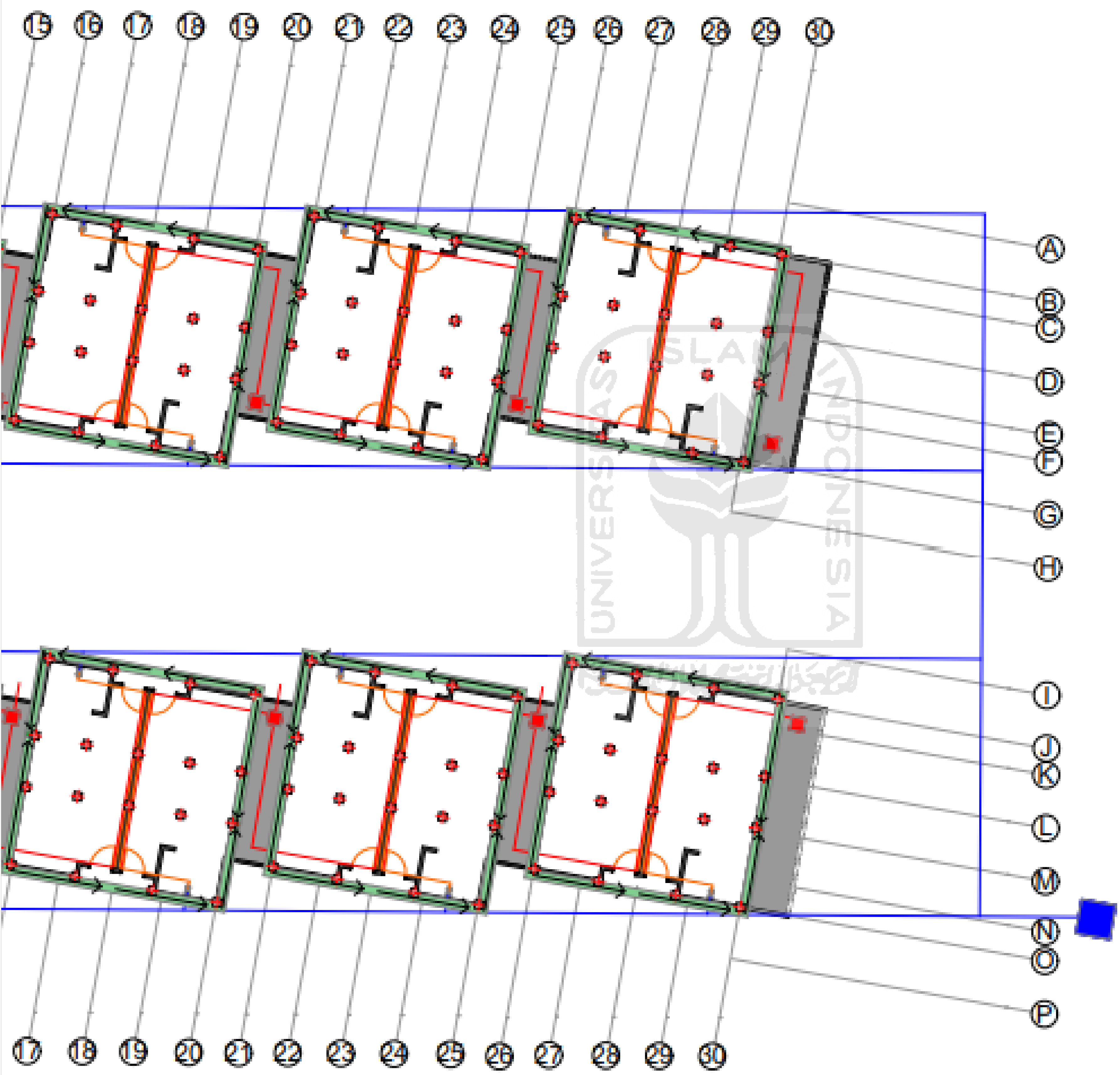
1.10. Plumbing and Drainage Plan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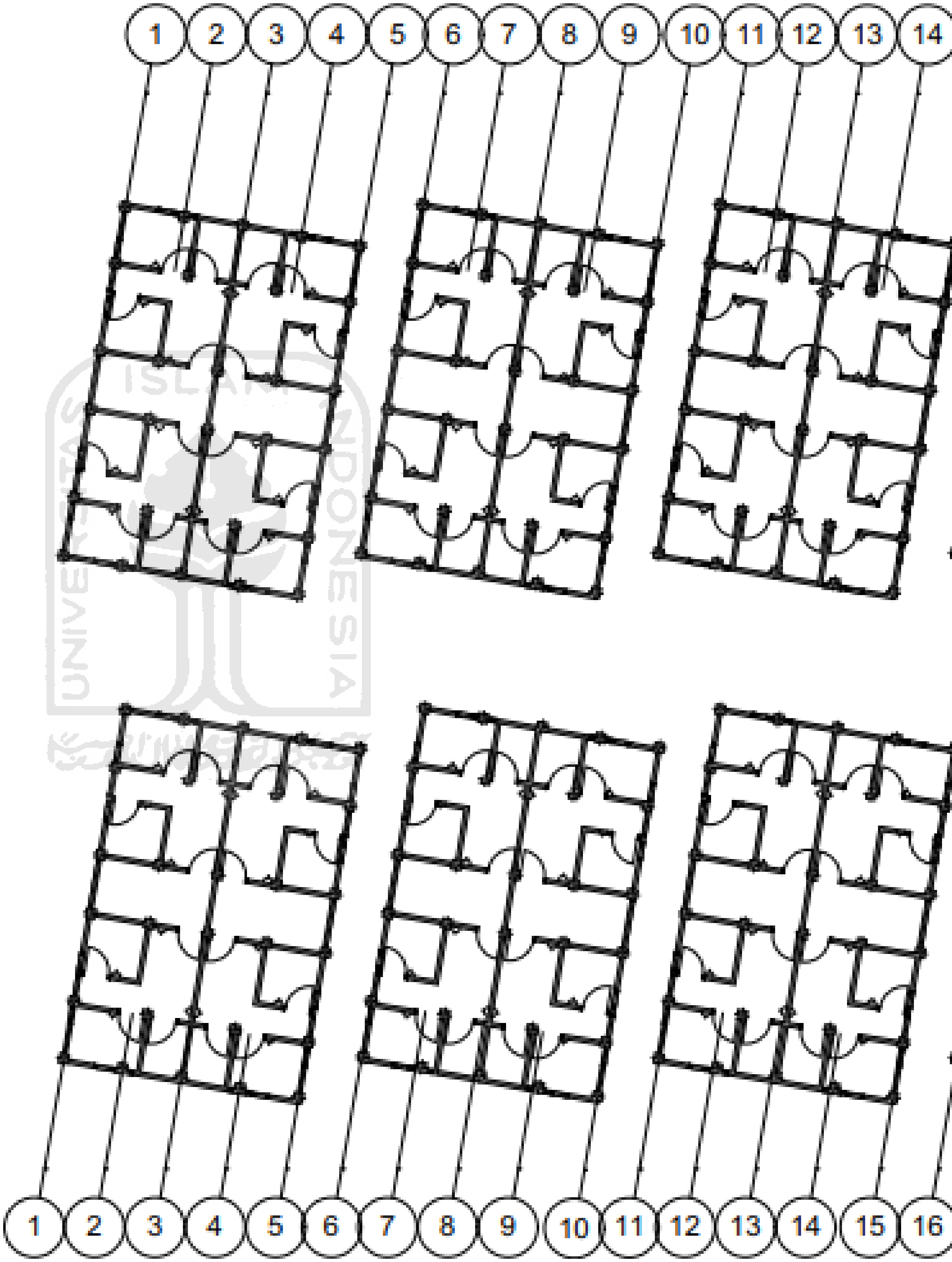
1.11. Electrical Plan



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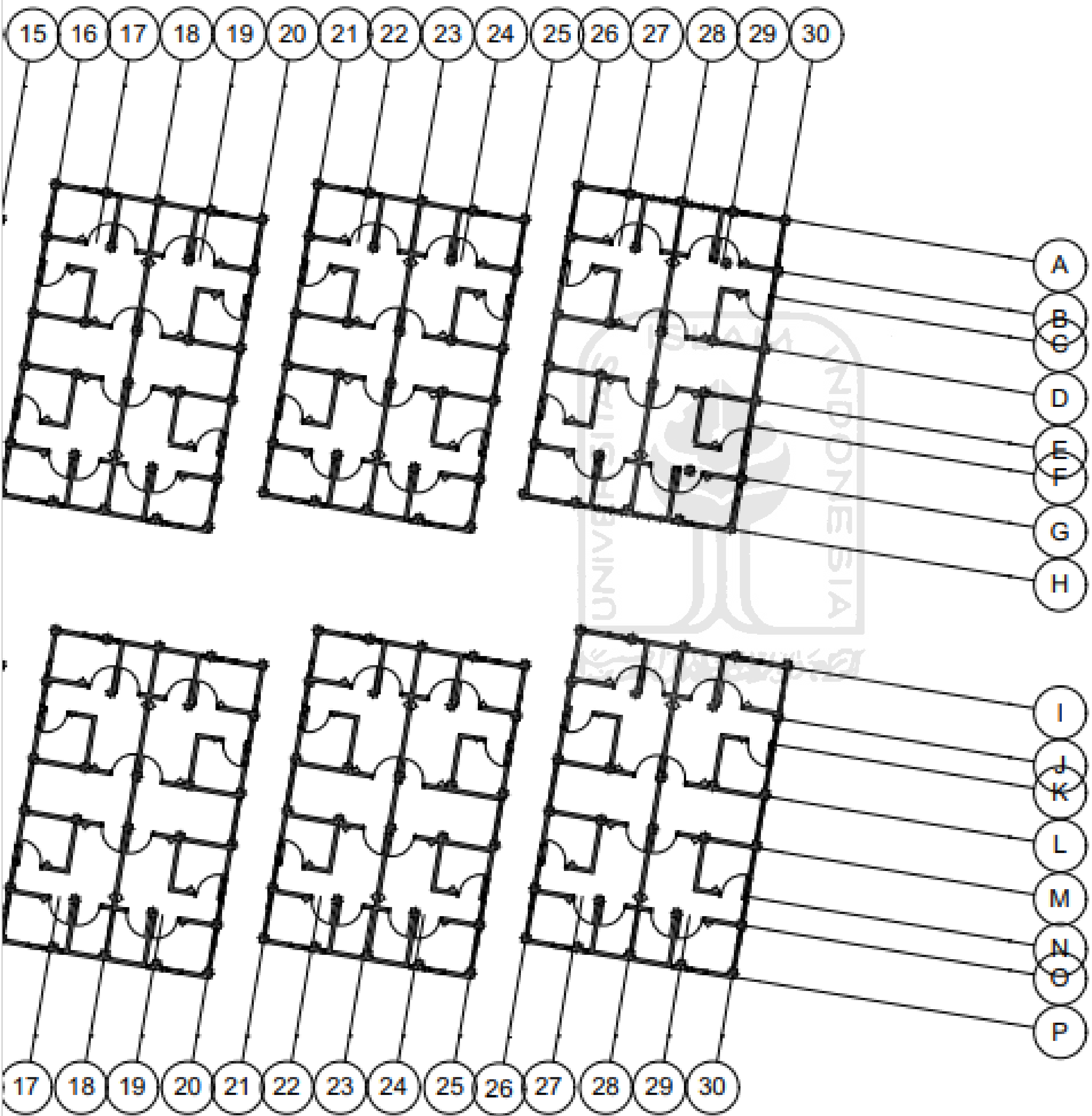
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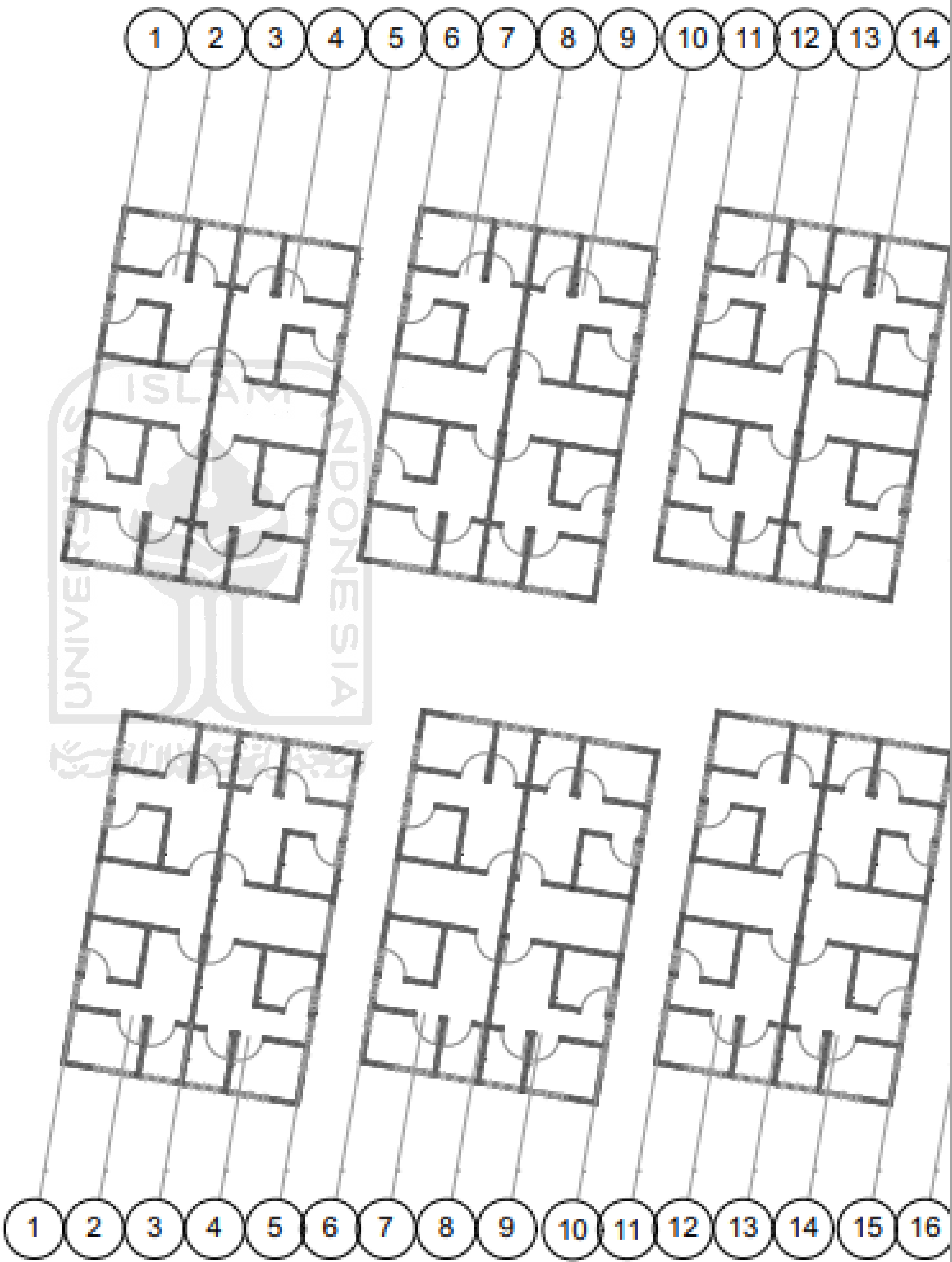
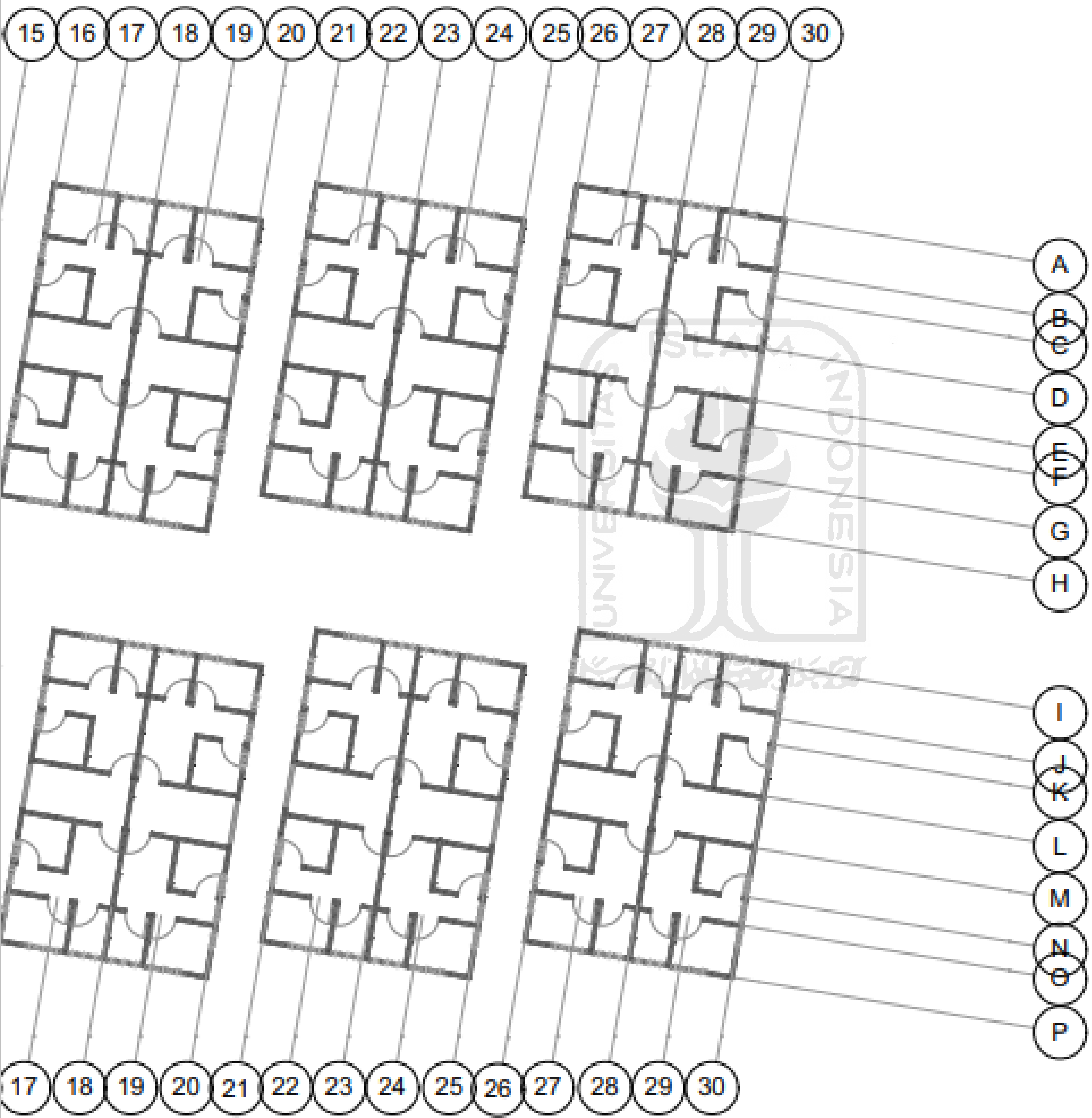
1.12. HVAC Plan





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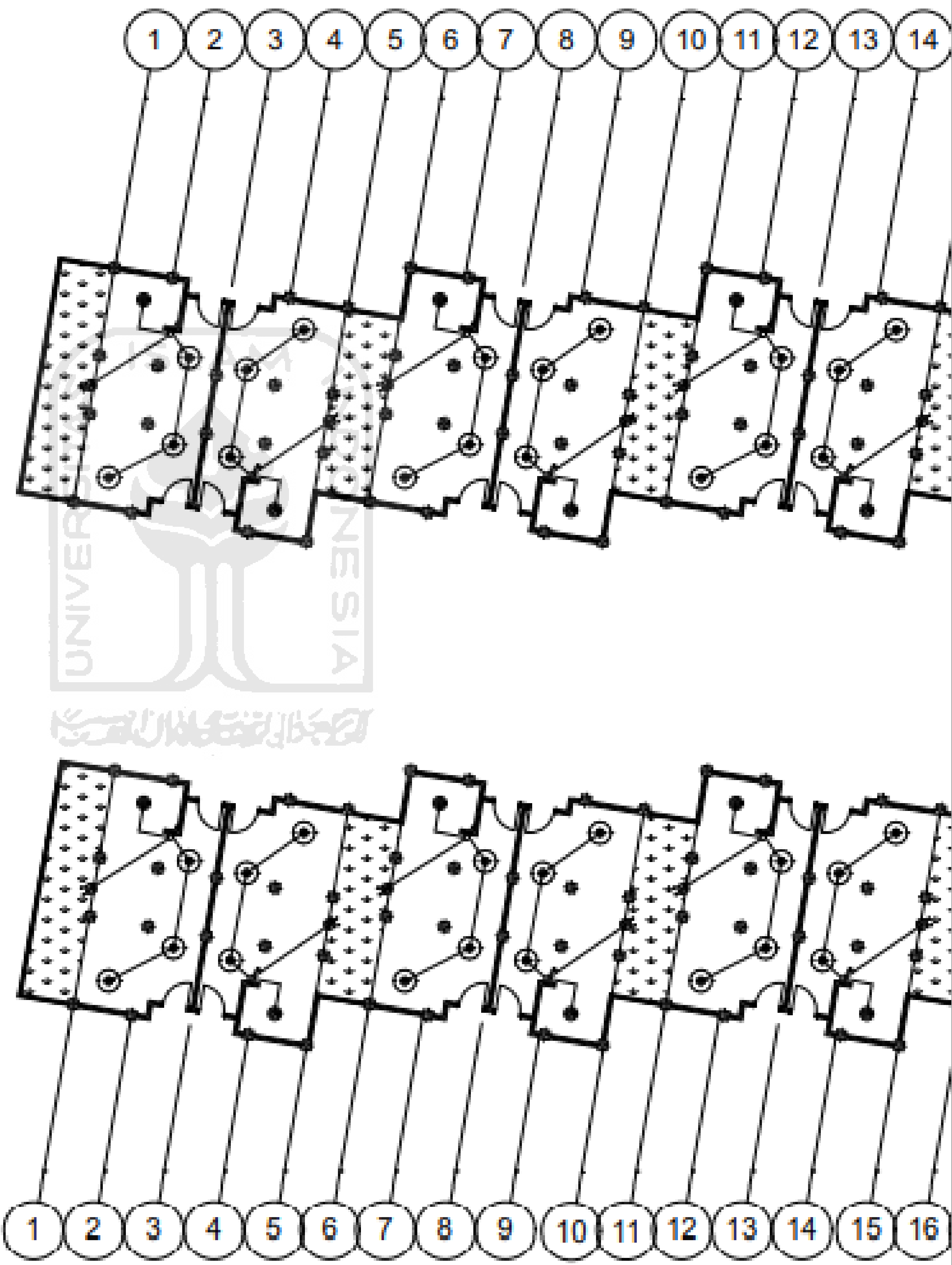
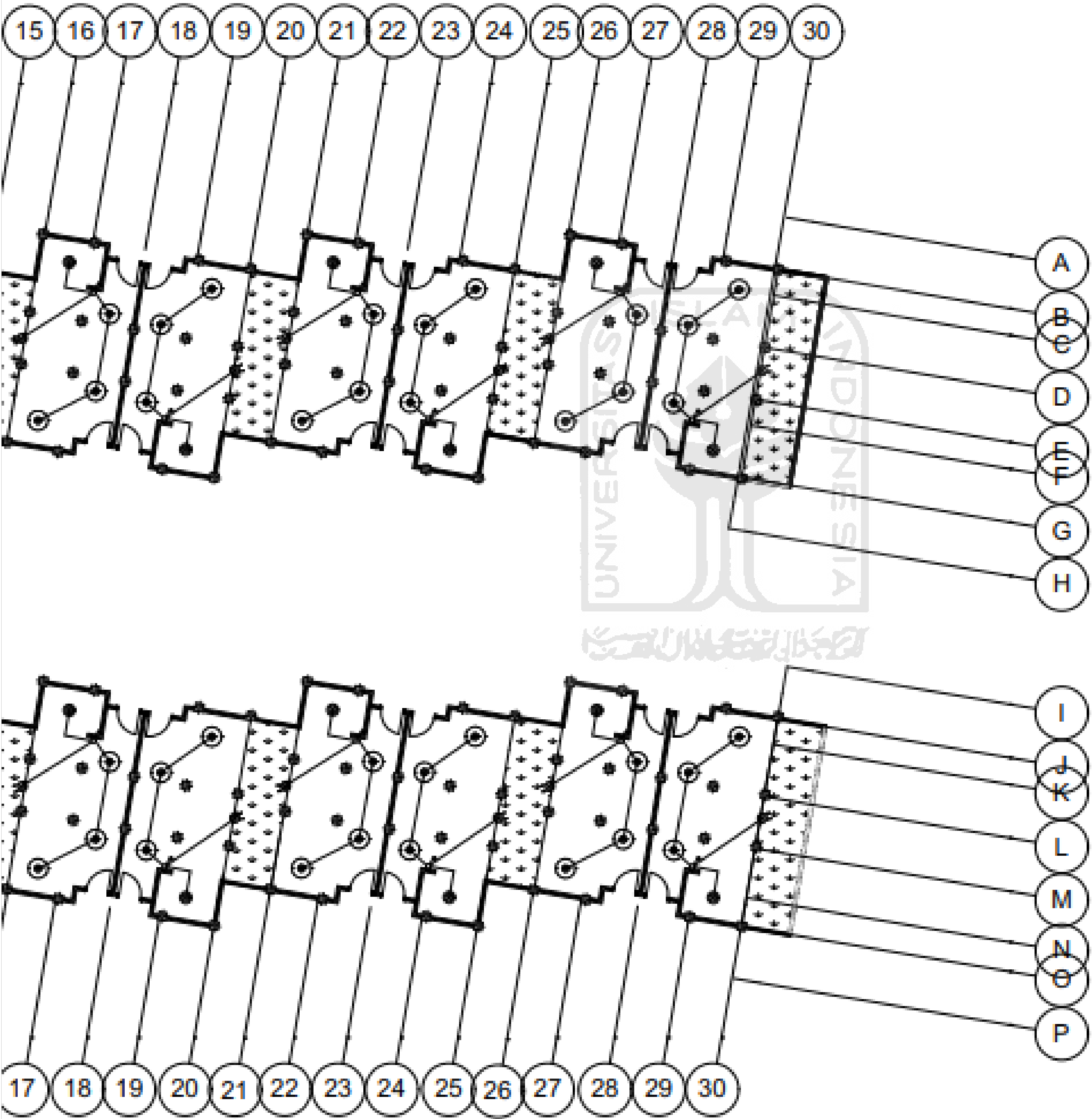
1.13. Lamp Armature Plan

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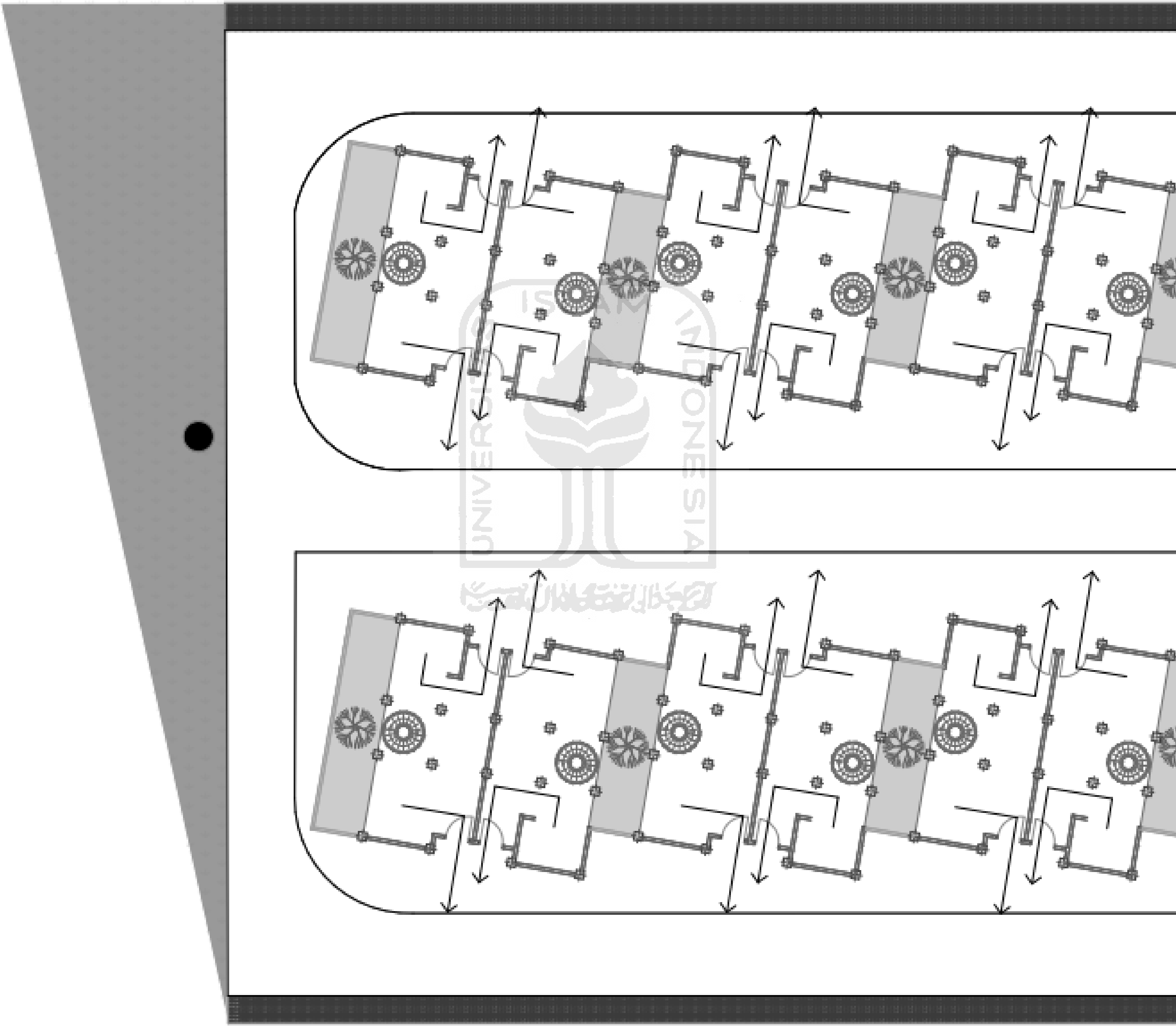
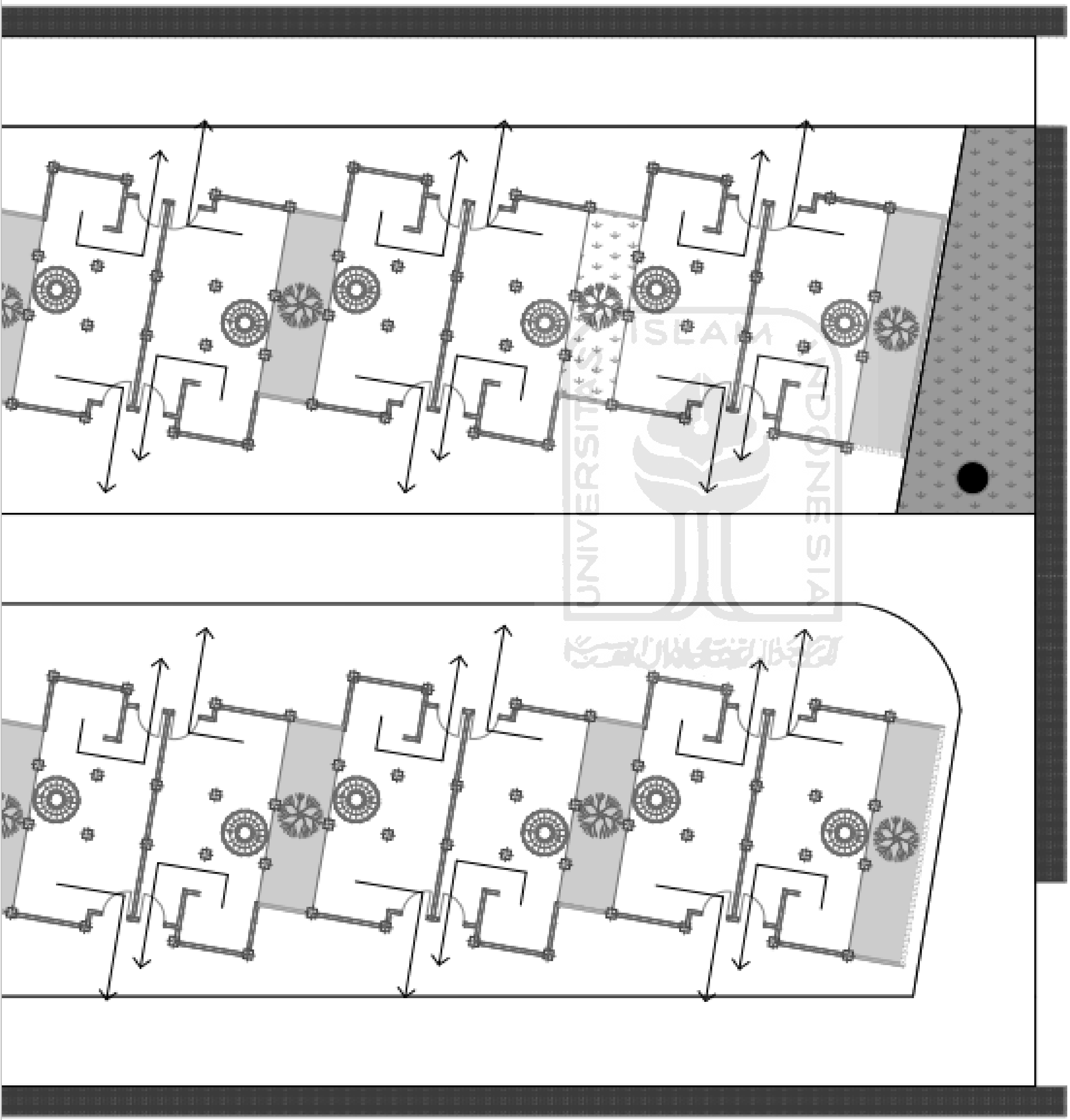
1.14. Safety Route Plan





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1.15. Building Perspectives

2. ARCHITECTURAL PRESENTATION BOARD

DESIGN OF FLATHOUSE
IN TERBAN, YOGYAKARTA WITH BIOCLIMATIC CONCEPT

Yogyakarta is one of the most visited cities in Indonesia. Many visitors came for tourism purpose, livelihood, or even for educational purpose. Badan Pusat Statistik in DI Yogyakarta have recorded that the population density in Yogyakarta City itself has reached 13,413.42 person/km² in 2020 with only 32.5 km² land area. This result as an issue related with spatial availability, especially in several locations at the center of the city like Babarsari. In order to solve the current spatial issues, effective spatial design can maximize the functional spaces and increase the user capacity of housing. The idea is to create vertical village which will focus on enhancing the space vertically. It will be multi-storey building, but not necessarily a one mass building like an apartment, so that the sense of living in a village neighborhood still exists.

Many housing in Yogyakarta have not yet implement the sustainable principles, especially in lighting and thermal elements. For instance, instead of having a design that may control unwanted heat, house owners prefer to use air conditioner. This is important enough knowing how rapid technology development nowadays and how it affected the world in a large scale. Compared to 8-10 years ago, the average temperature is increasing up to 1 degree celcius per year. Of course, external factor such as the carbon footprint from vehicles also affects the climate. However, in terms of architecture, I think it is important enough to consider lighting and thermal element as a part of design to help decrease the side effect of global warming.

Nevertheless, creating effective space only without any consideration in sustainable design will create more issues in the future as we all know how bad the climate is affected nowadays by the gas emission, air conditioner usage, as well as electricity usage. Therefore, the vertical village will be designed through bioclimatic approach which allows us to design based on the response towards the existing climate that wil be focusing on the thermal and lighting aspect of housing design.

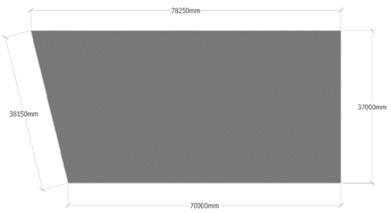
SITE AND CONTEXT

- SITE LOCATION
- COMMERCIALS
- SCHOOL
- RESIDENTIALS

Site Location and Neighborhood

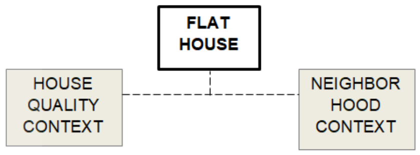
Located in Jl. C. Simanjuntak, Terban, Kec. Gondokusuman, Kota Yogyakarta, Daerah Istimewa Yogyakarta, Terban is one of the most strategic road in Yogyakarta since it is located near many commercial buildings as well as schools, such as SMA N 6 Yogyakarta, SMP N 8 Yogyakarta, SMA N 9 Yogyakarta, SMA Stella Duce, etc. Similar with Kaliurang Street, Palagan Street and Magelang Street, most of the people stay in these areas are newcomers that come for educational and livelihood purpose. Therefore, we can see so many housing complexes and apartments located in those areas.

Site Area



SITE AREA	2835 SQM
BUILDING COVERAGE RATIO	1,509 SQM
FLOOR AREA RATIO	3,456 SQM
BUILDING HEIGHT	4 STOREYS

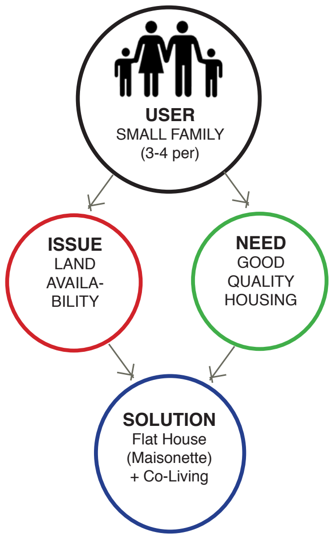
FLATHOUSE CONCEPT REVIEW



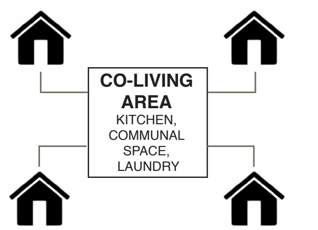
Providing good urban housing quality become the priority of this project. In order to enhance the quality, the housing design will be focused on each unit existence in terms of the daylighting element and the thermal comfort element. The landed house typology actually become the precedent in providing good housing quality. However, there has been issue related with land availability in Yogyakarta especially in high-dense urban area such as Terban. Therefore, the flathouse typology is choosen as an alternative typology to provide good housing quality.

The site located next to Code Riverside Village, which most of the houses there are landed house, as well as Terban Traditional Market that is still actively functions. Thus, creating a typical high-rise commercial residential building in that area will most likely be contradiction to the existing neighborhood. Therefore, the flathouse typology is choosen as a response of the neighborhood context. Though it will limit the building capacity, but there is still possible to at least double the capacity of housing to solve the limited land availability without compromising the neighborhood context.

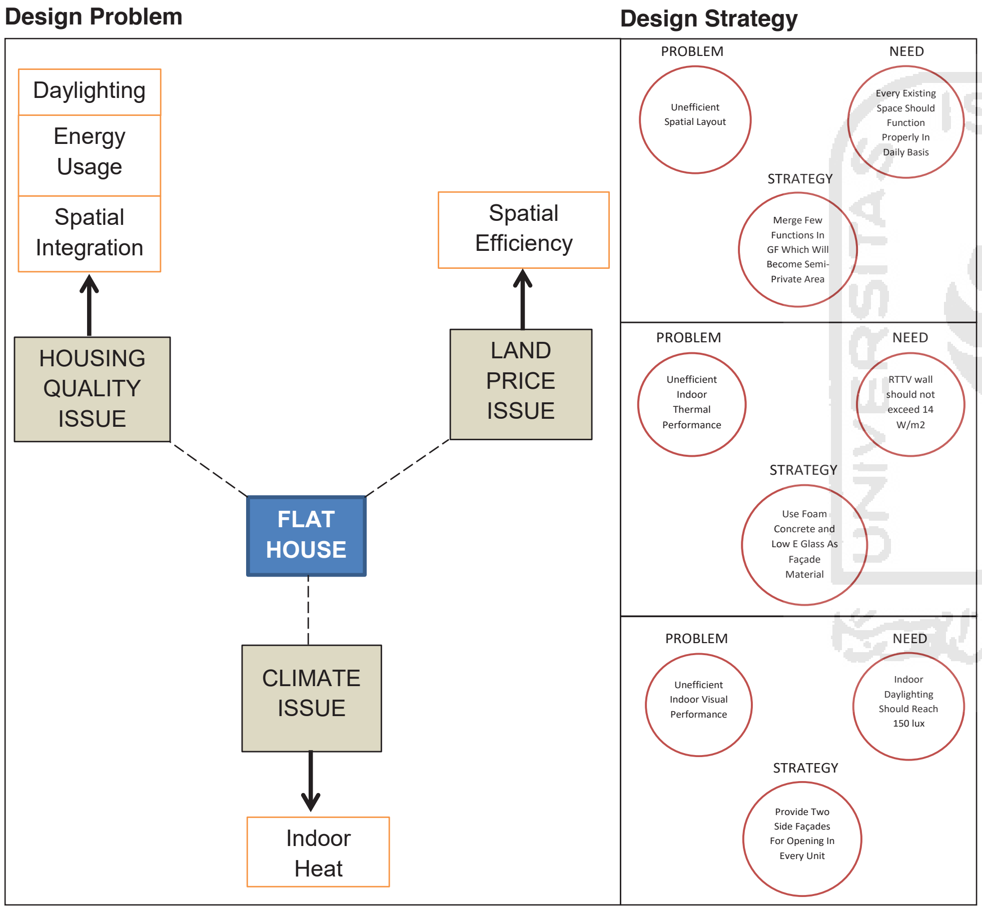
User and Capacity Review



In order to fulfil the user need while solving the current issue, providing flathouse that has collective living concept will be the solution. With other consideration of various context, it is decided that the housing unit will be spread into multiple masses which means that each building mass contains limited housing unit only. The proposed ratio of one collective living space area (co-living area) will be used for four units or four families to ensure the privacy aspect as well as to avoid the room usage traffic being too crowded.



DESIGN MIND MAP



DESIGN THEME STUDY

Bioclimatic Approach as Sustainable Design

Several components of bioclimatic design are including adaptive thermal comfort, climate types and microclimate (sun path, wind, rain), design elements (passive and active system), and assessment tools (Price and Myers, 2005). Bioclimatic design can become a way of achieving sustainable design. For instance during the construction process, several alternatives to maintain sustainability are enhancing passive design system rather than relying on mechanical equipment to save energy, or develop a certain area from a vehicle-based transport system into a multi-mobility transport. In terms of settlement, the final parameter is the life cycle of the building and the infrastructure and also to maintain user comfort and their well-being (Hyde, 2008).

Thermal Comfort in Tropical Building

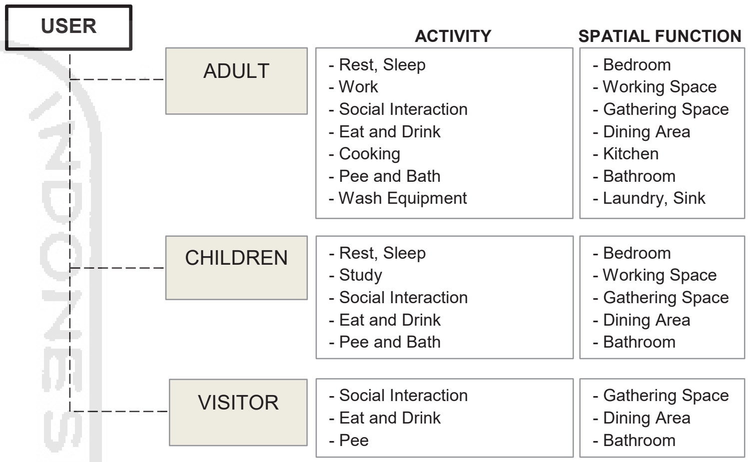
Santoso (2012) argues that thermal comfort in humid tropical climate for indoor areas with natural ventilation are most likely hard to reach the international comfort standard ASHRAE 55-92 because the average air temperature and the current humidity are relatively high, so the neutral temperature in these areas do not fulfill in the required comfort zone, which in between 23 ºC until 26 ºC. From several researches that have been done by Nugroho (2011), Roonak et al. (2009), Henry and Nyuk (2004), Sulaiman et al. (2011), Iftikhar et al. (2001) and Alison (2003) in humid tropical climate area with various type of building shows neutral temperature between 26.1ºC to 29.8 ºC. Based on those researches, the difficulty to reach neutral temperature based on thermal comfort zone affected by several factors including the limited amount of sun radiation (Nugroho, 2011), the air circulation which caused by low air velocity (Roonak et al., 2009), and the humidity caused by the current climate (humid tropical climate). In all climates to obtain thermal comfort using the passive method is to reduce the existing control equipment. In hot climates of massive buildings, good evaporation, and shade cooling can be used to improve comfort (Wang et al., 2015).

Daylighting and Indoor Visual Comfort

Activity	Illumination (lux, lumen/m^2)
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150

BUILDING FUNCTION EXPLORATION

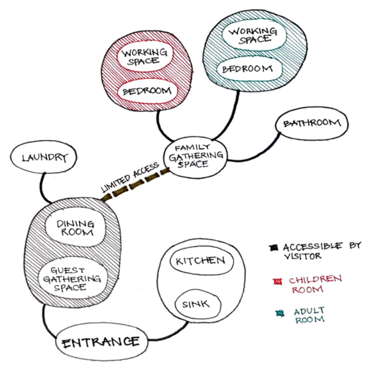
User Activity



Spatial Function Efficiency

Based on research conducted by Putri and Prianto (2016), average conventional housing do not consider the existence of dining room. The users tend to eat somewhere else, such as in living room or any other gathering space that is not specifically dining room. This also goes the same for guest room considering the user did not welcome guest every day, guest room become less functional. Therefore, certain activities in residential area actually can be merged in one functional area in order to increase the spatial layout effectiveness.

	CONVENTIONAL LANDED HOUSE	CONVENTIONAL APARTMENT	TERBAN FLAT HOUSE
GUEST ROOM	•		
LIVING ROOM	•	•	•
BEDROOM	•	•	•
KITCHEN	•	•	
DINING ROOM	•	•	
BATHROOM	•	•	•

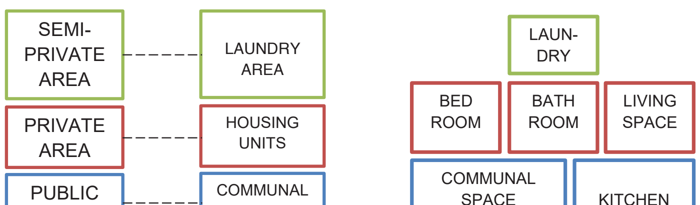


In conventional apartment, small studios often shrink the kitchen into kitchenette which usually has refrigerator, microwave, and sink only. Kitchen itself is indeed one of the most important elements in housing design. However, the essence of kitchen needs nowadays can be replaced by ordering food through delivery service or take away dishes from restaurants nearby. Especially in urban area where restaurants are usually only one block away. Thus, kitchen in average urban area housing is either removed or shrinked.

In Terban Flat House, rather than removing dining room, guest room, and kitchen which may be important for certain occasion, those three elements will be merged as one communal space which can be accessed collectively by several users from different units and it will become semi-private space. While the unit will consist of other functions that are effectively used in daily, such as bedroom, bathroom, and living room for family-scale gathering space.

Spatial Zoning and Plotting

VERTICAL ZONING AND PLOTTING



Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750

BUILDING TYPOLOGY STUDY

Residential Building Typology

Single-family home is an ideal housing type in terms of providing quality. However, with the rapid development in urban area, another issue related with land availability rise up which results in vertical housing as a way to compromise the situation. Suh (2020) stated that apartment, condominium, and townhouse are several example of multi-family home. Apartment and condominium has similar construction type which is a high-rise building consists of several units in every floor. The major difference between apartment and condominium is the ownership. Apartment units usually rented, while condominium units are owned by its users. The other type of multi-family home is townhouse. It appearance looks like single-family home but it is built very close together and often connected to each other making it look like one building mass. In Indonesia, the term townhouse often compared with cluster housing and defined as single-landed house located in urban area with exclusive facilities owned by a person. Nonetheless, townhouse in other region such as Europe and America can have individual ownership such as conventional landed housing or operate the ownership like condominium.

In Indonesia, conventional vertical housing usually focused on providing sufficient space for as many potential users as possible which is why apartment or flathouse typology are often used. However, the existence of high-rise residential buildings may cause another issues related with the housing quality itself. Therefore, there is another flat house typology that is not necessarily high-rise building, it is called maisonette or duplex. Maisonette has various meaning depends on its location. In United Kingdom and America, maisonette is a self-contained flat within a larger building, with its own staircase and entrance or a split level flat. In Scotland, maisonette is one of a group of duplex flats, positioned on top of each other as part of a housing block, accessed via a communal entrance. (Miles, 2020)

Occupant Affordability

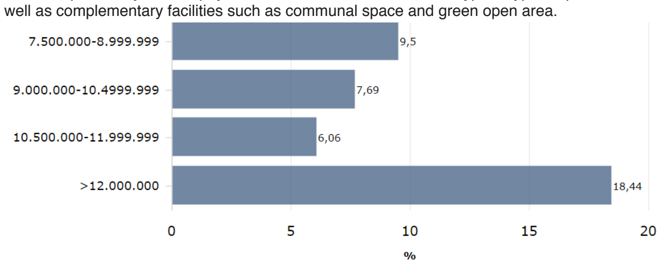
Apartment Type: 2BR / Full Furnished

NO	APARTMENT NAME	UNIT AREA (m^2)	RENT PRICE/MONTH
1	Malioboro City	40	5,500,000
2	Taman Melati	36	8,500,000
3	Uttara The Icon	42	4,500,000
		AVERAGE RENT PRICE	6,100,000

Apartment Type: Studio / Full Furnished

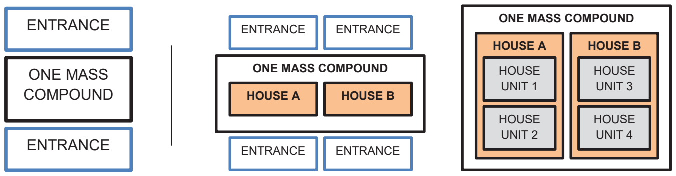
NO	APARTMENT NAME	UNIT AREA (m^2)	RENT PRICE/MONTH
1	Student Castle	21	3,300,000
2	Malioboro City	23	2,500,000
3	Taman Melati	22	3,400,000
		AVERAGE RENT PRICE	3,000,000

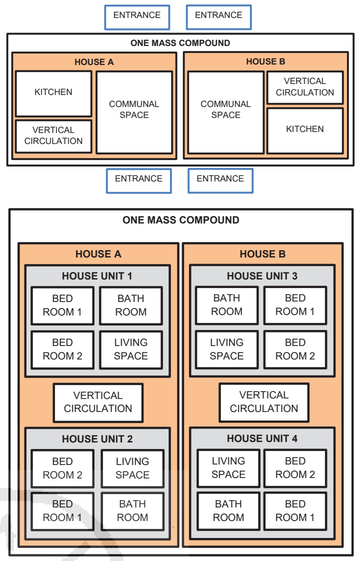
Based on the list above, the cost estimation for this flathouse project if it is based on the similar room type, two bedrooms and one bathroom, will be six million in average. However, in this project, the cost can be cut half of the ordinary price due to the spatial efficient design of this flathouse. Occupants only have to pay at the same amount as the studio type of typical apartment but will be getting two bedrooms and a bathroom as well as complementary facilities such as communal space and green open area.



Survey of Living Cost Survey in Yogyakarta conducted by Central Statistic Organization stated that the group that are able to spend 30% of their income to rent a house are the one that has nine million above per month. Thus, there will be 32.19% of citizen in Yogyakarta that will be able to rent this type of house.

HORIZONTAL ZONING AND PLOTTING





Based on the user analysis and spatial efficiency analysis, it is concluded that every mass will be divided vertically based on the privacy priority. The public area will be located on the ground floor which is accessible for visitor. Then, the upper floor will be used for the housing units which can only be accessed by the house owner. On the rooftop, there will be semi-private area which can be accessed by the occupants collectively.

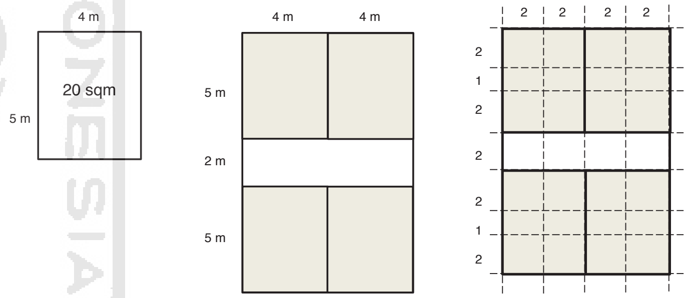
Since a building mass will be used collectively by several occupants, the access will be split into two entrance because every building mass will have two street circulation. Occupants can enter and exit through the closest access considering there might be occupants who bring vehicles and park near the house.

In every building mass (mass compound), the housing unit will again be split into two area considering each mass will be separated by inner courtyard. The limited access will increase the security of each housing unit without affecting the inner courtyard existence.

The horizontal plotting of each floor are made based on spatial efficiency study and user analysis. Altough the entrance split into two accesses, there only one vertical access to the housing unit to enhance spatial effiency. So the vertical access will be located in between housing unit. In terms of housing unit, the living space located near the unit entrance and is located on the area farthest from the facade due to daylighting priority analysis which has been conducted as well.

Modular Design

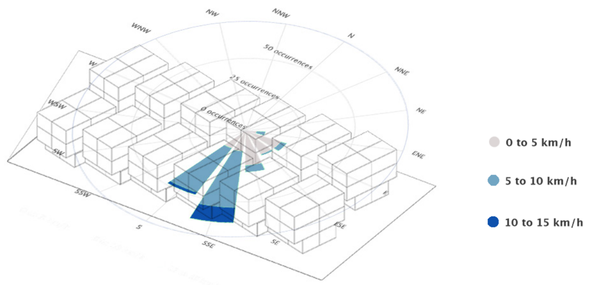
The building mass module wil be designed based on the housing unit module which located on the first and second floor. Based on the occupant affordability study, the unit module that will be used will have area of approximately 20 sqm or similar as typical studio apartment in Yogyakarta but it will consists of two bedrooms, a bathroom and a living space or family gathering space in each housing unit.



Each typical floor will consists of four housing units of 4 x 5 m which means that the area of each floor will be approximately 80 sqm with the additional area for vertical circulation 2 x 4 m. The total area of each floor should be 96 sqm which will be applied in typical rectangular form to ease the structural grid system as well as enhance the spatial efficiency of each buiding mass.

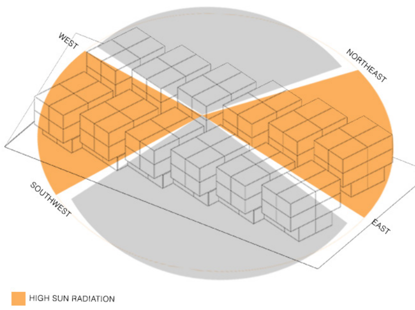
SITE CONTEXT EXPLORATION

WIND FLOW



Based on the analysis, the wind flow mostly from the south and east and both directions provide wind flow throughout the year. Thus, each unit should have facade that allows wind from either east or south to flow through. Since each unit will have two facades, front and side facade, the facade option should be either north-south or west-east. However if the building mass orientation is tilted, although there are still only two facades exist, but it will allow the air flow from at least three-directions.

SUN RADIATION



Baharuddin (2013) stated that sun radiation towards vertical surface varied throughout the year and is affected by the time and orientation. The biggest radiation comes from the surface that has east, northeast, west, and southwest orientation. While the least radiated comes from the south orientation. Based on that, it is better to avoid exposing building orientation towards east, northeast, west and southwest direction. However, due to spatial layout limitation, it is impossible to create all unit without those directions. Therefore, the building mass will be tilted in a way so that the building that has northeast and southwest orientation is the side that has less facade area.

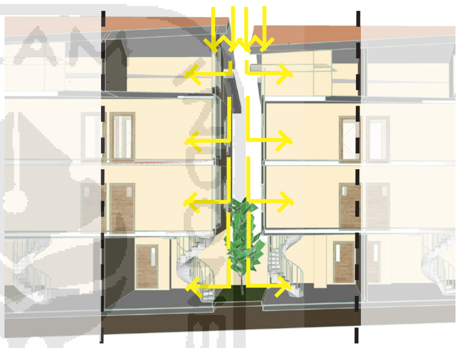
DESIGN THEME EXPLORATION

Thermal Performance

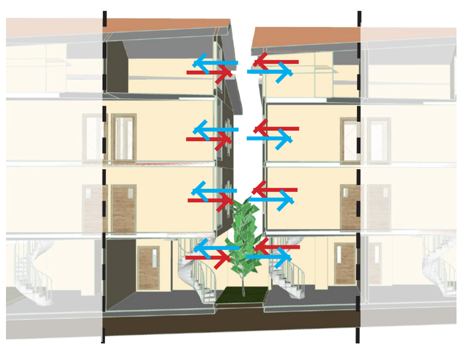
In terms of providing thermal quality, exposing the interior without proper heat filter could lead to temperature increase which may cause overheat and user uncomfort. According to research conducted by Brunner et al. (2015), foam concrete is one of building material that can become wall construction alternative due to its capability of insulate heat. As for initial concept, the glass facade wil be using coated glass such as Low Emissivity Glass and the wall will be using AAC Block instead of ordinary red brick. For facade near the stairs, it will be covered by alumunium panel in order to let the air circulate freely to the indoor area and even through the housing unit area.

Bioclimatic House Concept

The project idea is to design a house that is able to respond the current weather and climate condition. By creating the ability of a house to respond the climate condition with passive system, the architectural issues such as energy usage and pollution production will automatically decrease due to the housing ability to adapt while provide comfort for the user.



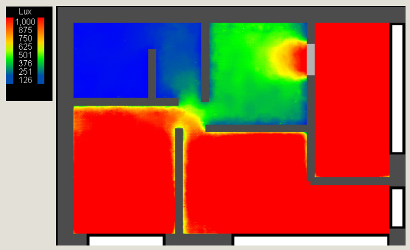
By creating the gap between each of housing mass, creating more opening to enhance daylighting within the interior area will be possible. The light that enter the building will possibly decrease the energy usage of artificial lighting within the interior area which will affect the housing energy usage especially during the daytime. Nonetheless, the communal space located on the ground floor has one side completely open. This will allow the ground floor area to have view to the inner courtyard as well as enhancement of the passive daylighting system within the area. The ground floor also has benefit of having more shaded area due to the building mass located next to it. The shade will decrease the incoming lighting and become filter which make it possible to create such open space for the ground floor area.



The opening located on the gap between each building mass will allow air flow to penetrate the housing interior area. Allowing air to circulate throughout the housing interior area will increase the interior thermal comfort. However, creating bigger opening may become unwise decision for the user thermal comfort considering the current tropical climate condition in Terban area. Therefore, it is necessary to create opening that allow air to circulate without the possibility to increase the house interior temperature by choosing building material that has better ability in absorbing and filtering the heat.

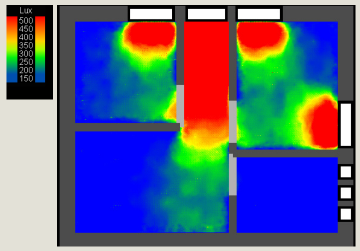
DESIGN SIMULATION

Daylighting Simulation



Initial Unit Layout
Daylighting Simulation

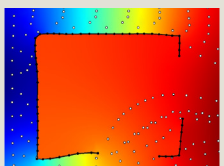
Most area of the floor plan are coloured red which means that the illuminance level in those areas reach approximately 1000 lux which considered too bright for residential purpose. Furthermore, these type of layout and opening will allow more heat to penetrate throughout the interior area which theoretically will cause another thermal issue.



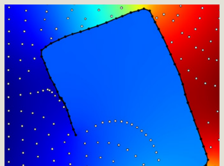
Final Unit Layout
Daylighting Simulation

Most area of the floor plan are coloured blue which means that the illuminance level are up to 150 lux which considered good for overall residential purpose. The area that has red colour located in the bedroom which will be used as working space. Therefore, the 500 lux requirement of the working area can be achieved through this type of layout and opening.

Wind Flow Simulation



Based on the climate analysis, majority of the wind flow from the south, east, and west. This unit only has east and north facade and the simulation shows the air flow from the south. This type of orientation will eventually bring disadvantages for the building performance since



On the other hand, if the mass is tilted, there will be air flow from the south that can enter the unit indoor area and circulate well as shown on the graphic. This orientation allow more air circulation performance to be enhanced rather than having the orientation not being tilted.

Autoclaved Aerated Concrete Block
(AAC Block)

One of the option to improve indoor thermal comfort is by having proper envelope design since building envelope will transfer the heat. Thus, to filter the unwanted heat, AAC Block is choosen due to its capability of filtering heat radiation.

Low Emissivity Glass
(Low E Glass)

Related with building visual performance or daylighting performance, it is necessary to have proper opening that allows light to penetrate throughout the interior. However, opening design increase the amount of heat transfer as well. Therefore, Low E Glass is choosen due to its capability of insulating heat.

there are no opening facing to the wind direction throughout the year.

Visual Performance

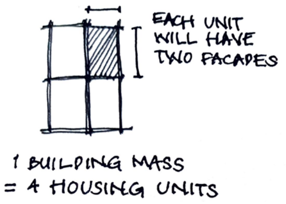
In order to provide sufficient daylighting that could save electricity usage, every housing unit will have two side facades. The opening will not only allow light to penetrate through the unit interior but also allow air to circulate well, Based on the literature study, overall residential daylighting light level should reach 150 lux. However, that level is not enough if the users are working in the unit. For instance, there might be users who need to study during the day. For these purpose, the light level neccessity increase up to 500 lux.

HOUSING UNIT ROOM

Room	User / Possible Activities	Room Needs
BEDROOM 1	User: Parents (Adults) Possible Activities: - Rest, Sleep - Work (Through book or gadgets) - Read, Write, Watch Knowledges/Entertainment	Room Needs: The priority need of lighting is when the room is used for working which light level is 500 lux.
BEDROOM 2	User: Children, Teenagers Possible Activities: - Rest, Sleep - Study (Through book or gadgets) - Play Games - Hobby Development (Sewing, Drawing, Play Music Instrument, etc.)	Room Needs: The priority need of lighting is when the room is used for studying which light level is also 500 lux.
LIVING SPACE	User: Adults, Children Possible Activities: - Family Interaction (Conversation) - Play Games - Eat and Drink	Room Needs: Since no certain work that needs high light level, light level requires here is 150 lux.
BATHROOM	User: Adults, Children Possible Activities: - Shower - Pee - Wash	Room Needs: Since no certain work that needs high light level, light level requires here is 150 lux.

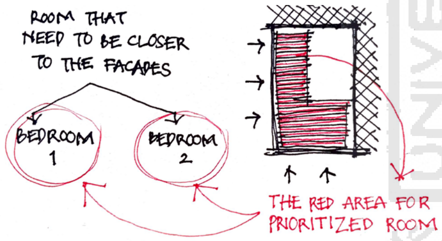
FACADE CONCEPT

Two fulfill the housing quality requirement, each unit will consists of two facades. Therefore, there will be two side of the building taht will get direct daylighting



SPATIAL LAYOUT PRIORITY

Based on the user activity analysis, there are two rooms that need to be prioritized in order for these function to be able to perform well. These prioritized room will be located near the daylighting source.



Envelope Material Calculation

Based on SNI 6389:2011 related with Envelope Energy Conservation in Building, the allowable OTTV value in Indonesia is 35 W/sqm. However, the implementation of OTTV in Indonesia are usually for the large-scale building such as high-rise building which make the current OTTV less applicable for residential buildings. Therefore, in residential scale, Hongkong Government issued a practice note namely Design and Construction Requirements for Energy Efficiency of Residential Buildings. To enhance energy efficiency of residential buildings, the RTTV of wall should not exceed 14 W/sqm. This standard is the one that is used for the OTTV parameter in this project.

RED BRICK CALCULATION

No	Side	Conduction Through Wall	Conduction Through Opening	Radiation Through Opening	Total	Façade Area Total	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D = A + B + C	E	D / E
1	NORTH	373.47	-	-	373.47	15.00	24.90
2	NORTHEAST	-	-	-	-	-	-
3	EAST	448.16	-	-	448.16	18.00	24.90
4	SOUTHEAST	-	-	-	-	-	-
5	SOUTH	373.47	-	-	373.47	15.00	24.90
6	SOUTHWEST	-	-	-	-	-	-
7	WEST	373.47	-	-	373.47	15.00	24.90
8	NORTHWEST	-	-	-	-	-	-
		1,568.56	-	-	1,568.56	63.00	24.90
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL

Do not fullfil the requirement.

FOAM CONCRETE CALCULATION

No	Side	Conduction Through Wall	Conduction Through Opening	Radiation Through Opening	Total	Façade Area Total	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D = A + B + C	E	D / E
1	NORTH	121.69	-	-	121.69	15.00	8.11
2	NORTHEAST	-	-	-	-	-	-
3	EAST	146.03	-	-	146.03	18.00	8.11
4	SOUTHEAST	-	-	-	-	-	-
5	SOUTH	121.69	-	-	121.69	15.00	8.11
6	SOUTHWEST	-	-	-	-	-	-
7	WEST	121.69	-	-	121.69	15.00	8.11
8	NORTHWEST	-	-	-	-	-	-
		511.09	-	-	511.09	63.00	8.11
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL

Has already fullfil the requirement.

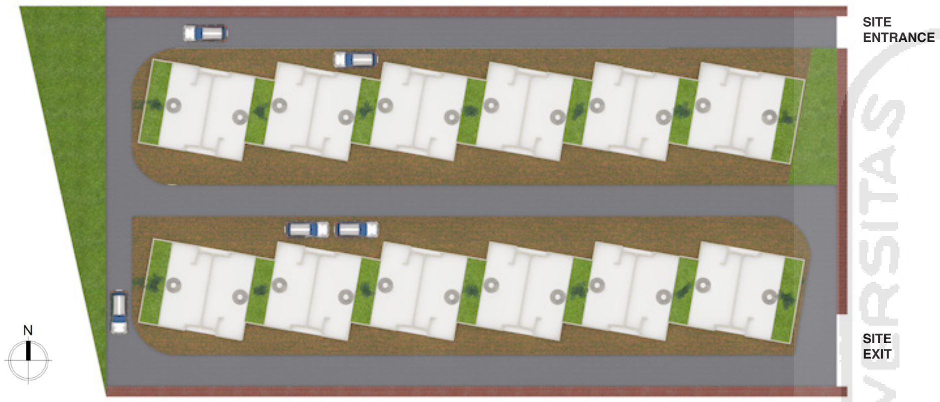
Energy Usage Calculation

The daylighting and thermal enhancement within the housing unit allows the energy usage inside a household to be reduced, especially inside the housing unit itself. The two of the main energy source that we focused on is the artificial lighting fixture and the active cooling fixture which is the lamps and the air conditioner. Therefore, it is measured through calculation below of how the design will be able to minimize the usage of those fixtures mentioned before.

AMOUNT	POWER NEEDS	USAGE PER DAY (HOUR)	TOTAL POWER (WATT)	TOTAL POWER PER DAY
		Normal Usage		
4	LED Lamps	16	8.5	544
2	Air Conditioner	16	750	24,000
			TOTAL	24,544
		Efficient Usage		
4	LED Lamps	5	8.5	170
0	Air Conditioner	-	-	-
			TOTAL	170

SITE DEVELOPMENT

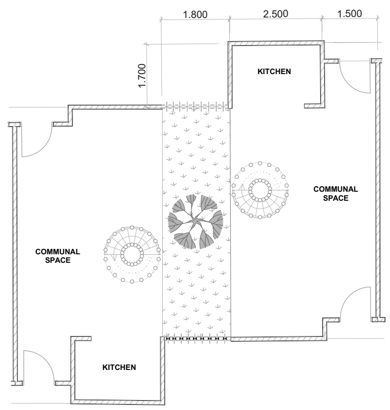
Site Plan



GREEN AREA
PEDESTRIAN PATHWAY
PAVEMENT ROAD
GRASS BLOCK AREA

The maisonettes and the main access will be located side by side throughout the site. So, a maisonette mass will have two accesses, which is the front side and the back side of each maisonette, depending on how close the unit located from the access. Then, in order to solve housing quality issue, each maisonette mass will be separated by inner garden which will provide air circulation and daylighting for each unit. Since the site access will be divided into three ways, the site circulation illustrated as shown below. The user who own vehicles and wants to park their vehicles can park right beside their housing unit. The westside of the side is planned to be used for public green open area for supporting facilities as well as to place the communal septic tank.

Inner Courtyard



The inner courtyard initially will be function as a gap between each mass to provide enough daylighting and air circulation throughout each of the housing unit. The inner courtyard provide 1,8 meters distance between each mass which can be accessed from the closest communal space on the ground floor.

The design of inner courtyard will allow two housing unit to have direct connection which hopefully will allow interaction between the users or even the guests, but at the same time it will give space for privacy between each communal space area.

Vegetation Specification

Madagascar Almond (*Terminalia Mantaly*)

Madagascar Almond or well-known as Pohon Ketapang Kencana in Indonesian is a plant that commonly use as shade tree that has unique shape as seen at Figure XX. This tree has many functions including pollution as-

Japanese Lawn Grass (*Zoysia Japonica*)

Japanese Lawn Grass is an easy-maintenance grass that is suitable for housing vegetation. This type of grass leaves are not too sharp, making it comfortable to sit and step on. With only watering this grass regularly will

Site Elevation

Front Elevation (East)

Side Elevation (South)

From the east elevation, it can be seen that the building mass divided into two rows and each masses are 10 degree tilted to northeast. The open area next to the building mass can be used as parking area if necessary. While from the south elevation, it can be seen that each masses has inner courtyard as the gap which will be function as air flow circulation as well as daylighting enhancement. It can also be seen that each mass has two separated entrance to the housing unit inside.

Site Section

Front Section (East)

Side Section (South)

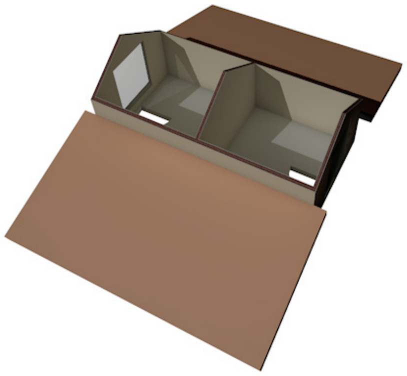
The front section shows the vertical integration in each mass from the ground floor to the rooftop floor. It can

including pollution absorption, increase productivity focus, as well as provide shading area from the sun.

this grass regularly will keep this grass alive and not easily withered.

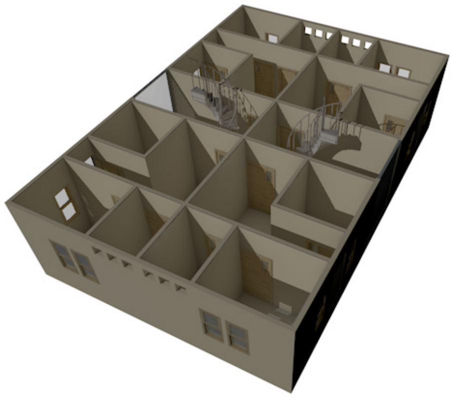
The front section shows the vertical integration in each mass from the ground floor to the rooftop floor. It can be seen that the staircase located in the middle area of the building mass as vertical circulation within the building. From the side section, it can also be seen that there is separation in the middle area of each mass which eventually limit the access in each housing unit while each mass still be able to access inner courtyard directly from the communal space.

HOUSING MASS LAYOUT



Rooftop

The rooftop area will be used mainly for laundry activity. Just like the communal space area, the rooftop will be available for the user and can be used collectively as semi-public area.



Typical Floor (1st and 2nd Floor)

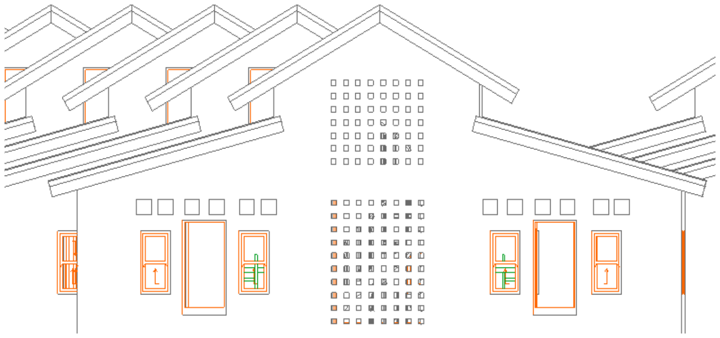
The housing units can be accessed by stairs located near the entrance. The stairs will be located in between two units of each floor. This layout applied in order to ensure that each housing unit will get at least two side facades so that the thermal and the visual quality of every housing unit can be enhanced as well as limit the access for each housing unit as offered by maisonette flat house typology. Each floor will consists of four housing unit which will be separated by two staircase access depends on the entrance unit.

Ground Floor

The ground floor can be accessed from two entrances which will lead to the staircase area to access housing units above. Each of communal space will be separated by an inner courtyard at one side and a wall at the other side. Although the ground floor is semi-open area, the access are limited only to the users that has access to the housing units above in order to ensure the housing privacy and building safety.

BUILDING ENVELOPE DESIGN

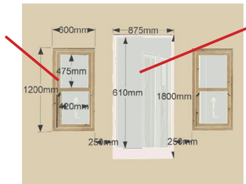
Housing Unit Opening



Based on the design simulation, the daylighting system within each housing unit performed well, or actually too many light penetrate through the interior. Therefore, in order to adjust with the possible thermal increase, the opening inside the housing unit will be made smaller, while the opening for the staircase area will maximized as it seen above.

Casement Window

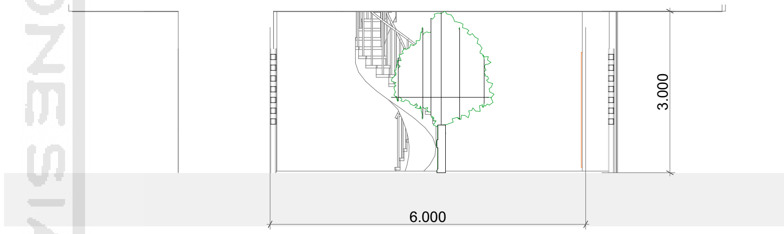
This type of window will be used in the bedroom area and is able to be open to let the air circulate through the indoor area.



Storefront Window

This window is used in alleys, such as staircase area and alley between room inside a housing unit.

Communal Space Opening Area

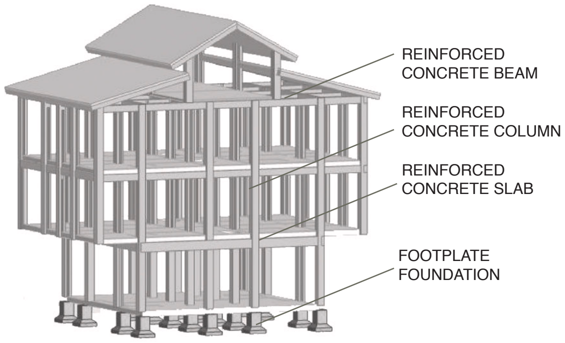


The communal space at the ground floor will have its one side open as seen above. The open side will allow air to circulate also to give direct view to the inner courtyard. Since its located on the lowest storey and is covered by the shade of the neighborhood building mass during the day, this semi-open area will become comfortable gathering space even during the day.

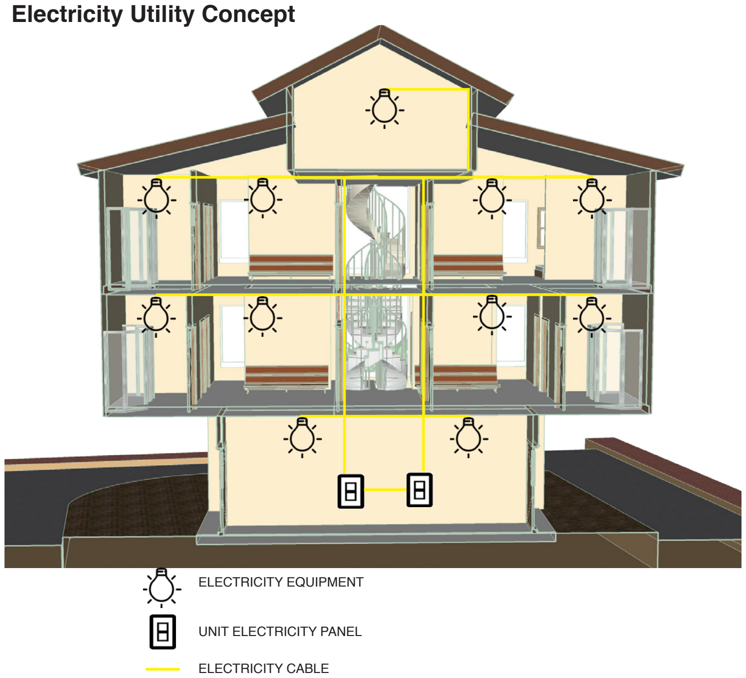
STRUCTURE AND INFRASTRUCTURE

Building Mass Structural System

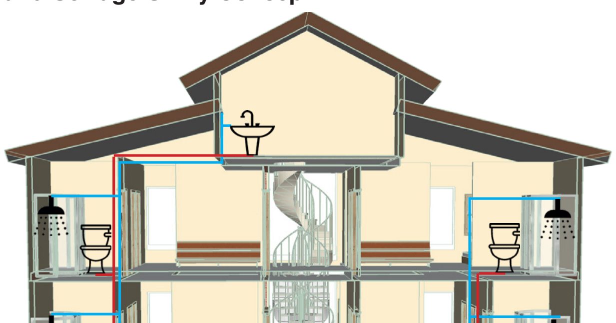
Each building mass consists of 4 storeys located above the ground and have no basement floor. The structural system will be using reinforced concrete as the main material of the columns, beams, slab, as well as the foundation structure. Hereby the column and beam initial calculation based on the structural chart:



Electricity Utility Concept

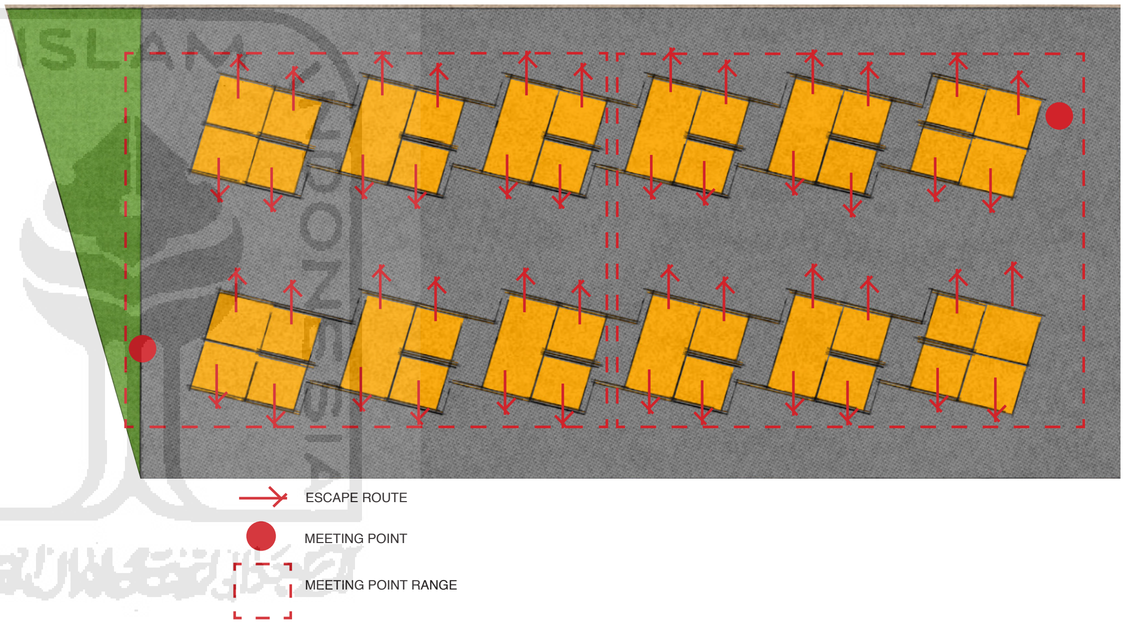


Water and Sewage Utility Concept



BUILDING SAFETY

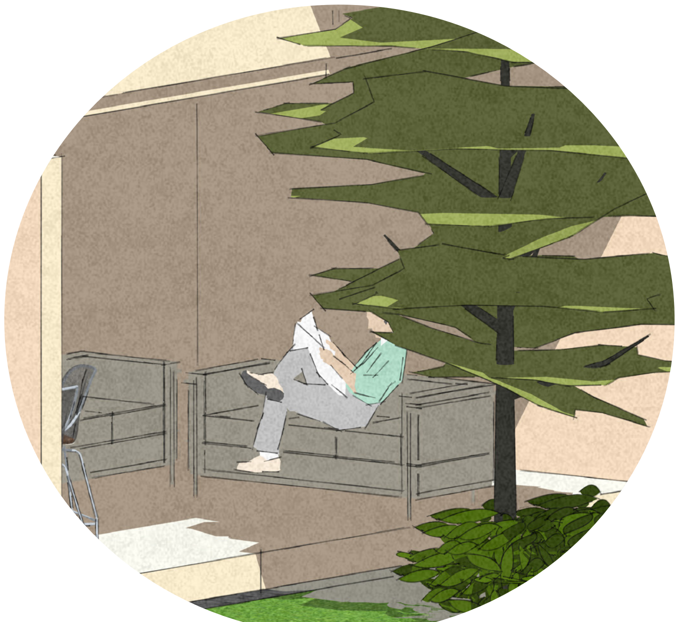
In every communal space there will be fire estinguisher since the potential fire source which is the kitchen located on the ground floor. To escape from th building, the user may use the stairs to escape from housing unit then walk out through entrance of each mass. There will be meeting points located as seen below.



BARRIER-FREE DESIGN

Ground Floor Area for Communal Space

The communal space located at the ground floor to ease the access for visitors or user's guest. That includes being accessible for the disabled. The gap between indoor and outdoor floor level are less than twenty centimeters which means that the ramp will take less space. The ramp will be located at indoor area with consideration to maximize the outdoor function as vehicles parking area.



Entrance Door Ramp

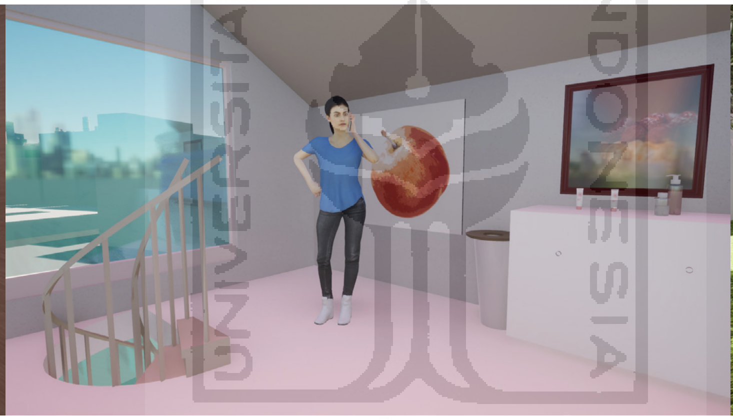
Ramp Slope Distance Required (d)
To overcome a height of 15 centimeters, we will use a slope of 20%, which results in a 15 meter horizontal length.

20 = (0.15m / d) x 100
d = 0.15m / 0.2

d = 75 centimeters





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